Reflectie onderzoek Geluidswal A12

Onderzoek naar reflectiehinder op weggebruikers van de A12, N198 en N419 afkomstig van zonnepanelen op de geluidswal nabij Woerden en Utrecht – Veldhuizen.

14 juli 2026

ROM 3D
verhelderen · wegwijzen · vormgeven

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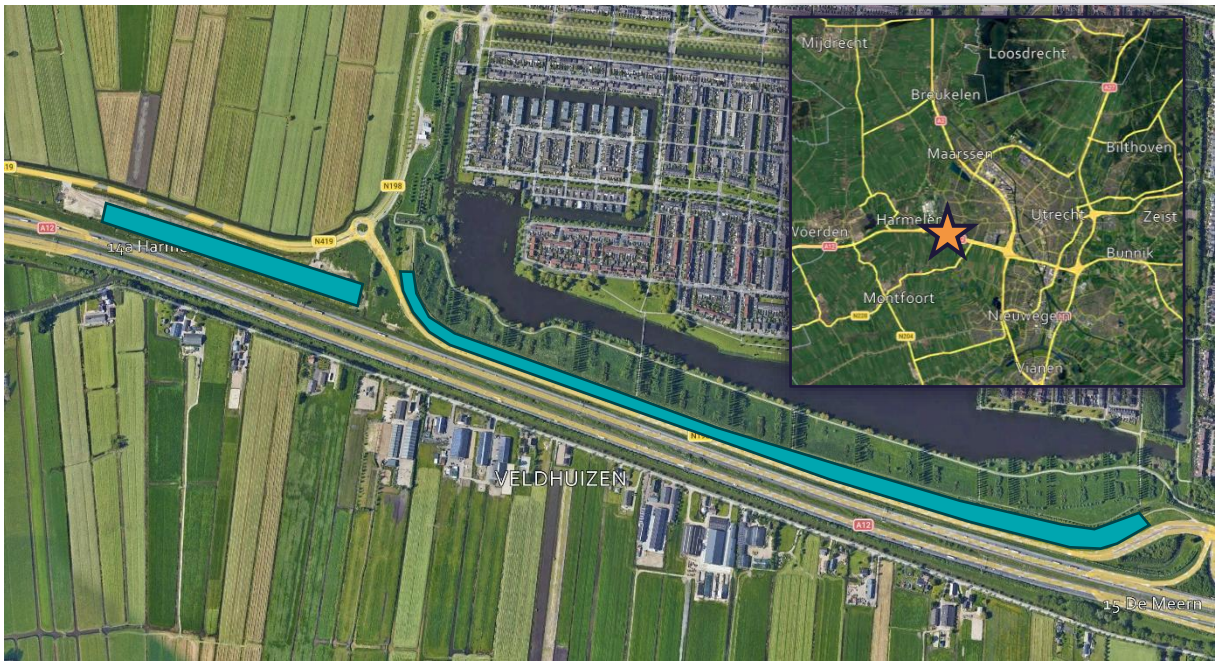
1 Introductie

Sweco heeft plannen voor zonnepanelen op een geluidswal aangeleverd aan ROM3D. De geluidswal ligt langs de A12, in twee delen nabij Woerden en Utrecht – Veldhuizen. Eventuele reflectiehinder veroorzaakt door dit park kan inzichtelijk worden gemaakt met een reflectiestudie. Er is gevraagd om een dergelijke studie uit te voeren om de schittering te bepalen voor weggebruikers van de A12 en de N198 en de N419. In de voorliggende rapportage wordt hierop ingegaan. Het te realiseren zonnepark ligt ten noorden van de A12, zie ook Figuur 1.1. Voor het reflectieonderzoek zal ROM3D uitgaan van eigenschappen zoals aangeleverd door de opdrachtgever.



Figuur 1.1: Plangebied Geluidswal A12, inzet: de locatie van het zonnepark aangeduid met de ster. Bron: Google Earth / Sweco

2 Beleid, regelgeving en kaders inzake reflectie

Voor hinder ten gevolge van reflectie bestaat géén specifiek beleid of regelgeving. Voor hinder voor omwonenden geldt echter dat in het kader van een goede ruimtelijke ordening en het in standhouden van een goed woonklimaat alle relevante aspecten moeten worden meegenomen. Reflectiehinder kan in dit kader worden beschouwd. Er zijn wel richtlijnen voor het wegverkeer opgesteld. Rijkswaterstaat heeft in samenwerking met TNO onderzocht wanneer en in welke mate reflectie hinder of verblinding voor de weggebruiker kan opleveren, met name veroorzaakt door geluidsschermen.

2.1 LICHTREFLECTIE

Reflectie kan in bepaalde gevallen leiden tot – tijdelijke - verblinding. Bij TNO Defensie en Veiligheid is een rekenmodel ontwikkeld dat de verblinding kwantificeert aan de hand van de parameters:

- Verblindings-/verlichtingssterkte,
- Verblindingshoek,
- Achtergrondluminantie en
- Dynamische eigenschappen, zoals duur en knipperfrequentie.

Verblinding wordt omschreven als een witte waas in de ogen waardoor de omgeving tijdelijk niet meer kan worden waargenomen.

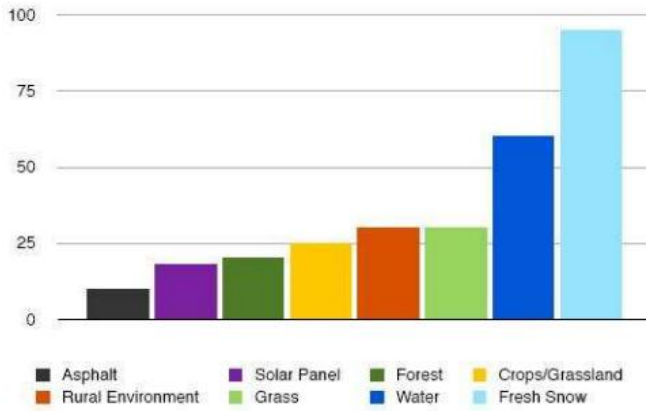
2.2 VERBLINDING

Verblinding treedt op als er zich in het gezichtsveld van de waarnemer een felle lichtbron bevindt die een veel hogere luminantie heeft dan de omgeving. De relatie met afleiding van personen is dat een felle lichtbron afhankelijk van de context (met name of het licht of donker is) meestal erg opvallend is en de aandacht kan trekken (los van het feit dat verblinding op zichzelf al onveiligheidsverhogend is).

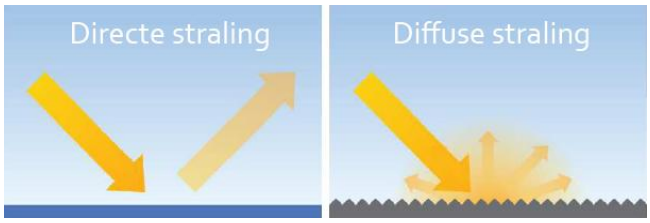
Er zijn twee soorten verblinding: maskerende verblinding (disability glare) en oncomfortabele verblinding (discomfort glare). Maskerende verblinding werpt een sluier (sluierluminantie) over het beeld waardoor het waarneembare contrast en daarmee de zichtbaarheid van objecten vermindert. Oncomfortabele verblinding veroorzaakt ongemak zonder daadwerkelijk het zicht te belemmeren. Rijkswaterstaat heeft een voorkeur voor het hanteren van maskerende verblinding als toetsingscriterium. In dit reflectieonderzoek wordt oncomfortabele verblinding daarom niet verder behandeld.

2.3 PERSPECTIEF

Zonnepanelen zijn niet de enige objecten waar reflectie kan optreden. Overal waar zonlicht op valt kan het zonlicht reflecteren. In Figuur 2.1 zijn resultaten van een reflectieanalyse weergegeven. Hieruit is op te maken dat bij onder andere vegetatie zoals gras en bos een groter percentage van het licht wordt gereflecteerd dan bij zonnepanelen. In de praktijk leidt dit niet vaak tot hinder. Of de reflectie hinderlijk is, is onder andere afhankelijk van de intensiteit van het gereflecteerde zonlicht. Bij een ruwere textuur, zoals bijvoorbeeld een grasland, is de intensiteit van het gereflecteerde licht veel lager (zie Figuur 2.2). Dit komt omdat alle grassprietjes het licht in verschillende richtingen reflecteren (diffuse straling). Bij een glad, spiegelend, oppervlakte wordt dezelfde hoeveelheid licht één richting op weerkaatst (directe straling). Dit leidt tot een hogere intensiteit en dus fellere reflectie van licht (FAA, 2018).

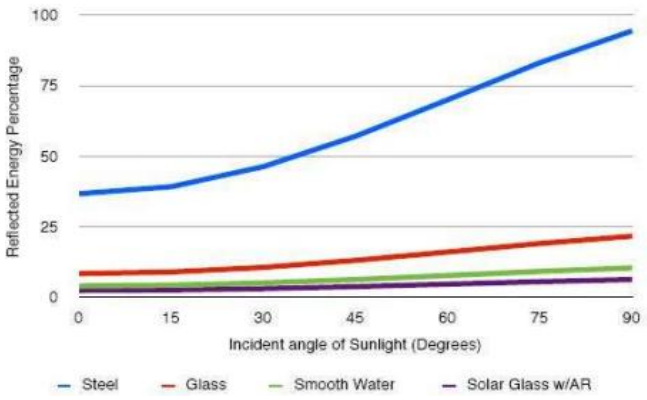


Figuur 2.1: Vergelijkende reflectie analyse (Spaven Consulting, 2011).



Figuur 2.2: Directe en diffuse straling (FAA, 2018)

De hoeveelheid licht die van een zonnepaneel af komt is ook afhankelijk van de oppervlaktereflectie, bewolkingsgraad, geografische locatie, opstellingsvariant (grootte, hellingshoek, hoogte en oriëntatie) en tijd (jaar en dag). Met de tijd verandert de invalshoek van het zonlicht. In Figuur 2.3 is de reflectiviteit van diverse materialen uitgezet tegen de invalshoek van het zonlicht. Onderzoek heeft aangetoond dat zonnepanelen minder reflectief zijn dan stilstaand water, houten dakspanen, gras, wegen, sneeuw, staal en glas (Slana, 2018). De paarse lijn in Figuur 2.3 geeft de reflectiviteit van zonnepanelen met antireflectiecoating weer, het is daarmee minder reflectief dan bijvoorbeeld stilstaand water. Open, stilstaand water is grofweg equivalent aan zonnepanelen zonder anti-reflectiecoating (Slana, 2018).



Figuur 2.3: Analyse van reflectiviteit van typische materialen versus de invalshoek van het zonlicht (Spaven Consulting, 2011).

3 Methode van onderzoek

De methode bestaat uit twee stappen:

1. Vaststellen van de variabelen voor de reflectiestudie:
   - Vaststellen van de specificaties van het zonnepark:
     - het type materiaal van de panelen,
     - wel of geen anti-reflectiecoating,
     - de hellingshoek,
     - de ligging,
     - de hoogte van de opstellingen,
     - de oriëntatie van de opstellingen.
   - Definiëren van observatiepunten en routes langs de opstellingen van zonnepanelen,
2. Analyse op reflectie en verblinding met ForgeSolar model met de kans op voorkomen (op basis van berekende grafieken van dag en seizoen) van reflectie en kans op verblinding.

3.1 FORGESOLAR TOOL

Voor reflectiestudies maakt ROM3D gebruik van een speciaal hiervoor ontwikkelde tool: ForgeSolar. Deze tool maakt gebruik van de Solar Glare Hazard Analysis Tool (SGHAT) van Sandia National Laboratories uit de VS. Het model wordt in de VS standaard en met een verplicht karakter ingezet voor de ontwikkeling van zonneparken of andere reflecterende elementen dichtbij vliegvelden. ForgeSolar voldoet daarmee aan zowel FAA als EU en andere wettelijke vereisten (ForgeSolar, 2023). Rijkswaterstaat heeft het gebruik van de SGHAT geaccepteerd als methode om de mogelijkheid van reflectie op weggebruikers te onderzoeken. Ook TNO ziet de SGHAT als een valide methode om reflectiehinder te onderzoeken (TNO, 2016).

Werking van de ForgeSolar tool

Over de opbouw van het model met aannames en berekeningswijze verwijzen wij naar de achtergrond documentatie die op de website kan worden gevonden (https://www.forgesolar.com/). De hinder wordt alleen berekend voor een situatie waarin reflectie maximaal is. Dat wil zeggen: geen atmosferische verstrooiing, geen bewolking en geen objecten tussen bron (zonnepark) en observatiepunt (bijvoorbeeld voertuig of gevel). Objecten in deze kunnen onder andere beplanting of andere bebouwing zijn. Als deze er wel zijn, wordt hier met de interpretatie en conclusie wel rekening mee gehouden.

De tool werkt samengevat met de volgende stappen:

1. Invoeren van de geografische afbakening van de opstellingen door polygonen te tekenen ter grootte van het oppervlak van de panelen in de ForgeSolar editor. In deze referentie zitten direct vele data

gekoppeld zoals de opkomst, ondergang en loopbaan van de zon en zonnesterkte in de seizoenen, en ook topografische hoogte in het landschap.

2. Keuze van specifieke karakteristieken van het zonneveld: oriëntatie van de panelen (in graden), vaste opstelling of meedraaiend met de zon, hoogte en hellingshoek van de panelen, helling in het landschap, ruwheid van het zon-PV glas met of zonder anti-reflectiecoating.
3. Markeren van posities (observatie punten) rond de panelen waarvoor de potentiële reflectie per zonnepanelen opstelling, in perfecte condities[1], wordt berekend.
4. Instellen van kijkhoogte van de observant.
5. Daarna wordt het model doorgerekend met als uitkomst een gevaar/risicofiguur (hazard plot) waarin verwachte reflectie wordt geplot gedurende het jaar in drie kleuren:
   - Groen: Kleine kans op reflectie met nabeelden op het netvlies (niet hinderlijk), vergelijkbaar met oncomfortabele verblinding,
   - Geel: Reële kans op nabeelden zonder oogschade (hinderlijk), vergelijkbaar met maskerende verblinding,
   - Rood: Sterke reflectie met kans op permanente oogschade (gevaarlijk).

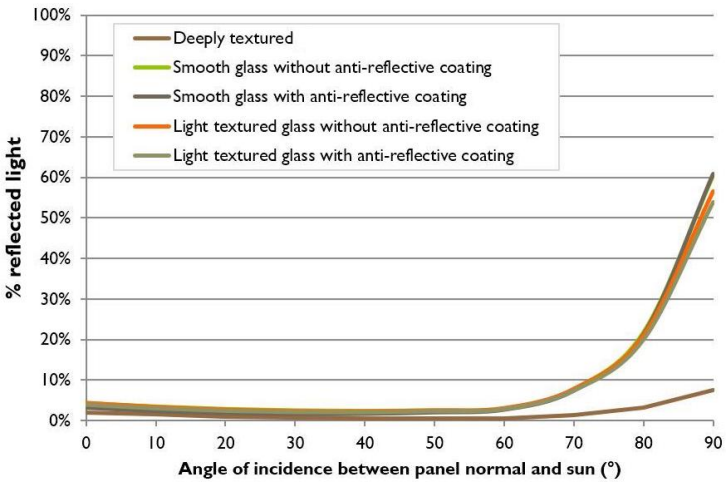
Reflectieprofielen[2]

Sandia National Laboratories heeft vijf generieke reflectie profielen ontwikkeld voor PV modules:

- *Smooth glass* (met en zonder anti-reflectiecoating)
- *Light textured glass* (met en zonder anti-reflectiecoating)
- *Deeply textured glass*

Deze profielen zijn tot stand gekomen door 26 bestaande PV modules te analyseren. Figuur 3.1 laat de reflectiviteit zien van elk ontwikkelde profiel als functie van de invalshoek van het zonlicht. Een hoek van 0° betekent hierin dat de panelen direct op de zon gericht staan. Een invalshoek van 90° komt voor als de panelen horizontaal liggen (helling van 0°) op moment dat de zon op komt en onder gaat.

Anti-reflectiecoatings (ARC) en oppervlakte textuur kunnen de reflectiviteit van panelen verminderen, maar dit is doorgaans minder dan 8%.



Figuur 3.1: Reflectiviteit ten opzichte van de invalshoek van het zonlicht voor de vijf generieke reflectie profielen (ForgeSolar, 2020).

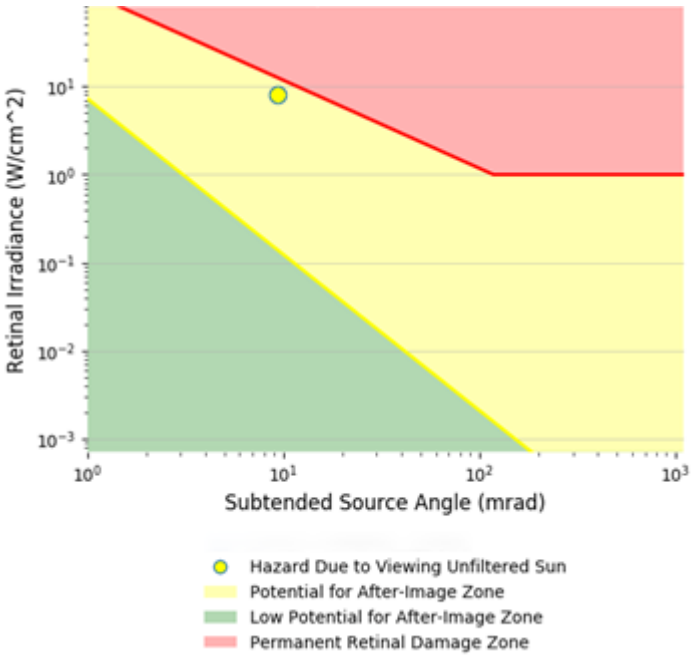
[1] Perfecte condities: Geen atmosferische blokkade van zon instraling door bijvoorbeeld atmosferische verstrooiing (bijvoorbeeld smog) of wolken en geen tussenobjecten die reflectie of straling kunnen blokkeren zoals gebouwen of beplanting.

[2] Bron voor deze hele sectie: www.forgesolar.com (ForgeSolar, 2020)

Daar komt bij dat een ruwere textuur de grootte van de gezichtshoek van lichtbron kan vergroten (zie ook het hoofdstuk "*Wat betekenen de resultaten van de tool*"). Dit laatste komt omdat een ruwere textuur meer diffuse reflectie veroorzaakt.

Wat betekenen de resultaten van de tool

De ForgeSolar tool bepaalt het effect op het oog uit twee aspecten (de assen van de grafiek in Figuur 3.2): de kracht van de straling op het oog in W/cm2 (*retinal irradiance*) en de grootte van de gezichtshoek van de lichtbron (*subtended source angle*). Een sterke lichtbron staat hoger op de verticale as in de grafiek dan een zwakke lichtbron. Op de horizontale as is de grootte van de hoek van de lichtbron weergegeven. Een kleine (punt) lichtbron staat verder naar links op de horizontale as dan een groot reflecterend vlak. De hoek van het oog naar de lichtbron is aangeduid in miliradialen. Een groter vlak zal sneller bij een lagere instralings kracht tot hinder leiden dan een kleiner vlak. De gele lijn tussen de groene en gele zone duidt de omslag tussen geen en wel kans op nabeelden. Permantente schade aan het oog ontstaat als de lichtbron in het rode gebied terecht komt. De gele stip in de gele zone geeft het gevaar/risico weer van het met het blote oog naar de zon kijken op een heldere dag.



Figuur 3.2: Tweedimensionaal ForgeSolar- plot van het effect van reflectie op het oog op basis van twee variabelen: de kracht van de straling op het oog in W/cm2 (retinal irradiance) en de grootte van de gezichtshoek van de lichtbron (subtended source angle). De kleuren geven het soort reflectie aan en de gele stip duidt ter referentie het gevaar/risico aan van het kijken naar de zon op een heldere dag met het blote oog. Als het onderzoek uitgevoerd is zal met oranje stippen het gevaar/risico op een observatiepunt aangeduid worden.

TNO (TNO, 2016) bepaalt maskerende verblinding (disability glare) op basis van enkele variabelen:

- Verblindings-/verlichtingssterkte,
- verblindingshoek,
- achtergrondluminantie en
- dynamische eigenschappen, zoals duur en knipperfrequentie.

De eerste twee variabelen vormen ook de basis in de ForgeSolar tool. Achtergrondluminantie en knipperfrequentie worden niet meegenomen.

De uitkomsten van de ForgeSolar tool worden strenger beoordeeld dan de uitkomsten van de TNO disability glare methode. De duur van de overschrijding van de lichthinder volgens de TNO disability beoordelingsmethode is gemiddeld 64% van de ForgeSolar tool. Maskerende verblinding werpt volgens TNO

een sluier (sluierluminantie) over het beeld waardoor het waarneembare contrast en daarmee de zichtbaarheid van objecten vermindert. De ForgeSolar tool geeft de kans op nabeelden (after image) en oogschade (retinal damage) aan. Dit zijn graadmeters voor het inschatten van de kans op verblinding. Maskerende verblinding kan gaan optreden in het gele gebied van de ForgeSolar-plot en zal vrijwel zeker optreden in het rode gebied. Indien de reflectieresultaten in het groene gebied liggen zal er geen reflectie met kans op maskerende verblinding optreden. Als geen enkele reflectie optreedt is er uiteraard ook geen kans op (maskerende) verblinding. In dit onderzoek wordt gesproken van hinder als de reflectie in het gele of rode gebied ligt.

Hinder

In dit onderzoek wordt gesproken van reflectiehinder in geval van maskerende verblinding. ForgeSolar geeft een goede indicatie van kans op maskerende verblinding door te bepalen of er sprake is van zogenoemde "gele" of "rode" reflectie, die in de uitkomsten van de figuren respectievelijk geel en rood gemarkeerd zijn.

4 Resultaten

4.1 UITGANGSPUNTEN

Voor de analyse van eventuele reflectie afkomstig van het Geluidswal A12 is uitgegaan van de volgende eigenschappen:

- Gemiddelde hoogte panelen: 1,0 meter[3]
- Hellingshoek panelen: 35° (Woerden), 25° (Utrecht - [redacted])
- Oriëntatie panelen: Wisselend, zie bijlagen
- Meedraaiend met de zon: Nee
- Panelen materiaal: Smooth glass met anti-reflectiecoating (ARC)
    - Bijbehorende 'slope error'[4]: Correleert met materiaal[5]
- Ooghoogte automobilist: 1,10 meter[6]
- Ooghoogte vrachtwagenchauffeur: 2,50 meter[6]
- Kijkhoek weggebruiker voor routes[7]: 50°
- Tijdzone: UTC +1 (wintertijd)

Op de geluidswal liggen verschillende velden die de oriëntatie van de geluidswal vinden. De verschillende velden zijn in deze studie gecodeerd als Woerden en UV (Utrecht-Veldhuizen) gevolgd door een nummer. In de bijlage kunnen de exacte gebruikte oriëntaties per veld gevonden worden. in Figuur 4.1 zijn de velden weergegeven. Elk veld wordt los van de andere berekend maar ze worden als één geheel per route geïnterpreteerd, zoals in werkelijkheid ook het geval zal zijn. De reflecties zijn berekend voor 6 routes, zie hiervoor ook Figuur 4.1.

Route 1. A12, rijdend richting het oosten (geel)
Route 2. A12, rijdend richting het westen (groen)
Route 3. N198, rijdend richting het oosten (paars)
Route 4. N198, rijdend richting het westen (lichtgeel)
Route 5. N419, rijdend richting het oosten (lichtblauw)
Route 6. N419, rijdend richting het westen (roze)

[3] Gemiddelde hoogte van de hellende panelen boven topografische hoogte van het maaiveld.
[4] De 'slope error' is verantwoordelijk voor de lichtbundelverstrooiing op de zonnepanelen (grotere verstrooiing zorgt voor minder hinderlijke reflectie). Het is een indicator voor de ruwheid van het glas van het zonnepaneel.
[5] Voor meer informatie zie achtergronddocumentatie op de website van de tool (www.forgesolar.com).
[6] Referentie ooghoogte automobilisten en vrachtwagenchauffeurs benoemd in de richtlijn ontwerp autosnelwegen; onder andere op pagina 49 (Rijkswaterstaat, 2022).
[7] Kijkhoek van de waarnemer in graden naar links en naar rechts ten opzichte van de rijrichting. FAA (Federal Aviation Administration) onderzoek heeft uitgewezen dat er buiten 50° geen impact is van schittering is op de ontvanger (ForgeSolar, 2021).

Figuur 4.1: Ingetekende zonnepark (transparant blauwe vlakken) met daarbij de zes routes waarvoor de reflectie berekend wordt en de obstructions in oranje.

Langs de snelweg zijn een aantal geluidschermen te vinden. Deze zijn ingetekend als "obstruction". Dit is als het ware een muur die al het inkomende zonlicht en uitgaande reflectie volledig blokkeert tot een vooraf ingegeven hoogte. Deze obstructions zijn ook te vinden in de bijlagen en weergegeven in oranje in Figuur 4.1.

Het hoogtemodel waar de ForgeSolar tool gebruik van maakt is niet toereikend/nauwkeurig genoeg. Daarom zijn de hoogtes herbepaald via het AHN5 (Actueel Hoogtebestand Nederland, www.ahn.nl). Alle gebruikte hoogtes kunnen gevonden worden in de bijlage.

De berekende reflectietijden in de Forgesolar tool zijn niet gecompenseerd voor wolken en filtering door autoruiten. TNO (2016) beschrijft dat de totale reflectietijd door drie gedeeld kan worden om tot een realistische reflectietijd te komen; in Nederland is er voor 2/3 deel van het jaar sprake van bewolkte omstandigheden. Ook autoruiten zwakken licht af. De transmissie van autoruiten moet minimaal 75% zijn, net als in het onderzoek van het TNO is dit ook in dit onderzoek aangehouden. In de tabellen in de komende paragrafen is gecompenseerd voor de bewolking en filtering door autoruiten, in de figuren niet. De reflectie is berekend bij perfecte condities: helder weer, geen atmosferische verstrooiing (bijvoorbeeld nevel), geen bewolking en geen blokkerende obstakels zoals beplanting en bebouwing. Als de weersomstandigheden slechter zijn en er minder zonlicht op de panelen valt, dan neemt de *retinal irradiance*, de kracht van de instraling van het zonlicht op de panelen en daardoor ook van de reflectie op het oog af. In de gevaarplots kunnen hierdoor waarnemingen (oranje bolletjes) verdwijnen of zakken in de plot naar beneden. In de figuren met de tijdswaarnemingen zal er daardoor mogelijk ook minder tijd reflectie te zien zijn. In de praktijk zal er minder schittering plaatsvinden dan in deze figuren geschetst is.

In de bijlagen kunnen alle resultaten per route gevonden worden per veld per reflectieprofiel.

4.2 UITKOMSTEN REFLECTIEONDERZOEK

Automobilisten

De resultaten van het reflectieonderzoek: de reflectietijden in uren per jaar die wel gecompenseerd zijn voor bewolking en filtering door autoruiten, kunnen in Tabel 4.1 gevonden worden. Hierin zijn de resultaten voor alle velden meegenomen. Als er reflectie optreedt kan dit op dat moment van meerdere velden tegelijk af komen.

Tabel 4.1: Gecompenseerde groene en gele reflecties voor automobilisten in uren per jaar.

	Route	Groene reflectie	Gele reflectie
1	A12, richting oost	114,5	20,0
2	A12, richting west	39,4	13,8
3	N198, richting oost	79,7	160,7
4	N198, richting west	29,2	40,0
5	N419, richting oost	104,1	2,3
6	N419, richting west	0,0	0,0

Zoals te zien is kunnen automobilisten hinder ondervinden van de reflecties. Op de de A12 in beide richtingen, de N198 in beide richtingen en de N419 in oostelijke rijrichting kan hinderlijke, gele, reflectie gezien worden. Op de N419 in westelijke rijrichting wordt er geen reflectie waargenomen.

Van welke velden de reflectie afkomstig is, is te zien in Tabel 4.2. Hierin is aangegeven per veld of de reflectie die hier per route optreed geel of groen is. De velden zelf zijn in Figuur 4.2 weergegeven. Als er reflectie optreedt komt dit in de meeste gevallen van het hele veld. In de bijlagen is te zien van welk deel van het veld de reflectie afkomt en van waar precies op de route de reflectie optreedt. Daar waar de zonnepanelen gekleurd zijn komt niet altijd reflectie vandaan, maar op een bepaald moment in het jaar wel. Afhankelijk van de stand van de zon komt de reflectie ergens anders vandaan. Elke dag en tijd staat de zon net anders, de reflectie komt dus ook steeds net ergens anders vandaan. Bij de berekening van de reflectie op de routes is rekening gehouden met een beoordelingsveld van 50 graden naar links en rechts ten opzichte van de rijrichting. Onderzoek heeft uitgewezen dat reflectie zichtbaar buiten dit beoordelingsveld geen impact heeft op de ontvanger (ForgeSolar, 2021) en zal daardoor niet tot hinderende verblinding leiden.

Tabel 4.2: Type reflectie (geel (hinderlijk) of groen (niet hinderlijk) per veld per route.

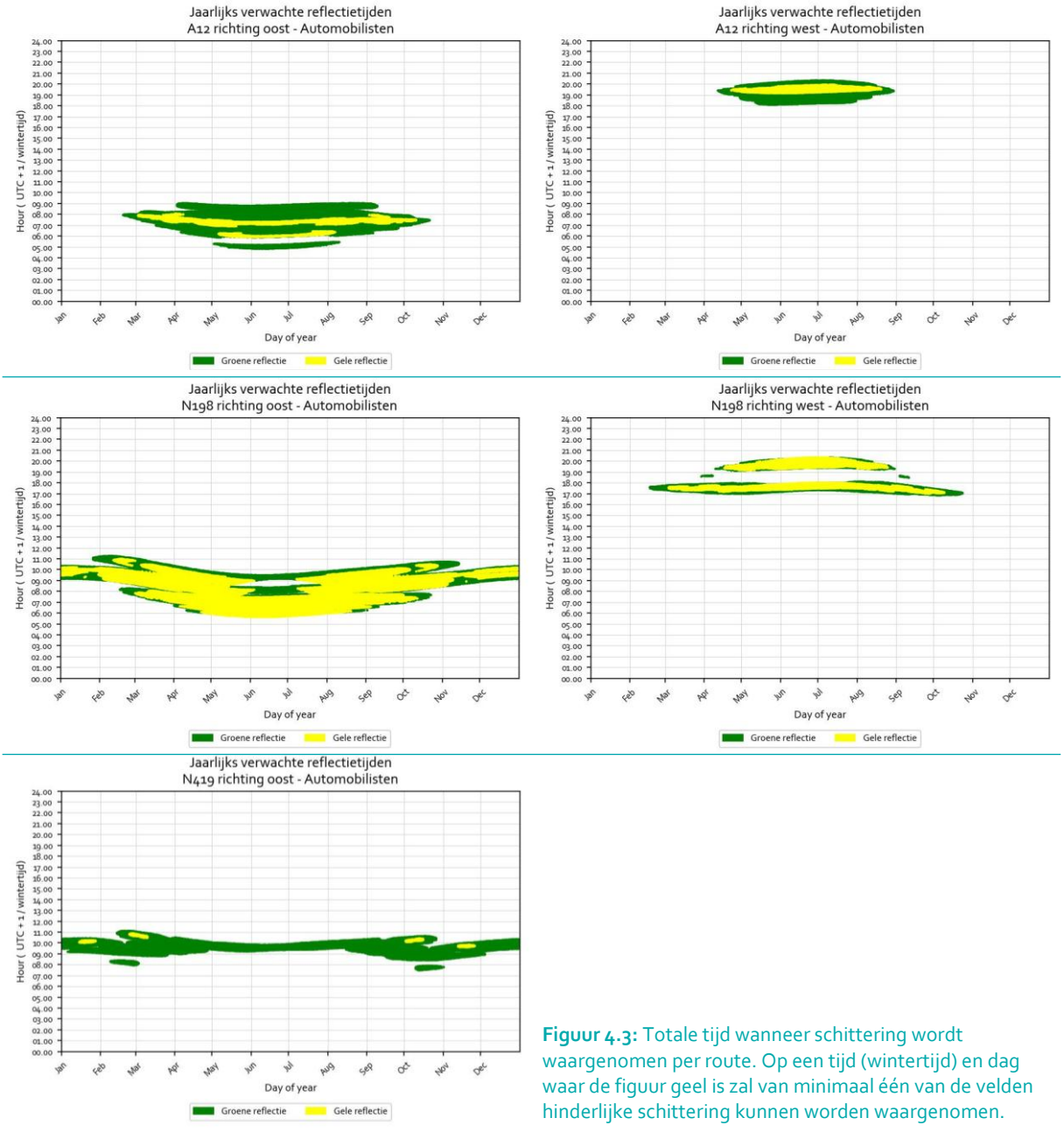
	Woerden	UV-01	UV-02	UV-03	UV-04	UV-05	UV-06	UV-07	UV-08	UV-09	UV-10	UV-11	UV-12	UV-13	UV-14	UV-15	UV-16
1: A12 ri oost	geel				groen	groen	groen	geel	geel	geel	groen	groen	groen	geel	groen	groen	groen
2: A12 ri west	geel					groen	groen	geel	geel	groen	groen	groen	groen	groen			
3: N198 ri oost		geel	geel	geel	geel	geel	geel	geel	geel	geel	geel	geel	geel	geel			
4: N198 ri west	geel					geel	geel	geel	geel	geel					geel	geel	geel
5: N419 ri oost		geel	geel	groen	groen	groen	groen										
6: N419 ri west																	

Figuur 4.1: Ingetekende en doorgerekende zonnevelden op de geluidswal.

De totale tijd van hinderlijke schittering per route is weergegeven in Figuur 4.3. Alleen gedurende de zomermaanden zal hinderlijke reflectie waar te nemen zijn. In westelijke rijrichting is de schittering 's avonds te zien en in oostelijke rijrichting in de ochtend.

Hieronder is opgesomd wanneer de schittering exact hinderlijk is per route:

- A12 richting oost: van begin maart tot half oktober, tussen 6.45 uur en 9.15 uur (rekening houdend met zomer- en wintertijd)
- A12 richting west: van half april tot half augustus, tussen 20.00 uur en 21.00 uur (zomertijd)
- N198 richting oost: hele jaar tussen 6.30 uur en 11.30 uur (rekening houdend met zomer- en wintertijd)
- N198 richting west: van begin maart tot half oktober, tussen 17.15 uur en 21.30 uur (rekening houdend met zomer- en wintertijd)

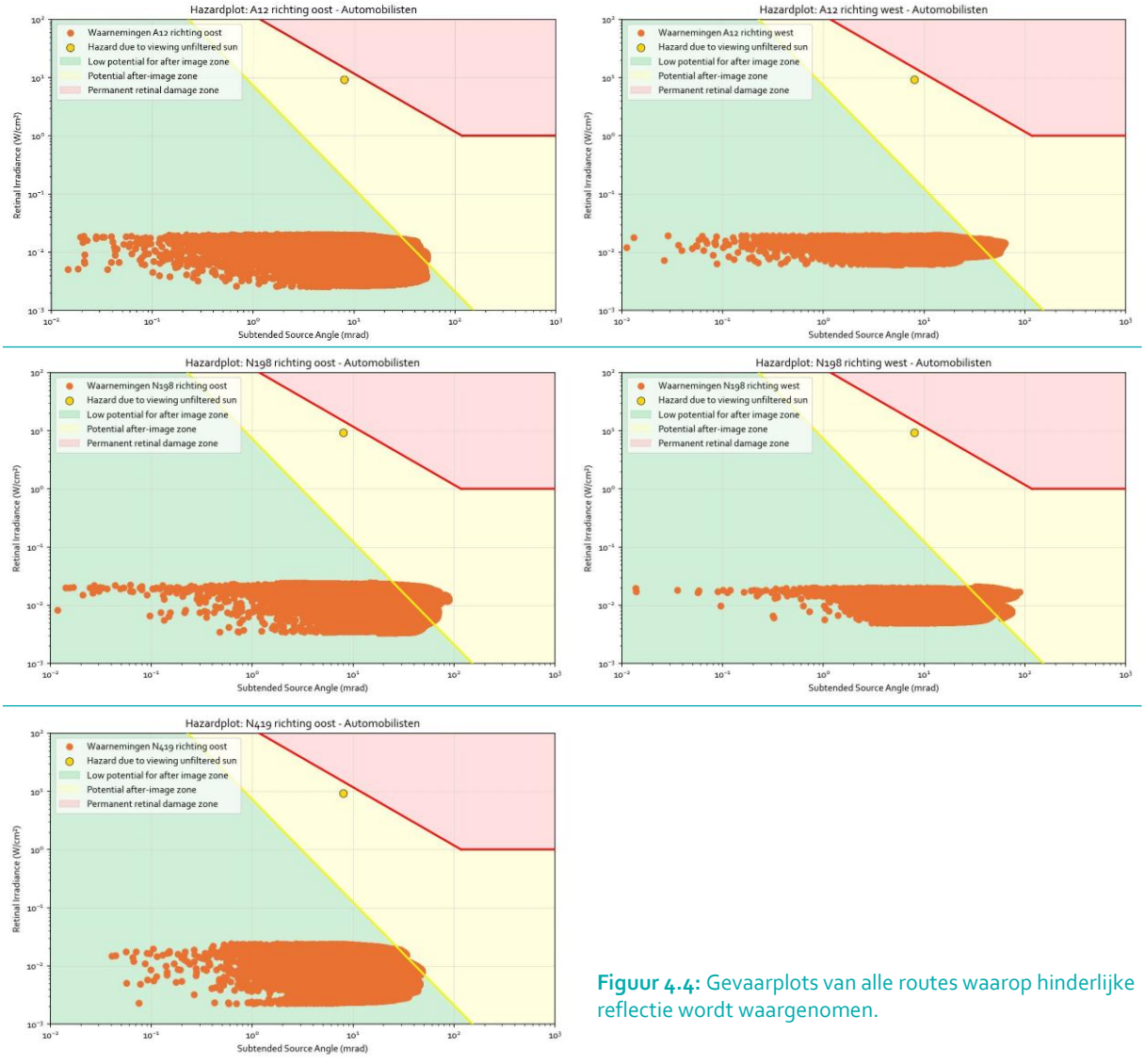


Figuur 4.3: Totale tijd wanneer schittering wordt waargenomen per route. Op een tijd (wintertijd) en dag waar de figuur geel is zal van minimaal één van de velden hinderlijke schittering kunnen worden waargenomen.

- N419 richting oost: vier periodes in het jaar;
    - van half tot eind januari rond 10.00 uur (wintertijd)
    - van eind februari tot begin maart rond 10.30 uur (wintertijd)
    - van begin tot half oktober rond 11.00 uur (zomertijd)
    - van half tot eind november rond 9.30 uur (wintertijd)

De schittering is dus te zien als men naar de zon toe rijdt. Hiermee is de kans groot dat de automobilist ook hinder ondervindt van het directe zonlicht. Het directe zonlicht is altijd feller dan de reflectie. Maatregelen die een bestuurder neemt tegen het directe zonlicht, zoals het dragen van een zonnebril of het uitklappen van de zonneklep, zullen ook hinder van de reflectie kunnen verminderen of voorkomen.

De mate van hinder wordt ook duidelijk uit Figuur 4.4 waarin te zien is dat veel waarnemingen (oranje bolletjes) in het groene gebied liggen, maar ook veel in in het gele gebied. Zoals beschreven in hoofdstuk 4.1 zullen, als de weersomstandigheden slechter zijn, de waarnemingen (oranje bolletjes) van geel richting groen schuiven als gevolg van een afname van de *retinal irradiance*. In Figuur 4.3 kan de gele kleur daardoor ook groen worden. In de praktijk zal er dan ook minder hinderlijke reflectie plaatsvinden dan in deze figuren geschetst is.



Figuur 4.4: Gevaarplots van alle routes waarop hinderlijke reflectie wordt waargenomen.

Vrachtwagenchauffeurs

Vrachtwagenchauffeurs zitten hoger dan de gemiddelde automobilist. Het reflectieonderzoek is ook uitgevoerd voor vrachtwagenchauffeurs. De uitgangspunten voor het onderzoek zijn niet veranderd, met uitzondering van de ooghoogte. Voor vrachtwagenchauffeurs is uitgegaan van een gemiddelde ooghoogte van 2,50 meter. De totale gecompenseerde reflectietijden in uren per jaar zijn te vinden in Tabel 4.2.

Tabel 4.3: Gecompenseerde groene en gele reflecties voor vrachtwagenchauffeurs in uren per jaar.

	Route	Groene reflectie	Gele reflectie
1	A12, richting oost	118,5	17,6
2	A12, richting west	40,2	14,0
3	N198, richting oost	86,9	184,1
4	N198, richting west	29,8	45,7
5	N419, richting oost	105,5	2,0
6	N419, richting west	0,0	0,0

Ten opzichte van automobilisten is de reflectie vergelijkbaar, alleen is de totale tijd waarvoor hinder wordt ondervonden groter voor vrachtwagenchauffeurs op de N198 en iets lager op de A12 en de N419. De richting en mate van hinder zijn wel vergelijkbaar met hinder die automobilisten ondervinden. Voor vrachtwagenschauffeurs kan dezelfde conclusie getrokken worden als voor automobilisten: er kan hinderlijke schittering ervaren worden op de A12 in beide richtingen, de N198 in beide richtingen en de N419 in oostelijke rijrichting. Ook hiervoor geldt dat de chauffeur richting de zon rijdt, en daarmee waarschijnlijk maatregelen zal nemen tegen het directe zonlicht die ook helpen bij het verminderen en/of voorkomen van de hinder. De resultaten per route zijn te vinden in de bijlage.

4.3 MITIGERENDE MAATREGELEN

Er kunnen een aantal oplossingen worden bedacht voor het verminderen of voorkomen van de (hinderlijke) reflectie. Hierbij kan de bijvoorbeeld de oriëntatie veranderd worden of de hellingshoek. Beiden zijn esthetisch minder wenselijk voor het landschap en aangezicht van de geluidswal. Daarbij zal het aanpassen van de hellingshoek, naar verwachting, weinig effect hebben. Om uit te zoeken of er een optimale oriëntatie en/of hellingshoek is waarbij geen reflectie optreedt zullen aanvullende berekeningen uitgevoerd moeten worden.

Een tweede mogelijkheid is om een ander zonnepaneel te kiezen. Er zijn zogenoemde "*deeply textured glass*" panelen. Deze panelen hebben een ruwere glasplaat of maken gebruik van innovatieve technieken. Hierdoor is er meer diffuse reflectie, waardoor de intensiteit afneemt. De reflectie zal op meer plekken te zien zijn, maar zal in die gevallen van dusdanige aard zijn dat ze nauwelijks te zien zal zien en dus niet tot hinder zullen leiden. Bij het kiezen van een *deeply textured* paneel dient wel rekening gehouden te worden dat het moet voldoen aan de door ForgeSolar opgestelde definitie. De term *deeply textured* is niet beschermd en mag daardoor door fabrikanten op alle type panelen gebruikt worden. Als een fabrikant iets als *deeply textured* beschrijft wil dat niet per definitie zeggen dat dit ook zo is in de gebruikt tool van ForgeSolar.

Op de website van ForgeSolar kunnen ook een aantal productspecifieke reflectieprofielen gevonden worden[8]. Deze type panelen zijn doorgemeten en geïntegreerd in ForgeSolar. Uit de grafiek op de website kan afgeleid worden of deze typen vergelijkbaar zijn met het generieke reflectieprofiel van *"deeply textured glass".*

In onderstaande tabel (Tabel 4.4) is *deeply textured glass* doorgerekend voor automobilisten en vrachtwagens. Dezelfde uitgangspunten als in hoofdstuk 4.1 en 4.2 zijn hiervoor aangehouden, met uitzondering van het reflectieprofiel. Hierin is te zien dat er geen hinder ondervonden zal worden bij de keuze voor deeply textured glass. Wel is er veel meer sprake van groene, niet hinderlijke reflectie. Dit komt dus vanwege de diffusere reflectie.

Tabel 4.3: Gecompenseerde groene en gele reflecties voor automobilisten en vrachtwagenchauffeurs in uren per jaar bij gebruik van deeply textured glass.

Route		Automobilisten		Vrachtwagenchauffeurs	
		Groene reflectie	Gele reflectie	Groene reflectie	Gele reflectie
1	A12, richting oost	584,0	0,0	586,4	0,0
2	A12, richting west	377,9	0,0	381,5	0,0
3	N198, richting oost	661,1	0,0	656,4	0,0
4	N198, richting west	508,2	0,0	515,7	0,0
5	N419, richting oost	554,9	0,0	557,6	0,0
6	N419, richting west	501,8	0,0	506,0	0,0

Een laatste mitigerende maatregel is het blokkeren van de reflectie. Dit zou middels schermen of een haag kunnen. Hierdoor kan inkomend zonlicht geblokkeerd worden, of uitgaande reflectie. In beide gevallen zal de reflectie de weggebruiker dan niet bereiken. De inpassing moet dan wel dermate hoog worden dat de weggebruiker de zonnepanelen niet kan zien (naar schatting: ongeveer 8,5 meter boven maaiveld[9]).

[8] Zie hiervoor: https://www.forgesolar.com/help/ onder het kopje "*Fundamentals*" en dan "*Module Reflectance Profiles*"
[9] Hoogste punt panelen met gele reflectie op de A12 (UV-09): 14,2 meter, hoogte wegdek: 0,3 meter, ooghoogte vrachtwagen: 2,5 m. komt ongeveer halverwege de weg en het hoogste punt → (14,2 + 2,8) / 2 = 8,5 m

5 Conclusie

Er is een reflectieonderzoek gedaan naar eventuele (hinderlijke) schittering afkomstig van zonnepanelen op de geluidswal langs de A12. De reflectie is berekend voor automobilisten en vrachtwagenchauffeurs rijdend over de A12, de N198 en de N419. Voor de zonnepanelen is gerekend met een generiek reflectieprofiel voor glad glas met antireflectiecoating.

Zowel op de A12 als de N198 is er in beide richtingen hinderlijke schittering waar te nemen en ook op de N419 in oostelijke rijrichting. Op de N419 is er in westelijke rijrichting geen reflectie te zien.

De schittering kan optreden op de volgende momenten:

- A12 richting oost: van begin maart tot half oktober, tussen 6.45 uur en 9.15 uur (rekening houdend met zomer- en wintertijd)
- A12 richting west: van half april tot half augustus, tussen 20.00 uur en 21.00 uur (zomertijd)
- N198 richting oost: hele jaar tussen 6.30 uur en 11.30 uur (rekening houdend met zomer- en wintertijd)
- N198 richting west: van begin maart tot half oktober, tussen 17.15 uur en 21.30 uur (rekening houdend met zomer- en wintertijd)
- N419 richting oost: vier periodes in het jaar;
    - van half tot eind januari rond 10.00 uur (wintertijd)
    - van eind februari tot begin maart rond 10.30 uur (wintertijd)
    - van begin tot half oktober rond 11.00 uur (zomertijd)
    - van half tot eind november rond 9.30 uur (wintertijd)

De hinderlijke schittering treedt op als de bestuurder naar de zon toe rijdt. Hiermee is de kans groot dat de bestuurder ook hinder ondervindt van het directe zonlicht. Direct zonlicht is altijd feller dan de reflectie. Maatregelen die een bestuurder neemt tegen het directe zonlicht, zoals het dragen van een zonnebril of het uitklappen van de zonneklep, zullen ook hinder van de reflectie kunnen verminderen of voorkomen.

Het gebruik van deeply textured glass zal hinderlijke schittering voorkomen. De enige schittering die dan nog zichtbaar zal zijn is niet hinderlijk.

6 Referenties

FAA. (2018). *Technical Guidance for Evaluating Selected Solar Technologies on Airports.* Washington.

ForgeSolar. (2020). *Module Reflectance Profiles*, Release 2020.04. Opgeroepen op 10 mei, 2020, van ForgeSolar Help: https://www.forgesolar.com/help/#reflectivity

ForgeSolar. (2021). *Route Parameters*. Opgeroepen op 7 april, 2021, van ForgeSolar Help: https://www.forgesolar.com/help/#route

ForgeSolar. (2023). *Homepage*. Opgeroepen op 23 November, 2023, van ForgeSolar: https://www.forgesolar.com/

Rijkswaterstaat. (2022). *Richtlijn Ontwerp Autosnelweg 2019 (ROA2019).* Rijkswaterstaat - Ministerie van Infrastructuur en Waterstaat.

[redacted] (2018). *Solar Glare Catalogue Development For Solar Photovoltaic Project Proposals.* [redacted]: University of Calgery.

Spaven Consulting. (2011). *Solar Photovoltaic energy facilities: assessment of potential for impact on aviation.* Report No.10/344/RPS/1.

TNO. (2016). *Lichthinder zonreflectie voor weggebruikers – ontwikkeling beoordelingsmethode op basis van disability glare.* TNO 2016 R10690.

7 Bijlagen

In de bijlage zijn de modeluitkomsten van het reflectieonderzoek bijgevoegd. Deze zijn bijgevoegd als afzonderlijke pdf. In deze PDF rapporten is niet gecompenseerd voor de situatie met een wolkendek. Er wordt dus overal uitgegaan van perfecte – dat wil zeggen zonnige en heldere - condities voor reflectie. In de praktijk zullen bewolking en atmosferische verstrooiing zorgen voor minder schittering. De benaming DTG in de documentnaam geeft aan dat er met deeply textured glass is gerekend.

Bijlage 1 – modelresultaten reflectieonderzoek:

- ForgeSolar Analysis Report – auto.pdf
- ForgeSolar Analysis Report – auto DTG.pdf
- ForgeSolar Analysis Report – vrachtwagen.pdf
- ForgeSolar Analysis Report – vrachtwagen DTG.pdf

FORGESOLAR GLARE ANALYSIS

Project: **Geluidswal A12**

Sweco heeft plannen voor een zonnepanelen op een geluidswal aangeleverd aan ROM3D. De geluidswal ligt langs de A12, in twee delen nabij Woerden en Utrecht – Veldhuizen. Eventuele reflectiehinder veroorzaakt door dit park kan inzichtelijk worden gemaakt met een reflectiestudie. Er is gevraagd om een dergelijke studie uit te voeren om de schittering te bepalen voor weggebruikers van de A12 en de N198 en de N419. Het te realiseren zonnepark ligt ten noorden van de A12. Voor het reflectieonderzoek zal ROM3D uitgaan van eigenschappen zoals aangeleverd door de opdrachtgever.

Site configuration: **Automobilisten - SG**

Calculated via ForgeSolar Radiometric Physics Engine v3.2.1

Client: Sweco

Created 13 Jul, 2026
Updated 13 Jul, 2026
Time-step 1 minute
Timezone offset UTC1
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 1 MW to 5 MW
Site ID 182854.29739

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Min luminance threshold 5,000 cd/m^2

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	18,001	300.0	6,346	105.8	-
UV-02	25.0	241.68	12,917	215.3	6,136	102.3	-
UV-03	25.0	233.48	8,929	148.8	7,572	126.2	-
UV-04	25.0	225.18	14,431	240.5	7,175	119.6	-
UV-05	25.0	202.75	13,756	229.3	6,519	108.7	-
UV-06	25.0	204.1	14,246	237.4	6,829	113.8	-
UV-07	25.0	197.55	10,476	174.6	11,246	187.4	-
UV-08	25.0	195.26	10,605	176.8	10,757	179.3	-
UV-09	25.0	192.6	11,292	188.2	7,152	119.2	-
UV-10	25.0	189.34	12,109	201.8	1,310	21.8	-
UV-11	25.0	184.09	7,140	119.0	1,328	22.1	-
UV-12	25.0	181.74	9,261	154.3	4,504	75.1	-
UV-13	25.0	174.0	6,185	103.1	3,201	53.4	-
UV-14	25.0	154.86	5,009	83.5	657	10.9	-
UV-15	25.0	152.49	5,484	91.4	2,325	38.8	-
UV-16	25.0	150.5	3,489	58.1	3,187	53.1	-
Woerden	35.0	197.87	11,344	189.1	1,976	32.9	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	65,144	1,085.7	5,771	96.2
A12 ri west	23,423	390.4	4,094	68.2
N198 ri oost	41,585	693.1	62,590	1,043.2
N198 ri west	16,870	281.2	15,203	253.4
N419 ri oost	27,652	460.9	562	9.4
N419 ri west	0	0.0	0	0.0

Component Data

PV Arrays

Name: UV-01
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 259.2°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079394	5.002834	1.80	1.00	2.80
2	52.079414	5.003086	8.90	1.00	9.90
3	52.079165	5.003165	8.90	1.00	9.90
4	52.079133	5.002909	1.80	1.00	2.80

Name: UV-02
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 241.68°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079089	5.002938	1.80	1.00	2.80
2	52.079160	5.003172	8.90	1.00	9.90
3	52.078925	5.003359	8.90	1.00	9.90
4	52.078846	5.003115	1.80	1.00	2.80

Name: UV-03
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 233.48°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078921	5.003362	8.90	1.00	9.90
2	52.078714	5.003589	8.90	1.00	9.90
3	52.078621	5.003381	1.80	1.00	2.80
4	52.078821	5.003140	1.80	1.00	2.80

Name: UV-04
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 225.18°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078709	5.003596	8.90	1.00	9.90
2	52.078528	5.003883	8.90	1.00	9.90
3	52.078416	5.003701	1.80	1.00	2.80
4	52.078600	5.003403	1.80	1.00	2.80

Name: UV-05
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 202.75°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078514	5.003900	8.90	1.00	9.90
2	52.078381	5.003765	1.80	1.00	2.80
3	52.078243	5.004127	1.80	1.00	2.80
4	52.078381	5.004253	8.90	1.00	9.90

Name: UV-06
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 204.1°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078369	5.004292	8.90	1.00	9.90
2	52.078224	5.004187	1.80	1.00	2.80
3	52.078116	5.004577	1.80	1.00	2.80
4	52.078262	5.004685	8.90	1.00	9.90

Name: UV-07
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 197.55°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078252	5.004723	8.90	1.00	9.90
2	52.078105	5.004623	1.80	1.00	2.80
3	52.075796	5.015377	1.80	1.00	2.80
4	52.075952	5.015472	8.90	1.00	9.90

Name: UV-08
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 195.26°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.075783	5.015424	1.80	1.00	2.80
2	52.075941	5.015508	8.90	1.00	9.90
3	52.075166	5.019634	8.90	1.00	9.90
4	52.075013	5.019572	1.80	1.00	2.80

Name: UV-09
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 192.6°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074996	5.019648	1.80	1.00	2.80
2	52.075298	5.019780	13.20	1.00	14.20
3	52.074991	5.021772	13.20	1.00	14.20
4	52.074895	5.021732	10.70	1.00	11.70
5	52.075209	5.019742	10.70	1.00	11.70
6	52.075150	5.019719	8.90	1.00	9.90
7	52.074833	5.021708	8.90	1.00	9.90
8	52.074676	5.021644	1.80	1.00	2.80

Name: UV-10
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 189.34°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074664	5.021722	1.80	1.00	2.80
2	52.074982	5.021799	13.20	1.00	14.20
3	52.074937	5.022221	13.20	1.00	14.20
4	52.074836	5.022191	10.70	1.00	11.70
5	52.074886	5.021778	10.70	1.00	11.70
6	52.074822	5.021763	8.90	1.00	9.90
7	52.074777	5.022181	8.90	1.00	9.90
8	52.074615	5.022144	1.80	1.00	2.80

Name: UV-11
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 184.09°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074834	5.022217	10.70	1.00	11.70
2	52.074935	5.022232	13.20	1.00	14.20
3	52.074915	5.022546	13.20	1.00	14.20
4	52.074816	5.022533	10.70	1.00	11.70

Name: UV-12
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 181.74°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074614	5.022176	1.80	1.00	2.80
2	52.074775	5.022196	8.90	1.00	9.90
3	52.074757	5.022614	8.90	1.00	9.90
4	52.074598	5.022600	1.80	1.00	2.80

Name: UV-13
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 174.0°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074915	5.022550	13.20	1.00	14.20
2	52.074816	5.022559	10.70	1.00	11.70
3	52.074756	5.022630	8.90	1.00	9.90
4	52.074597	5.022632	1.80	1.00	2.80
5	52.074618	5.023055	1.80	1.00	2.80
6	52.074772	5.023044	8.90	1.00	9.90
7	52.074756	5.022633	8.90	1.00	9.90
8	52.074816	5.022561	10.70	1.00	11.70
9	52.074842	5.022989	10.70	1.00	11.70
10	52.074944	5.022973	13.20	1.00	14.20

Name: UV-14
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 154.86°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074628	5.023148	1.80	1.00	2.80
2	52.074774	5.023052	8.90	1.00	9.90
3	52.074852	5.023036	10.70	1.00	11.70
4	52.074944	5.022977	13.20	1.00	14.20
5	52.075047	5.023366	13.20	1.00	14.20
6	52.074951	5.023433	10.70	1.00	11.70
7	52.074852	5.023038	10.70	1.00	11.70
8	52.074774	5.023053	8.90	1.00	9.90
9	52.074870	5.023429	8.90	1.00	9.90
10	52.074733	5.023531	1.80	1.00	2.80

Name: UV-15
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 152.49°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074747	5.023569	1.80	1.00	2.80
2	52.074879	5.023456	8.90	1.00	9.90
3	52.074953	5.023449	10.70	1.00	11.70
4	52.075052	5.023380	13.20	1.00	14.20
5	52.075161	5.023755	13.20	1.00	14.20
6	52.075074	5.023830	10.70	1.00	11.70
7	52.074954	5.023453	10.70	1.00	11.70
8	52.074880	5.023458	8.90	1.00	9.90
9	52.074999	5.023829	8.90	1.00	9.90
10	52.074861	5.023942	1.80	1.00	2.80

Name: UV-16
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 150.5°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074866	5.023959	1.80	1.00	2.80
2	52.075003	5.023849	8.90	1.00	9.90
3	52.075082	5.023858	10.70	1.00	11.70
4	52.075168	5.023782	13.20	1.00	14.20
5	52.075292	5.024144	13.20	1.00	14.20
6	52.075202	5.024226	10.70	1.00	11.70
7	52.075083	5.023860	10.70	1.00	11.70
8	52.075004	5.023851	8.90	1.00	9.90
9	52.075121	5.024220	8.90	1.00	9.90
10	52.074982	5.024340	1.80	1.00	2.80

Name: Woerden
Axis tracking: Fixed (no rotation)
Tilt: 35.0°
Orientation: 197.87°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080468	4.994350	8.00	1.00	9.00
2	52.080330	4.994286	0.00	1.00	1.00
3	52.078807	5.001345	0.00	1.00	1.00
4	52.078932	5.001420	8.00	1.00	9.00

Route Receptors

Name: A12 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080355	4.978381	1.00	1.10	2.10
2	52.080361	4.986477	1.00	1.10	2.10
3	52.080353	4.987236	1.00	1.10	2.10
4	52.080321	4.988051	1.00	1.10	2.10
5	52.080287	4.988839	1.00	1.10	2.10
6	52.080232	4.989657	1.00	1.10	2.10
7	52.080152	4.990527	1.00	1.10	2.10
8	52.080056	4.991406	1.00	1.10	2.10
9	52.079931	4.992347	1.00	1.10	2.10
10	52.079788	4.993302	1.00	1.10	2.10
11	52.079504	4.994866	1.00	1.10	2.10
12	52.079123	4.996740	1.00	1.10	2.10
13	52.078467	4.999653	1.00	1.10	2.10
14	52.076884	5.006915	1.00	1.10	2.10
15	52.074587	5.017750	1.00	1.10	2.10
16	52.074013	5.021057	1.00	1.10	2.10
17	52.073363	5.025614	2.90	1.10	4.00

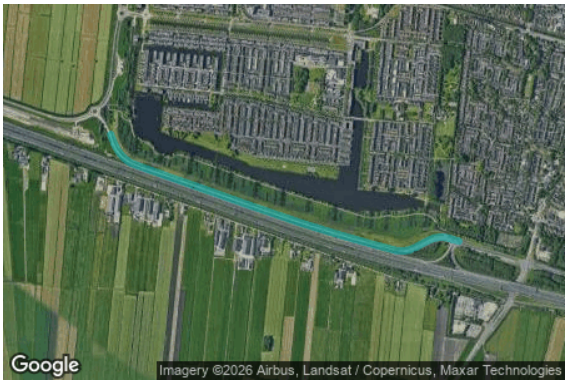
Name: A12 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.073024	5.030141	5.70	1.10	6.80
2	52.073632	5.025983	3.10	1.10	4.20
3	52.074258	5.022036	0.90	1.10	2.00
4	52.074627	5.019886	0.30	1.10	1.40
5	52.075057	5.017533	0.30	1.10	1.40
6	52.075477	5.015418	0.30	1.10	1.40
7	52.078108	5.003266	0.30	1.10	1.40
8	52.079515	4.996721	0.30	1.10	1.40
9	52.079856	4.995053	0.30	1.10	1.40
10	52.080115	4.993585	0.30	1.10	1.40

Name: N198 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080085	5.001737	-0.10	1.10	1.00
2	52.080033	5.001839	-0.10	1.10	1.00
3	52.079835	5.002108	-0.20	1.10	0.90
4	52.079653	5.002301	-0.20	1.10	0.90
5	52.079353	5.002564	-0.20	1.10	0.90
6	52.079129	5.002711	-0.20	1.10	0.90
7	52.078917	5.002845	-0.20	1.10	0.90
8	52.078747	5.002987	-0.20	1.10	0.90
9	52.078547	5.003213	-0.20	1.10	0.90
10	52.078402	5.003425	-0.20	1.10	0.90
11	52.078270	5.003666	-0.20	1.10	0.90
12	52.078170	5.003902	-0.20	1.10	0.90
13	52.078079	5.004197	-0.20	1.10	0.90
14	52.076426	5.011812	-0.20	1.10	0.90
15	52.075637	5.015559	-0.20	1.10	0.90
16	52.075116	5.018307	-0.20	1.10	0.90
17	52.074736	5.020489	-0.20	1.10	0.90
18	52.074459	5.022255	-0.20	1.10	0.90
19	52.074397	5.022726	0.00	1.10	1.10
20	52.074403	5.022983	0.10	1.10	1.20
21	52.074431	5.023301	0.10	1.10	1.20
22	52.074616	5.023981	0.20	1.10	1.30
23	52.074830	5.024727	0.60	1.10	1.70

Name: N198 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074878	5.026535	0.80	1.10	1.90
2	52.075013	5.025811	0.90	1.10	2.00
3	52.075044	5.025508	0.90	1.10	2.00
4	52.075046	5.025211	0.90	1.10	2.00
5	52.075008	5.024850	0.90	1.10	2.00
6	52.074927	5.024526	0.70	1.10	1.80
7	52.074765	5.024016	0.30	1.10	1.40
8	52.074624	5.023588	0.00	1.10	1.10
9	52.074537	5.023293	-0.10	1.10	1.00
10	52.074489	5.023027	-0.20	1.10	0.90
11	52.074463	5.022713	-0.20	1.10	0.90
12	52.074483	5.022262	-0.20	1.10	0.90
13	52.074768	5.020499	-0.20	1.10	0.90
14	52.075144	5.018318	-0.20	1.10	0.90
15	52.075667	5.015564	-0.20	1.10	0.90
16	52.076455	5.011826	-0.20	1.10	0.90
17	52.078113	5.004211	-0.20	1.10	0.90
18	52.078192	5.003935	-0.20	1.10	0.90
19	52.078291	5.003707	-0.20	1.10	0.90
20	52.078421	5.003473	-0.20	1.10	0.90
21	52.078568	5.003259	-0.20	1.10	0.90
22	52.078759	5.003042	-0.20	1.10	0.90
23	52.078929	5.002897	-0.20	1.10	0.90
24	52.079136	5.002763	-0.20	1.10	0.90
25	52.079367	5.002623	-0.20	1.10	0.90

Name: N419 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

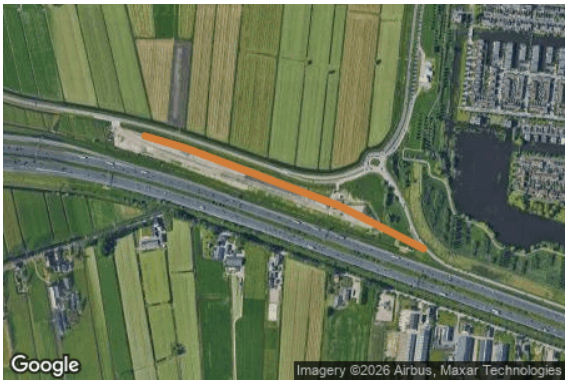
Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081519	4.989885	-0.60	1.10	0.50
2	52.081272	4.992168	-0.60	1.10	0.50
3	52.081193	4.992811	-0.60	1.10	0.50
4	52.080995	4.994115	-0.60	1.10	0.50
5	52.080769	4.995295	-0.60	1.10	0.50
6	52.080146	4.998197	-0.60	1.10	0.50
7	52.080033	4.998680	-0.60	1.10	0.50
8	52.079948	4.999080	-0.60	1.10	0.50
9	52.079892	4.999530	-0.60	1.10	0.50
10	52.079884	4.999975	-0.60	1.10	0.50
11	52.079911	5.000375	-0.60	1.10	0.50
12	52.079943	5.000638	-0.50	1.10	0.60
13	52.080009	5.000952	-0.40	1.10	0.70
14	52.080143	5.001405	-0.10	1.10	1.00
15	52.080123	5.001518	-0.10	1.10	1.00
16	52.080130	5.001668	-0.10	1.10	1.00
17	52.080163	5.001797	-0.10	1.10	1.00
18	52.080229	5.001885	-0.10	1.10	1.00
19	52.080351	5.001901	-0.10	1.10	1.00

Name: N419 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081289	5.002510	0.40	1.10	1.50
2	52.081097	5.002414	0.30	1.10	1.40
3	52.080891	5.002242	0.10	1.10	1.20
4	52.080703	5.002033	0.10	1.10	1.20
5	52.080552	5.001832	0.00	1.10	1.10
6	52.080494	5.001684	-0.10	1.10	1.00
7	52.080504	5.001545	-0.10	1.10	1.00
8	52.080487	5.001402	-0.10	1.10	1.00
9	52.080438	5.001298	-0.10	1.10	1.00
10	52.080324	5.001228	-0.10	1.10	1.00
11	52.080262	5.001174	-0.10	1.10	1.00
12	52.080202	5.001043	-0.30	1.10	0.80
13	52.080122	5.000756	-0.40	1.10	0.70
14	52.080047	5.000397	-0.50	1.10	0.60
15	52.080008	5.000016	-0.60	1.10	0.50
16	52.080013	4.999479	-0.60	1.10	0.50
17	52.080052	4.999013	-0.60	1.10	0.50
18	52.080156	4.998334	-0.60	1.10	0.50
19	52.080802	4.995308	-0.60	1.10	0.50
20	52.081030	4.994115	-0.60	1.10	0.50

Obstruction Components

Name: Geluidsscherm I en Talud
Top height: 8.80 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.080881	4.993642	0.00
2	52.080621	4.995064	0.00
3	52.079412	5.000313	0.00
4	52.078512	5.003205	0.00

Name: Geluidsscherm II
Top height: 4.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.074608	5.021008	0.00
2	52.074201	5.023580	0.00
3	52.074150	5.024043	0.00
4	52.074115	5.024569	0.00
5	52.074116	5.024735	0.00
6	52.074144	5.024934	0.00
7	52.074201	5.025140	0.00
8	52.074267	5.025320	0.00
9	52.074389	5.025528	0.00
10	52.074562	5.025741	0.00

Name: Geluidsscherm III
Top height: 7.00 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.073659	5.026506	0.00
2	52.073916	5.024693	0.00

Name: Geluidsscherm IV
Top height: 7.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.072916	5.031908	0.00
2	52.073542	5.027611	0.00
3	52.073628	5.027161	0.00
4	52.073705	5.026887	0.00
5	52.073862	5.026614	0.00
6	52.073992	5.026453	0.00
7	52.074149	5.026345	0.00
8	52.074236	5.026300	0.00

Glare Analysis Results

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	18,001	300.0	6,346	105.8	-
UV-02	25.0	241.68	12,917	215.3	6,136	102.3	-
UV-03	25.0	233.48	8,929	148.8	7,572	126.2	-
UV-04	25.0	225.18	14,431	240.5	7,175	119.6	-
UV-05	25.0	202.75	13,756	229.3	6,519	108.7	-
UV-06	25.0	204.1	14,246	237.4	6,829	113.8	-
UV-07	25.0	197.55	10,476	174.6	11,246	187.4	-
UV-08	25.0	195.26	10,605	176.8	10,757	179.3	-
UV-09	25.0	192.6	11,292	188.2	7,152	119.2	-
UV-10	25.0	189.34	12,109	201.8	1,310	21.8	-
UV-11	25.0	184.09	7,140	119.0	1,328	22.1	-
UV-12	25.0	181.74	9,261	154.3	4,504	75.1	-
UV-13	25.0	174.0	6,185	103.1	3,201	53.4	-
UV-14	25.0	154.86	5,009	83.5	657	10.9	-
UV-15	25.0	152.49	5,484	91.4	2,325	38.8	-
UV-16	25.0	150.5	3,489	58.1	3,187	53.1	-
Woerden	35.0	197.87	11,344	189.1	1,976	32.9	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	65,144	1,085.7	5,771	96.2
A12 ri west	23,423	390.4	4,094	68.2
N198 ri oost	41,585	693.1	62,590	1,043.2
N198 ri west	16,870	281.2	15,203	253.4
N419 ri oost	27,652	460.9	562	9.4
N419 ri west	0	0.0	0	0.0

PV: UV-01 potential temporary after-image

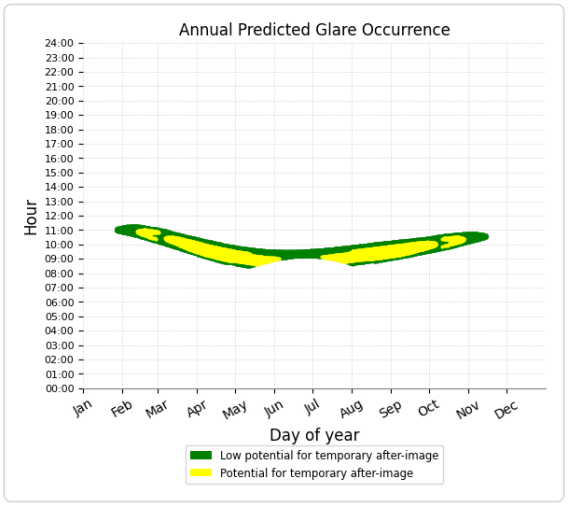
Receptor results ordered by category of glare

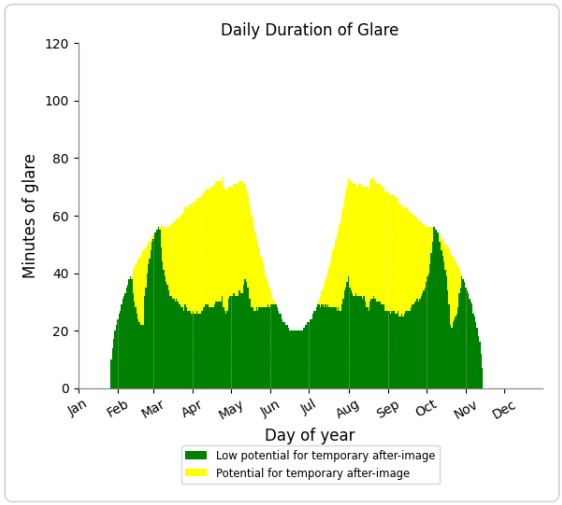
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	8,855	147.6	6,038	100.6
N419 ri oost	9,146	152.4	308	5.1
A12 ri oost	0	0.0	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

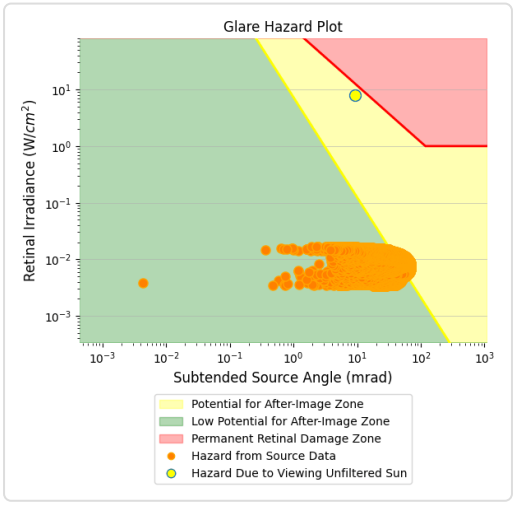
UV-01 and Route: N198 ri oost

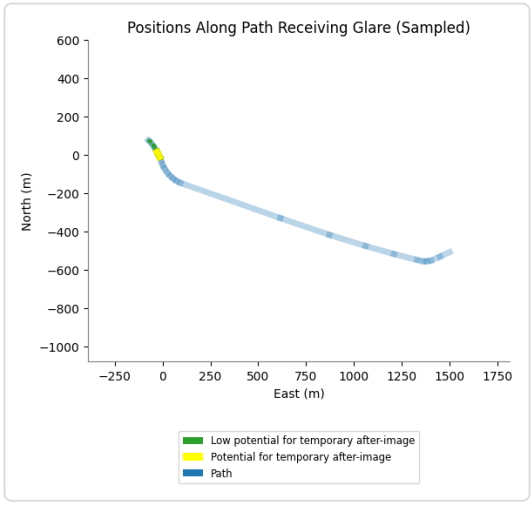
Yellow glare: 6,038 min.

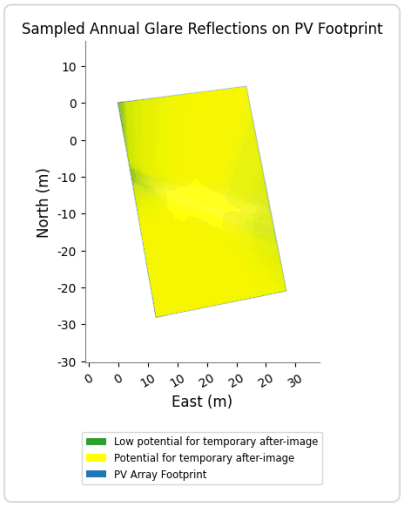
Green glare: 8,855 min.







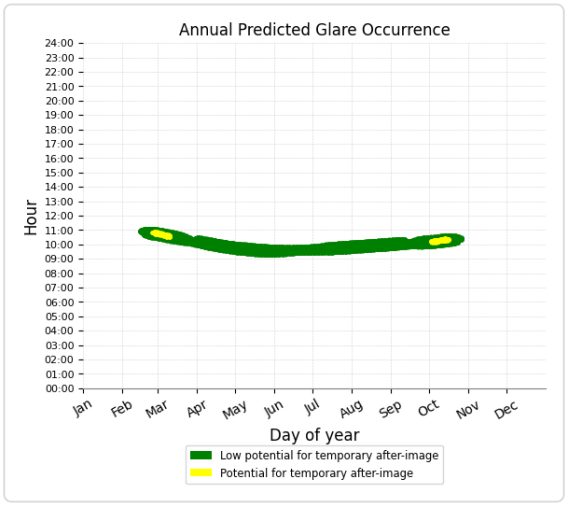


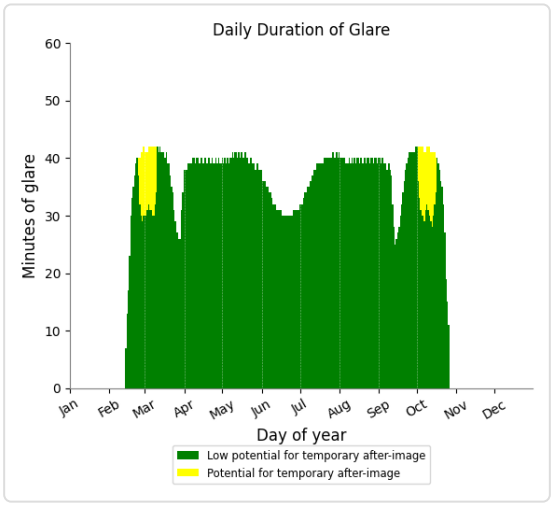


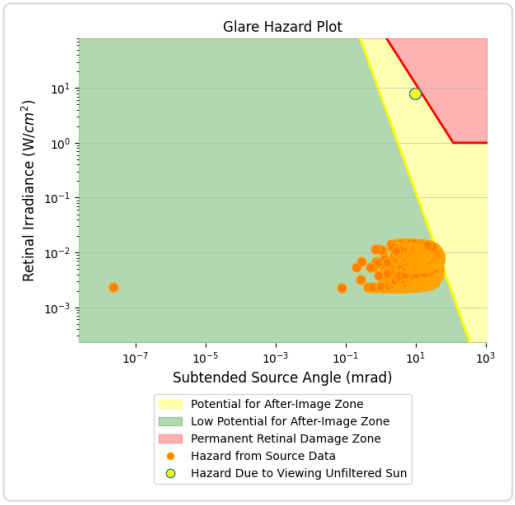
UV-01 and Route: N419 ri oost

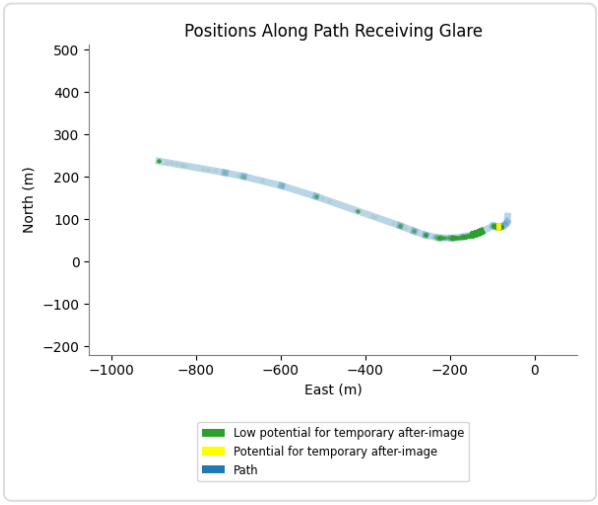
Yellow glare: 308 min.

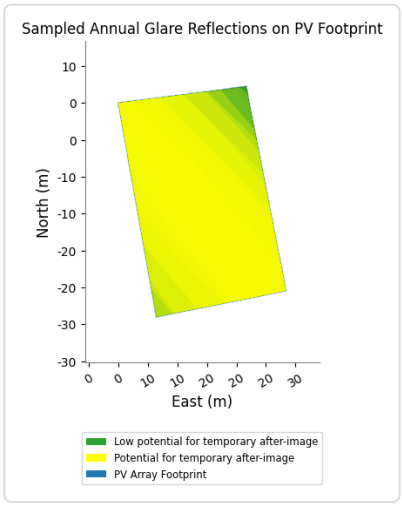
Green glare: 9,146 min.











UV-01 and Route: A12 ri oost

No glare found

UV-01 and Route: A12 ri west

No glare found

UV-01 and Route: N198 ri west

No glare found

UV-01 and Route: N419 ri west

No glare found

PV: UV-02 potential temporary after-image

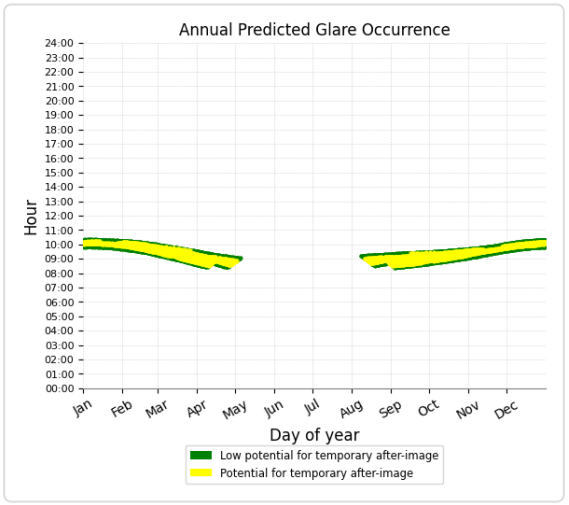
Receptor results ordered by category of glare

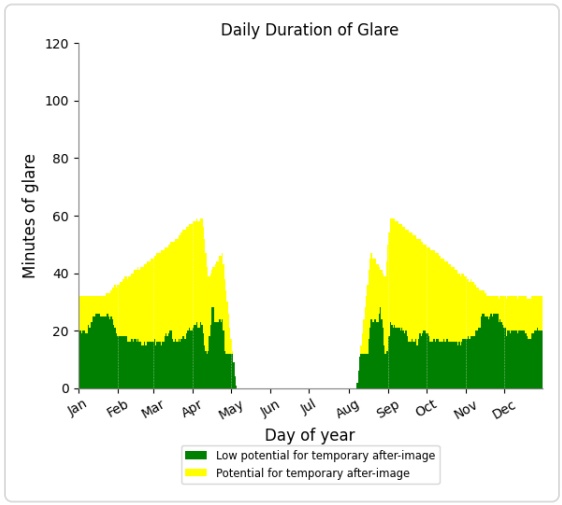
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	5,100	85.0	5,882	98.0
N419 ri oost	7,817	130.3	254	4.2
A12 ri oost	0	0.0	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

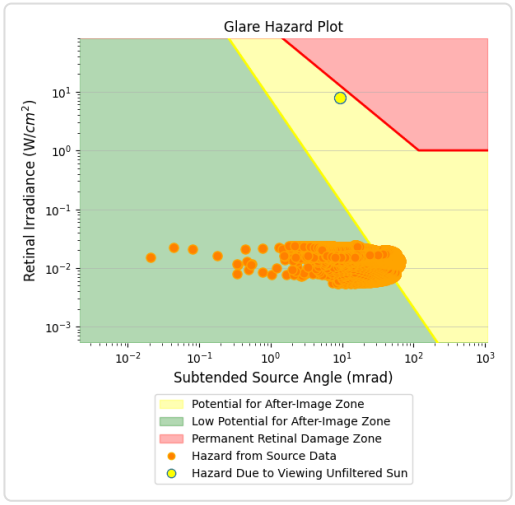
UV-02 and Route: N198 ri oost

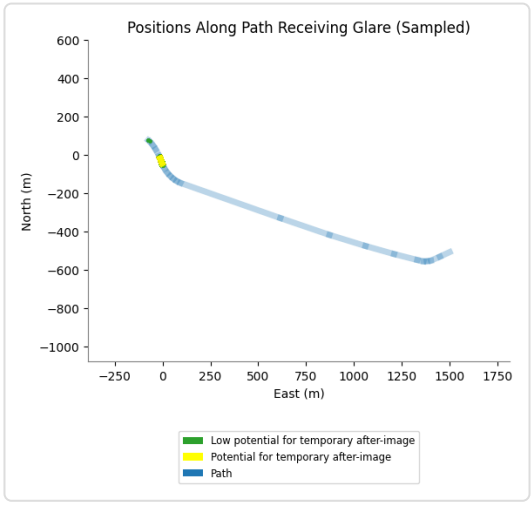
Yellow glare: 5,882 min.

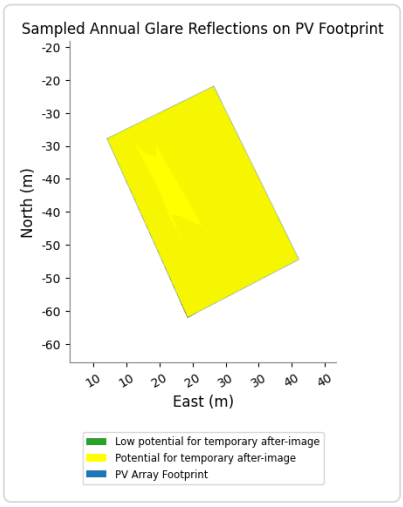
Green glare: 5,100 min.







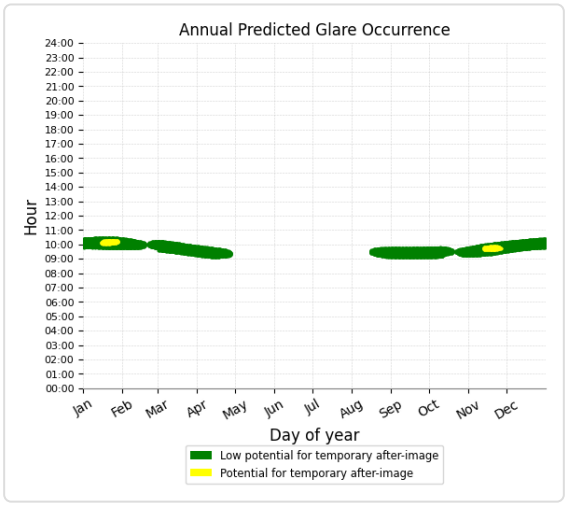


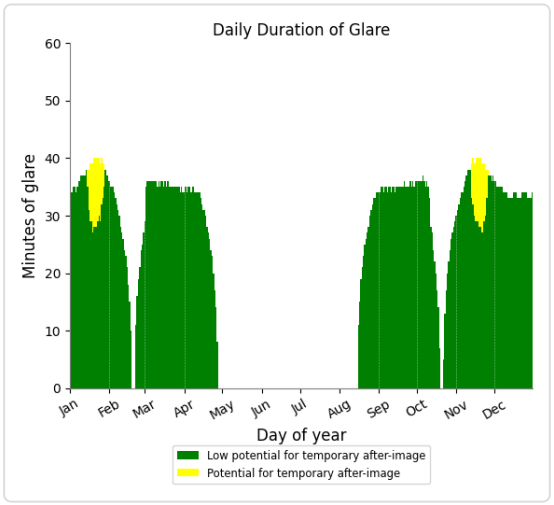


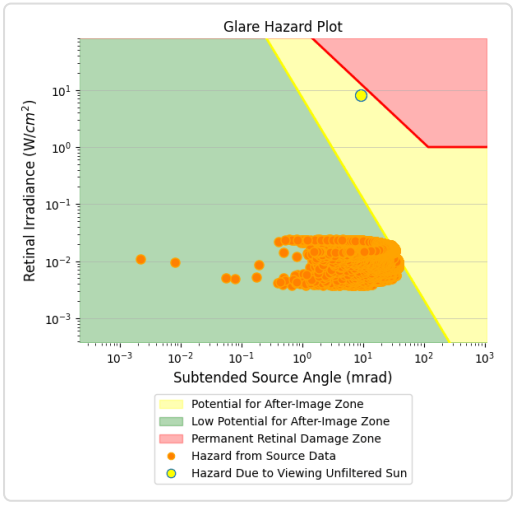
UV-02 and Route: N419 ri oost

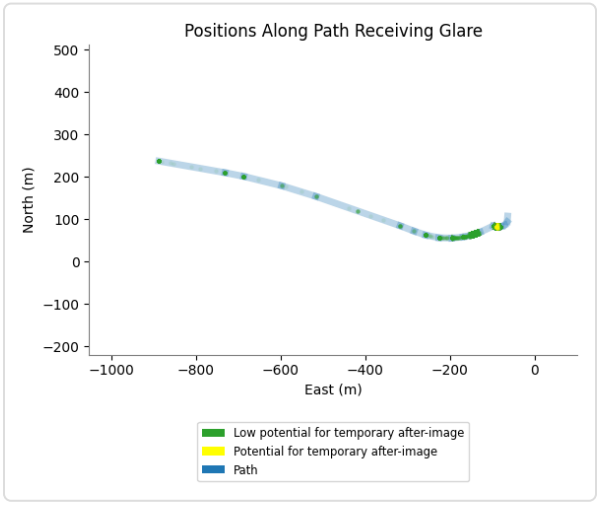
Yellow glare: 254 min.

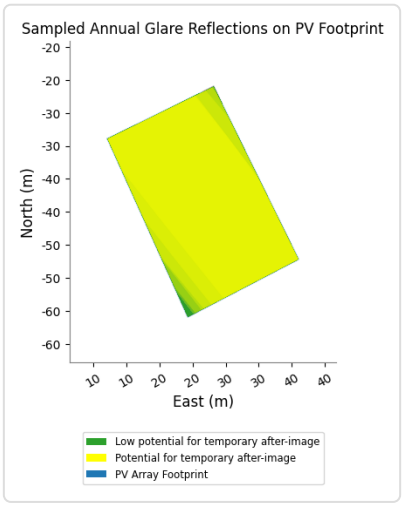
Green glare: 7,817 min.











UV-02 and Route: A12 ri oost

No glare found

UV-02 and Route: A12 ri west

No glare found

UV-02 and Route: N198 ri west

No glare found

UV-02 and Route: N419 ri west

No glare found

PV: UV-03 potential temporary after-image

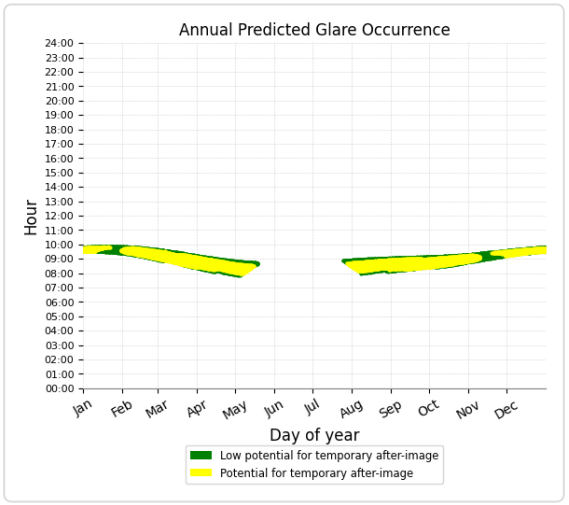
Receptor results ordered by category of glare

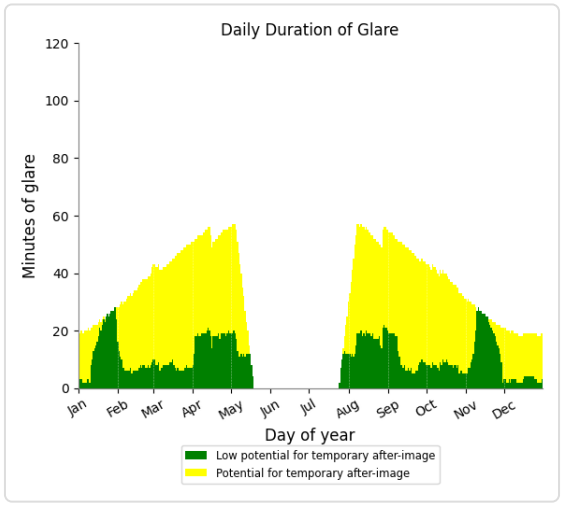
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	3,453	57.5	7,572	126.2
N419 ri oost	5,476	91.3	0	0.0
A12 ri oost	0	0.0	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

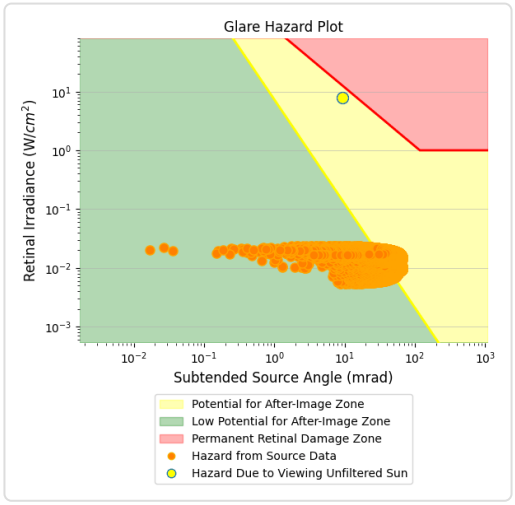
UV-03 and Route: N198 ri oost

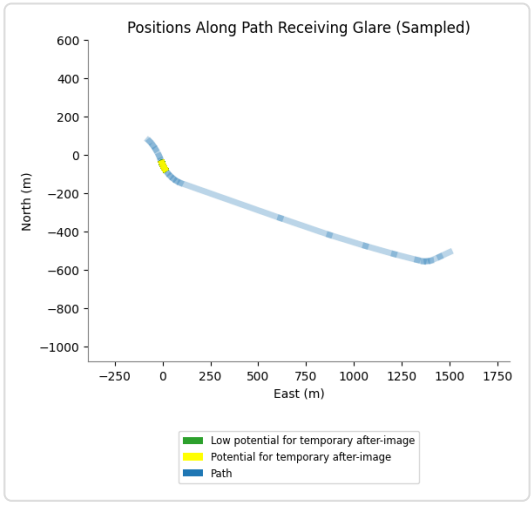
Yellow glare: 7,572 min.

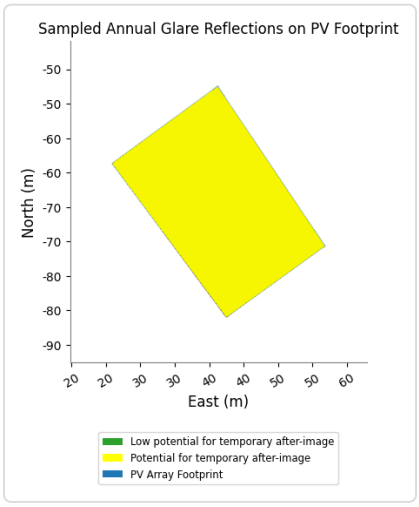
Green glare: 3,453 min.







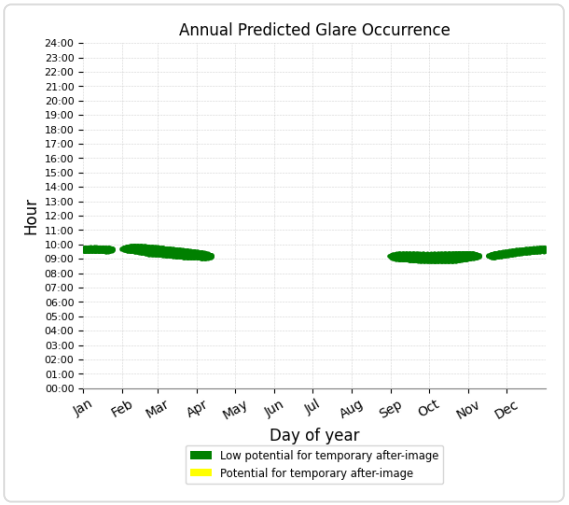


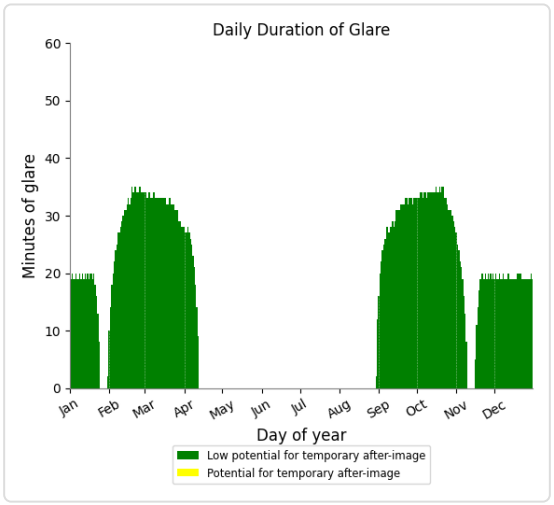


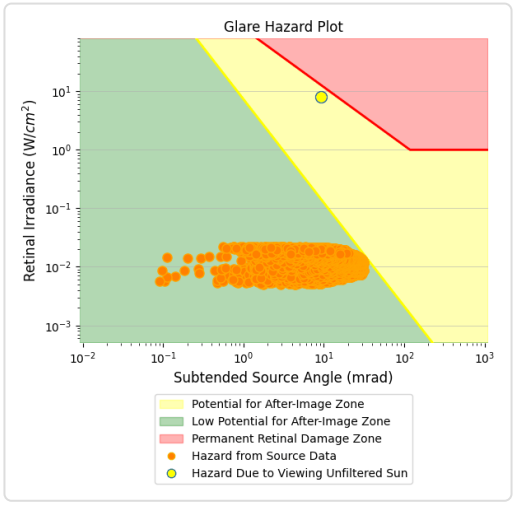
UV-03 and Route: N419 ri oost

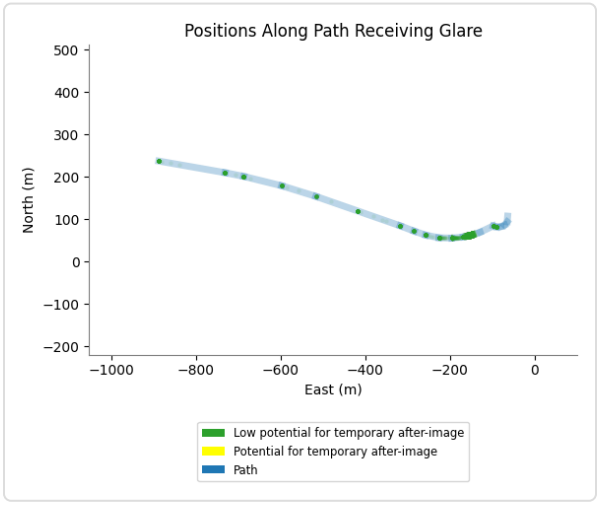
Yellow glare: none

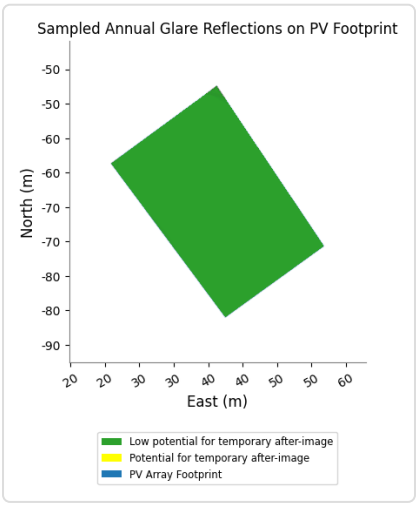
Green glare: 5,476 min.











UV-03 and Route: A12 ri oost

No glare found

UV-03 and Route: A12 ri west

No glare found

UV-03 and Route: N198 ri west

No glare found

UV-03 and Route: N419 ri west

No glare found

PV: UV-04 potential temporary after-image

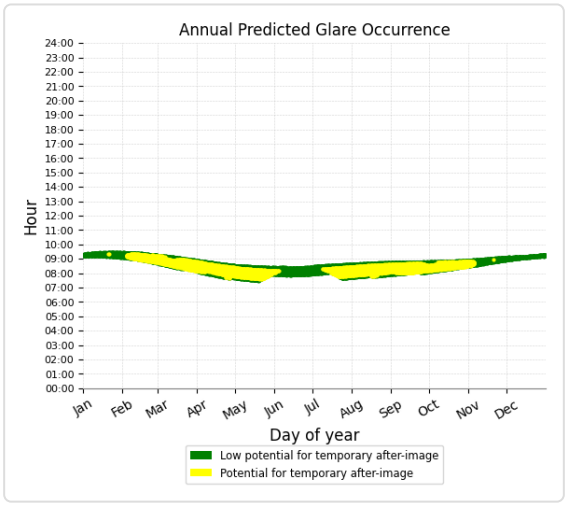
Receptor results ordered by category of glare

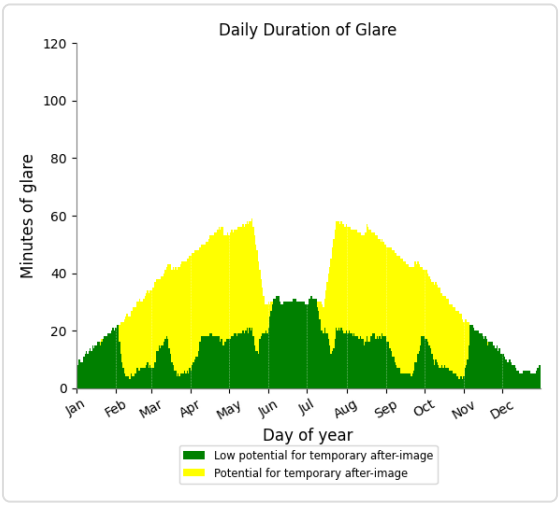
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	5,401	90.0	7,175	119.6
A12 ri oost	4,943	82.4	0	0.0
N419 ri oost	4,087	68.1	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

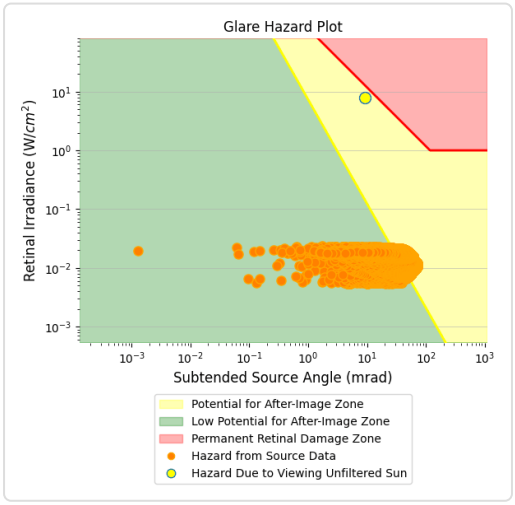
UV-04 and Route: N198 ri oost

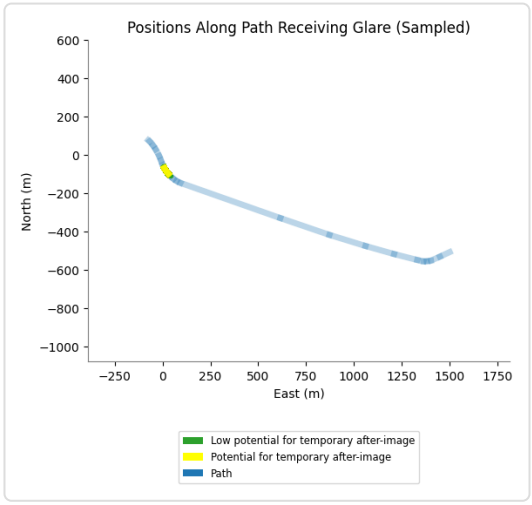
Yellow glare: 7,175 min.

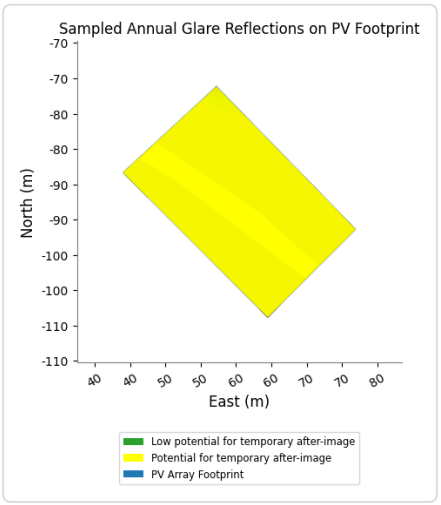
Green glare: 5,401 min.







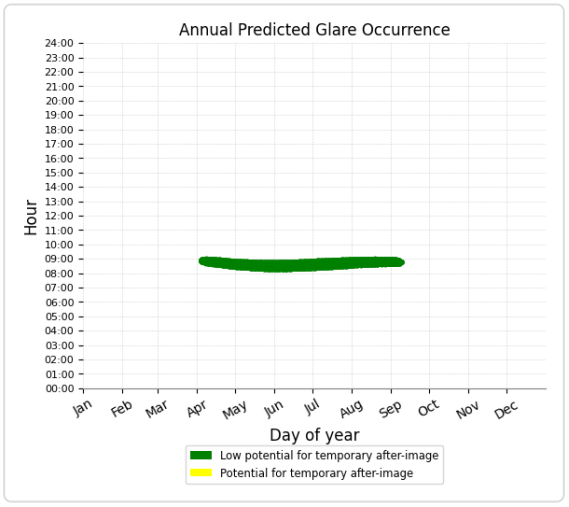


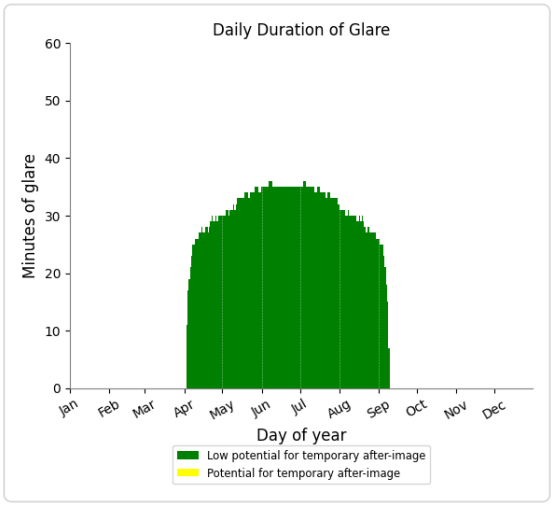


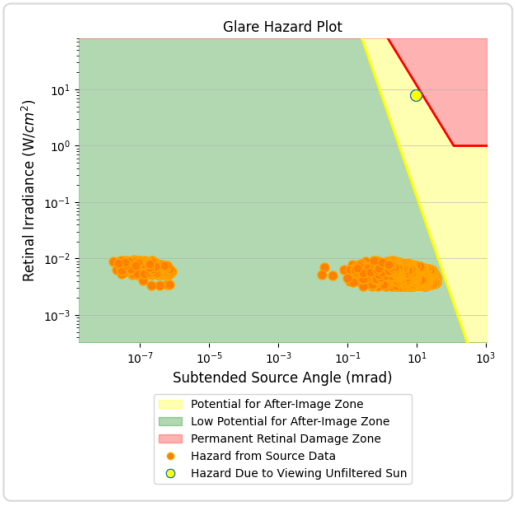
UV-04 and Route: A12 ri oost

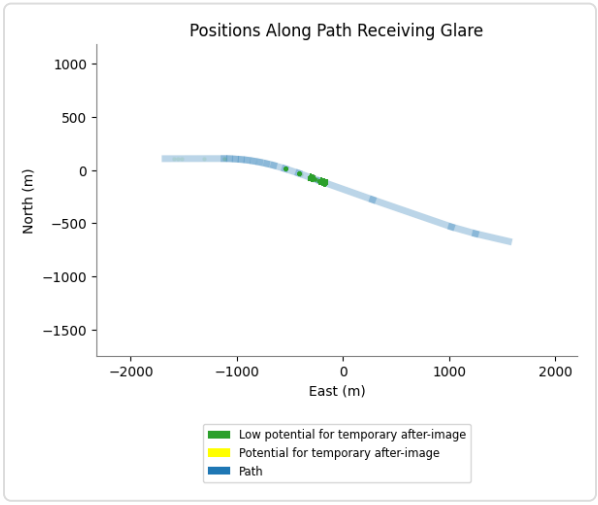
Yellow glare: none

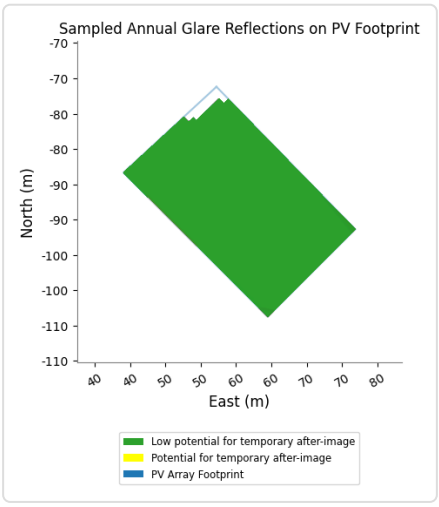
Green glare: 4,943 min.







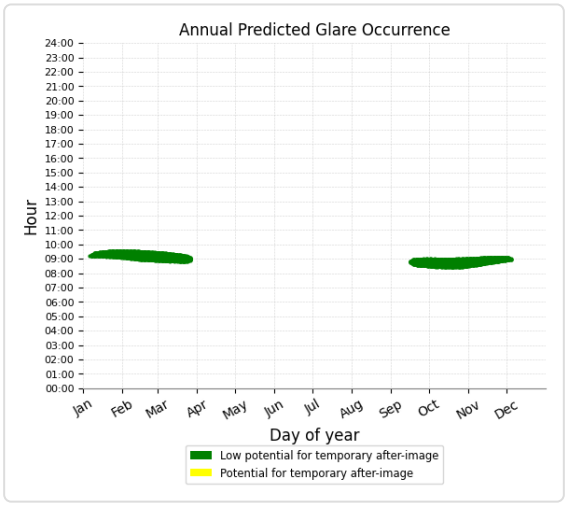


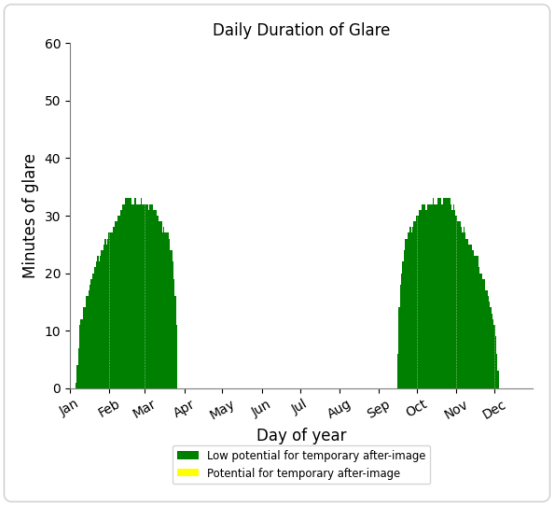


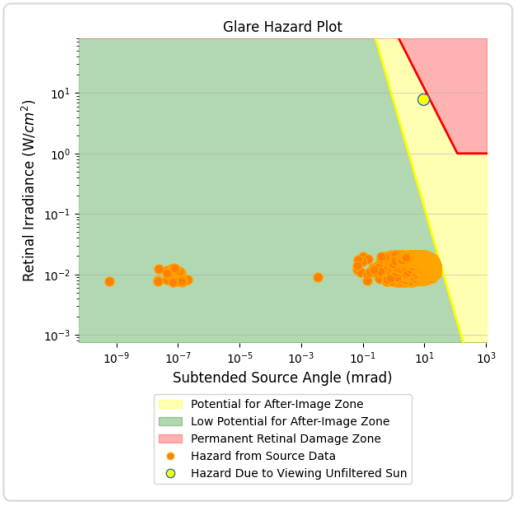
UV-04 and Route: N419 ri oost

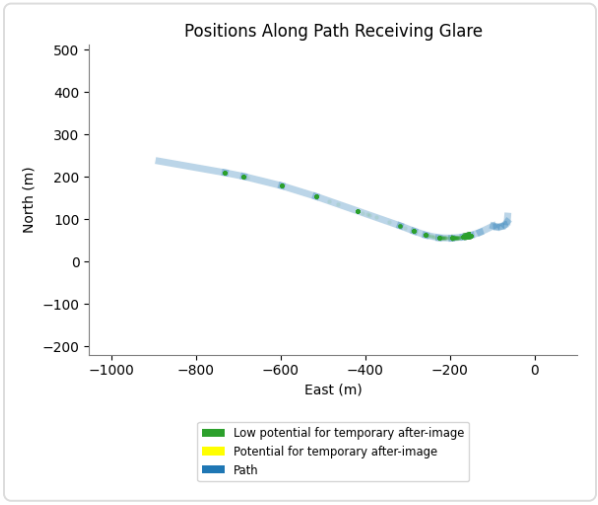
Yellow glare: none

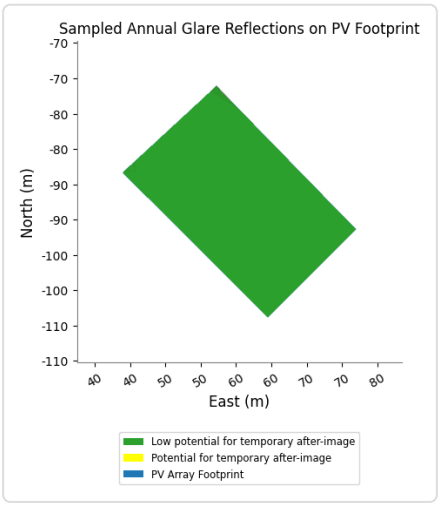
Green glare: 4,087 min.











UV-04 and Route: A12 ri west

No glare found

UV-04 and Route: N198 ri west

No glare found

UV-04 and Route: N419 ri west

No glare found

PV: UV-05 potential temporary after-image

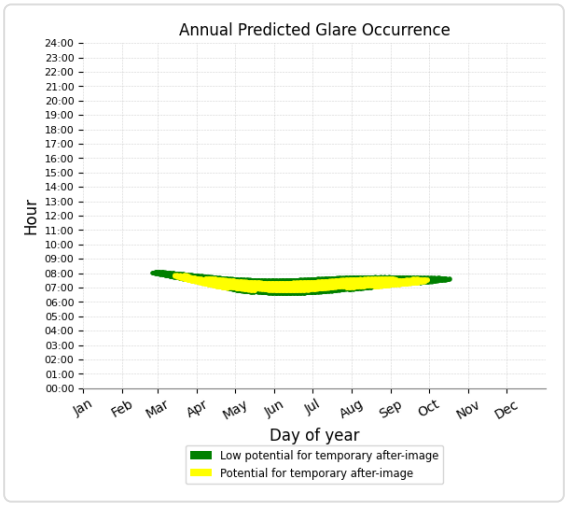
Receptor results ordered by category of glare

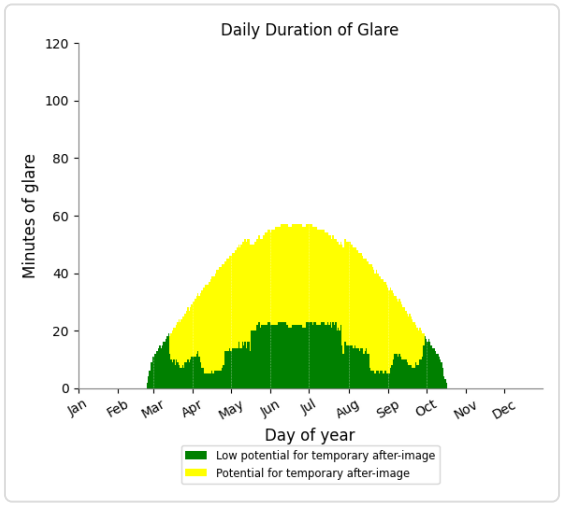
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	3,302	55.0	5,773	96.2
N198 ri west	773	12.9	746	12.4
A12 ri oost	7,124	118.7	0	0.0
A12 ri west	2,058	34.3	0	0.0
N419 ri oost	499	8.3	0	0.0
N419 ri west	0	0.0	0	0.0

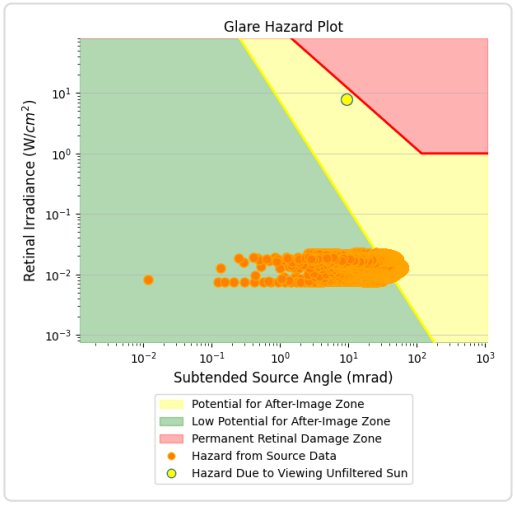
UV-05 and Route: N198 ri oost

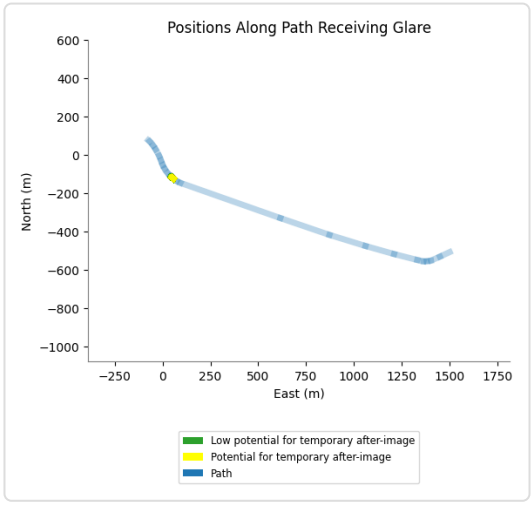
Yellow glare: 5,773 min.

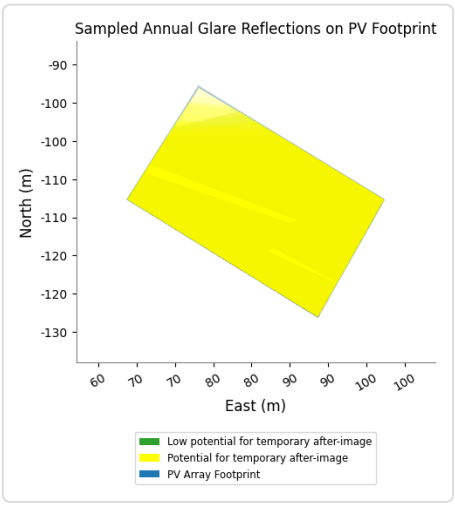
Green glare: 3,302 min.







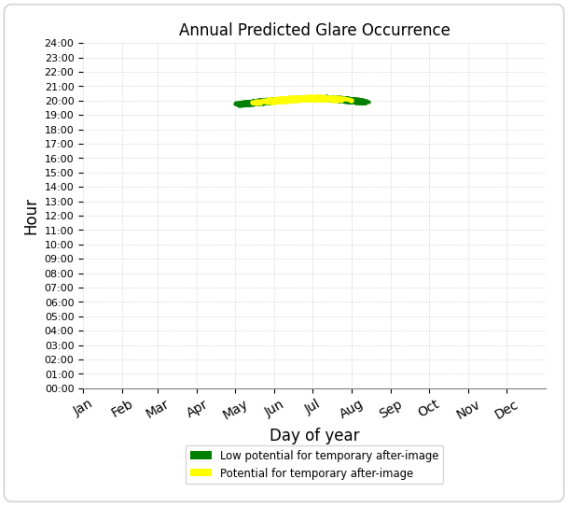


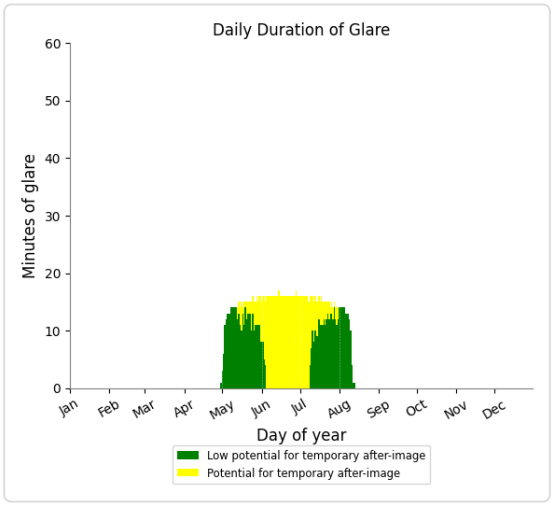


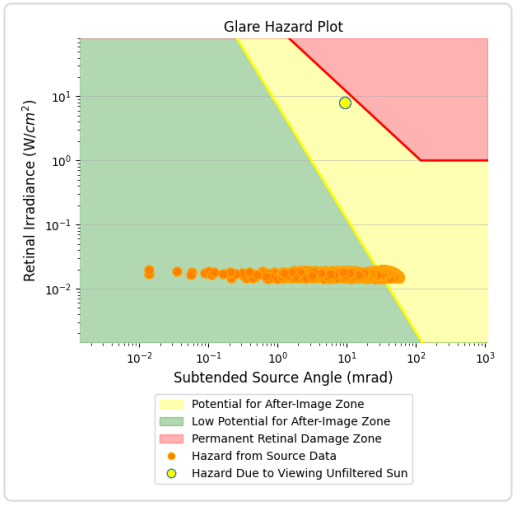
UV-05 and Route: N198 ri west

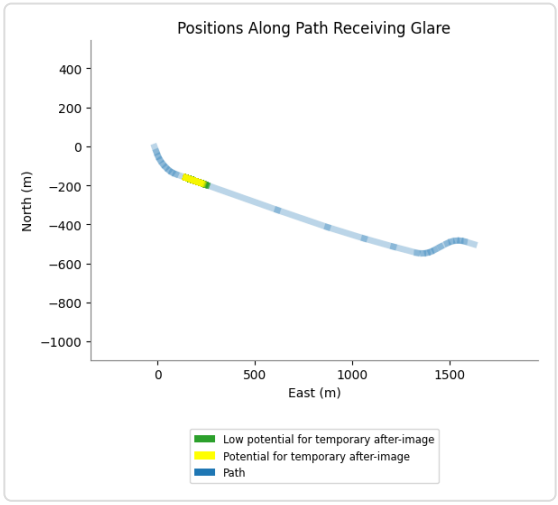
Yellow glare: 746 min.

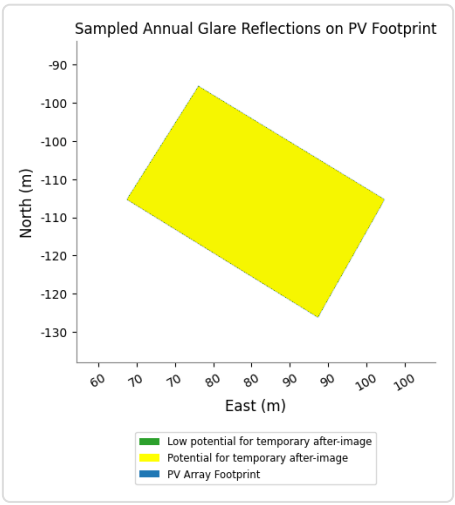
Green glare: 773 min.







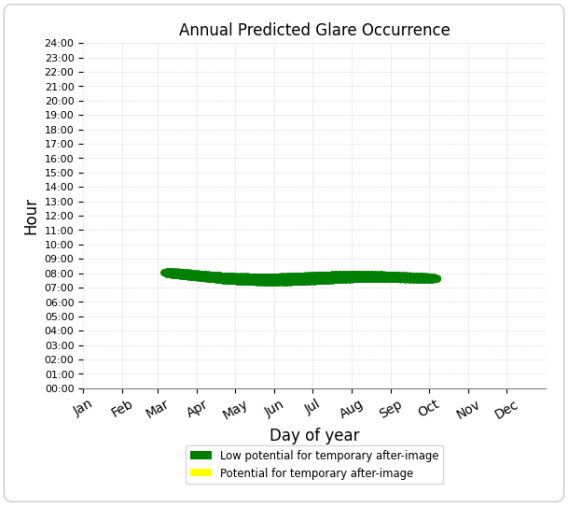


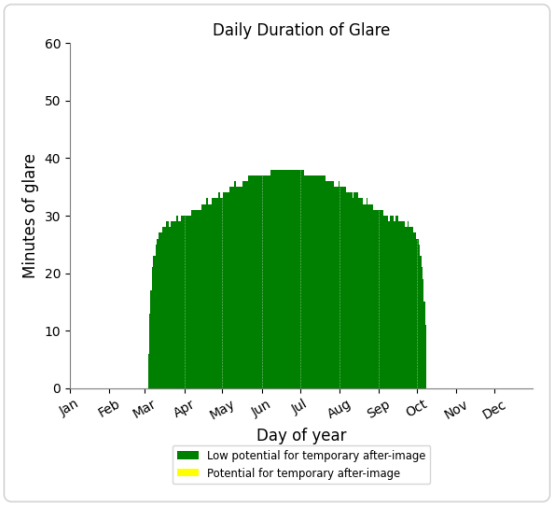


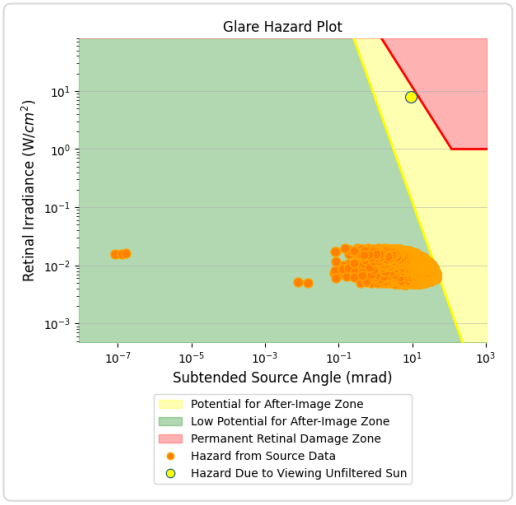
UV-05 and Route: A12 ri oost

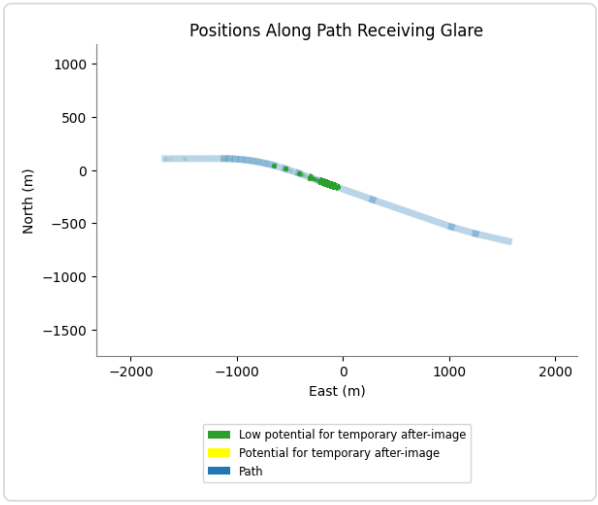
Yellow glare: none

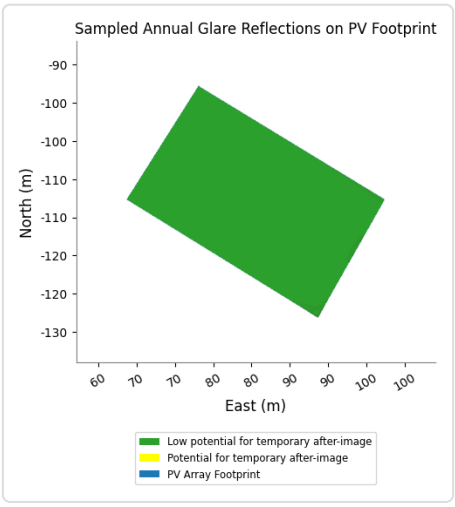
Green glare: 7,124 min.







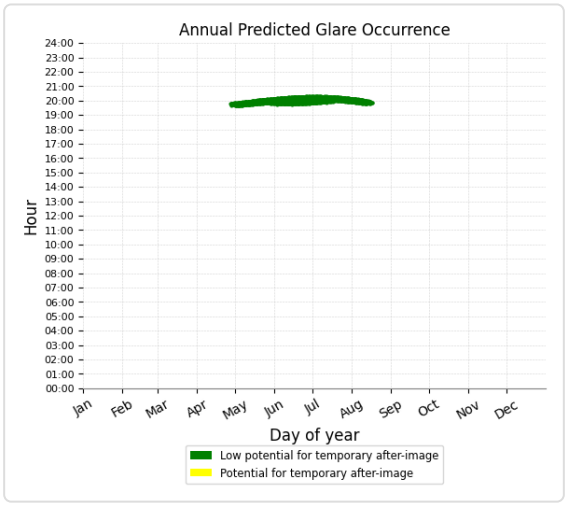


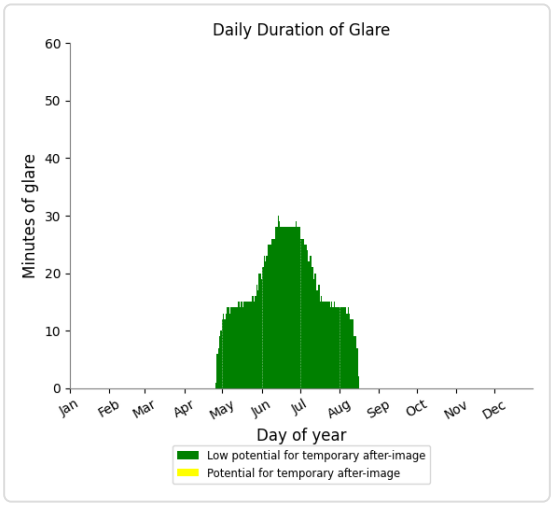


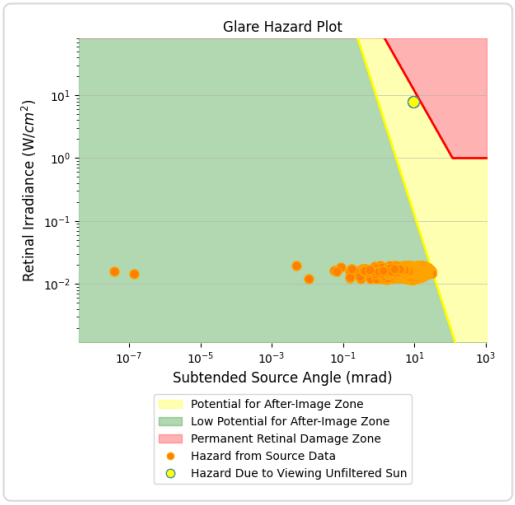
UV-05 and Route: A12 ri west

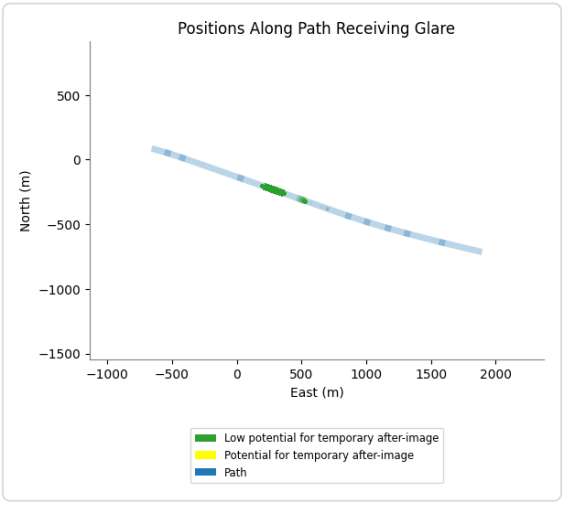
Yellow glare: none

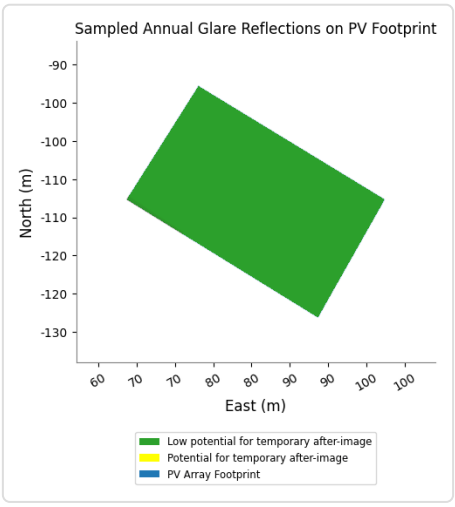
Green glare: 2,058 min.







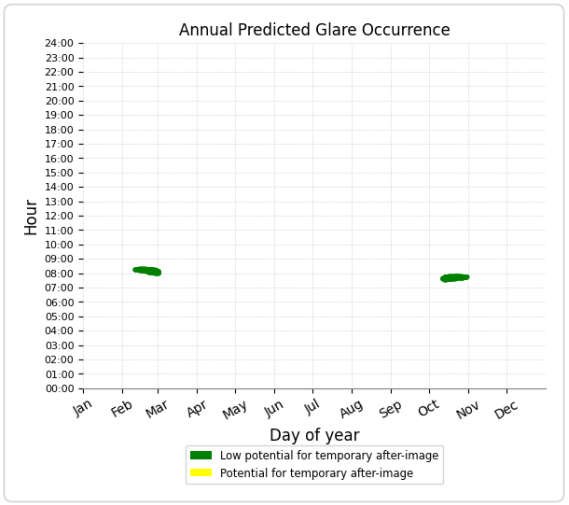


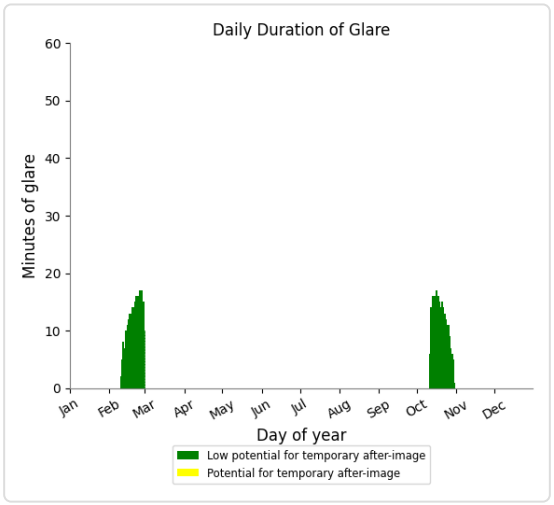


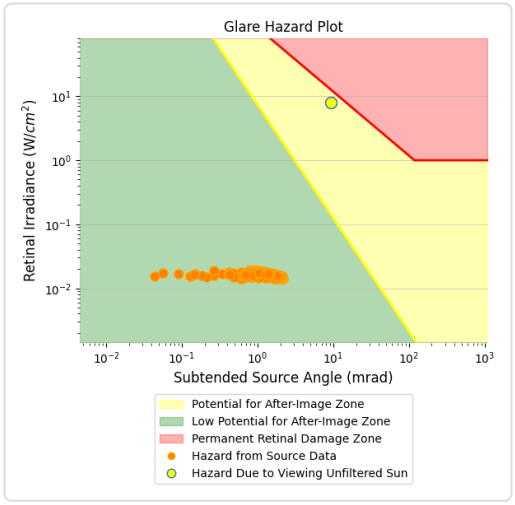
UV-05 and Route: N419 ri oost

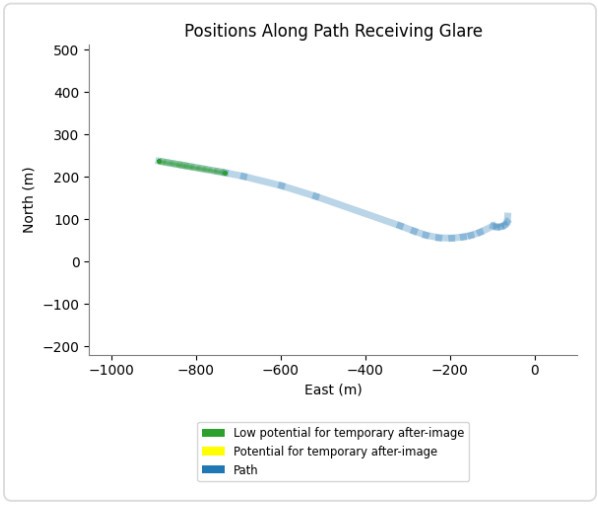
Yellow glare: none

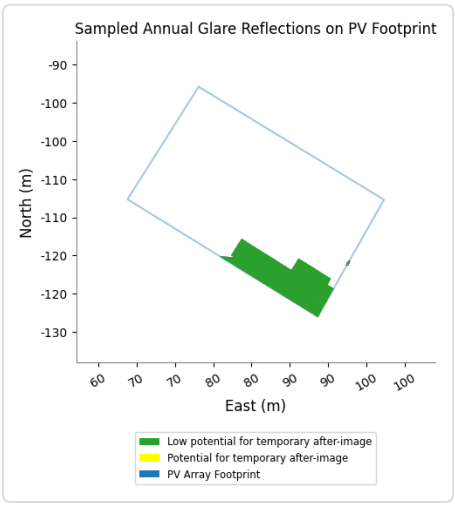
Green glare: 499 min.











UV-05 and Route: N419 ri west

No glare found

PV: UV-06 potential temporary after-image

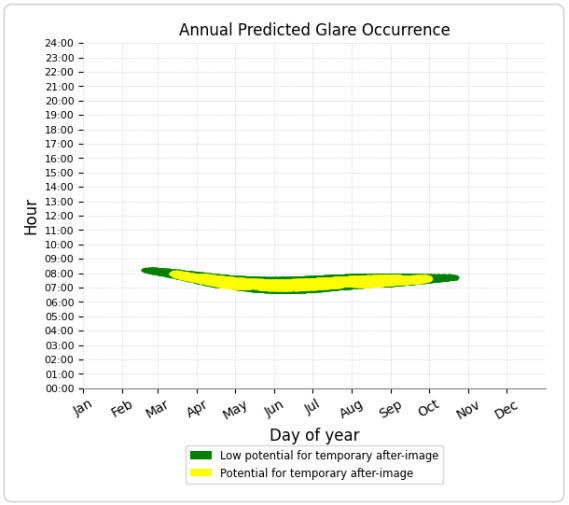
Receptor results ordered by category of glare

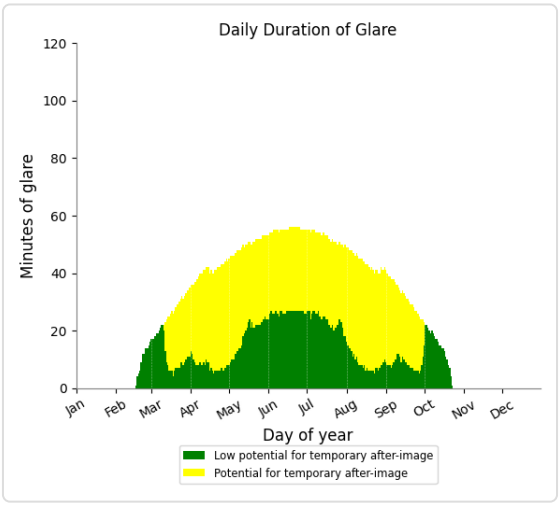
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	3,695	61.6	5,942	99.0
N198 ri west	578	9.6	887	14.8
A12 ri oost	7,132	118.9	0	0.0
A12 ri west	2,214	36.9	0	0.0
N419 ri oost	627	10.4	0	0.0
N419 ri west	0	0.0	0	0.0

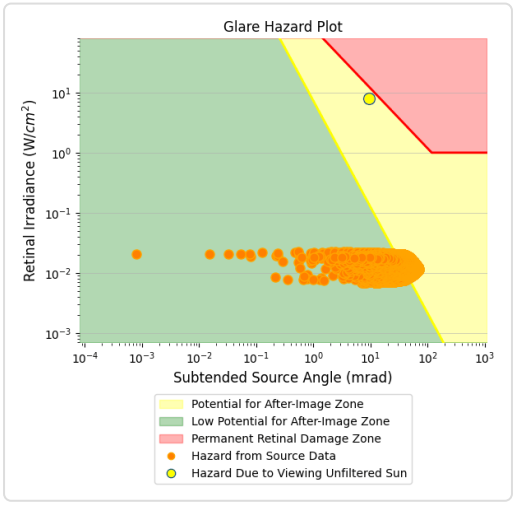
UV-06 and Route: N198 ri oost

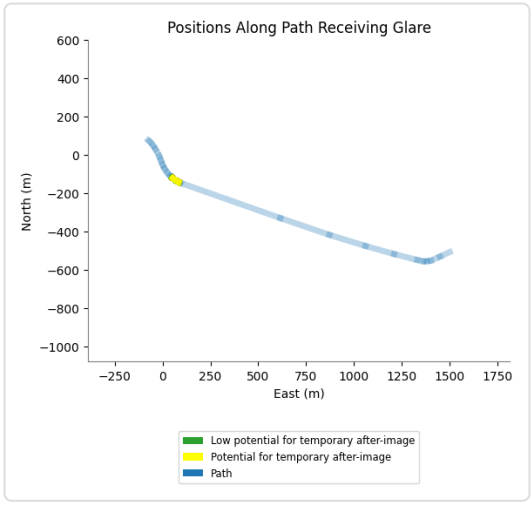
Yellow glare: 5,942 min.

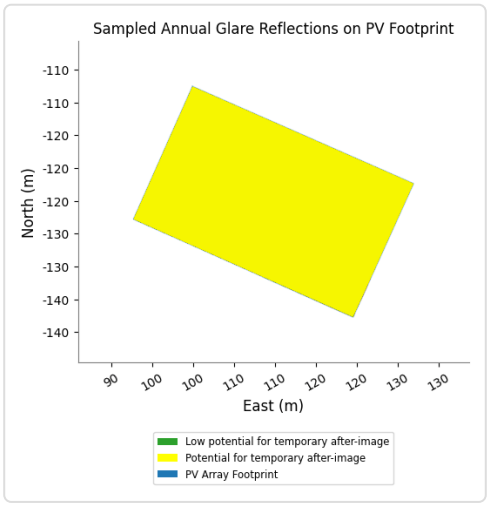
Green glare: 3,695 min.







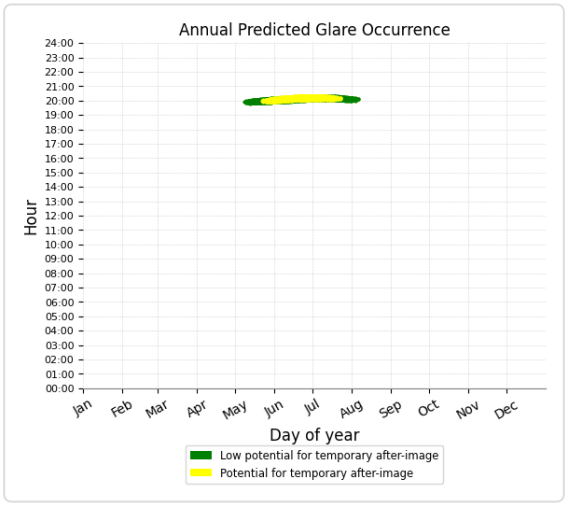


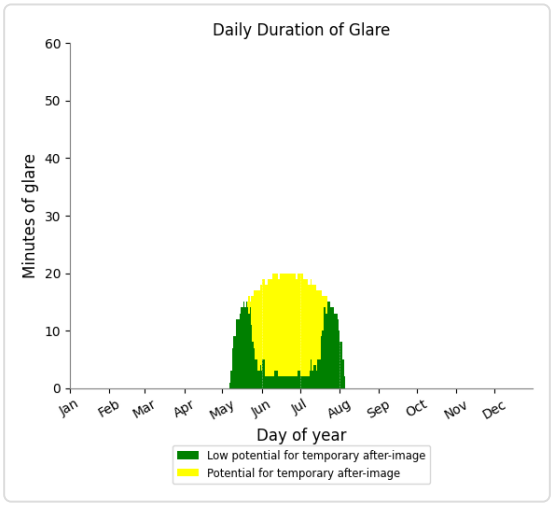


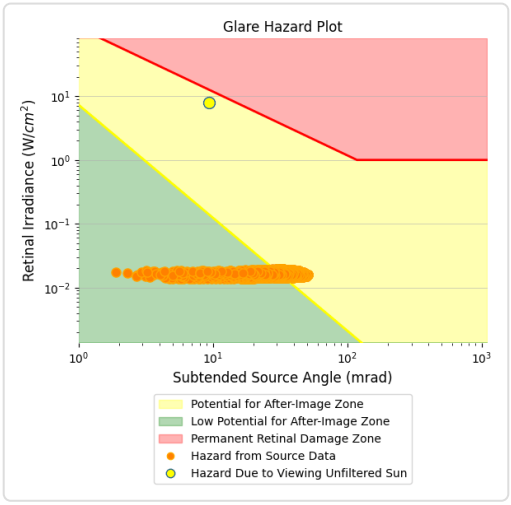
UV-06 and Route: N198 ri west

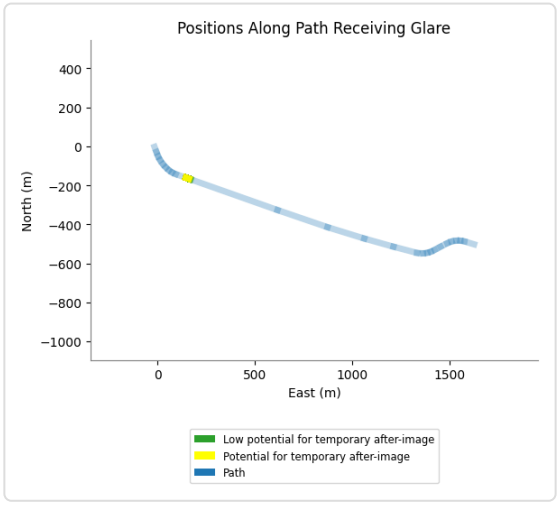
Yellow glare: 887 min.

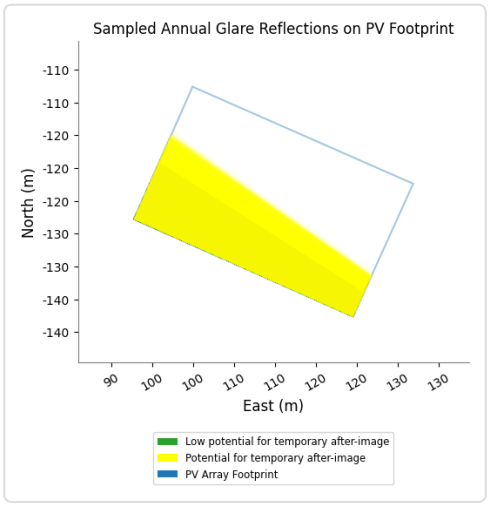
Green glare: 578 min.







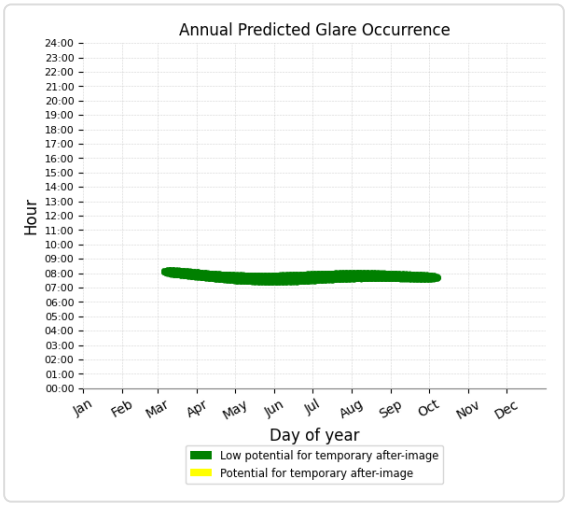


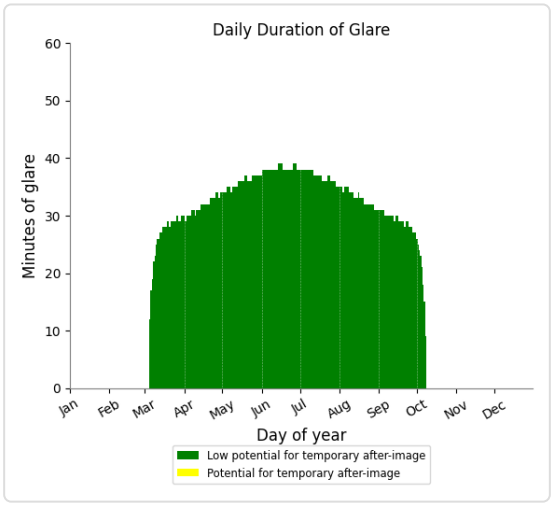


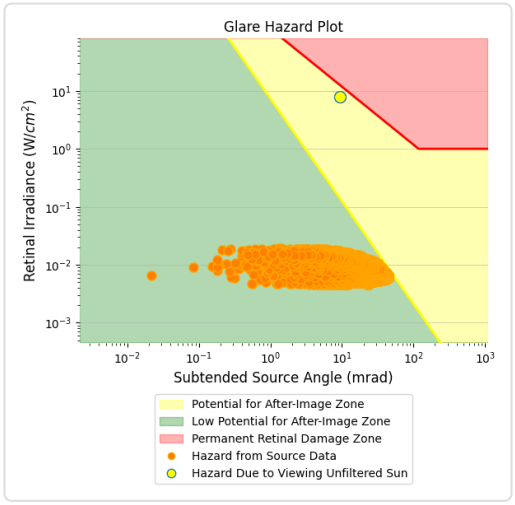
UV-06 and Route: A12 ri oost

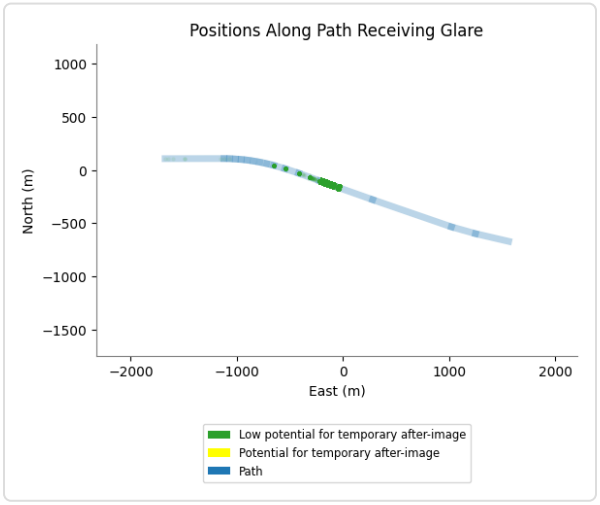
Yellow glare: none

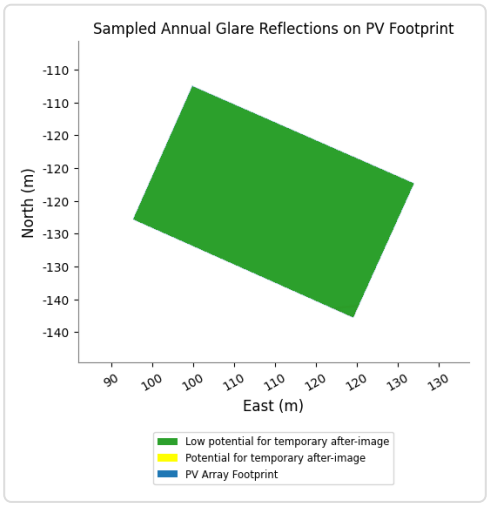
Green glare: 7,132 min.







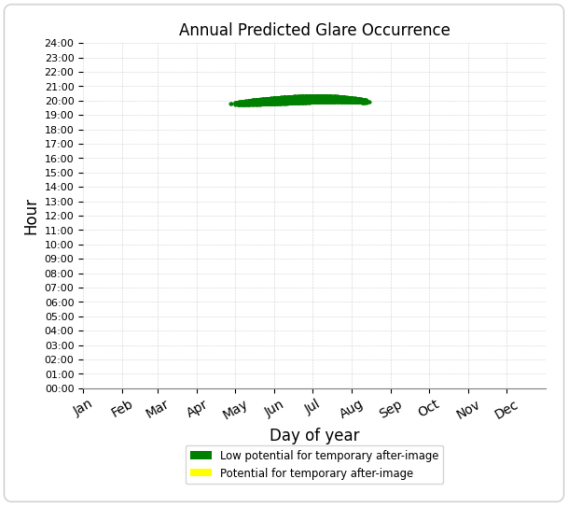


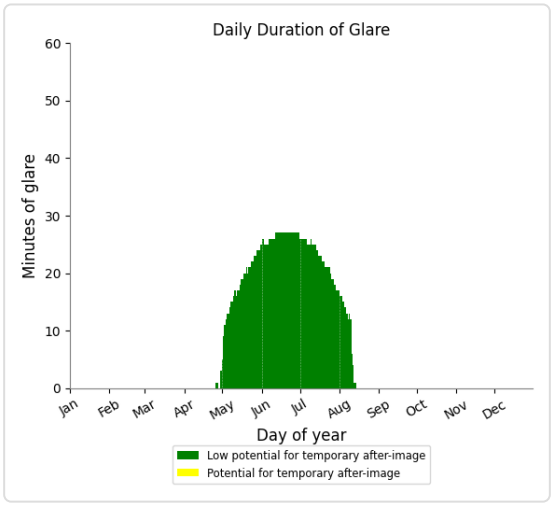


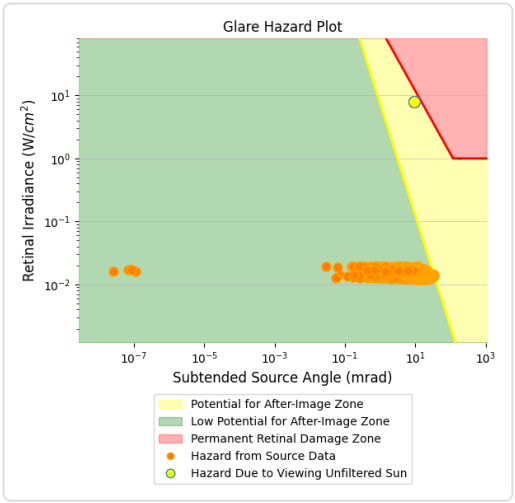
UV-06 and Route: A12 ri west

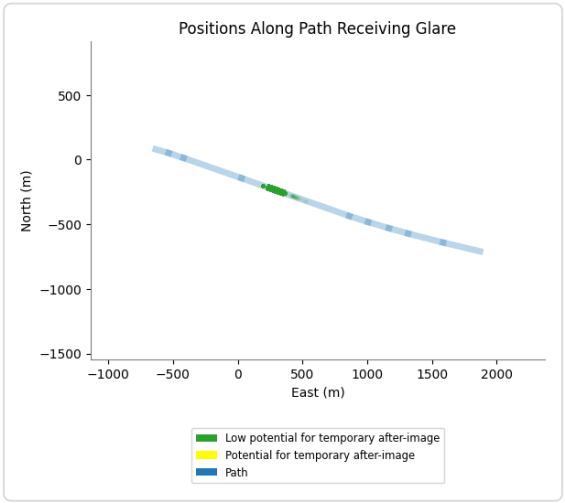
Yellow glare: none

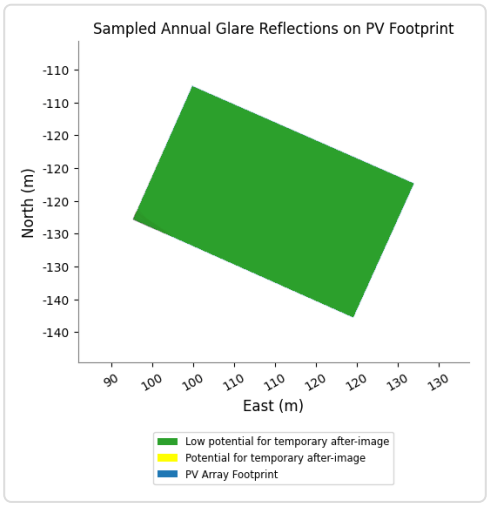
Green glare: 2,214 min.







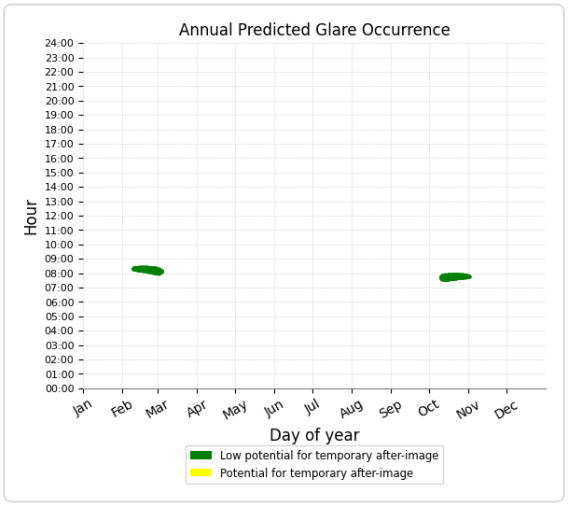


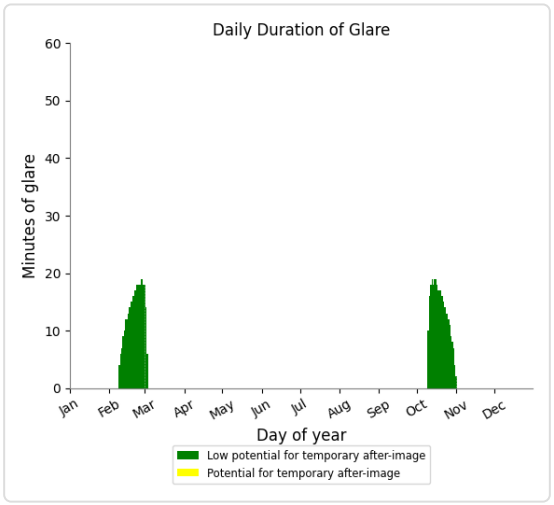


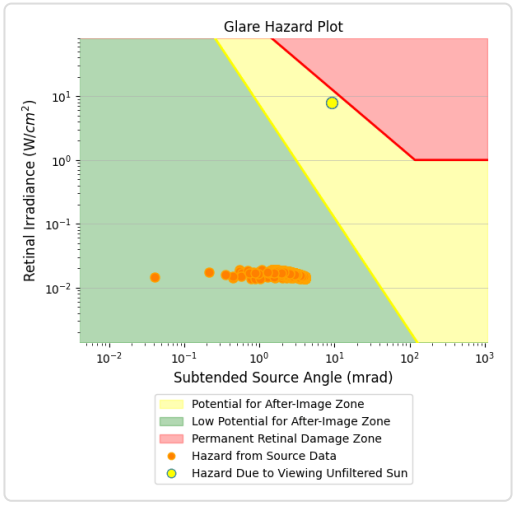
UV-06 and Route: N419 ri oost

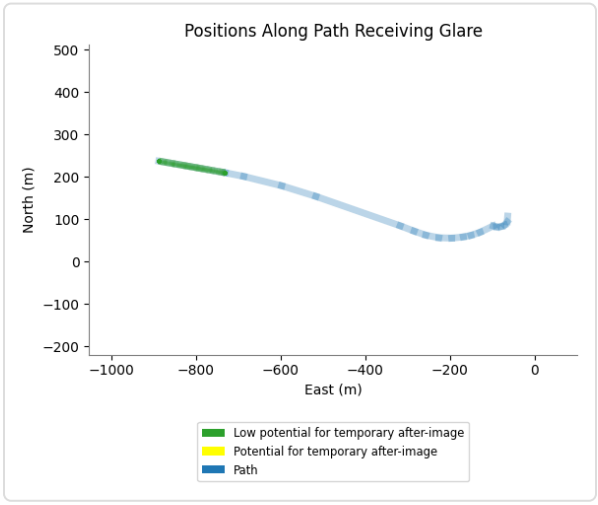
Yellow glare: none

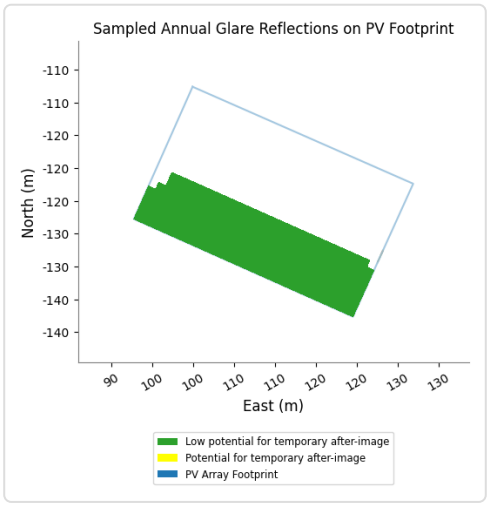
Green glare: 627 min.











UV-06 and Route: N419 ri west

No glare found

PV: UV-07 potential temporary after-image

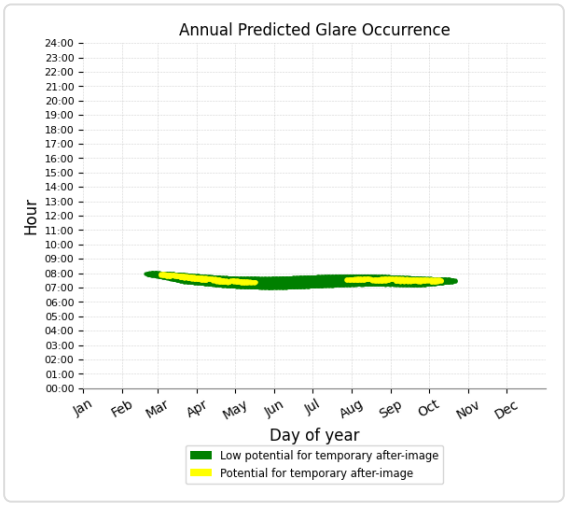
Receptor results ordered by category of glare

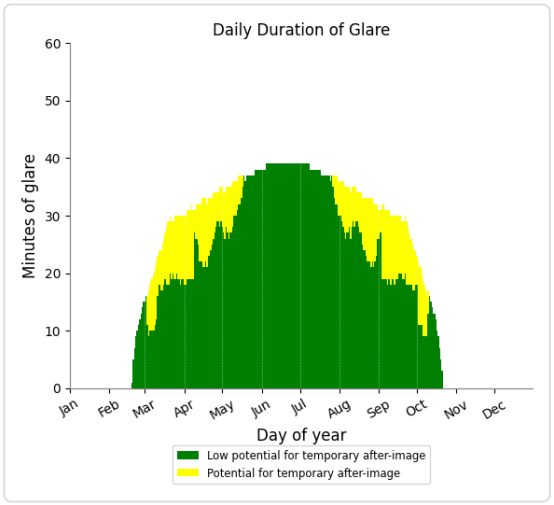
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	6,238	104.0	1,307	21.8
A12 ri west	1,216	20.3	1,771	29.5
N198 ri oost	2,471	41.2	6,085	101.4
N198 ri west	551	9.2	2,083	34.7
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

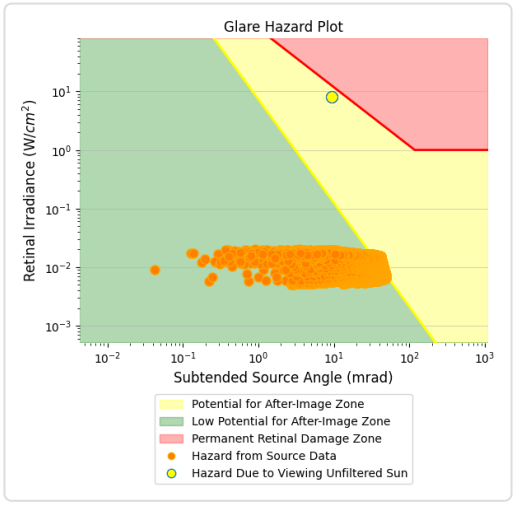
UV-07 and Route: A12 ri oost

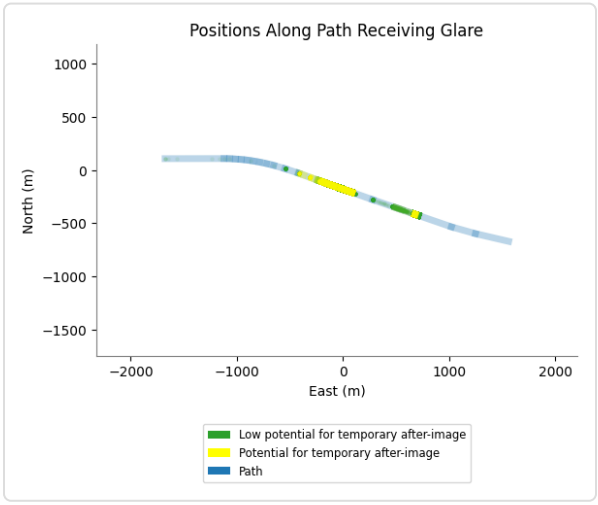
Yellow glare: 1,307 min.

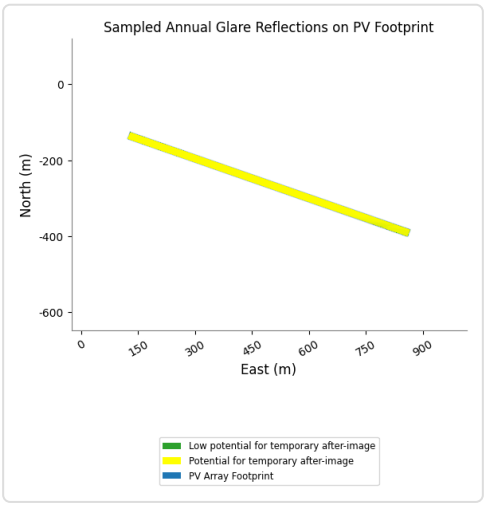
Green glare: 6,238 min.







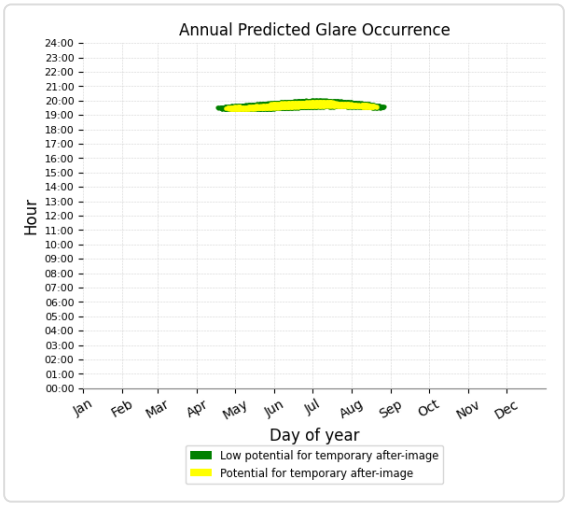


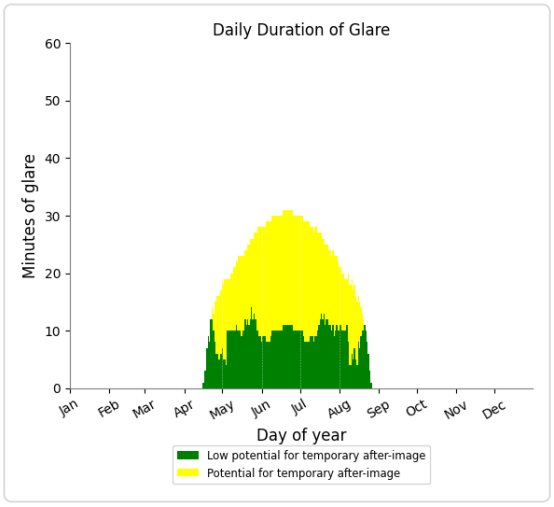


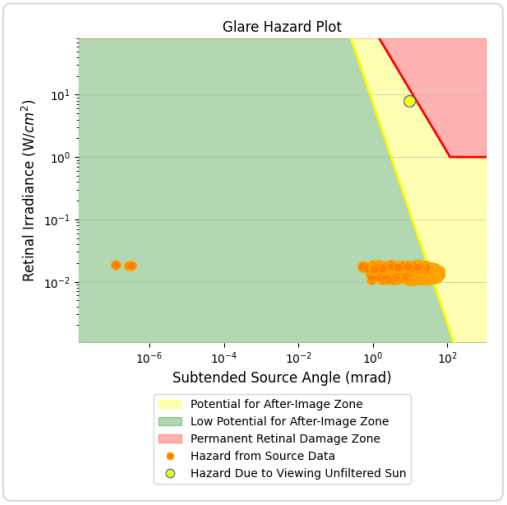
UV-07 and Route: A12 ri west

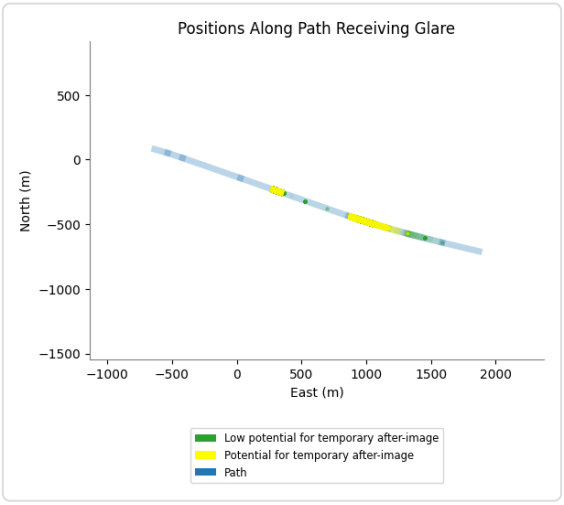
Yellow glare: 1,771 min.

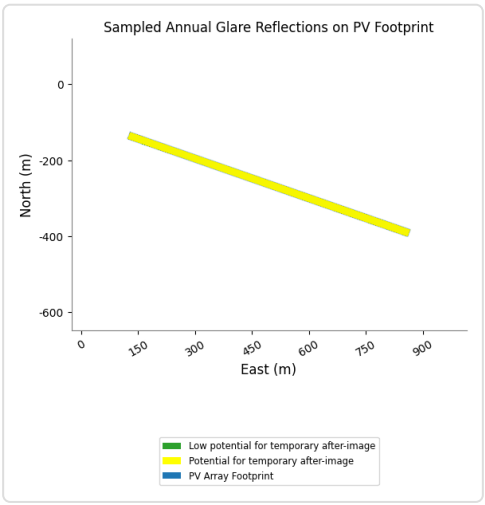
Green glare: 1,216 min.







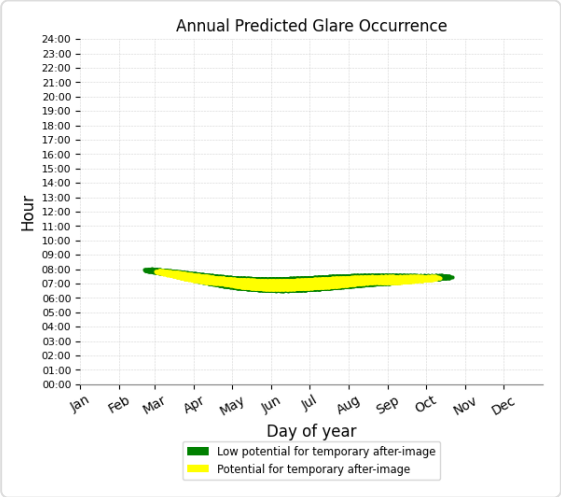


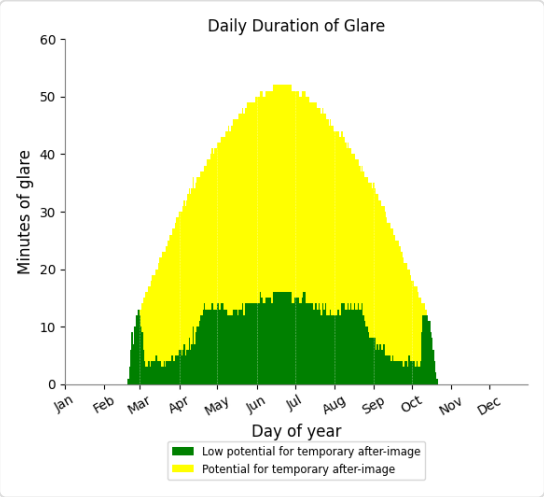


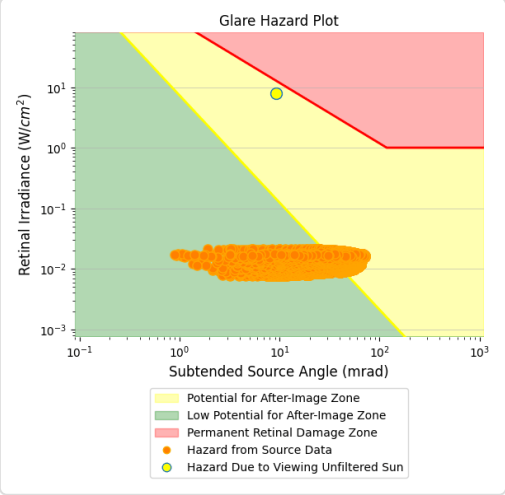
UV-07 and Route: N198 ri oost

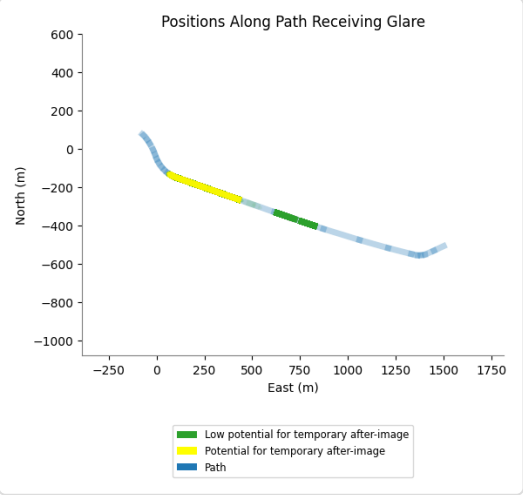
Yellow glare: 6,085 min.

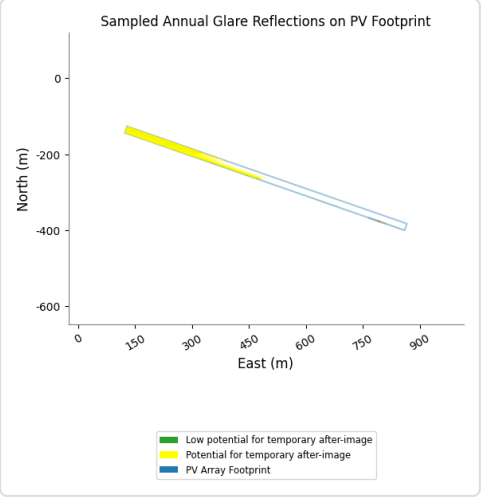
Green glare: 2,471 min.







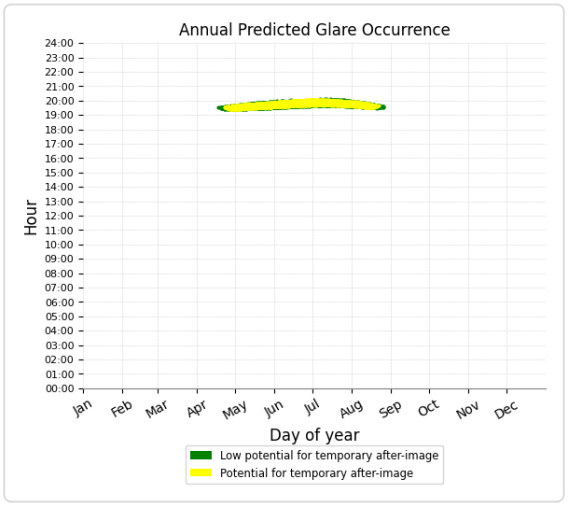


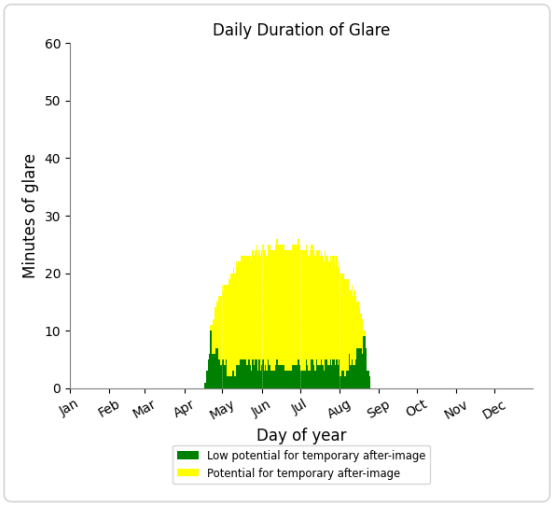


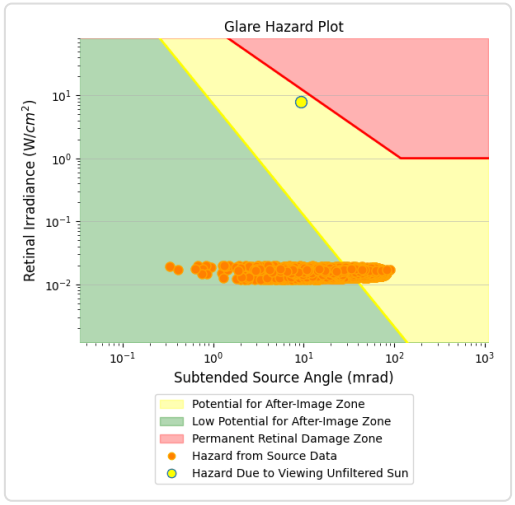
UV-07 and Route: N198 ri west

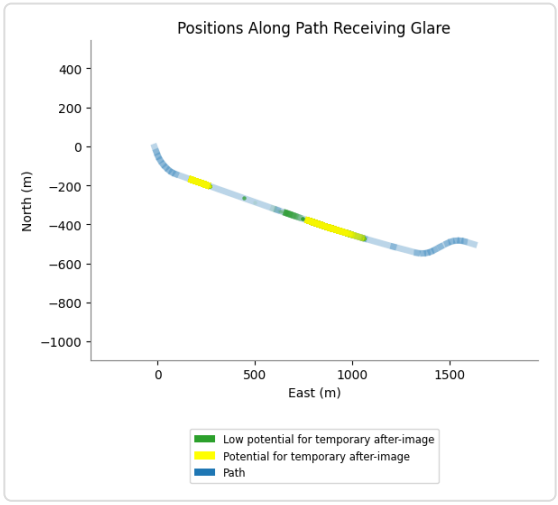
Yellow glare: 2,083 min.

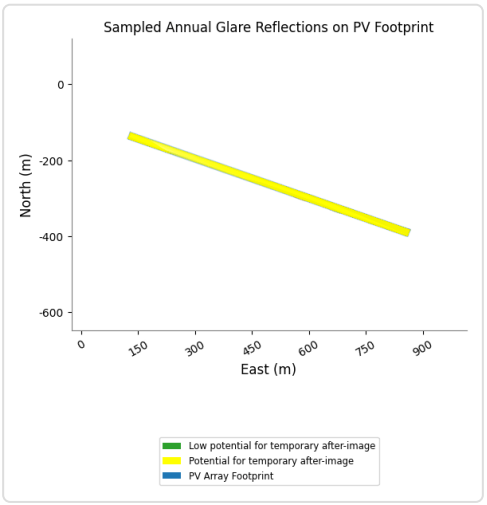
Green glare: 551 min.











UV-07 and Route: N419 ri oost

No glare found

UV-07 and Route: N419 ri west

No glare found

PV: UV-08 potential temporary after-image

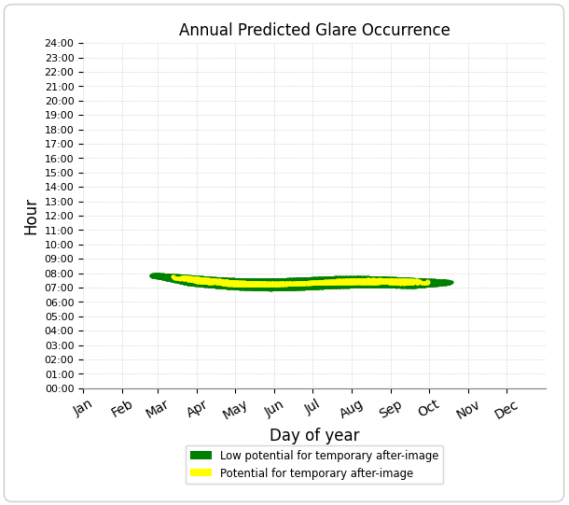
Receptor results ordered by category of glare

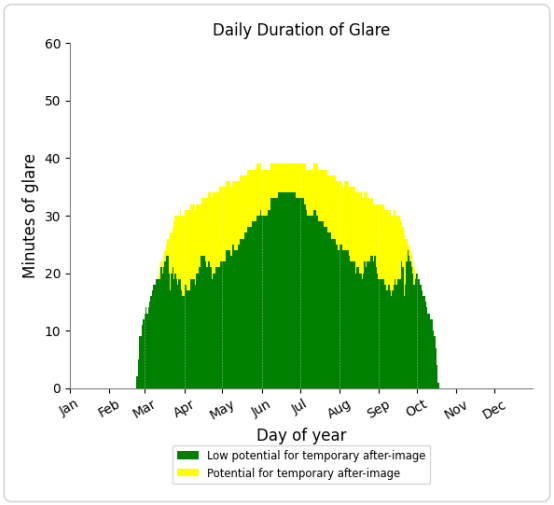
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	5,413	90.2	1,953	32.5
A12 ri west	2,237	37.3	1,178	19.6
N198 ri oost	2,406	40.1	5,315	88.6
N198 ri west	549	9.2	2,311	38.5
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

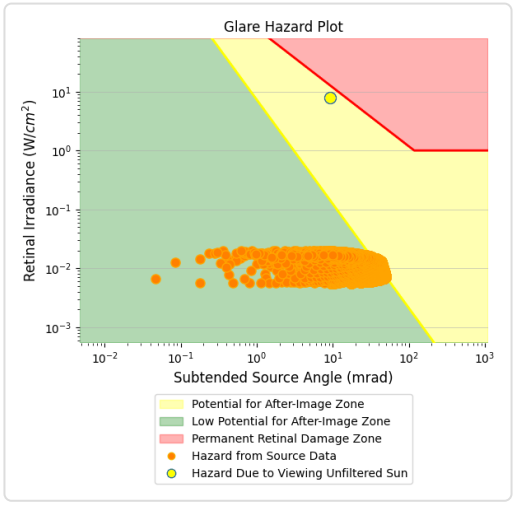
UV-08 and Route: A12 ri oost

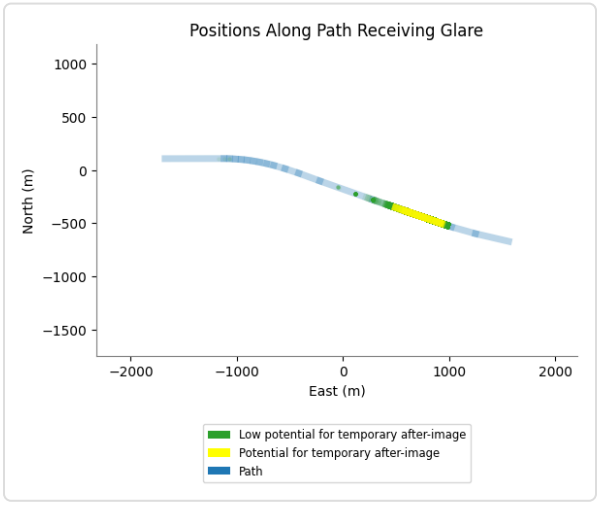
Yellow glare: 1,953 min.

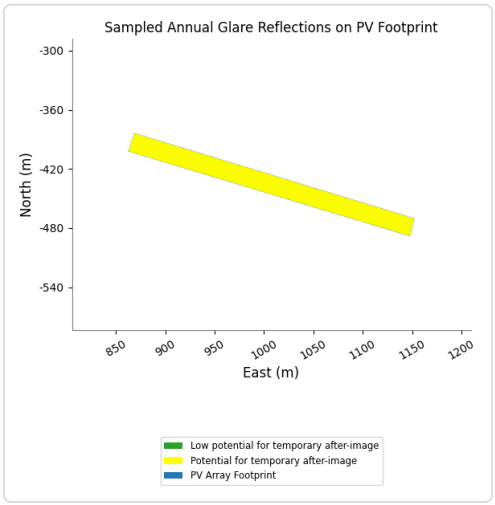
Green glare: 5,413 min.







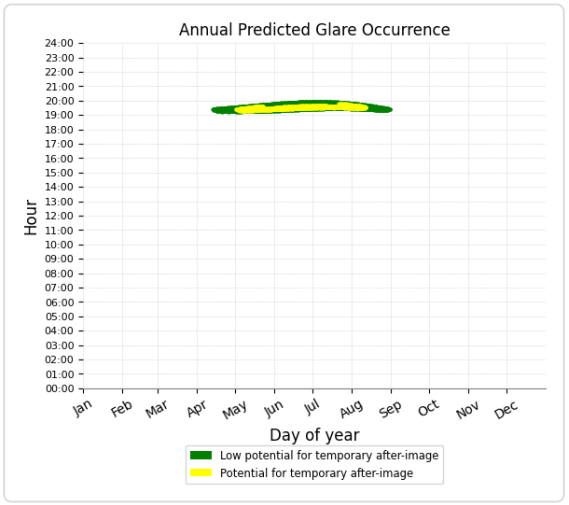


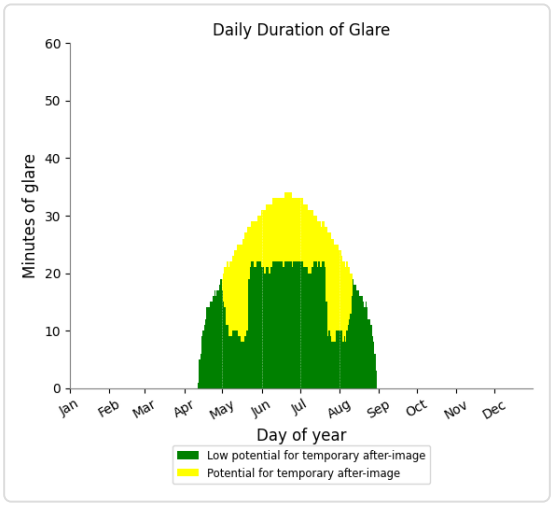


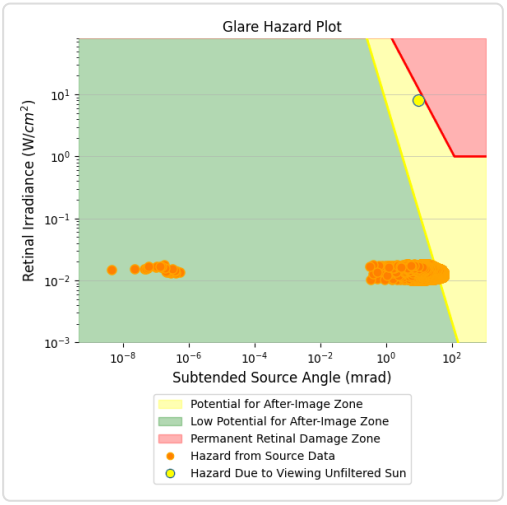
UV-08 and Route: A12 ri west

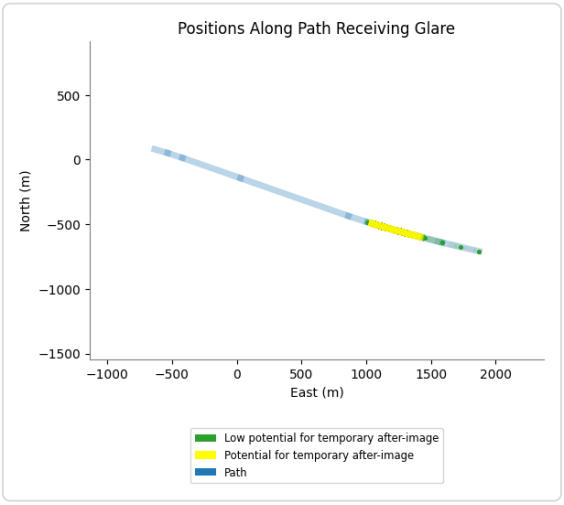
Yellow glare: 1,178 min.

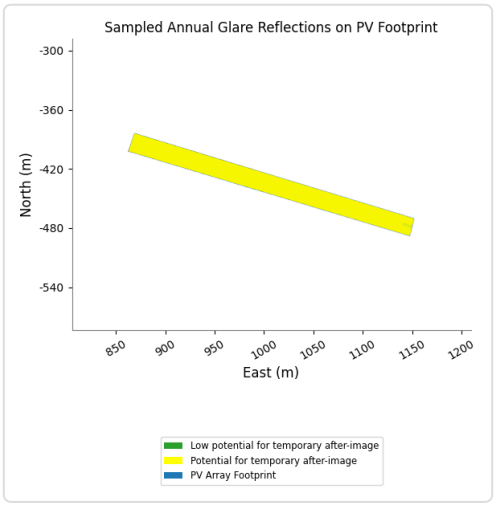
Green glare: 2,237 min.







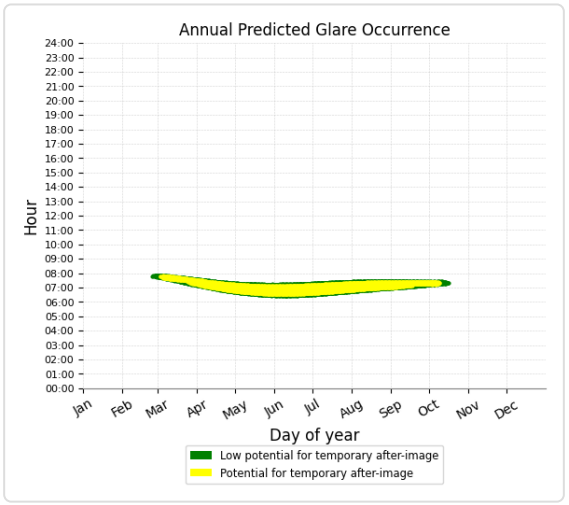


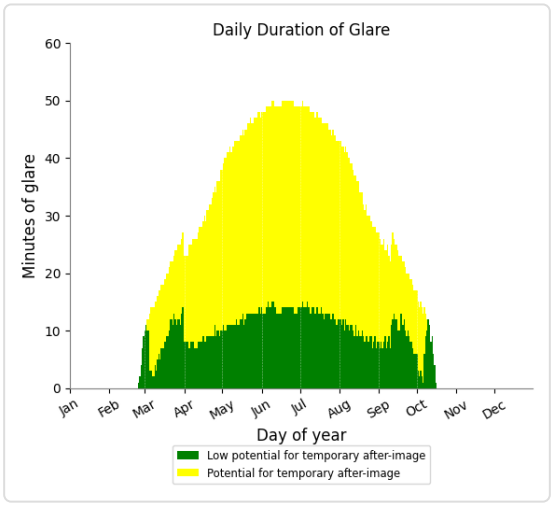


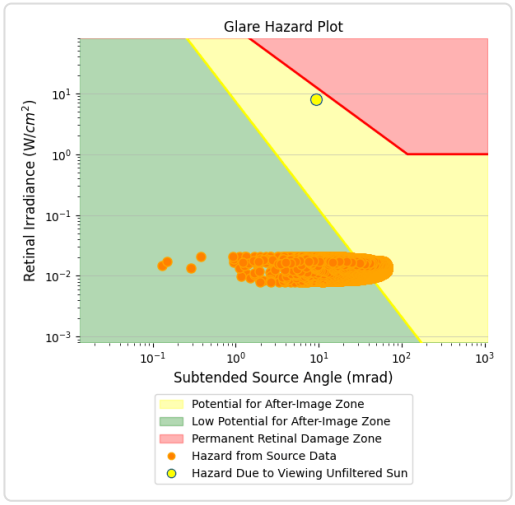
UV-08 and Route: N198 ri oost

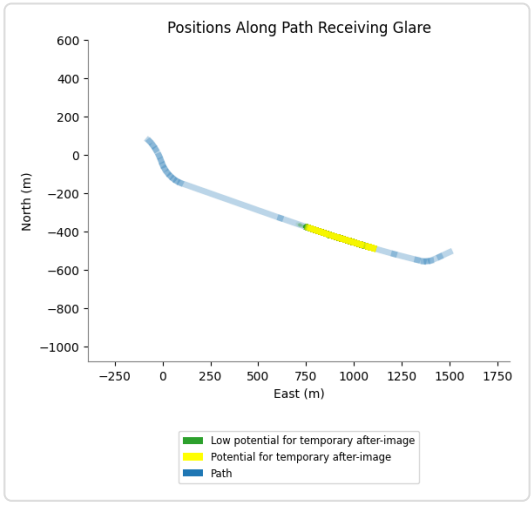
Yellow glare: 5,315 min.

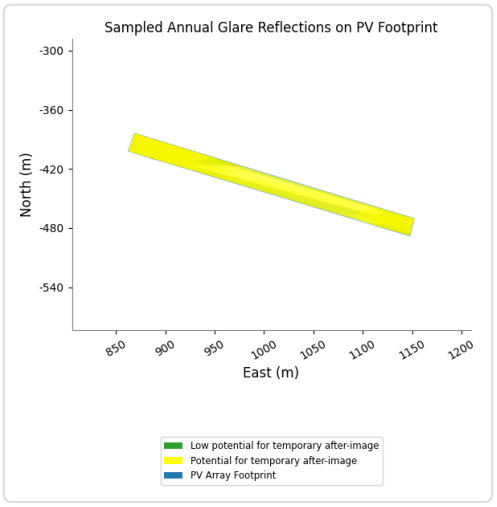
Green glare: 2,406 min.







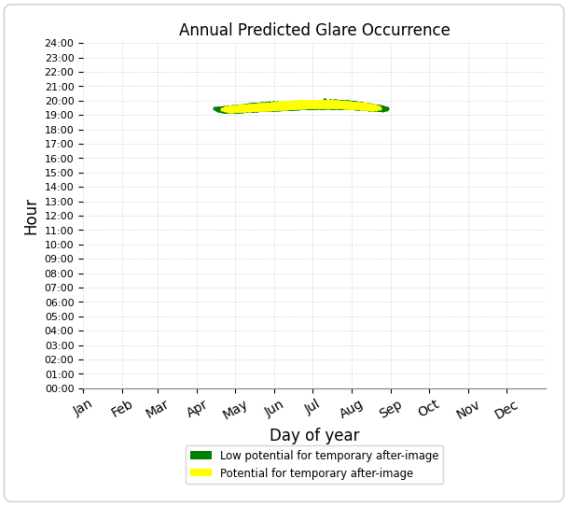


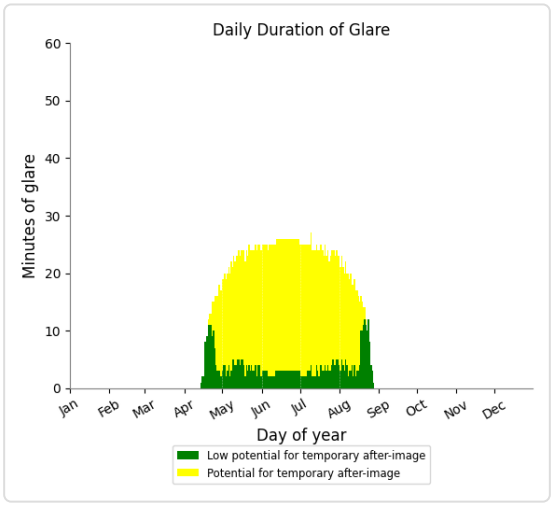


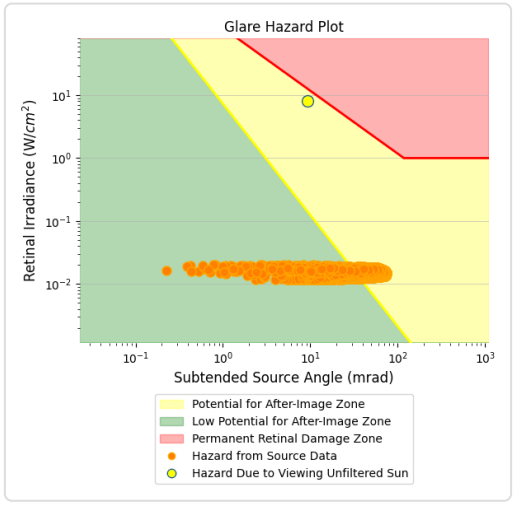
UV-08 and Route: N198 ri west

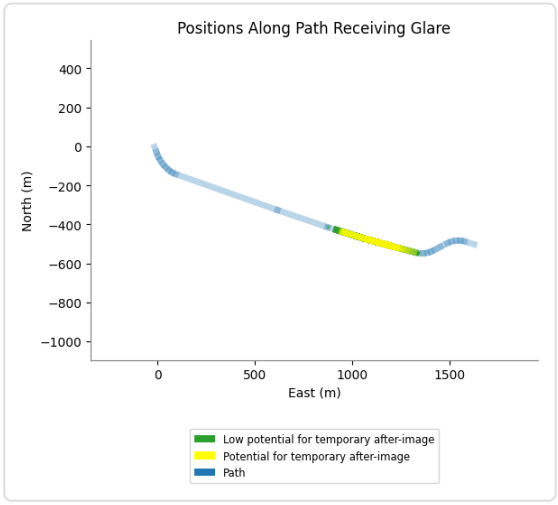
Yellow glare: 2,311 min.

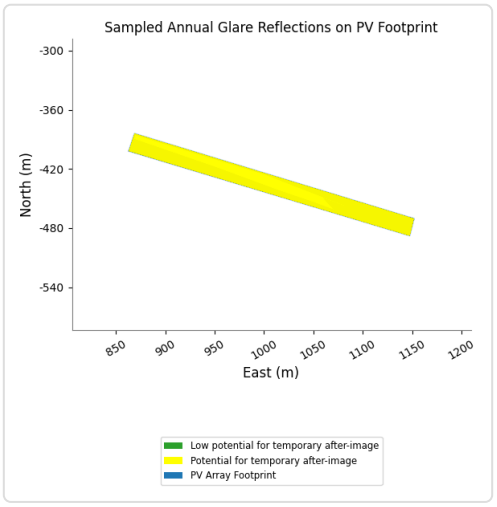
Green glare: 549 min.











UV-08 and Route: N419 ri oost

No glare found

UV-08 and Route: N419 ri west

No glare found

PV: UV-09 potential temporary after-image

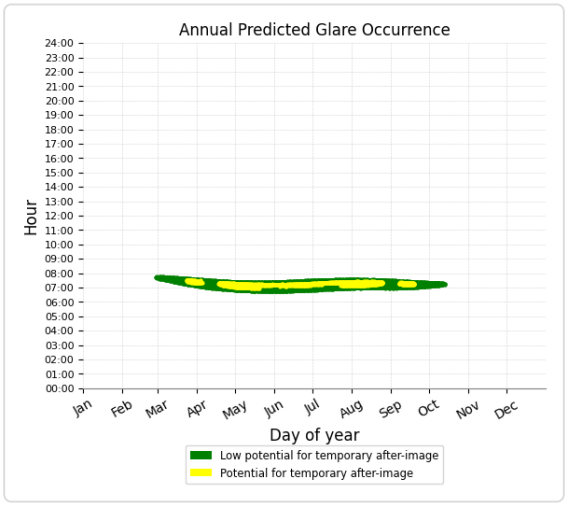
Receptor results ordered by category of glare

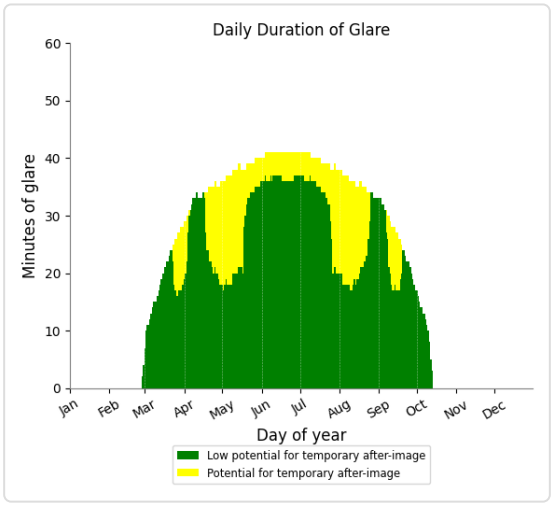
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	5,745	95.8	1,552	25.9
N198 ri oost	1,610	26.8	3,292	54.9
N198 ri west	948	15.8	2,308	38.5
A12 ri west	2,989	49.8	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

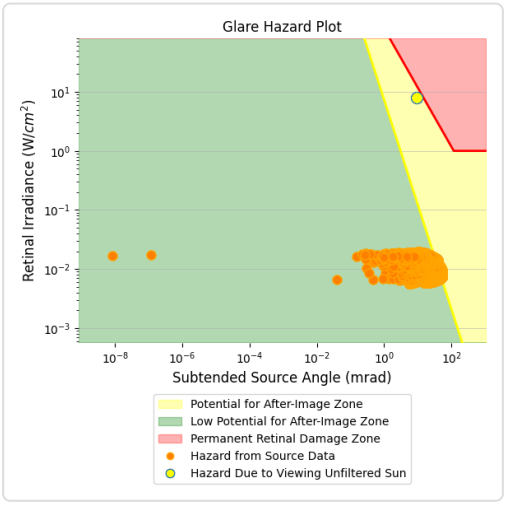
UV-09 and Route: A12 ri oost

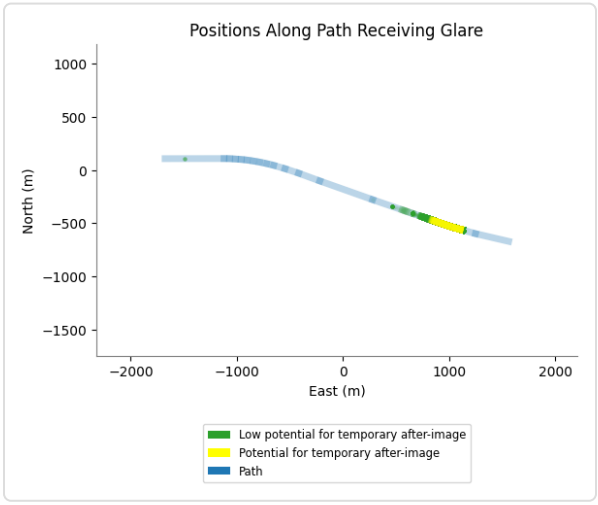
Yellow glare: 1,552 min.

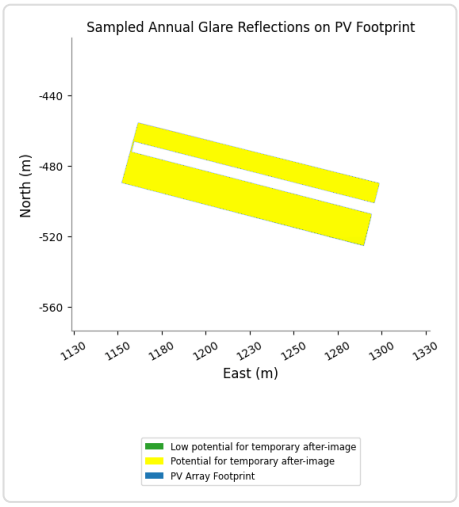
Green glare: 5,745 min.







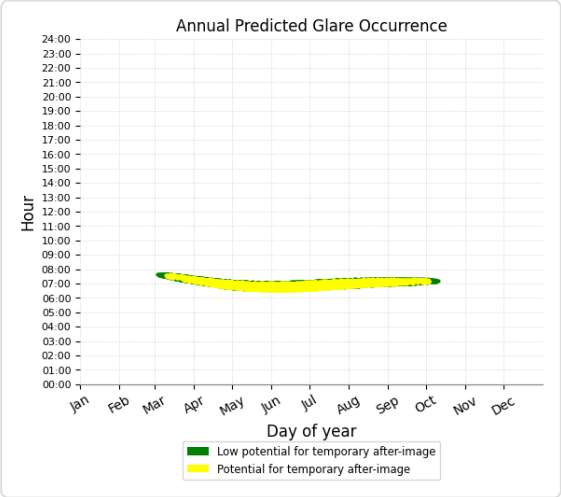


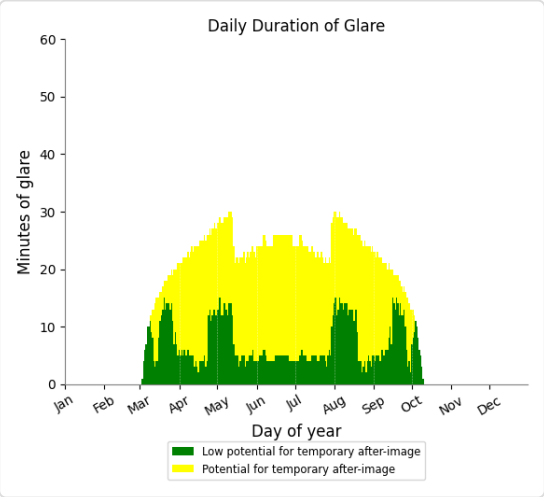


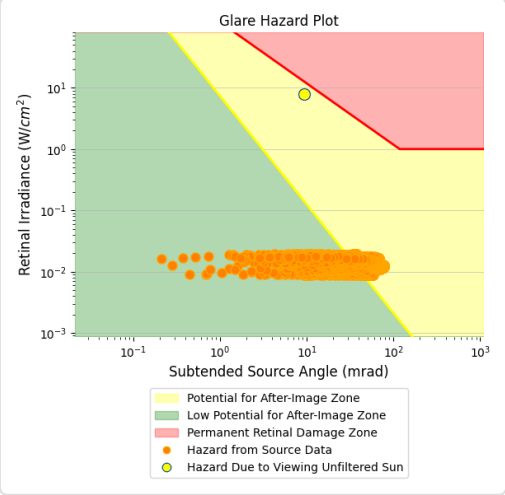
UV-09 and Route: N198 ri oost

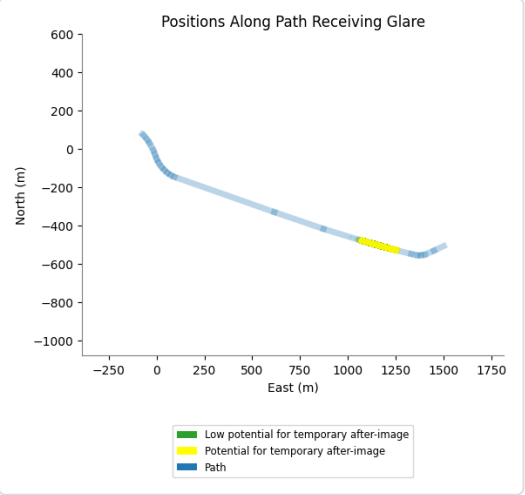
Yellow glare: 3,292 min.

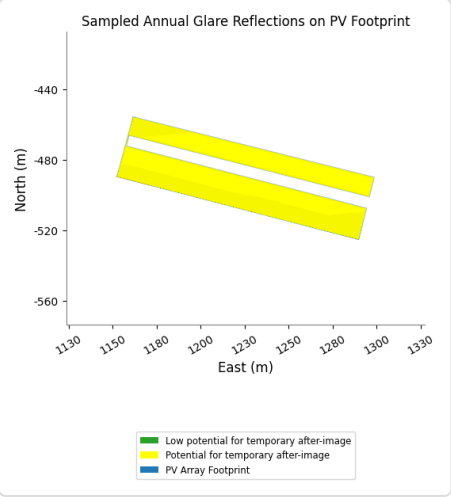
Green glare: 1,610 min.







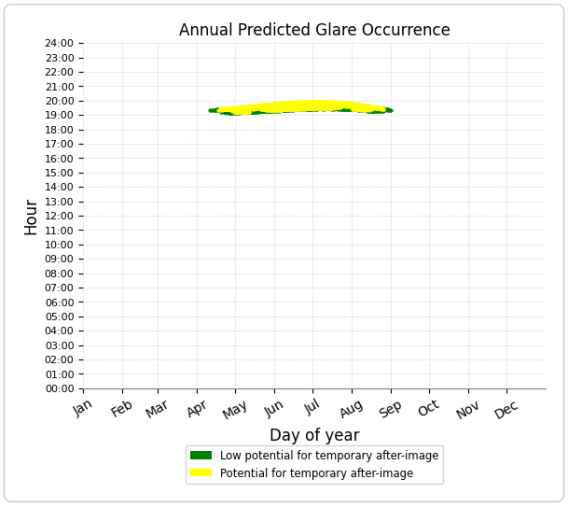


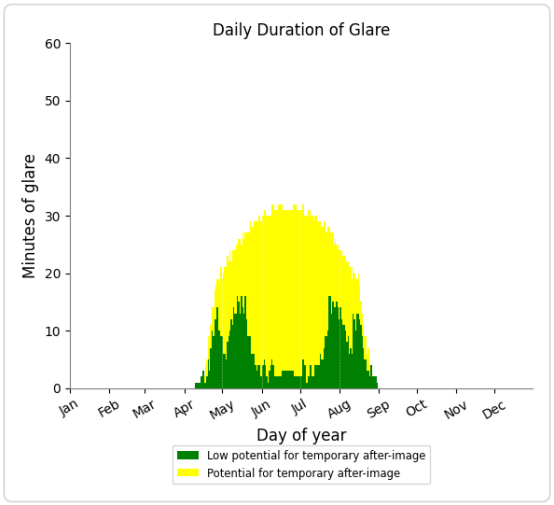


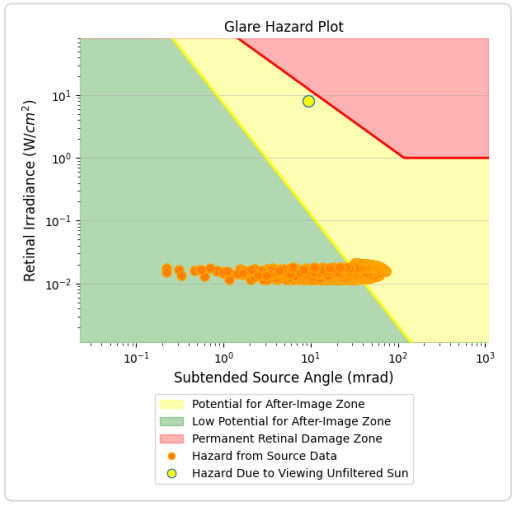
UV-09 and Route: N198 ri west

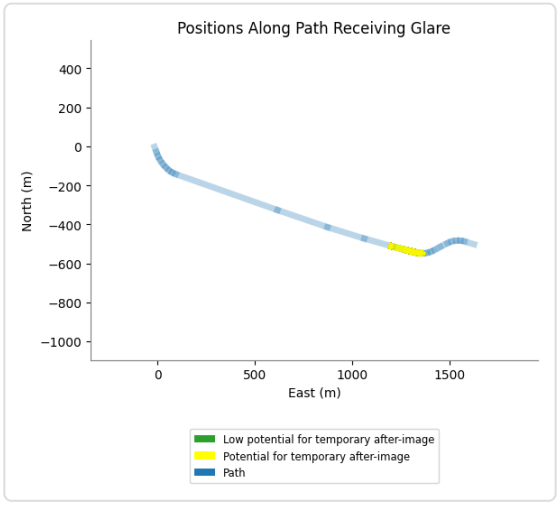
Yellow glare: 2,308 min.

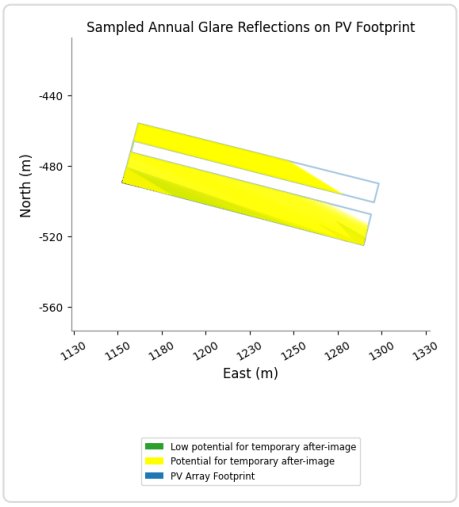
Green glare: 948 min.







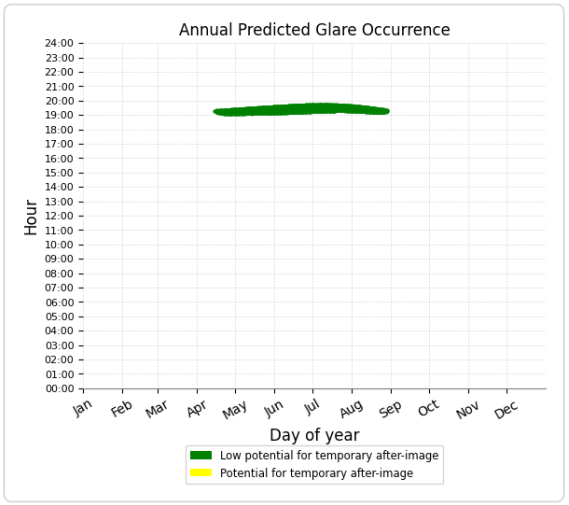


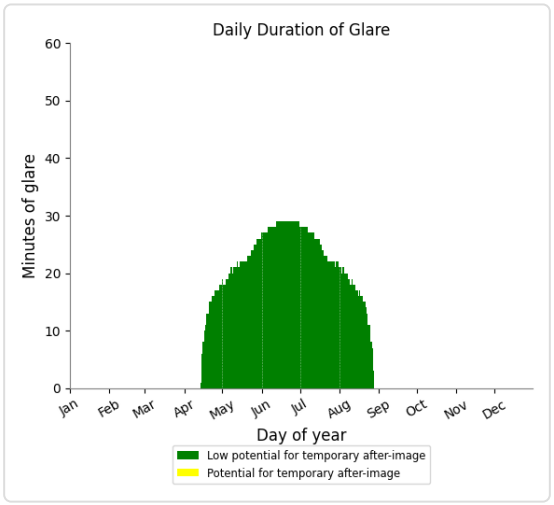


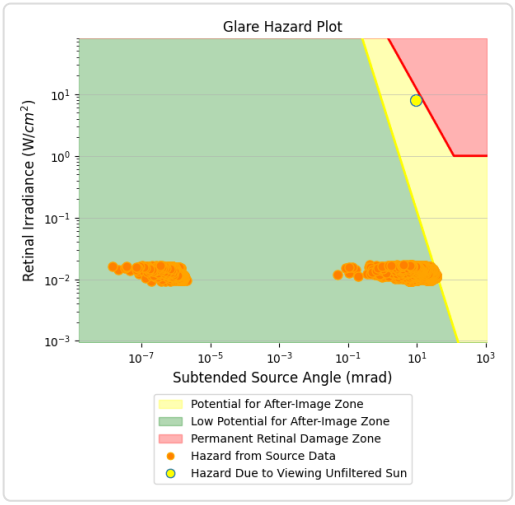
UV-09 and Route: A12 ri west

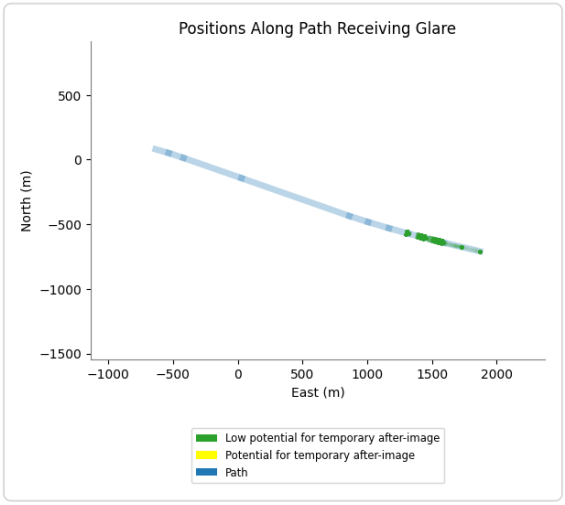
Yellow glare: none

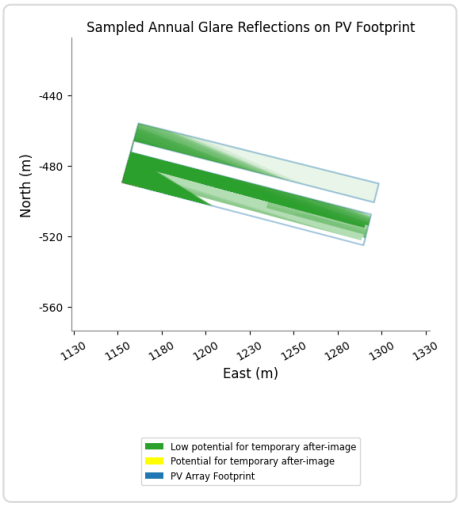
Green glare: 2,989 min.











UV-09 and Route: N419 ri oost

No glare found

UV-09 and Route: N419 ri west

No glare found

PV: UV-10 potential temporary after-image

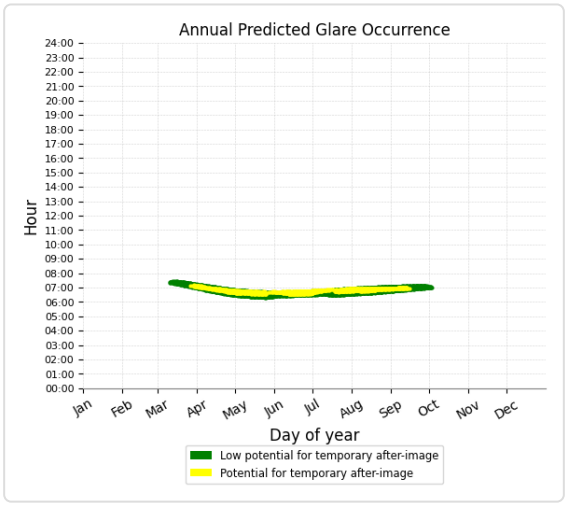
Receptor results ordered by category of glare

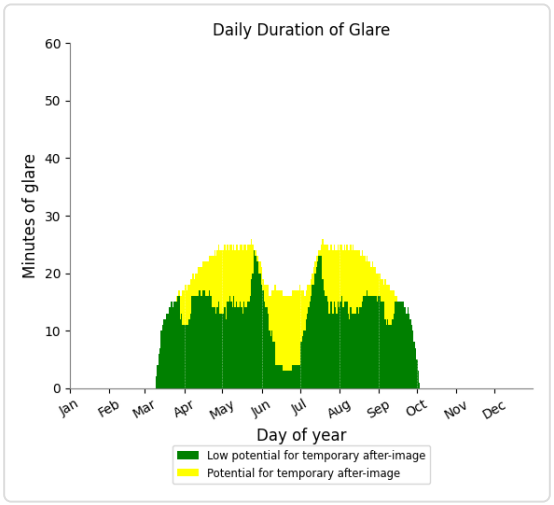
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	2,737	45.6	1,310	21.8
A12 ri oost	6,848	114.1	0	0.0
A12 ri west	2,524	42.1	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

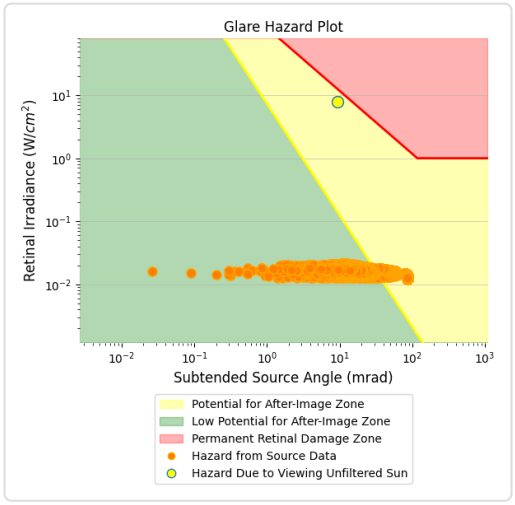
UV-10 and Route: N198 ri oost

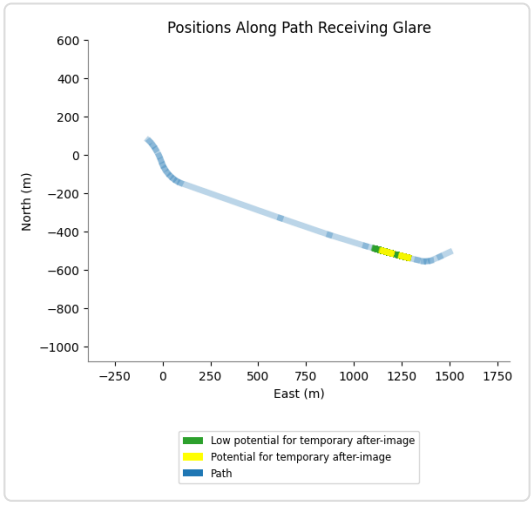
Yellow glare: 1,310 min.

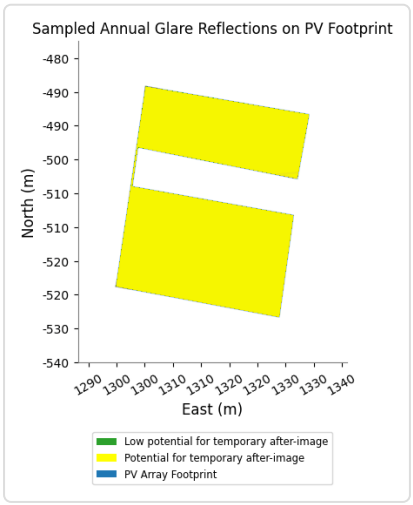
Green glare: 2,737 min.







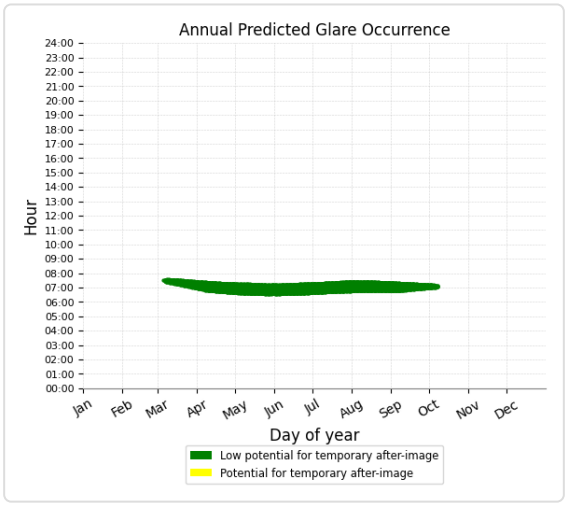


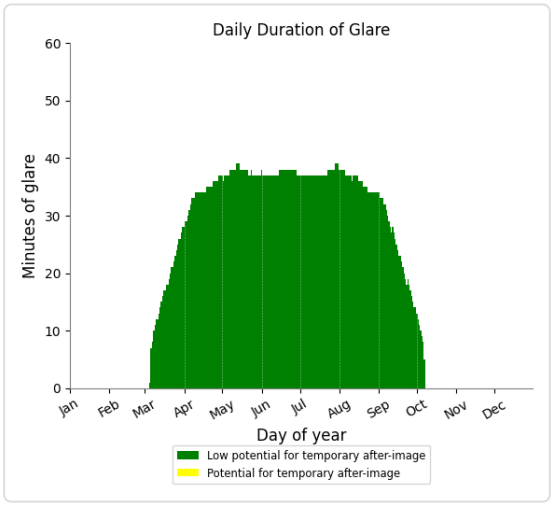


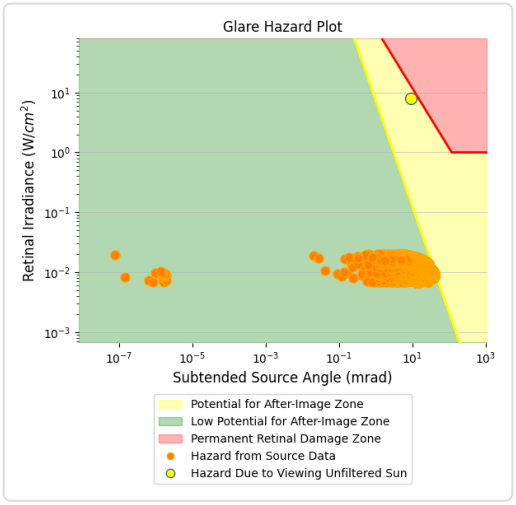
UV-10 and Route: A12 ri oost

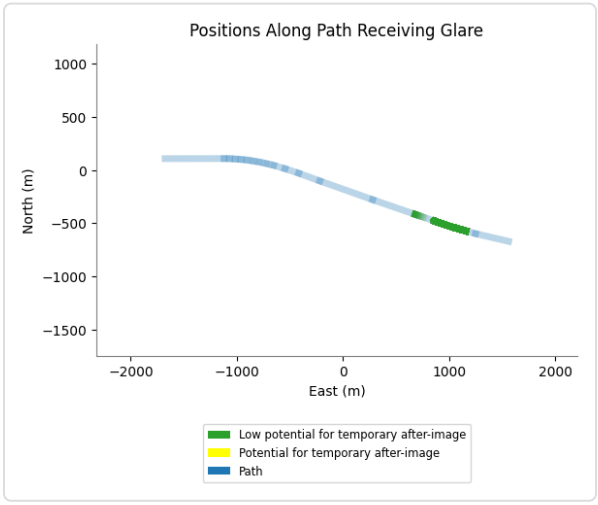
Yellow glare: none

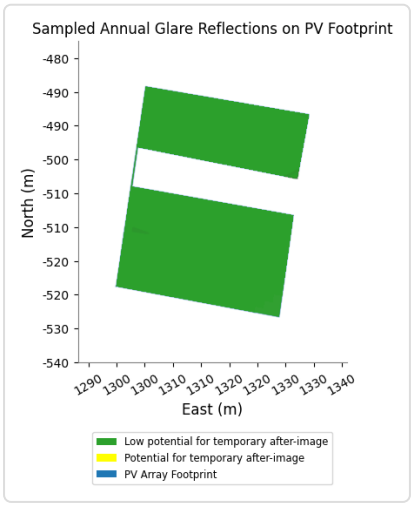
Green glare: 6,848 min.







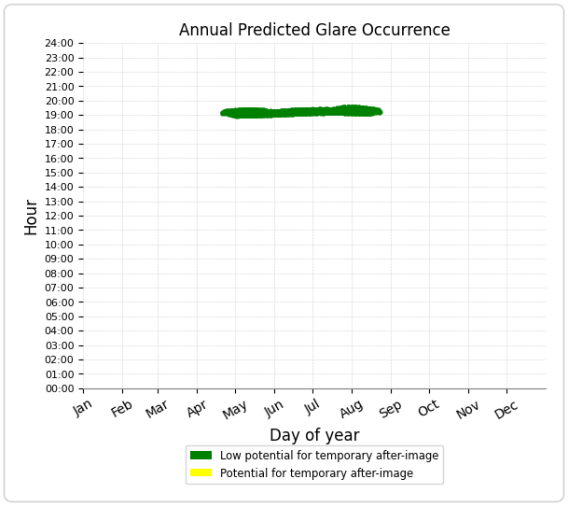


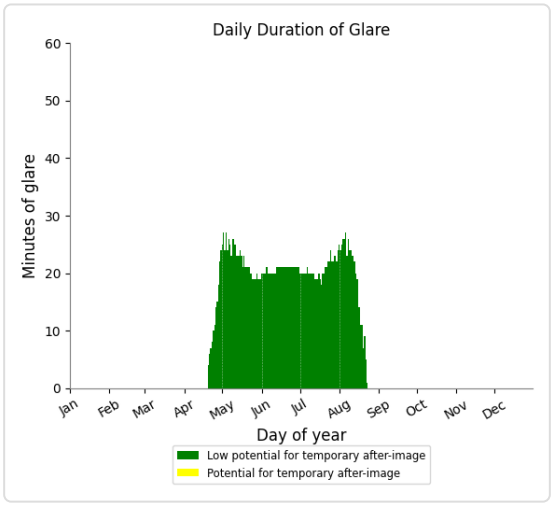


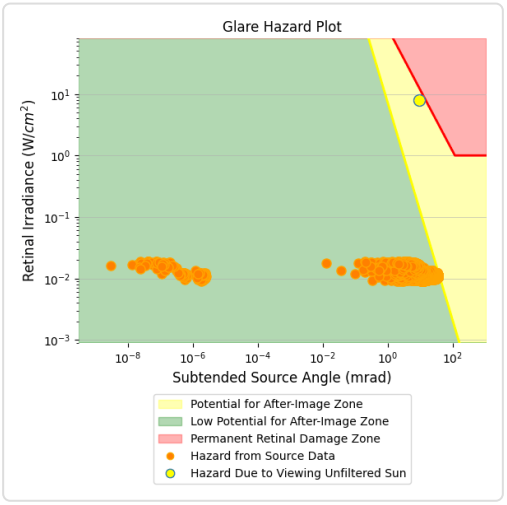
UV-10 and Route: A12 ri west

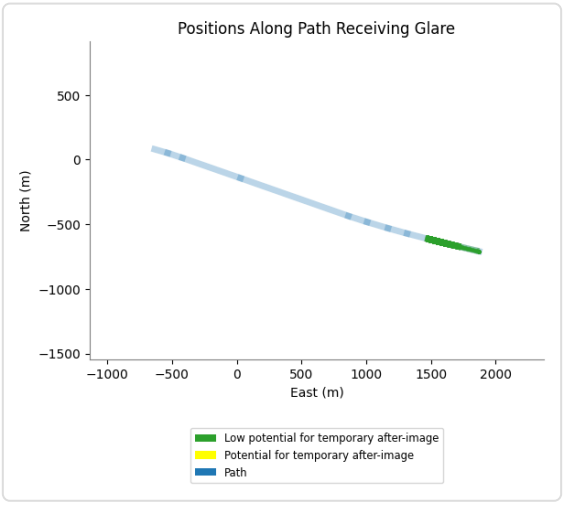
Yellow glare: none

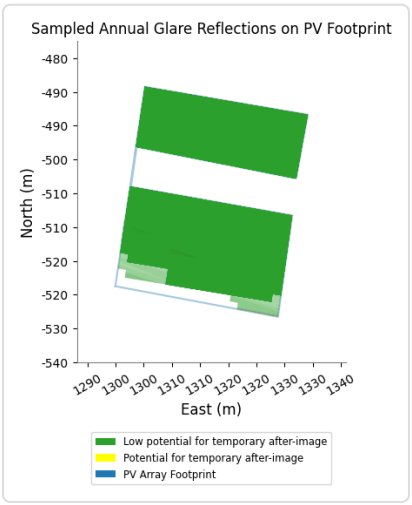
Green glare: 2,524 min.











UV-10 and Route: N198 ri west

No glare found

UV-10 and Route: N419 ri oost

No glare found

UV-10 and Route: N419 ri west

No glare found

PV: UV-11 potential temporary after-image

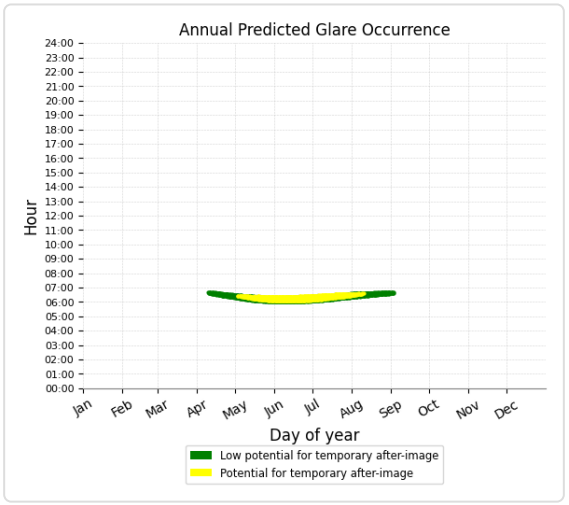
Receptor results ordered by category of glare

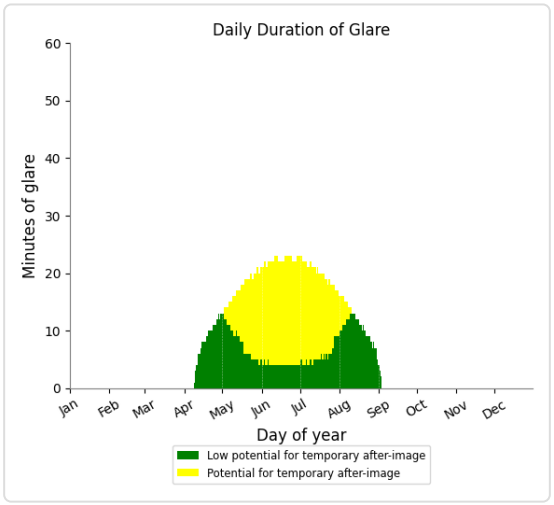
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	1,060	17.7	1,328	22.1
A12 ri oost	3,657	61.0	0	0.0
A12 ri west	2,423	40.4	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

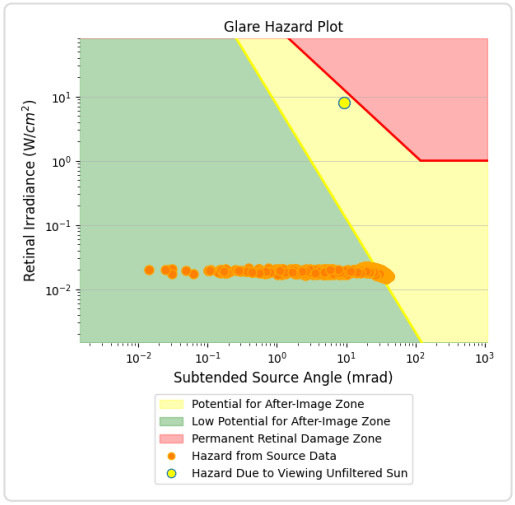
UV-11 and Route: N198 ri oost

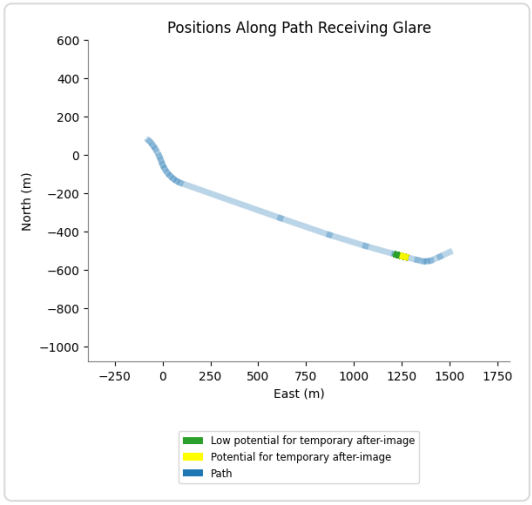
Yellow glare: 1,328 min.

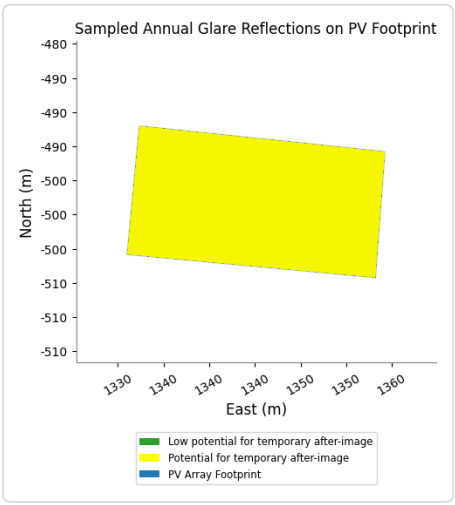
Green glare: 1,060 min.







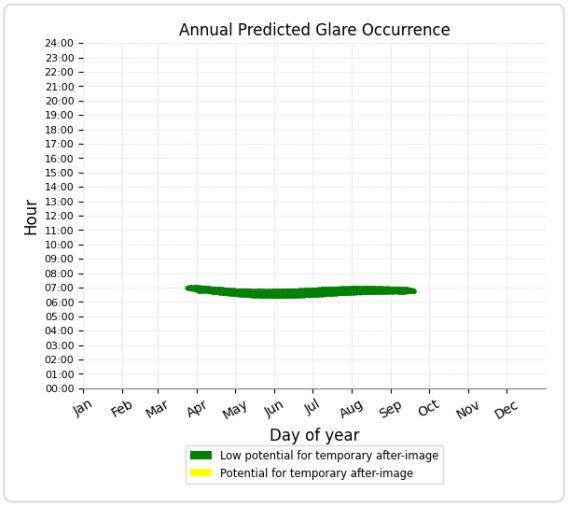


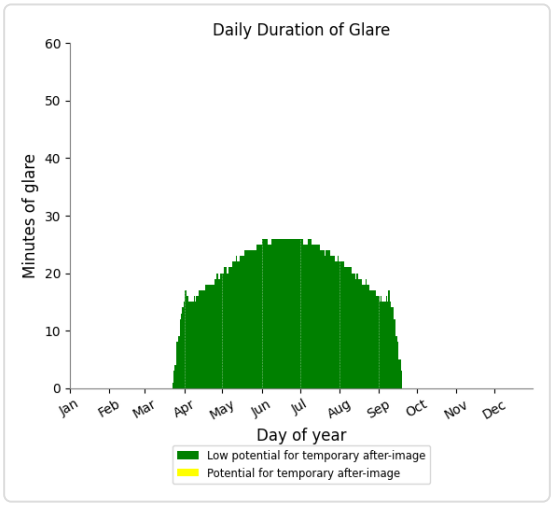


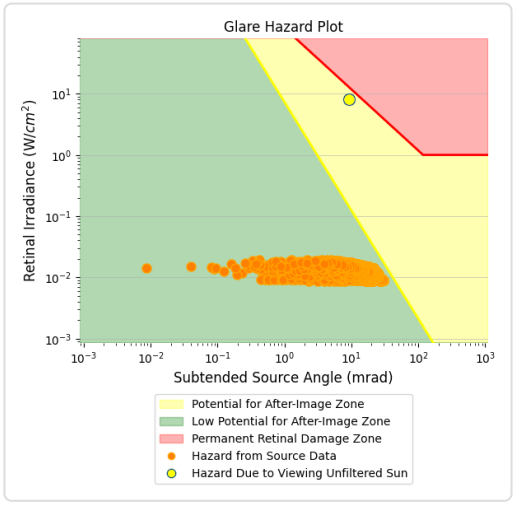
UV-11 and Route: A12 ri oost

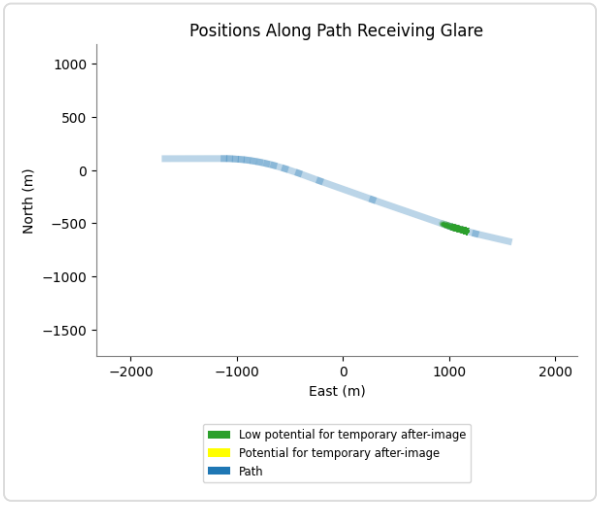
Yellow glare: none

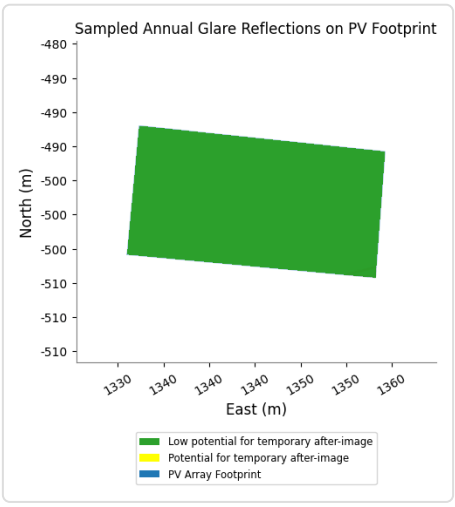
Green glare: 3,657 min.







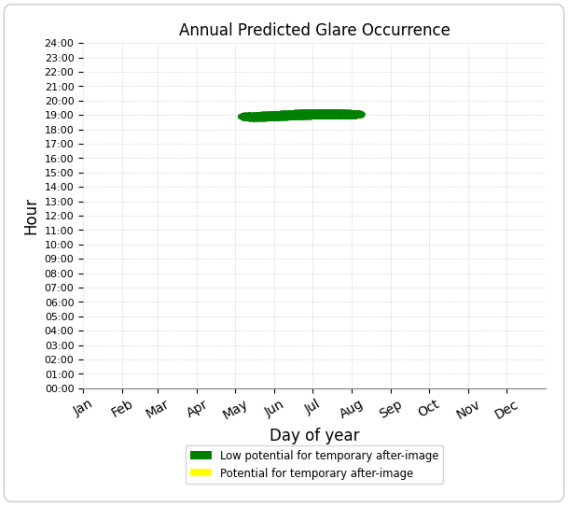


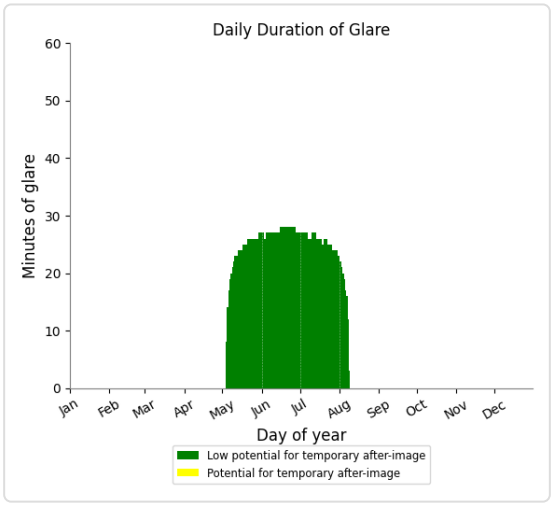


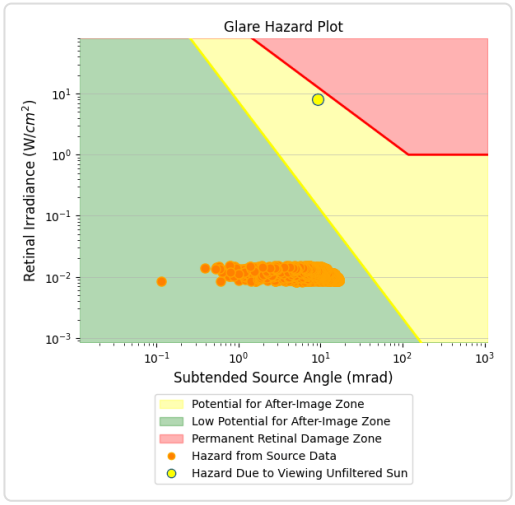
UV-11 and Route: A12 ri west

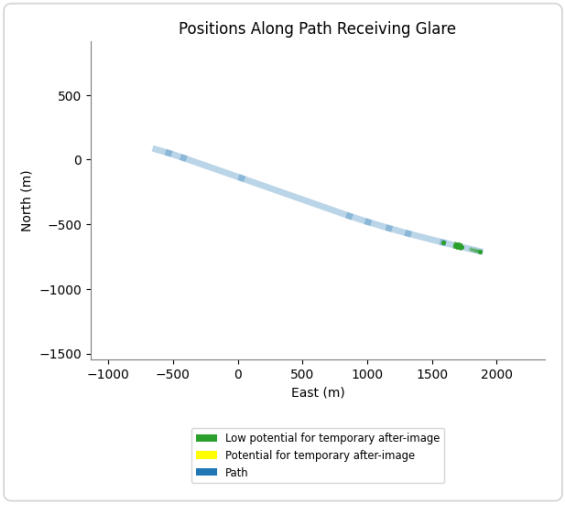
Yellow glare: none

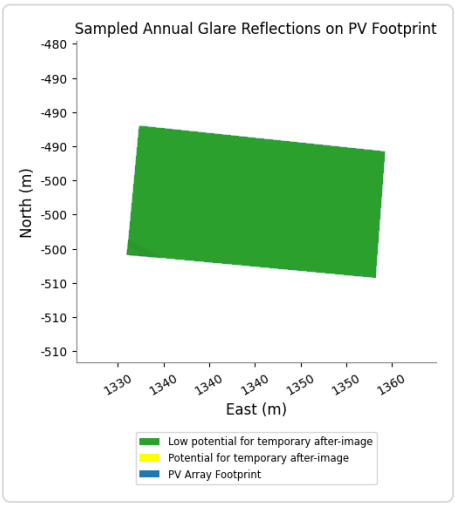
Green glare: 2,423 min.











UV-11 and Route: N198 ri west

No glare found

UV-11 and Route: N419 ri oost

No glare found

UV-11 and Route: N419 ri west

No glare found

PV: UV-12 potential temporary after-image

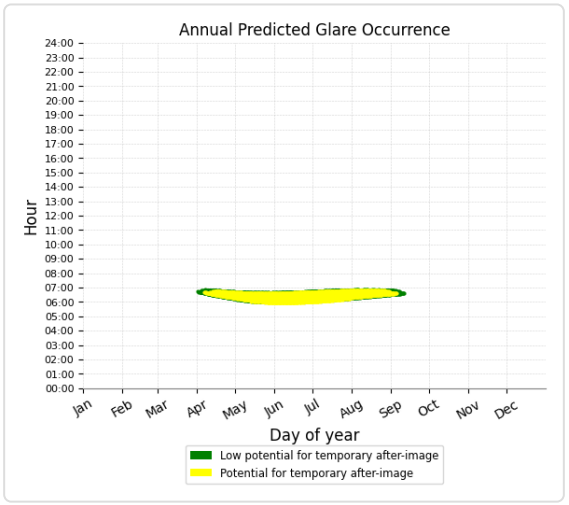
Receptor results ordered by category of glare

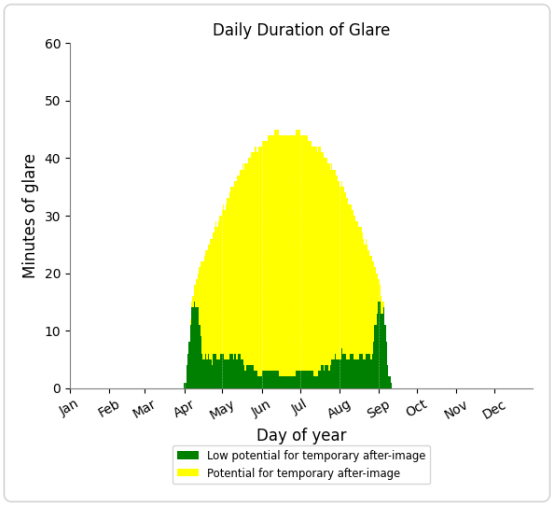
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	837	13.9	4,504	75.1
A12 ri oost	5,405	90.1	0	0.0
A12 ri west	3,019	50.3	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

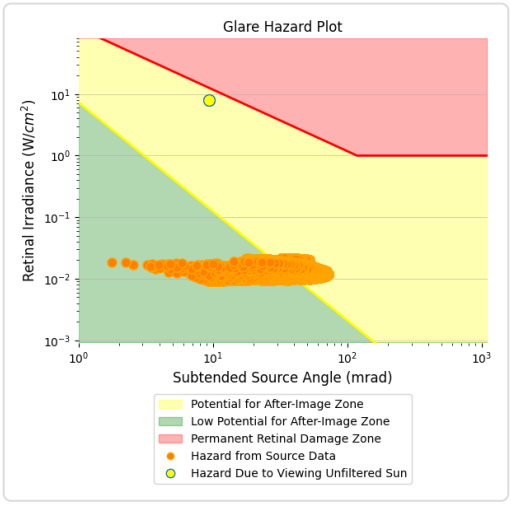
UV-12 and Route: N198 ri oost

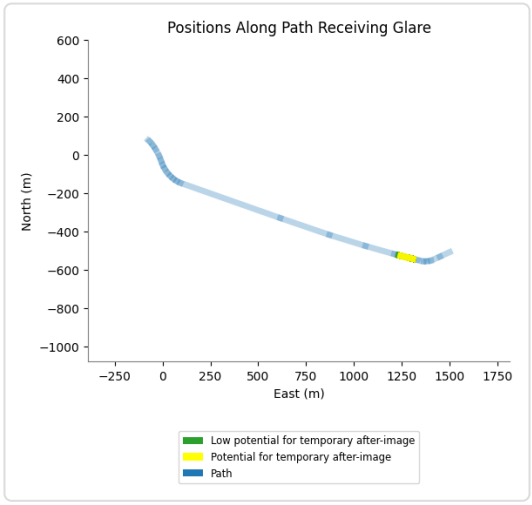
Yellow glare: 4,504 min.

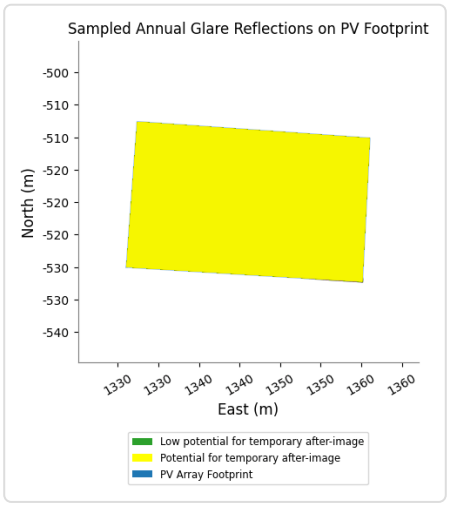
Green glare: 837 min.







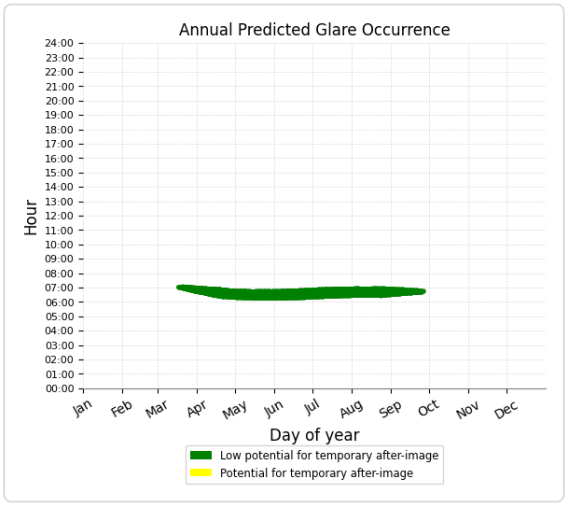


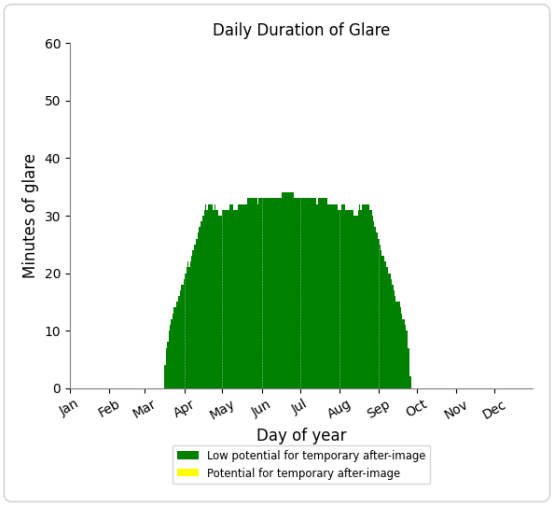


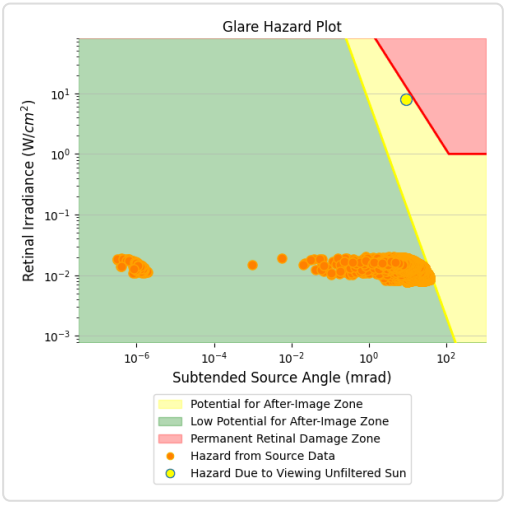
UV-12 and Route: A12 ri oost

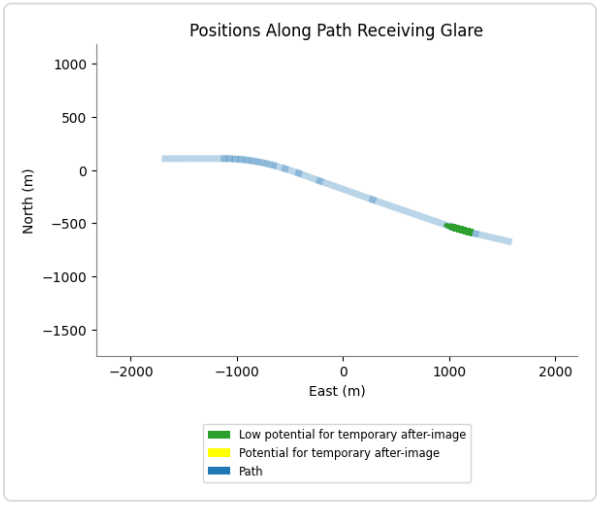
Yellow glare: none

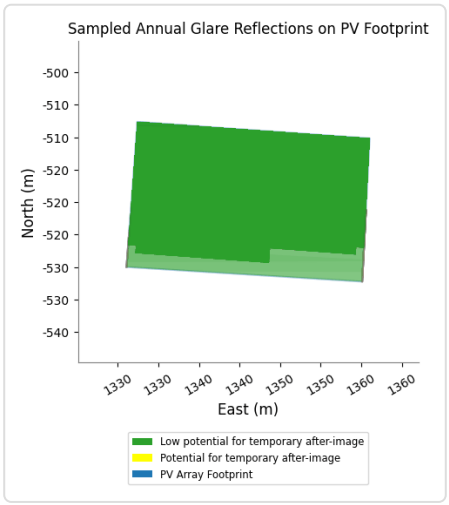
Green glare: 5,405 min.







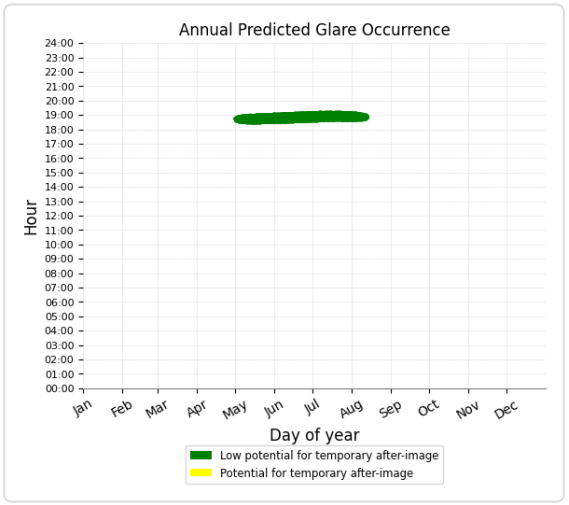


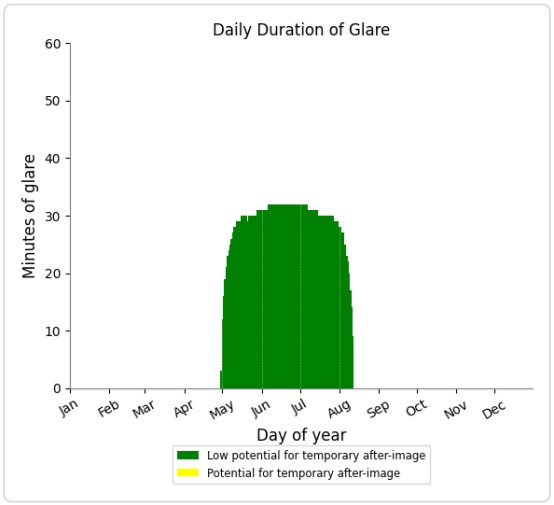


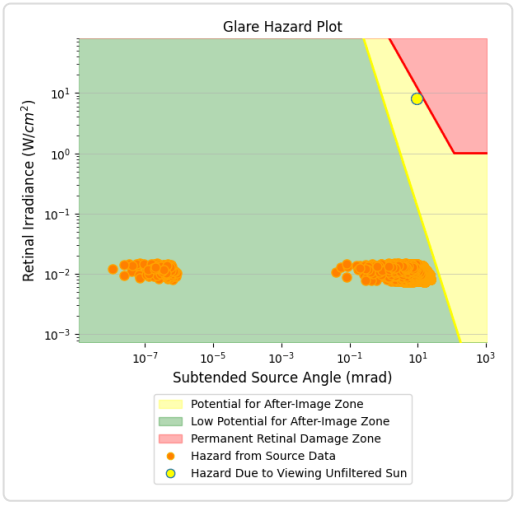
UV-12 and Route: A12 ri west

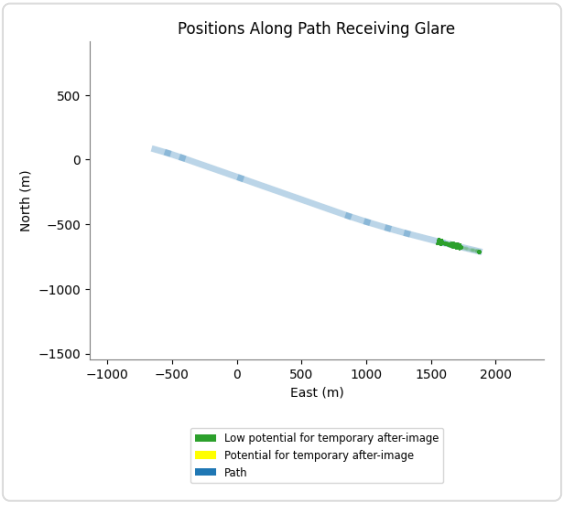
Yellow glare: none

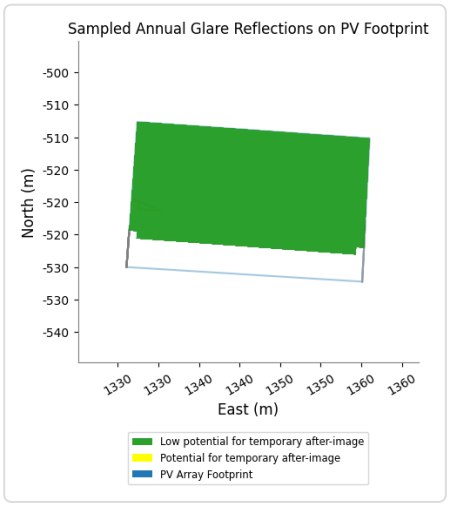
Green glare: 3,019 min.











UV-12 and Route: N198 ri west

No glare found

UV-12 and Route: N419 ri oost

No glare found

UV-12 and Route: N419 ri west

No glare found

PV: UV-13 potential temporary after-image

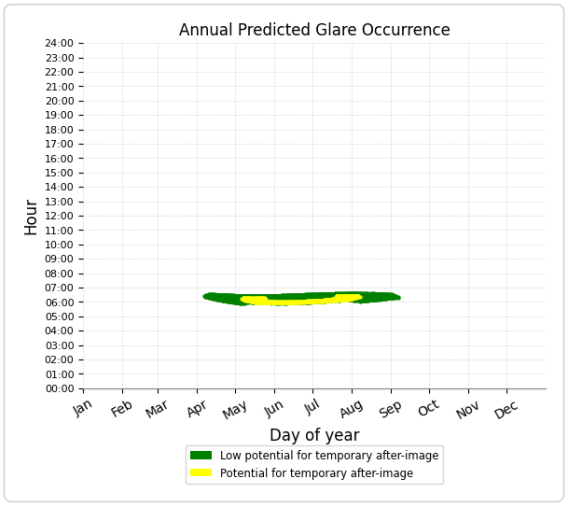
Receptor results ordered by category of glare

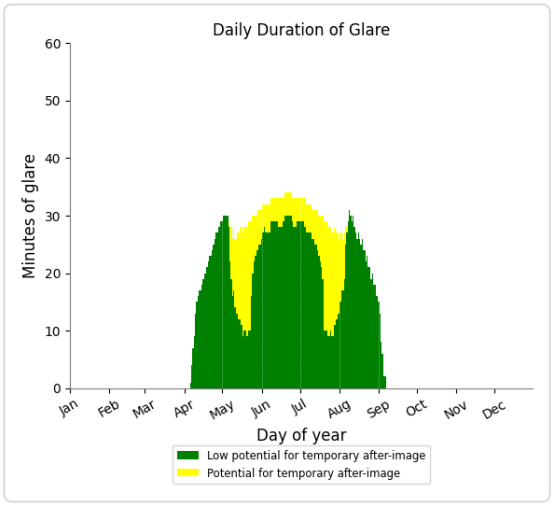
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	3,274	54.6	827	13.8
N198 ri oost	658	11.0	2,374	39.6
A12 ri west	2,208	36.8	0	0.0
N198 ri west	45	0.8	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

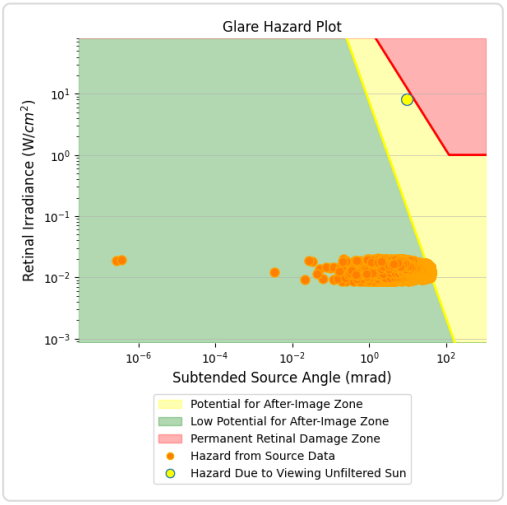
UV-13 and Route: A12 ri oost

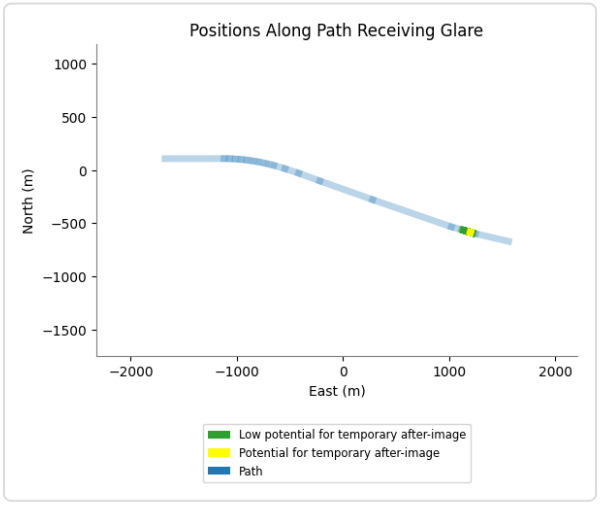
Yellow glare: 827 min.

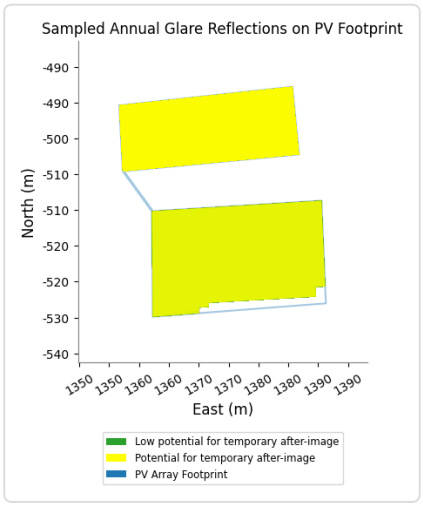
Green glare: 3,274 min.







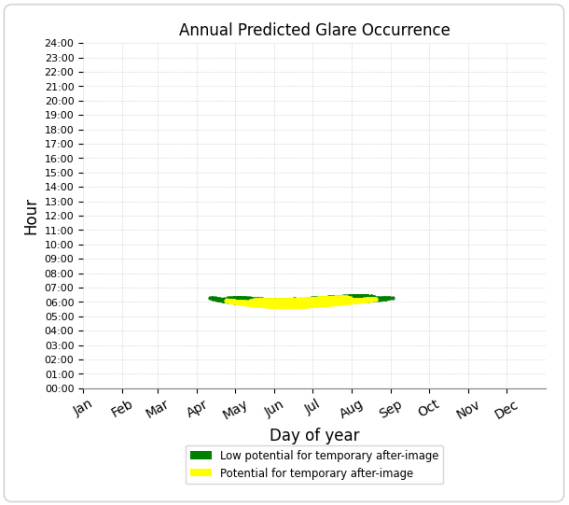


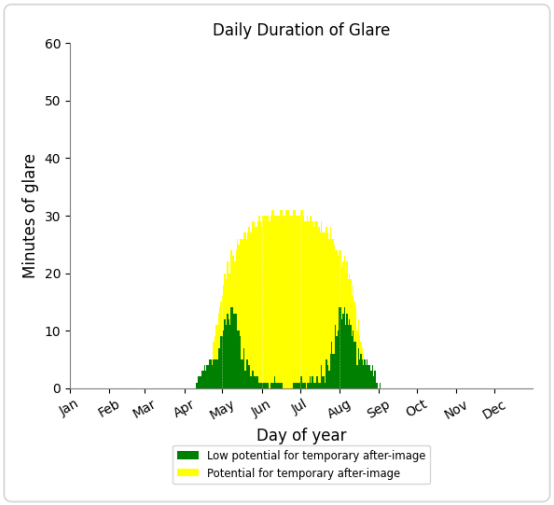


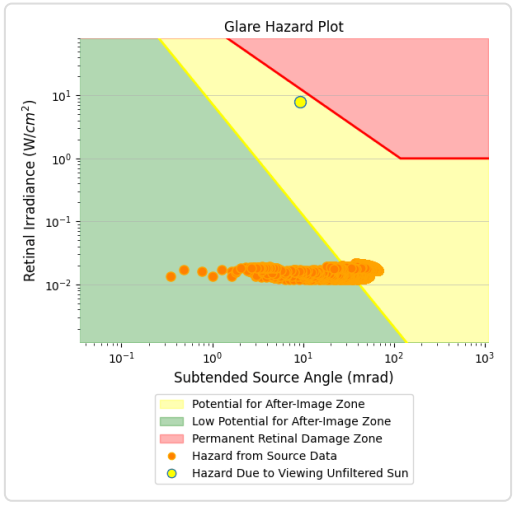
UV-13 and Route: N198 ri oost

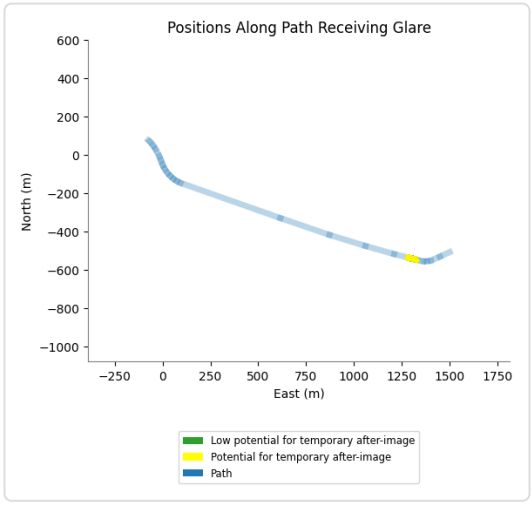
Yellow glare: 2,374 min.

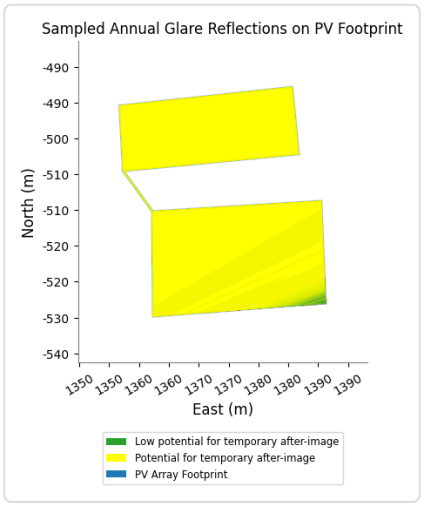
Green glare: 658 min.







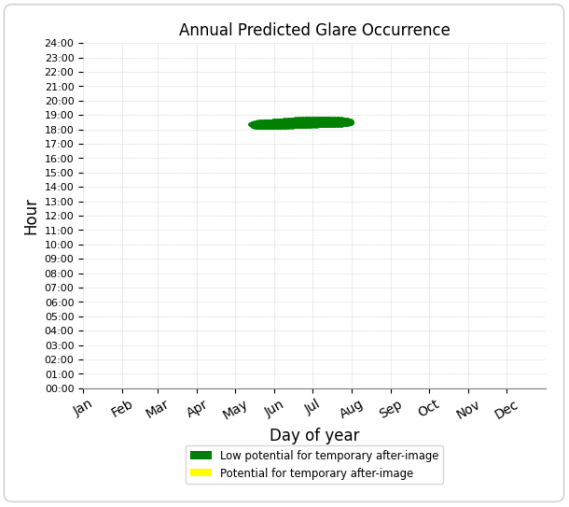


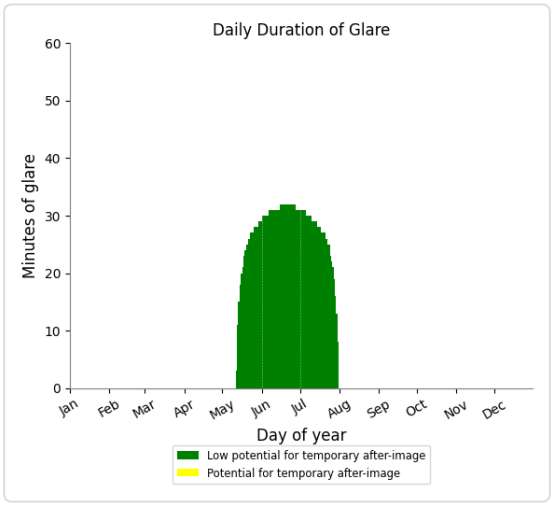


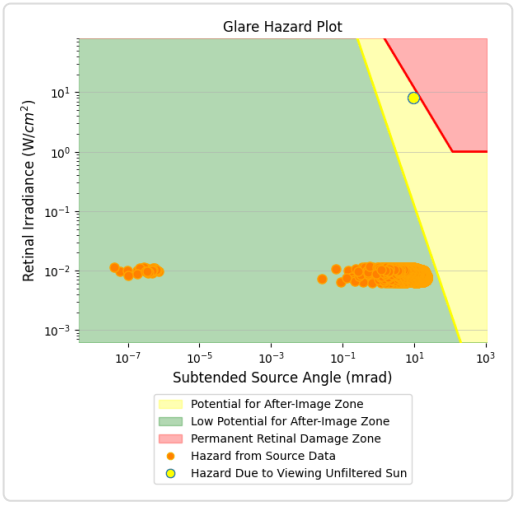
UV-13 and Route: A12 ri west

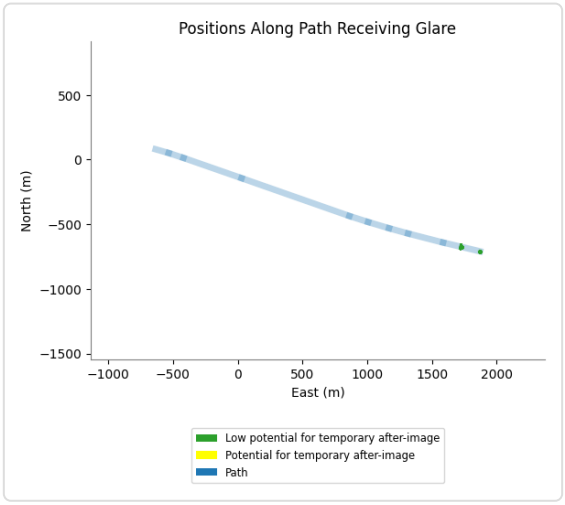
Yellow glare: none

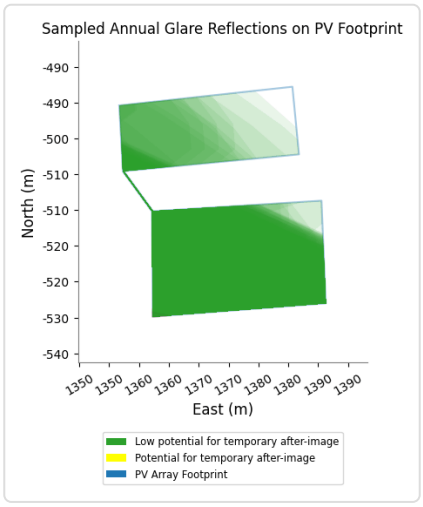
Green glare: 2,208 min.







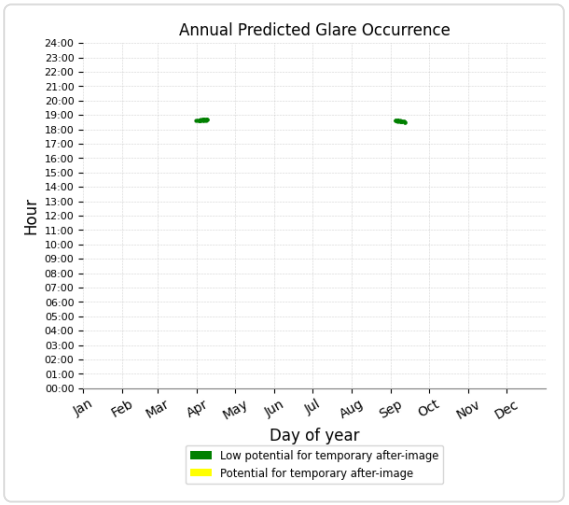


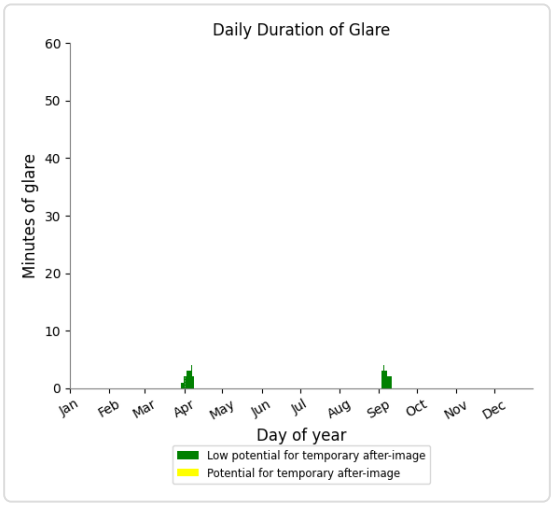


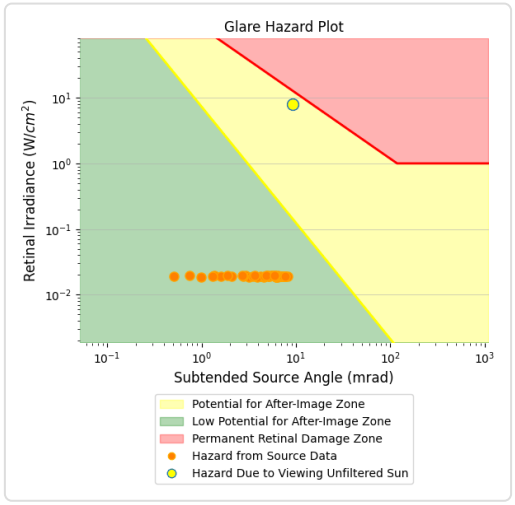
UV-13 and Route: N198 ri west

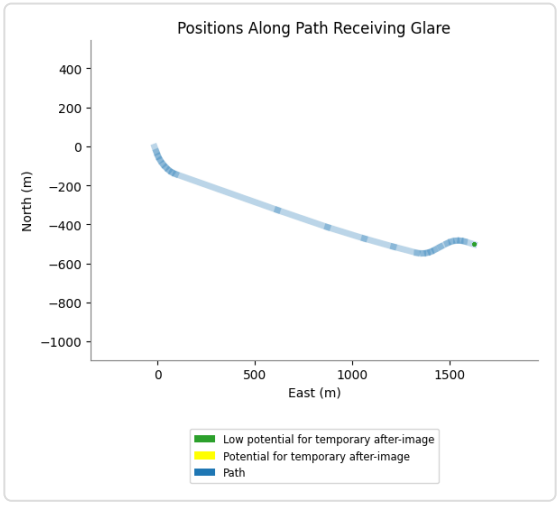
Yellow glare: none

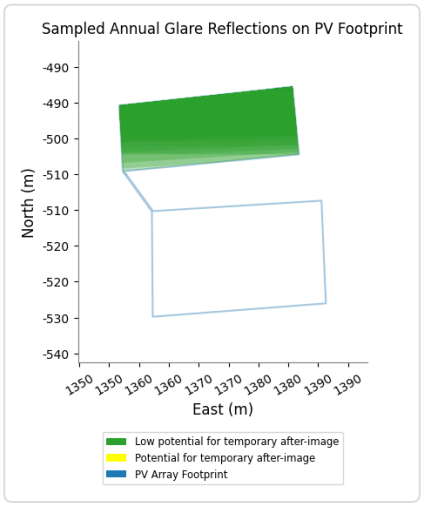
Green glare: 45 min.











UV-13 and Route: N419 ri oost

No glare found

UV-13 and Route: N419 ri west

No glare found

PV: UV-14 potential temporary after-image

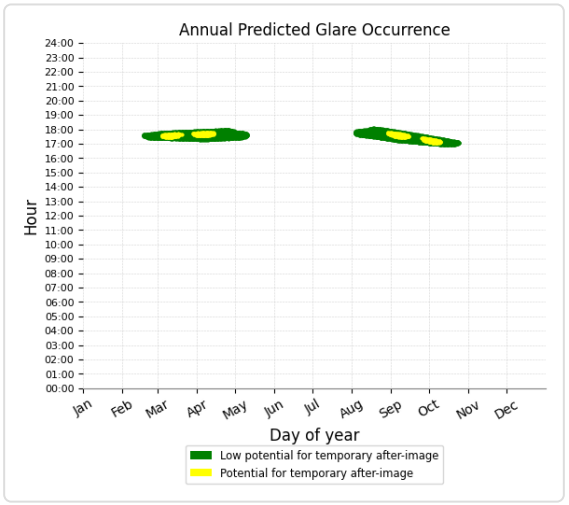
Receptor results ordered by category of glare

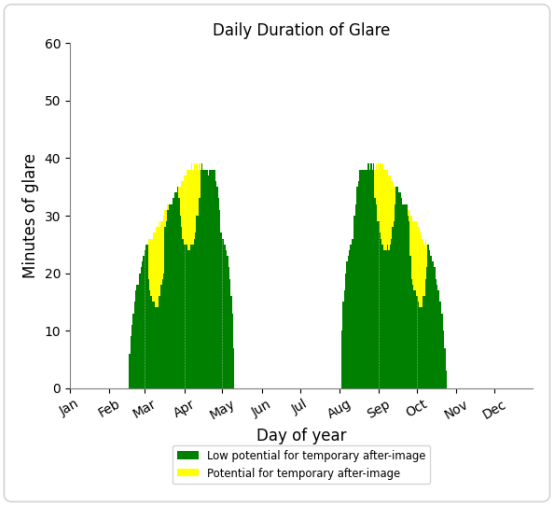
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri west	4,225	70.4	657	10.9
A12 ri oost	784	13.1	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

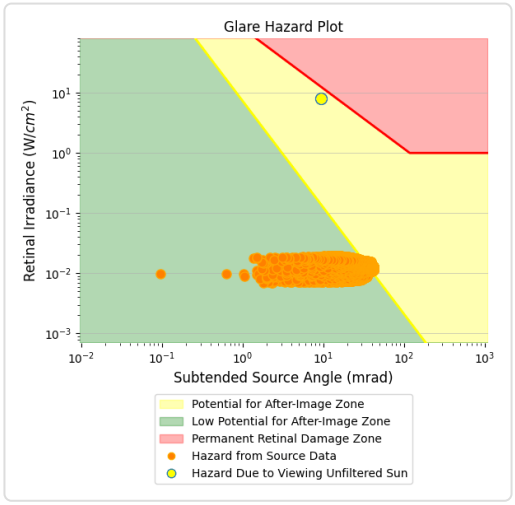
UV-14 and Route: N198 ri west

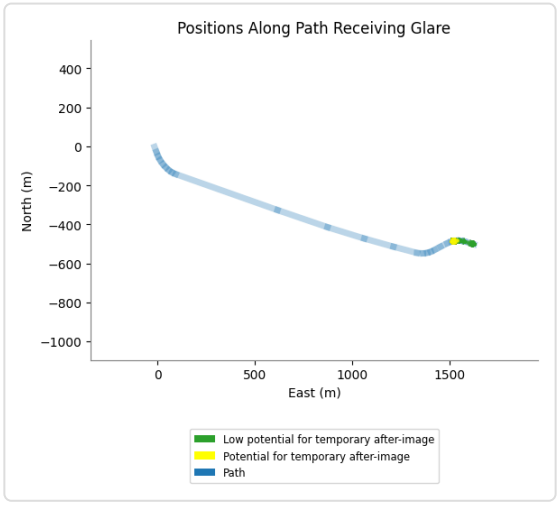
Yellow glare: 657 min.

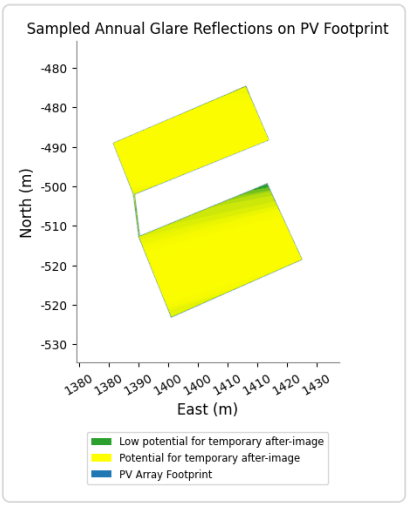
Green glare: 4,225 min.







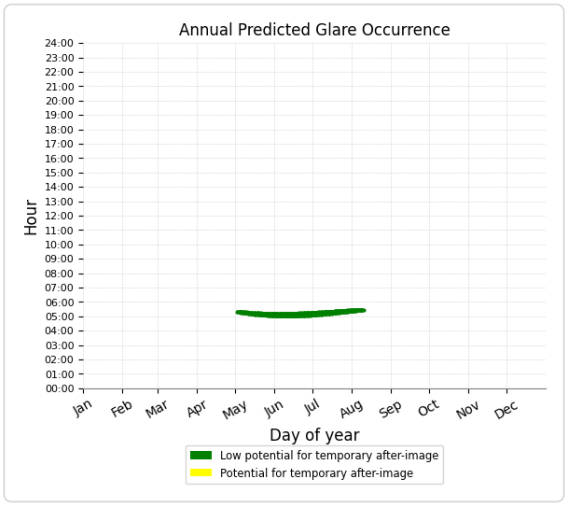


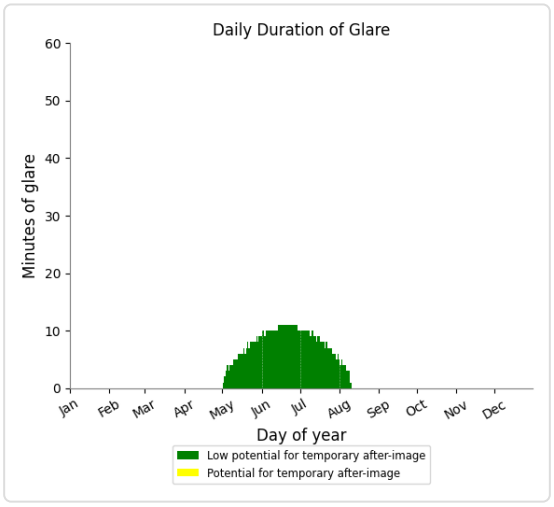


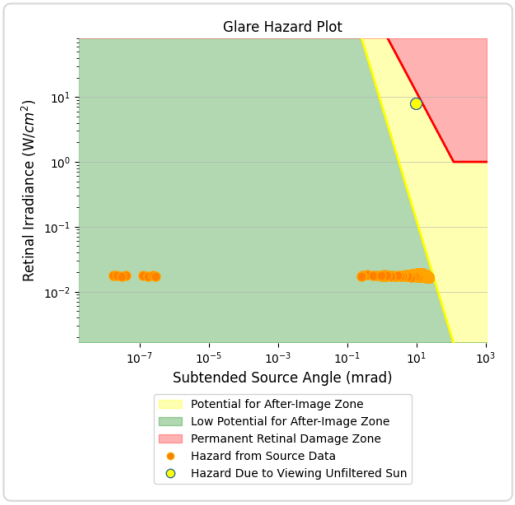
UV-14 and Route: A12 ri oost

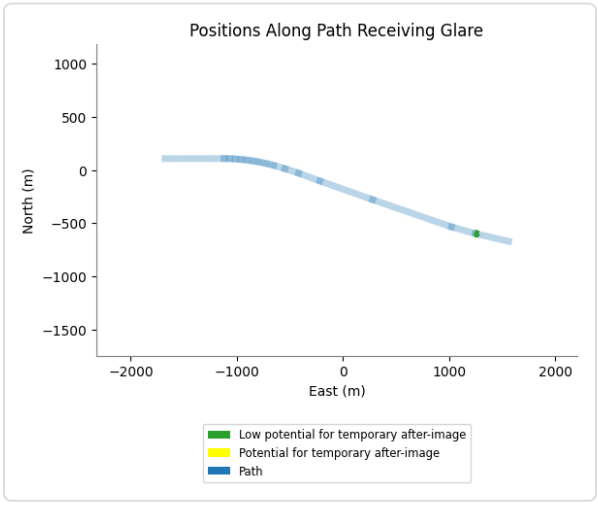
Yellow glare: none

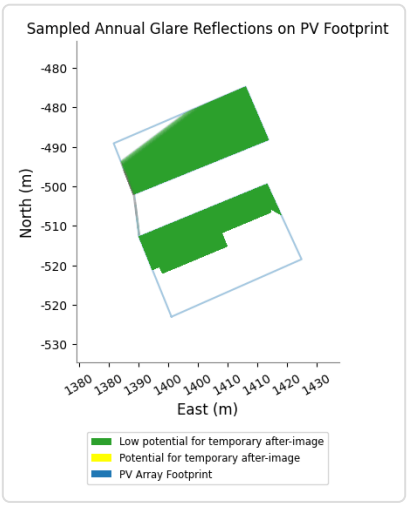
Green glare: 784 min.











UV-14 and Route: A12 ri west

No glare found

UV-14 and Route: N198 ri oost

No glare found

UV-14 and Route: N419 ri oost

No glare found

UV-14 and Route: N419 ri west

No glare found

PV: UV-15 potential temporary after-image

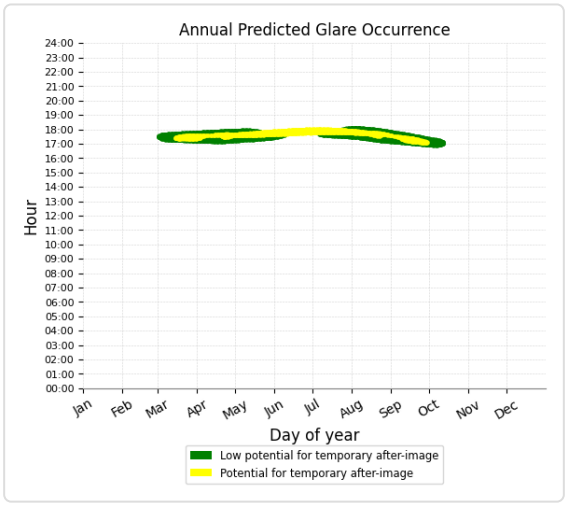
Receptor results ordered by category of glare

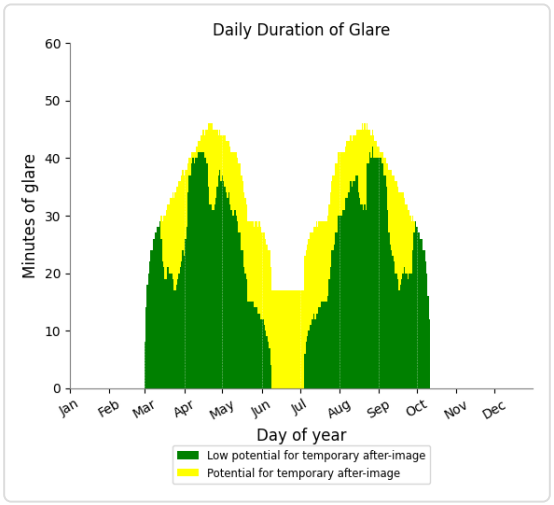
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri west	5,099	85.0	2,325	38.8
A12 ri oost	385	6.4	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

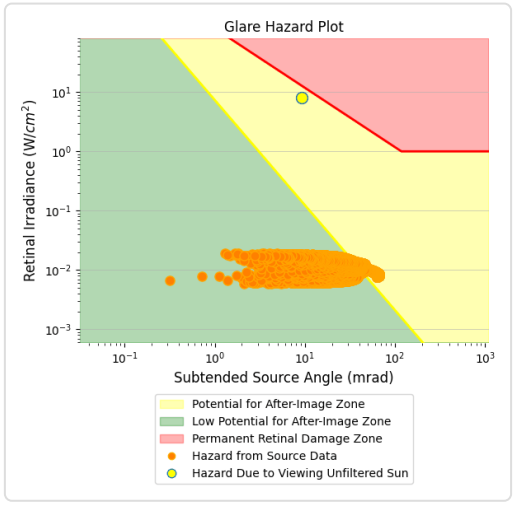
UV-15 and Route: N198 ri west

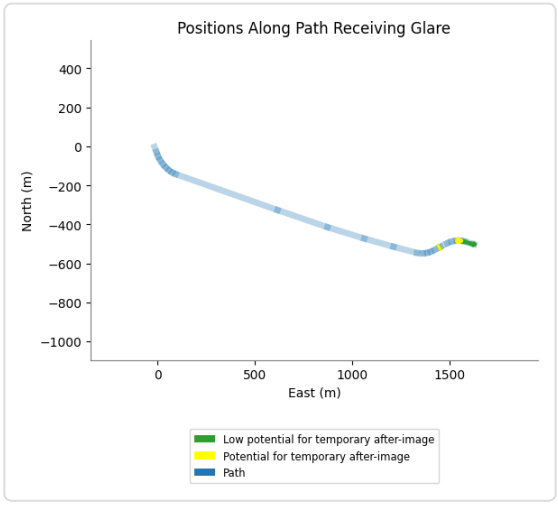
Yellow glare: 2,325 min.

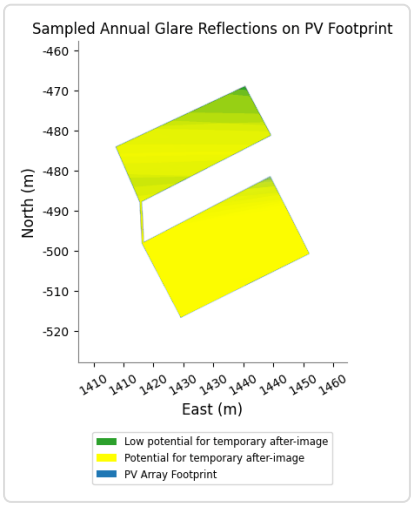
Green glare: 5,099 min.







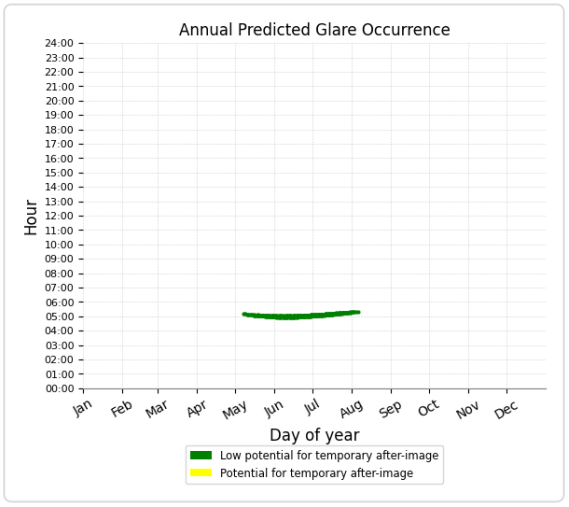


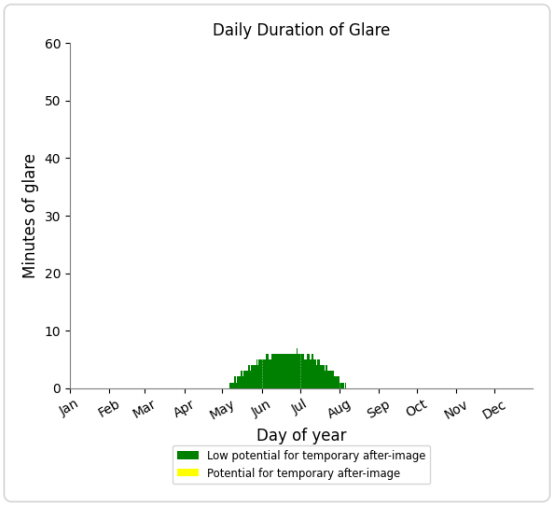


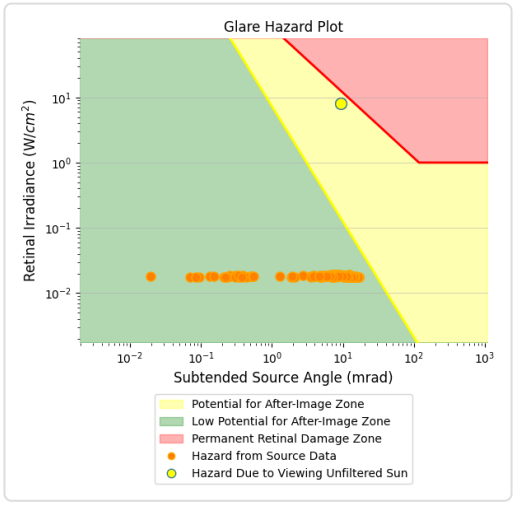
UV-15 and Route: A12 ri oost

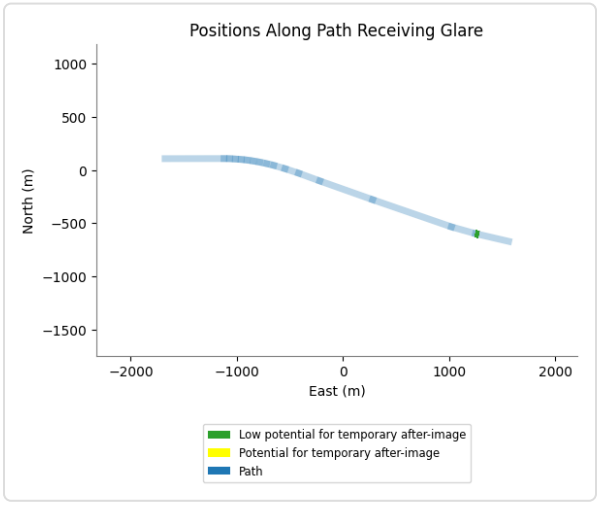
Yellow glare: none

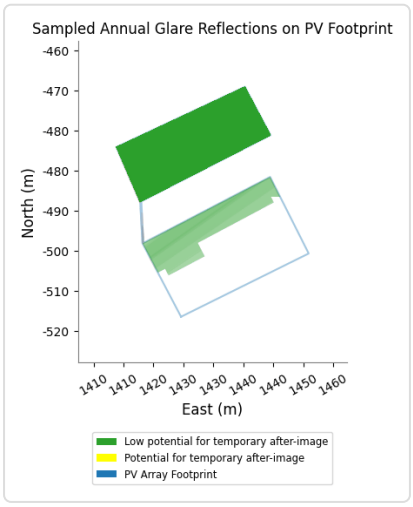
Green glare: 385 min.











UV-15 and Route: A12 ri west

No glare found

UV-15 and Route: N198 ri oost

No glare found

UV-15 and Route: N419 ri oost

No glare found

UV-15 and Route: N419 ri west

No glare found

PV: UV-16 potential temporary after-image

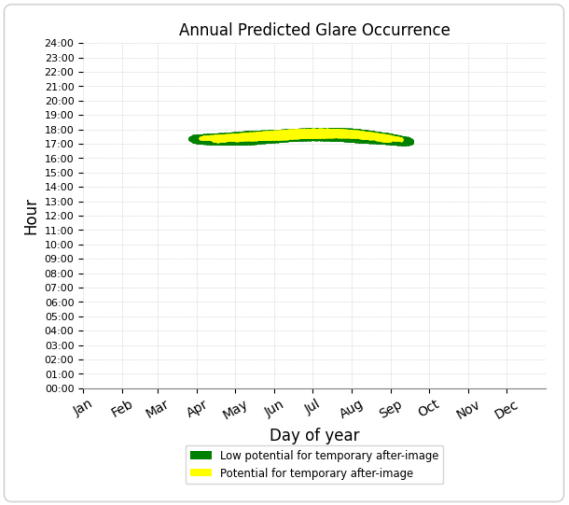
Receptor results ordered by category of glare

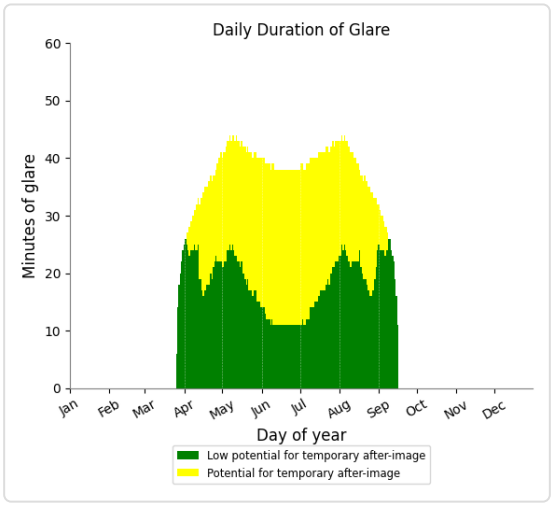
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri west	3,222	53.7	3,187	53.1
A12 ri oost	267	4.5	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

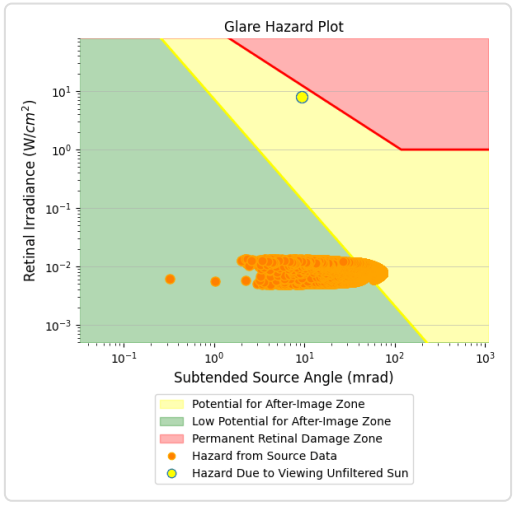
UV-16 and Route: N198 ri west

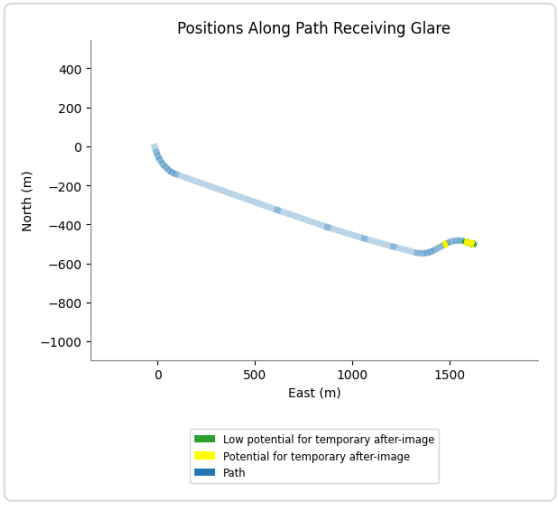
Yellow glare: 3,187 min.

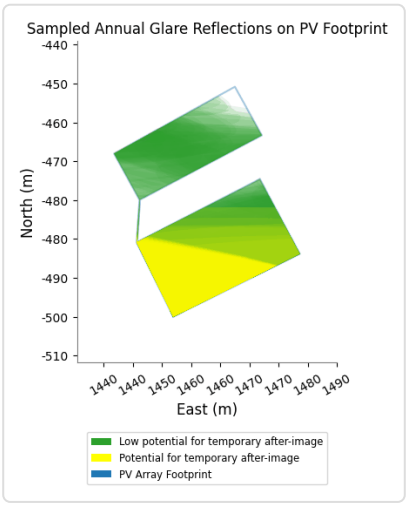
Green glare: 3,222 min.







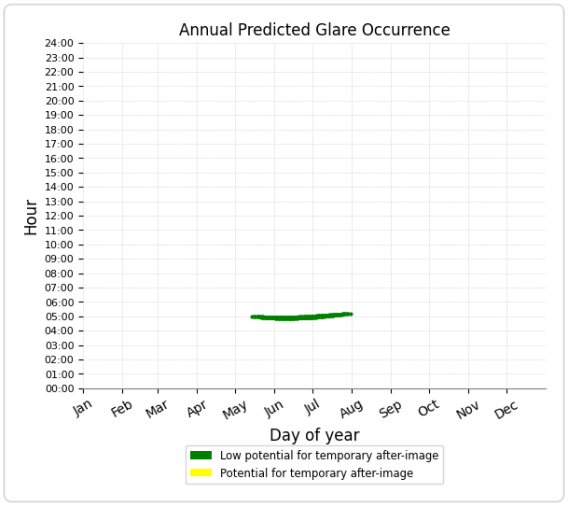


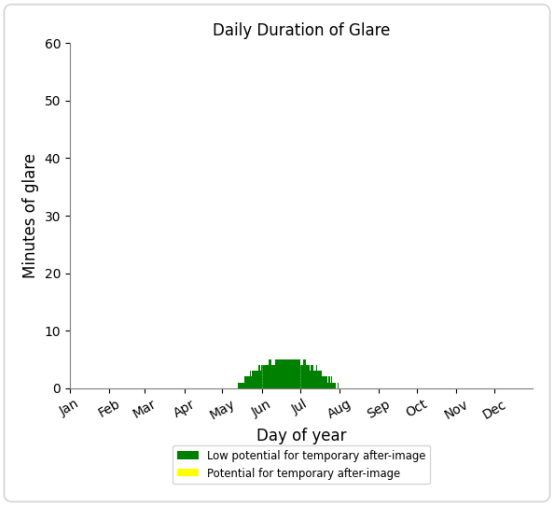


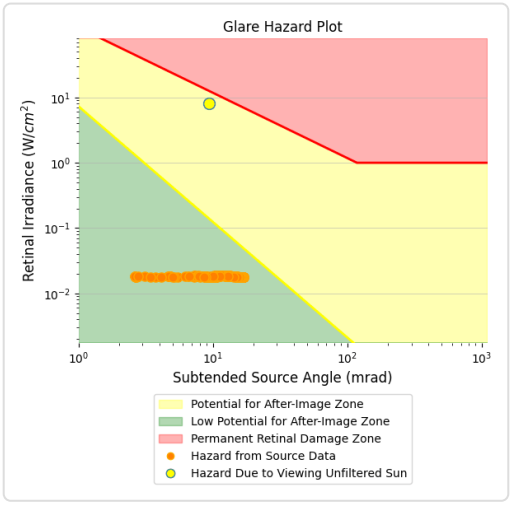
UV-16 and Route: A12 ri oost

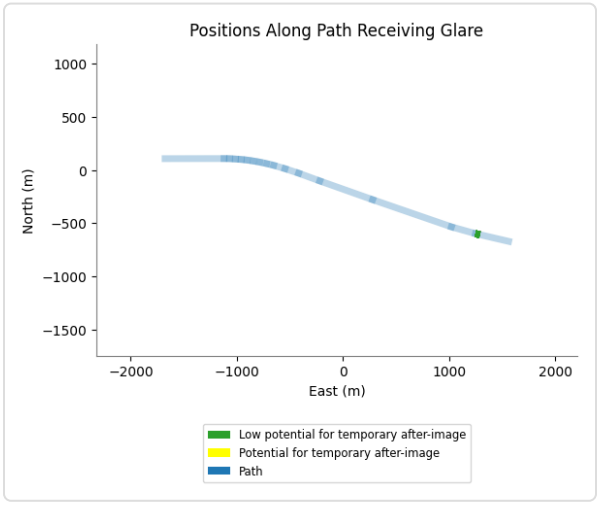
Yellow glare: none

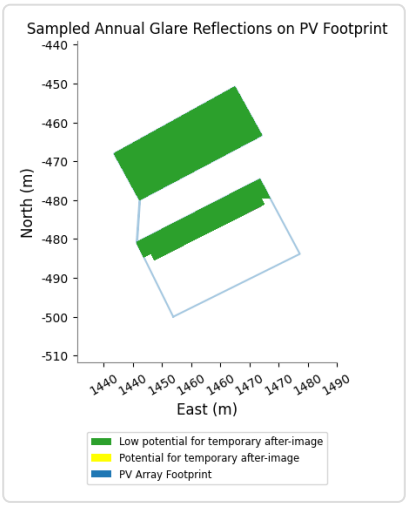
Green glare: 267 min.











UV-16 and Route: A12 ri west

No glare found

UV-16 and Route: N198 ri oost

No glare found

UV-16 and Route: N419 ri oost

No glare found

UV-16 and Route: N419 ri west

No glare found

PV: Woerden potential temporary after-image

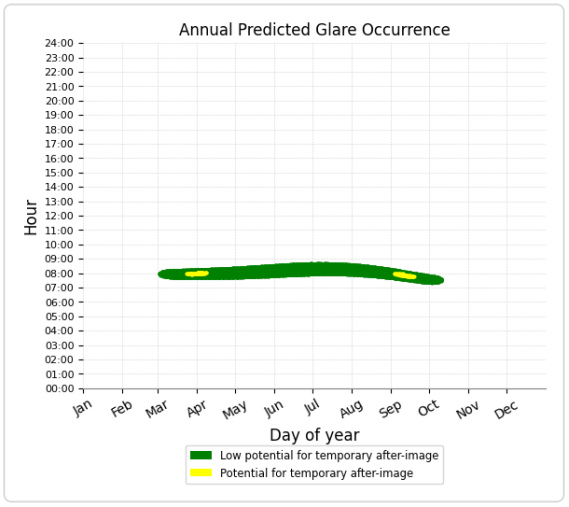
Receptor results ordered by category of glare

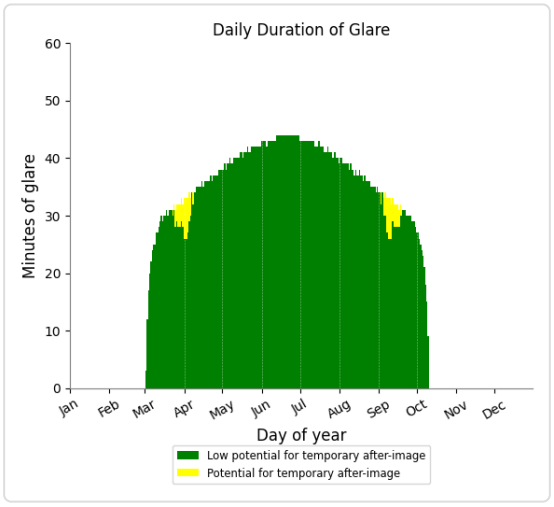
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	7,929	132.2	132	2.2
A12 ri west	2,535	42.2	1,145	19.1
N198 ri west	880	14.7	699	11.7
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

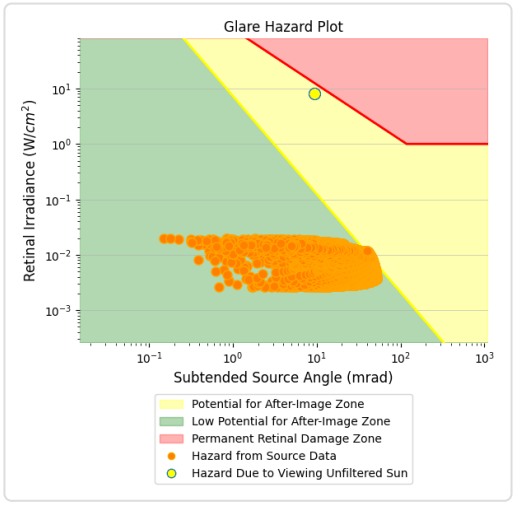
Woerden and Route: A12 ri oost

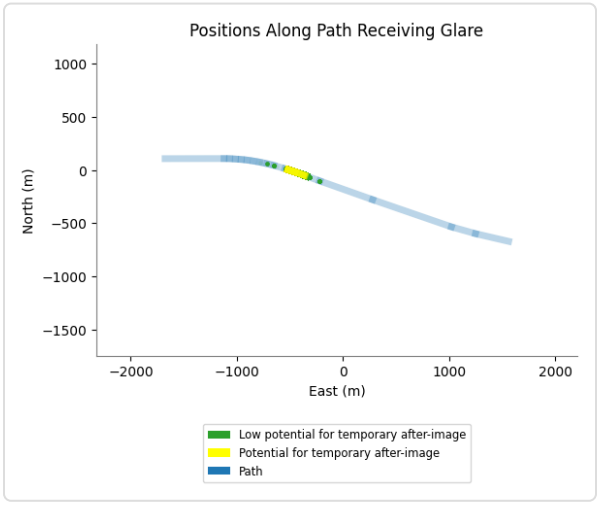
Yellow glare: 132 min.

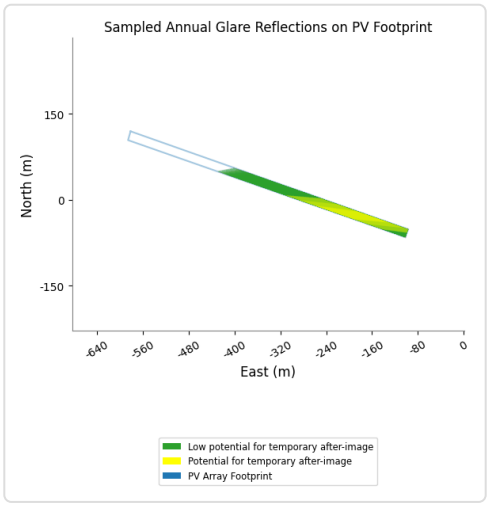
Green glare: 7,929 min.







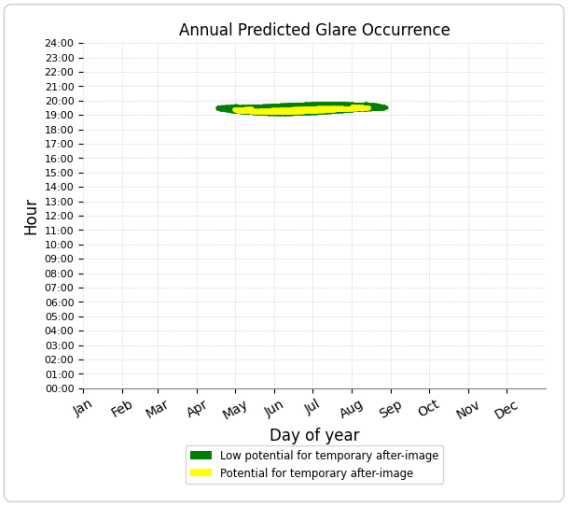


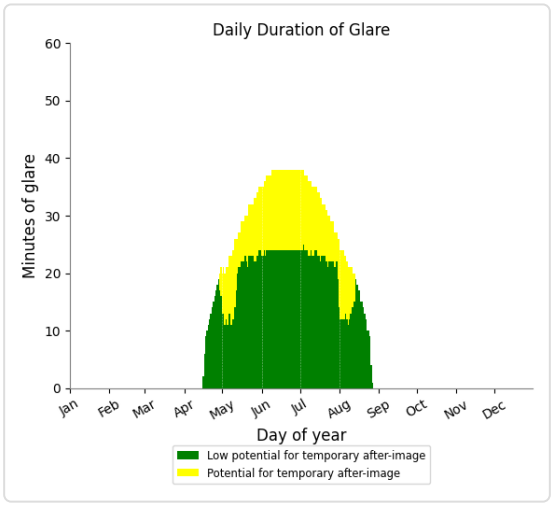


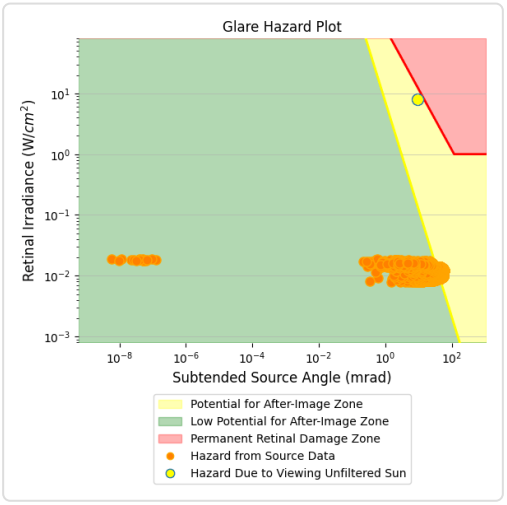
Woerden and Route: A12 ri west

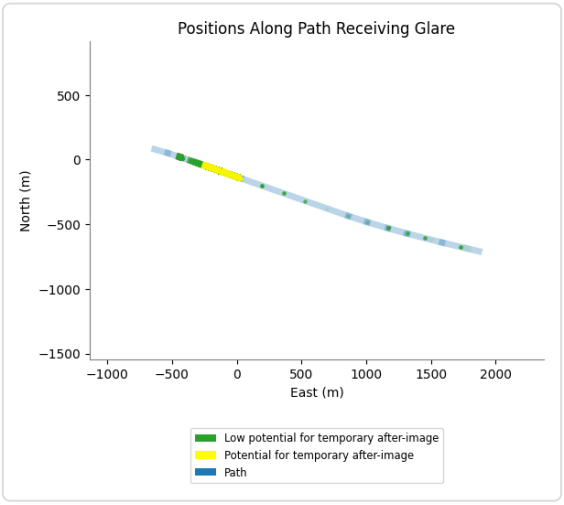
Yellow glare: 1,145 min.

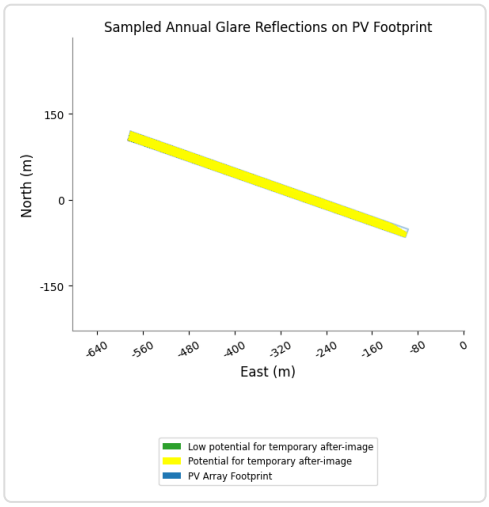
Green glare: 2,535 min.







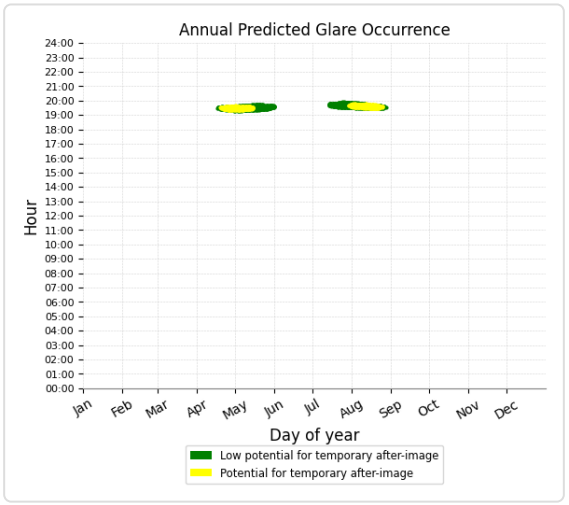


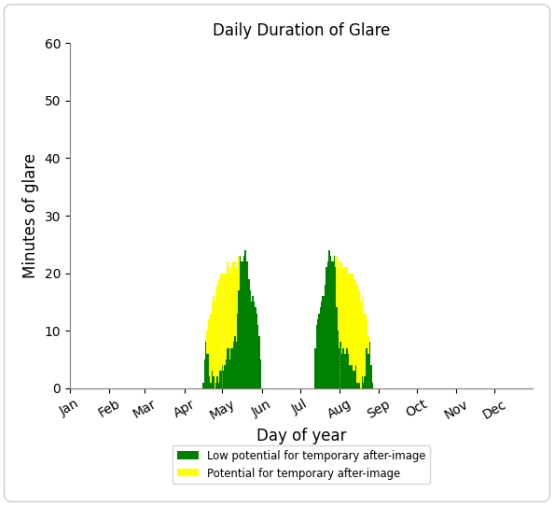


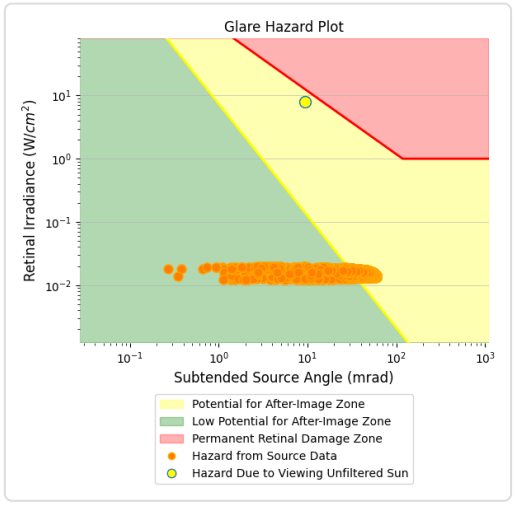
Woerden and Route: N198 ri west

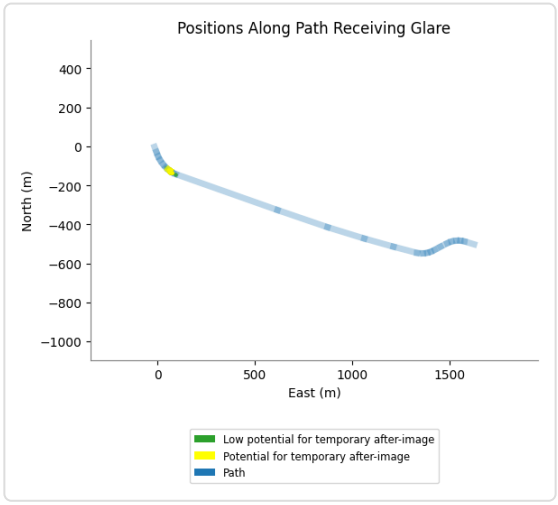
Yellow glare: 699 min.

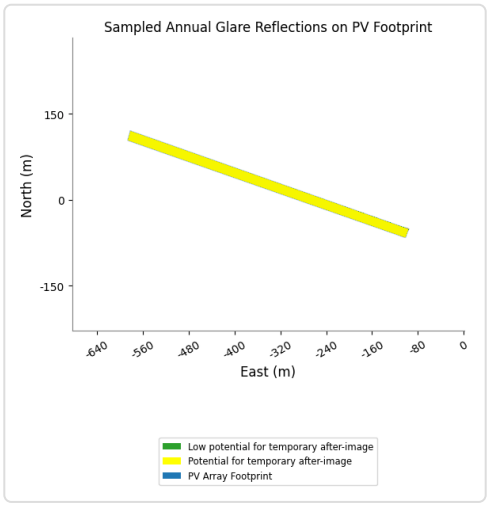
Green glare: 880 min.











Woerden and Route: N198 ri oost

No glare found

Woerden and Route: N419 ri oost

No glare found

Woerden and Route: N419 ri west

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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This analysis was conducted using the best available radiometric modeling at the time of generation. Future updates to the modeling methodology may yield different results.

FORGESOLAR GLARE ANALYSIS

Project: **Geluidswal A12**

Sweco heeft plannen voor een zonnepanelen op een geluidswal aangeleverd aan ROM3D. De geluidswal ligt langs de A12, in twee delen nabij Woerden en Utrecht – Veldhuizen. Eventuele reflectiehinder veroorzaakt door dit park kan inzichtelijk worden gemaakt met een reflectiestudie. Er is gevraagd om een dergelijke studie uit te voeren om de schittering te bepalen voor weggebruikers van de A12 en de N198 en de N419. Het te realiseren zonnepark ligt ten noorden van de A12. Voor het reflectieonderzoek zal ROM3D uitgaan van eigenschappen zoals aangeleverd door de opdrachtgever.

Site configuration: **Automobilisten - DTG**

Calculated via ForgeSolar Radiometric Physics Engine v3.2.1

Client: Sweco

Created 13 Jul, 2026
Updated 13 Jul, 2026
Time-step 1 minute
Timezone offset UTC1
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 1 MW to 5 MW
Site ID 182856.29739

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Min luminance threshold 5,000 cd/m^2

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	347,878	5,798.0	0	0.0	-
UV-02	25.0	241.68	342,029	5,700.5	0	0.0	-
UV-03	25.0	233.48	287,872	4,797.9	0	0.0	-
UV-04	25.0	225.18	350,189	5,836.5	0	0.0	-
UV-05	25.0	202.75	276,041	4,600.7	0	0.0	-
UV-06	25.0	204.1	279,651	4,660.9	0	0.0	-
UV-07	25.0	197.55	288,533	4,808.9	0	0.0	-
UV-08	25.0	195.26	289,142	4,819.0	0	0.0	-
UV-09	25.0	192.6	261,123	4,352.1	0	0.0	-
UV-10	25.0	189.34	130,380	2,173.0	0	0.0	-
UV-11	25.0	184.09	45,155	752.6	0	0.0	-
UV-12	25.0	181.74	188,688	3,144.8	0	0.0	-
UV-13	25.0	174.0	73,386	1,223.1	0	0.0	-
UV-14	25.0	154.86	118,486	1,974.8	0	0.0	-
UV-15	25.0	152.49	138,571	2,309.5	0	0.0	-
UV-16	25.0	150.5	150,779	2,513.0	0	0.0	-
Woerden	35.0	197.87	194,869	3,247.8	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	968,713	16,145.2	0	0.0
A12 ri west	682,747	11,379.1	0	0.0
N198 ri oost	954,870	15,914.5	0	0.0
N198 ri west	507,117	8,452.0	0	0.0
N419 ri oost	420,028	7,000.5	0	0.0
N419 ri west	229,297	3,821.6	0	0.0

Component Data

PV Arrays

Name: UV-01
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 259.2°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079394	5.002834	1.80	1.00	2.80
2	52.079414	5.003086	8.90	1.00	9.90
3	52.079165	5.003165	8.90	1.00	9.90
4	52.079133	5.002909	1.80	1.00	2.80

Name: UV-02
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 241.68°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079089	5.002938	1.80	1.00	2.80
2	52.079160	5.003172	8.90	1.00	9.90
3	52.078925	5.003359	8.90	1.00	9.90
4	52.078846	5.003115	1.80	1.00	2.80

Name: UV-03
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 233.48°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078921	5.003362	8.90	1.00	9.90
2	52.078714	5.003589	8.90	1.00	9.90
3	52.078621	5.003381	1.80	1.00	2.80
4	52.078821	5.003140	1.80	1.00	2.80

Name: UV-04
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 225.18°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078709	5.003596	8.90	1.00	9.90
2	52.078528	5.003883	8.90	1.00	9.90
3	52.078416	5.003701	1.80	1.00	2.80
4	52.078600	5.003403	1.80	1.00	2.80

Name: UV-05
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 202.75°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078514	5.003900	8.90	1.00	9.90
2	52.078381	5.003765	1.80	1.00	2.80
3	52.078243	5.004127	1.80	1.00	2.80
4	52.078381	5.004253	8.90	1.00	9.90

Name: UV-06
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 204.1°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078369	5.004292	8.90	1.00	9.90
2	52.078224	5.004187	1.80	1.00	2.80
3	52.078116	5.004577	1.80	1.00	2.80
4	52.078262	5.004685	8.90	1.00	9.90

Name: UV-07
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 197.55°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078252	5.004723	8.90	1.00	9.90
2	52.078105	5.004623	1.80	1.00	2.80
3	52.075796	5.015377	1.80	1.00	2.80
4	52.075952	5.015472	8.90	1.00	9.90

Name: UV-08
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 195.26°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.075783	5.015424	1.80	1.00	2.80
2	52.075941	5.015508	8.90	1.00	9.90
3	52.075166	5.019634	8.90	1.00	9.90
4	52.075013	5.019572	1.80	1.00	2.80

Name: UV-09
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 192.6°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074996	5.019648	1.80	1.00	2.80
2	52.075298	5.019780	13.20	1.00	14.20
3	52.074991	5.021772	13.20	1.00	14.20
4	52.074895	5.021732	10.70	1.00	11.70
5	52.075209	5.019742	10.70	1.00	11.70
6	52.075150	5.019719	8.90	1.00	9.90
7	52.074833	5.021708	8.90	1.00	9.90
8	52.074676	5.021644	1.80	1.00	2.80

Name: UV-10
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 189.34°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074664	5.021722	1.80	1.00	2.80
2	52.074982	5.021799	13.20	1.00	14.20
3	52.074937	5.022221	13.20	1.00	14.20
4	52.074836	5.022191	10.70	1.00	11.70
5	52.074886	5.021778	10.70	1.00	11.70
6	52.074822	5.021763	8.90	1.00	9.90
7	52.074777	5.022181	8.90	1.00	9.90
8	52.074615	5.022144	1.80	1.00	2.80

Name: UV-11
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 184.09°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074834	5.022217	10.70	1.00	11.70
2	52.074935	5.022232	13.20	1.00	14.20
3	52.074915	5.022546	13.20	1.00	14.20
4	52.074816	5.022533	10.70	1.00	11.70

Name: UV-12
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 181.74°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074614	5.022176	1.80	1.00	2.80
2	52.074775	5.022196	8.90	1.00	9.90
3	52.074757	5.022614	8.90	1.00	9.90
4	52.074598	5.022600	1.80	1.00	2.80

Name: UV-13
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 174.0°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074915	5.022550	13.20	1.00	14.20
2	52.074816	5.022559	10.70	1.00	11.70
3	52.074756	5.022630	8.90	1.00	9.90
4	52.074597	5.022632	1.80	1.00	2.80
5	52.074618	5.023055	1.80	1.00	2.80
6	52.074772	5.023044	8.90	1.00	9.90
7	52.074756	5.022633	8.90	1.00	9.90
8	52.074816	5.022561	10.70	1.00	11.70
9	52.074842	5.022989	10.70	1.00	11.70
10	52.074944	5.022973	13.20	1.00	14.20

Name: UV-14
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 154.86°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074628	5.023148	1.80	1.00	2.80
2	52.074774	5.023052	8.90	1.00	9.90
3	52.074852	5.023036	10.70	1.00	11.70
4	52.074944	5.022977	13.20	1.00	14.20
5	52.075047	5.023366	13.20	1.00	14.20
6	52.074951	5.023433	10.70	1.00	11.70
7	52.074852	5.023038	10.70	1.00	11.70
8	52.074774	5.023053	8.90	1.00	9.90
9	52.074870	5.023429	8.90	1.00	9.90
10	52.074733	5.023531	1.80	1.00	2.80

Name: UV-15
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 152.49°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074747	5.023569	1.80	1.00	2.80
2	52.074879	5.023456	8.90	1.00	9.90
3	52.074953	5.023449	10.70	1.00	11.70
4	52.075052	5.023380	13.20	1.00	14.20
5	52.075161	5.023755	13.20	1.00	14.20
6	52.075074	5.023830	10.70	1.00	11.70
7	52.074954	5.023453	10.70	1.00	11.70
8	52.074880	5.023458	8.90	1.00	9.90
9	52.074999	5.023829	8.90	1.00	9.90
10	52.074861	5.023942	1.80	1.00	2.80

Name: UV-16
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 150.5°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074866	5.023959	1.80	1.00	2.80
2	52.075003	5.023849	8.90	1.00	9.90
3	52.075082	5.023858	10.70	1.00	11.70
4	52.075168	5.023782	13.20	1.00	14.20
5	52.075292	5.024144	13.20	1.00	14.20
6	52.075202	5.024226	10.70	1.00	11.70
7	52.075083	5.023860	10.70	1.00	11.70
8	52.075004	5.023851	8.90	1.00	9.90
9	52.075121	5.024220	8.90	1.00	9.90
10	52.074982	5.024340	1.80	1.00	2.80

Name: Woerden
Axis tracking: Fixed (no rotation)
Tilt: 35.0°
Orientation: 197.87°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080468	4.994350	8.00	1.00	9.00
2	52.080330	4.994286	0.00	1.00	1.00
3	52.078807	5.001345	0.00	1.00	1.00
4	52.078932	5.001420	8.00	1.00	9.00

Route Receptors

Name: A12 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080355	4.978381	1.00	1.10	2.10
2	52.080361	4.986477	1.00	1.10	2.10
3	52.080353	4.987236	1.00	1.10	2.10
4	52.080321	4.988051	1.00	1.10	2.10
5	52.080287	4.988839	1.00	1.10	2.10
6	52.080232	4.989657	1.00	1.10	2.10
7	52.080152	4.990527	1.00	1.10	2.10
8	52.080056	4.991406	1.00	1.10	2.10
9	52.079931	4.992347	1.00	1.10	2.10
10	52.079788	4.993302	1.00	1.10	2.10
11	52.079504	4.994866	1.00	1.10	2.10
12	52.079123	4.996740	1.00	1.10	2.10
13	52.078467	4.999653	1.00	1.10	2.10
14	52.076884	5.006915	1.00	1.10	2.10
15	52.074587	5.017750	1.00	1.10	2.10
16	52.074013	5.021057	1.00	1.10	2.10
17	52.073363	5.025614	2.90	1.10	4.00

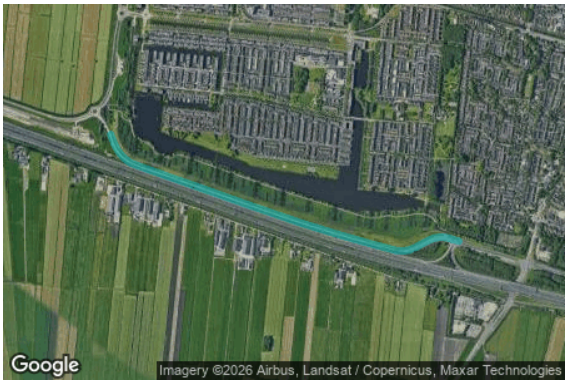
Name: A12 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.073024	5.030141	5.70	1.10	6.80
2	52.073632	5.025983	3.10	1.10	4.20
3	52.074258	5.022036	0.90	1.10	2.00
4	52.074627	5.019886	0.30	1.10	1.40
5	52.075057	5.017533	0.30	1.10	1.40
6	52.075477	5.015418	0.30	1.10	1.40
7	52.078108	5.003266	0.30	1.10	1.40
8	52.079515	4.996721	0.30	1.10	1.40
9	52.079856	4.995053	0.30	1.10	1.40
10	52.080115	4.993585	0.30	1.10	1.40

Name: N198 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080085	5.001737	-0.10	1.10	1.00
2	52.080033	5.001839	-0.10	1.10	1.00
3	52.079835	5.002108	-0.20	1.10	0.90
4	52.079653	5.002301	-0.20	1.10	0.90
5	52.079353	5.002564	-0.20	1.10	0.90
6	52.079129	5.002711	-0.20	1.10	0.90
7	52.078917	5.002845	-0.20	1.10	0.90
8	52.078747	5.002987	-0.20	1.10	0.90
9	52.078547	5.003213	-0.20	1.10	0.90
10	52.078402	5.003425	-0.20	1.10	0.90
11	52.078270	5.003666	-0.20	1.10	0.90
12	52.078170	5.003902	-0.20	1.10	0.90
13	52.078079	5.004197	-0.20	1.10	0.90
14	52.076426	5.011812	-0.20	1.10	0.90
15	52.075637	5.015559	-0.20	1.10	0.90
16	52.075116	5.018307	-0.20	1.10	0.90
17	52.074736	5.020489	-0.20	1.10	0.90
18	52.074459	5.022255	-0.20	1.10	0.90
19	52.074397	5.022726	0.00	1.10	1.10
20	52.074403	5.022983	0.10	1.10	1.20
21	52.074431	5.023301	0.10	1.10	1.20
22	52.074616	5.023981	0.20	1.10	1.30
23	52.074830	5.024727	0.60	1.10	1.70

Name: N198 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074878	5.026535	0.80	1.10	1.90
2	52.075013	5.025811	0.90	1.10	2.00
3	52.075044	5.025508	0.90	1.10	2.00
4	52.075046	5.025211	0.90	1.10	2.00
5	52.075008	5.024850	0.90	1.10	2.00
6	52.074927	5.024526	0.70	1.10	1.80
7	52.074765	5.024016	0.30	1.10	1.40
8	52.074624	5.023588	0.00	1.10	1.10
9	52.074537	5.023293	-0.10	1.10	1.00
10	52.074489	5.023027	-0.20	1.10	0.90
11	52.074463	5.022713	-0.20	1.10	0.90
12	52.074483	5.022262	-0.20	1.10	0.90
13	52.074768	5.020499	-0.20	1.10	0.90
14	52.075144	5.018318	-0.20	1.10	0.90
15	52.075667	5.015564	-0.20	1.10	0.90
16	52.076455	5.011826	-0.20	1.10	0.90
17	52.078113	5.004211	-0.20	1.10	0.90
18	52.078192	5.003935	-0.20	1.10	0.90
19	52.078291	5.003707	-0.20	1.10	0.90
20	52.078421	5.003473	-0.20	1.10	0.90
21	52.078568	5.003259	-0.20	1.10	0.90
22	52.078759	5.003042	-0.20	1.10	0.90
23	52.078929	5.002897	-0.20	1.10	0.90
24	52.079136	5.002763	-0.20	1.10	0.90
25	52.079367	5.002623	-0.20	1.10	0.90

Name: N419 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

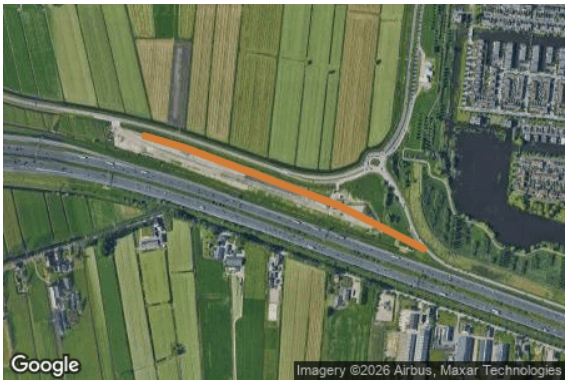
Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081519	4.989885	-0.60	1.10	0.50
2	52.081272	4.992168	-0.60	1.10	0.50
3	52.081193	4.992811	-0.60	1.10	0.50
4	52.080995	4.994115	-0.60	1.10	0.50
5	52.080769	4.995295	-0.60	1.10	0.50
6	52.080146	4.998197	-0.60	1.10	0.50
7	52.080033	4.998680	-0.60	1.10	0.50
8	52.079948	4.999080	-0.60	1.10	0.50
9	52.079892	4.999530	-0.60	1.10	0.50
10	52.079884	4.999975	-0.60	1.10	0.50
11	52.079911	5.000375	-0.60	1.10	0.50
12	52.079943	5.000638	-0.50	1.10	0.60
13	52.080009	5.000952	-0.40	1.10	0.70
14	52.080143	5.001405	-0.10	1.10	1.00
15	52.080123	5.001518	-0.10	1.10	1.00
16	52.080130	5.001668	-0.10	1.10	1.00
17	52.080163	5.001797	-0.10	1.10	1.00
18	52.080229	5.001885	-0.10	1.10	1.00
19	52.080351	5.001901	-0.10	1.10	1.00

Name: N419 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081289	5.002510	0.40	1.10	1.50
2	52.081097	5.002414	0.30	1.10	1.40
3	52.080891	5.002242	0.10	1.10	1.20
4	52.080703	5.002033	0.10	1.10	1.20
5	52.080552	5.001832	0.00	1.10	1.10
6	52.080494	5.001684	-0.10	1.10	1.00
7	52.080504	5.001545	-0.10	1.10	1.00
8	52.080487	5.001402	-0.10	1.10	1.00
9	52.080438	5.001298	-0.10	1.10	1.00
10	52.080324	5.001228	-0.10	1.10	1.00
11	52.080262	5.001174	-0.10	1.10	1.00
12	52.080202	5.001043	-0.30	1.10	0.80
13	52.080122	5.000756	-0.40	1.10	0.70
14	52.080047	5.000397	-0.50	1.10	0.60
15	52.080008	5.000016	-0.60	1.10	0.50
16	52.080013	4.999479	-0.60	1.10	0.50
17	52.080052	4.999013	-0.60	1.10	0.50
18	52.080156	4.998334	-0.60	1.10	0.50
19	52.080802	4.995308	-0.60	1.10	0.50
20	52.081030	4.994115	-0.60	1.10	0.50

Obstruction Components

Name: Geluidsscherm I en Talud
Top height: 8.80 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.080881	4.993642	0.00
2	52.080621	4.995064	0.00
3	52.079412	5.000313	0.00
4	52.078512	5.003205	0.00

Name: Geluidsscherm II
Top height: 4.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.074608	5.021008	0.00
2	52.074201	5.023580	0.00
3	52.074150	5.024043	0.00
4	52.074115	5.024569	0.00
5	52.074116	5.024735	0.00
6	52.074144	5.024934	0.00
7	52.074201	5.025140	0.00
8	52.074267	5.025320	0.00
9	52.074389	5.025528	0.00
10	52.074562	5.025741	0.00

Name: Geluidsscherm III
Top height: 7.00 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.073659	5.026506	0.00
2	52.073916	5.024693	0.00

Name: Geluidsscherm IV
Top height: 7.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.072916	5.031908	0.00
2	52.073542	5.027611	0.00
3	52.073628	5.027161	0.00
4	52.073705	5.026887	0.00
5	52.073862	5.026614	0.00
6	52.073992	5.026453	0.00
7	52.074149	5.026345	0.00
8	52.074236	5.026300	0.00

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	347,878	5,798.0	0	0.0	-
UV-02	25.0	241.68	342,029	5,700.5	0	0.0	-
UV-03	25.0	233.48	287,872	4,797.9	0	0.0	-
UV-04	25.0	225.18	350,189	5,836.5	0	0.0	-
UV-05	25.0	202.75	276,041	4,600.7	0	0.0	-
UV-06	25.0	204.1	279,651	4,660.9	0	0.0	-
UV-07	25.0	197.55	288,533	4,808.9	0	0.0	-
UV-08	25.0	195.26	289,142	4,819.0	0	0.0	-
UV-09	25.0	192.6	261,123	4,352.1	0	0.0	-
UV-10	25.0	189.34	130,380	2,173.0	0	0.0	-
UV-11	25.0	184.09	45,155	752.6	0	0.0	-
UV-12	25.0	181.74	188,688	3,144.8	0	0.0	-
UV-13	25.0	174.0	73,386	1,223.1	0	0.0	-
UV-14	25.0	154.86	118,486	1,974.8	0	0.0	-
UV-15	25.0	152.49	138,571	2,309.5	0	0.0	-
UV-16	25.0	150.5	150,779	2,513.0	0	0.0	-
Woerden	35.0	197.87	194,869	3,247.8	0	0.0	-

Note: One or more PV arrays use a module profile that produces highly diffuse reflections. The analysis models these as diffuse reflective surfaces with a beam divergence cap of 120°, which is the limit of the analytical projection method.

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	968,713	16,145.2	0	0.0
A12 ri west	682,747	11,379.1	0	0.0
N198 ri oost	954,870	15,914.5	0	0.0
N198 ri west	507,117	8,452.0	0	0.0
N419 ri oost	420,028	7,000.5	0	0.0
N419 ri west	229,297	3,821.6	0	0.0

PV: UV-01 low potential for temporary after-image

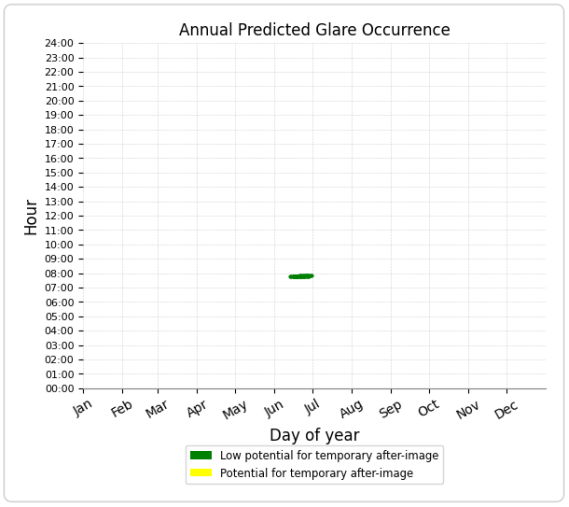
Receptor results ordered by category of glare

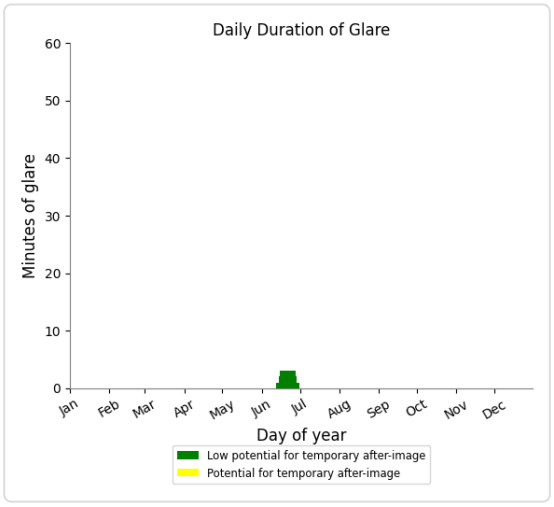
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	44	0.7	0	0.0
N198 ri oost	114,521	1,908.7	0	0.0
N198 ri west	3,714	61.9	0	0.0
N419 ri oost	114,464	1,907.7	0	0.0
N419 ri west	115,135	1,918.9	0	0.0
A12 ri west	0	0.0	0	0.0

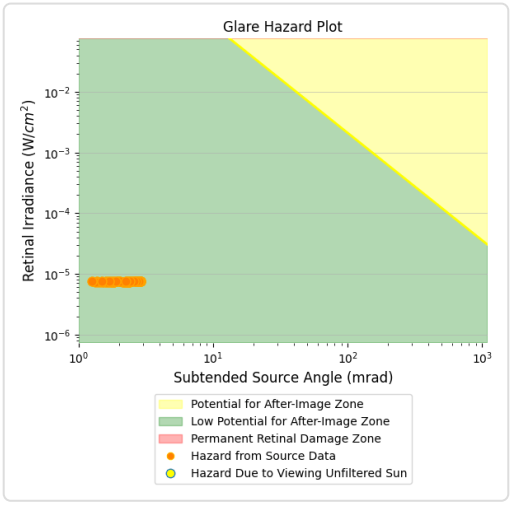
UV-01 and Route: A12 ri oost

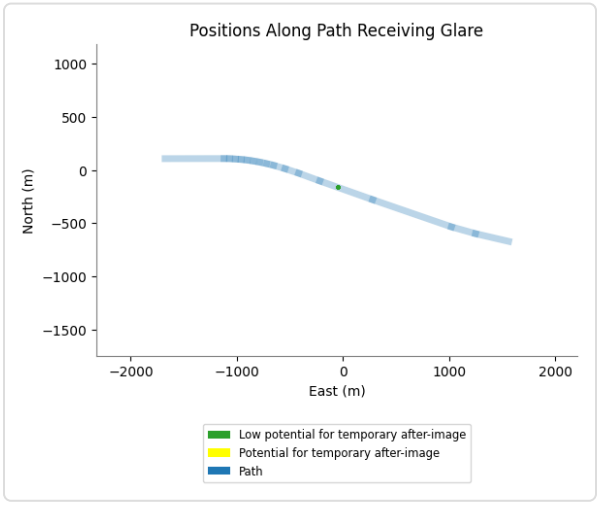
Yellow glare: none

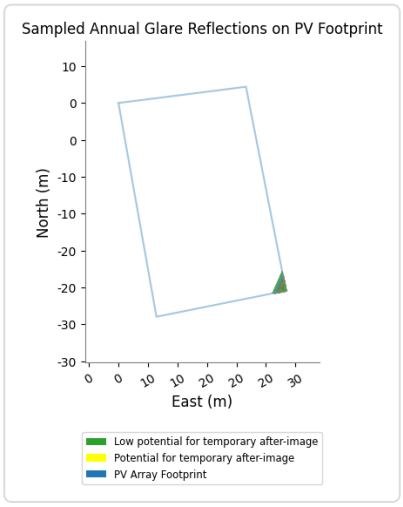
Green glare: 44 min.







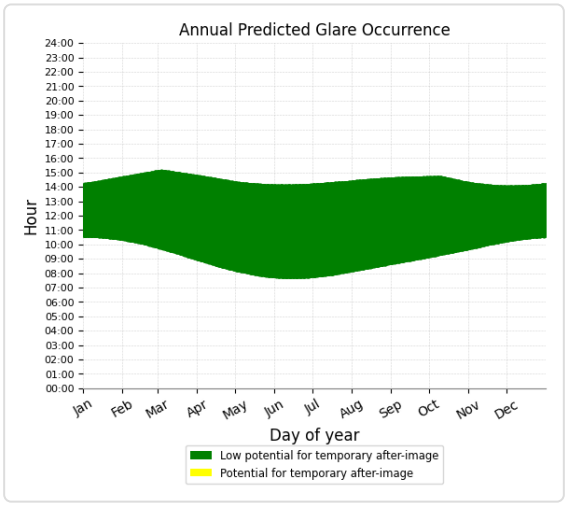


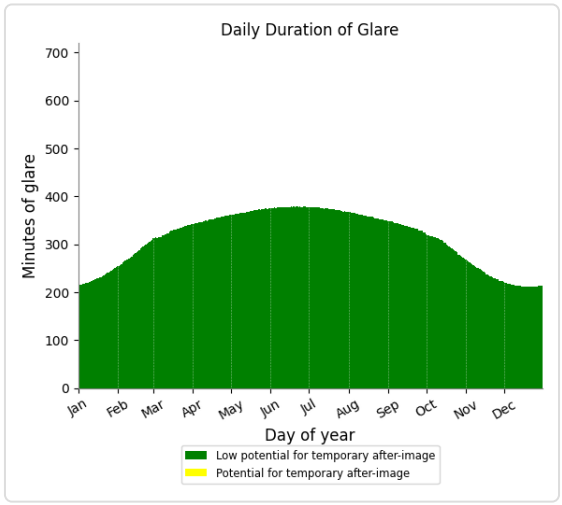


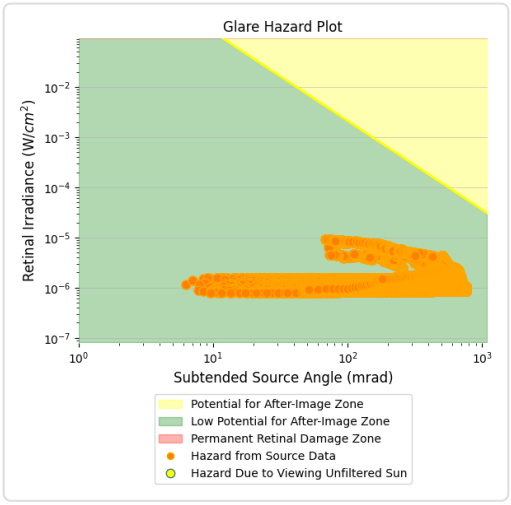
UV-01 and Route: N198 ri oost

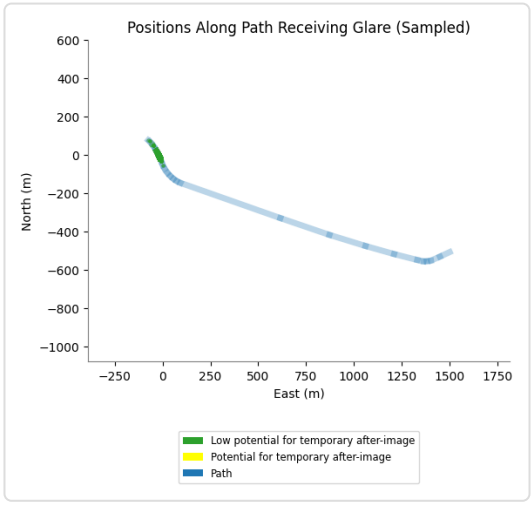
Yellow glare: none

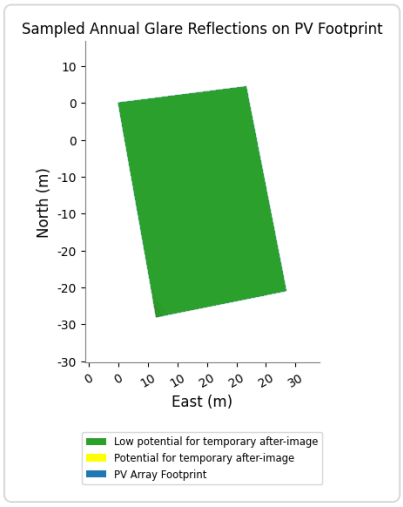
Green glare: 114,521 min.







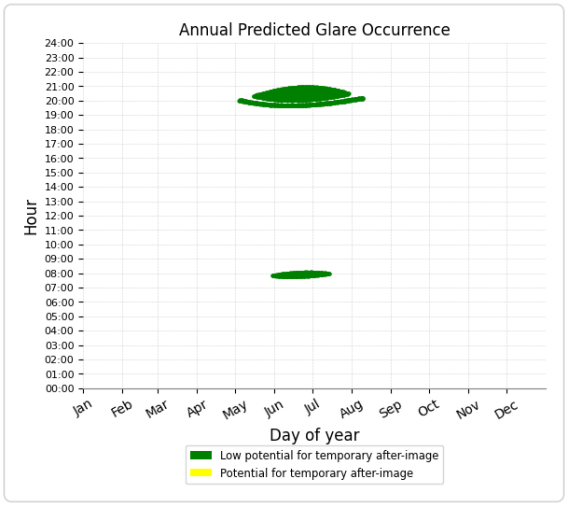


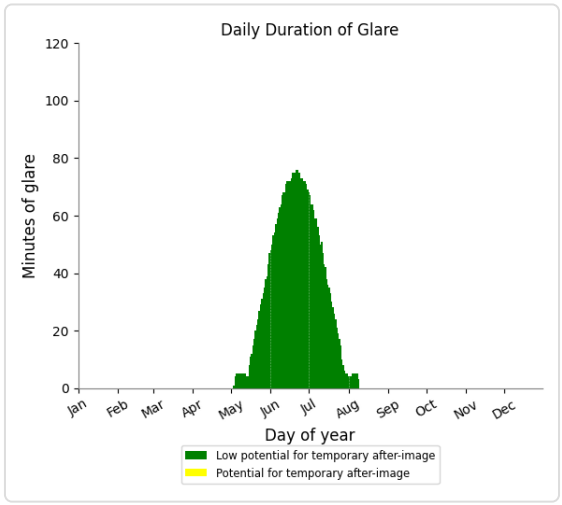


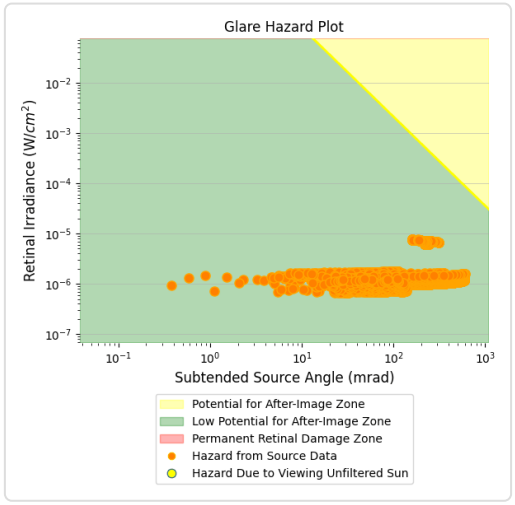
UV-01 and Route: N198 ri west

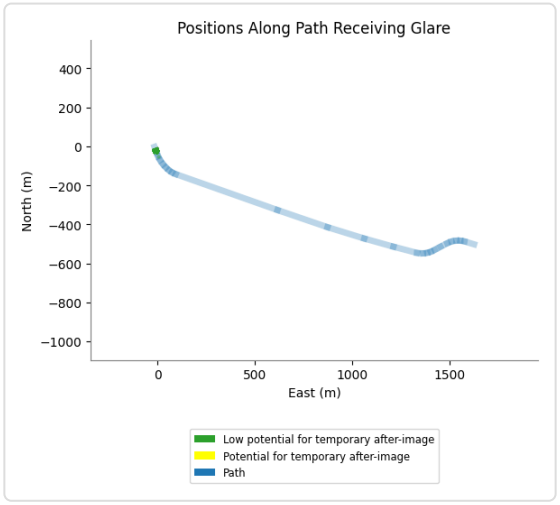
Yellow glare: none

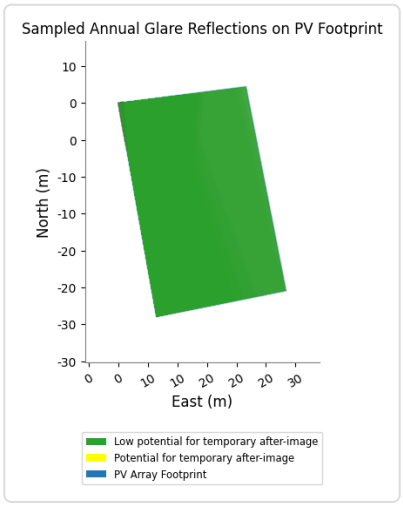
Green glare: 3,714 min.







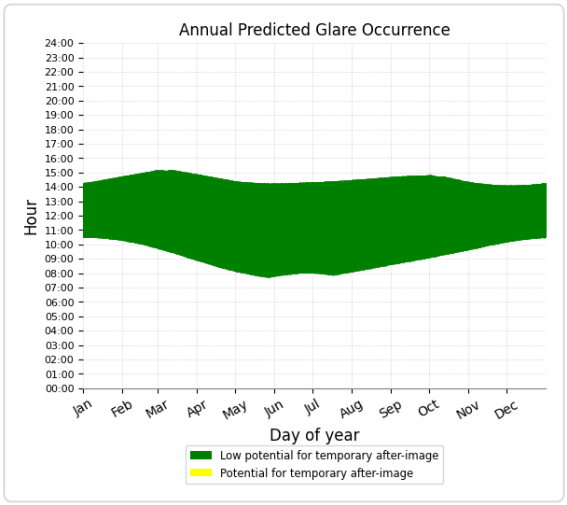


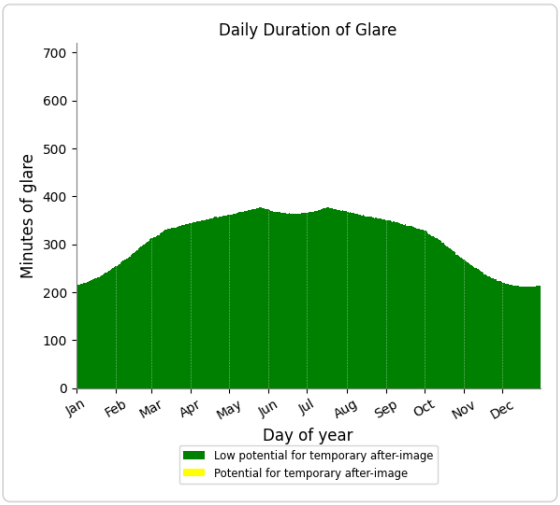


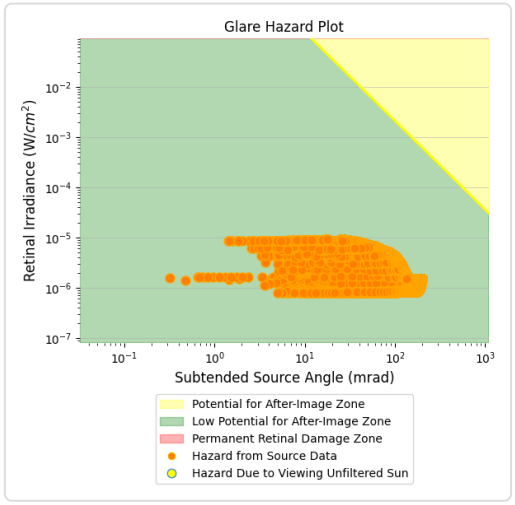
UV-01 and Route: N419 ri oost

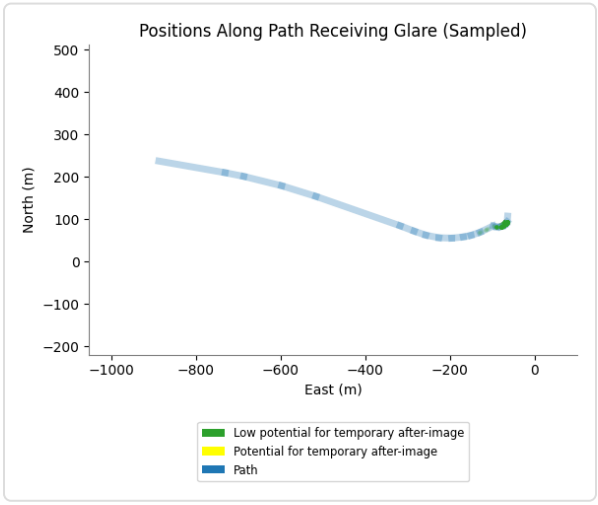
Yellow glare: none

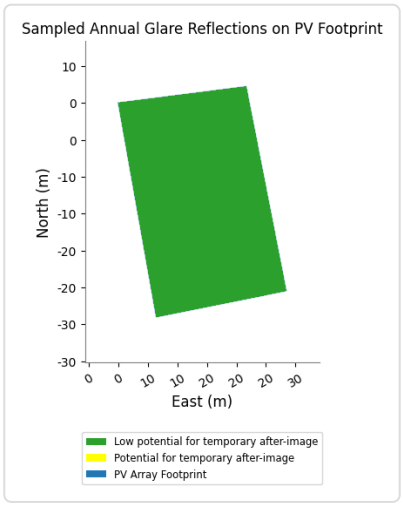
Green glare: 114,464 min.







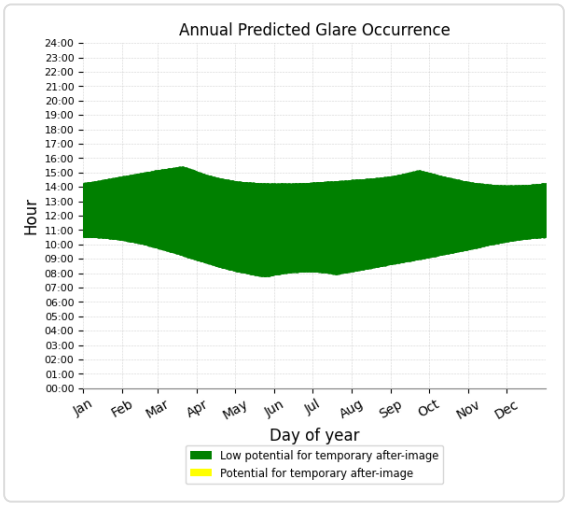


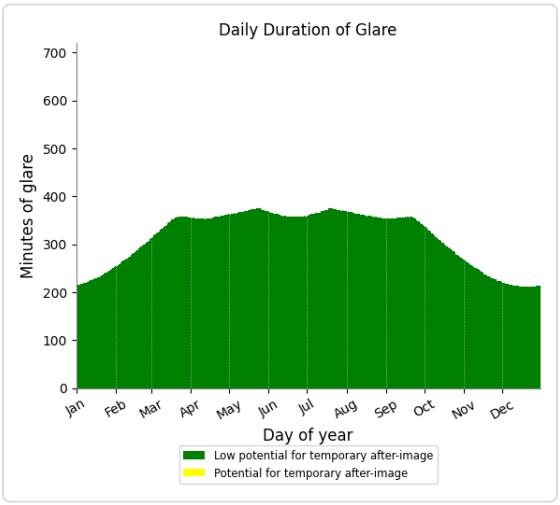


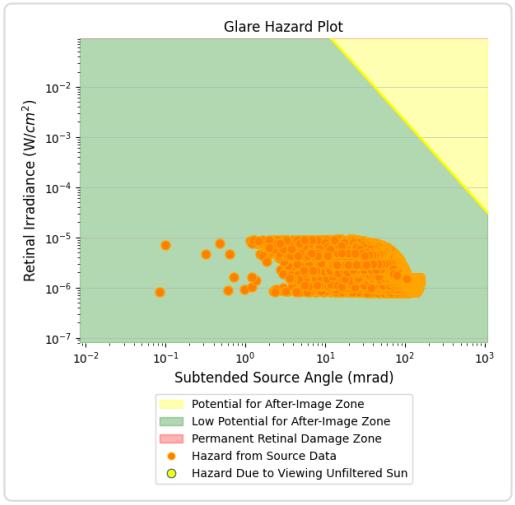
UV-01 and Route: N419 ri west

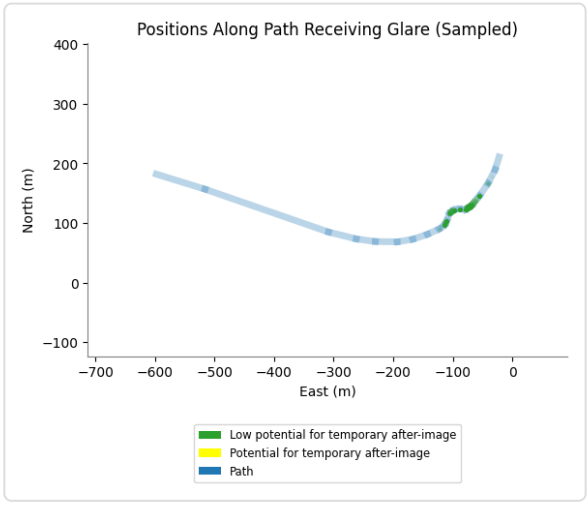
Yellow glare: none

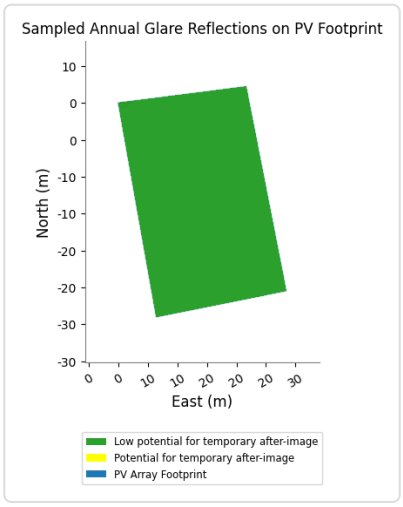
Green glare: 115,135 min.











UV-01 and Route: A12 ri west

No glare found

PV: UV-02 low potential for temporary after-image

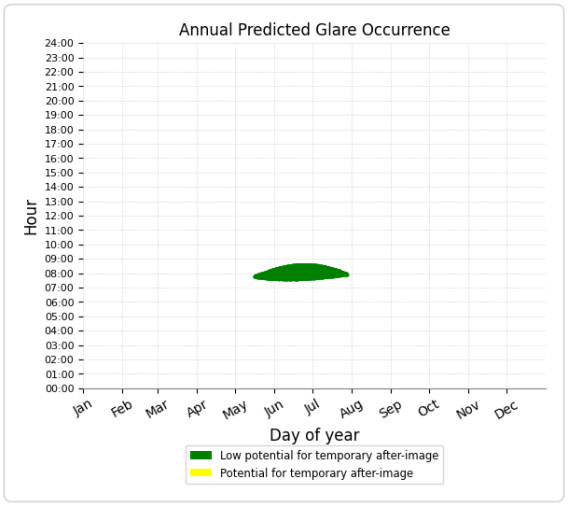
Receptor results ordered by category of glare

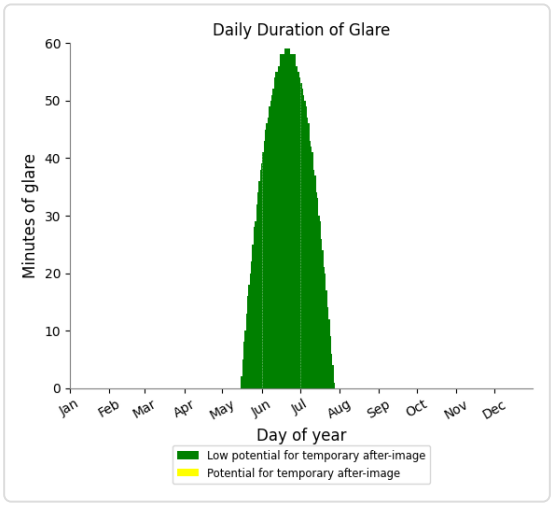
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	2,826	47.1	0	0.0
A12 ri west	16,998	283.3	0	0.0
N198 ri oost	112,095	1,868.2	0	0.0
N198 ri west	15,421	257.0	0	0.0
N419 ri oost	112,796	1,879.9	0	0.0
N419 ri west	81,893	1,364.9	0	0.0

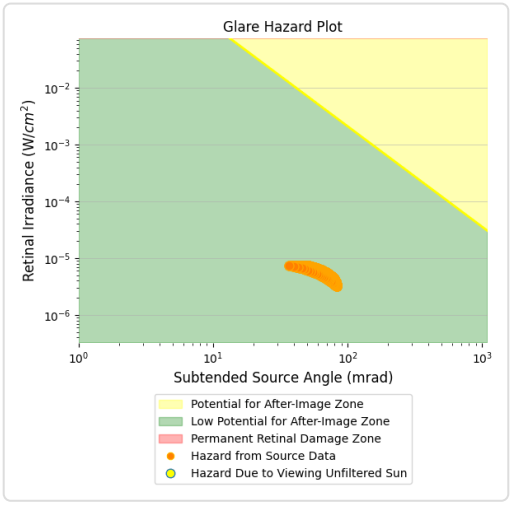
UV-02 and Route: A12 ri oost

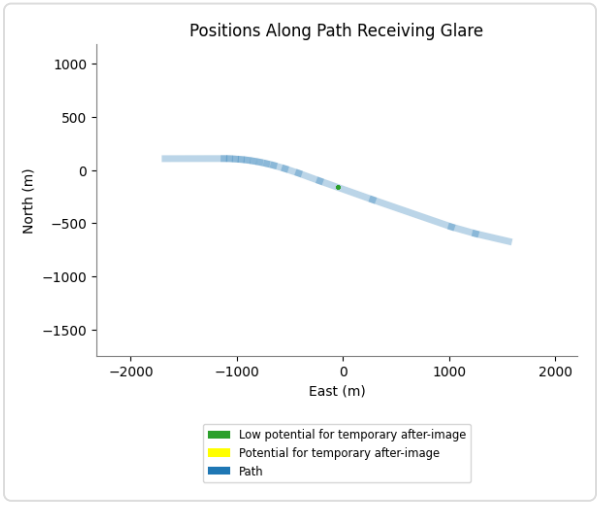
Yellow glare: none

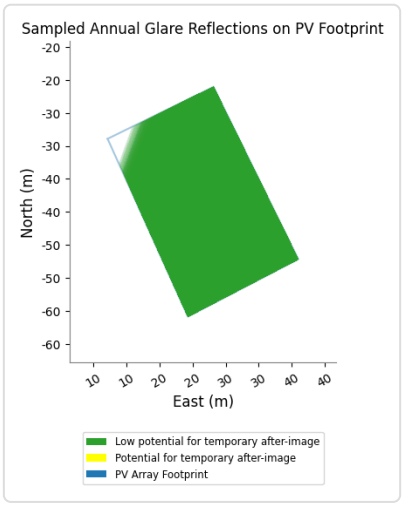
Green glare: 2,826 min.







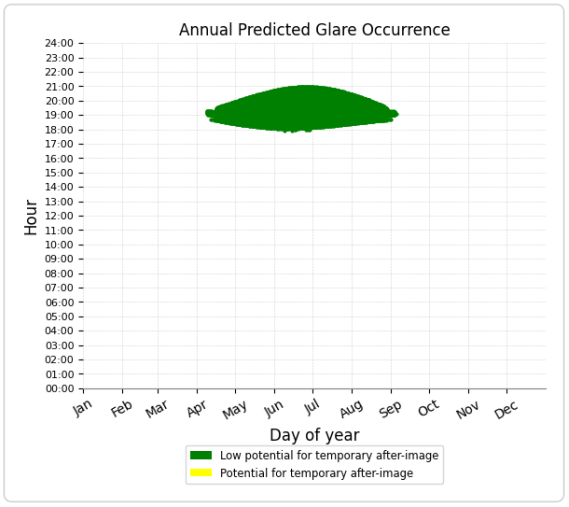


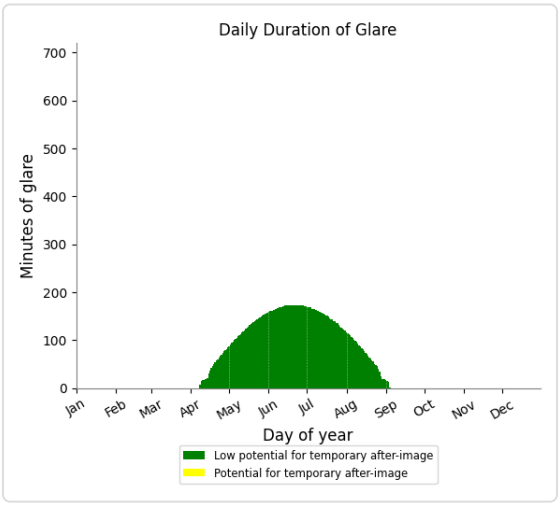


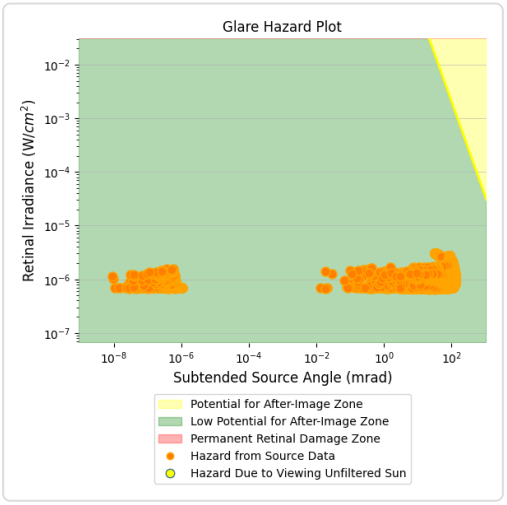
UV-02 and Route: A12 ri west

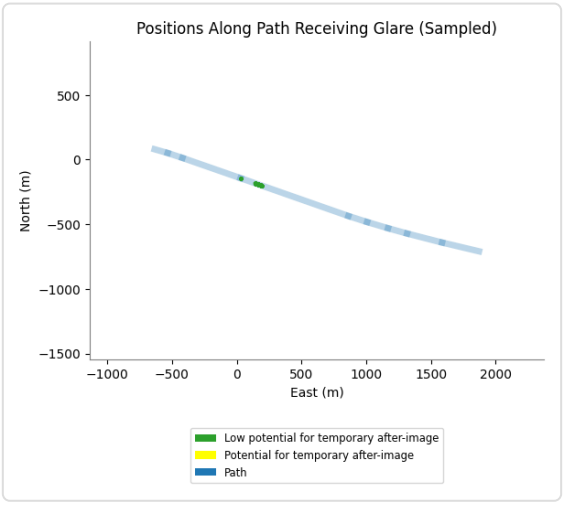
Yellow glare: none

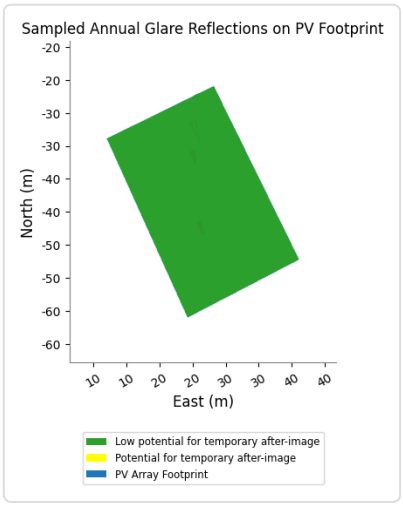
Green glare: 16,998 min.







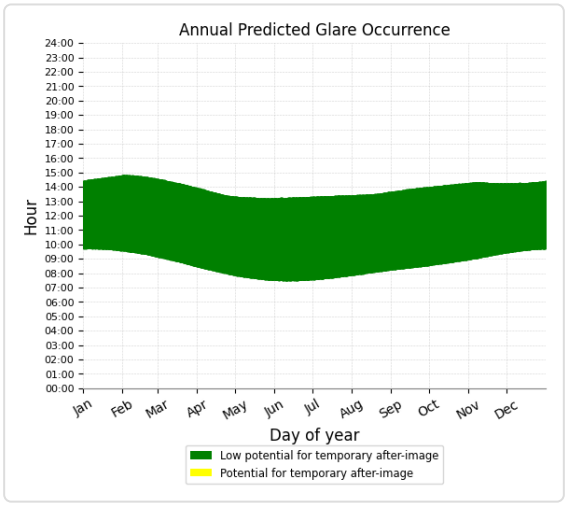


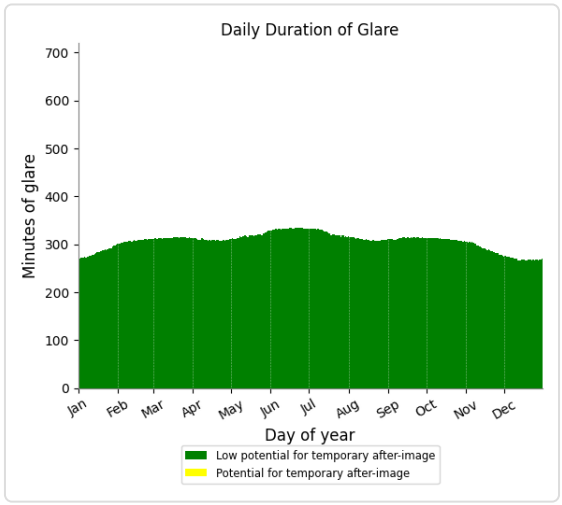


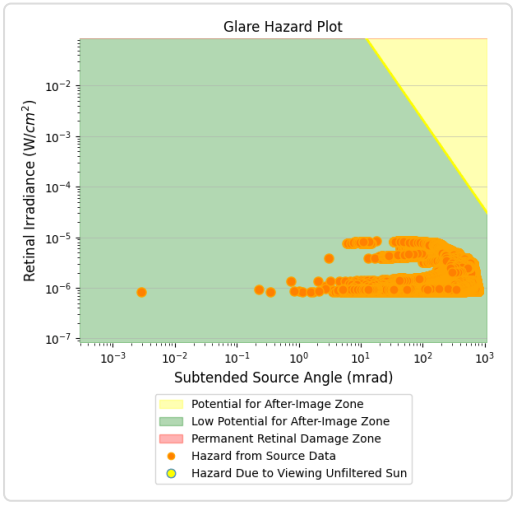
UV-02 and Route: N198 ri oost

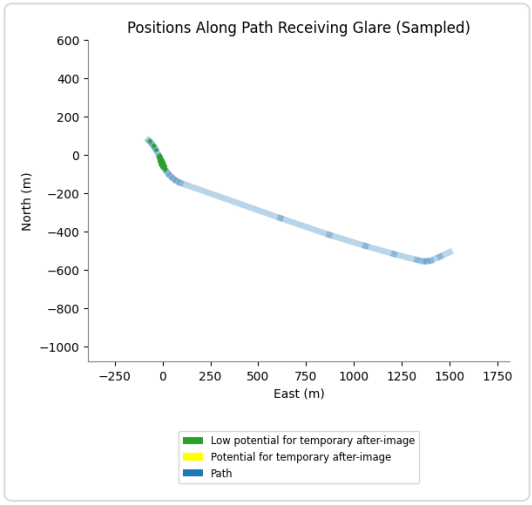
Yellow glare: none

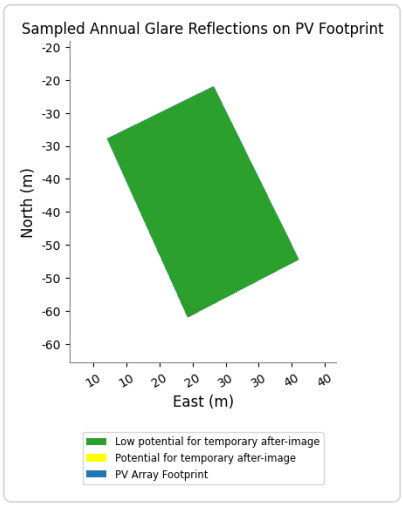
Green glare: 112,095 min.







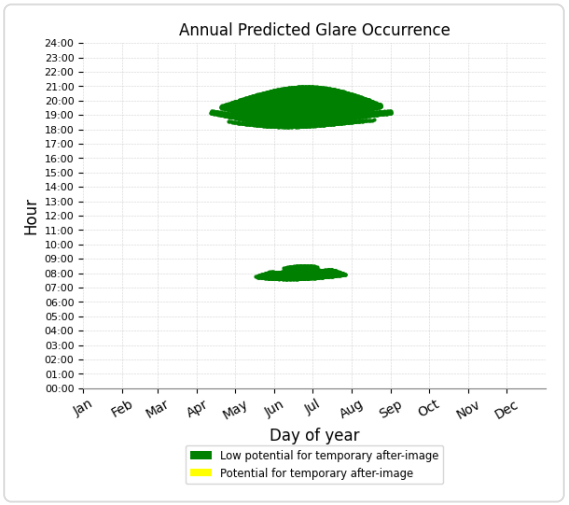


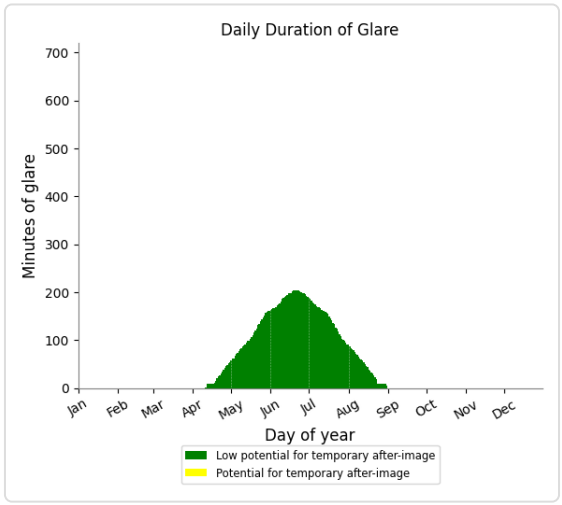


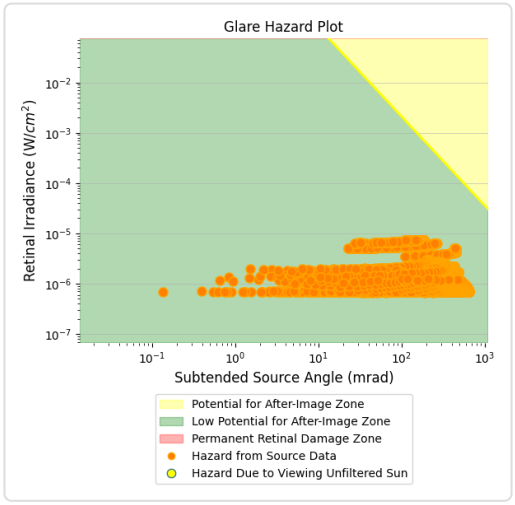
UV-02 and Route: N198 ri west

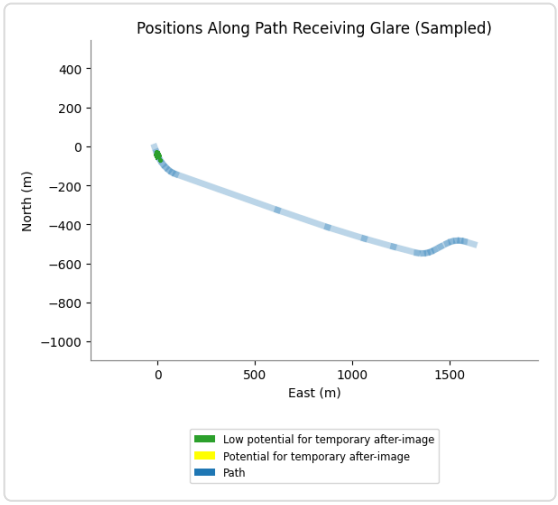
Yellow glare: none

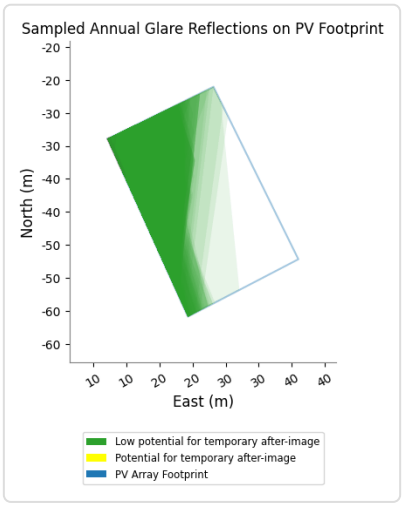
Green glare: 15,421 min.







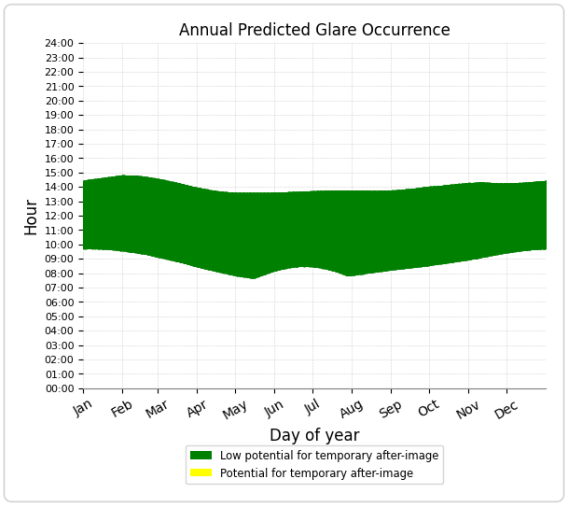


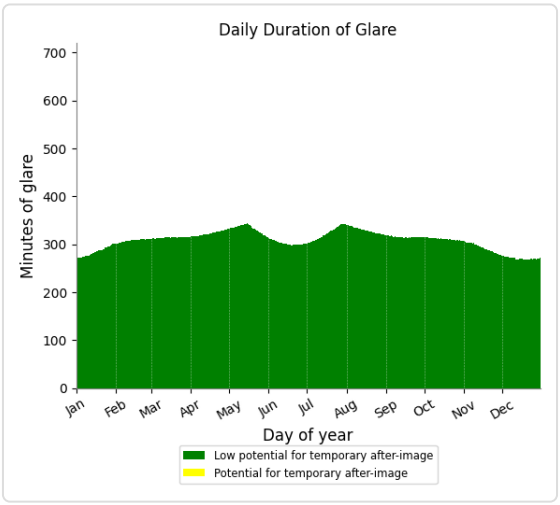


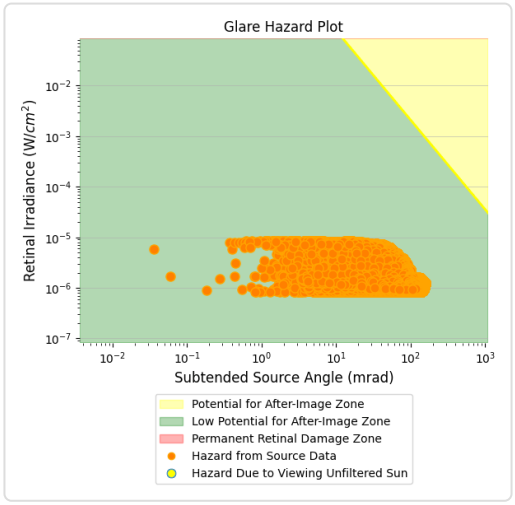
UV-02 and Route: N419 ri oost

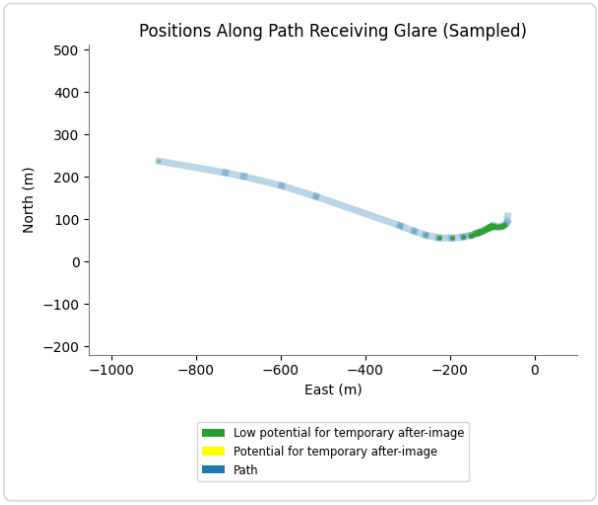
Yellow glare: none

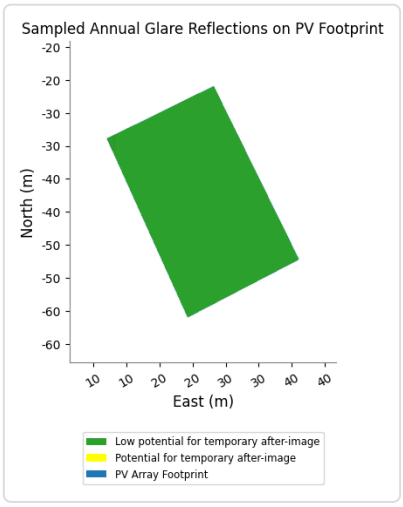
Green glare: 112,796 min.







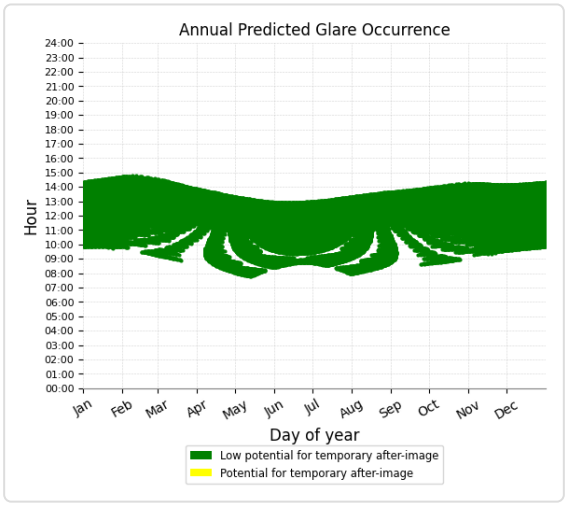


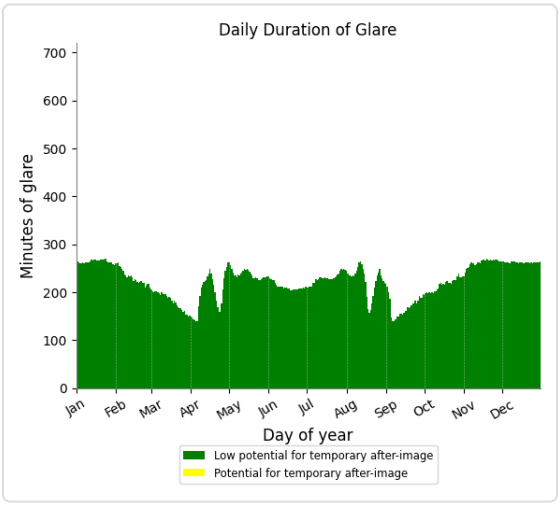


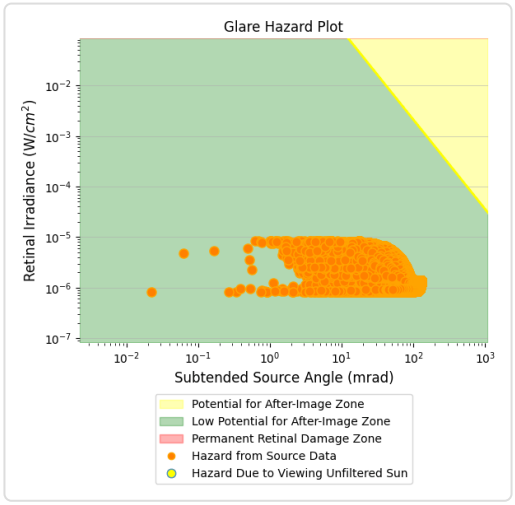
UV-02 and Route: N419 ri west

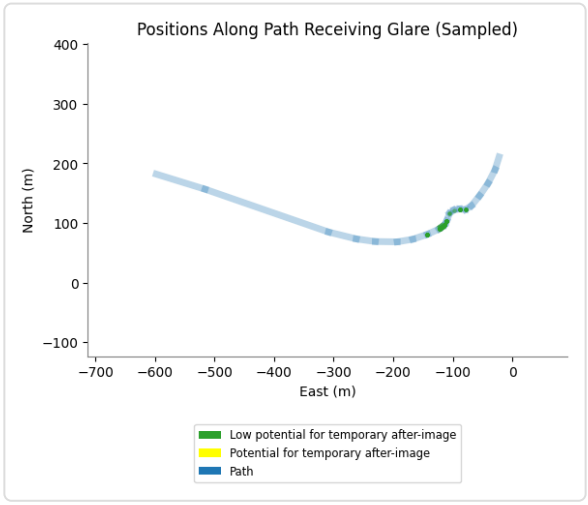
Yellow glare: none

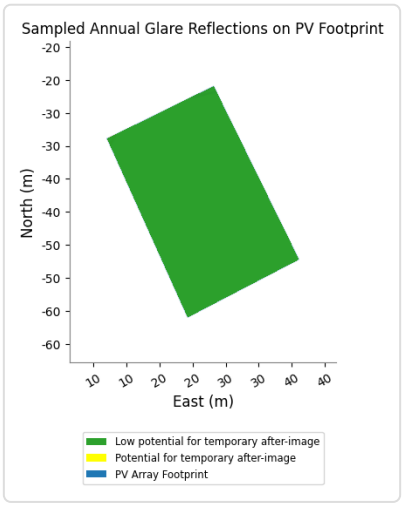
Green glare: 81,893 min.











PV: UV-03 low potential for temporary after-image

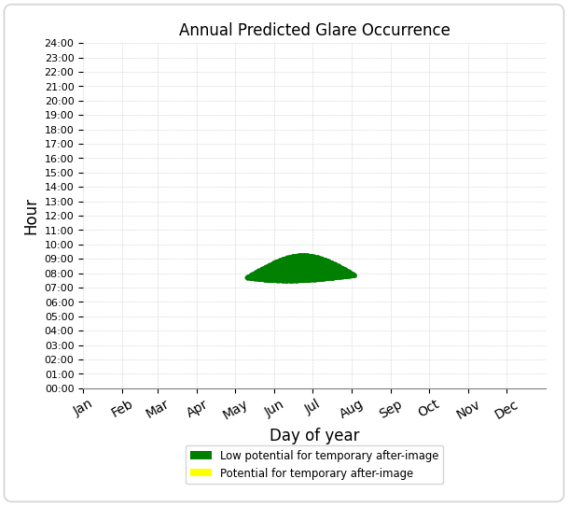
Receptor results ordered by category of glare

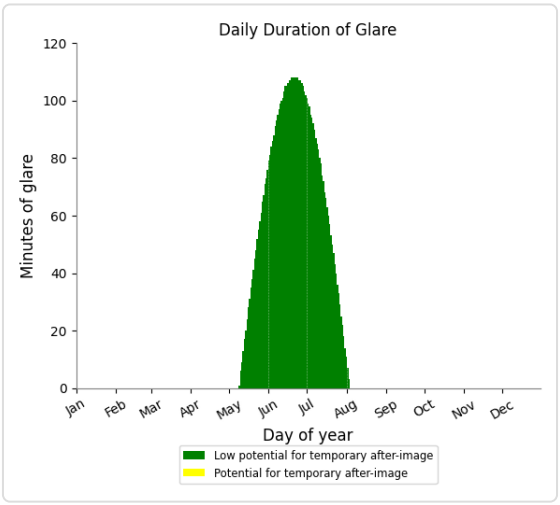
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	5,912	98.5	0	0.0
A12 ri west	24,343	405.7	0	0.0
N198 ri oost	105,614	1,760.2	0	0.0
N198 ri west	21,290	354.8	0	0.0
N419 ri oost	105,432	1,757.2	0	0.0
N419 ri west	25,281	421.4	0	0.0

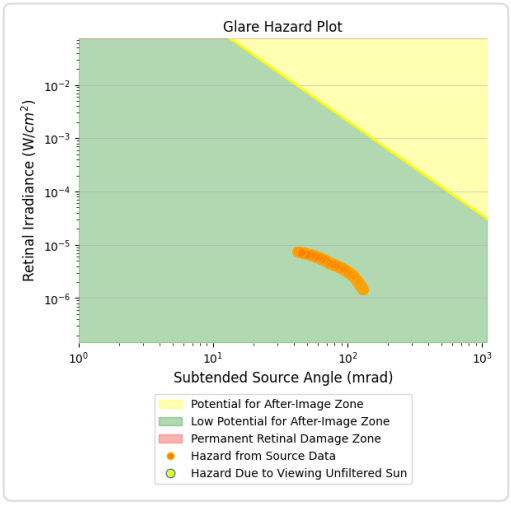
UV-03 and Route: A12 ri oost

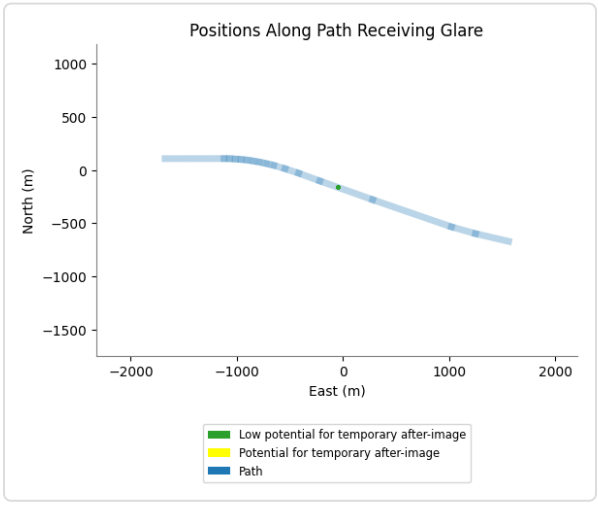
Yellow glare: none

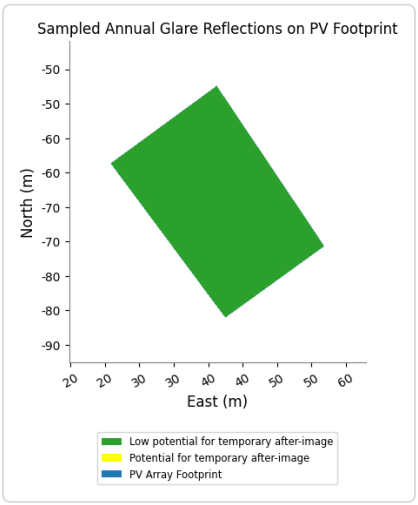
Green glare: 5,912 min.







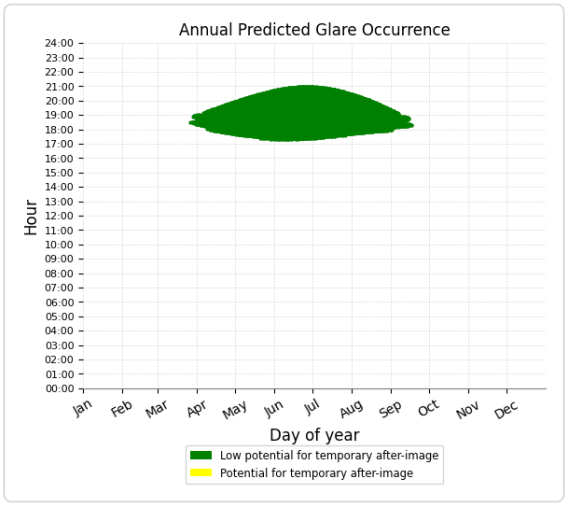


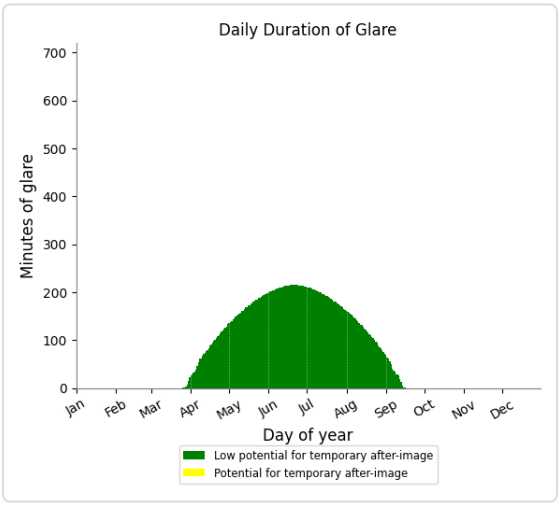


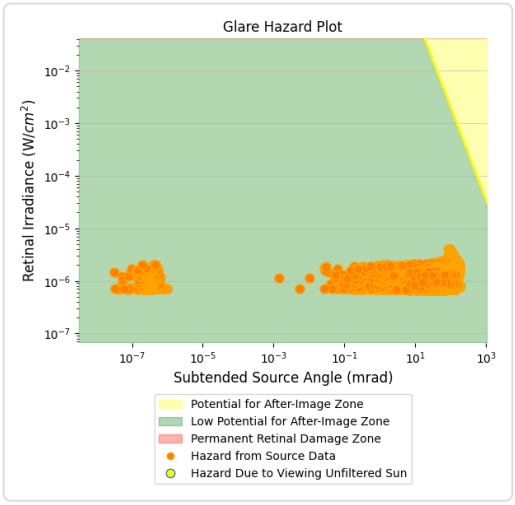
UV-03 and Route: A12 ri west

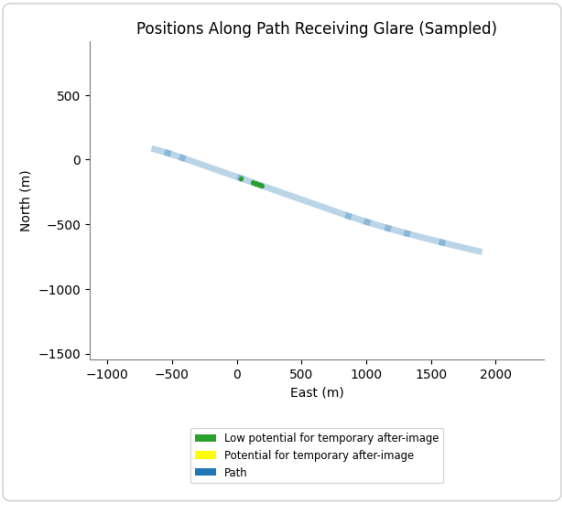
Yellow glare: none

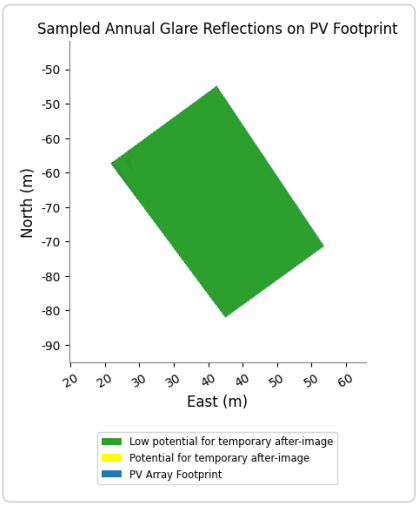
Green glare: 24,343 min.







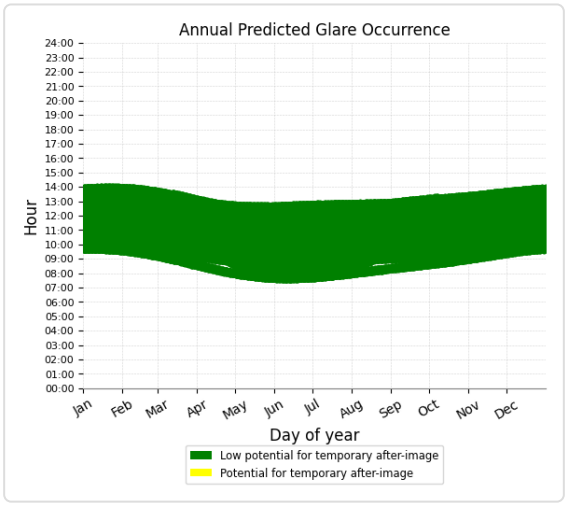


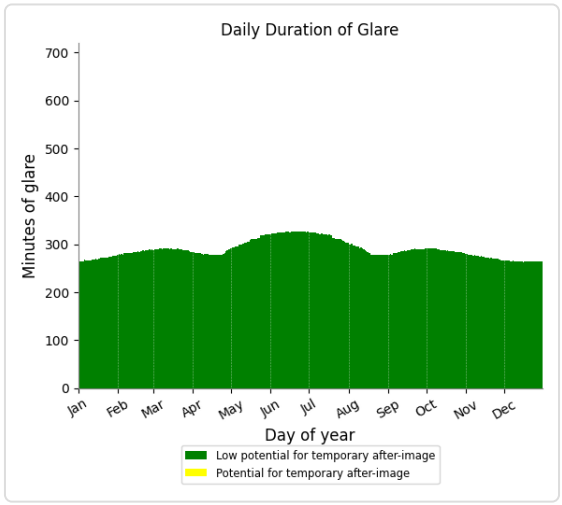


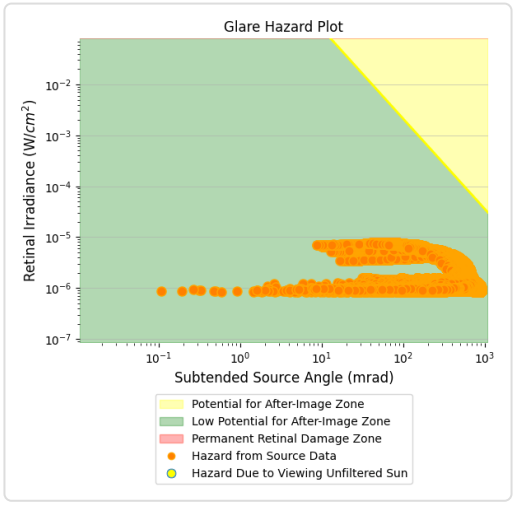
UV-03 and Route: N198 ri oost

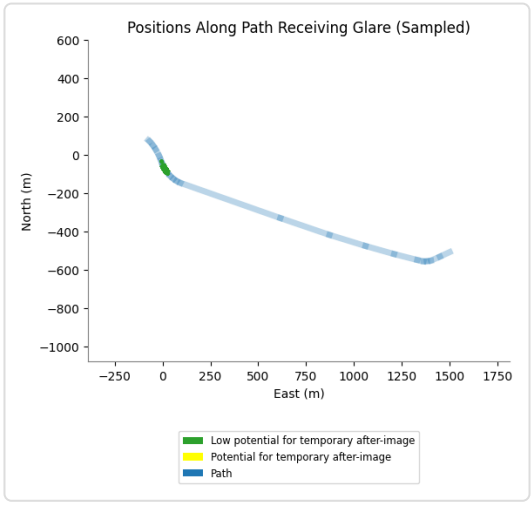
Yellow glare: none

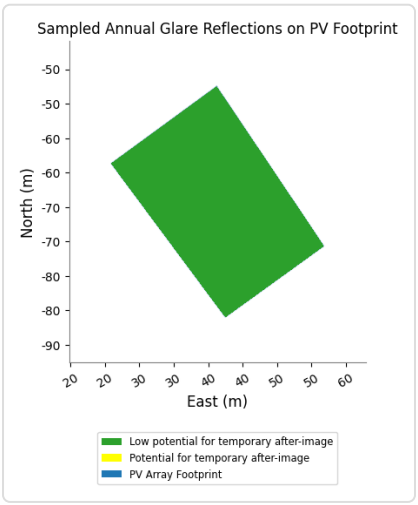
Green glare: 105,614 min.







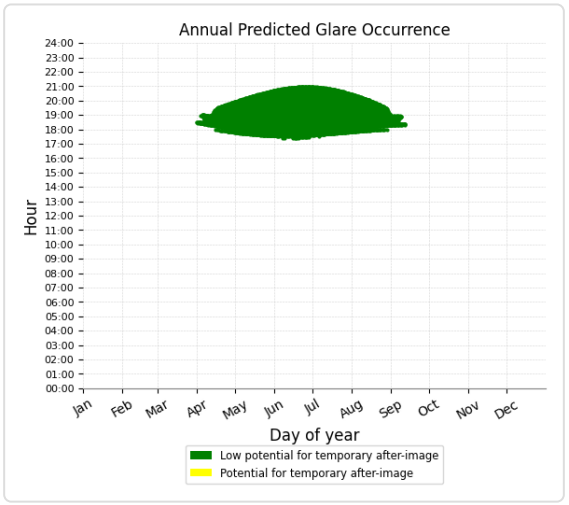


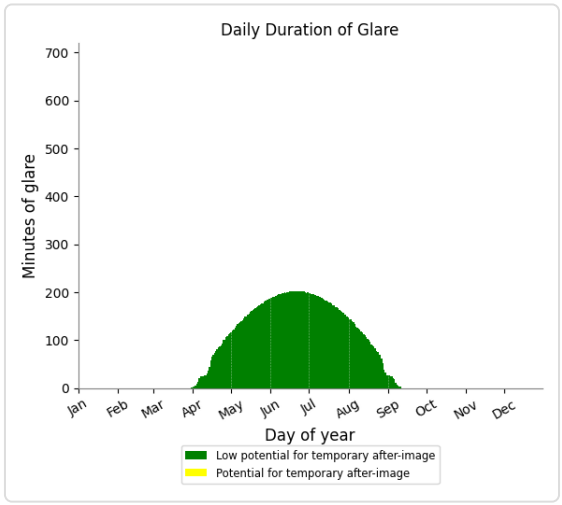


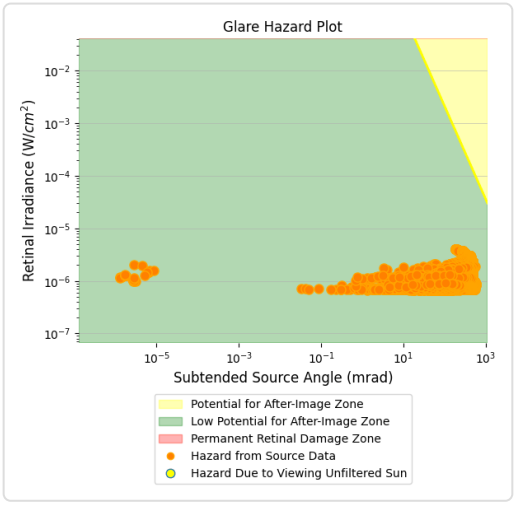
UV-03 and Route: N198 ri west

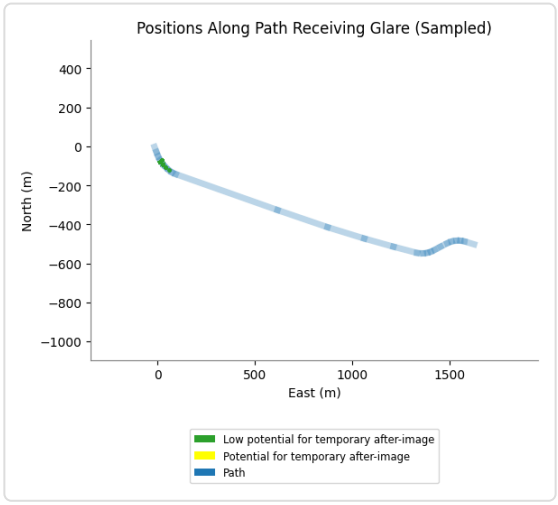
Yellow glare: none

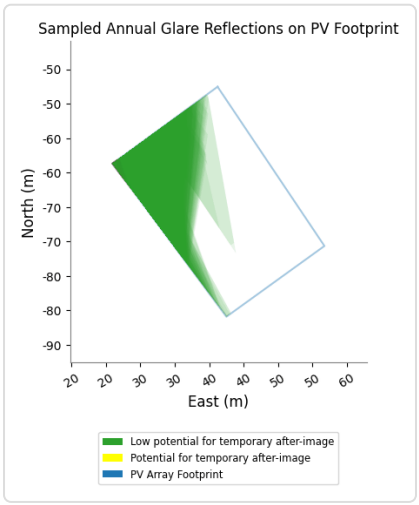
Green glare: 21,290 min.







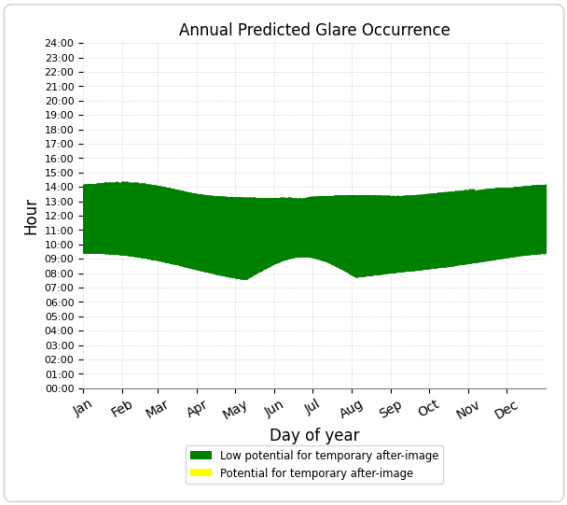


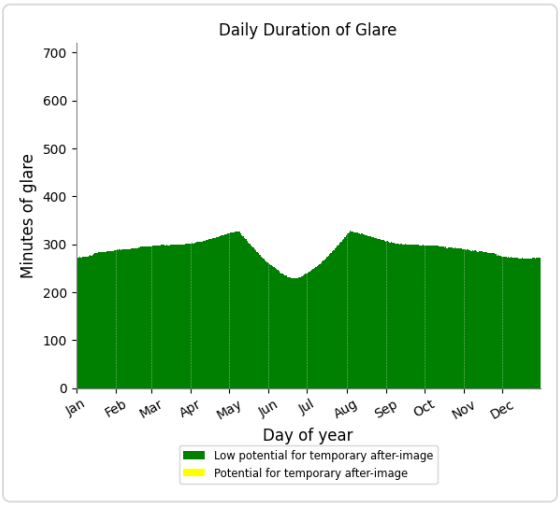


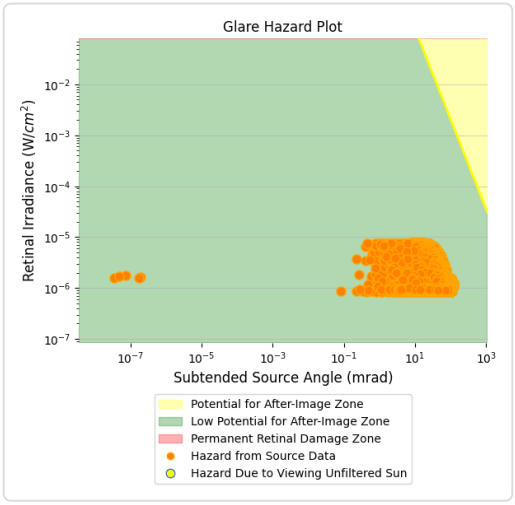
UV-03 and Route: N419 ri oost

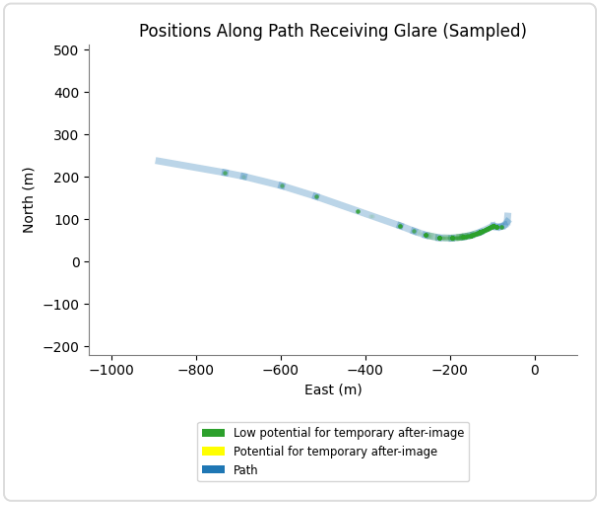
Yellow glare: none

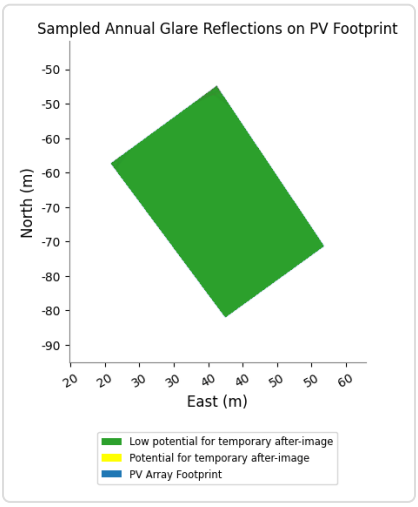
Green glare: 105,432 min.







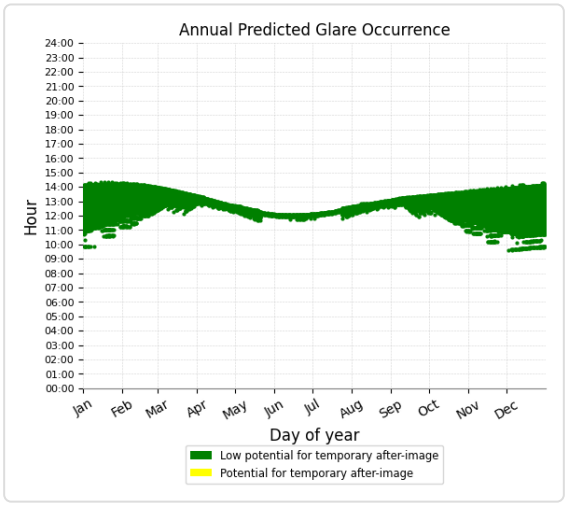


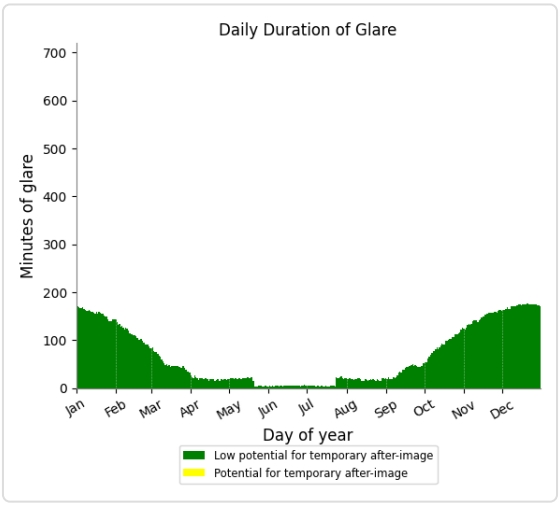


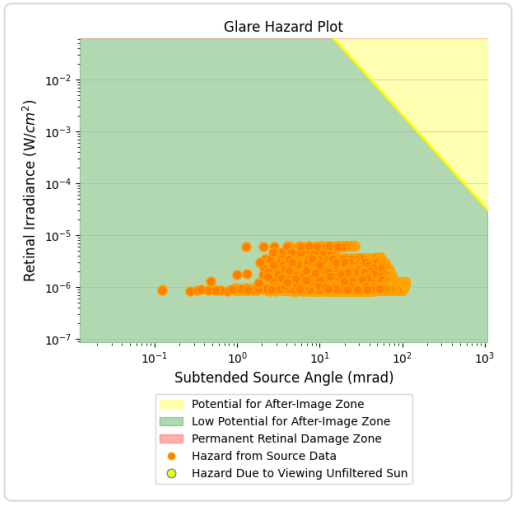
UV-03 and Route: N419 ri west

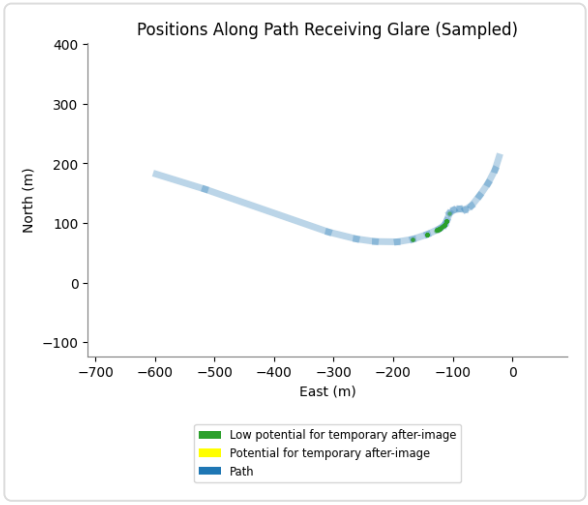
Yellow glare: none

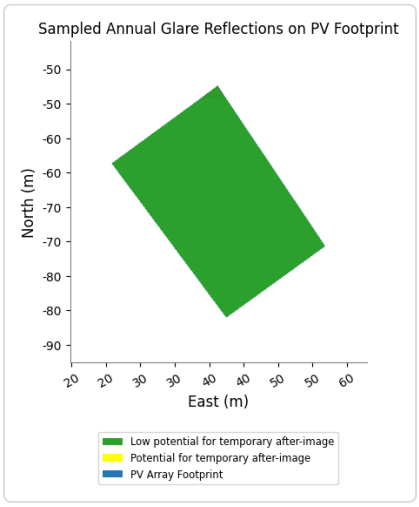
Green glare: 25,281 min.











PV: UV-04 low potential for temporary after-image

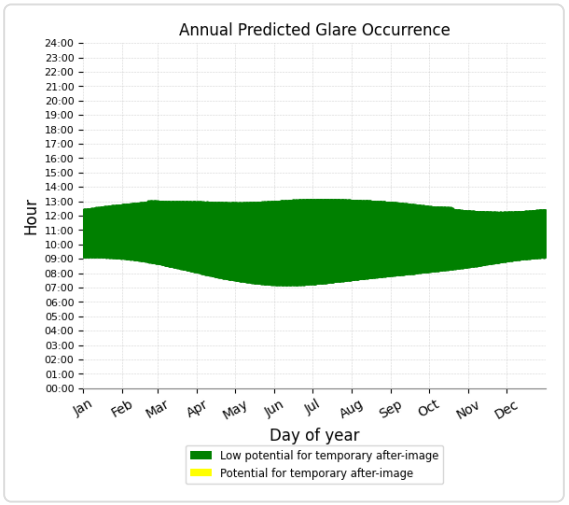
Receptor results ordered by category of glare

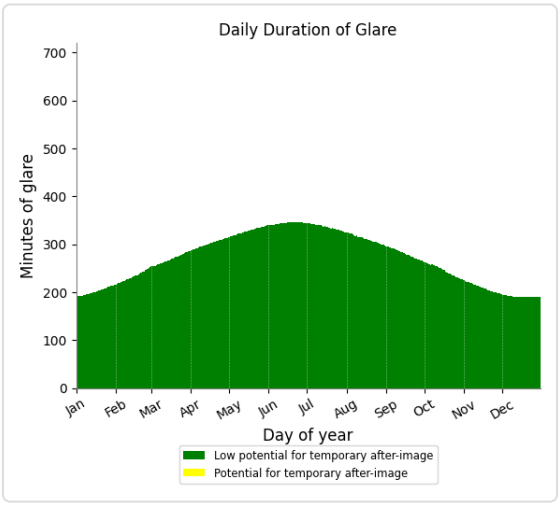
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	98,998	1,650.0	0	0.0
A12 ri west	32,330	538.8	0	0.0
N198 ri oost	101,343	1,689.0	0	0.0
N198 ri west	28,952	482.5	0	0.0
N419 ri oost	81,578	1,359.6	0	0.0
N419 ri west	6,988	116.5	0	0.0

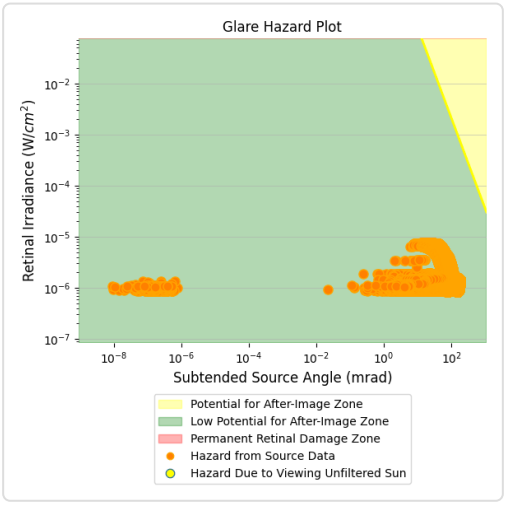
UV-04 and Route: A12 ri oost

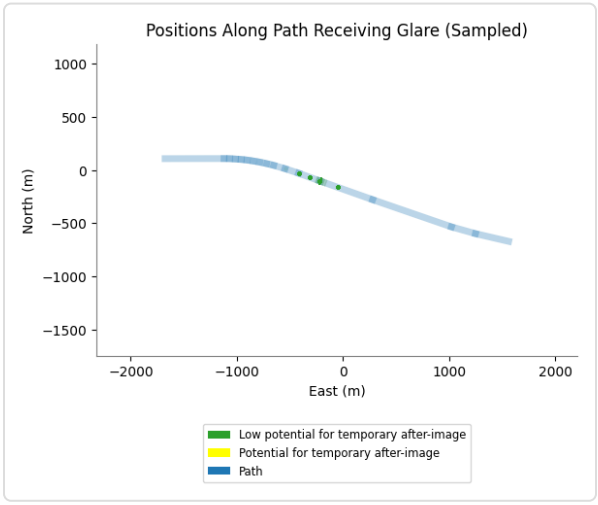
Yellow glare: none

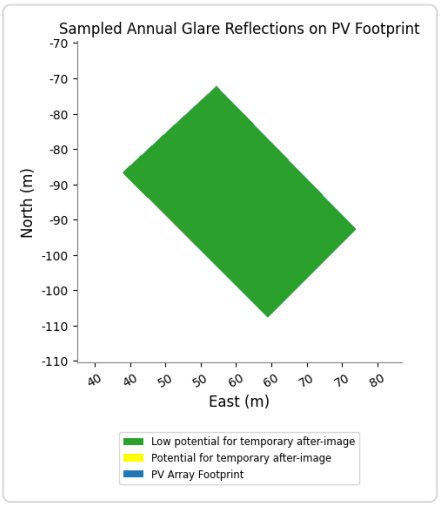
Green glare: 98,998 min.







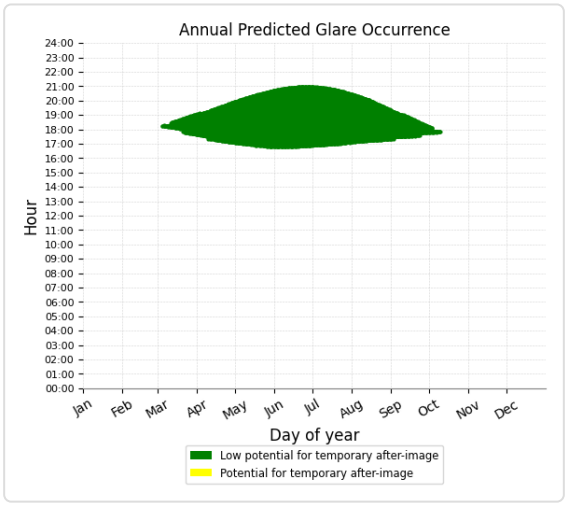


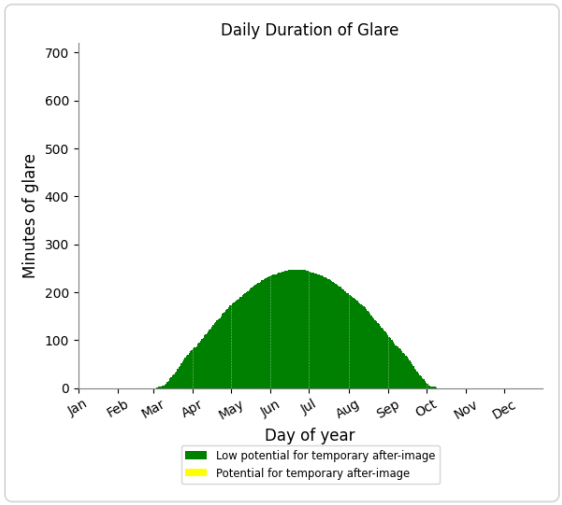


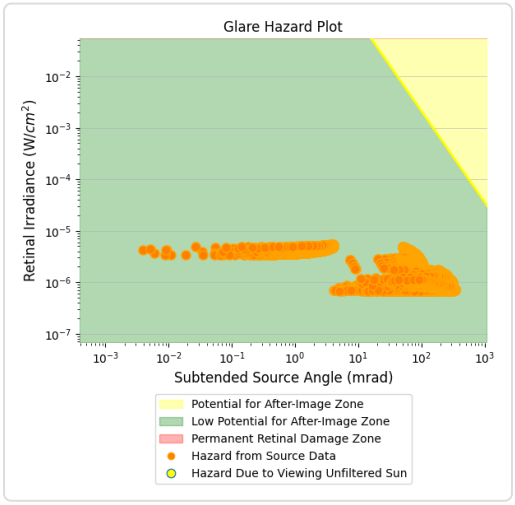
UV-04 and Route: A12 ri west

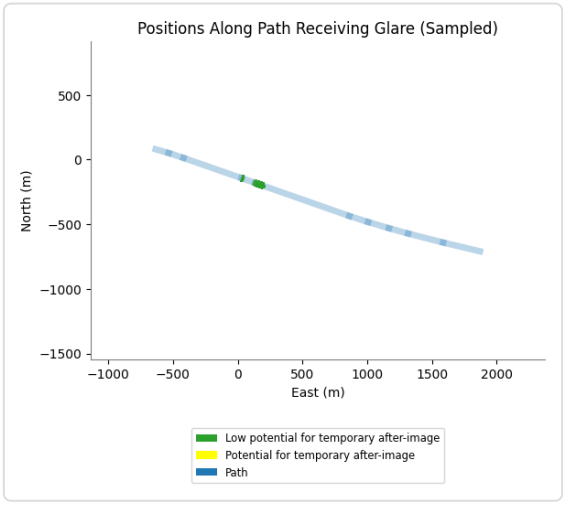
Yellow glare: none

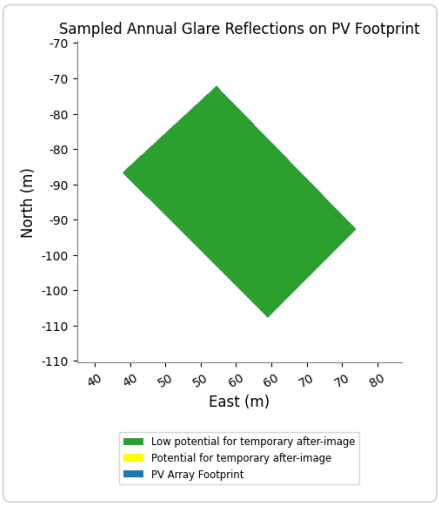
Green glare: 32,330 min.







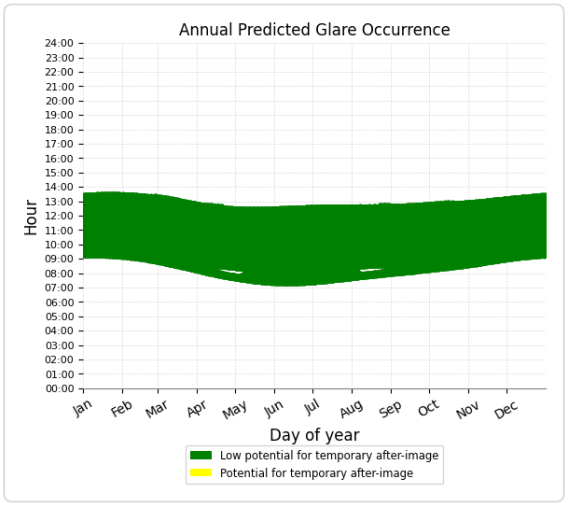


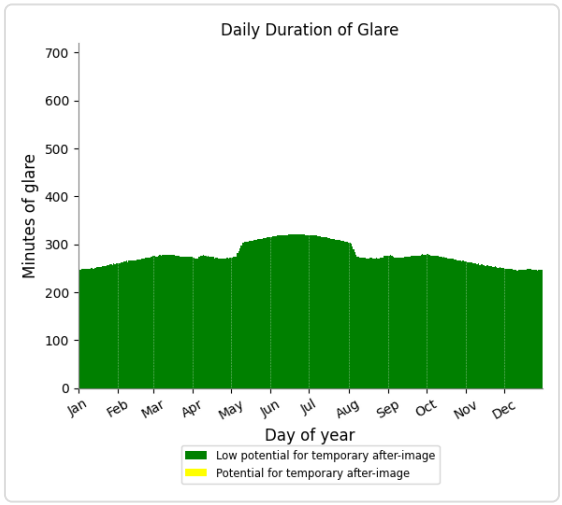


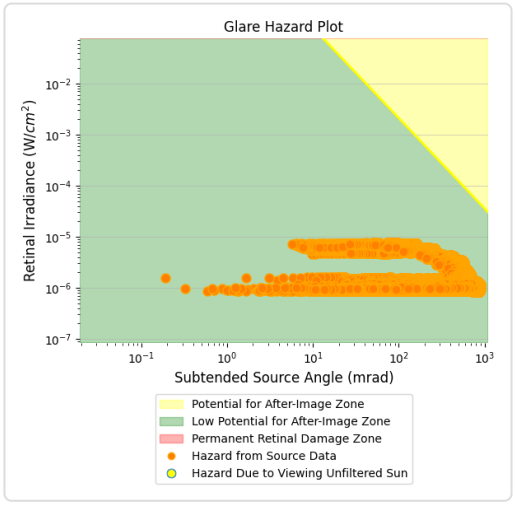
UV-04 and Route: N198 ri oost

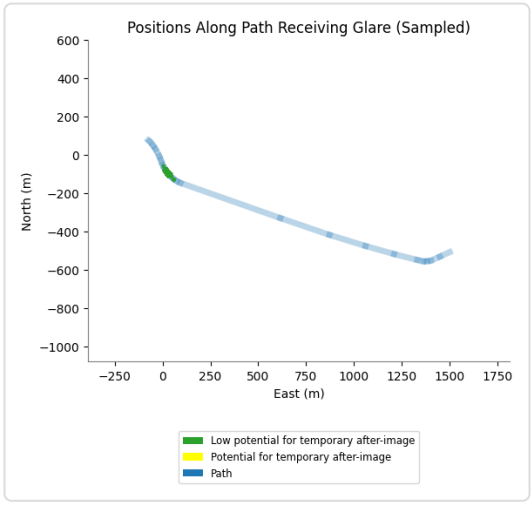
Yellow glare: none

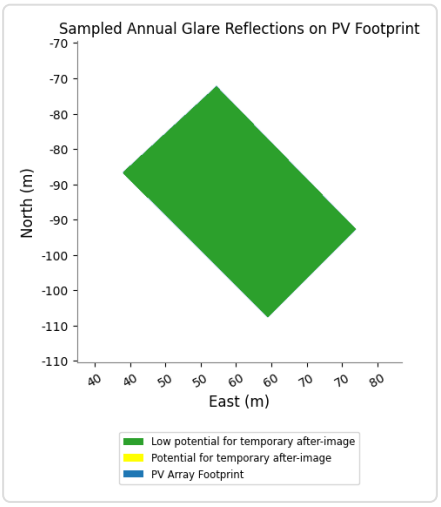
Green glare: 101,343 min.







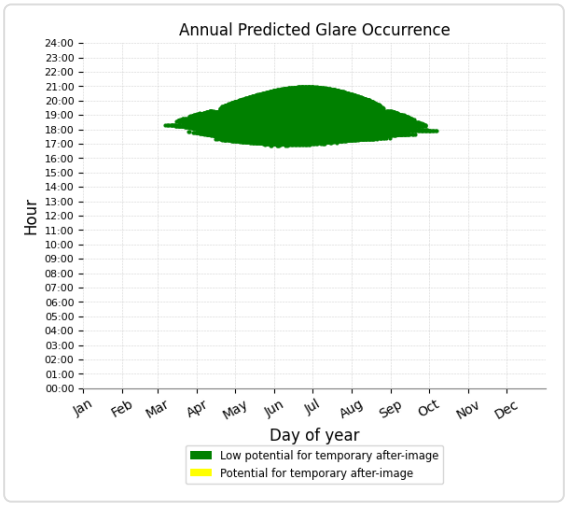


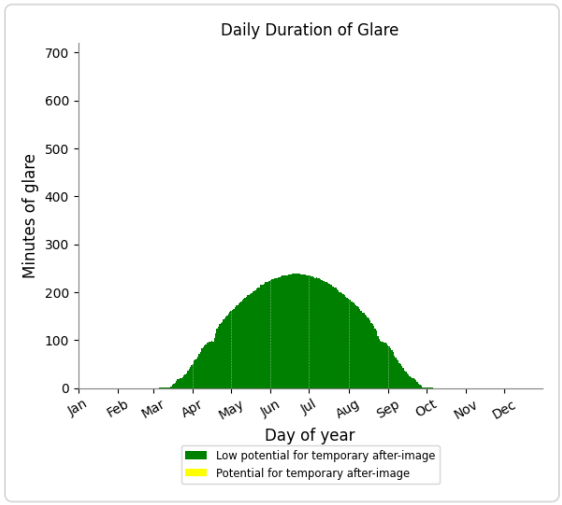


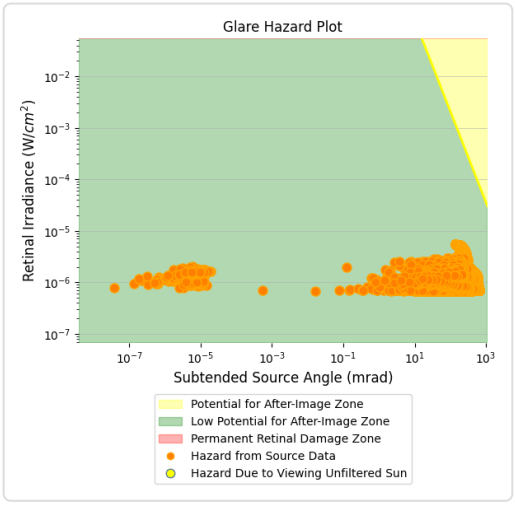
UV-04 and Route: N198 ri west

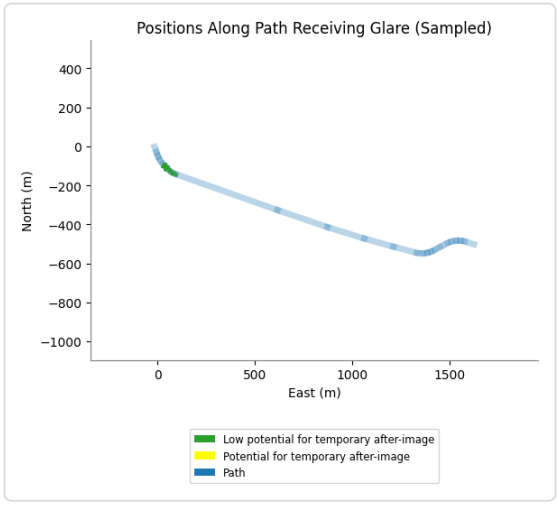
Yellow glare: none

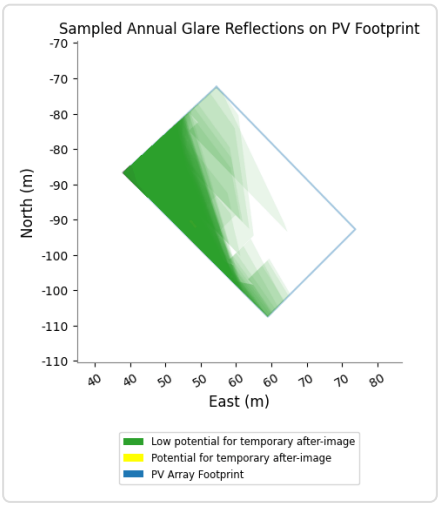
Green glare: 28,952 min.







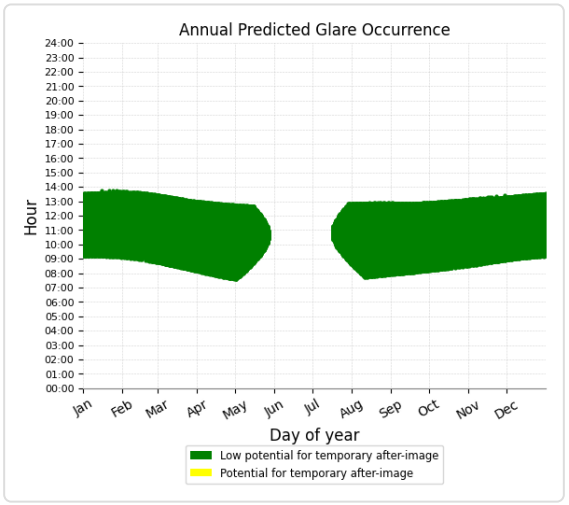


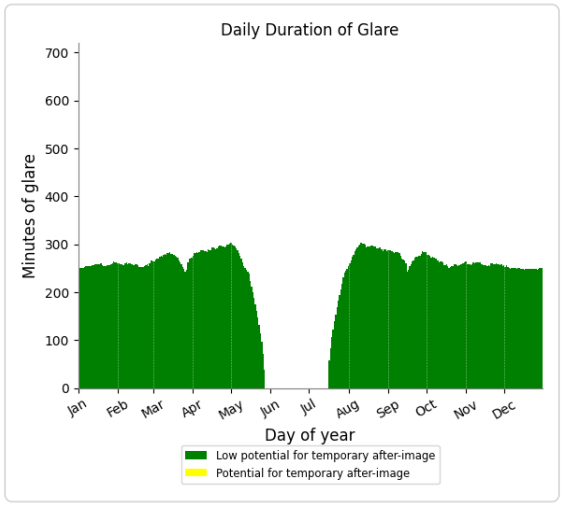


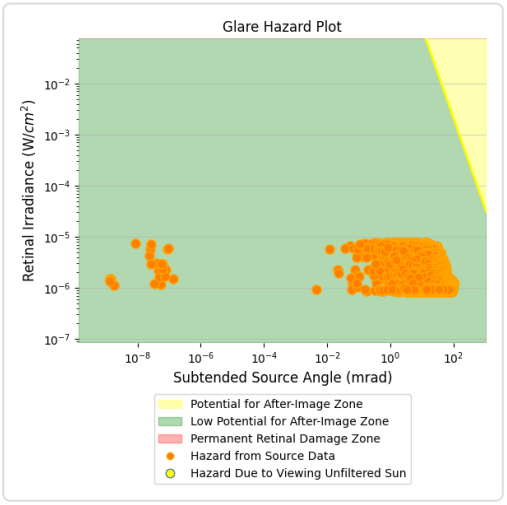
UV-04 and Route: N419 ri oost

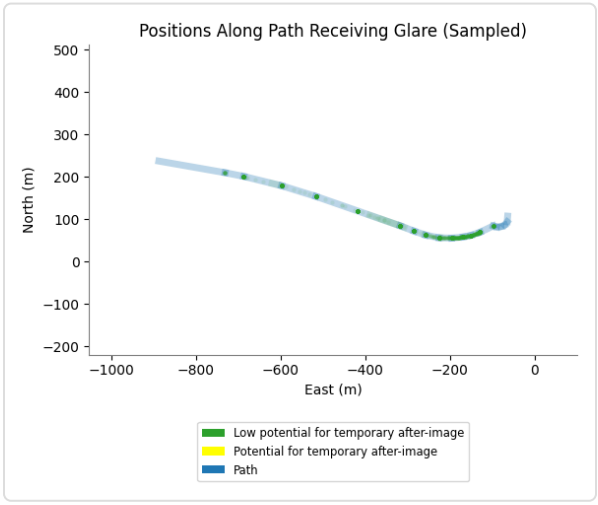
Yellow glare: none

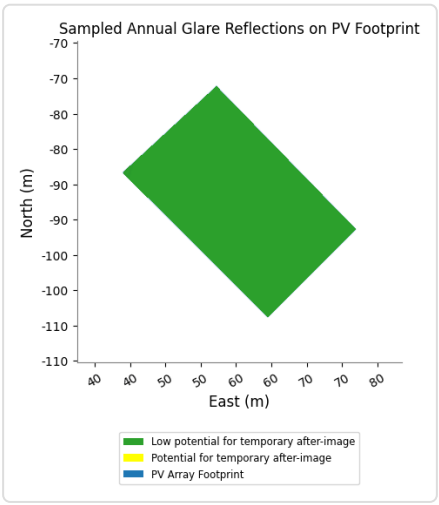
Green glare: 81,578 min.







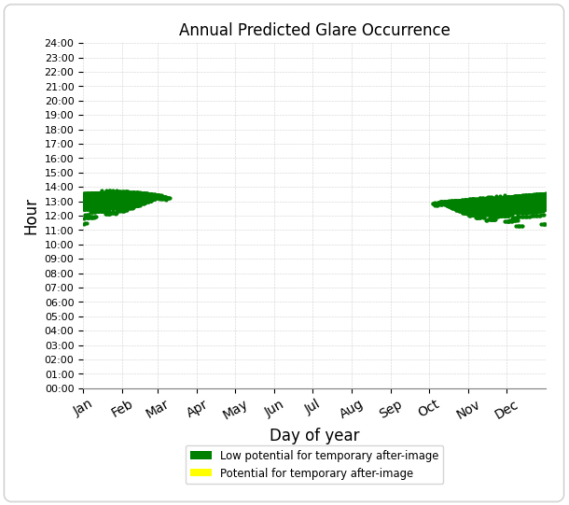


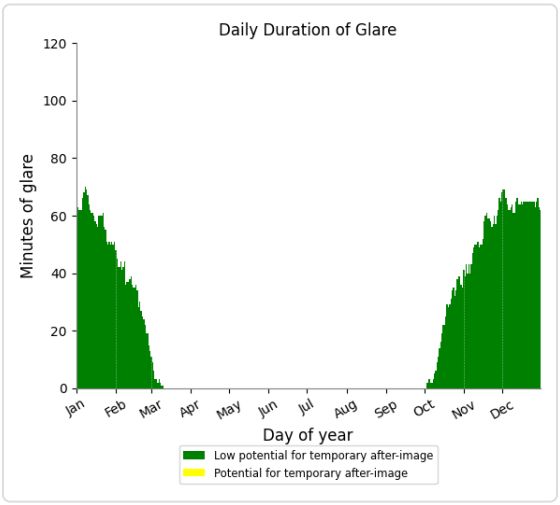


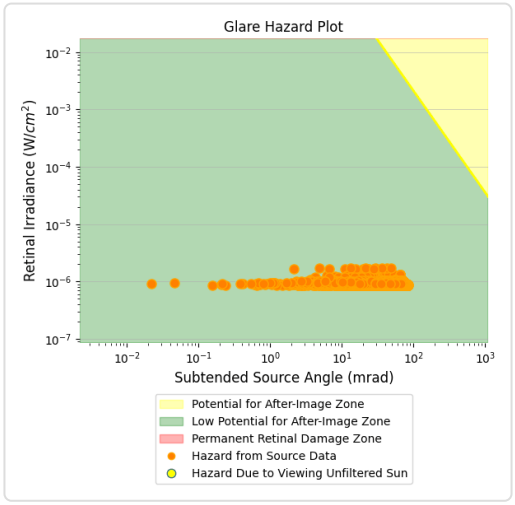
UV-04 and Route: N419 ri west

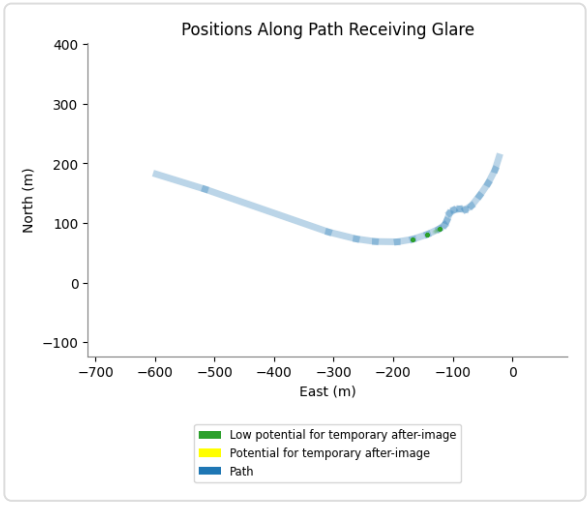
Yellow glare: none

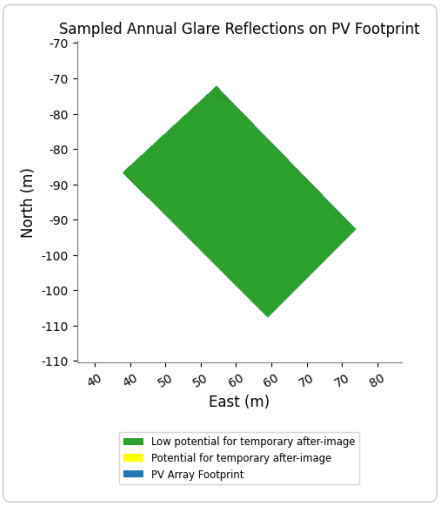
Green glare: 6,988 min.











PV: UV-05 low potential for temporary after-image

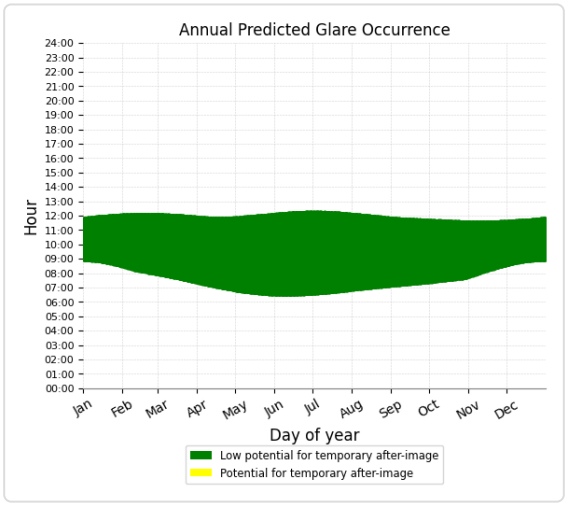
Receptor results ordered by category of glare

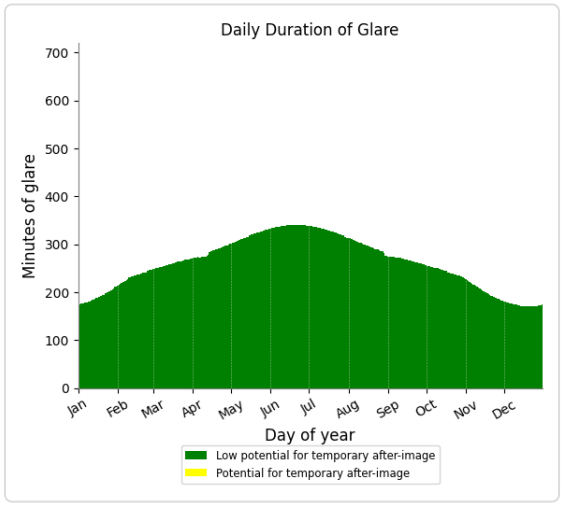
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	95,448	1,590.8	0	0.0
A12 ri west	44,657	744.3	0	0.0
N198 ri oost	89,456	1,490.9	0	0.0
N198 ri west	42,832	713.9	0	0.0
N419 ri oost	3,648	60.8	0	0.0
N419 ri west	0	0.0	0	0.0

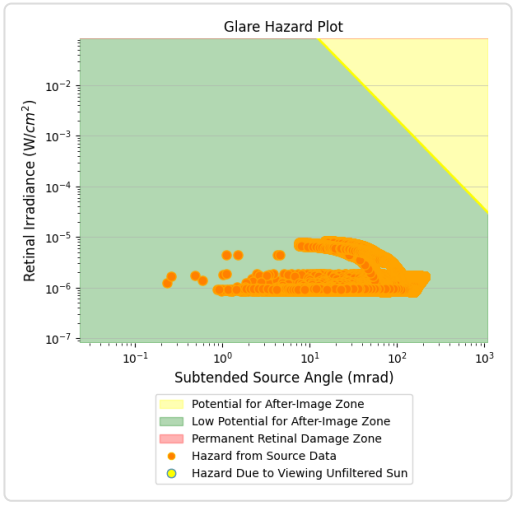
UV-05 and Route: A12 ri oost

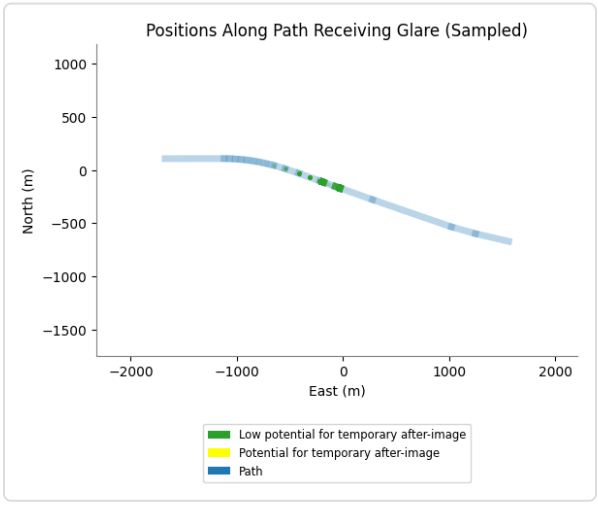
Yellow glare: none

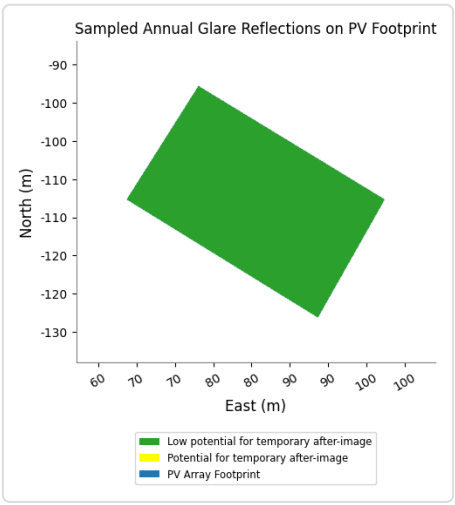
Green glare: 95,448 min.







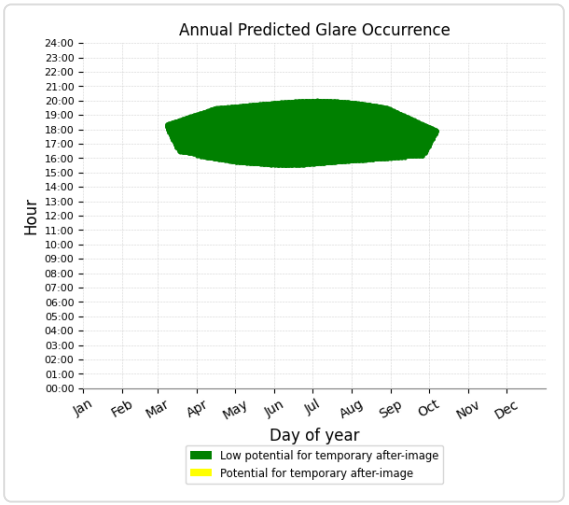


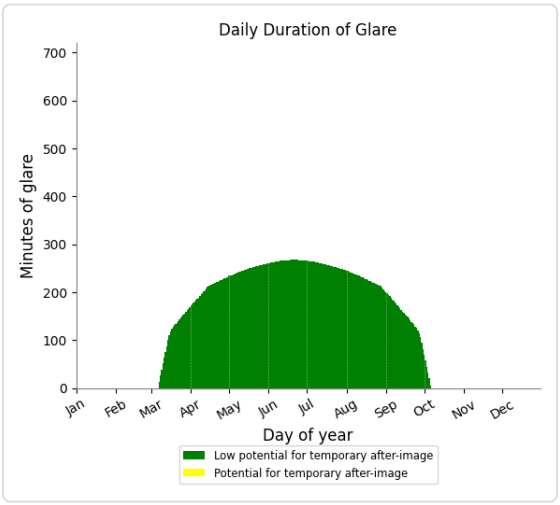


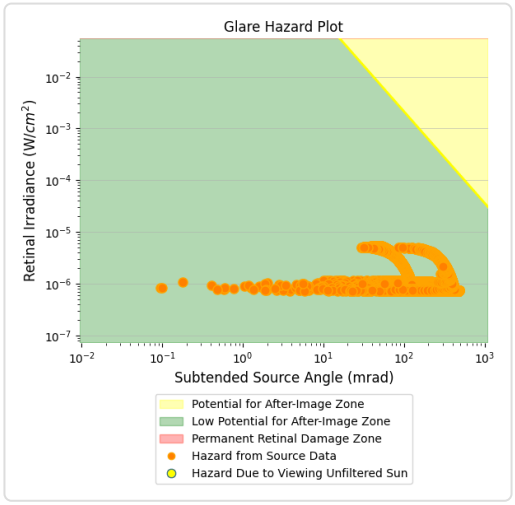
UV-05 and Route: A12 ri west

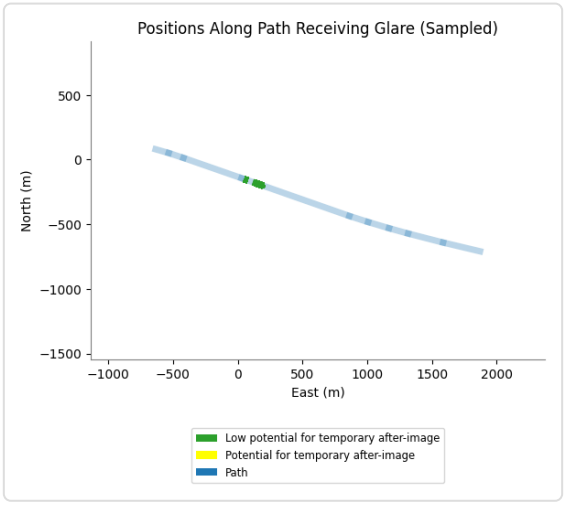
Yellow glare: none

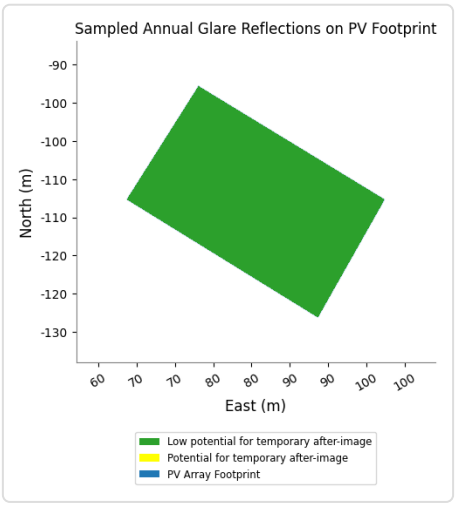
Green glare: 44,657 min.







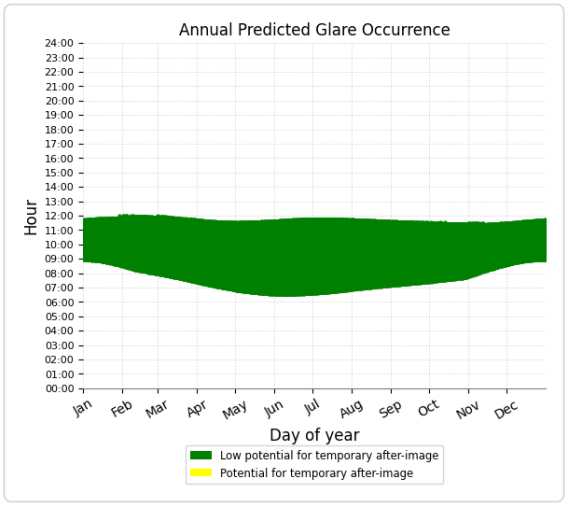


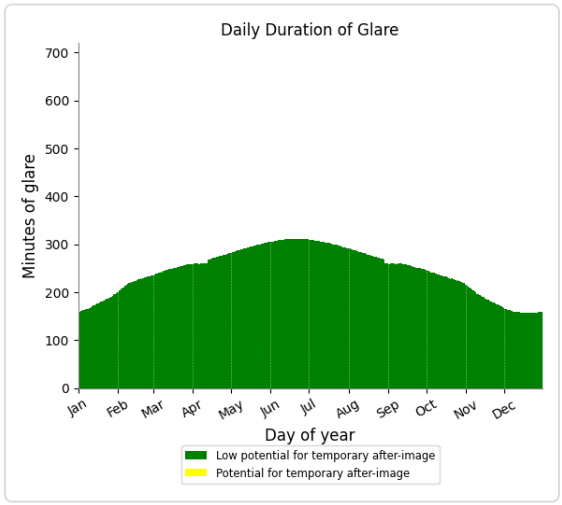


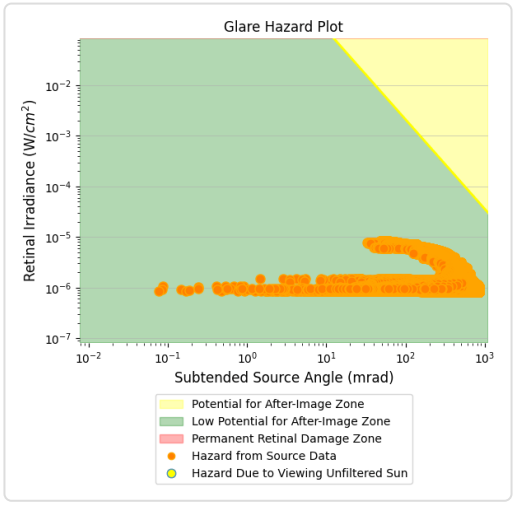
UV-05 and Route: N198 ri oost

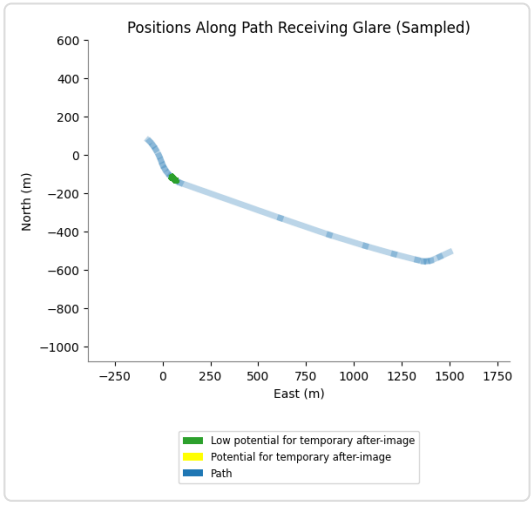
Yellow glare: none

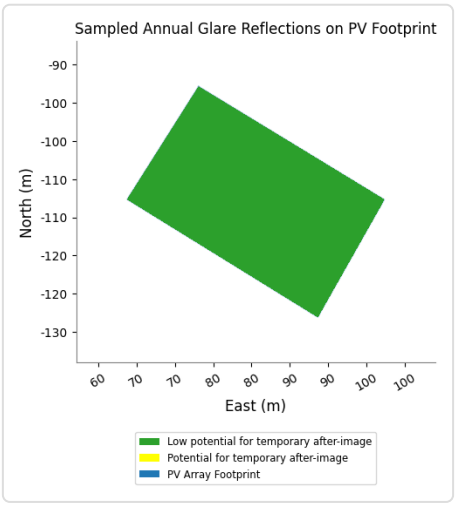
Green glare: 89,456 min.







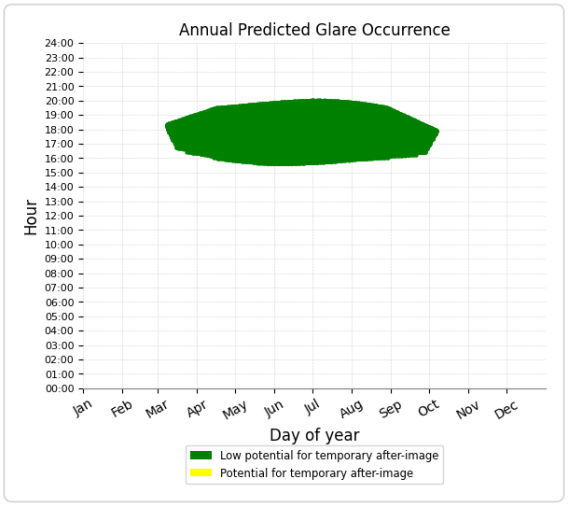


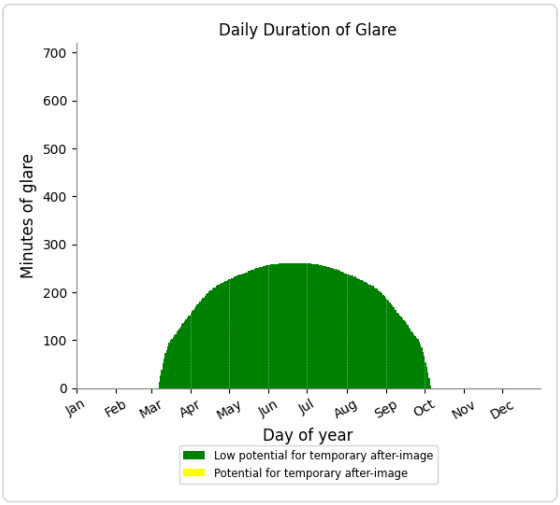


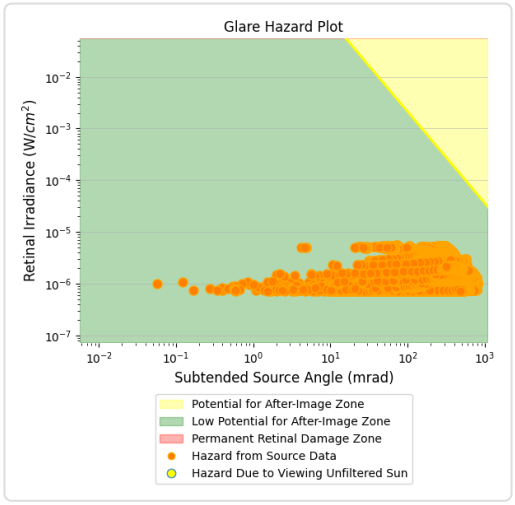
UV-05 and Route: N198 ri west

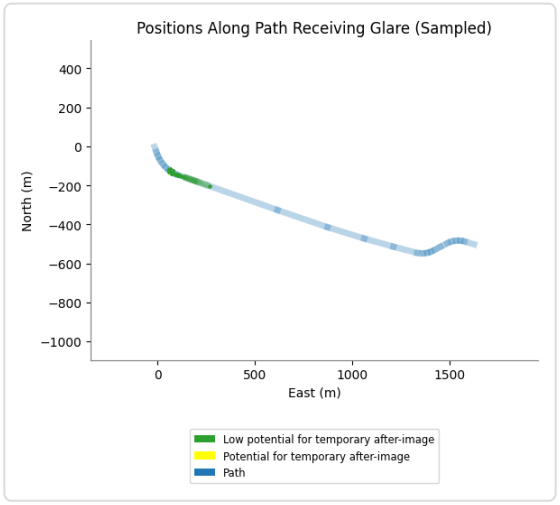
Yellow glare: none

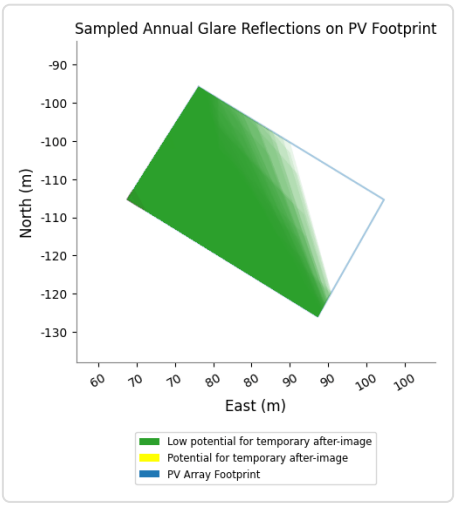
Green glare: 42,832 min.







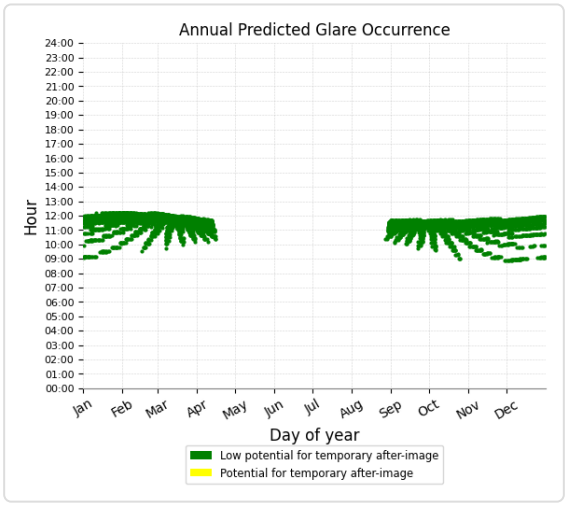


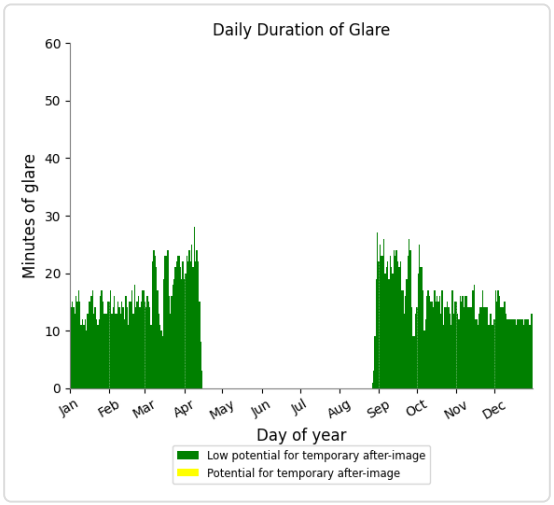


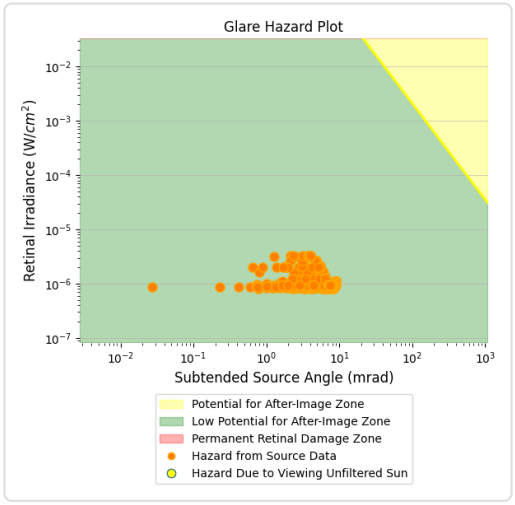
UV-05 and Route: N419 ri oost

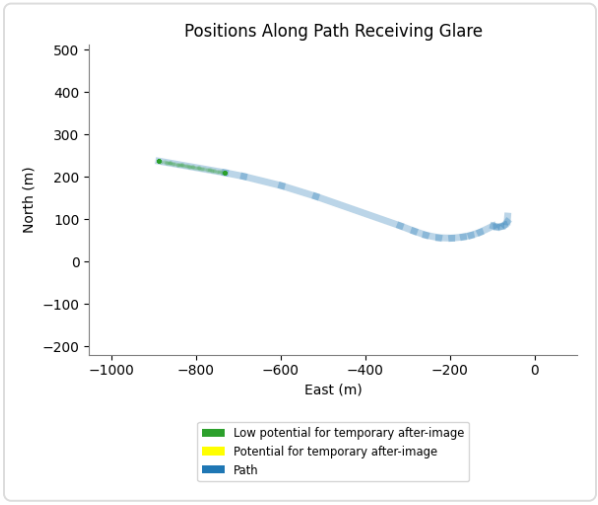
Yellow glare: none

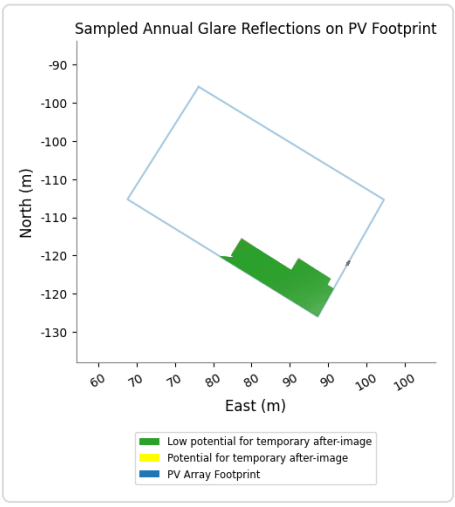
Green glare: 3,648 min.











UV-05 and Route: N419 ri west

No glare found

PV: UV-06 low potential for temporary after-image

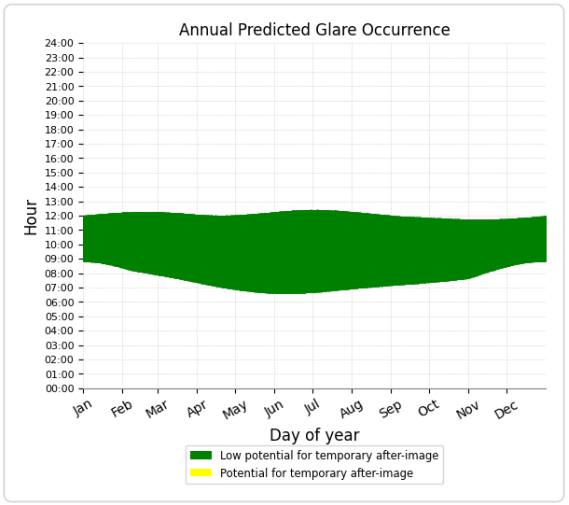
Receptor results ordered by category of glare

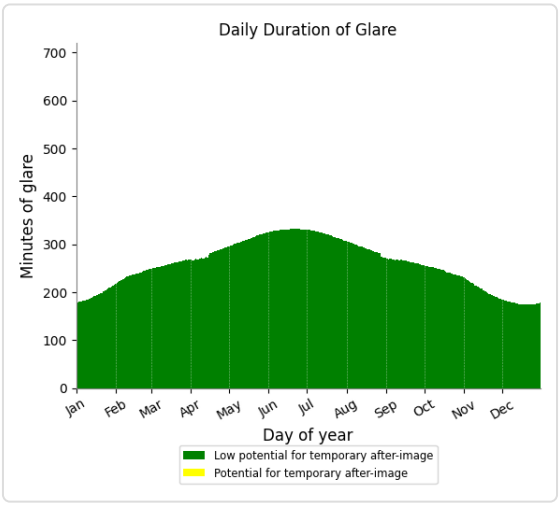
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	94,759	1,579.3	0	0.0
A12 ri west	46,780	779.7	0	0.0
N198 ri oost	90,993	1,516.5	0	0.0
N198 ri west	45,009	750.1	0	0.0
N419 ri oost	2,110	35.2	0	0.0
N419 ri west	0	0.0	0	0.0

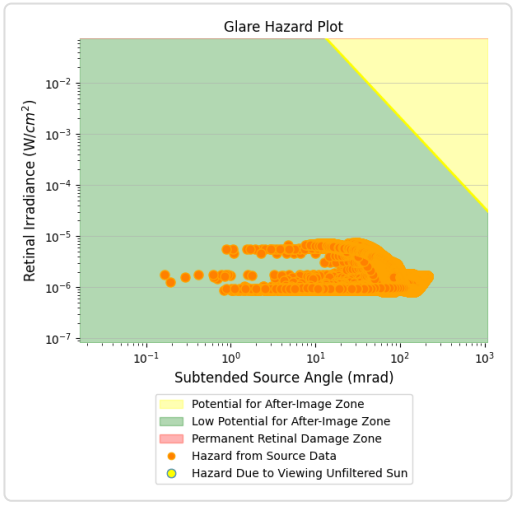
UV-06 and Route: A12 ri oost

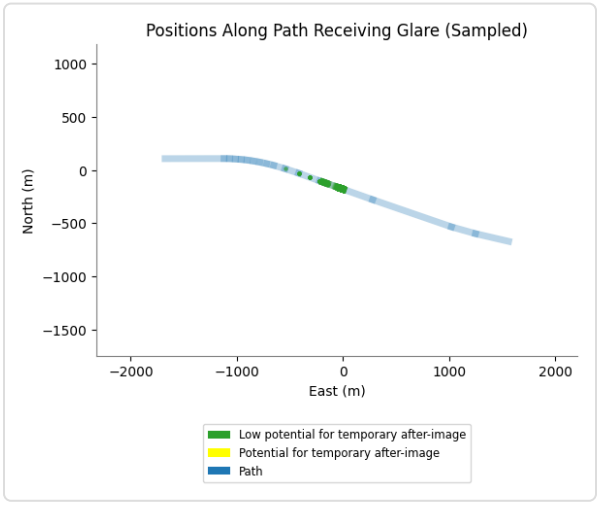
Yellow glare: none

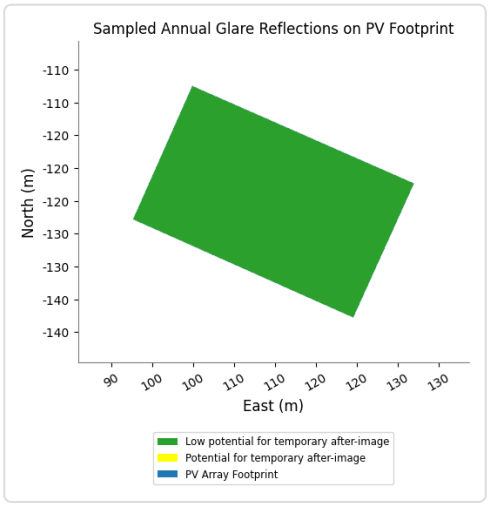
Green glare: 94,759 min.







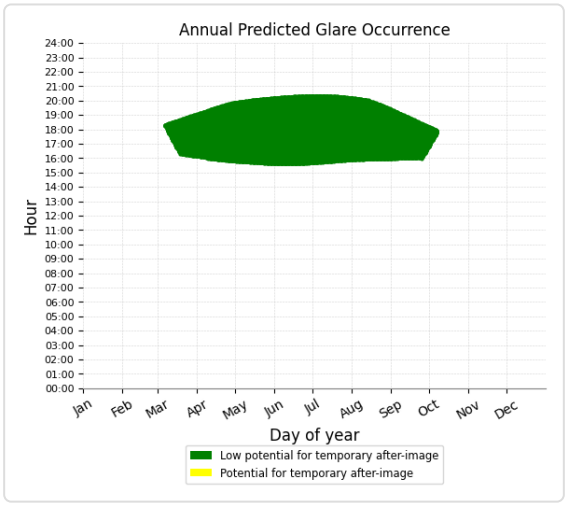


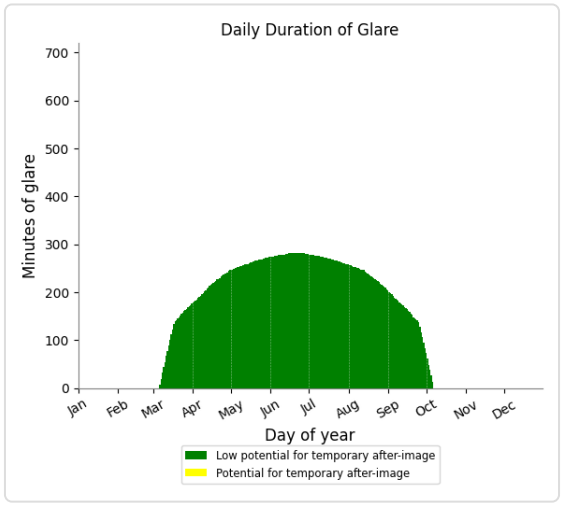


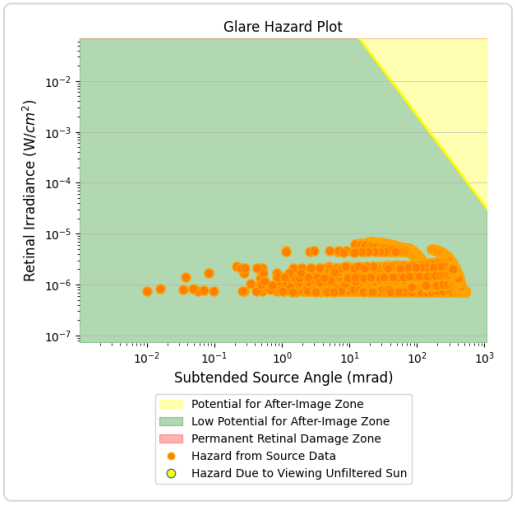
UV-06 and Route: A12 ri west

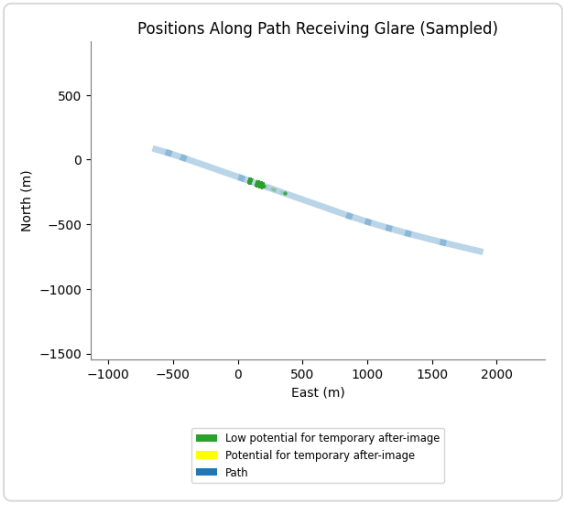
Yellow glare: none

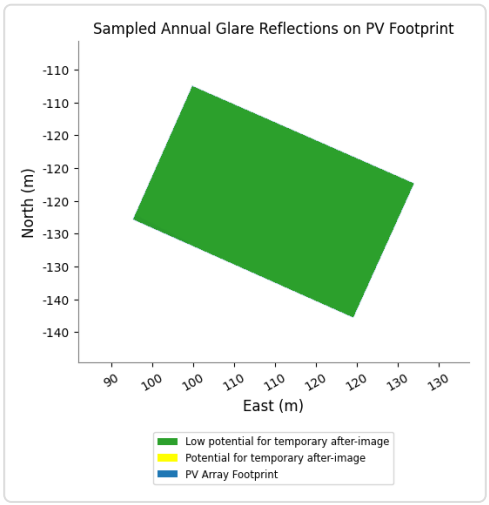
Green glare: 46,780 min.







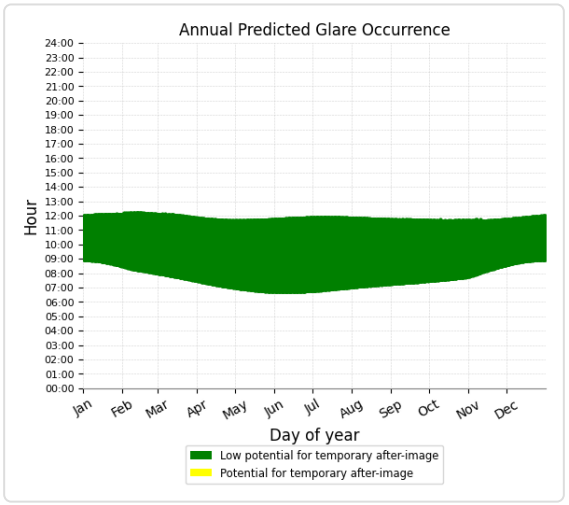


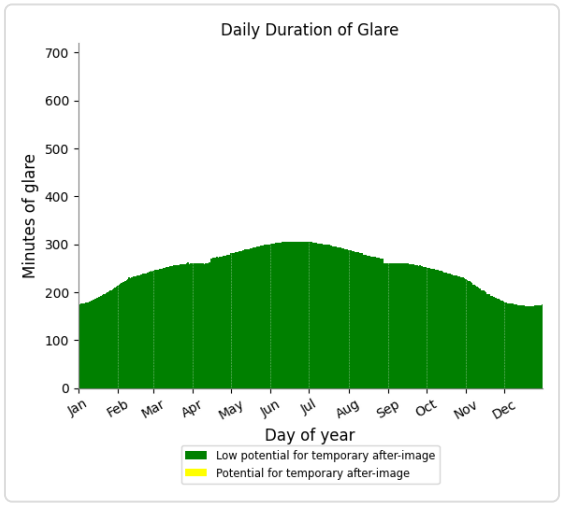


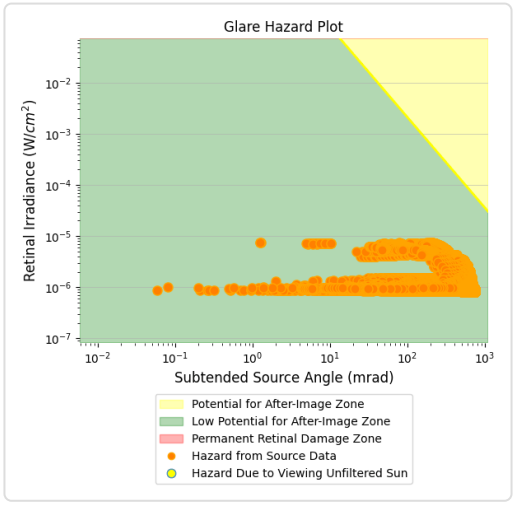
UV-06 and Route: N198 ri oost

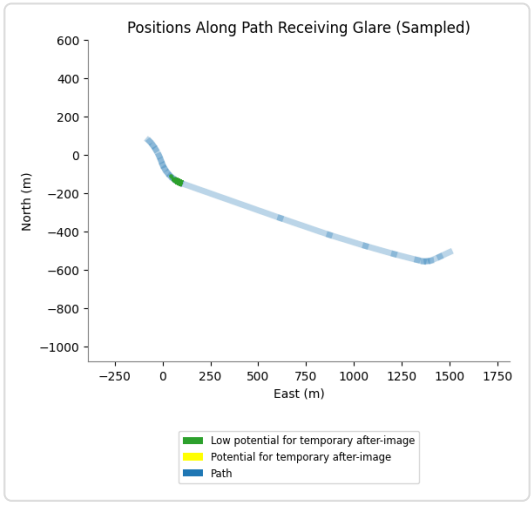
Yellow glare: none

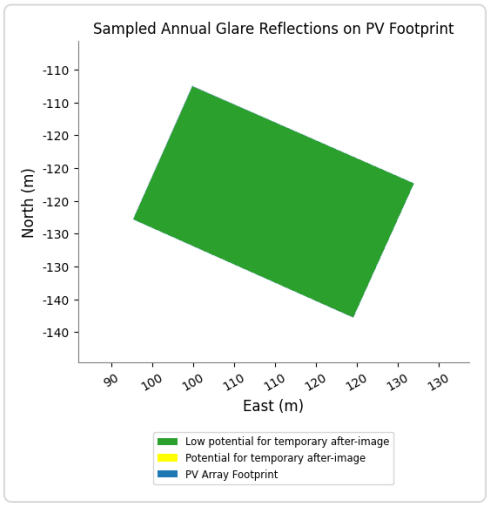
Green glare: 90,993 min.







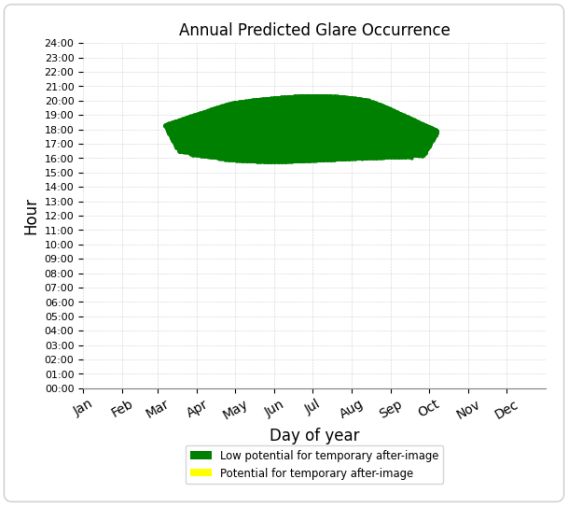


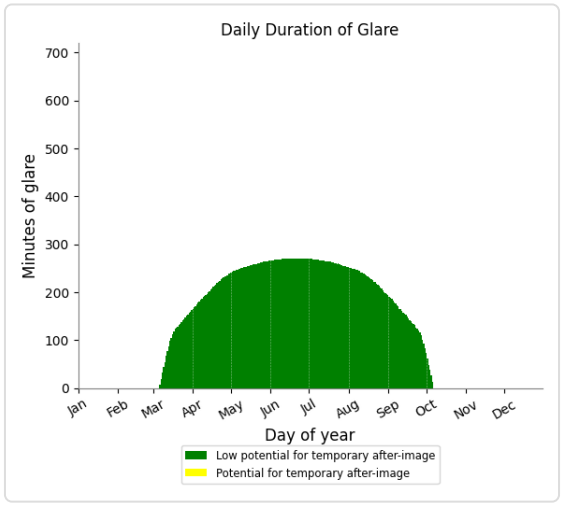


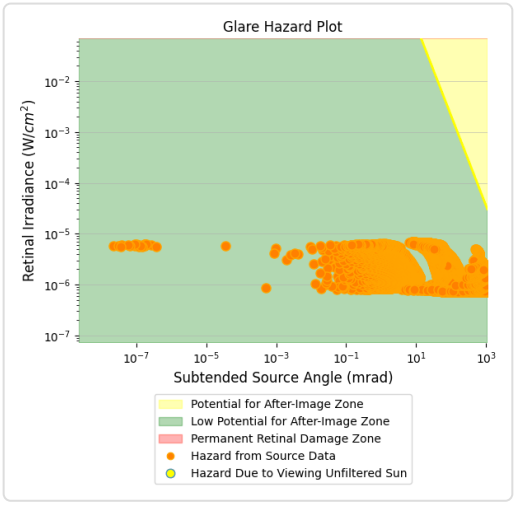
UV-06 and Route: N198 ri west

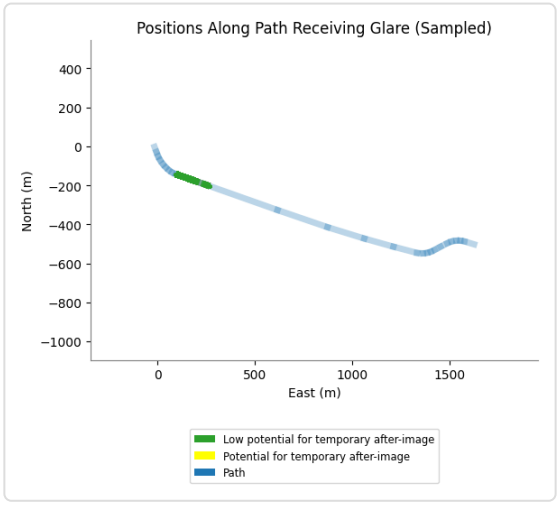
Yellow glare: none

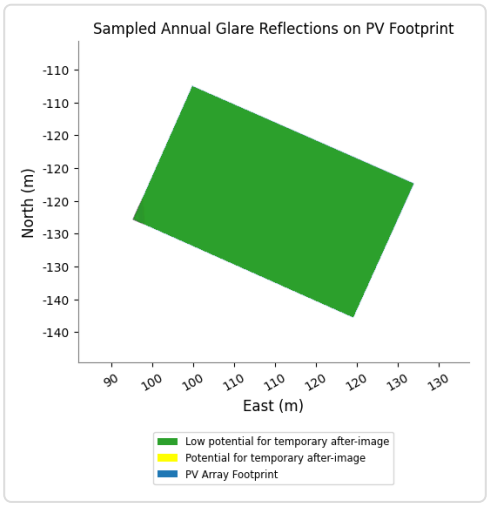
Green glare: 45,009 min.







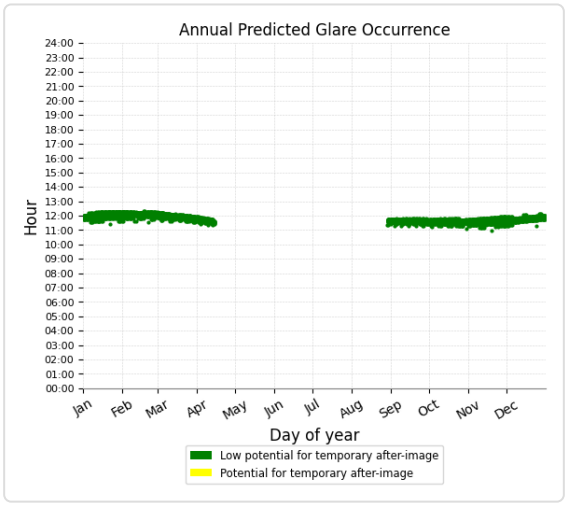


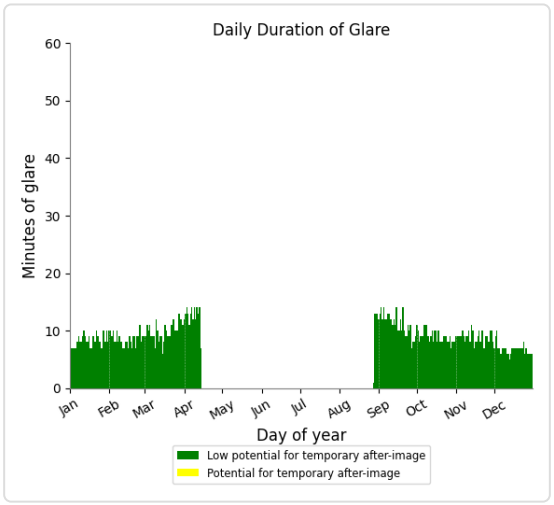


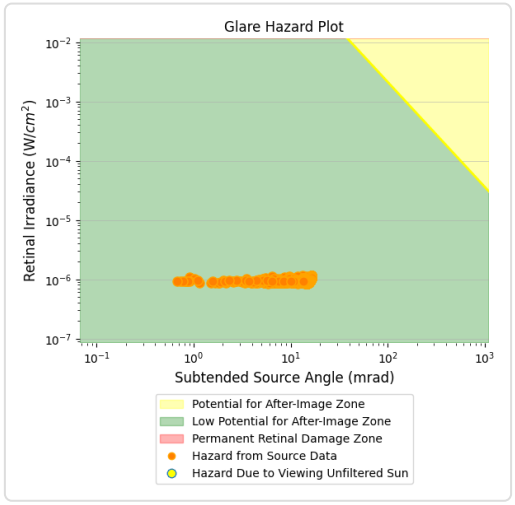
UV-06 and Route: N419 ri oost

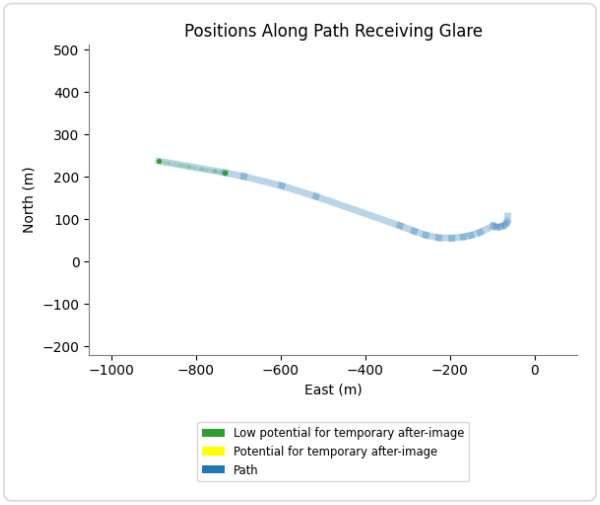
Yellow glare: none

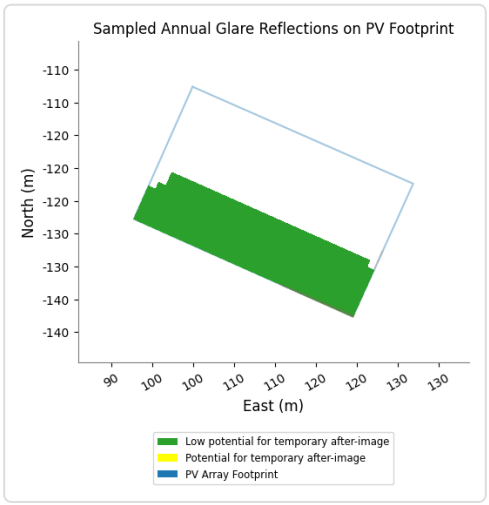
Green glare: 2,110 min.











UV-06 and Route: N419 ri west

No glare found

PV: UV-07 low potential for temporary after-image

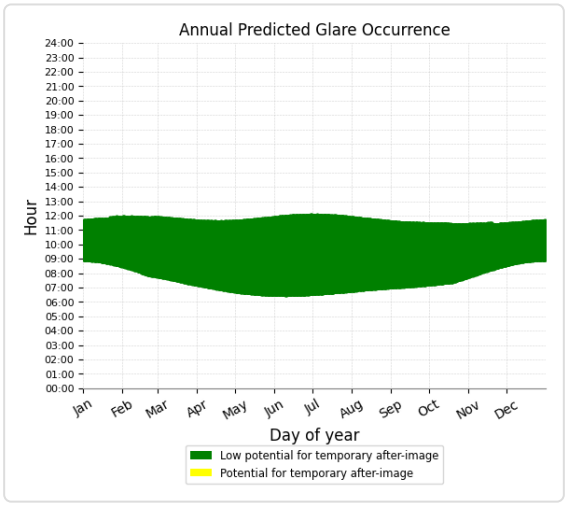
Receptor results ordered by category of glare

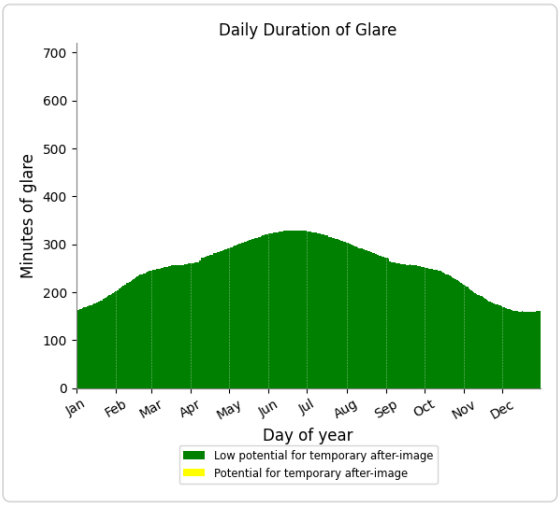
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	92,052	1,534.2	0	0.0
A12 ri west	57,110	951.8	0	0.0
N198 ri oost	85,422	1,423.7	0	0.0
N198 ri west	53,949	899.1	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

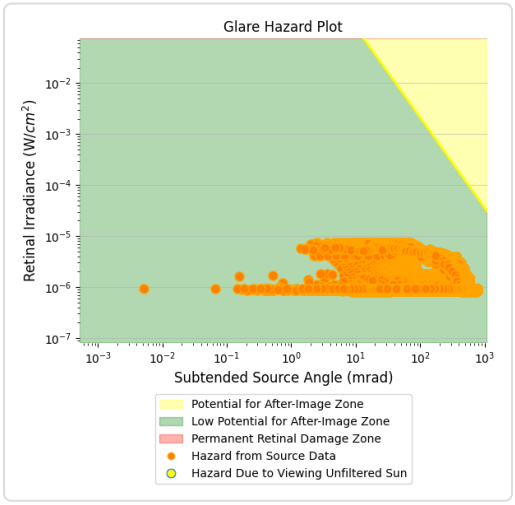
UV-07 and Route: A12 ri oost

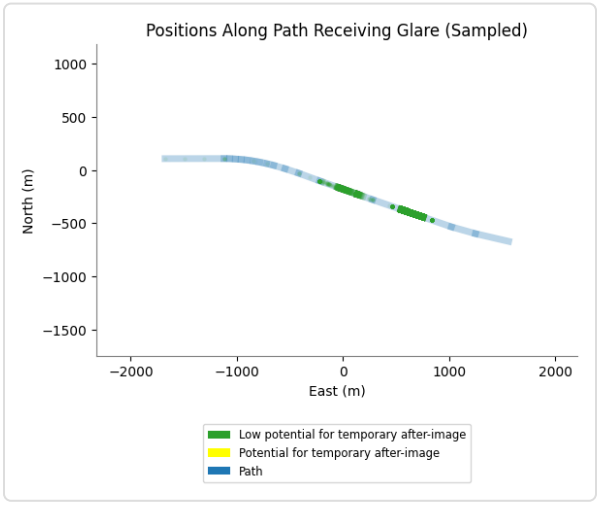
Yellow glare: none

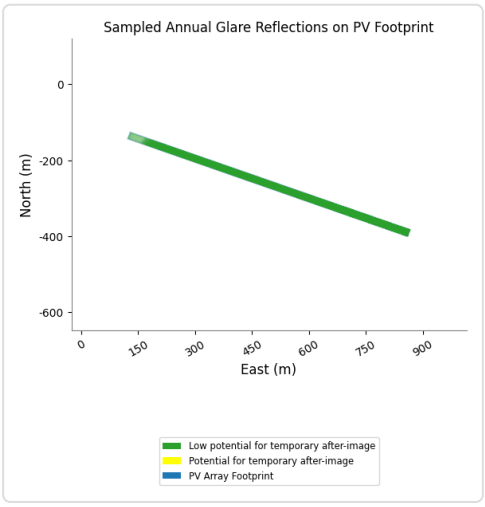
Green glare: 92,052 min.







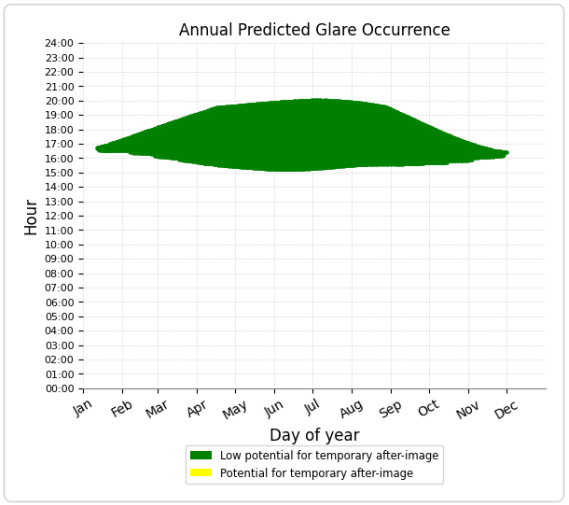


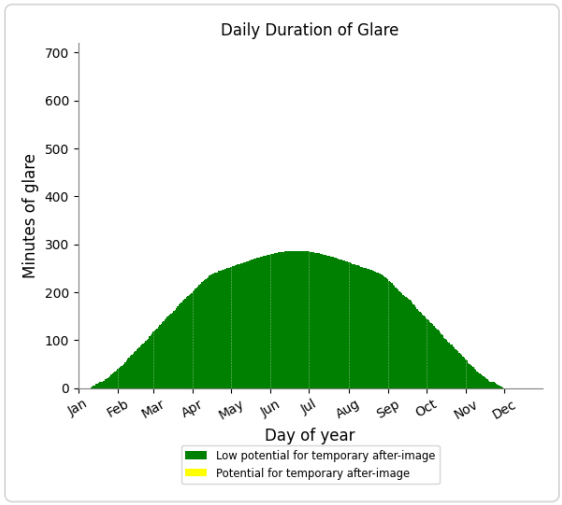


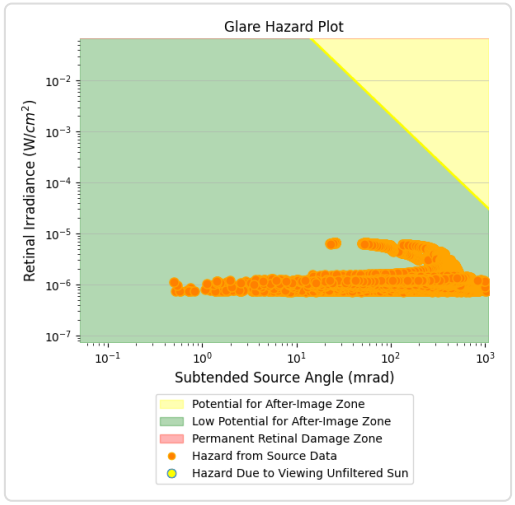
UV-07 and Route: A12 ri west

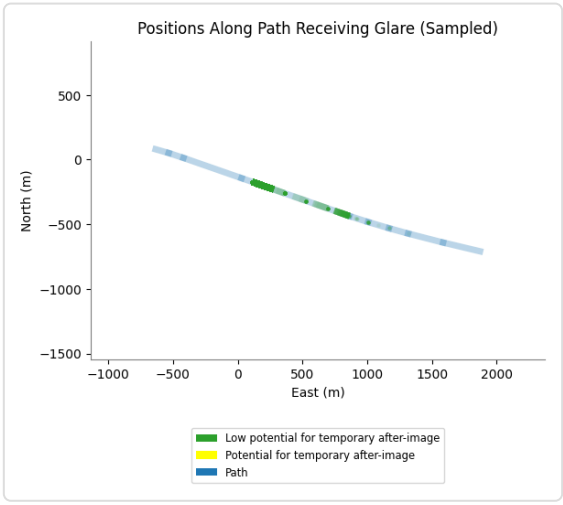
Yellow glare: none

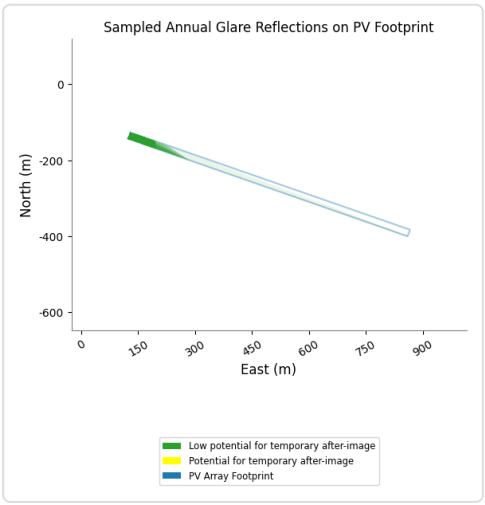
Green glare: 57,110 min.







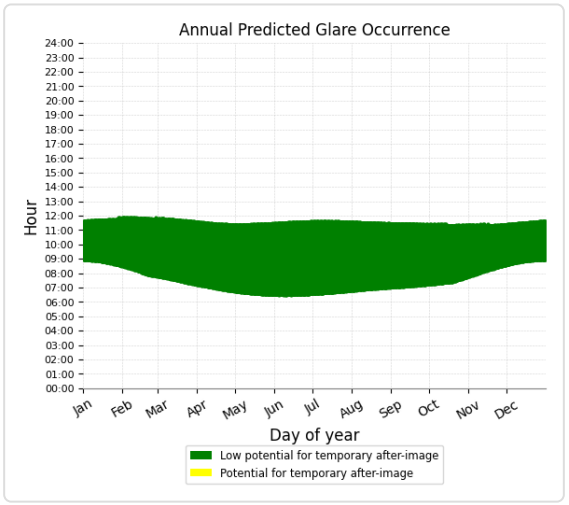


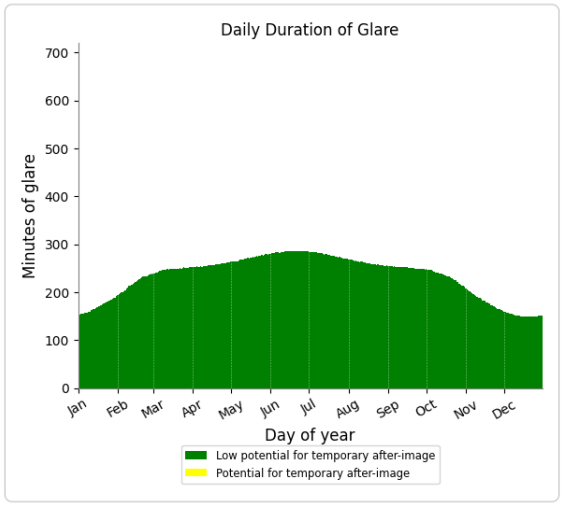


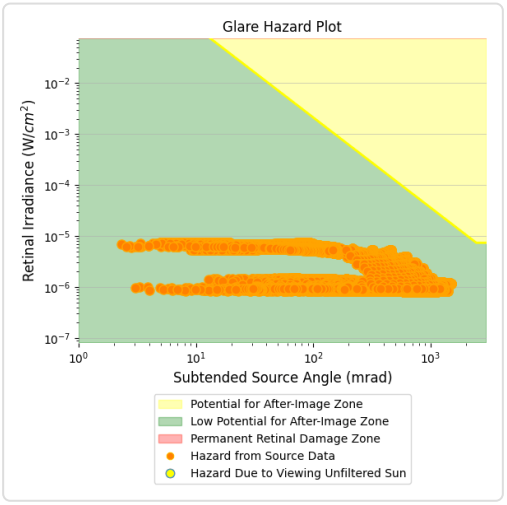
UV-07 and Route: N198 ri oost

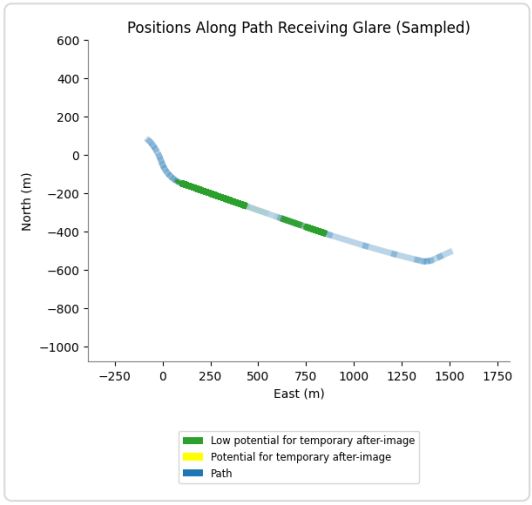
Yellow glare: none

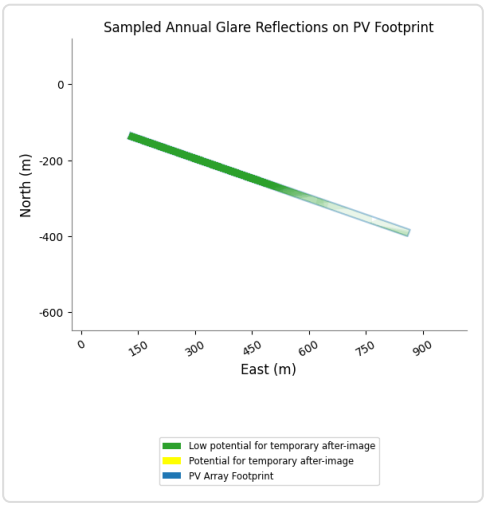
Green glare: 85,422 min.







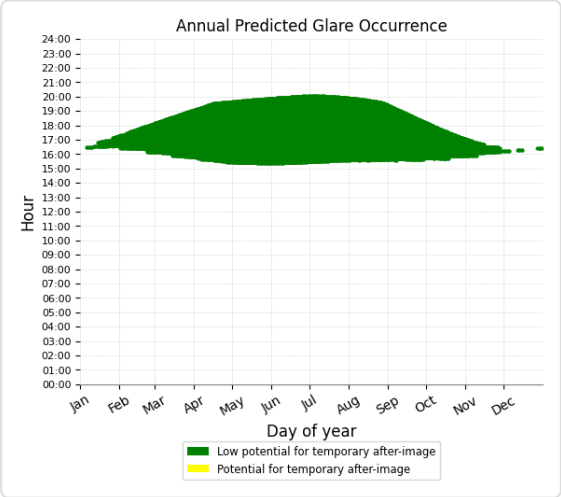


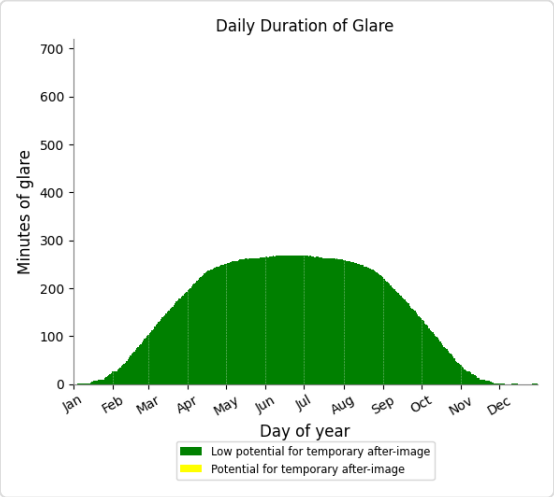


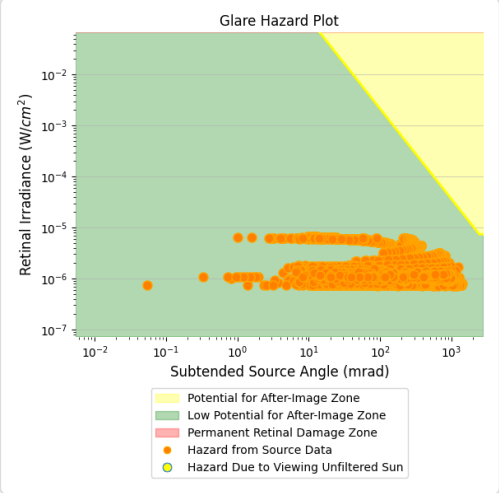
UV-07 and Route: N198 ri west

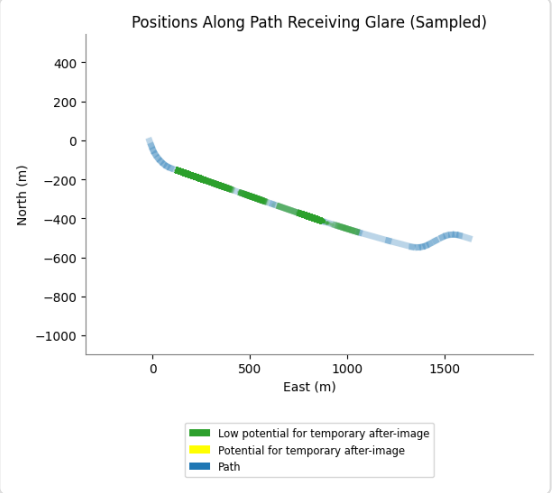
Yellow glare: none

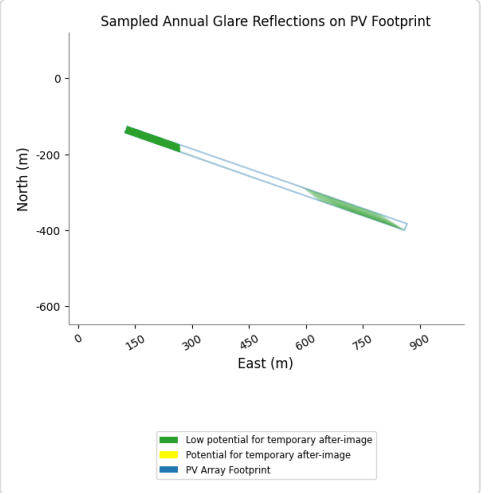
Green glare: 53,949 min.











UV-07 and Route: N419 ri oost

No glare found

UV-07 and Route: N419 ri west

No glare found

PV: UV-08 low potential for temporary after-image

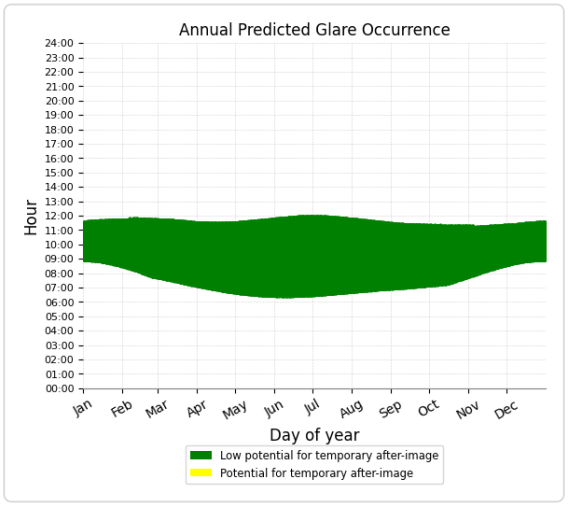
Receptor results ordered by category of glare

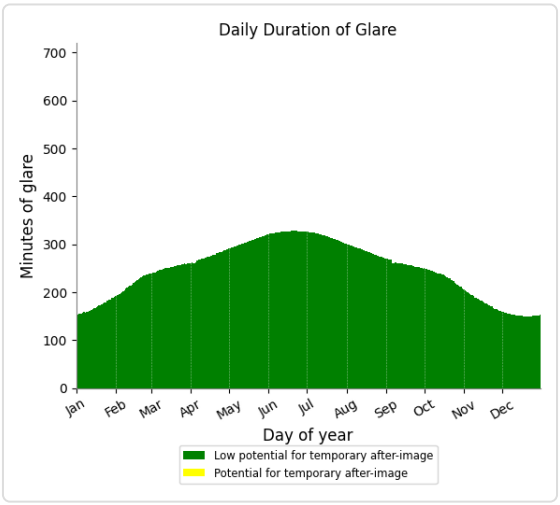
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	90,504	1,508.4	0	0.0
A12 ri west	58,962	982.7	0	0.0
N198 ri oost	83,441	1,390.7	0	0.0
N198 ri west	56,235	937.2	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

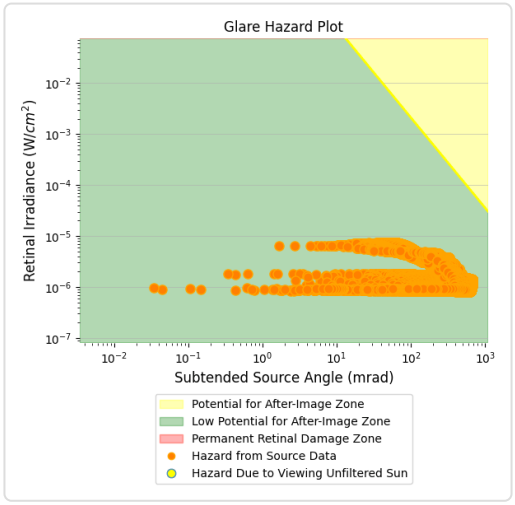
UV-08 and Route: A12 ri oost

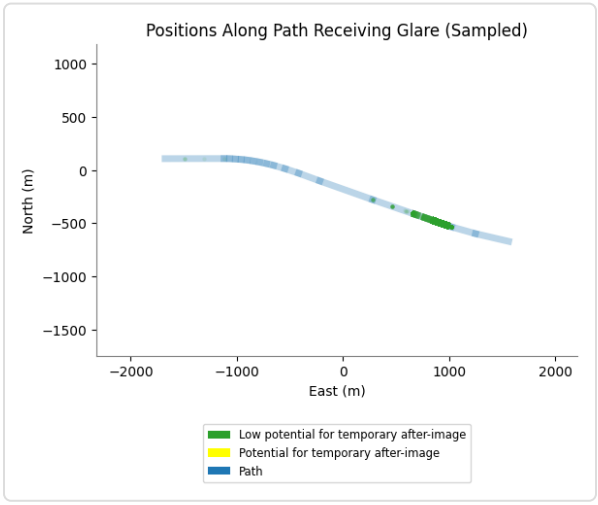
Yellow glare: none

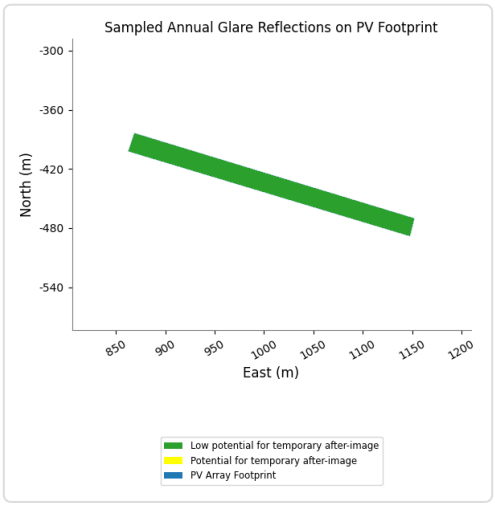
Green glare: 90,504 min.







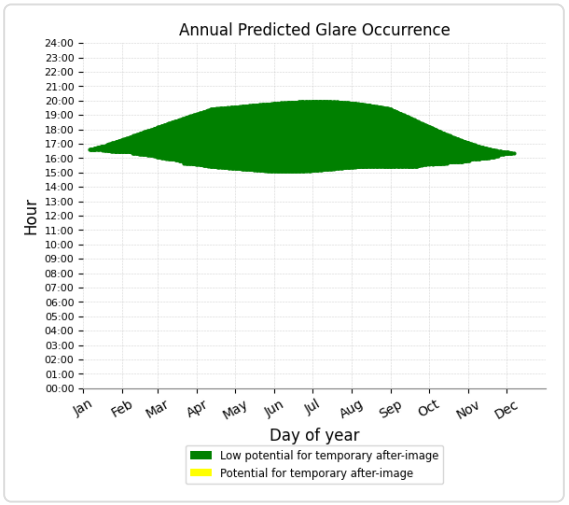


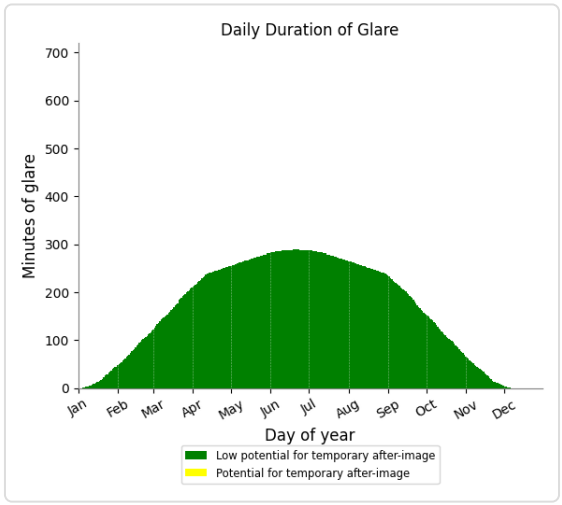


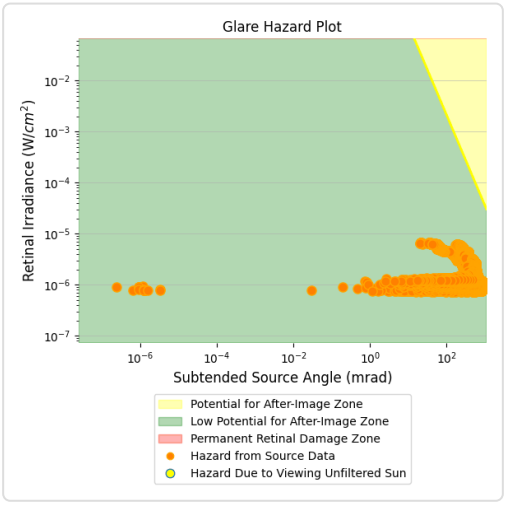
UV-08 and Route: A12 ri west

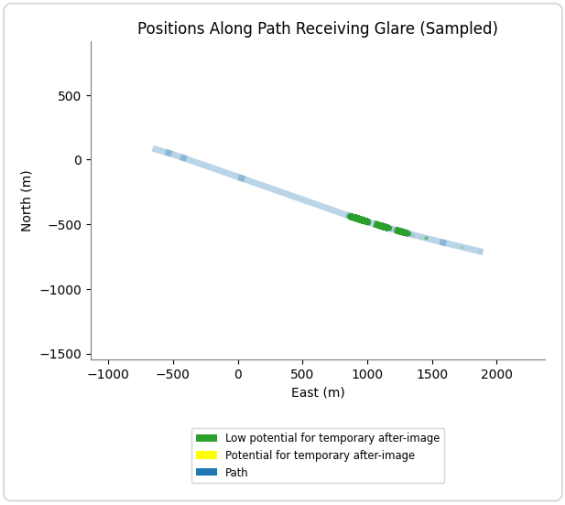
Yellow glare: none

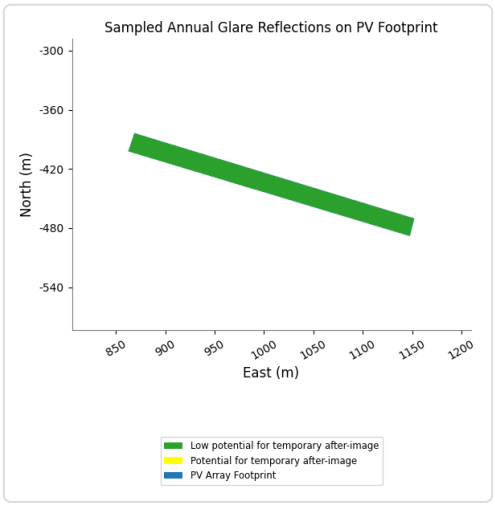
Green glare: 58,962 min.







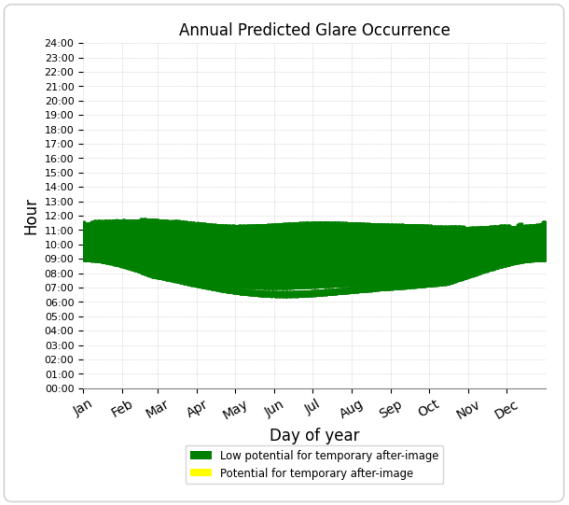


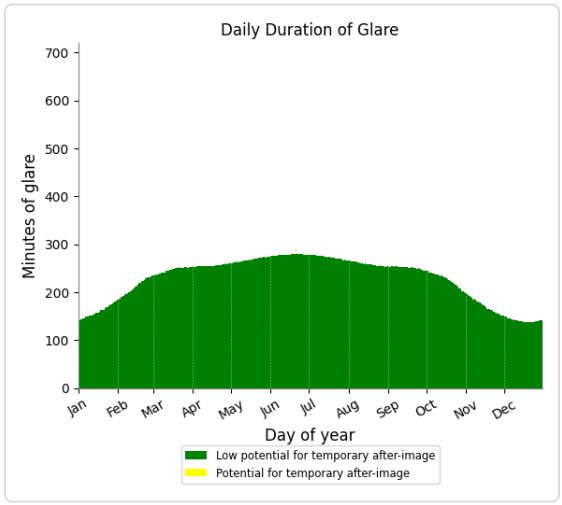


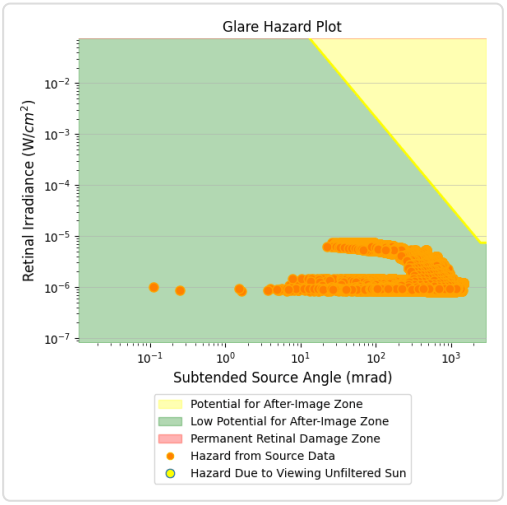
UV-08 and Route: N198 ri oost

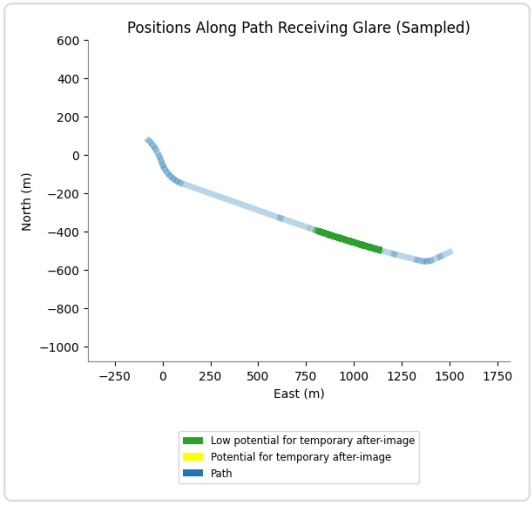
Yellow glare: none

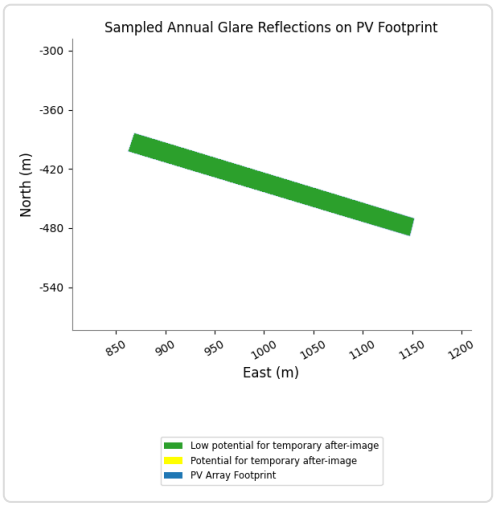
Green glare: 83,441 min.







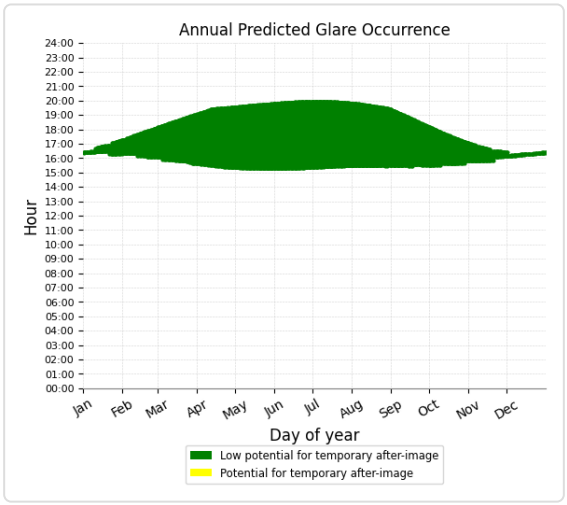


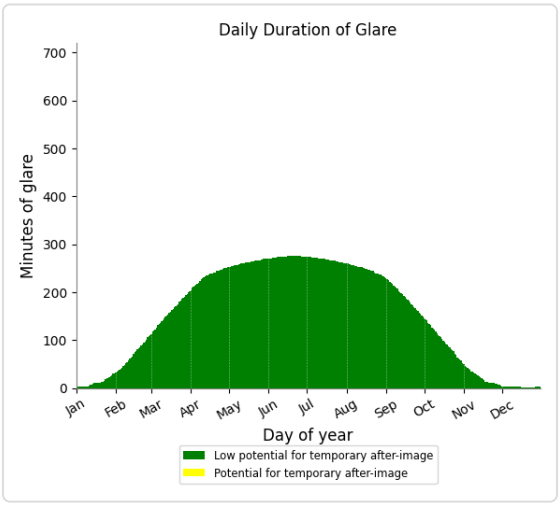


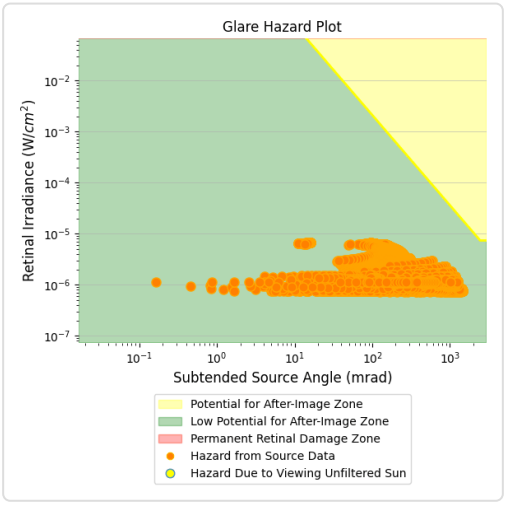
UV-08 and Route: N198 ri west

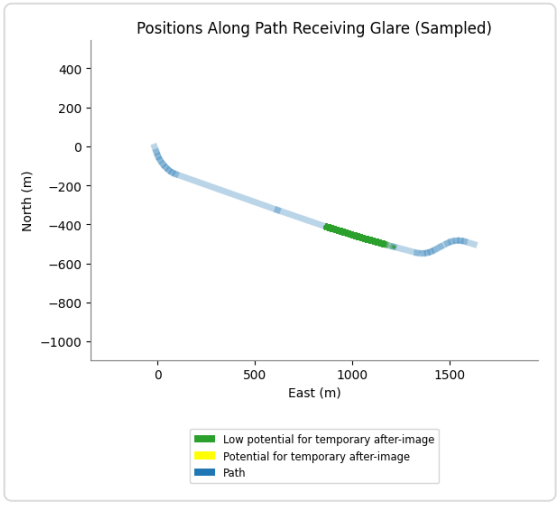
Yellow glare: none

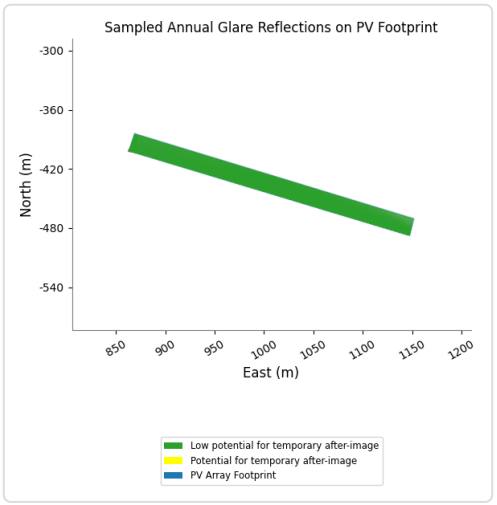
Green glare: 56,235 min.











UV-08 and Route: N419 ri oost

No glare found

UV-08 and Route: N419 ri west

No glare found

PV: UV-09 low potential for temporary after-image

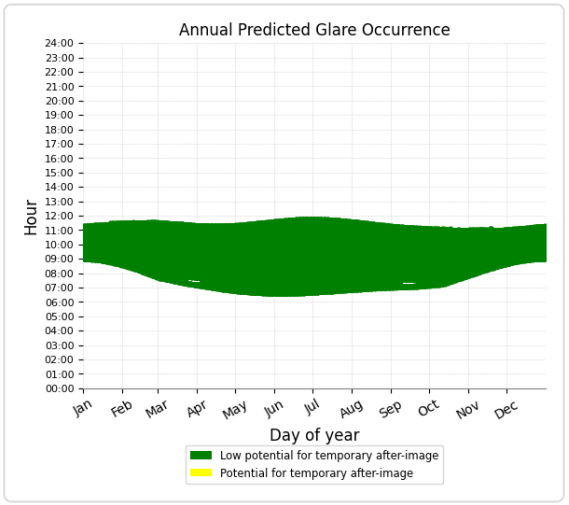
Receptor results ordered by category of glare

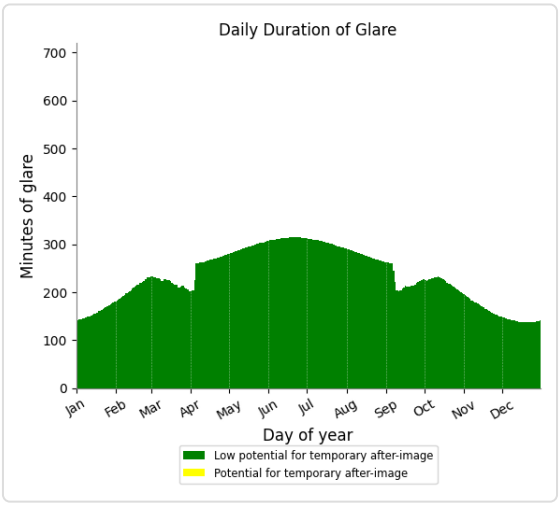
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	84,883	1,414.7	0	0.0
A12 ri west	48,894	814.9	0	0.0
N198 ri oost	79,261	1,321.0	0	0.0
N198 ri west	48,085	801.4	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

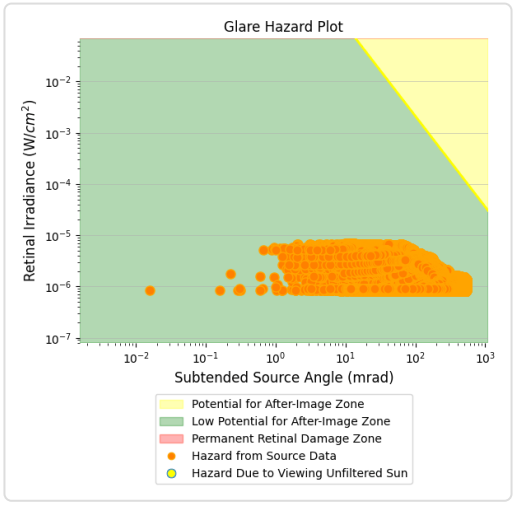
UV-09 and Route: A12 ri oost

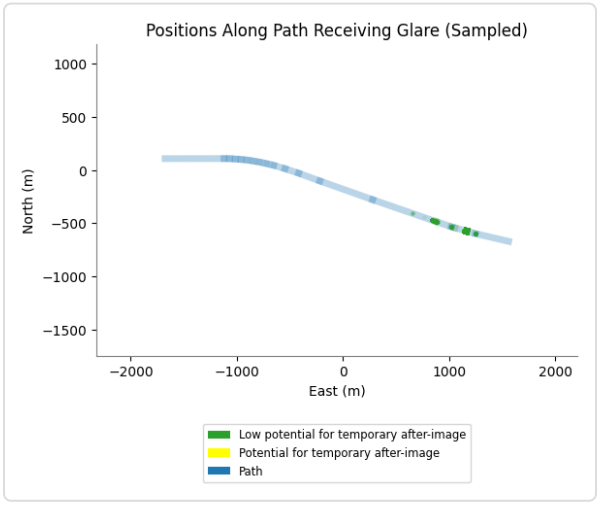
Yellow glare: none

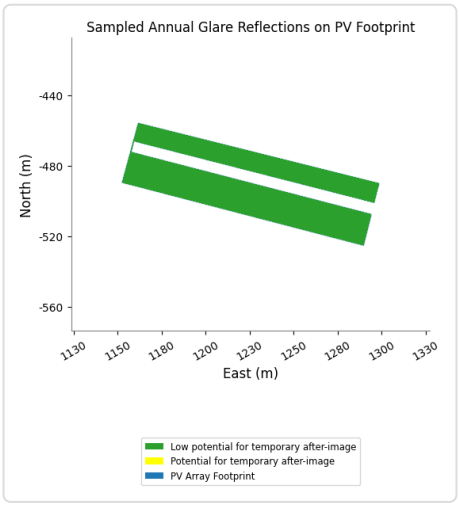
Green glare: 84,883 min.







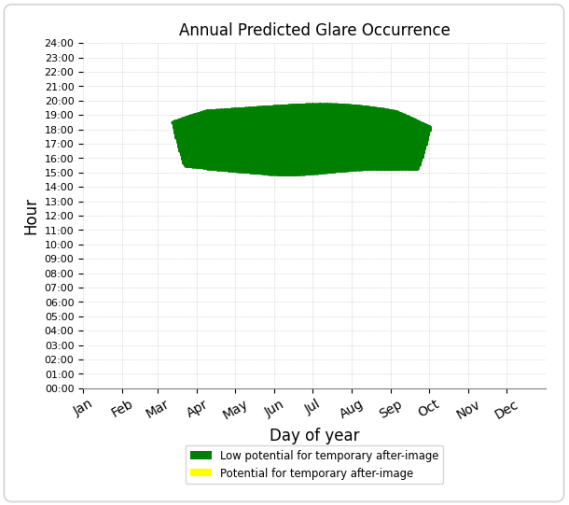


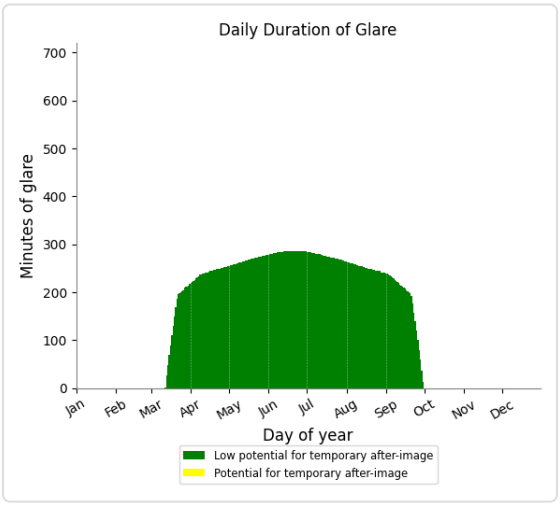


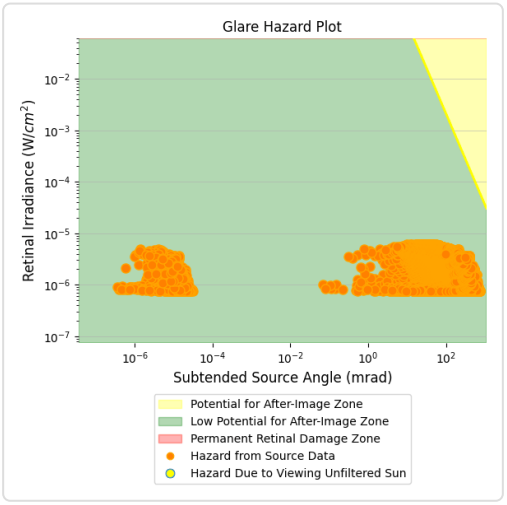
UV-09 and Route: A12 ri west

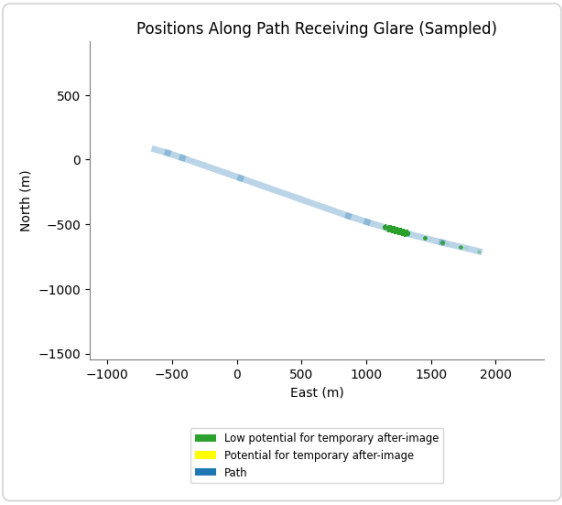
Yellow glare: none

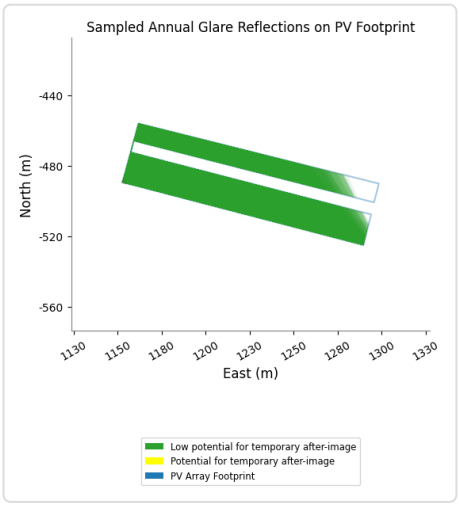
Green glare: 48,894 min.







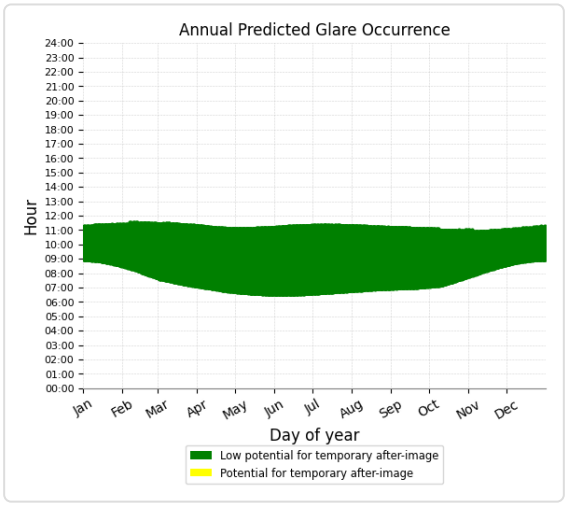


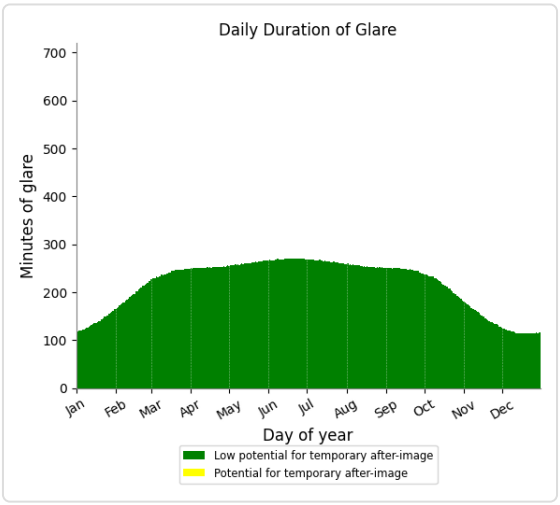


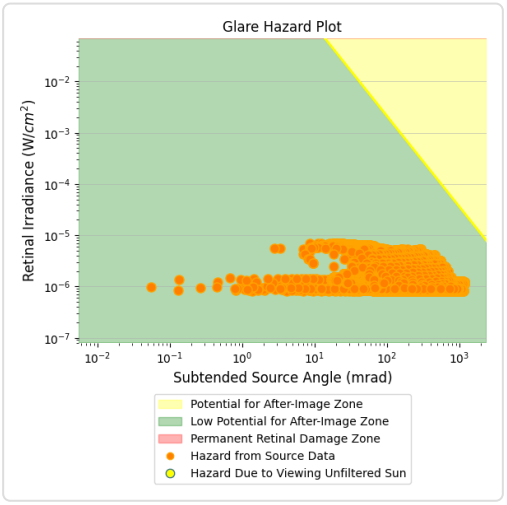
UV-09 and Route: N198 ri oost

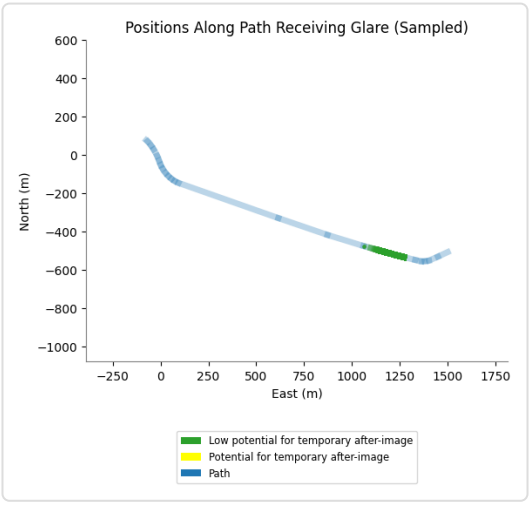
Yellow glare: none

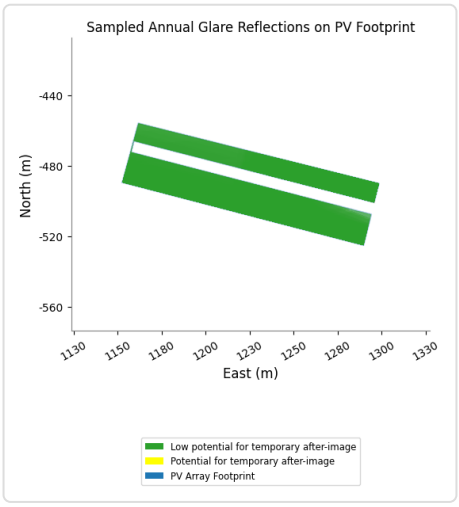
Green glare: 79,261 min.







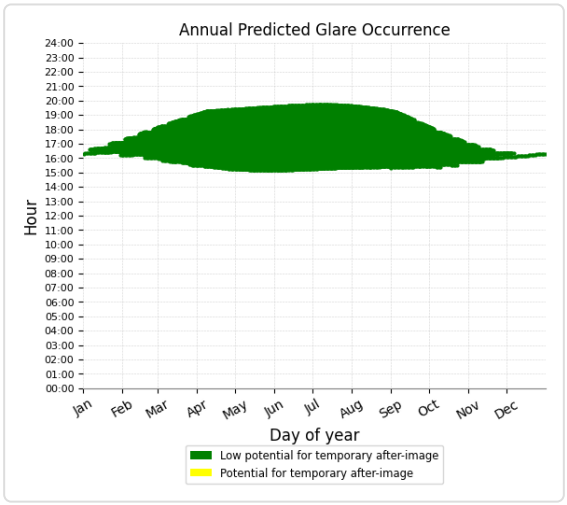


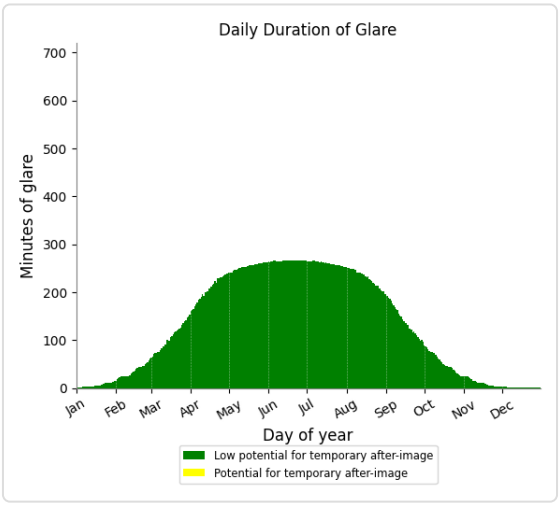


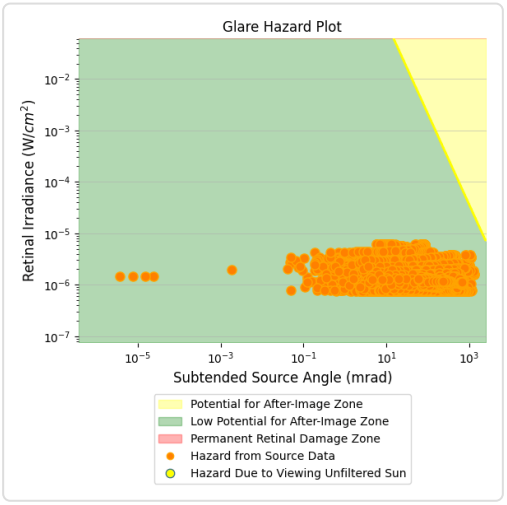
UV-09 and Route: N198 ri west

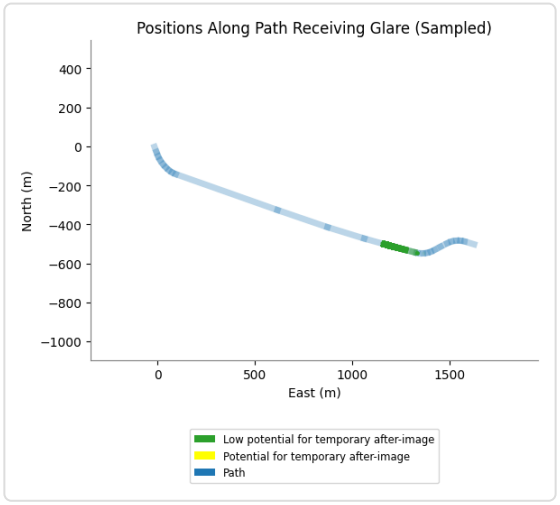
Yellow glare: none

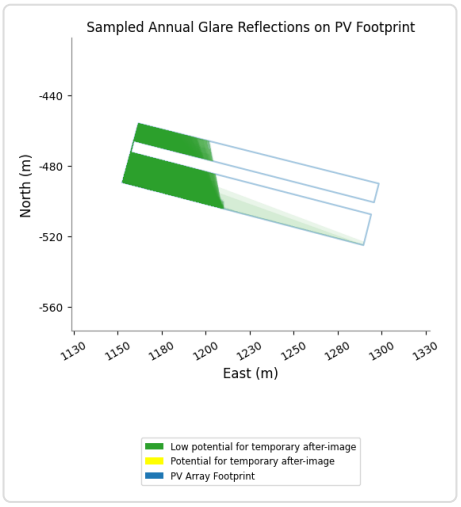
Green glare: 48,085 min.











UV-09 and Route: N419 ri oost

No glare found

UV-09 and Route: N419 ri west

No glare found

PV: UV-10 low potential for temporary after-image

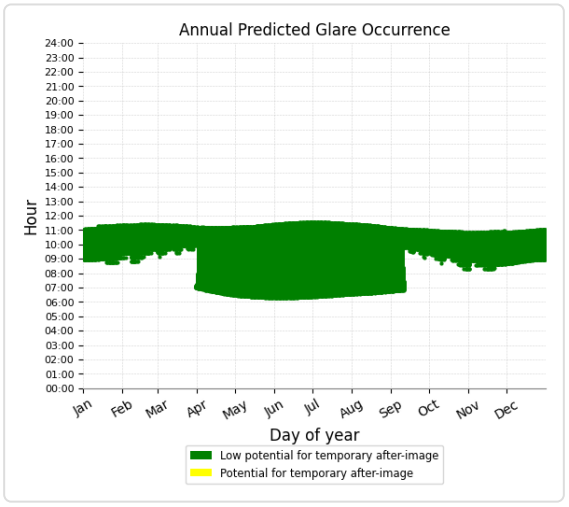
Receptor results ordered by category of glare

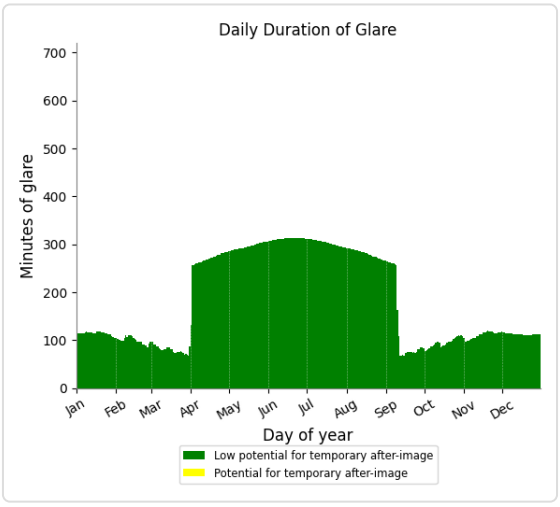
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	67,270	1,121.2	0	0.0
A12 ri west	46,940	782.3	0	0.0
N198 ri oost	16,170	269.5	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

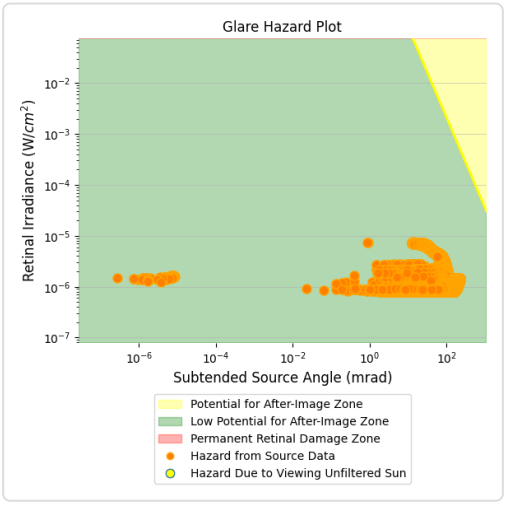
UV-10 and Route: A12 ri oost

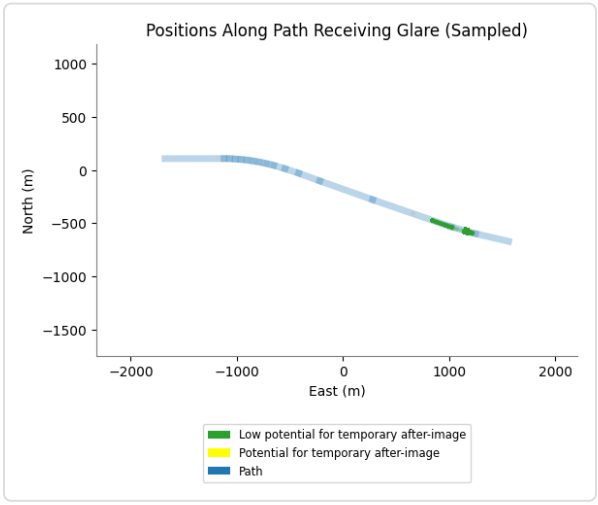
Yellow glare: none

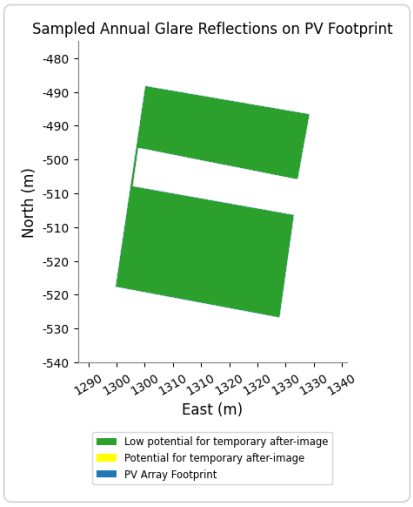
Green glare: 67,270 min.







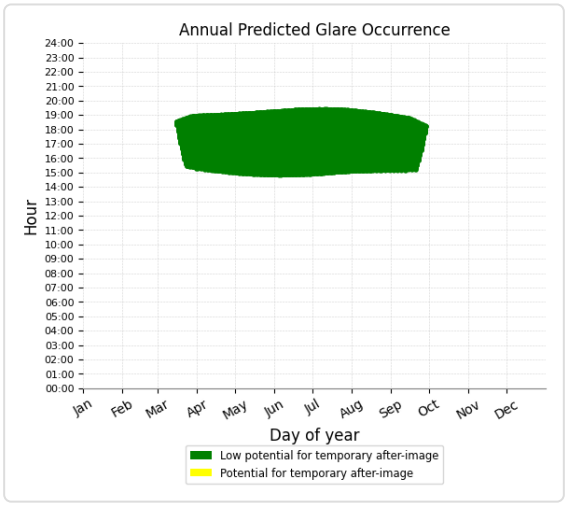


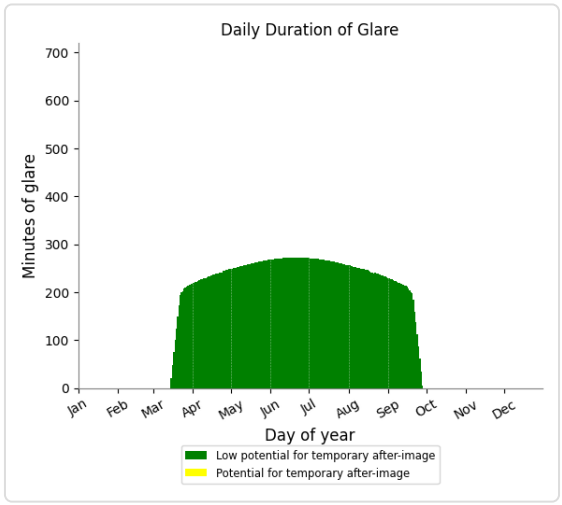


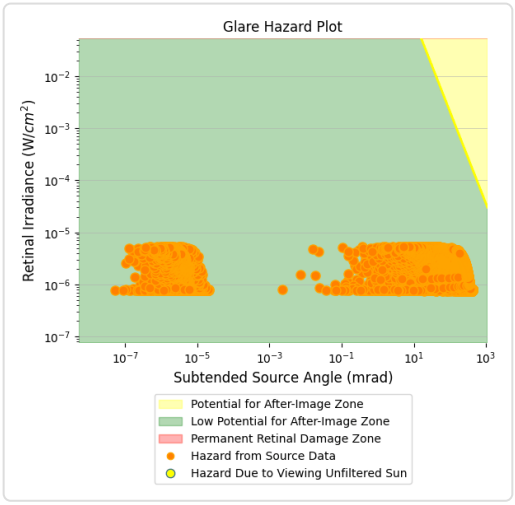
UV-10 and Route: A12 ri west

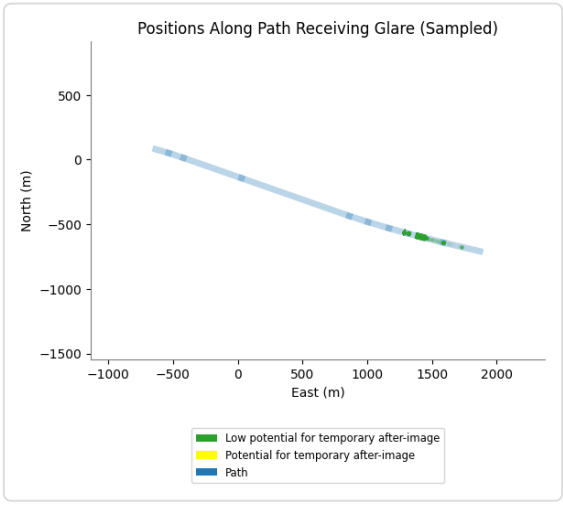
Yellow glare: none

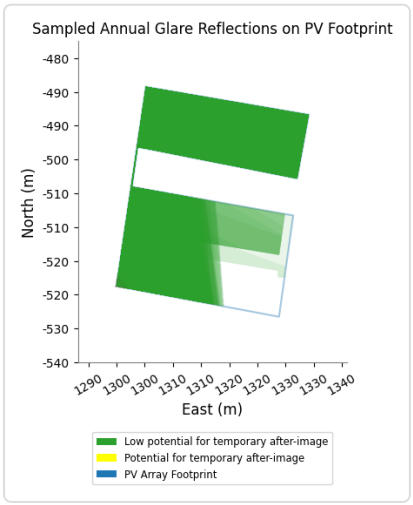
Green glare: 46,940 min.







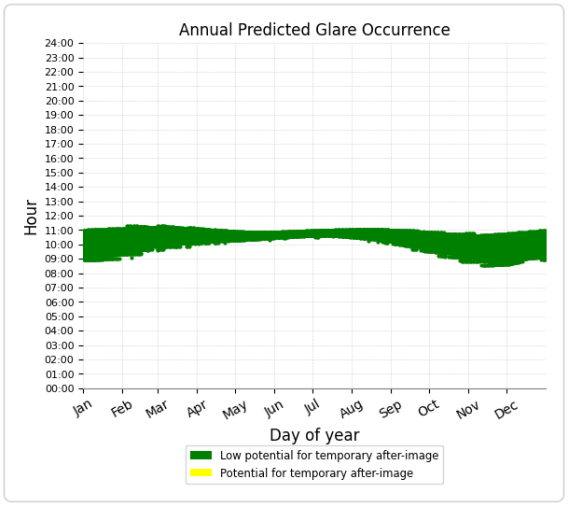


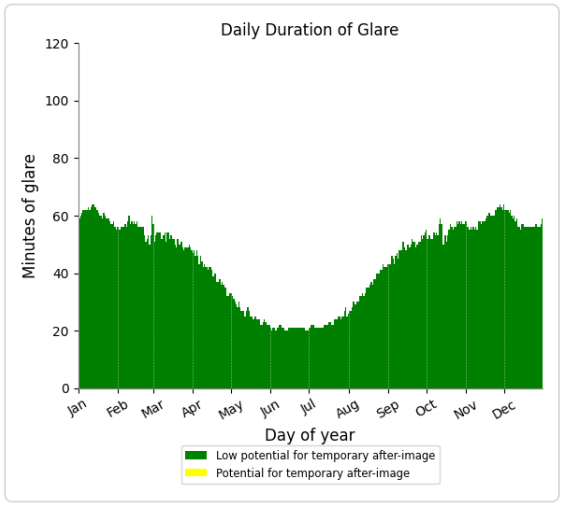


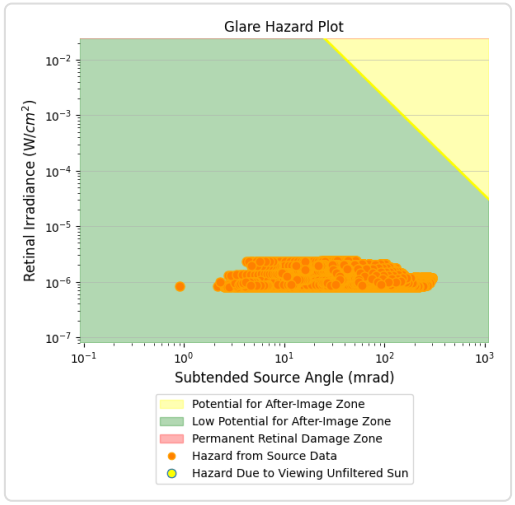
UV-10 and Route: N198 ri oost

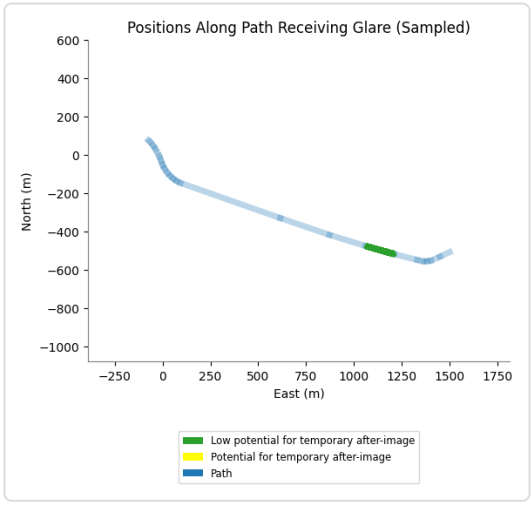
Yellow glare: none

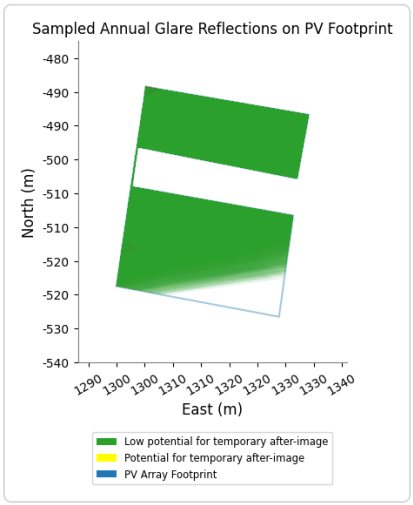
Green glare: 16,170 min.











UV-10 and Route: N198 ri west

No glare found

UV-10 and Route: N419 ri oost

No glare found

UV-10 and Route: N419 ri west

No glare found

PV: UV-11 low potential for temporary after-image

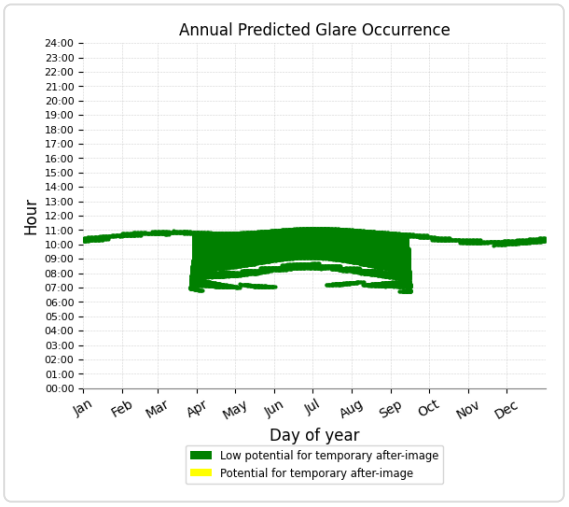
Receptor results ordered by category of glare

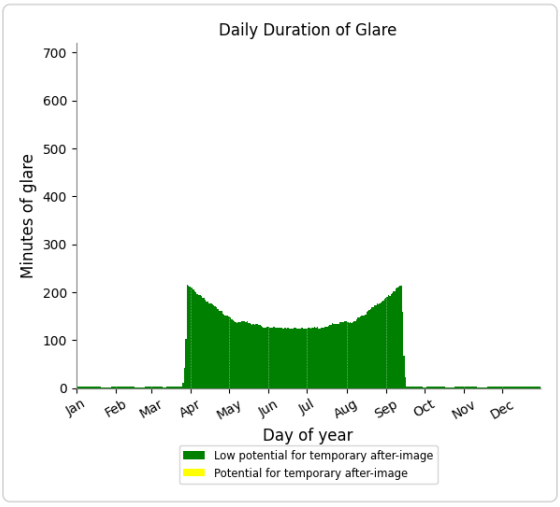
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	26,512	441.9	0	0.0
A12 ri west	15,953	265.9	0	0.0
N198 ri oost	2,447	40.8	0	0.0
N198 ri west	243	4.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

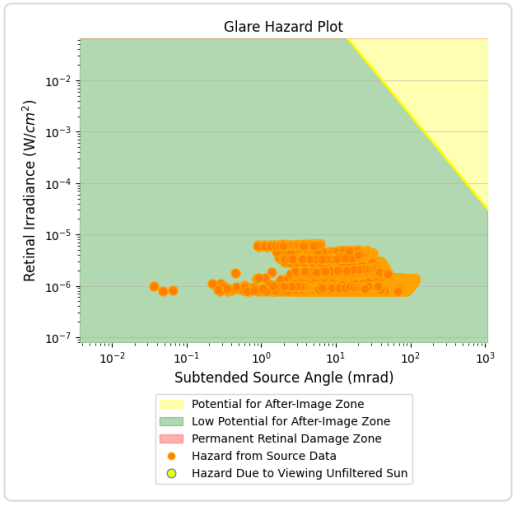
UV-11 and Route: A12 ri oost

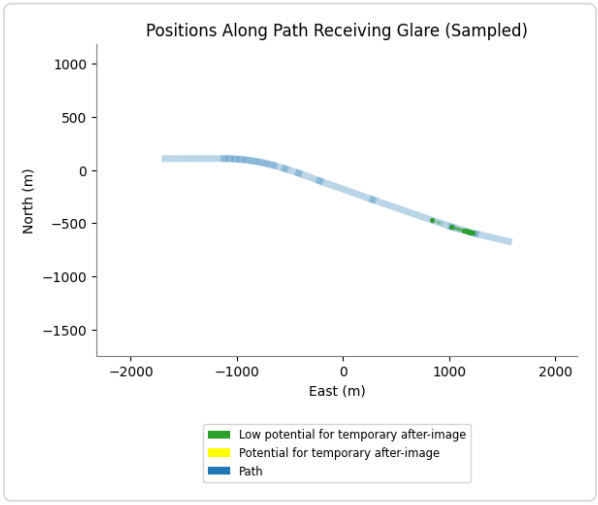
Yellow glare: none

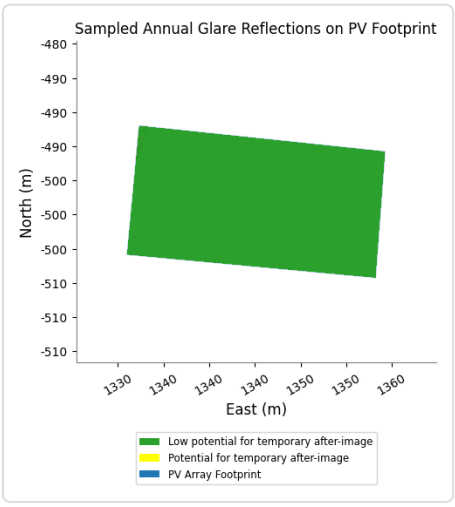
Green glare: 26,512 min.







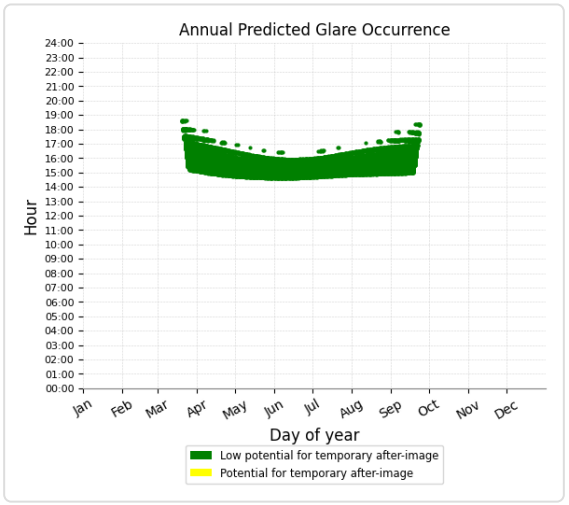


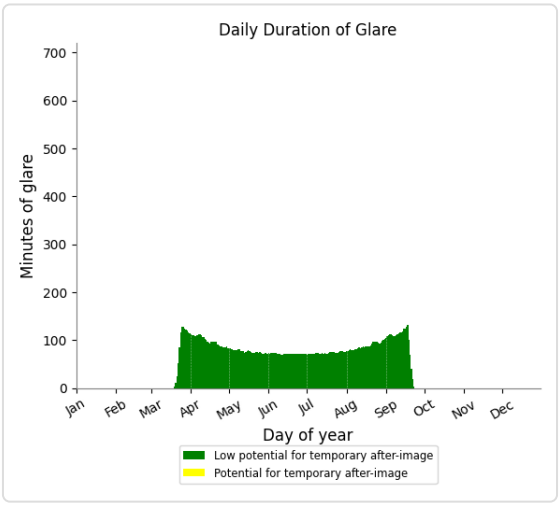


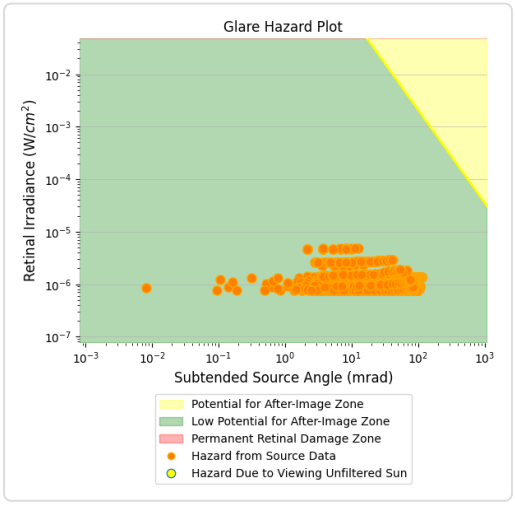
UV-11 and Route: A12 ri west

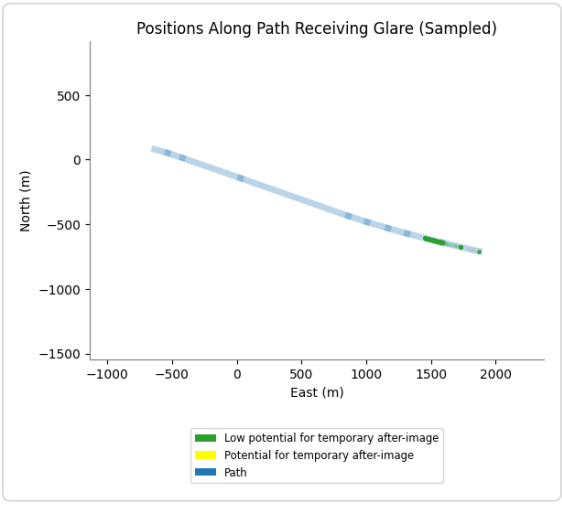
Yellow glare: none

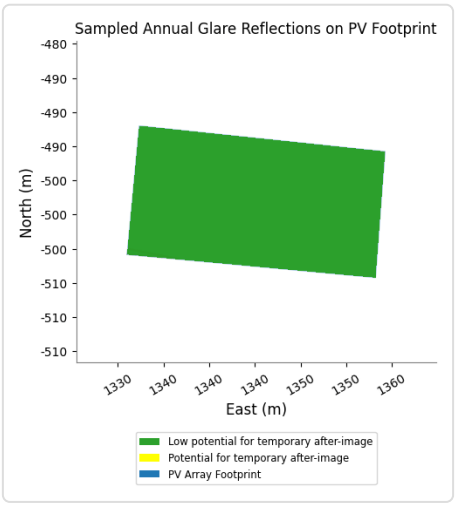
Green glare: 15,953 min.







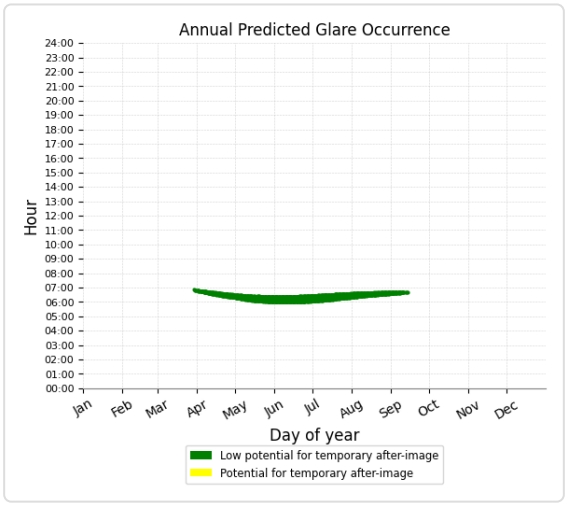


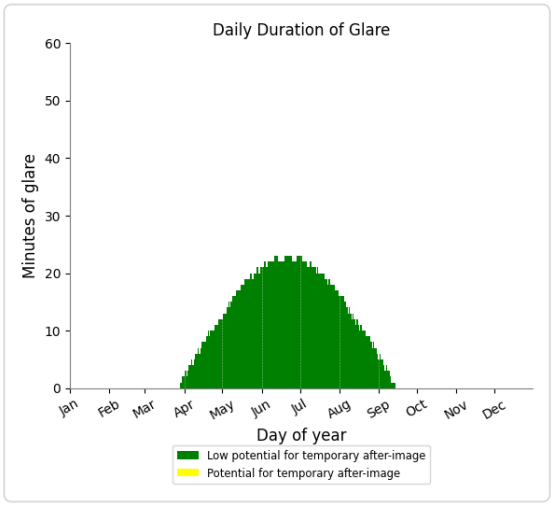


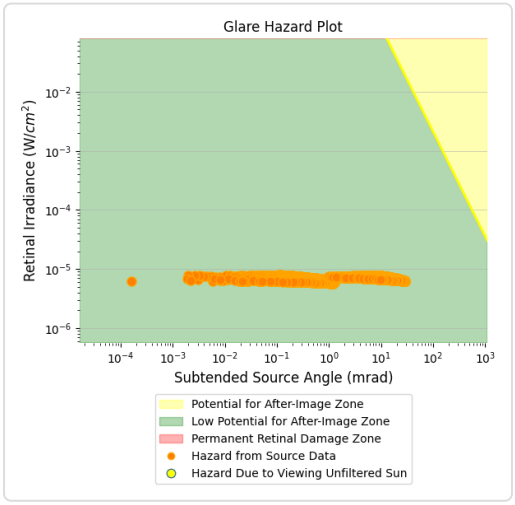
UV-11 and Route: N198 ri oost

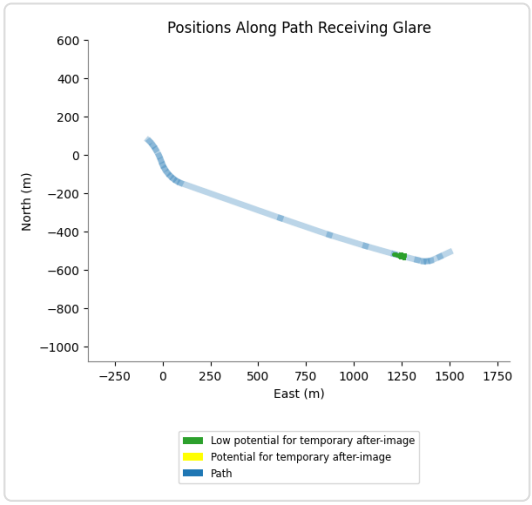
Yellow glare: none

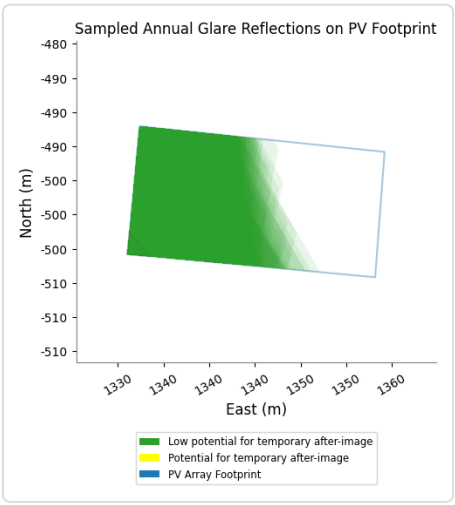
Green glare: 2,447 min.







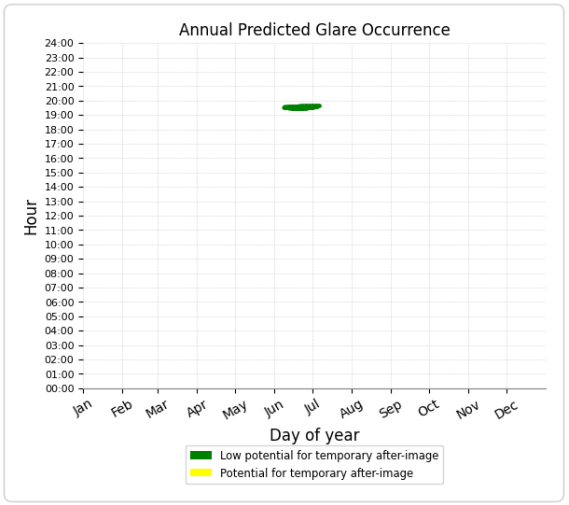


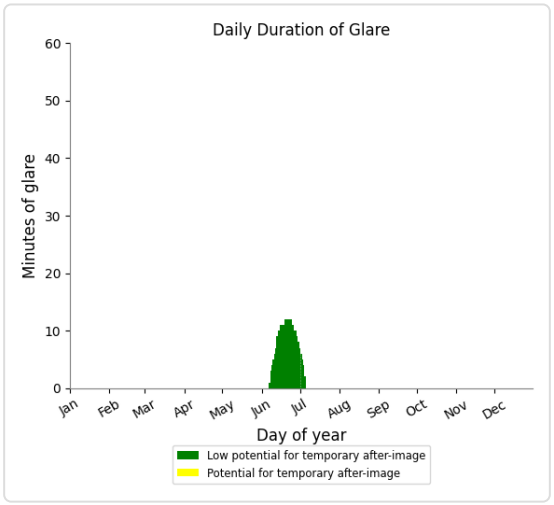


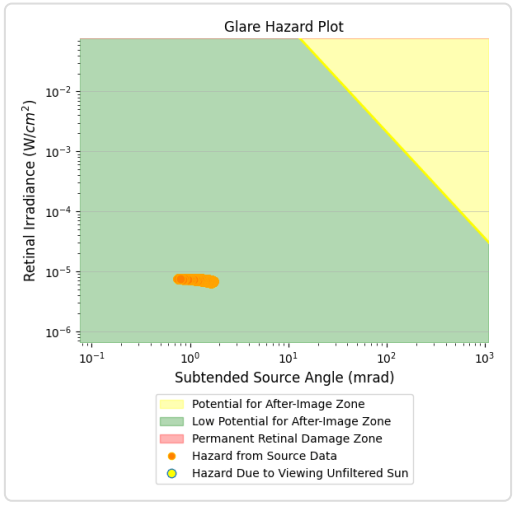
UV-11 and Route: N198 ri west

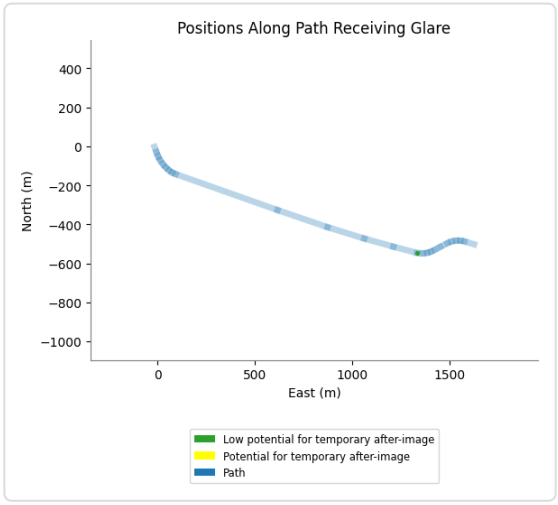
Yellow glare: none

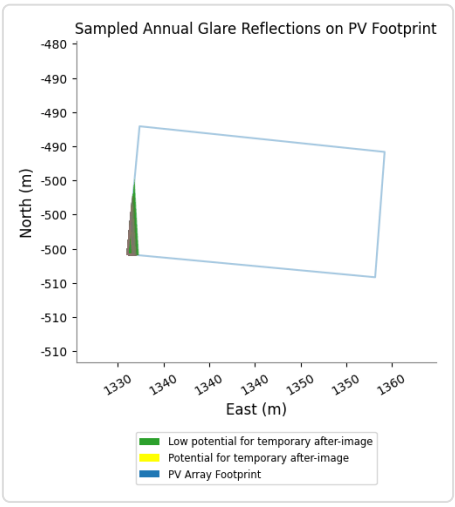
Green glare: 243 min.











UV-11 and Route: N419 ri oost

No glare found

UV-11 and Route: N419 ri west

No glare found

PV: UV-12 low potential for temporary after-image

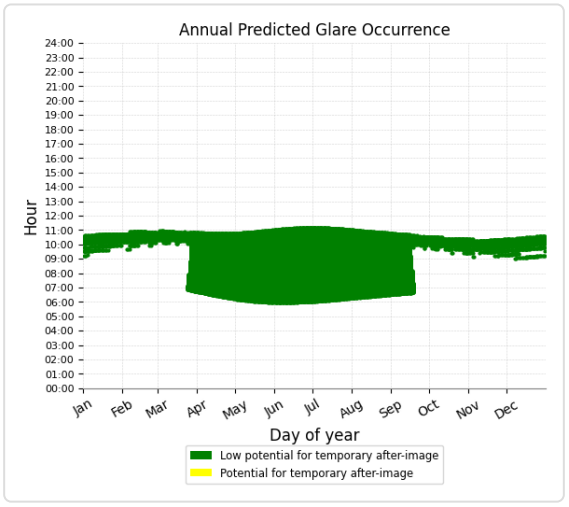
Receptor results ordered by category of glare

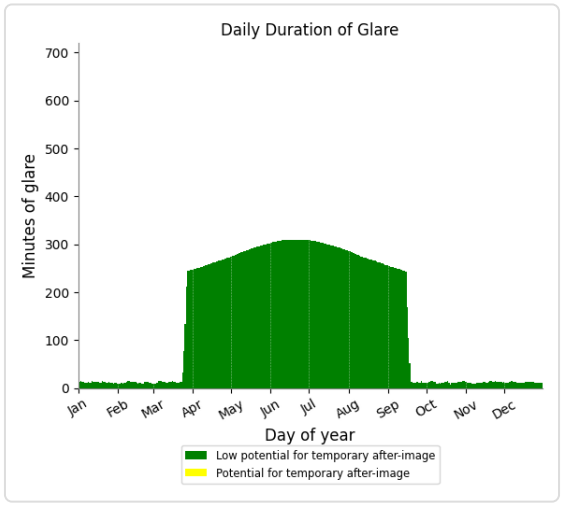
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	51,533	858.9	0	0.0
A12 ri west	49,273	821.2	0	0.0
N198 ri oost	68,753	1,145.9	0	0.0
N198 ri west	19,129	318.8	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

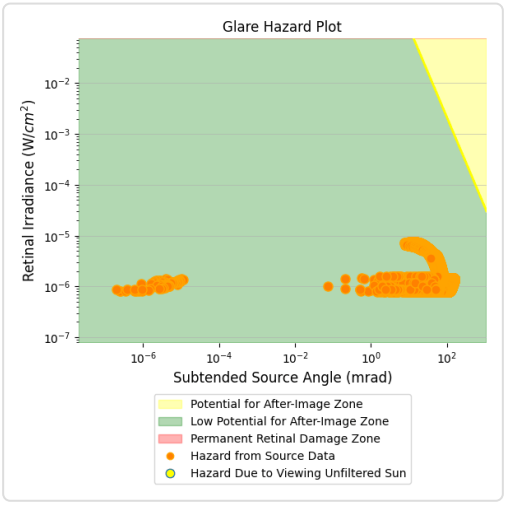
UV-12 and Route: A12 ri oost

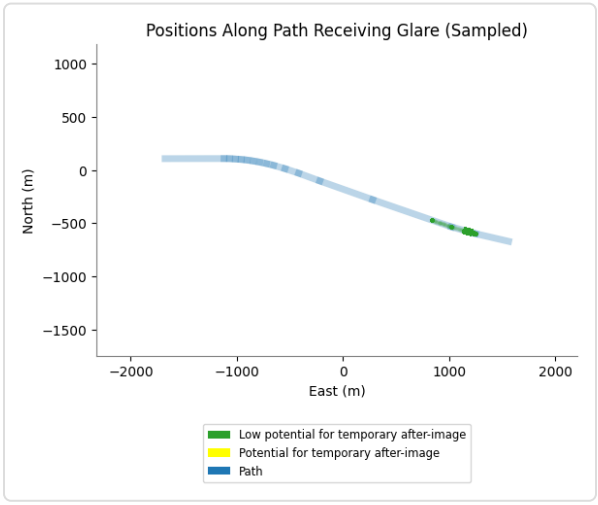
Yellow glare: none

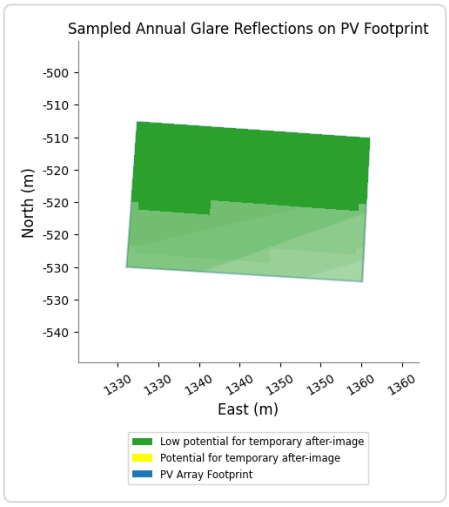
Green glare: 51,533 min.







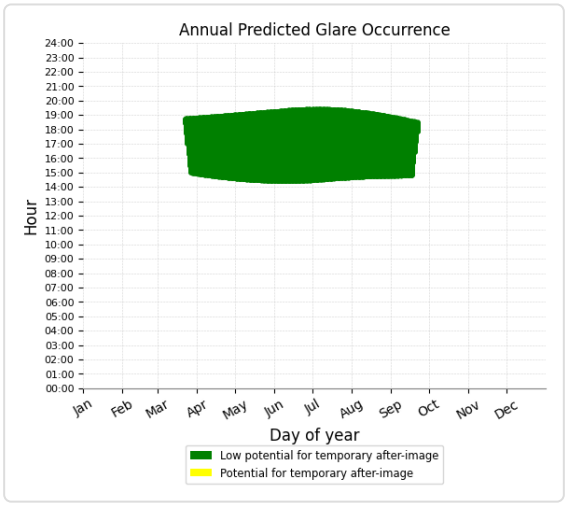


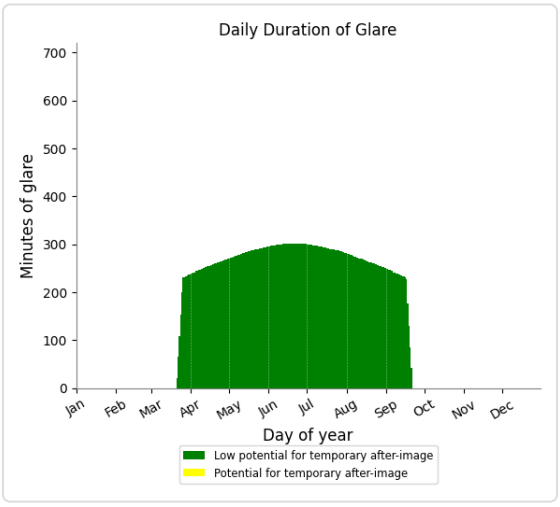


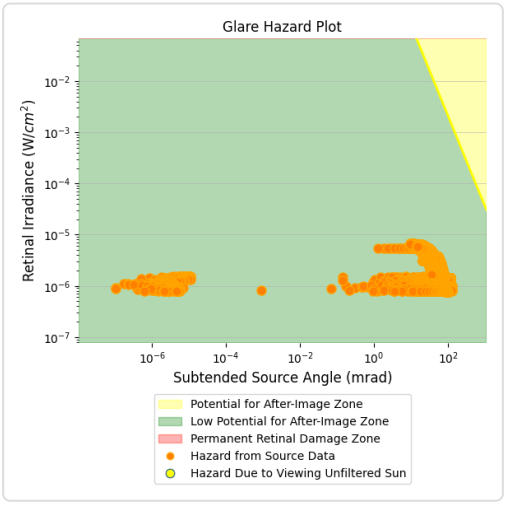
UV-12 and Route: A12 ri west

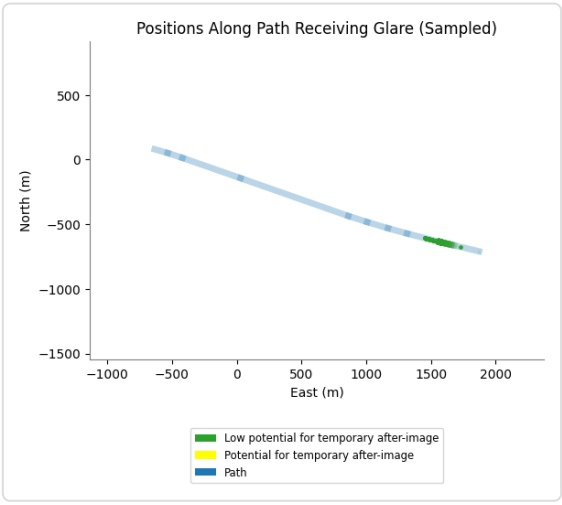
Yellow glare: none

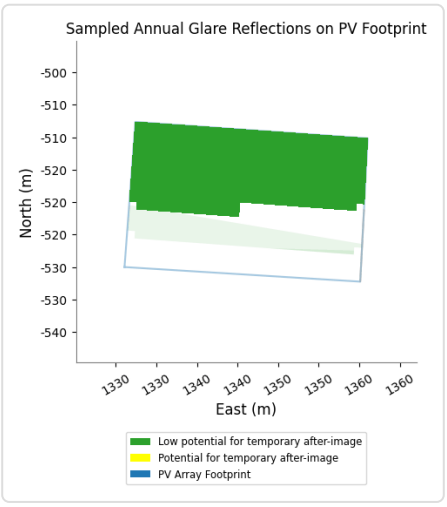
Green glare: 49,273 min.







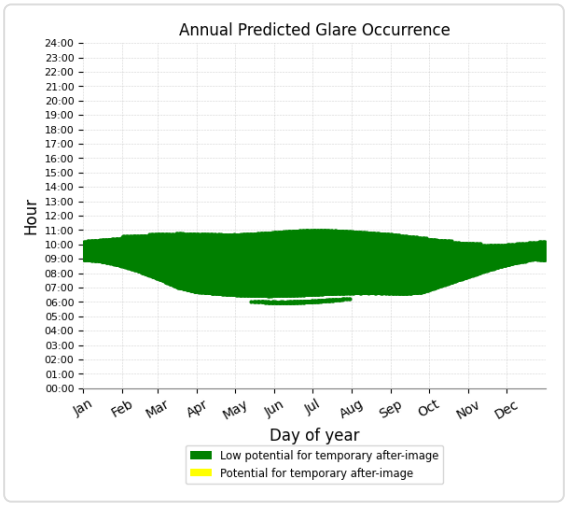


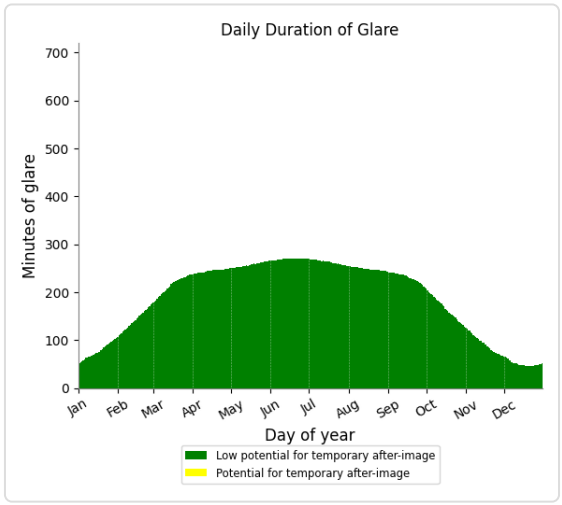


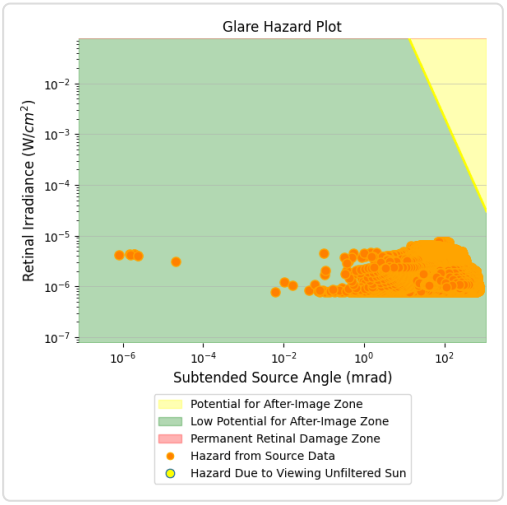
UV-12 and Route: N198 ri oost

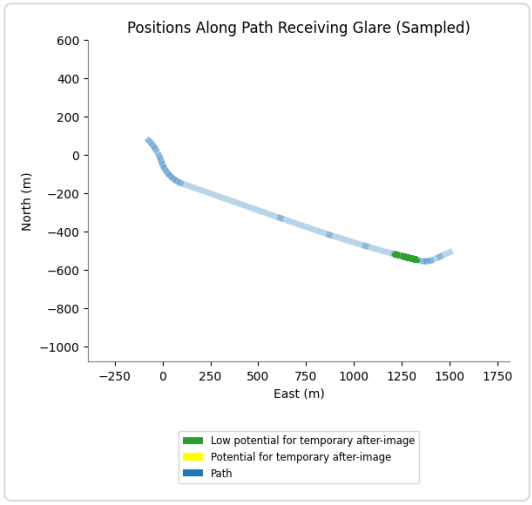
Yellow glare: none

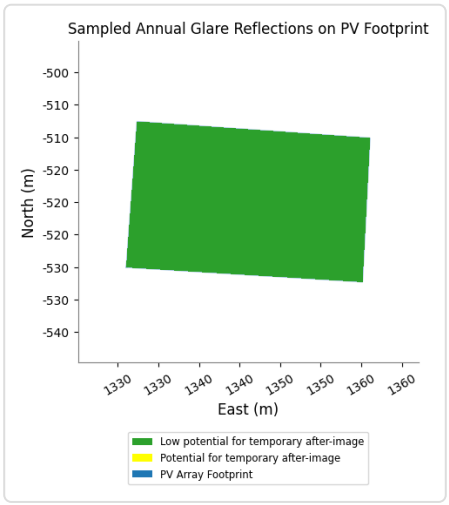
Green glare: 68,753 min.







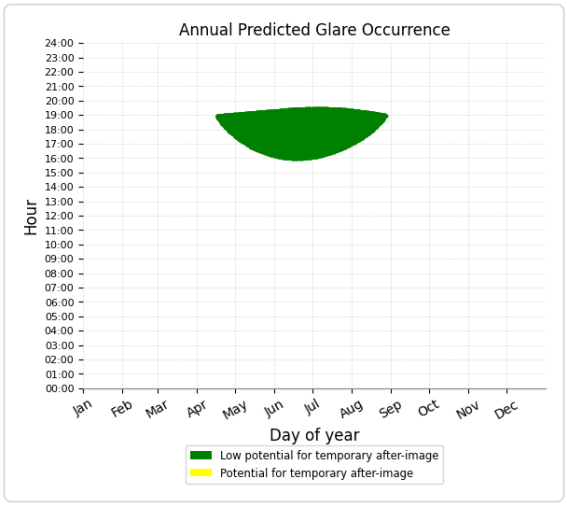


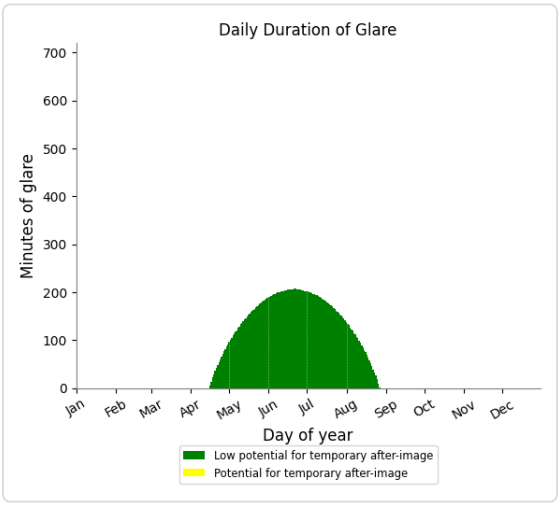


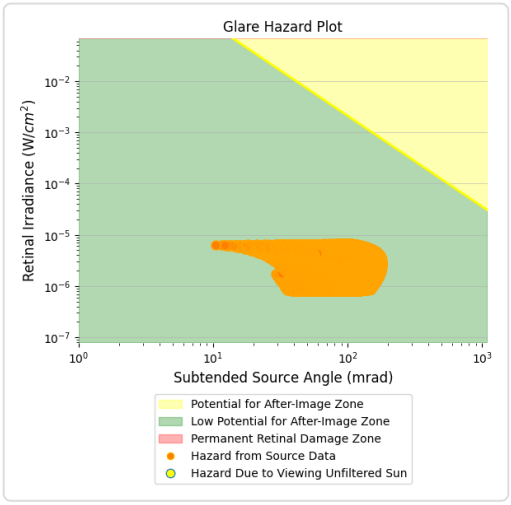
UV-12 and Route: N198 ri west

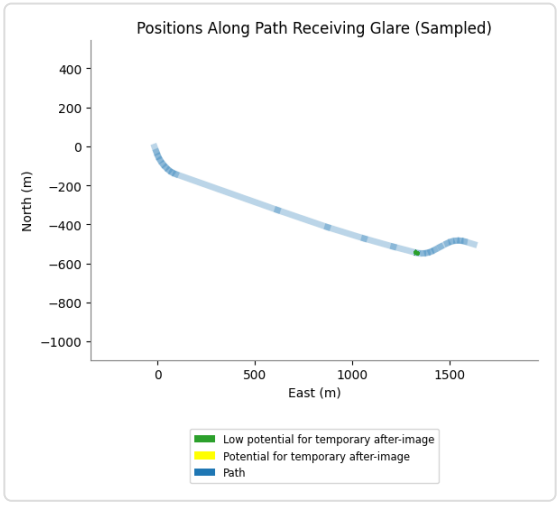
Yellow glare: none

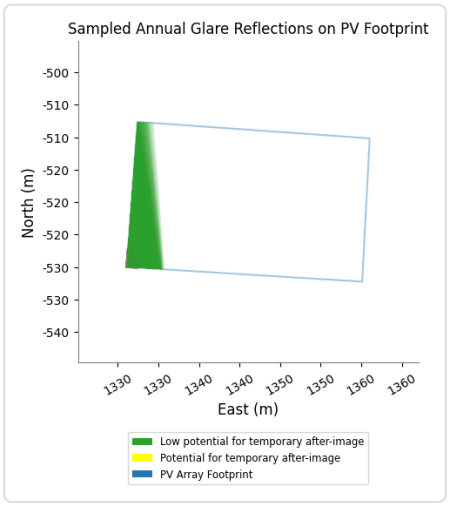
Green glare: 19,129 min.











UV-12 and Route: N419 ri oost

No glare found

UV-12 and Route: N419 ri west

No glare found

PV: UV-13 low potential for temporary after-image

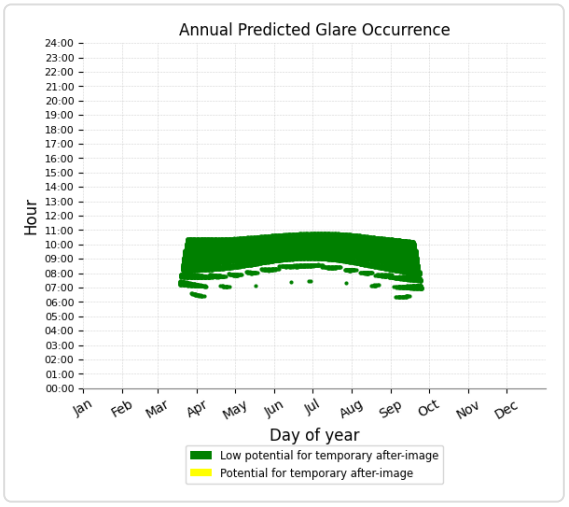
Receptor results ordered by category of glare

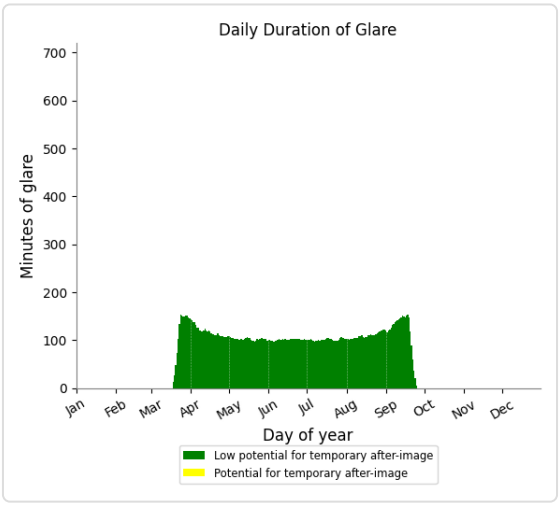
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	20,857	347.6	0	0.0
A12 ri west	47,175	786.2	0	0.0
N198 ri oost	5,354	89.2	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

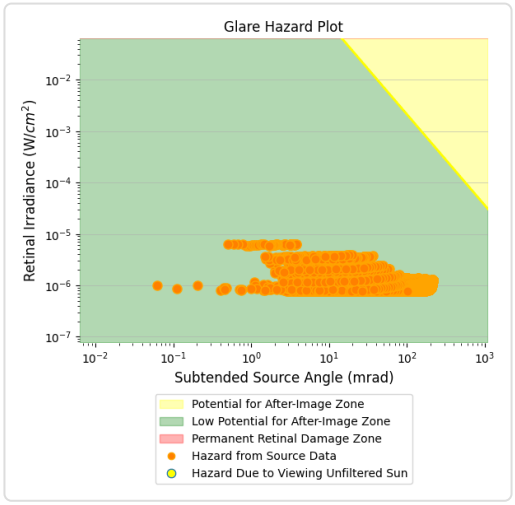
UV-13 and Route: A12 ri oost

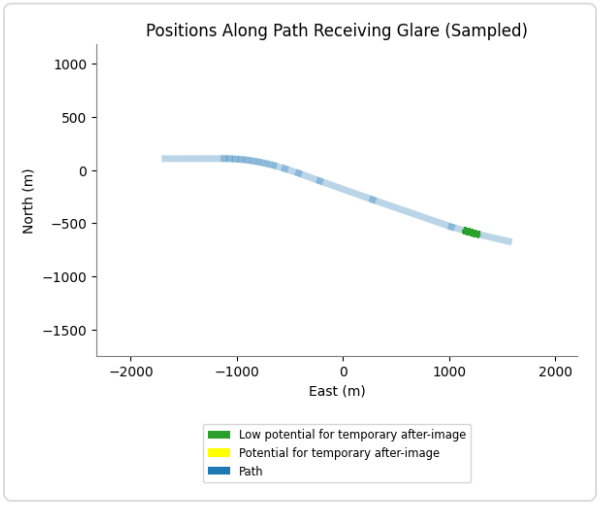
Yellow glare: none

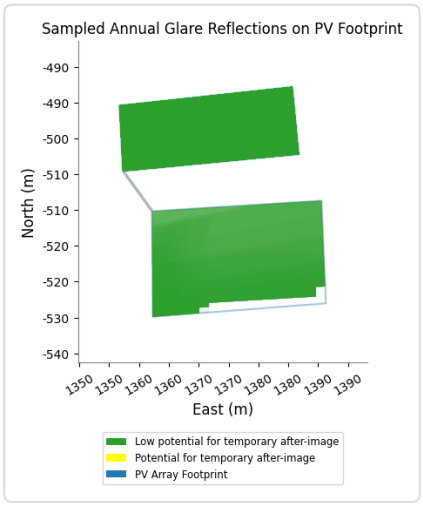
Green glare: 20,857 min.







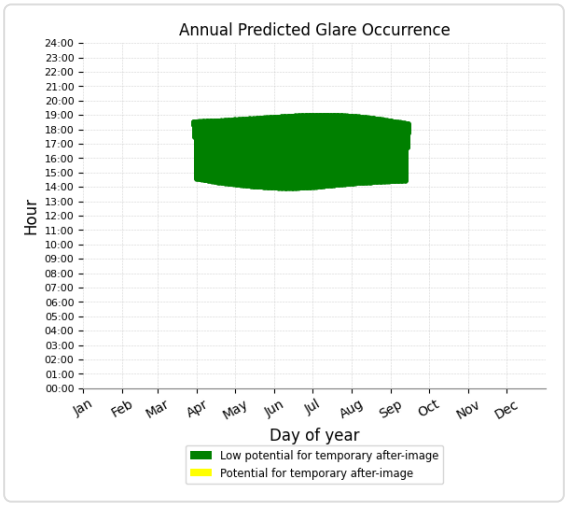


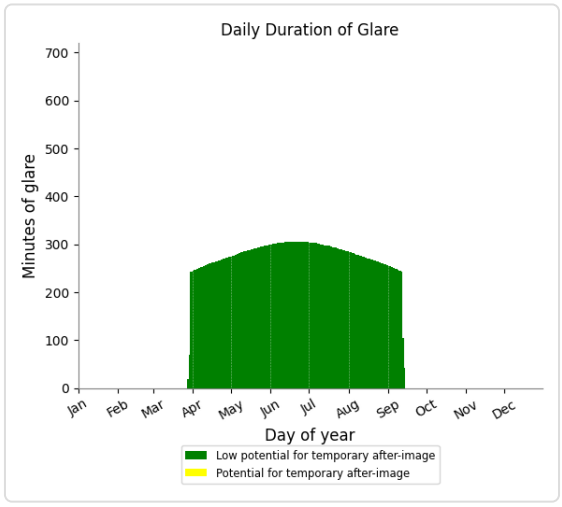


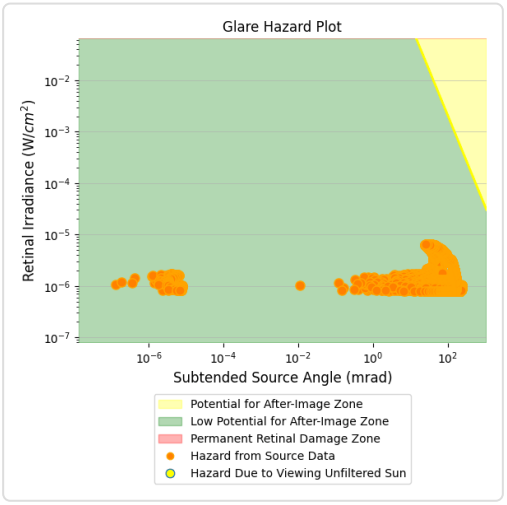
UV-13 and Route: A12 ri west

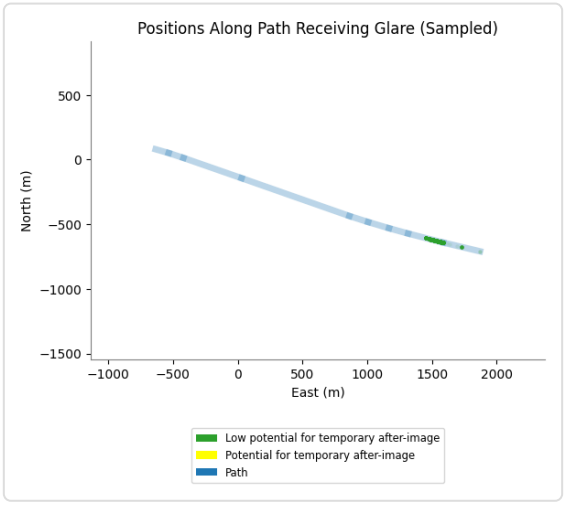
Yellow glare: none

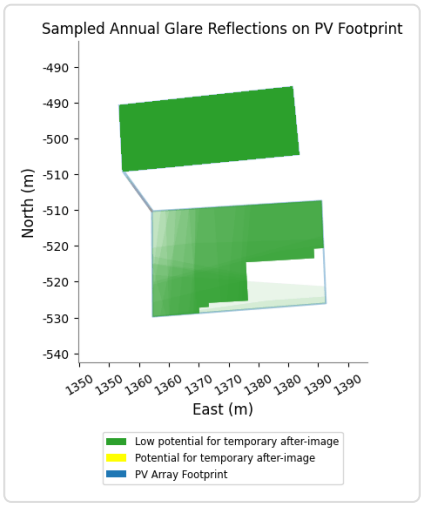
Green glare: 47,175 min.







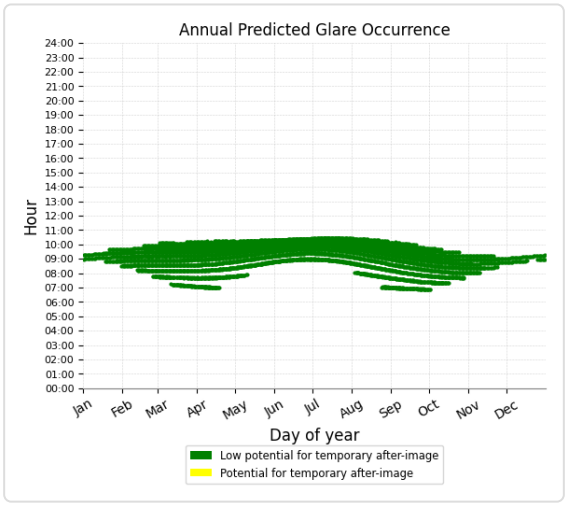


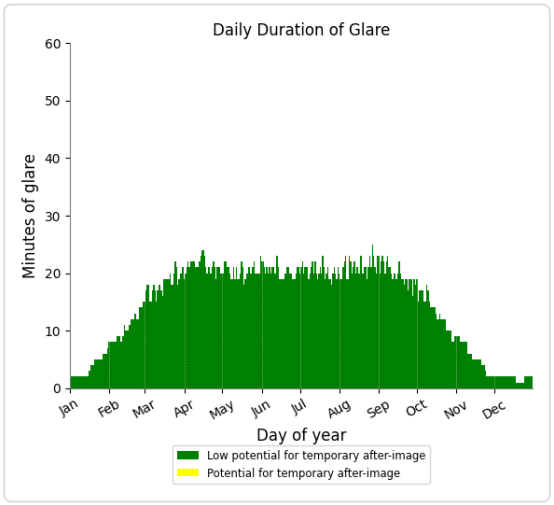


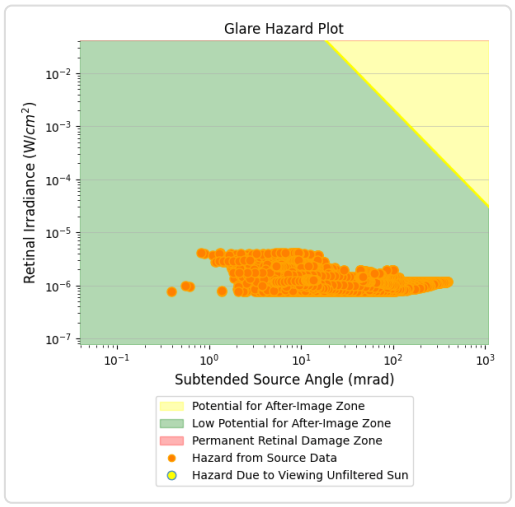
UV-13 and Route: N198 ri oost

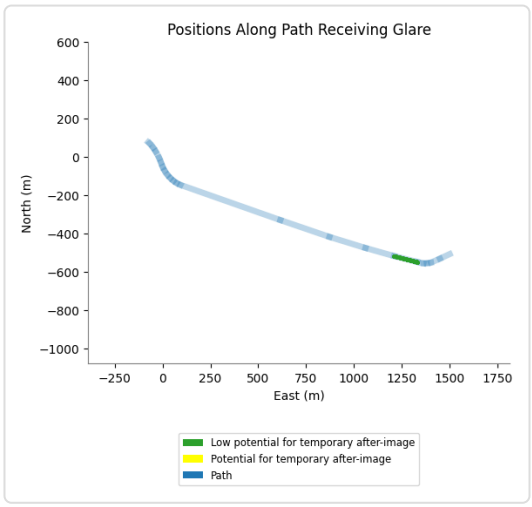
Yellow glare: none

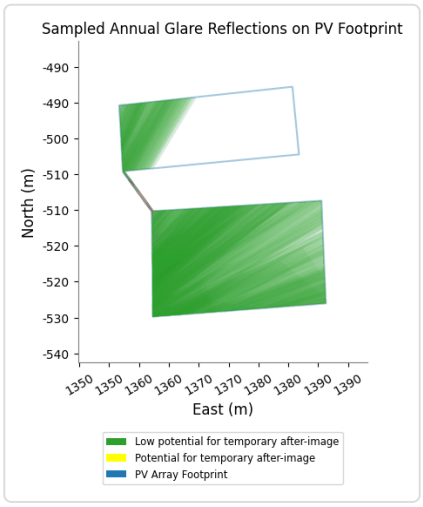
Green glare: 5,354 min.











UV-13 and Route: N198 ri west

No glare found

UV-13 and Route: N419 ri oost

No glare found

UV-13 and Route: N419 ri west

No glare found

PV: UV-14 low potential for temporary after-image

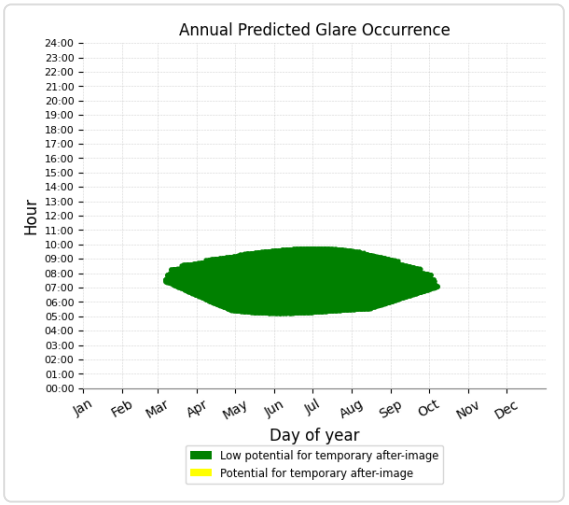
Receptor results ordered by category of glare

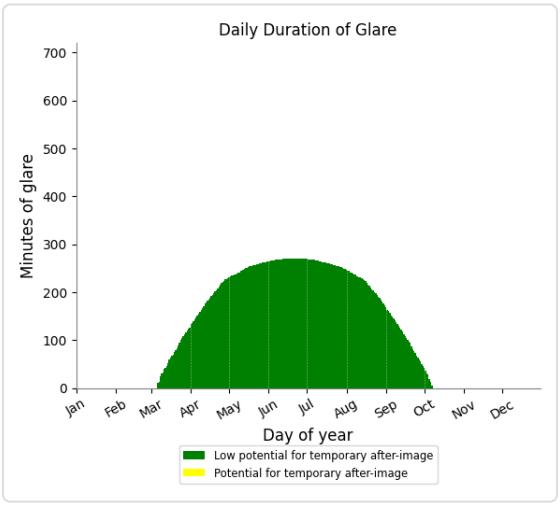
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	41,559	692.6	0	0.0
A12 ri west	38,760	646.0	0	0.0
N198 ri west	38,167	636.1	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

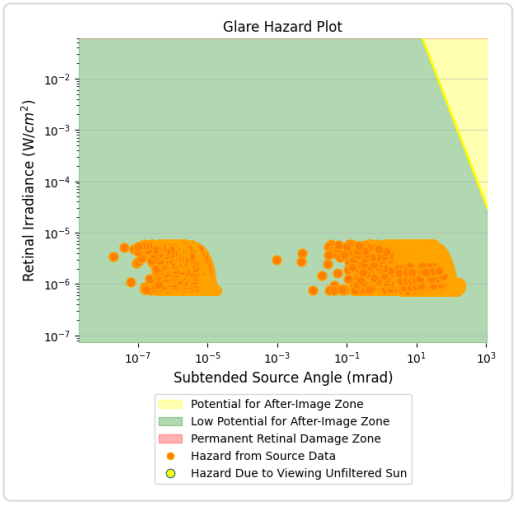
UV-14 and Route: A12 ri oost

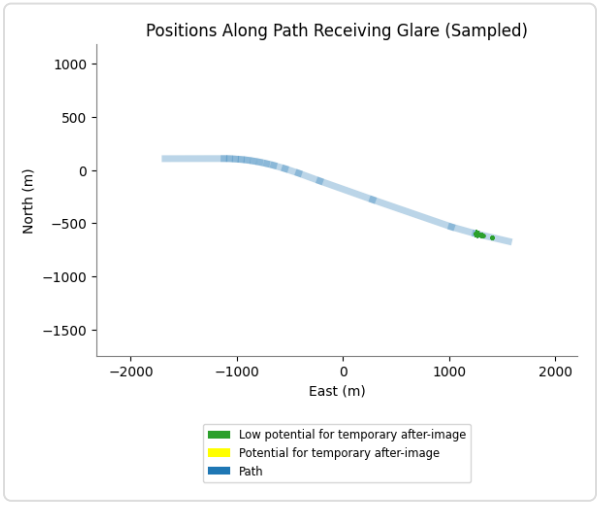
Yellow glare: none

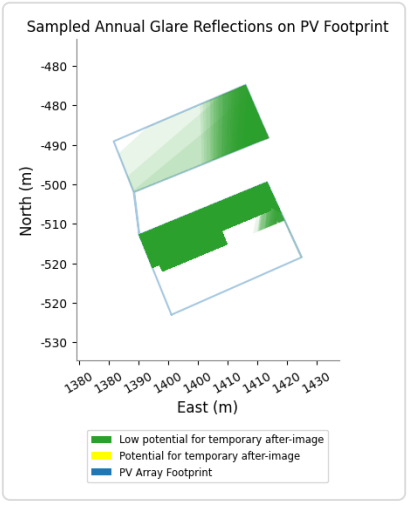
Green glare: 41,559 min.







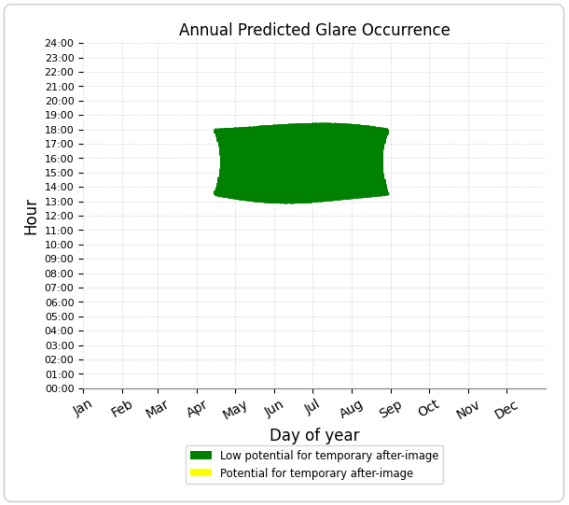


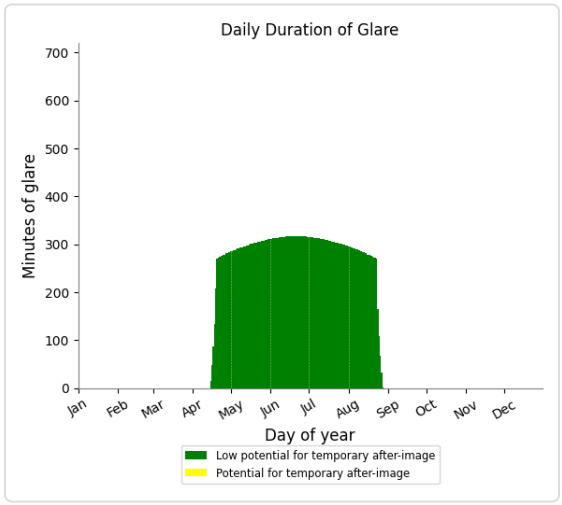


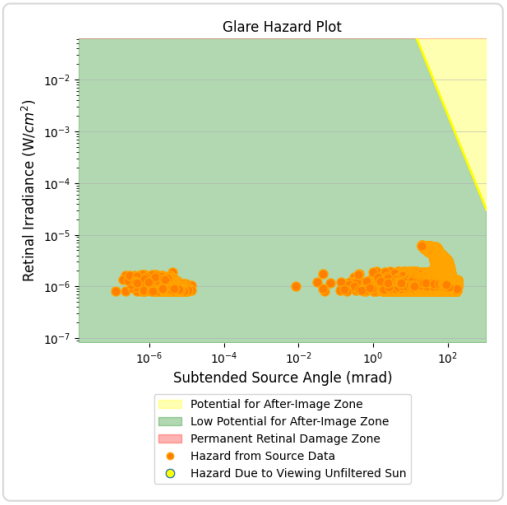
UV-14 and Route: A12 ri west

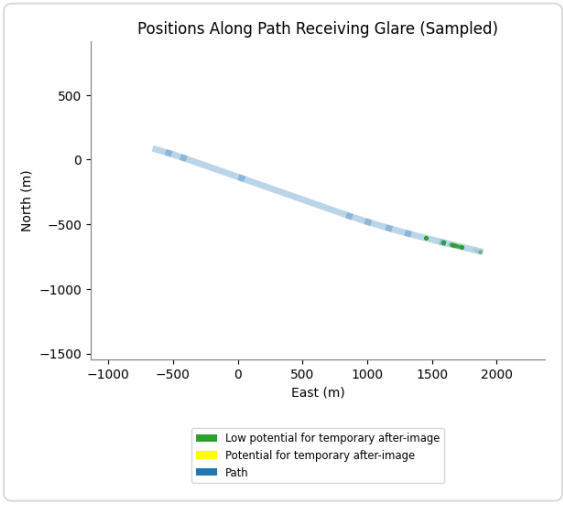
Yellow glare: none

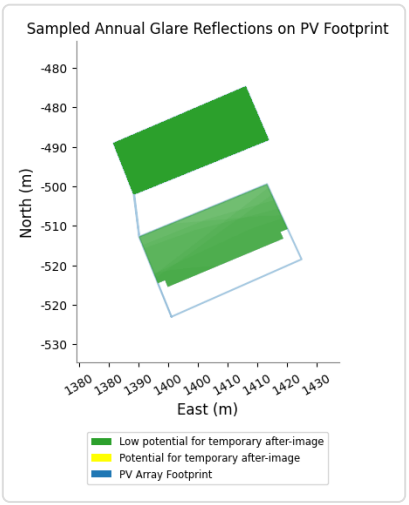
Green glare: 38,760 min.







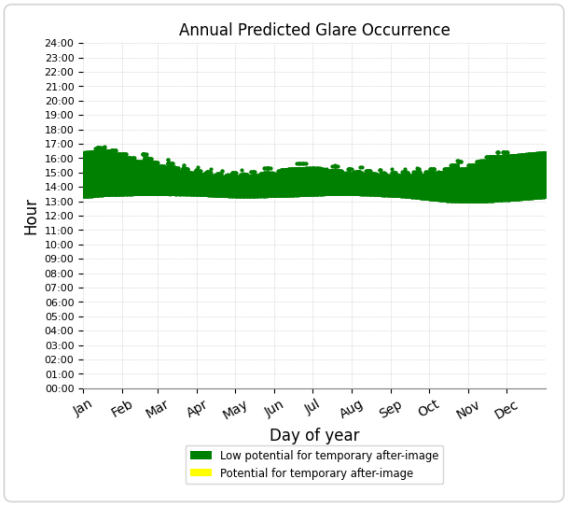


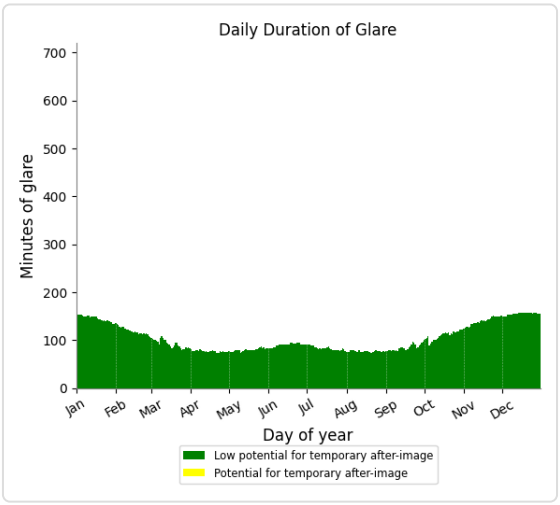


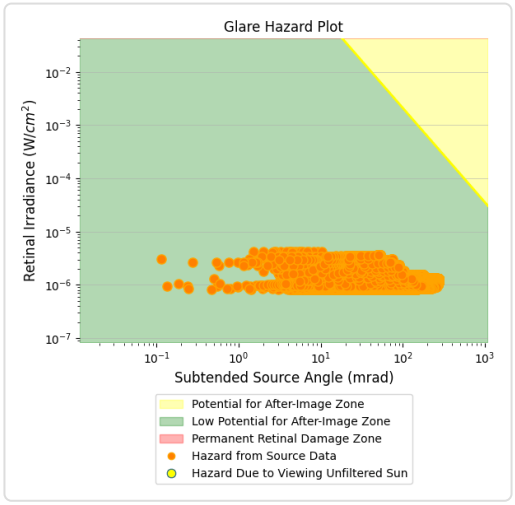
UV-14 and Route: N198 ri west

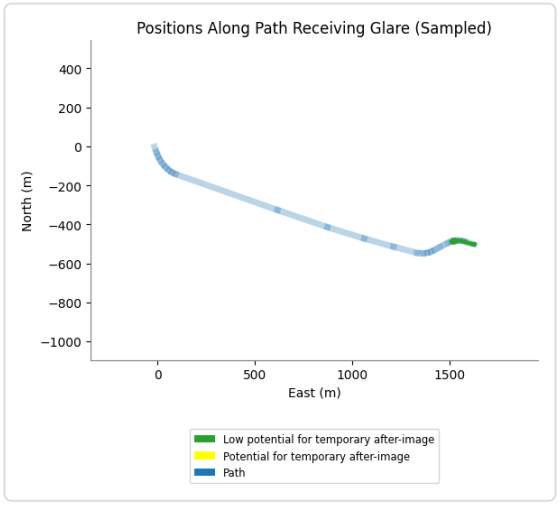
Yellow glare: none

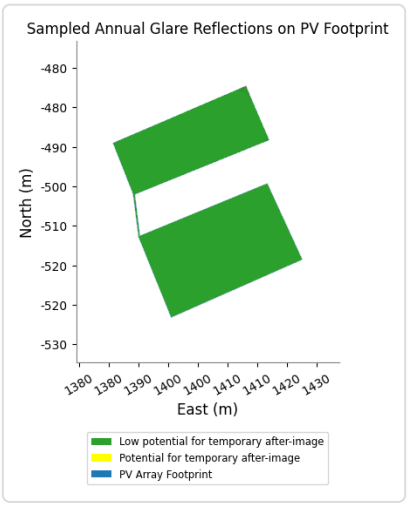
Green glare: 38,167 min.











UV-14 and Route: N198 ri oost

No glare found

UV-14 and Route: N419 ri oost

No glare found

UV-14 and Route: N419 ri west

No glare found

PV: UV-15 low potential for temporary after-image

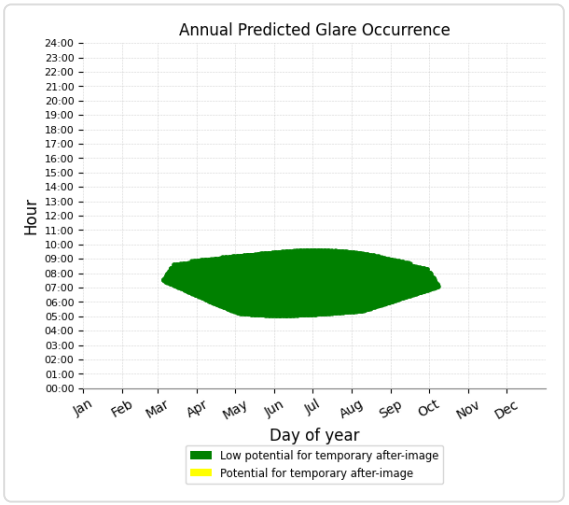
Receptor results ordered by category of glare

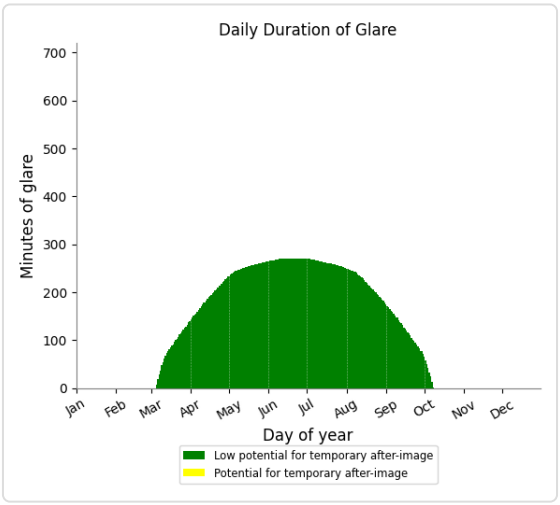
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	42,930	715.5	0	0.0
A12 ri west	37,123	618.7	0	0.0
N198 ri west	58,518	975.3	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

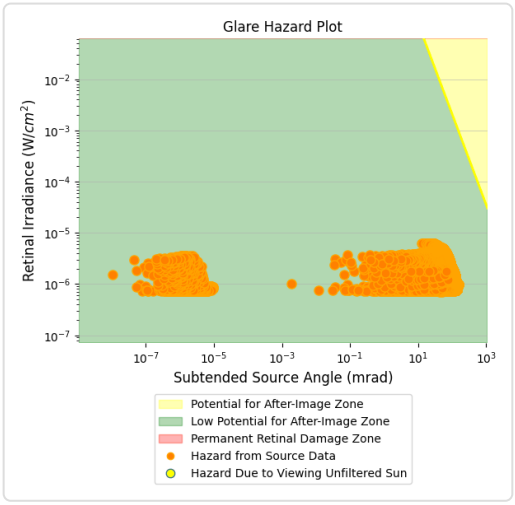
UV-15 and Route: A12 ri oost

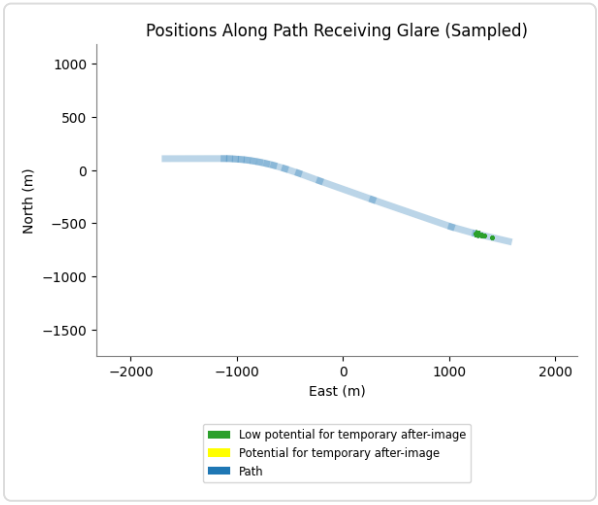
Yellow glare: none

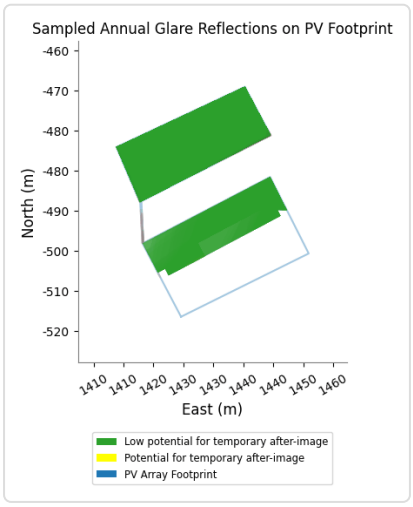
Green glare: 42,930 min.







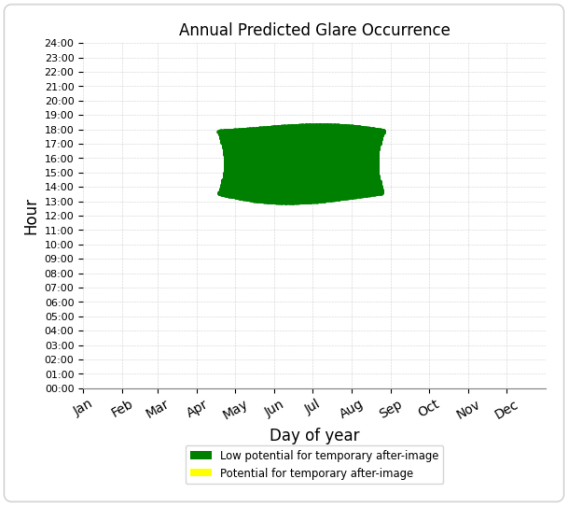


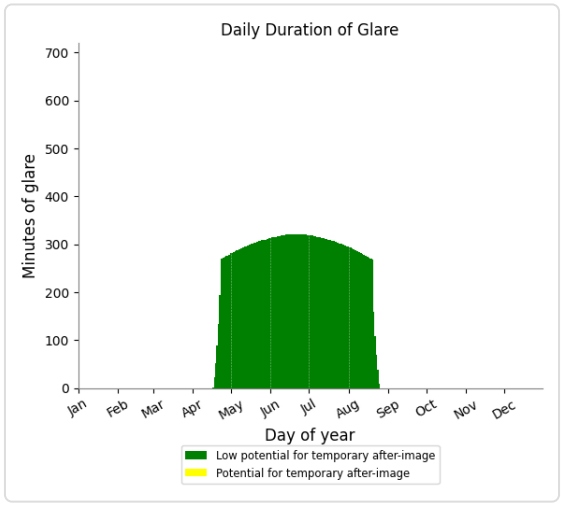


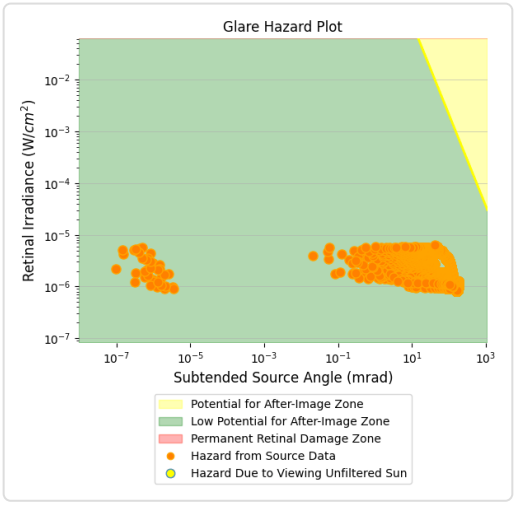
UV-15 and Route: A12 ri west

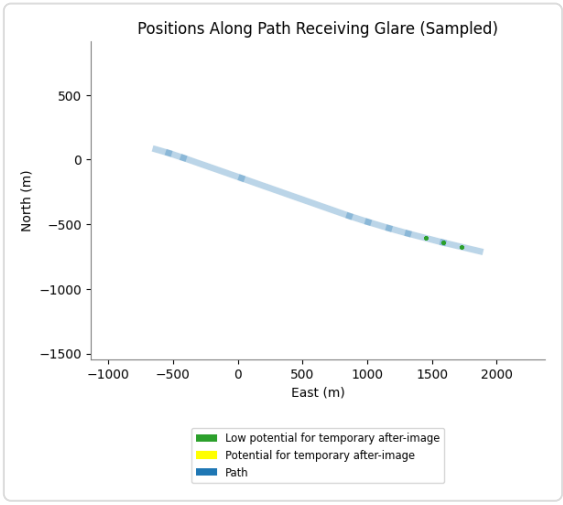
Yellow glare: none

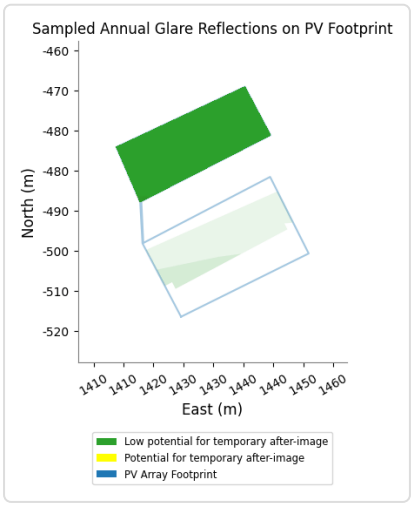
Green glare: 37,123 min.







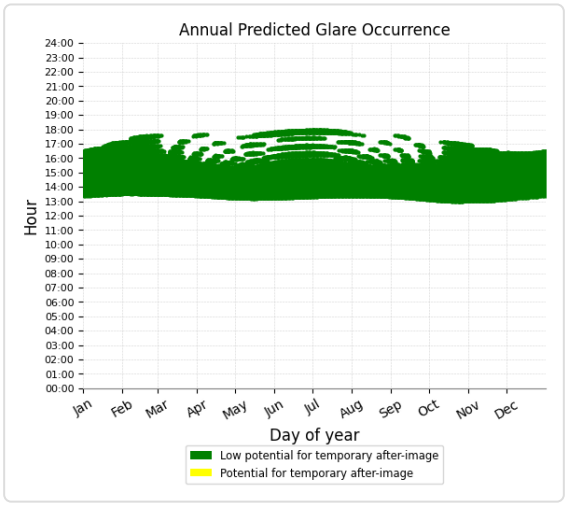


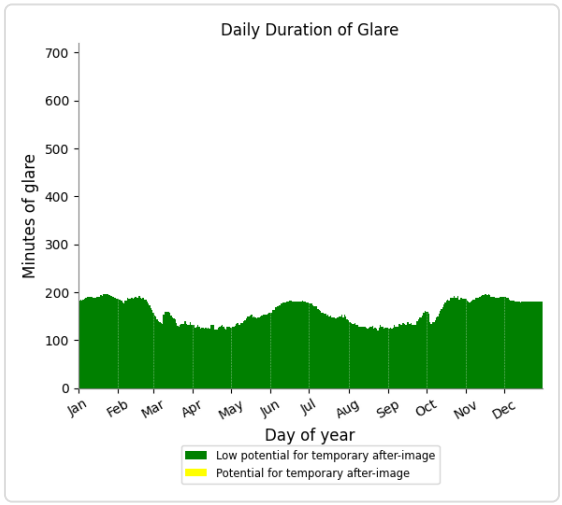


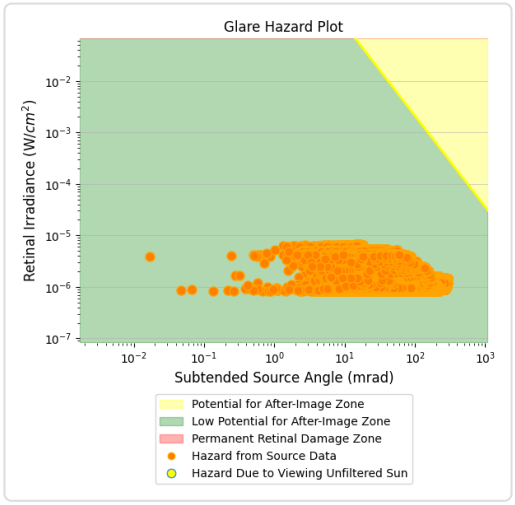
UV-15 and Route: N198 ri west

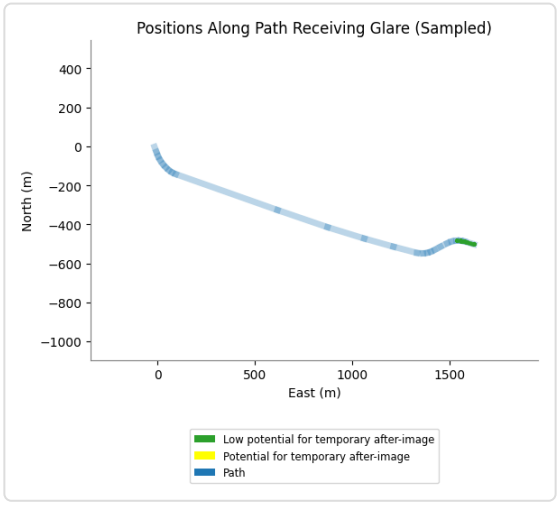
Yellow glare: none

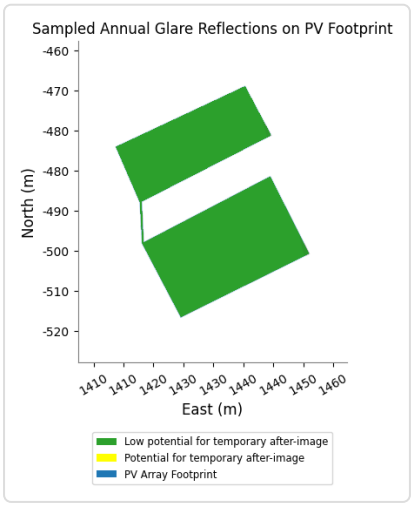
Green glare: 58,518 min.











UV-15 and Route: N198 ri oost

No glare found

UV-15 and Route: N419 ri oost

No glare found

UV-15 and Route: N419 ri west

No glare found

PV: UV-16 low potential for temporary after-image

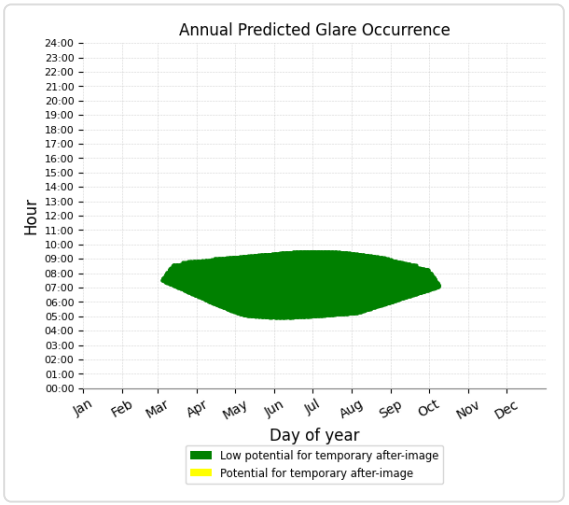
Receptor results ordered by category of glare

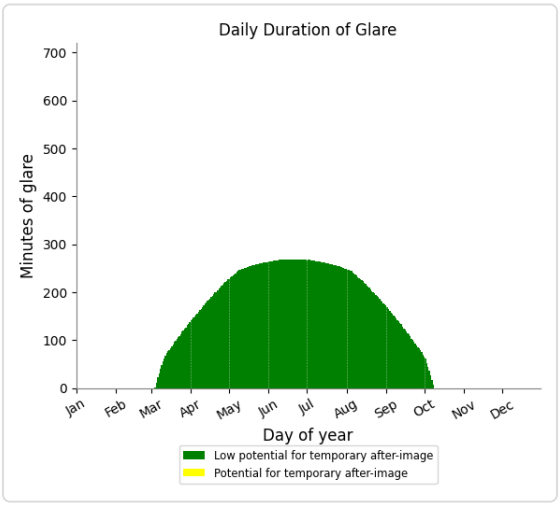
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	42,450	707.5	0	0.0
A12 ri west	35,340	589.0	0	0.0
N198 ri west	72,989	1,216.5	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

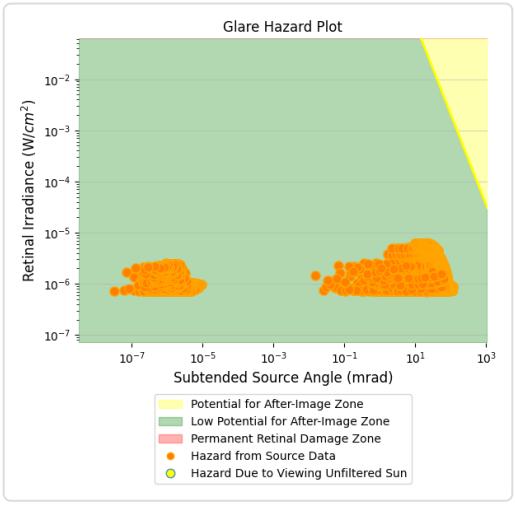
UV-16 and Route: A12 ri oost

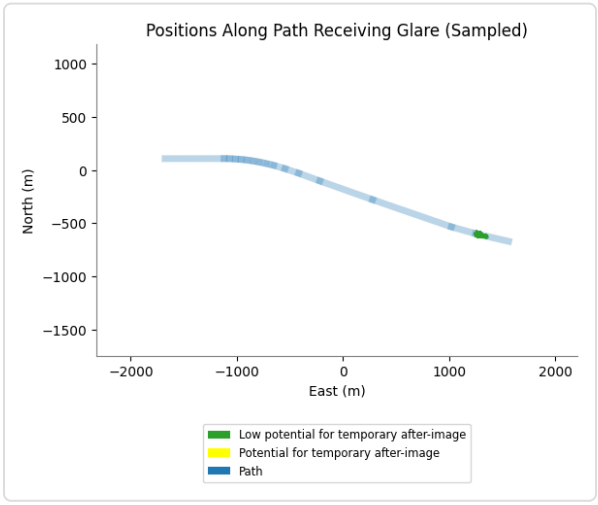
Yellow glare: none

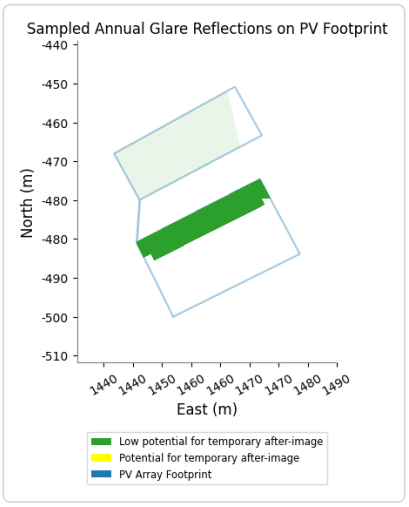
Green glare: 42,450 min.







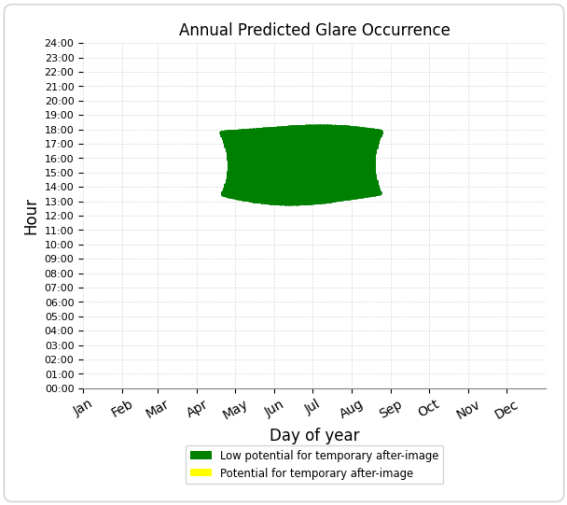


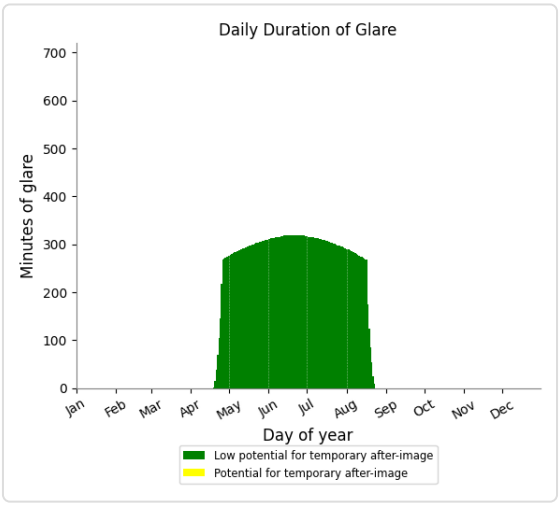


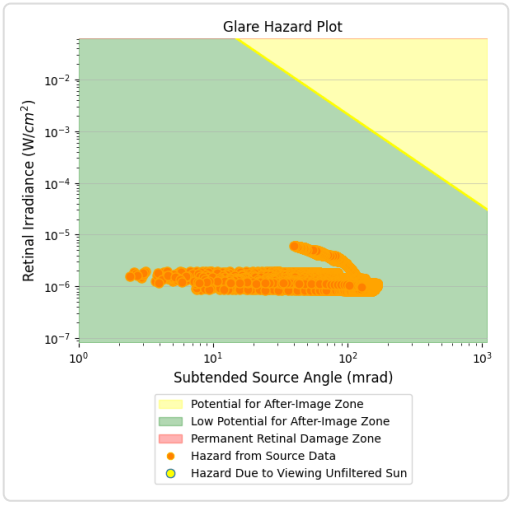
UV-16 and Route: A12 ri west

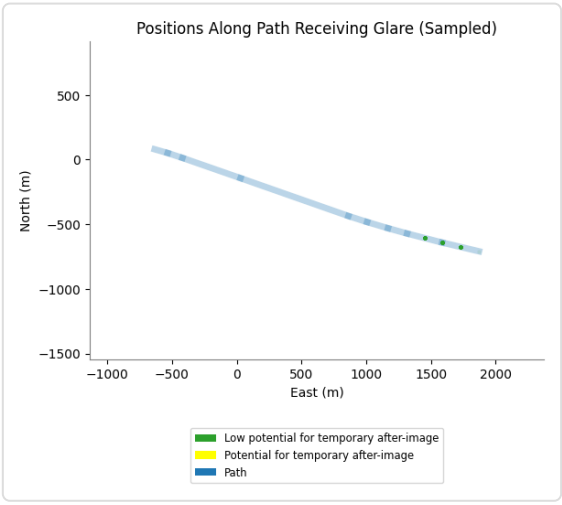
Yellow glare: none

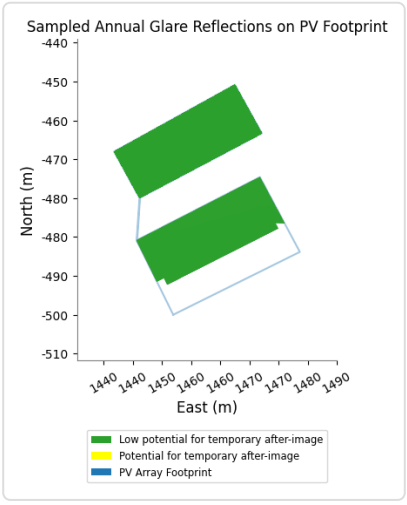
Green glare: 35,340 min.







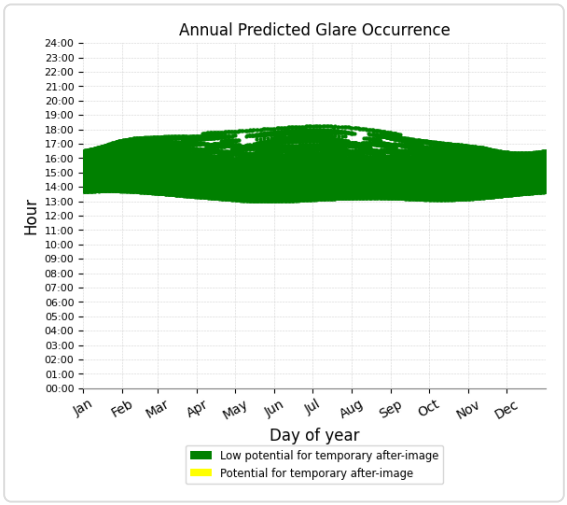


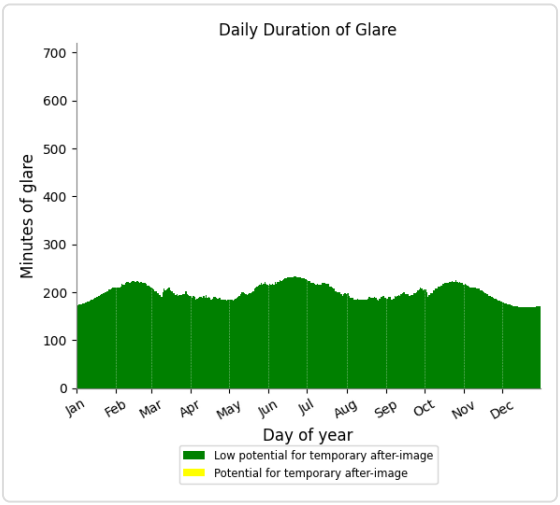


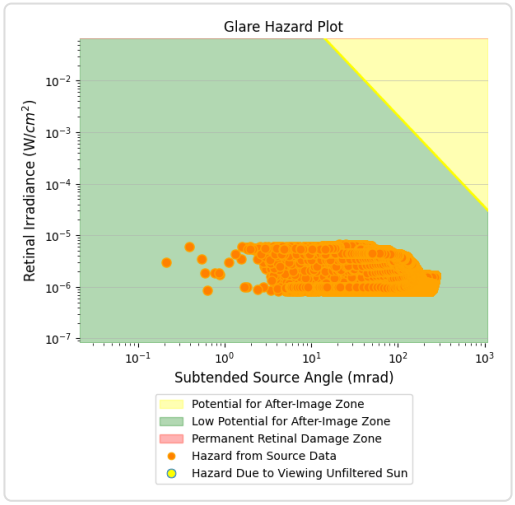
UV-16 and Route: N198 ri west

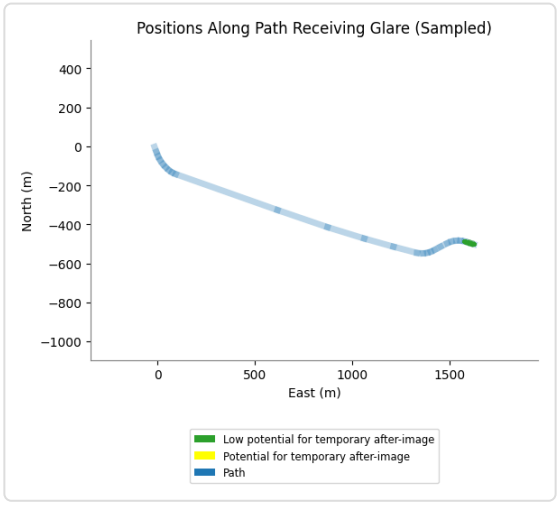
Yellow glare: none

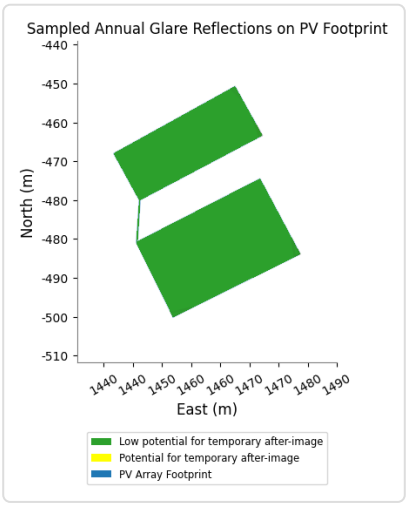
Green glare: 72,989 min.











UV-16 and Route: N198 ri oost

No glare found

UV-16 and Route: N419 ri oost

No glare found

UV-16 and Route: N419 ri west

No glare found

PV: Woerden low potential for temporary after-image

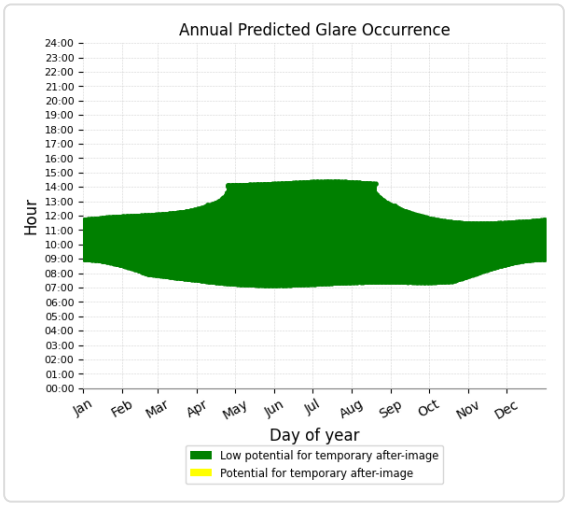
Receptor results ordered by category of glare

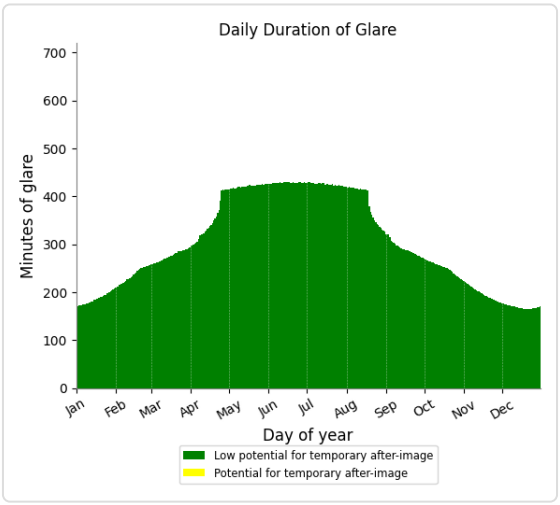
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	110,176	1,836.3	0	0.0
A12 ri west	82,109	1,368.5	0	0.0
N198 ri west	2,584	43.1	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

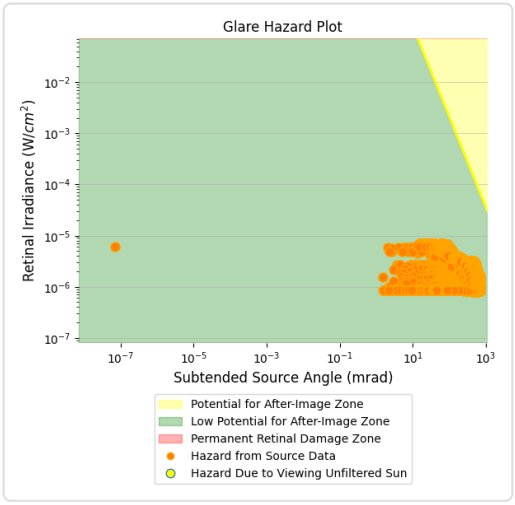
Woerden and Route: A12 ri oost

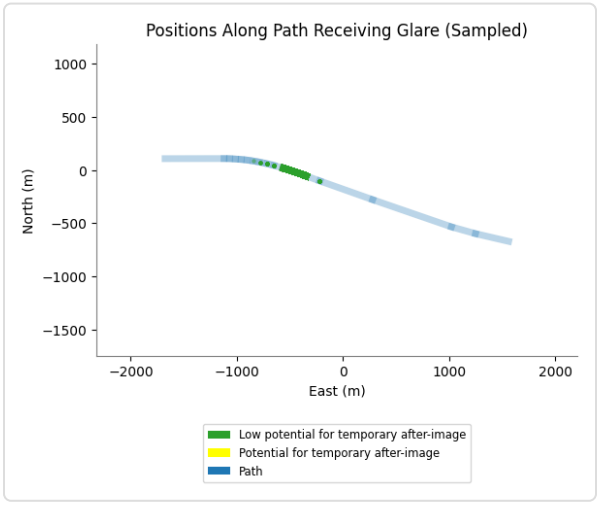
Yellow glare: none

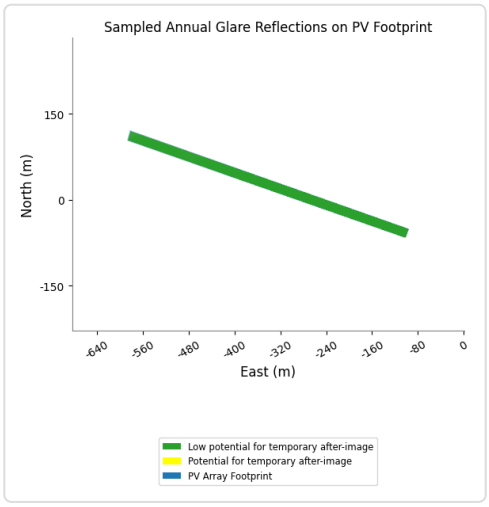
Green glare: 110,176 min.







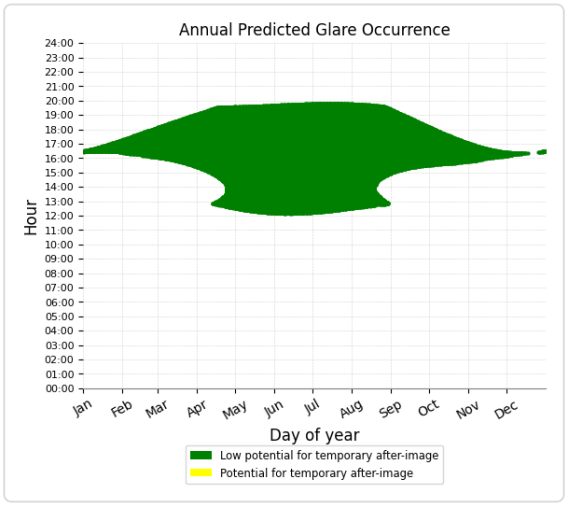


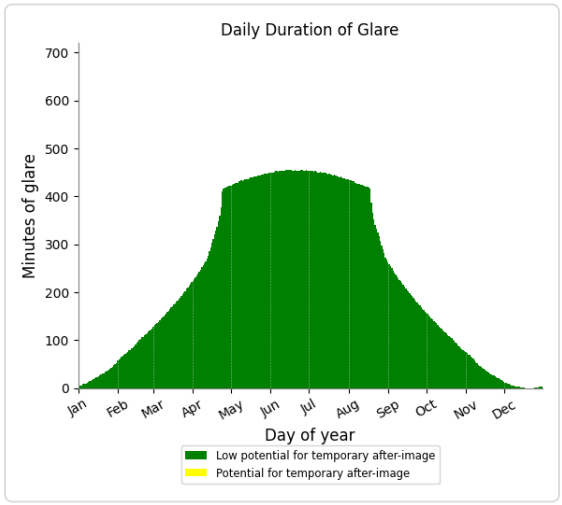


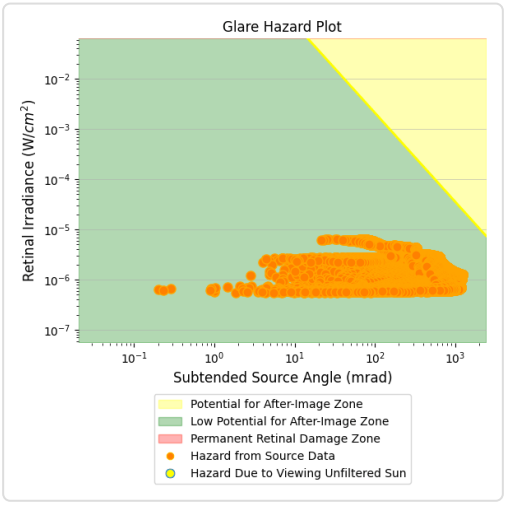
Woerden and Route: A12 ri west

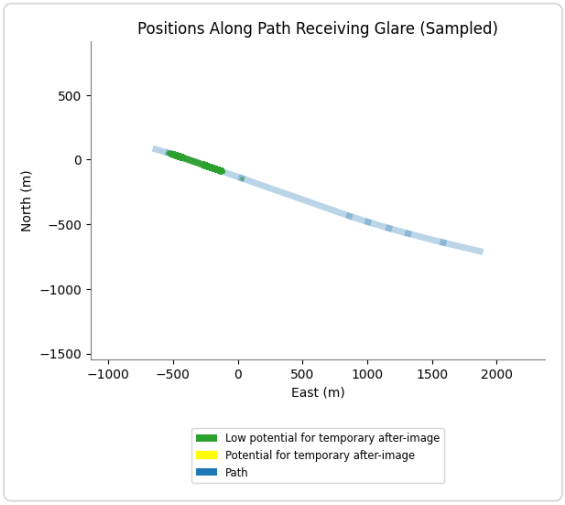
Yellow glare: none

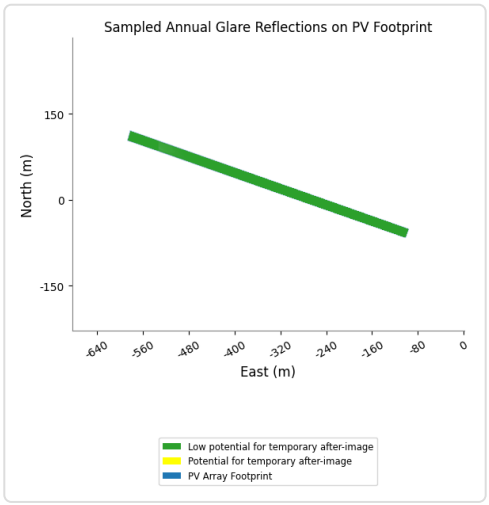
Green glare: 82,109 min.







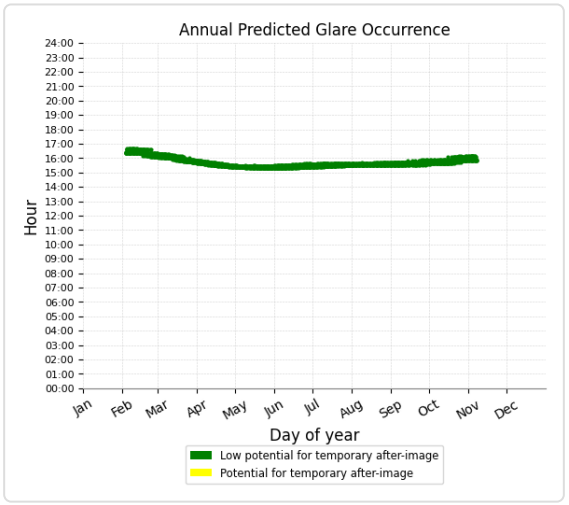


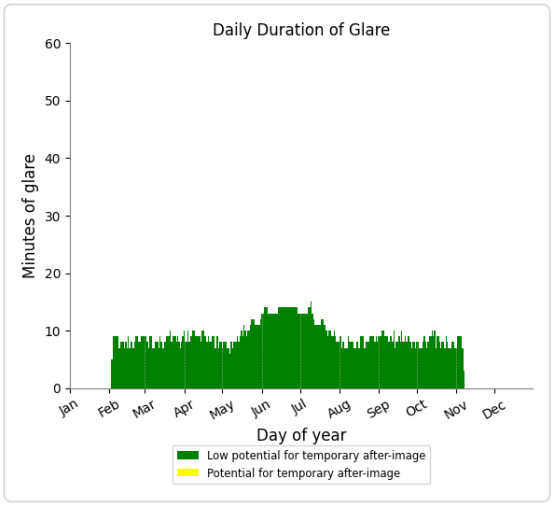


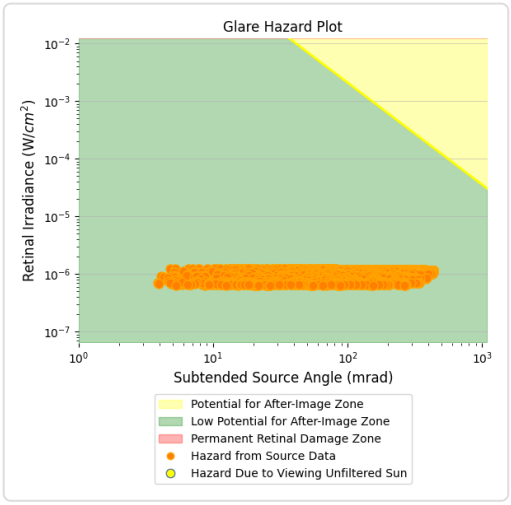
Woerden and Route: N198 ri west

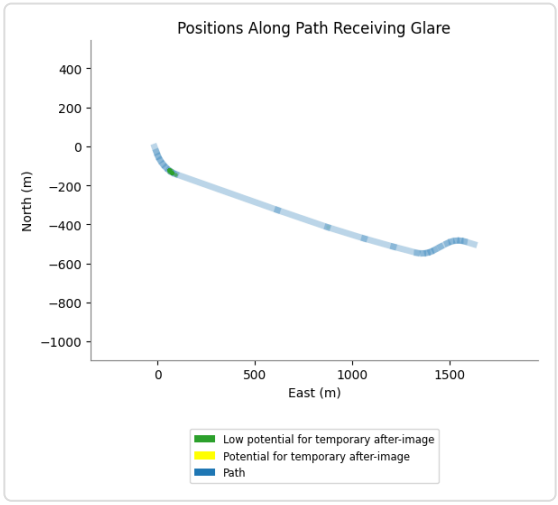
Yellow glare: none

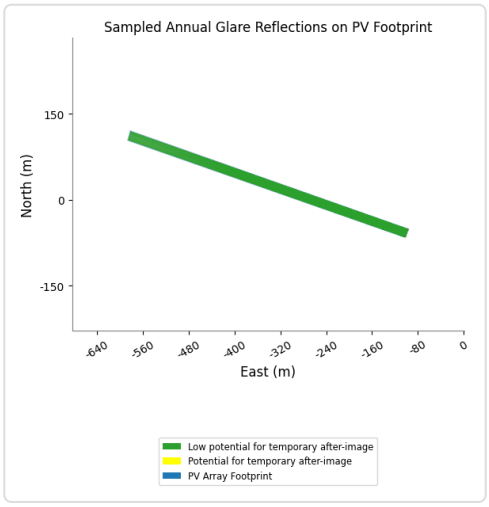
Green glare: 2,584 min.











Woerden and Route: N198 ri oost

No glare found

Woerden and Route: N419 ri oost

No glare found

Woerden and Route: N419 ri west

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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This analysis was conducted using the best available radiometric modeling at the time of generation. Future updates to the modeling methodology may yield different results.

FORGESOLAR GLARE ANALYSIS

Project: **Geluidswal A12**

Sweco heeft plannen voor een zonnepanelen op een geluidswal aangeleverd aan ROM3D. De geluidswal ligt langs de A12, in twee delen nabij Woerden en Utrecht – Veldhuizen. Eventuele reflectiehinder veroorzaakt door dit park kan inzichtelijk worden gemaakt met een reflectiestudie. Er is gevraagd om een dergelijke studie uit te voeren om de schittering te bepalen voor weggebruikers van de A12 en de N198 en de N419. Het te realiseren zonnepark ligt ten noorden van de A12. Voor het reflectieonderzoek zal ROM3D uitgaan van eigenschappen zoals aangeleverd door de opdrachtgever.

Site configuration: **Vrachtwagenchauffeurs - SG**
Calculated via ForgeSolar Radiometric Physics Engine v3.2.1

Client: Sweco

Created 13 Jul, 2026
Updated 13 Jul, 2026
Time-step 1 minute
Timezone offset UTC1
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 1 MW to 5 MW
Site ID 182853.29739

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Min luminance threshold 5,000 cd/m^2

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	20,174	336.2	5,364	89.4	-
UV-02	25.0	241.68	15,091	251.5	6,532	108.9	-
UV-03	25.0	233.48	10,369	172.8	9,366	156.1	-
UV-04	25.0	225.18	15,475	257.9	9,074	151.2	-
UV-05	25.0	202.75	15,738	262.3	8,062	134.4	-
UV-06	25.0	204.1	15,821	263.7	8,378	139.6	-
UV-07	25.0	197.55	11,807	196.8	12,415	206.9	-
UV-08	25.0	195.26	12,401	206.7	11,903	198.4	-
UV-09	25.0	192.6	12,886	214.8	9,782	163.0	-
UV-10	25.0	189.34	12,163	202.7	2,893	48.2	-
UV-11	25.0	184.09	7,432	123.9	1,509	25.1	-
UV-12	25.0	181.74	9,575	159.6	6,020	100.3	-
UV-13	25.0	174.0	7,395	123.2	3,826	63.8	-
UV-14	25.0	154.86	5,737	95.6	672	11.2	-
UV-15	25.0	152.49	4,869	81.2	3,041	50.7	-
UV-16	25.0	150.5	3,745	62.4	3,651	60.9	-
Woerden	35.0	197.87	11,853	197.6	1,834	30.6	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	68,034	1,133.9	4,963	82.7
A12 ri west	24,663	411.1	4,135	68.9
N198 ri oost	54,652	910.9	76,185	1,269.8
N198 ri west	17,335	288.9	18,557	309.3
N419 ri oost	27,847	464.1	482	8.0
N419 ri west	0	0.0	0	0.0

Component Data

PV Arrays

Name: UV-01
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 259.2°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079394	5.002834	1.80	1.00	2.80
2	52.079414	5.003086	8.90	1.00	9.90
3	52.079165	5.003165	8.90	1.00	9.90
4	52.079133	5.002909	1.80	1.00	2.80

Name: UV-02
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 241.68°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079089	5.002938	1.80	1.00	2.80
2	52.079160	5.003172	8.90	1.00	9.90
3	52.078925	5.003359	8.90	1.00	9.90
4	52.078846	5.003115	1.80	1.00	2.80

Name: UV-03
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 233.48°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078921	5.003362	8.90	1.00	9.90
2	52.078714	5.003589	8.90	1.00	9.90
3	52.078621	5.003381	1.80	1.00	2.80
4	52.078821	5.003140	1.80	1.00	2.80

Name: UV-04
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 225.18°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078709	5.003596	8.90	1.00	9.90
2	52.078528	5.003883	8.90	1.00	9.90
3	52.078416	5.003701	1.80	1.00	2.80
4	52.078600	5.003403	1.80	1.00	2.80

Name: UV-05
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 202.75°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078514	5.003900	8.90	1.00	9.90
2	52.078381	5.003765	1.80	1.00	2.80
3	52.078243	5.004127	1.80	1.00	2.80
4	52.078381	5.004253	8.90	1.00	9.90

Name: UV-06
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 204.1°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078369	5.004292	8.90	1.00	9.90
2	52.078224	5.004187	1.80	1.00	2.80
3	52.078116	5.004577	1.80	1.00	2.80
4	52.078262	5.004685	8.90	1.00	9.90

Name: UV-07
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 197.55°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078252	5.004723	8.90	1.00	9.90
2	52.078105	5.004623	1.80	1.00	2.80
3	52.075796	5.015377	1.80	1.00	2.80
4	52.075952	5.015472	8.90	1.00	9.90

Name: UV-08
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 195.26°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.075783	5.015424	1.80	1.00	2.80
2	52.075941	5.015508	8.90	1.00	9.90
3	52.075166	5.019634	8.90	1.00	9.90
4	52.075013	5.019572	1.80	1.00	2.80

Name: UV-09
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 192.6°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074996	5.019648	1.80	1.00	2.80
2	52.075298	5.019780	13.20	1.00	14.20
3	52.074991	5.021772	13.20	1.00	14.20
4	52.074895	5.021732	10.70	1.00	11.70
5	52.075209	5.019742	10.70	1.00	11.70
6	52.075150	5.019719	8.90	1.00	9.90
7	52.074833	5.021708	8.90	1.00	9.90
8	52.074676	5.021644	1.80	1.00	2.80

Name: UV-10
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 189.34°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074664	5.021722	1.80	1.00	2.80
2	52.074982	5.021799	13.20	1.00	14.20
3	52.074937	5.022221	13.20	1.00	14.20
4	52.074836	5.022191	10.70	1.00	11.70
5	52.074886	5.021778	10.70	1.00	11.70
6	52.074822	5.021763	8.90	1.00	9.90
7	52.074777	5.022181	8.90	1.00	9.90
8	52.074615	5.022144	1.80	1.00	2.80

Name: UV-11
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 184.09°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074834	5.022217	10.70	1.00	11.70
2	52.074935	5.022232	13.20	1.00	14.20
3	52.074915	5.022546	13.20	1.00	14.20
4	52.074816	5.022533	10.70	1.00	11.70

Name: UV-12
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 181.74°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074614	5.022176	1.80	1.00	2.80
2	52.074775	5.022196	8.90	1.00	9.90
3	52.074757	5.022614	8.90	1.00	9.90
4	52.074598	5.022600	1.80	1.00	2.80

Name: UV-13
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 174.0°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074915	5.022550	13.20	1.00	14.20
2	52.074816	5.022559	10.70	1.00	11.70
3	52.074756	5.022630	8.90	1.00	9.90
4	52.074597	5.022632	1.80	1.00	2.80
5	52.074618	5.023055	1.80	1.00	2.80
6	52.074772	5.023044	8.90	1.00	9.90
7	52.074756	5.022633	8.90	1.00	9.90
8	52.074816	5.022561	10.70	1.00	11.70
9	52.074842	5.022989	10.70	1.00	11.70
10	52.074944	5.022973	13.20	1.00	14.20

Name: UV-14
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 154.86°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074628	5.023148	1.80	1.00	2.80
2	52.074774	5.023052	8.90	1.00	9.90
3	52.074852	5.023036	10.70	1.00	11.70
4	52.074944	5.022977	13.20	1.00	14.20
5	52.075047	5.023366	13.20	1.00	14.20
6	52.074951	5.023433	10.70	1.00	11.70
7	52.074852	5.023038	10.70	1.00	11.70
8	52.074774	5.023053	8.90	1.00	9.90
9	52.074870	5.023429	8.90	1.00	9.90
10	52.074733	5.023531	1.80	1.00	2.80

Name: UV-15
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 152.49°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074747	5.023569	1.80	1.00	2.80
2	52.074879	5.023456	8.90	1.00	9.90
3	52.074953	5.023449	10.70	1.00	11.70
4	52.075052	5.023380	13.20	1.00	14.20
5	52.075161	5.023755	13.20	1.00	14.20
6	52.075074	5.023830	10.70	1.00	11.70
7	52.074954	5.023453	10.70	1.00	11.70
8	52.074880	5.023458	8.90	1.00	9.90
9	52.074999	5.023829	8.90	1.00	9.90
10	52.074861	5.023942	1.80	1.00	2.80

Name: UV-16
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 150.5°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074866	5.023959	1.80	1.00	2.80
2	52.075003	5.023849	8.90	1.00	9.90
3	52.075082	5.023858	10.70	1.00	11.70
4	52.075168	5.023782	13.20	1.00	14.20
5	52.075292	5.024144	13.20	1.00	14.20
6	52.075202	5.024226	10.70	1.00	11.70
7	52.075083	5.023860	10.70	1.00	11.70
8	52.075004	5.023851	8.90	1.00	9.90
9	52.075121	5.024220	8.90	1.00	9.90
10	52.074982	5.024340	1.80	1.00	2.80

Name: Woerden
Axis tracking: Fixed (no rotation)
Tilt: 35.0°
Orientation: 197.87°
Rated power: -
Panel material: Smooth glass with AR coating (revised)

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080468	4.994350	8.00	1.00	9.00
2	52.080330	4.994286	0.00	1.00	1.00
3	52.078807	5.001345	0.00	1.00	1.00
4	52.078932	5.001420	8.00	1.00	9.00

Route Receptors

Name: A12 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080355	4.978381	1.00	2.50	3.50
2	52.080361	4.986477	1.00	2.50	3.50
3	52.080353	4.987236	1.00	2.50	3.50
4	52.080321	4.988051	1.00	2.50	3.50
5	52.080287	4.988839	1.00	2.50	3.50
6	52.080232	4.989657	1.00	2.50	3.50
7	52.080152	4.990527	1.00	2.50	3.50
8	52.080056	4.991406	1.00	2.50	3.50
9	52.079931	4.992347	1.00	2.50	3.50
10	52.079788	4.993302	1.00	2.50	3.50
11	52.079504	4.994866	1.00	2.50	3.50
12	52.079123	4.996740	1.00	2.50	3.50
13	52.078467	4.999653	1.00	2.50	3.50
14	52.076884	5.006915	1.00	2.50	3.50
15	52.074587	5.017750	1.00	2.50	3.50
16	52.074013	5.021057	1.00	2.50	3.50
17	52.073363	5.025614	2.90	2.50	5.40

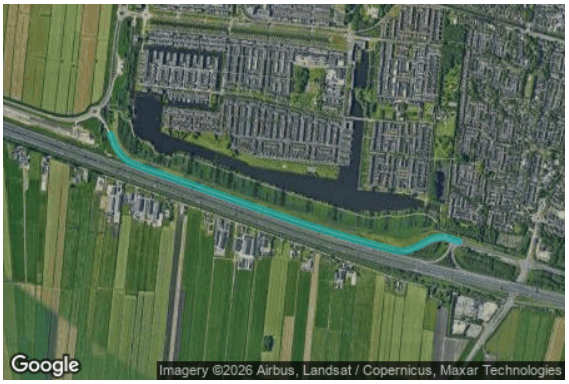
Name: A12 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.073024	5.030141	5.70	2.50	8.20
2	52.073632	5.025983	3.10	2.50	5.60
3	52.074258	5.022036	0.90	2.50	3.40
4	52.074627	5.019886	0.30	2.50	2.80
5	52.075057	5.017533	0.30	2.50	2.80
6	52.075477	5.015418	0.30	2.50	2.80
7	52.078108	5.003266	0.30	2.50	2.80
8	52.079515	4.996721	0.30	2.50	2.80
9	52.079856	4.995053	0.30	2.50	2.80
10	52.080115	4.993585	0.30	2.50	2.80

Name: N198 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080085	5.001737	-0.10	2.50	2.40
2	52.080033	5.001839	-0.10	2.50	2.40
3	52.079835	5.002108	-0.20	2.50	2.30
4	52.079653	5.002301	-0.20	2.50	2.30
5	52.079353	5.002564	-0.20	2.50	2.30
6	52.079129	5.002711	-0.20	2.50	2.30
7	52.078917	5.002845	-0.20	2.50	2.30
8	52.078747	5.002987	-0.20	2.50	2.30
9	52.078547	5.003213	-0.20	2.50	2.30
10	52.078402	5.003425	-0.20	2.50	2.30
11	52.078270	5.003666	-0.20	2.50	2.30
12	52.078170	5.003902	-0.20	2.50	2.30
13	52.078079	5.004197	-0.20	2.50	2.30
14	52.076426	5.011812	-0.20	2.50	2.30
15	52.075637	5.015559	-0.20	2.50	2.30
16	52.075116	5.018307	-0.20	2.50	2.30
17	52.074736	5.020489	-0.20	2.50	2.30
18	52.074459	5.022255	-0.20	2.50	2.30
19	52.074397	5.022726	0.00	2.50	2.50
20	52.074403	5.022983	0.10	2.50	2.60
21	52.074431	5.023301	0.10	2.50	2.60
22	52.074616	5.023981	0.20	2.50	2.70
23	52.074830	5.024727	0.60	2.50	3.10

Name: N198 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074878	5.026535	0.80	2.50	3.30
2	52.075013	5.025811	0.90	2.50	3.40
3	52.075044	5.025508	0.90	2.50	3.40
4	52.075046	5.025211	0.90	2.50	3.40
5	52.075008	5.024850	0.90	2.50	3.40
6	52.074927	5.024526	0.70	2.50	3.20
7	52.074765	5.024016	0.30	2.50	2.80
8	52.074624	5.023588	0.00	2.50	2.50
9	52.074537	5.023293	-0.10	2.50	2.40
10	52.074489	5.023027	-0.20	2.50	2.30
11	52.074463	5.022713	-0.20	2.50	2.30
12	52.074483	5.022262	-0.20	2.50	2.30
13	52.074768	5.020499	-0.20	2.50	2.30
14	52.075144	5.018318	-0.20	2.50	2.30
15	52.075667	5.015564	-0.20	2.50	2.30
16	52.076455	5.011826	-0.20	2.50	2.30
17	52.078113	5.004211	-0.20	2.50	2.30
18	52.078192	5.003935	-0.20	2.50	2.30
19	52.078291	5.003707	-0.20	2.50	2.30
20	52.078421	5.003473	-0.20	2.50	2.30
21	52.078568	5.003259	-0.20	2.50	2.30
22	52.078759	5.003042	-0.20	2.50	2.30
23	52.078929	5.002897	-0.20	2.50	2.30
24	52.079136	5.002763	-0.20	2.50	2.30
25	52.079367	5.002623	-0.20	2.50	2.30

Name: N419 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

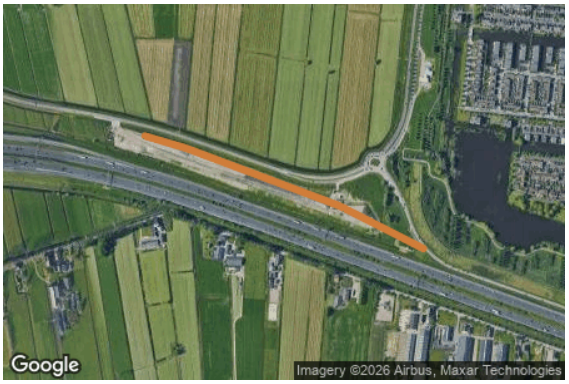
Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081519	4.989885	-0.60	2.50	1.90
2	52.081272	4.992168	-0.60	2.50	1.90
3	52.081193	4.992811	-0.60	2.50	1.90
4	52.080995	4.994115	-0.60	2.50	1.90
5	52.080769	4.995295	-0.60	2.50	1.90
6	52.080146	4.998197	-0.60	2.50	1.90
7	52.080033	4.998680	-0.60	2.50	1.90
8	52.079948	4.999080	-0.60	2.50	1.90
9	52.079892	4.999530	-0.60	2.50	1.90
10	52.079884	4.999975	-0.60	2.50	1.90
11	52.079911	5.000375	-0.60	2.50	1.90
12	52.079943	5.000638	-0.50	2.50	2.00
13	52.080009	5.000952	-0.40	2.50	2.10
14	52.080143	5.001405	-0.10	2.50	2.40
15	52.080123	5.001518	-0.10	2.50	2.40
16	52.080130	5.001668	-0.10	2.50	2.40
17	52.080163	5.001797	-0.10	2.50	2.40
18	52.080229	5.001885	-0.10	2.50	2.40
19	52.080351	5.001901	-0.10	2.50	2.40

Name: N419 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081289	5.002510	0.40	2.50	2.90
2	52.081097	5.002414	0.30	2.50	2.80
3	52.080891	5.002242	0.10	2.50	2.60
4	52.080703	5.002033	0.10	2.50	2.60
5	52.080552	5.001832	0.00	2.50	2.50
6	52.080494	5.001684	-0.10	2.50	2.40
7	52.080504	5.001545	-0.10	2.50	2.40
8	52.080487	5.001402	-0.10	2.50	2.40
9	52.080438	5.001298	-0.10	2.50	2.40
10	52.080324	5.001228	-0.10	2.50	2.40
11	52.080262	5.001174	-0.10	2.50	2.40
12	52.080202	5.001043	-0.30	2.50	2.20
13	52.080122	5.000756	-0.40	2.50	2.10
14	52.080047	5.000397	-0.50	2.50	2.00
15	52.080008	5.000016	-0.60	2.50	1.90
16	52.080013	4.999479	-0.60	2.50	1.90
17	52.080052	4.999013	-0.60	2.50	1.90
18	52.080156	4.998334	-0.60	2.50	1.90
19	52.080802	4.995308	-0.60	2.50	1.90
20	52.081030	4.994115	-0.60	2.50	1.90

Obstruction Components

Name: Geluidsscherm I en Talud
Top height: 8.80 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.080881	4.993642	0.00
2	52.080621	4.995064	0.00
3	52.079412	5.000313	0.00
4	52.078512	5.003205	0.00

Name: Geluidsscherm II
Top height: 4.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.074608	5.021008	0.00
2	52.074201	5.023580	0.00
3	52.074150	5.024043	0.00
4	52.074115	5.024569	0.00
5	52.074116	5.024735	0.00
6	52.074144	5.024934	0.00
7	52.074201	5.025140	0.00
8	52.074267	5.025320	0.00
9	52.074389	5.025528	0.00
10	52.074562	5.025741	0.00

Name: Geluidsscherm III
Top height: 7.00 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.073659	5.026506	0.00
2	52.073916	5.024693	0.00

Name: Geluidsscherm IV
Top height: 7.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.072916	5.031908	0.00
2	52.073542	5.027611	0.00
3	52.073628	5.027161	0.00
4	52.073705	5.026887	0.00
5	52.073862	5.026614	0.00
6	52.073992	5.026453	0.00
7	52.074149	5.026345	0.00
8	52.074236	5.026300	0.00

Glare Analysis Results

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	20,174	336.2	5,364	89.4	-
UV-02	25.0	241.68	15,091	251.5	6,532	108.9	-
UV-03	25.0	233.48	10,369	172.8	9,366	156.1	-
UV-04	25.0	225.18	15,475	257.9	9,074	151.2	-
UV-05	25.0	202.75	15,738	262.3	8,062	134.4	-
UV-06	25.0	204.1	15,821	263.7	8,378	139.6	-
UV-07	25.0	197.55	11,807	196.8	12,415	206.9	-
UV-08	25.0	195.26	12,401	206.7	11,903	198.4	-
UV-09	25.0	192.6	12,886	214.8	9,782	163.0	-
UV-10	25.0	189.34	12,163	202.7	2,893	48.2	-
UV-11	25.0	184.09	7,432	123.9	1,509	25.1	-
UV-12	25.0	181.74	9,575	159.6	6,020	100.3	-
UV-13	25.0	174.0	7,395	123.2	3,826	63.8	-
UV-14	25.0	154.86	5,737	95.6	672	11.2	-
UV-15	25.0	152.49	4,869	81.2	3,041	50.7	-
UV-16	25.0	150.5	3,745	62.4	3,651	60.9	-
Woerden	35.0	197.87	11,853	197.6	1,834	30.6	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	68,034	1,133.9	4,963	82.7
A12 ri west	24,663	411.1	4,135	68.9
N198 ri oost	54,652	910.9	76,185	1,269.8
N198 ri west	17,335	288.9	18,557	309.3
N419 ri oost	27,847	464.1	482	8.0
N419 ri west	0	0.0	0	0.0

PV: UV-01 potential temporary after-image

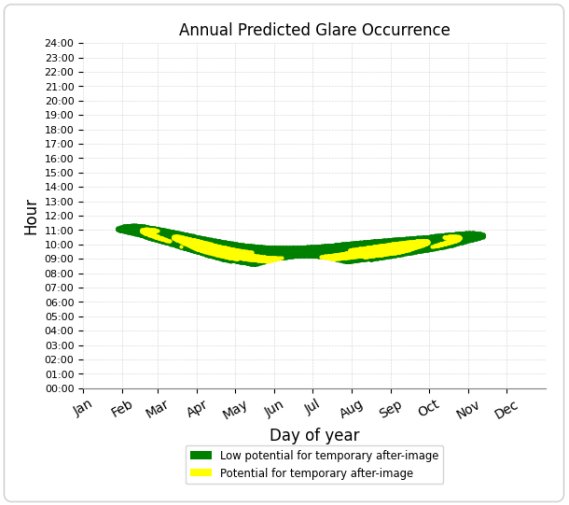
Receptor results ordered by category of glare

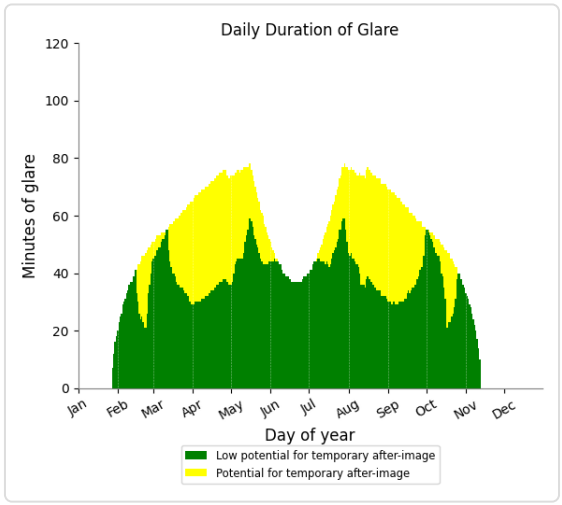
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	11,030	183.8	5,160	86.0
N419 ri oost	9,144	152.4	204	3.4
A12 ri oost	0	0.0	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

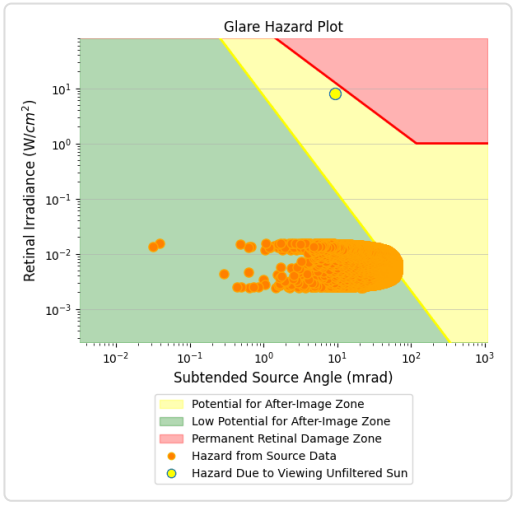
UV-01 and Route: N198 ri oost

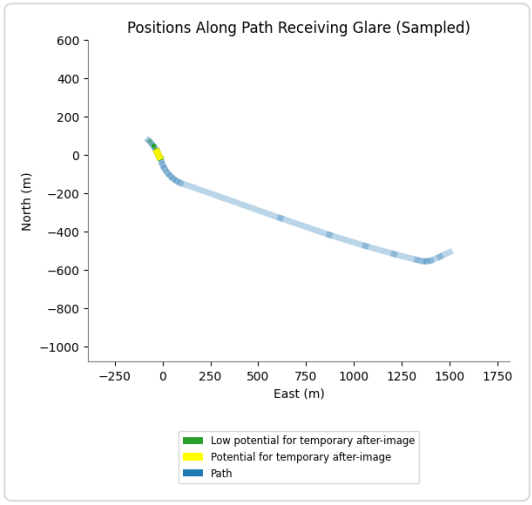
Yellow glare: 5,160 min.

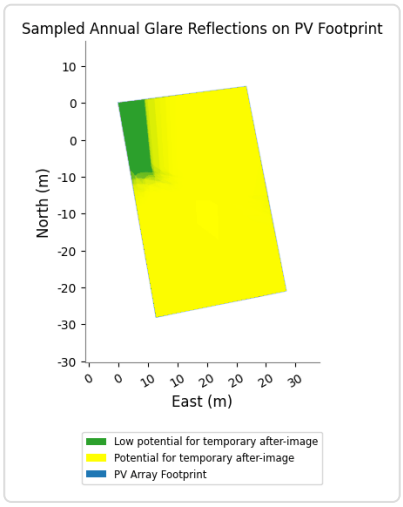
Green glare: 11,030 min.







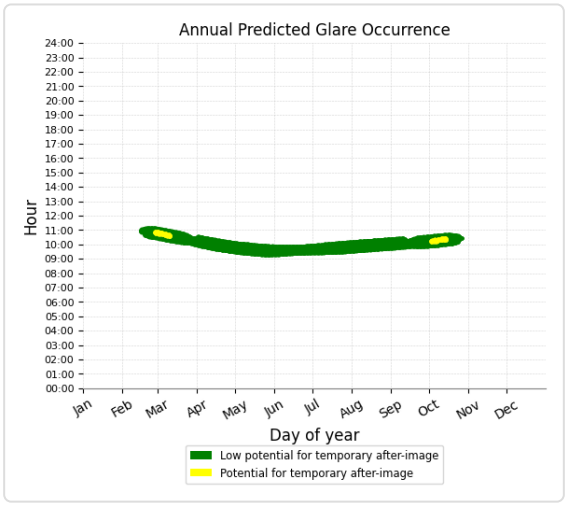


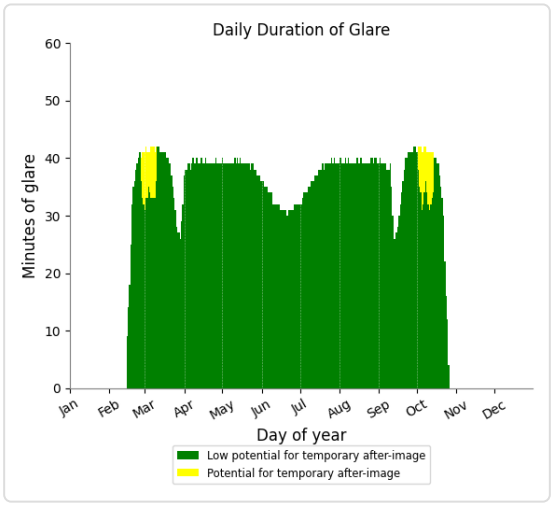


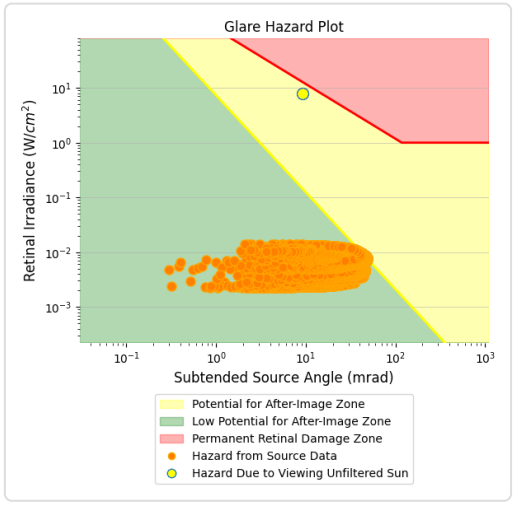
UV-01 and Route: N419 ri oost

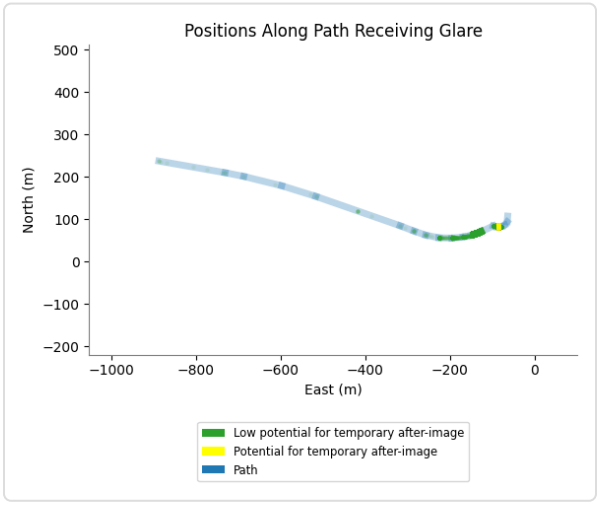
Yellow glare: 204 min.

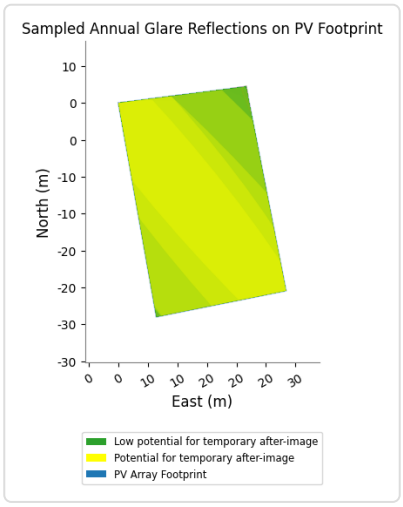
Green glare: 9,144 min.











UV-01 and Route: A12 ri oost

No glare found

UV-01 and Route: A12 ri west

No glare found

UV-01 and Route: N198 ri west

No glare found

UV-01 and Route: N419 ri west

No glare found

PV: UV-02 potential temporary after-image

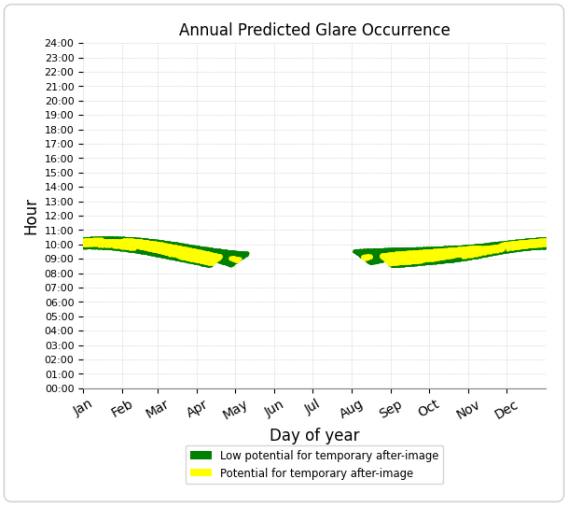
Receptor results ordered by category of glare

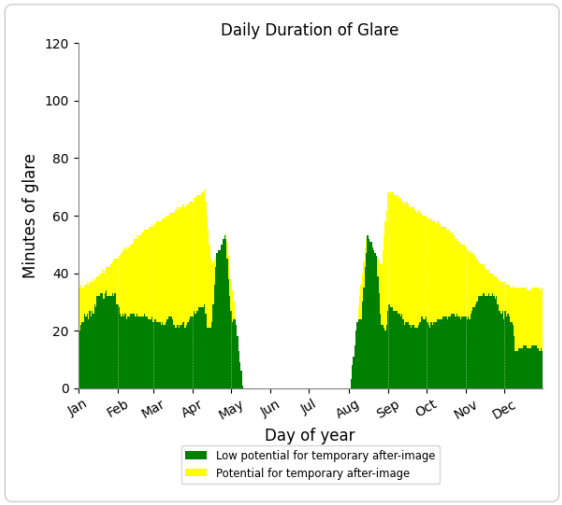
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	7,298	121.6	6,254	104.2
N419 ri oost	7,793	129.9	278	4.6
A12 ri oost	0	0.0	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

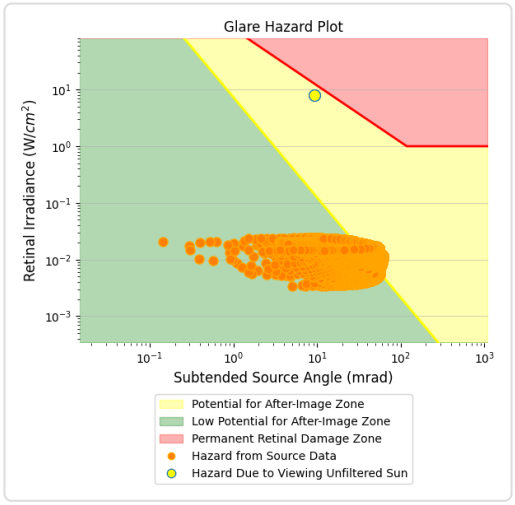
UV-02 and Route: N198 ri oost

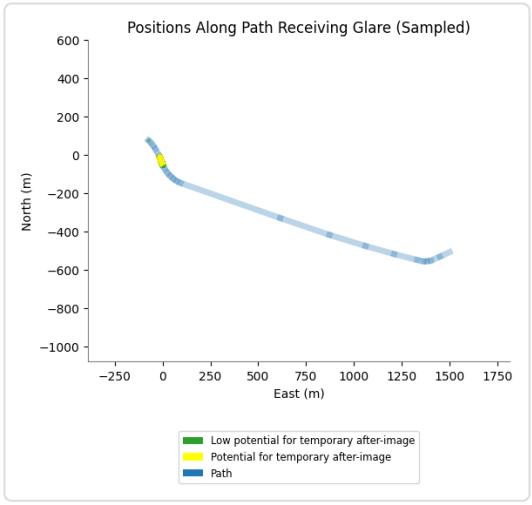
Yellow glare: 6,254 min.

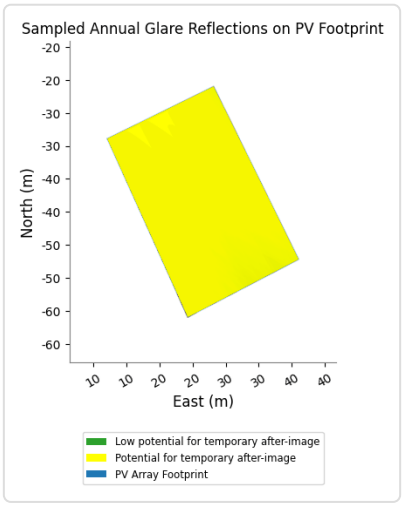
Green glare: 7,298 min.







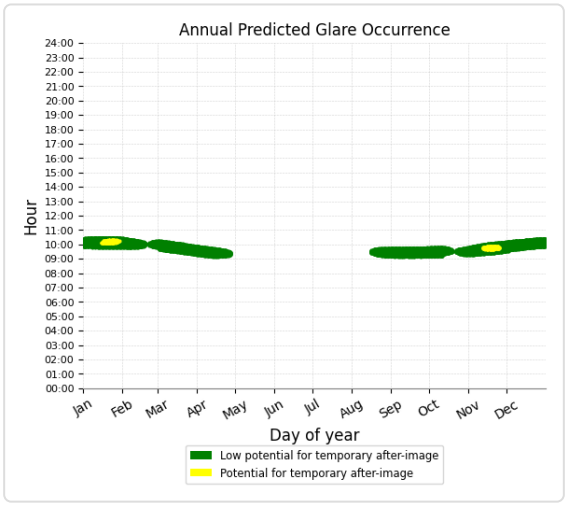


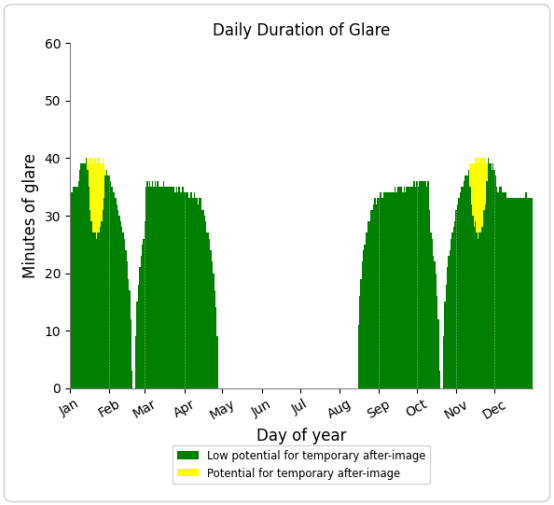


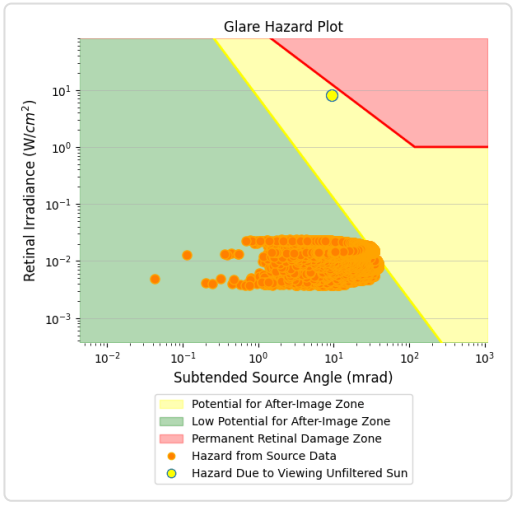
UV-02 and Route: N419 ri oost

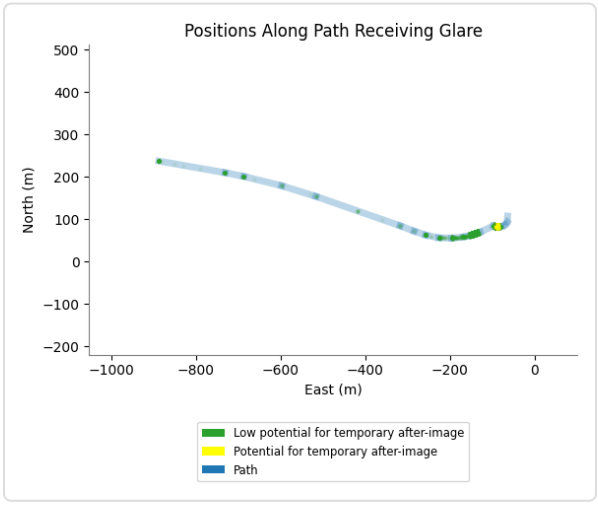
Yellow glare: 278 min.

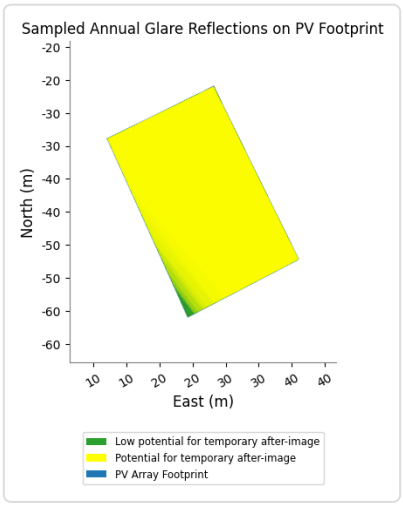
Green glare: 7,793 min.











UV-02 and Route: A12 ri oost

No glare found

UV-02 and Route: A12 ri west

No glare found

UV-02 and Route: N198 ri west

No glare found

UV-02 and Route: N419 ri west

No glare found

PV: UV-03 potential temporary after-image

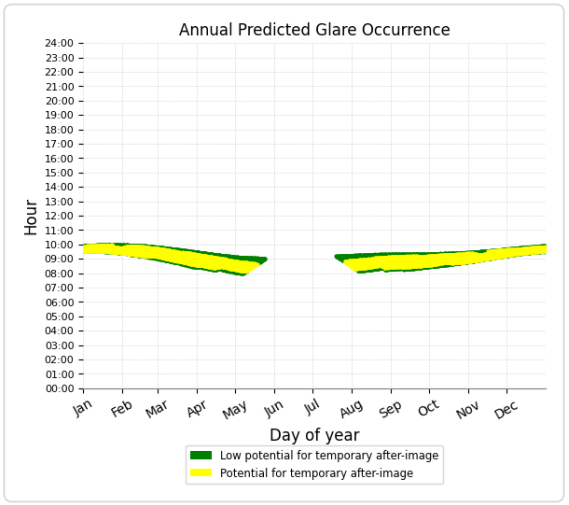
Receptor results ordered by category of glare

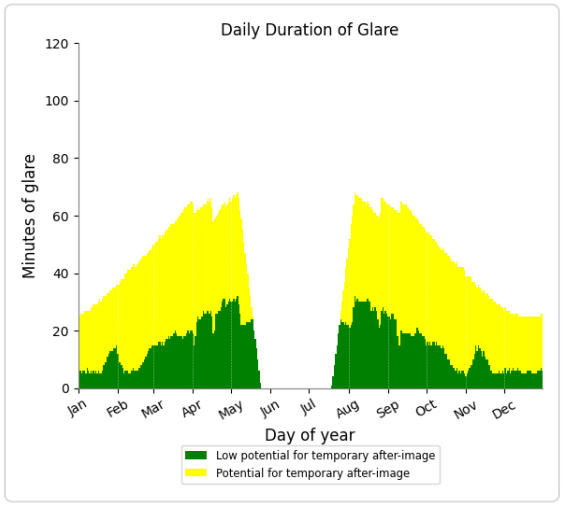
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	4,774	79.6	9,366	156.1
N419 ri oost	5,595	93.2	0	0.0
A12 ri oost	0	0.0	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

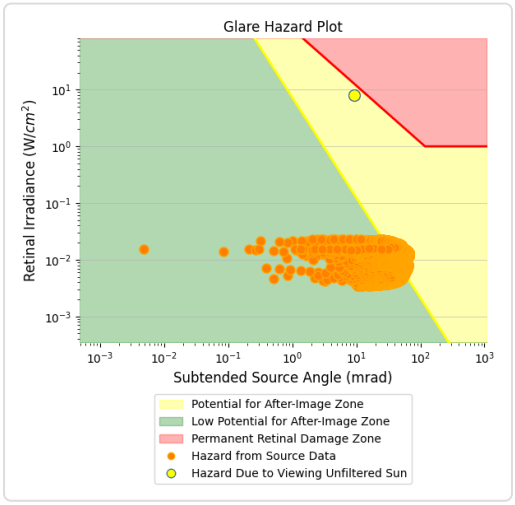
UV-03 and Route: N198 ri oost

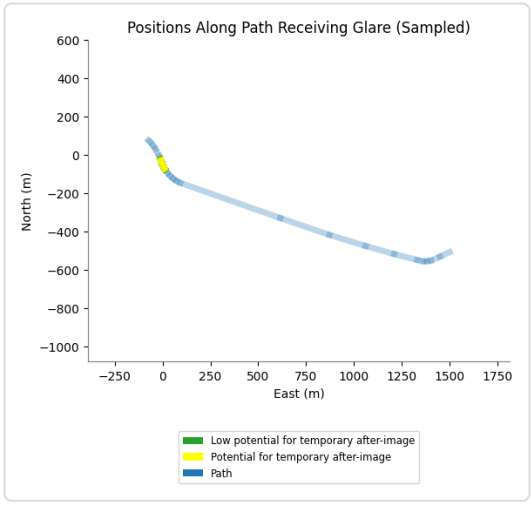
Yellow glare: 9,366 min.

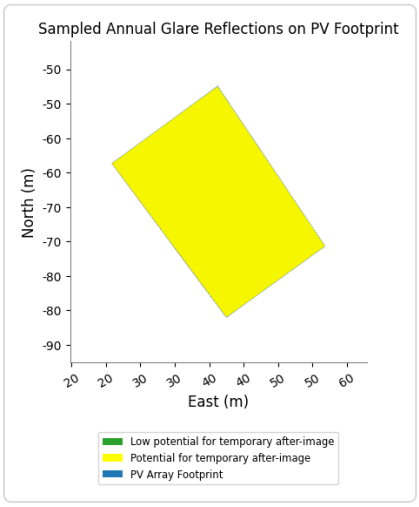
Green glare: 4,774 min.







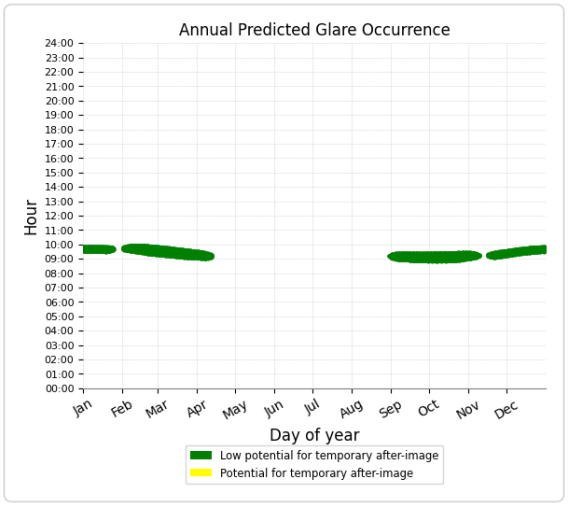


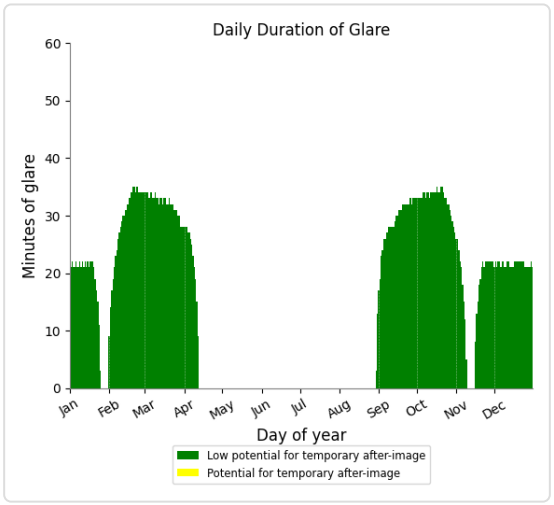


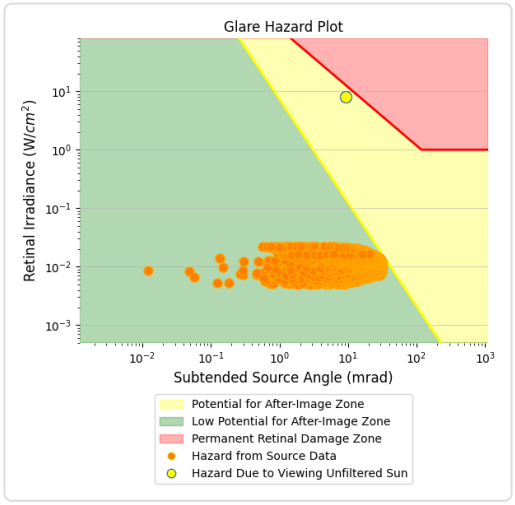
UV-03 and Route: N419 ri oost

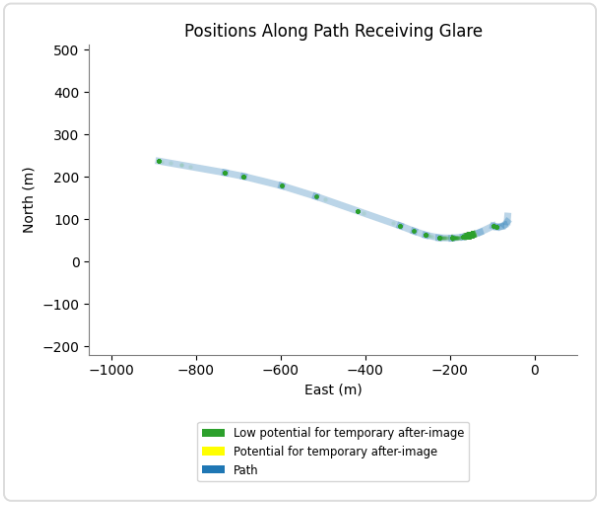
Yellow glare: none

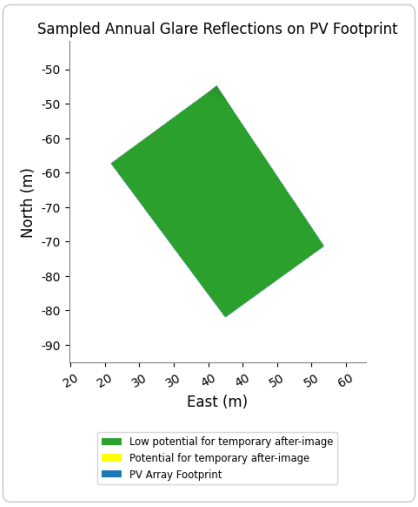
Green glare: 5,595 min.











UV-03 and Route: A12 ri oost

No glare found

UV-03 and Route: A12 ri west

No glare found

UV-03 and Route: N198 ri west

No glare found

UV-03 and Route: N419 ri west

No glare found

PV: UV-04 potential temporary after-image

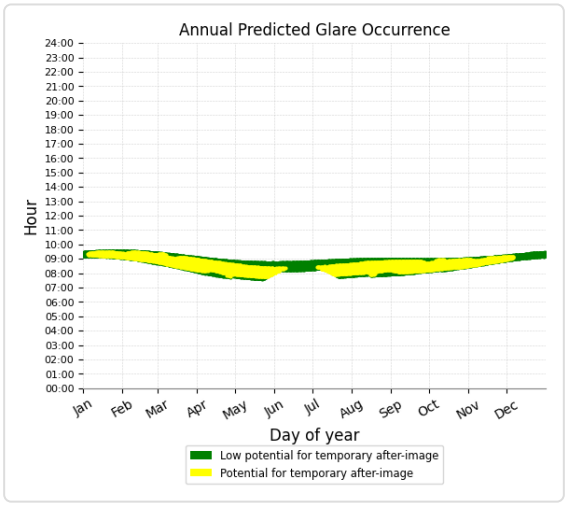
Receptor results ordered by category of glare

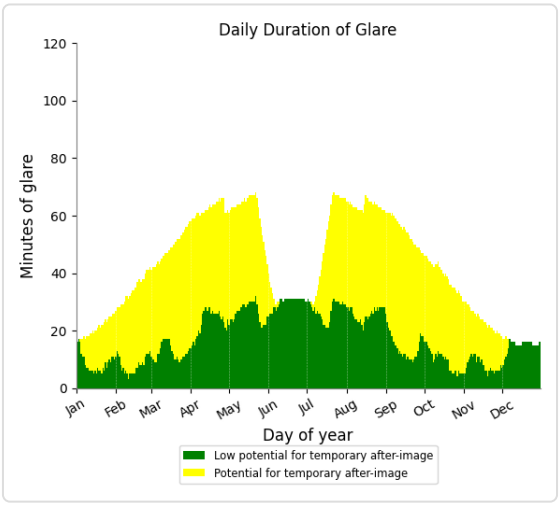
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	6,363	106.0	9,074	151.2
A12 ri oost	4,953	82.5	0	0.0
N419 ri oost	4,159	69.3	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

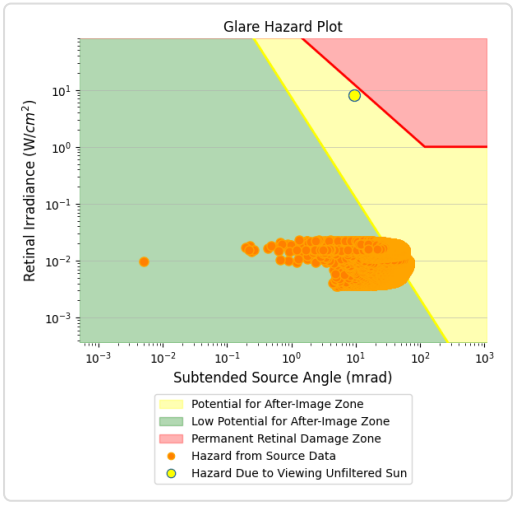
UV-04 and Route: N198 ri oost

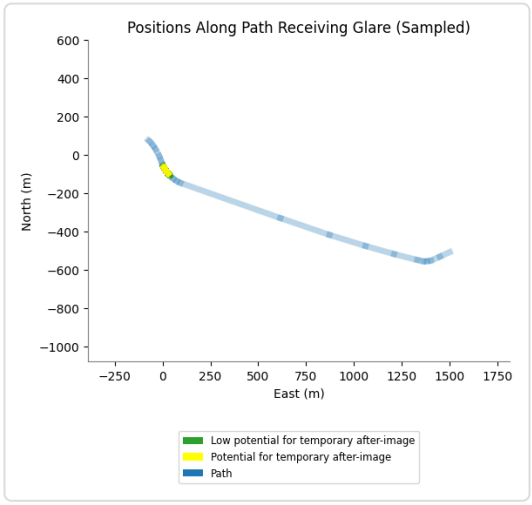
Yellow glare: 9,074 min.

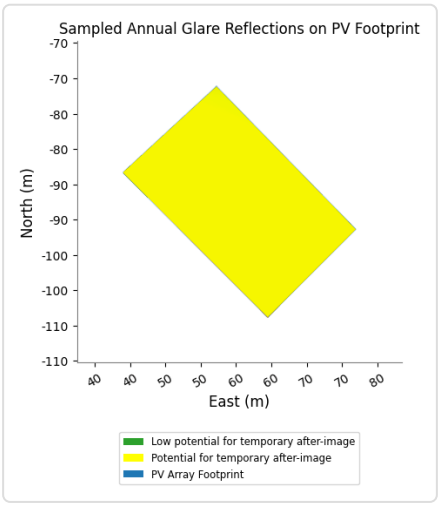
Green glare: 6,363 min.







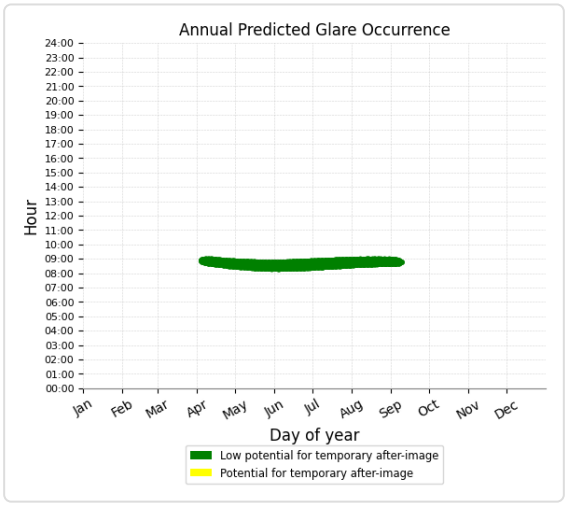


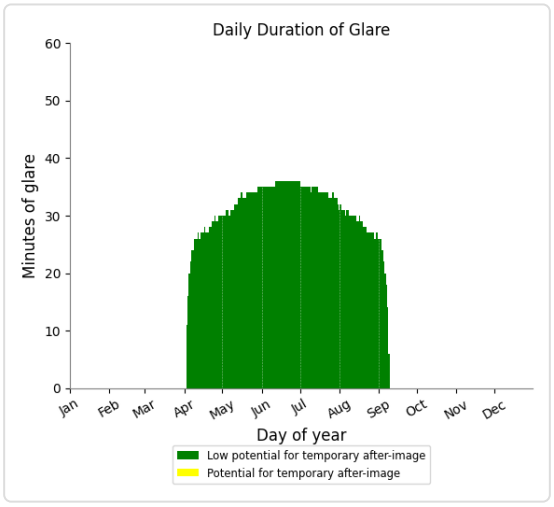


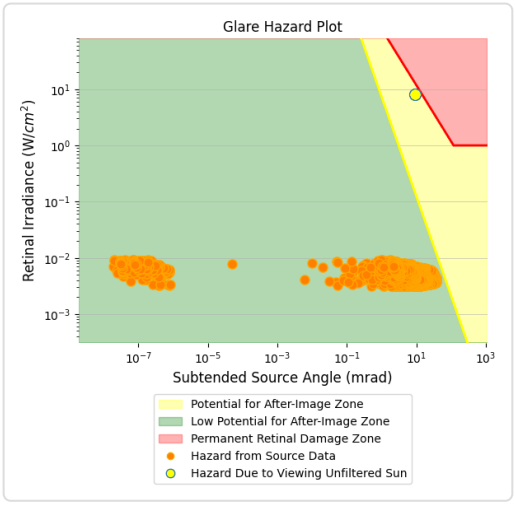
UV-04 and Route: A12 ri oost

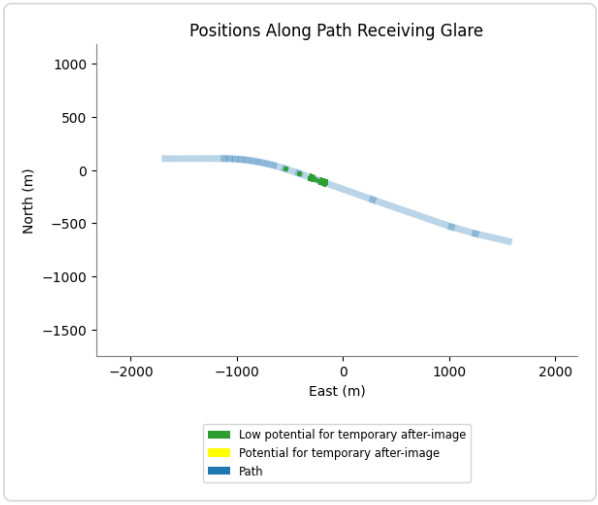
Yellow glare: none

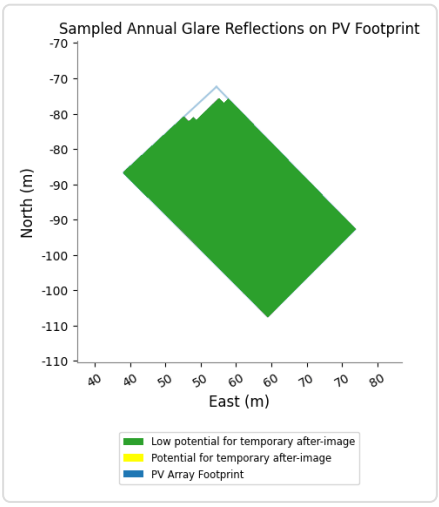
Green glare: 4,953 min.







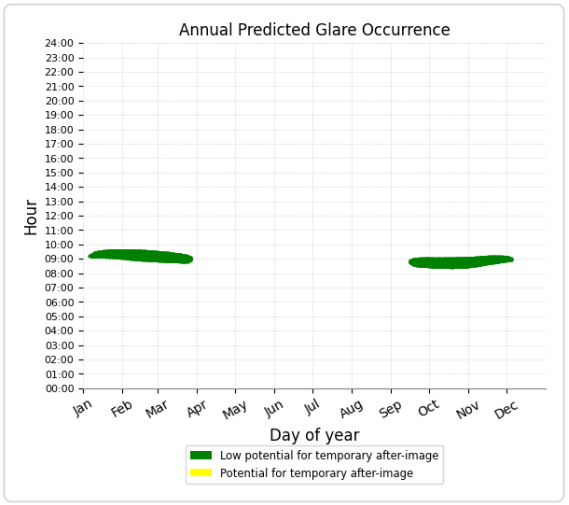


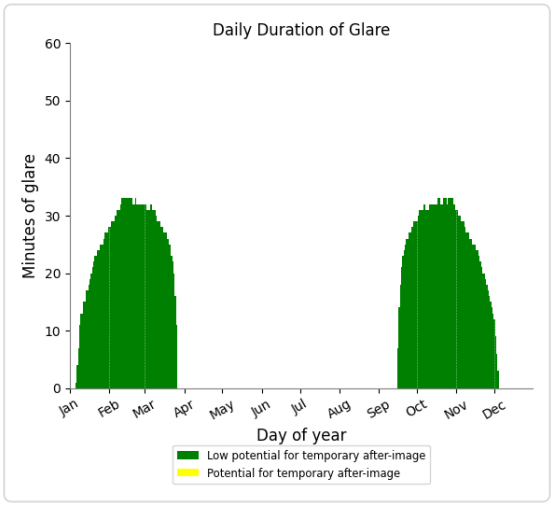


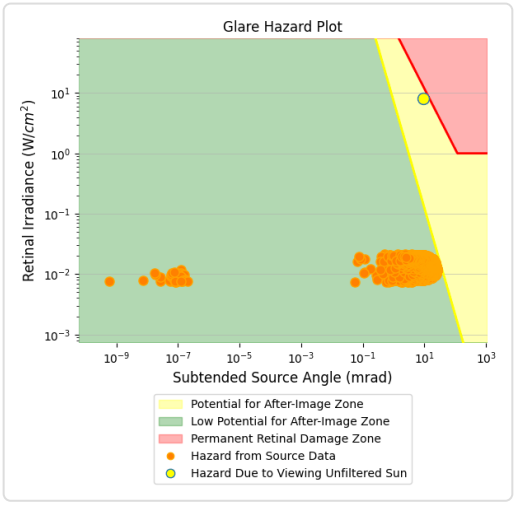
UV-04 and Route: N419 ri oost

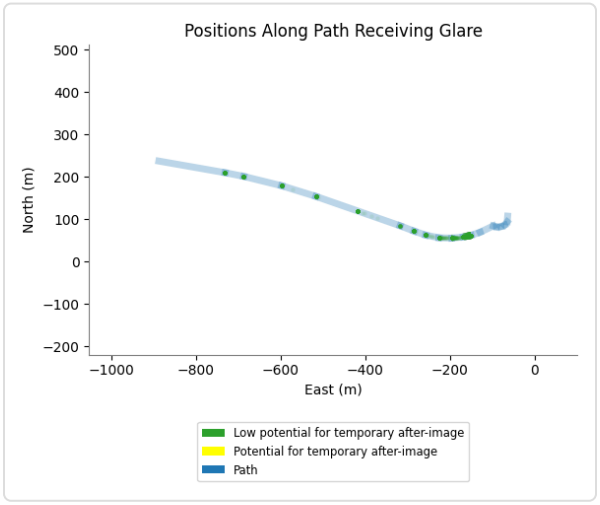
Yellow glare: none

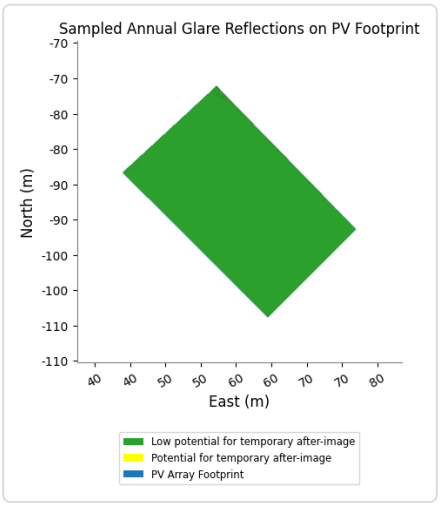
Green glare: 4,159 min.











UV-04 and Route: A12 ri west

No glare found

UV-04 and Route: N198 ri west

No glare found

UV-04 and Route: N419 ri west

No glare found

PV: UV-05 potential temporary after-image

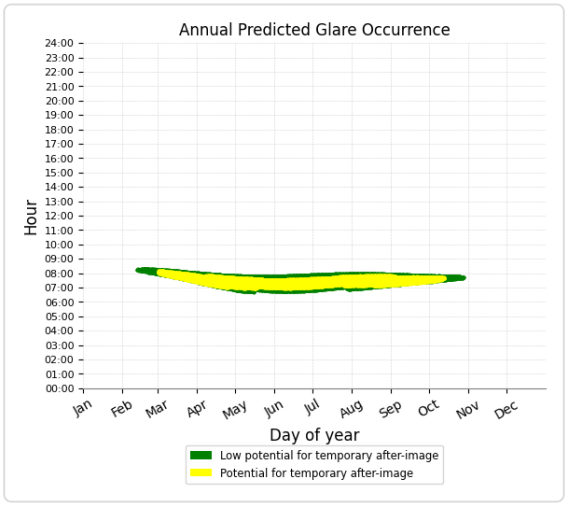
Receptor results ordered by category of glare

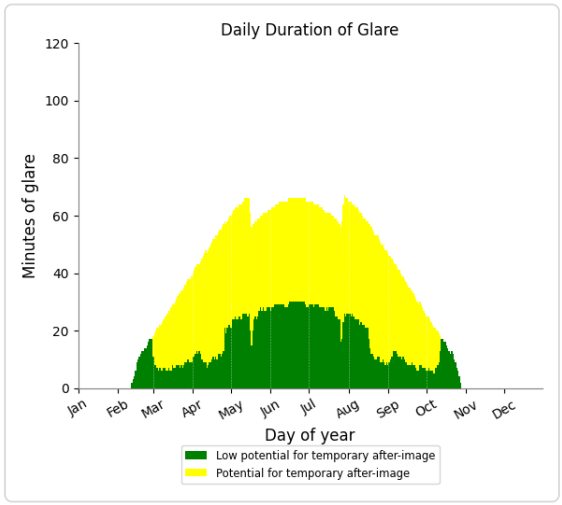
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	4,349	72.5	7,351	122.5
N198 ri west	1,332	22.2	711	11.8
A12 ri oost	7,158	119.3	0	0.0
A12 ri west	2,382	39.7	0	0.0
N419 ri oost	517	8.6	0	0.0
N419 ri west	0	0.0	0	0.0

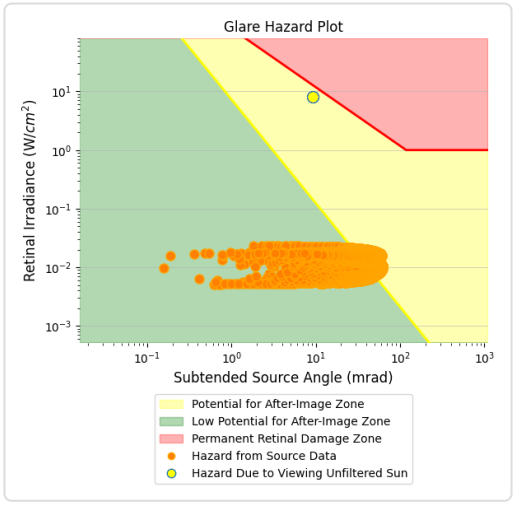
UV-05 and Route: N198 ri oost

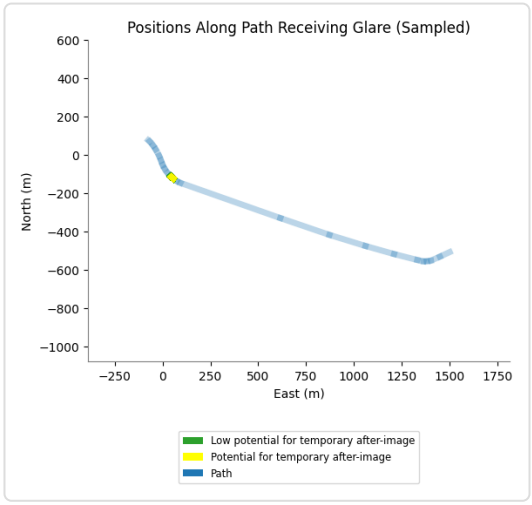
Yellow glare: 7,351 min.

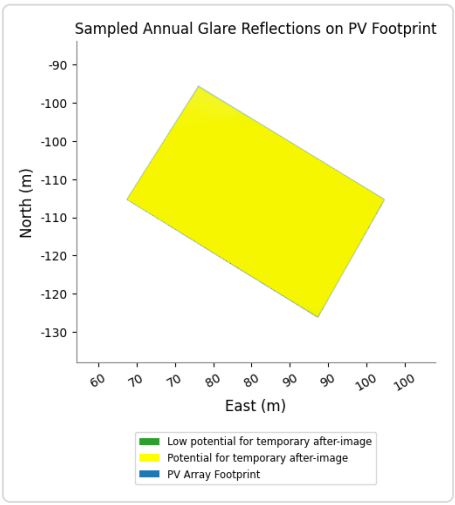
Green glare: 4,349 min.







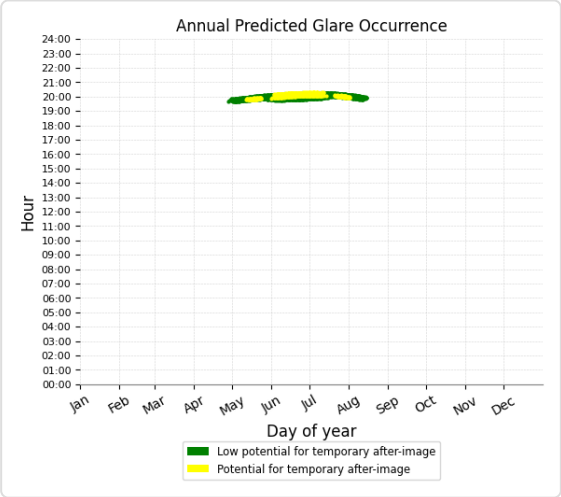


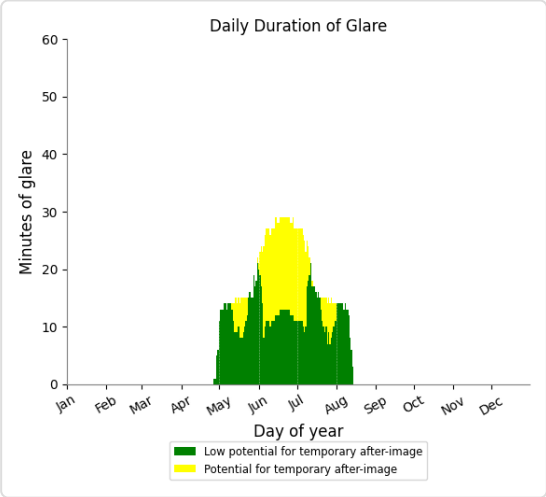


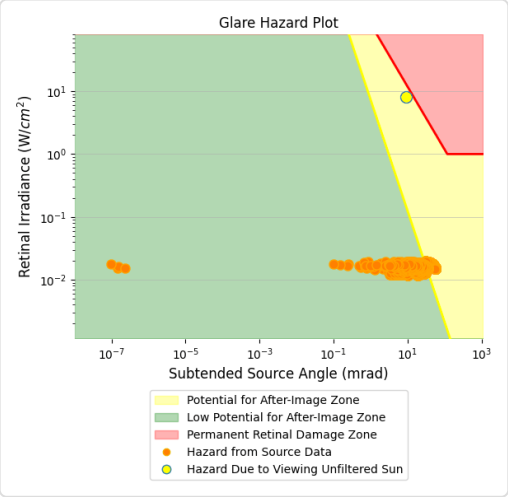
UV-05 and Route: N198 ri west

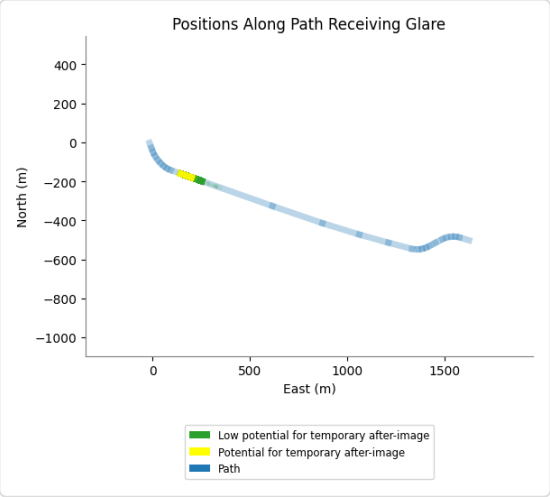
Yellow glare: 711 min.

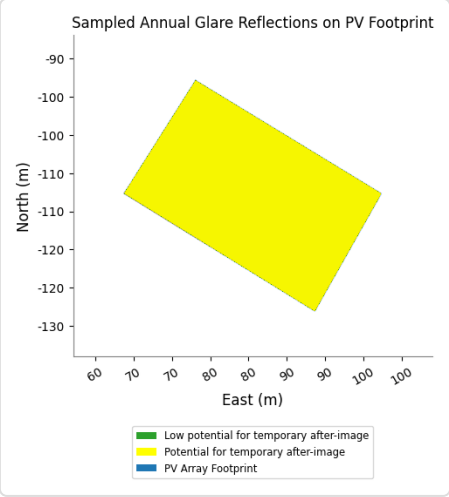
Green glare: 1,332 min.







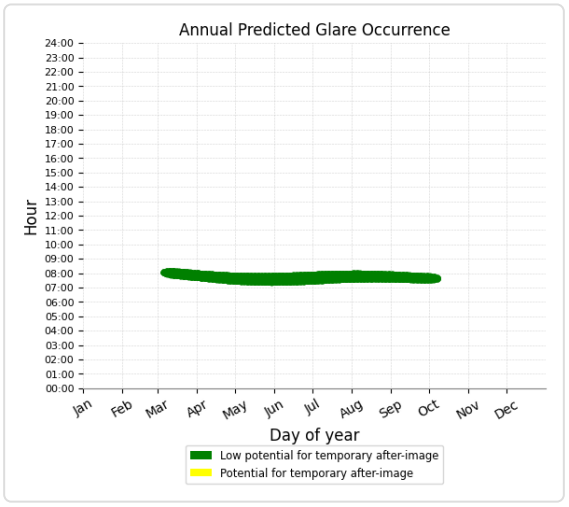


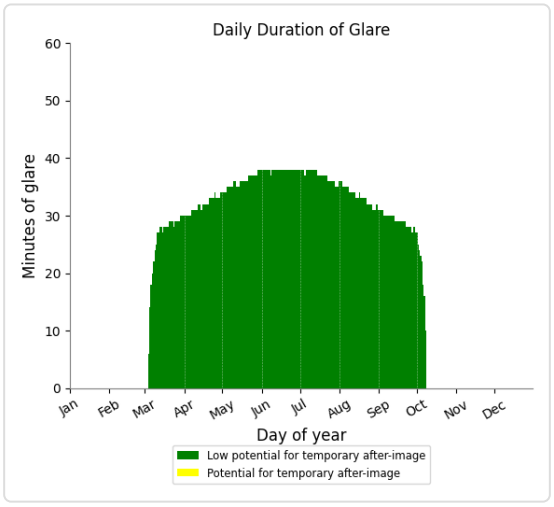


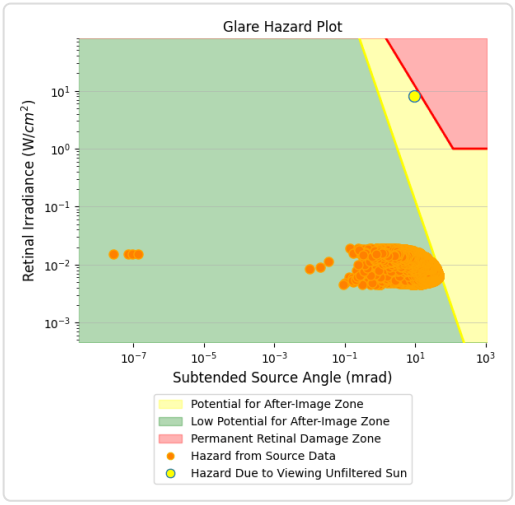
UV-05 and Route: A12 ri oost

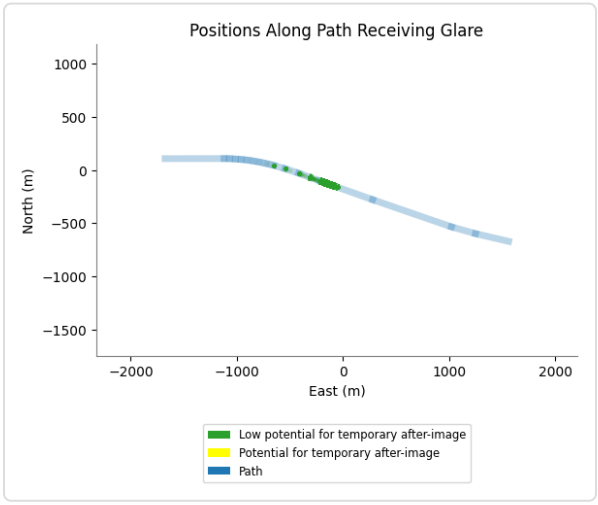
Yellow glare: none

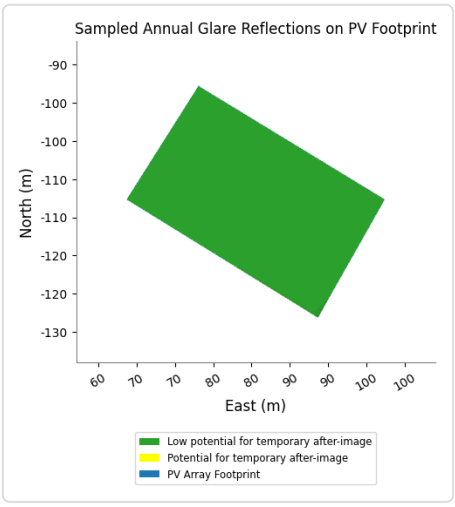
Green glare: 7,158 min.







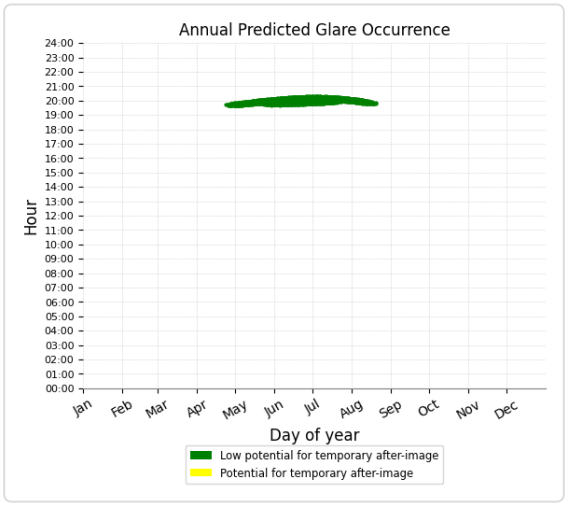


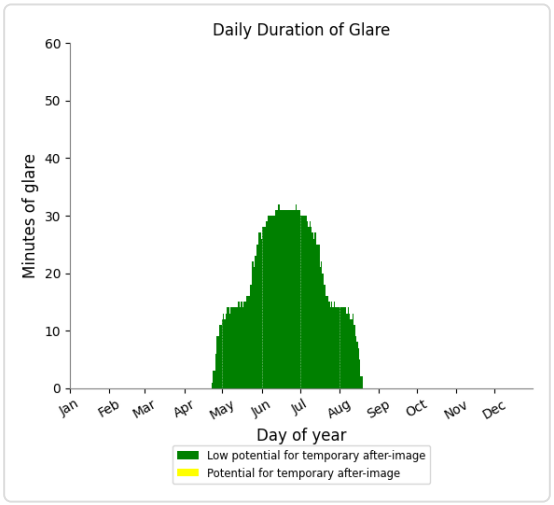


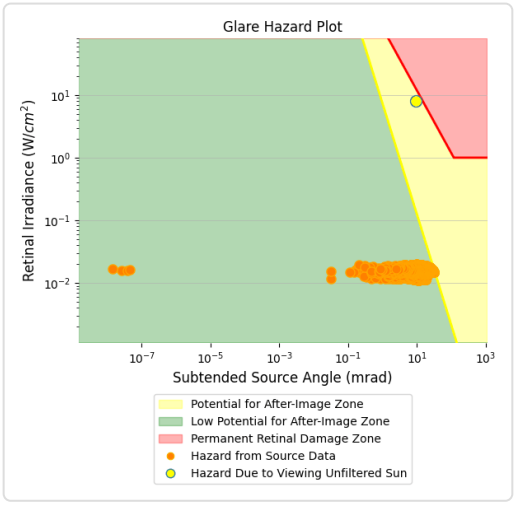
UV-05 and Route: A12 ri west

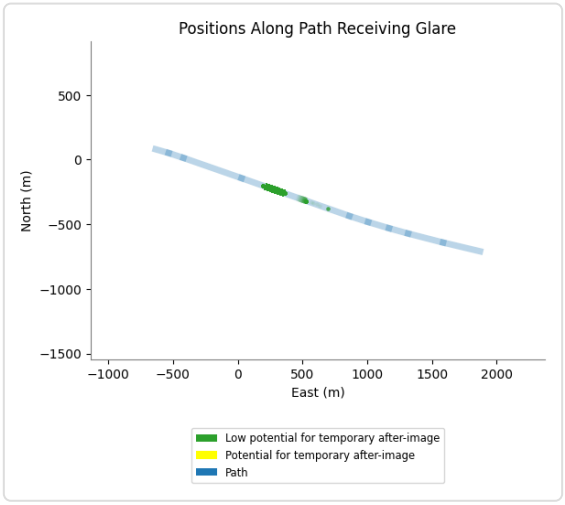
Yellow glare: none

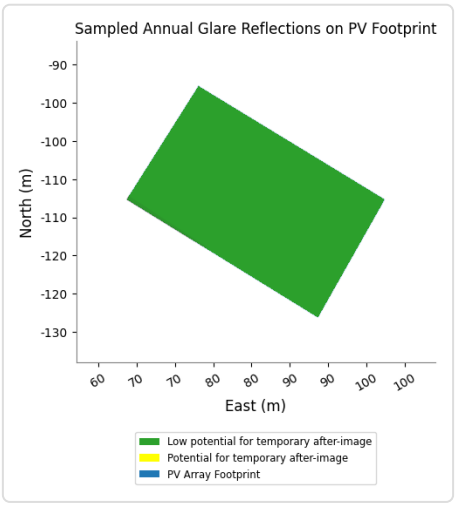
Green glare: 2,382 min.







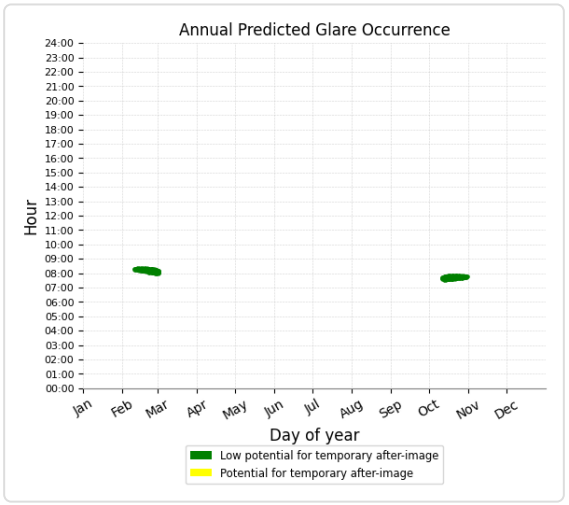


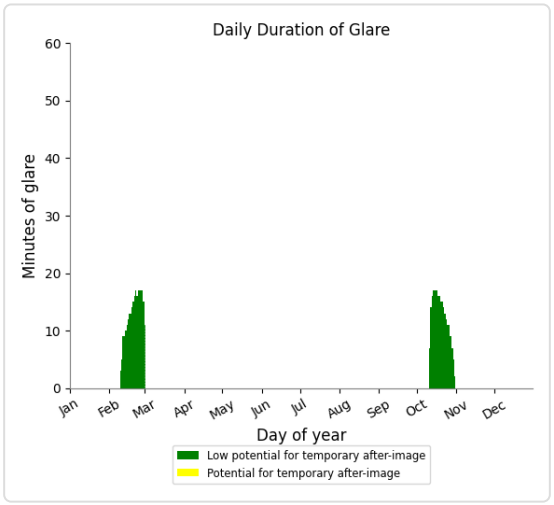


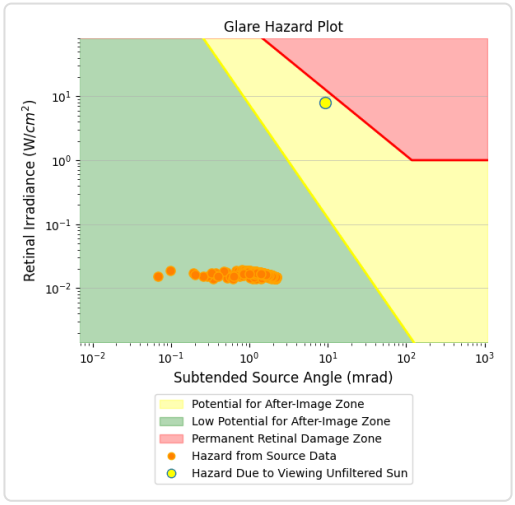
UV-05 and Route: N419 ri oost

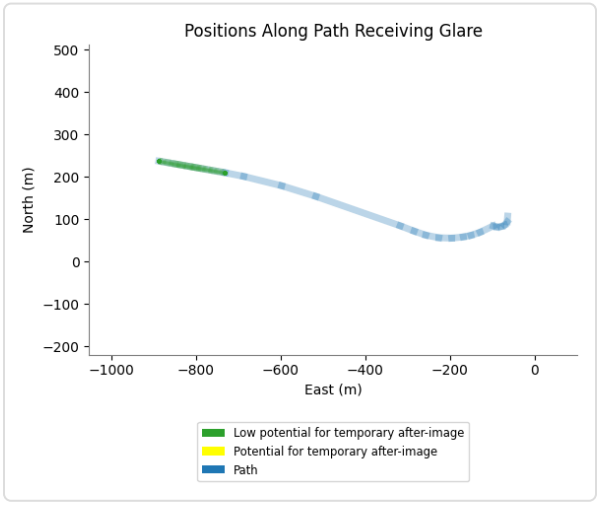
Yellow glare: none

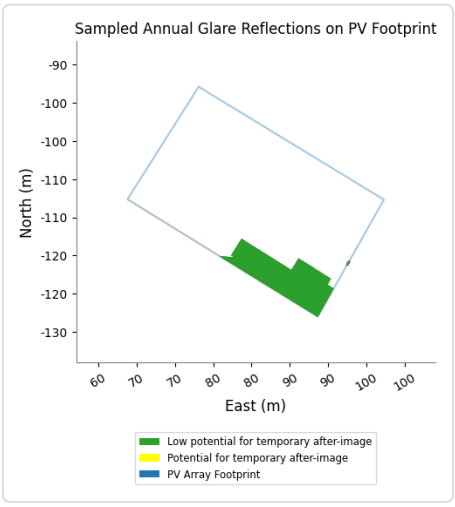
Green glare: 517 min.











UV-05 and Route: N419 ri west

No glare found

PV: UV-06 potential temporary after-image

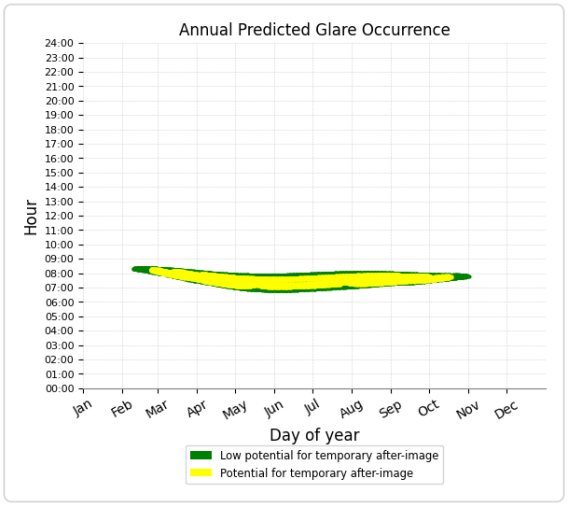
Receptor results ordered by category of glare

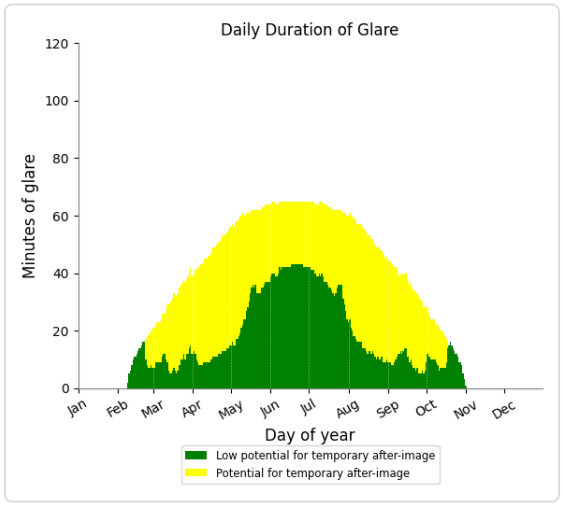
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	5,067	84.5	6,686	111.4
N198 ri west	485	8.1	1,692	28.2
A12 ri oost	7,159	119.3	0	0.0
A12 ri west	2,471	41.2	0	0.0
N419 ri oost	639	10.7	0	0.0
N419 ri west	0	0.0	0	0.0

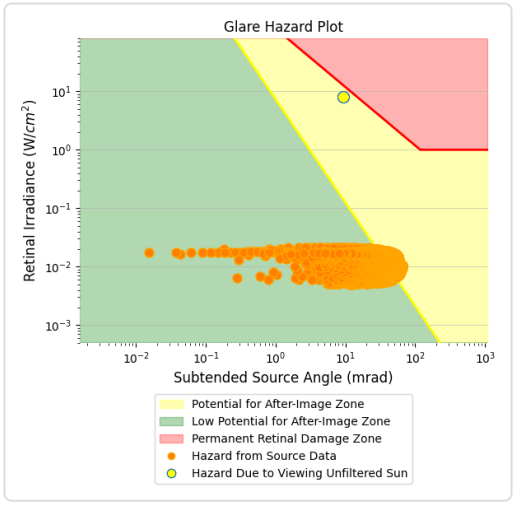
UV-06 and Route: N198 ri oost

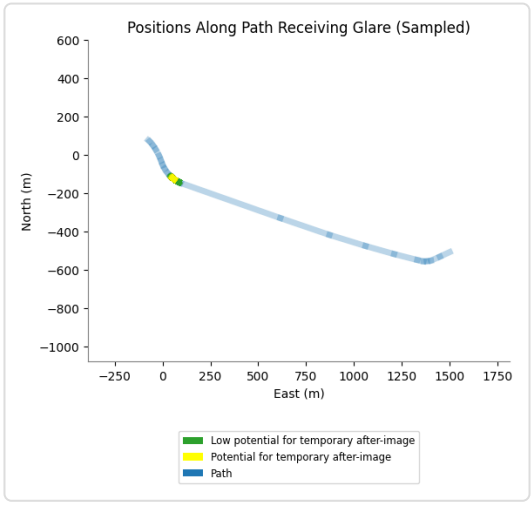
Yellow glare: 6,686 min.

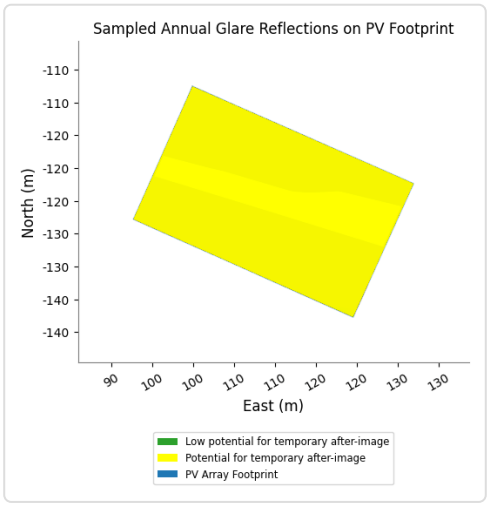
Green glare: 5,067 min.







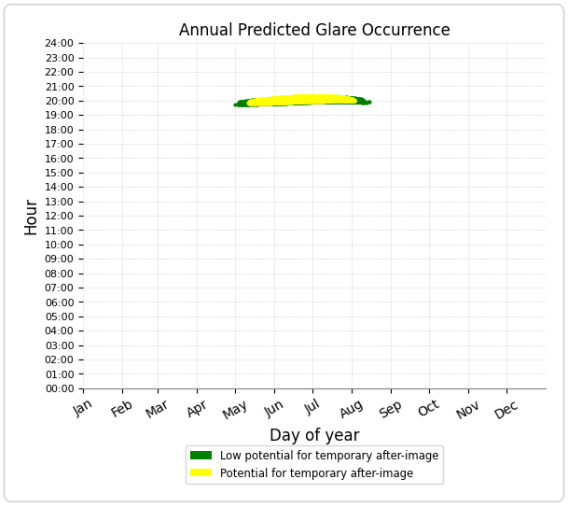


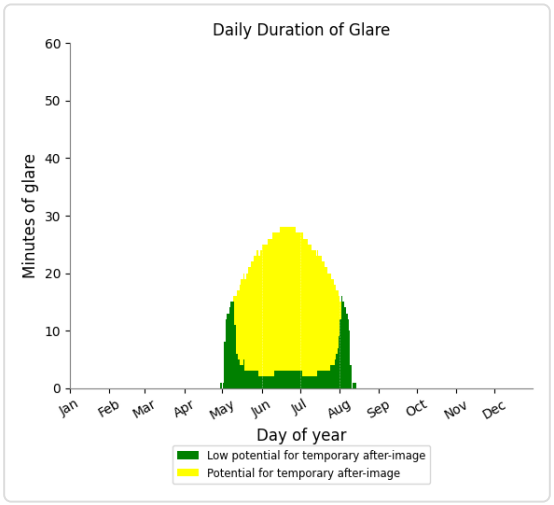


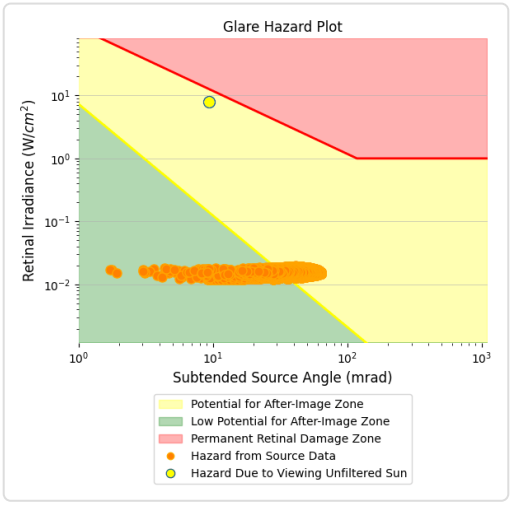
UV-06 and Route: N198 ri west

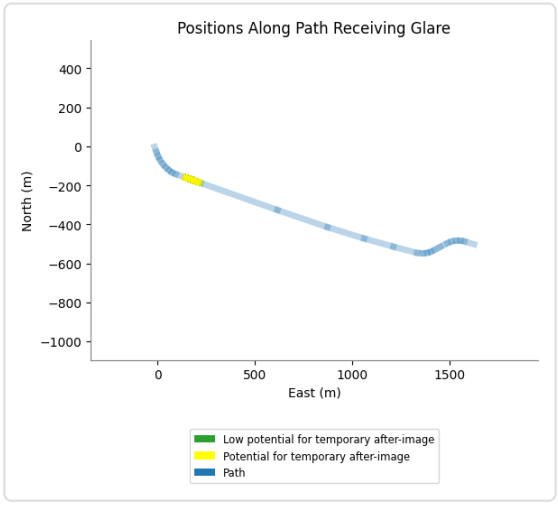
Yellow glare: 1,692 min.

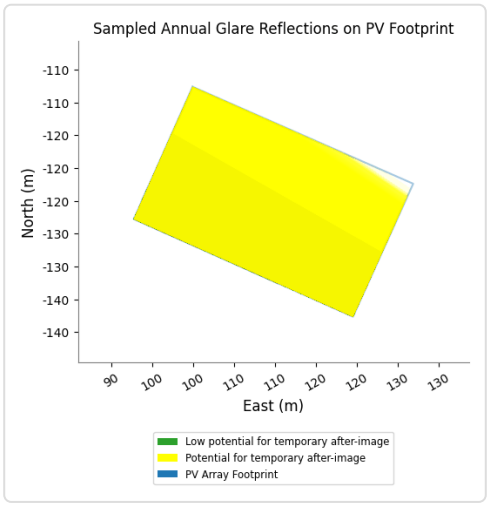
Green glare: 485 min.







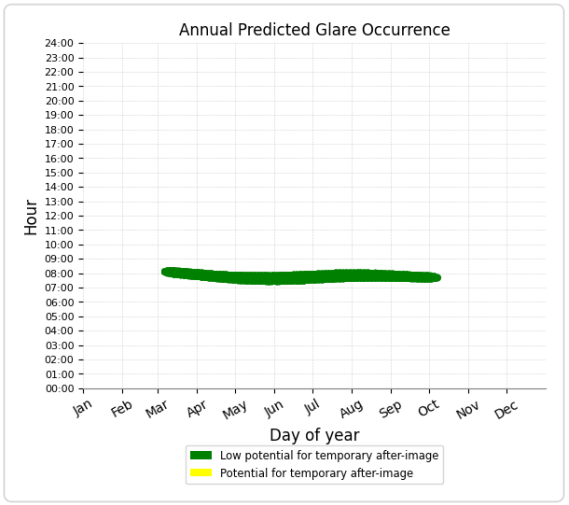


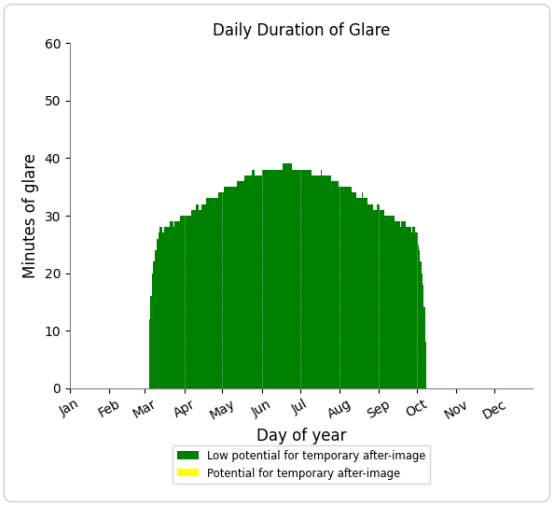


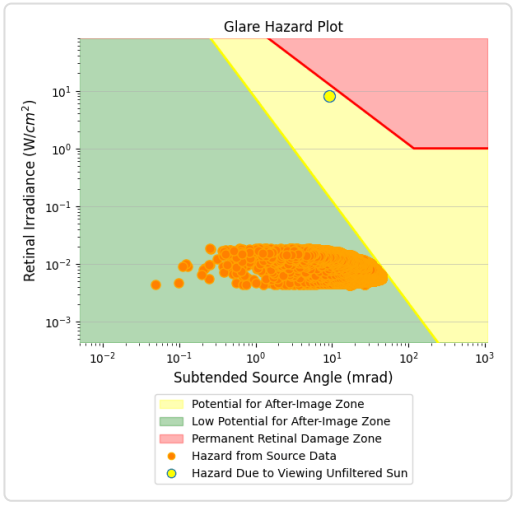
UV-06 and Route: A12 ri oost

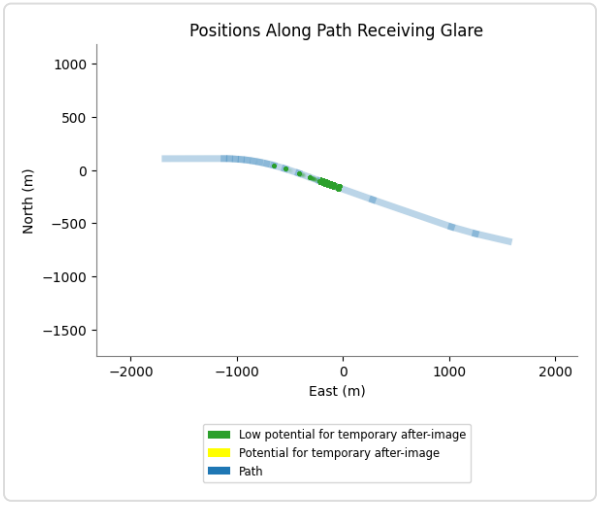
Yellow glare: none

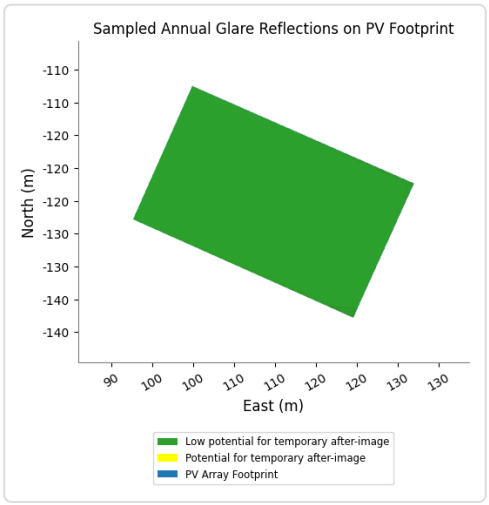
Green glare: 7,159 min.







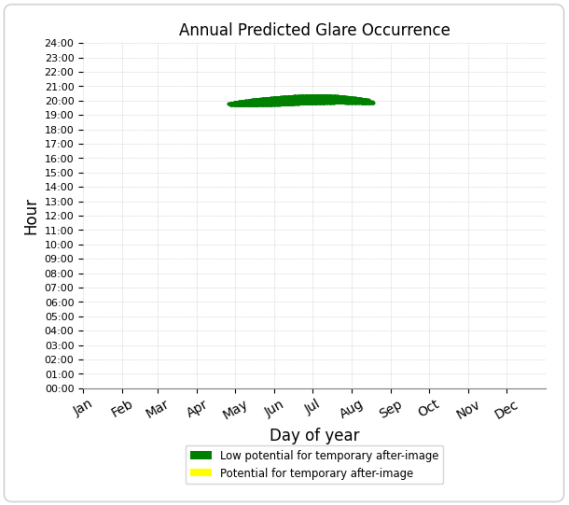


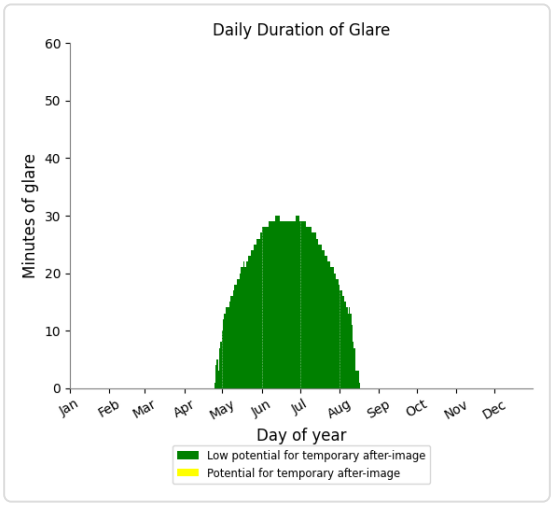


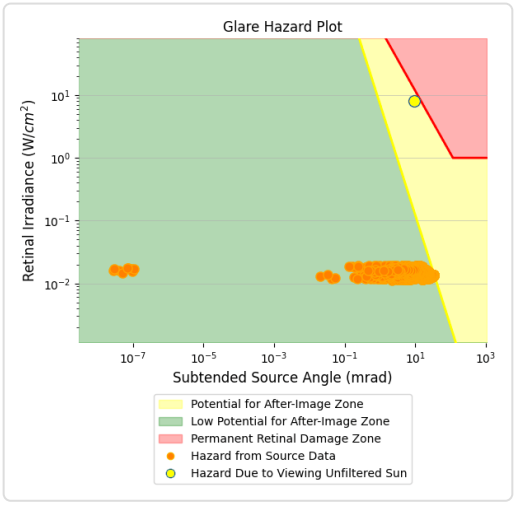
UV-06 and Route: A12 ri west

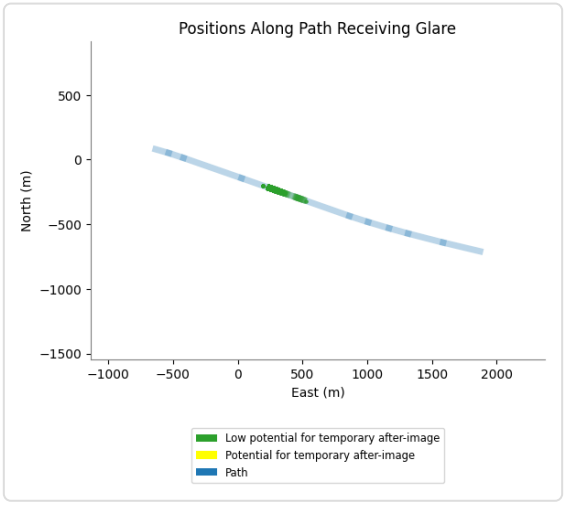
Yellow glare: none

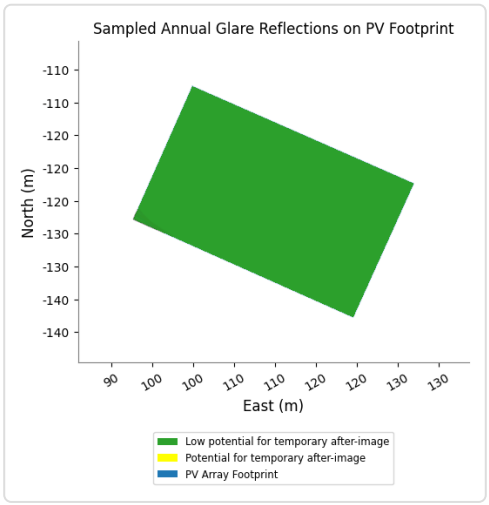
Green glare: 2,471 min.







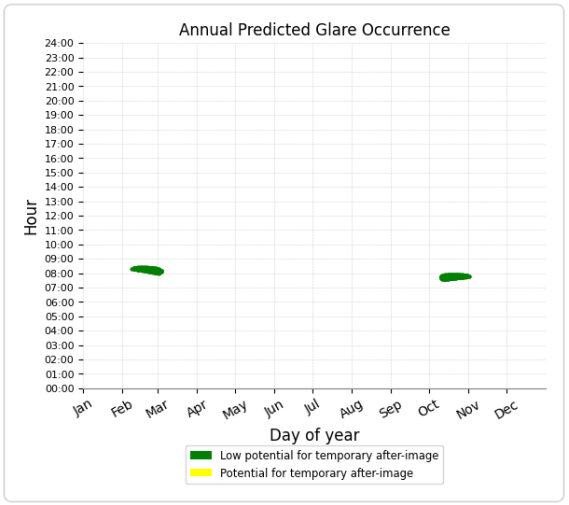


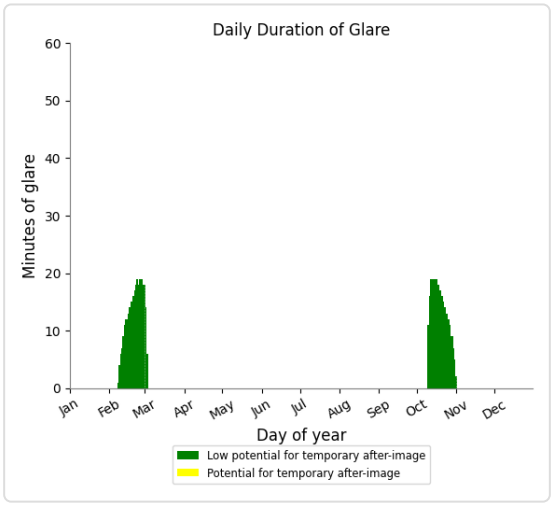


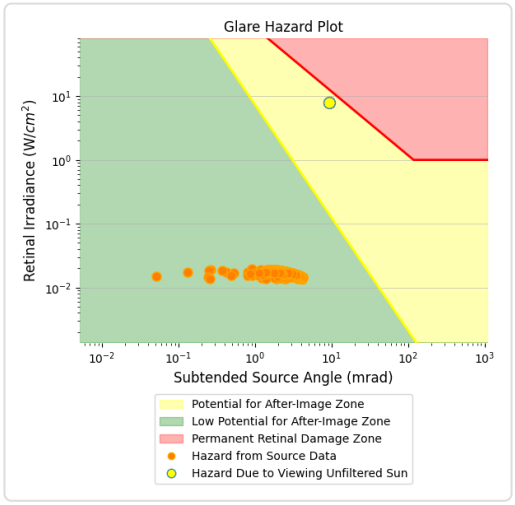
UV-06 and Route: N419 ri oost

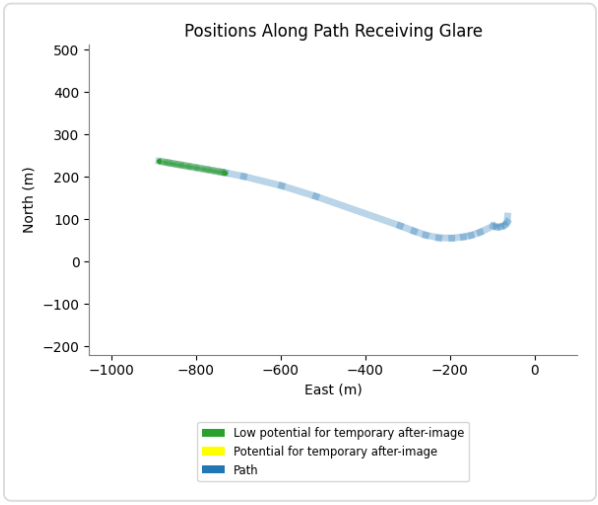
Yellow glare: none

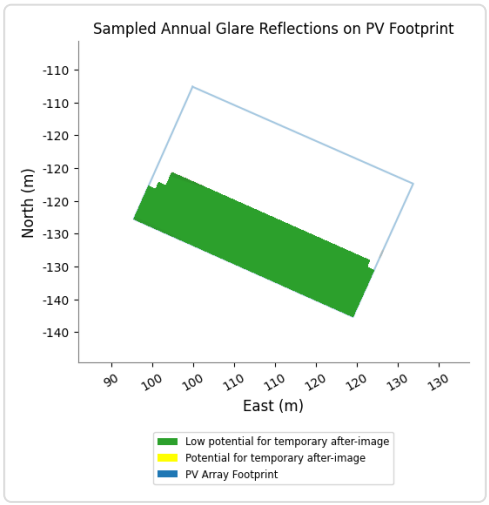
Green glare: 639 min.











UV-06 and Route: N419 ri west

No glare found

PV: UV-07 potential temporary after-image

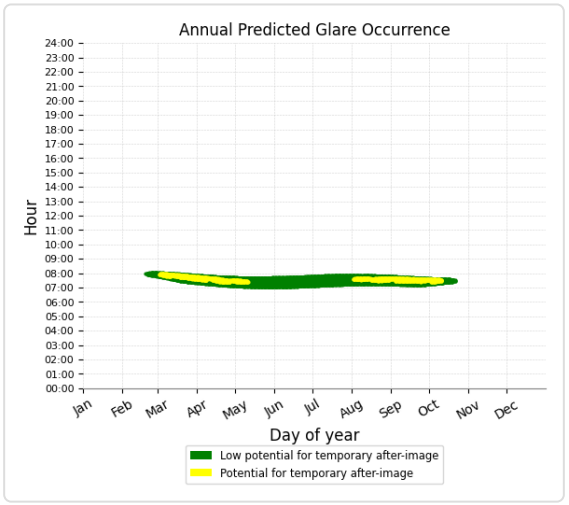
Receptor results ordered by category of glare

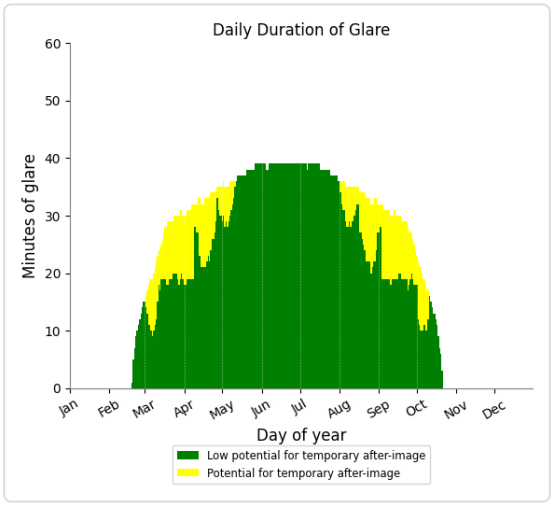
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	6,428	107.1	1,189	19.8
A12 ri west	1,377	22.9	1,784	29.7
N198 ri oost	3,370	56.2	7,036	117.3
N198 ri west	632	10.5	2,406	40.1
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

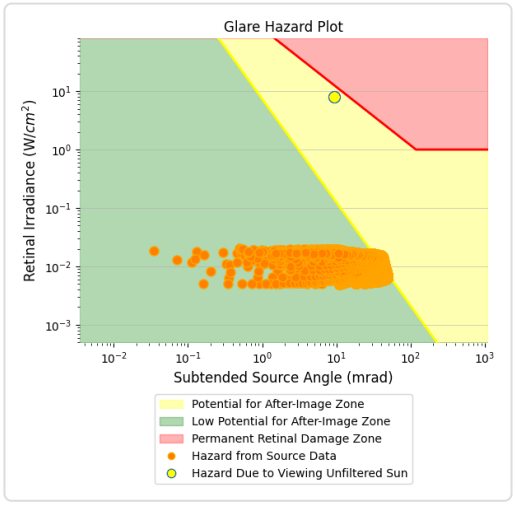
UV-07 and Route: A12 ri oost

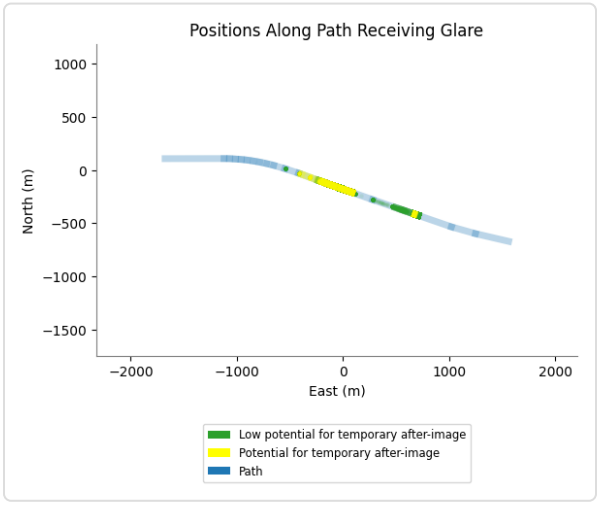
Yellow glare: 1,189 min.

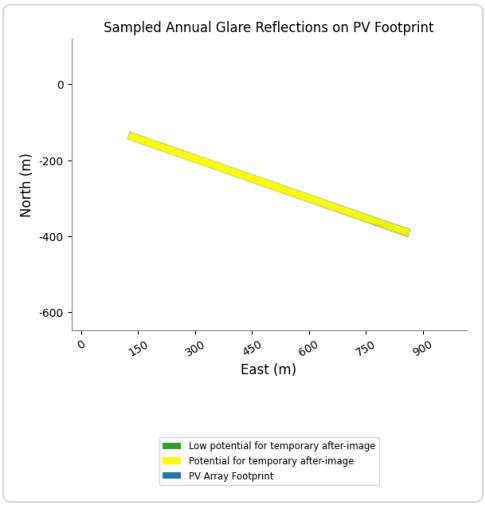
Green glare: 6,428 min.







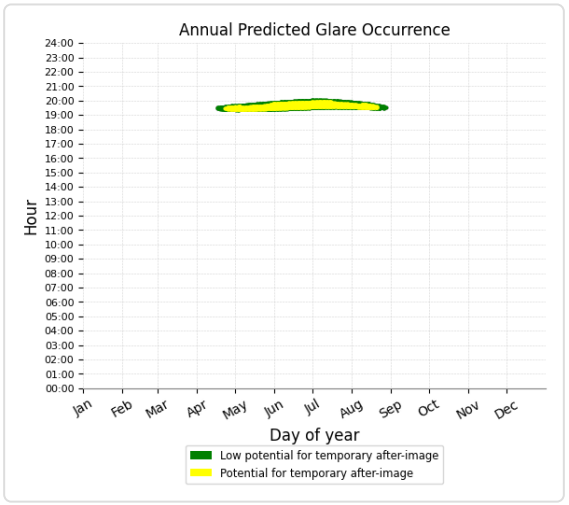


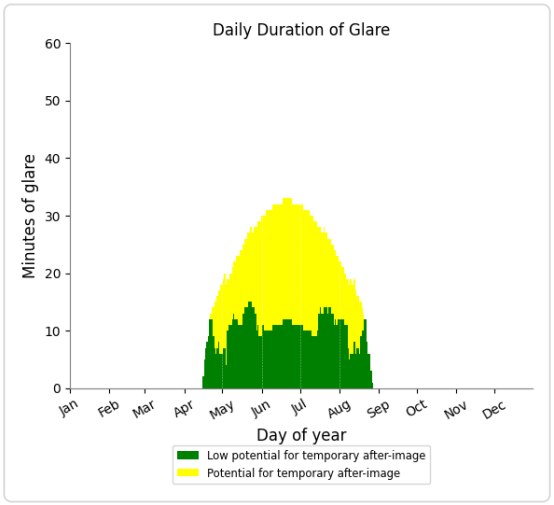


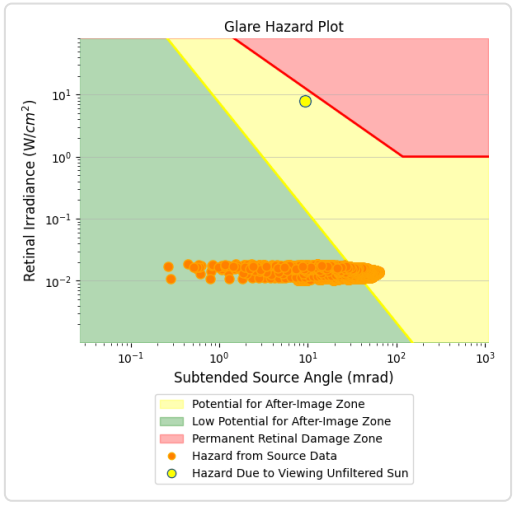
UV-07 and Route: A12 ri west

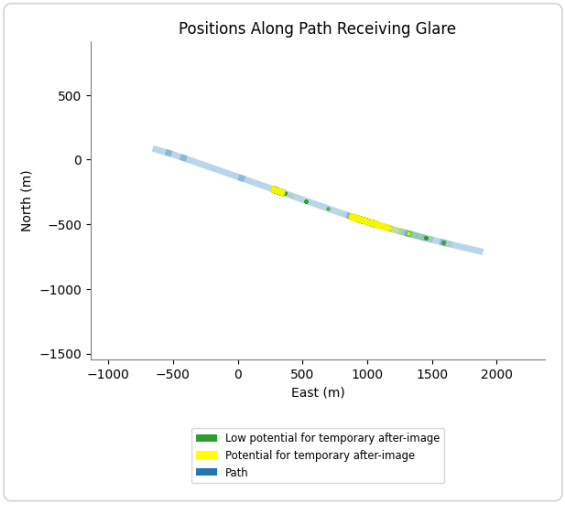
Yellow glare: 1,784 min.

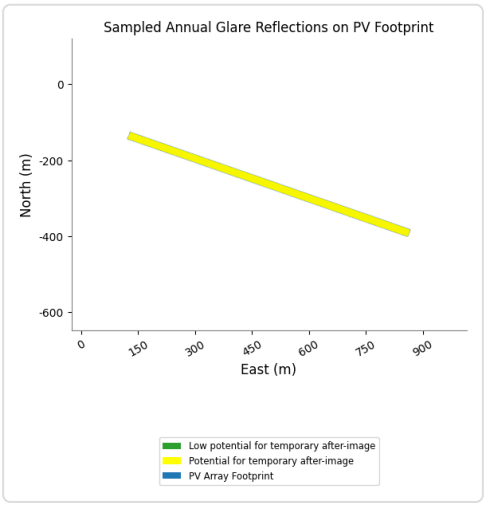
Green glare: 1,377 min.







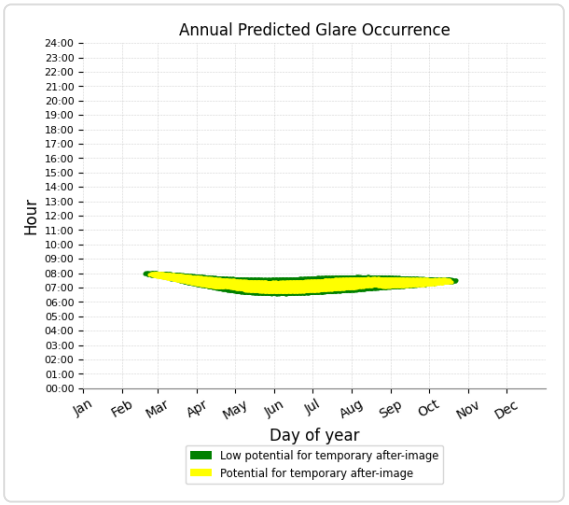


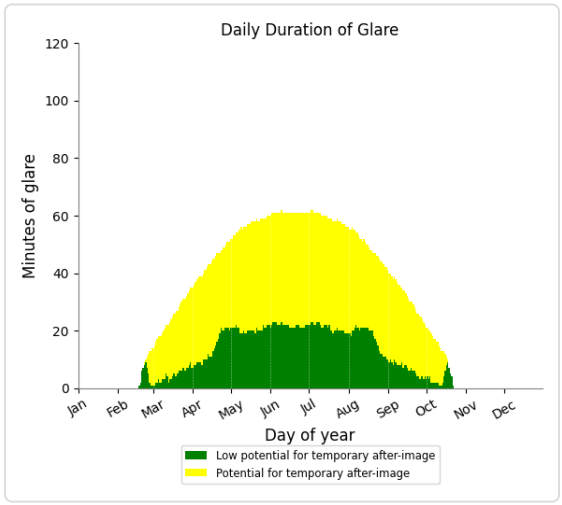


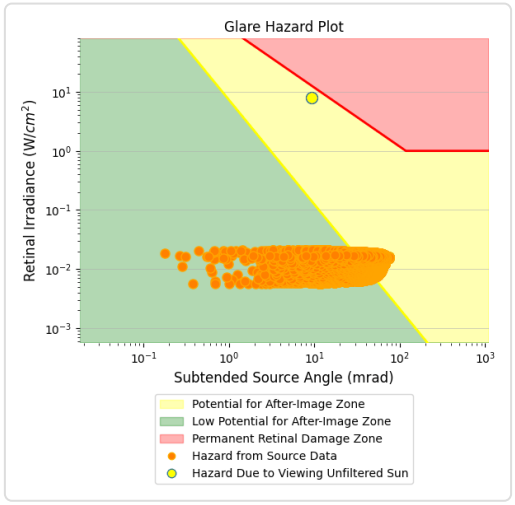
UV-07 and Route: N198 ri oost

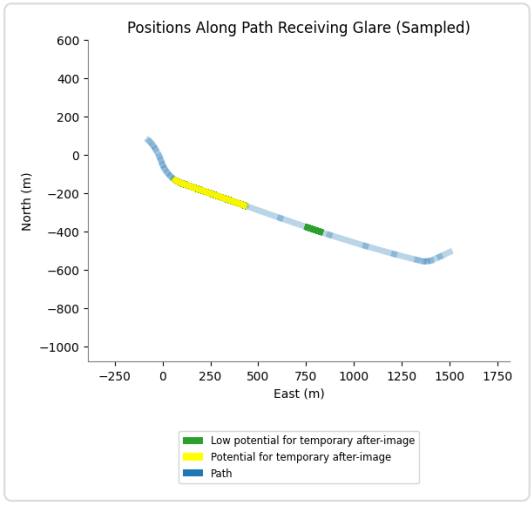
Yellow glare: 7,036 min.

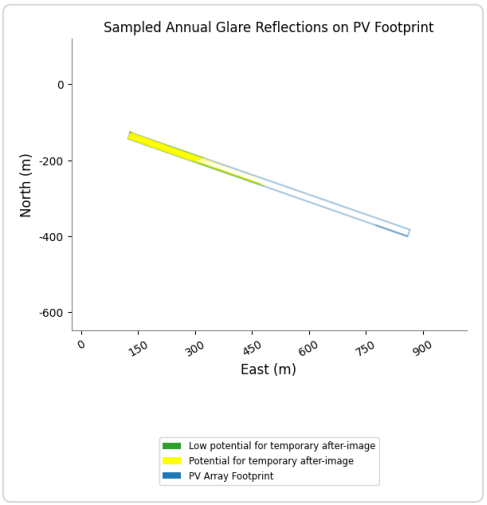
Green glare: 3,370 min.







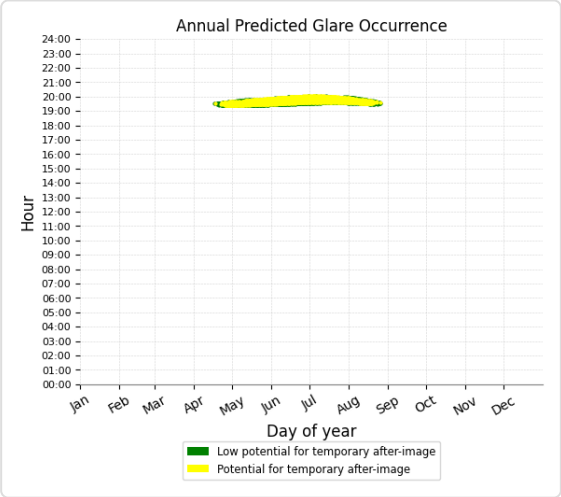


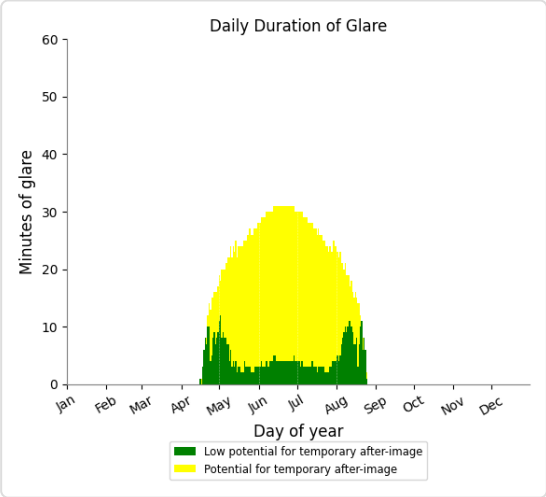


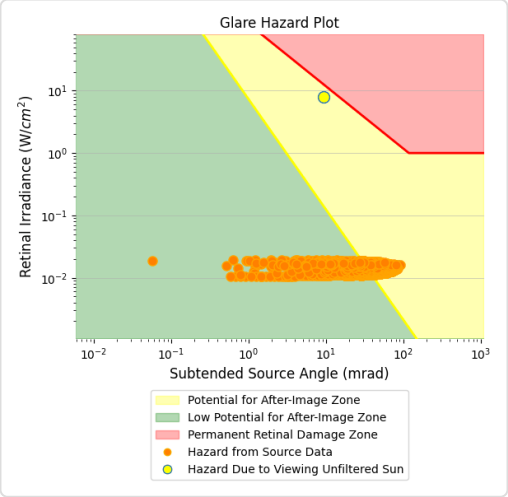
UV-07 and Route: N198 ri west

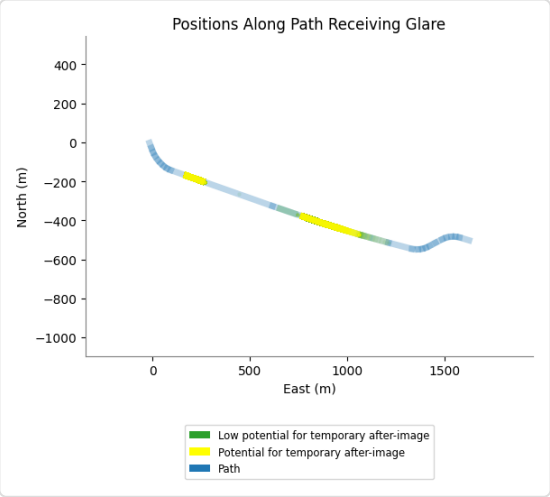
Yellow glare: 2,406 min.

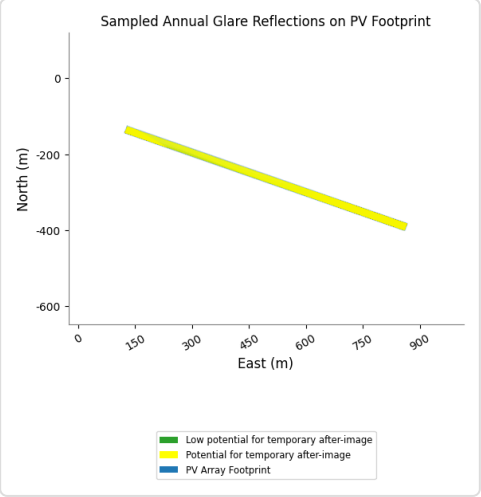
Green glare: 632 min.











UV-07 and Route: N419 ri oost

No glare found

UV-07 and Route: N419 ri west

No glare found

PV: UV-08 potential temporary after-image

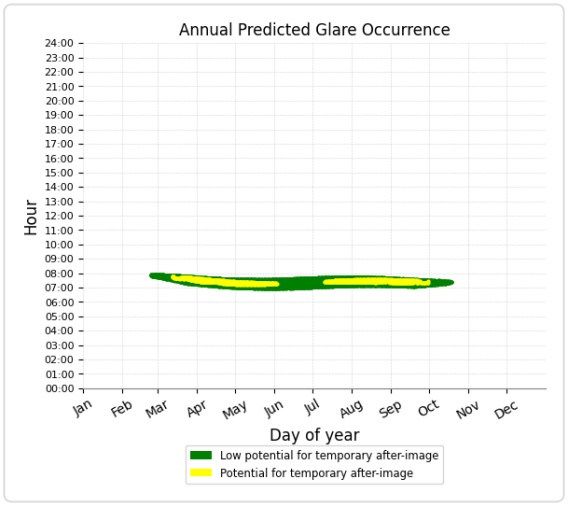
Receptor results ordered by category of glare

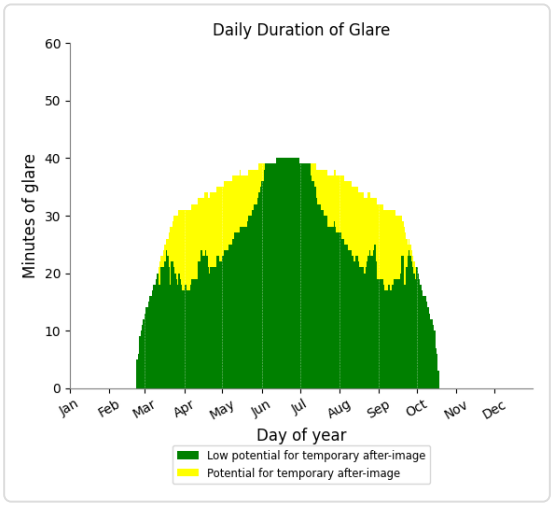
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	5,883	98.0	1,590	26.5
A12 ri west	2,431	40.5	1,186	19.8
N198 ri oost	3,493	58.2	6,330	105.5
N198 ri west	594	9.9	2,797	46.6
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

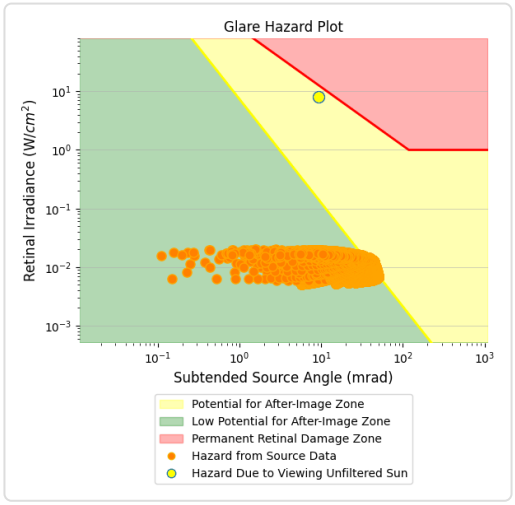
UV-08 and Route: A12 ri oost

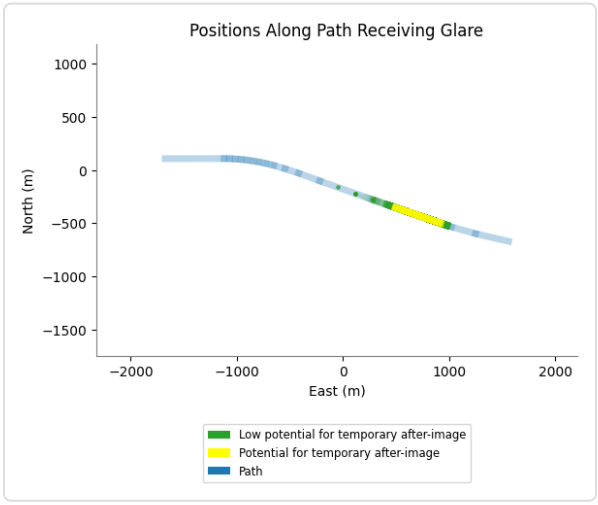
Yellow glare: 1,590 min.

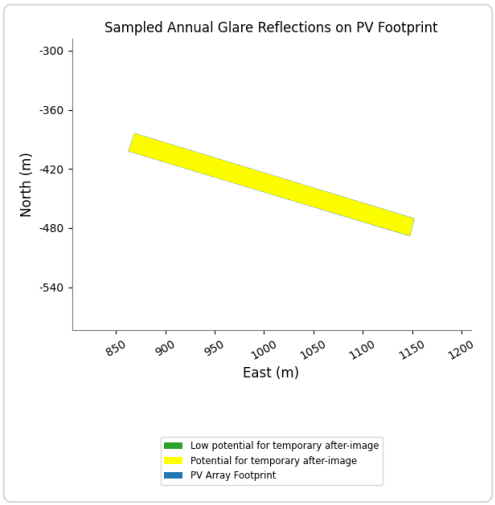
Green glare: 5,883 min.







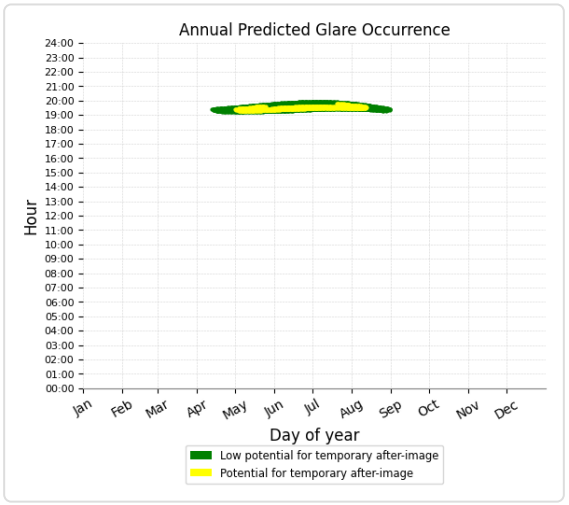


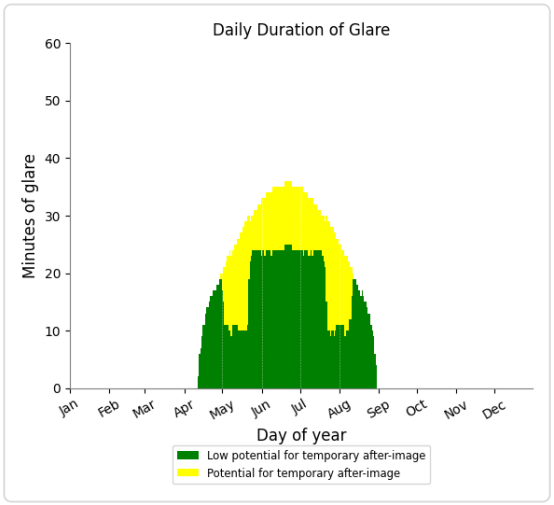


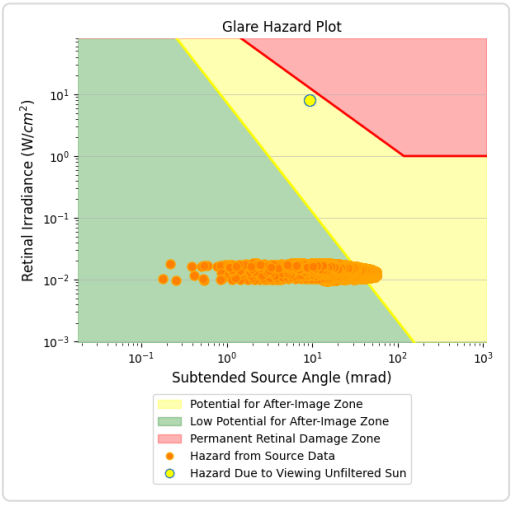
UV-08 and Route: A12 ri west

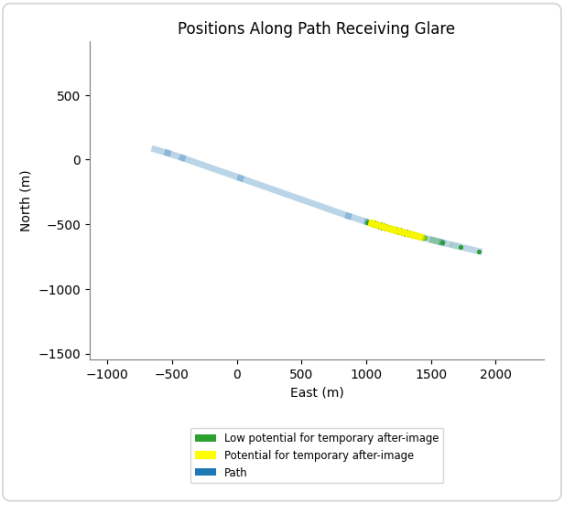
Yellow glare: 1,186 min.

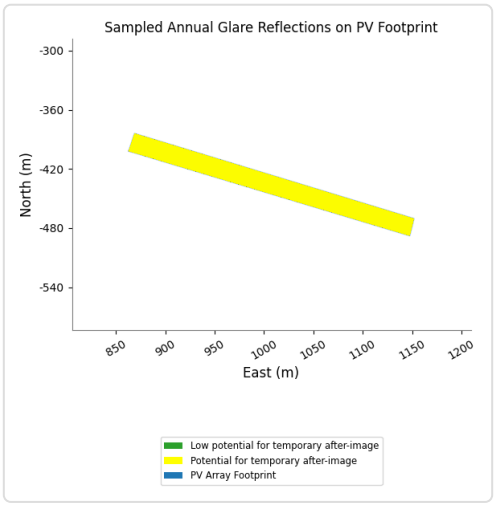
Green glare: 2,431 min.







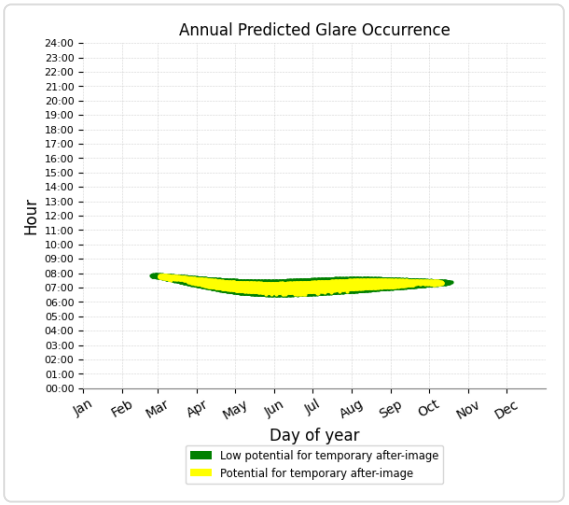


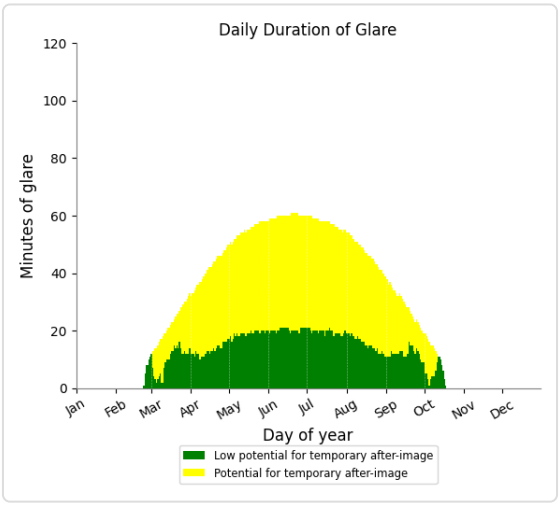


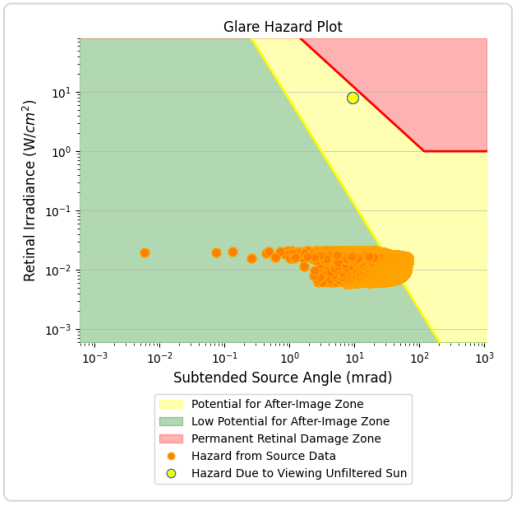
UV-08 and Route: N198 ri oost

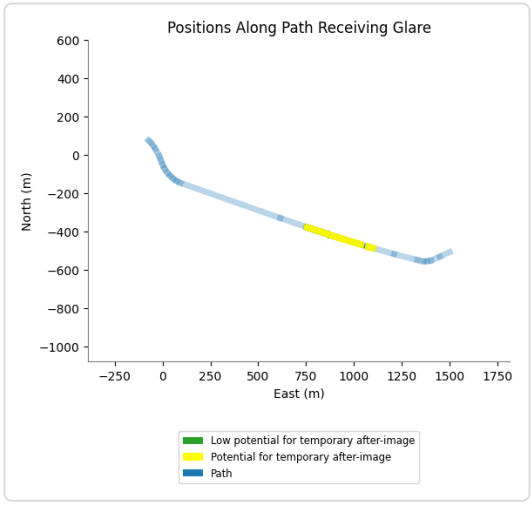
Yellow glare: 6,330 min.

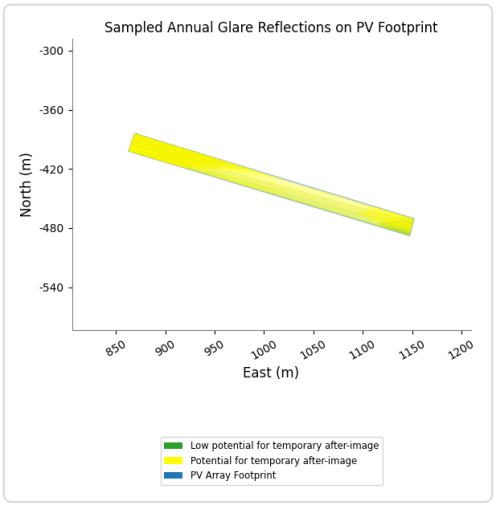
Green glare: 3,493 min.







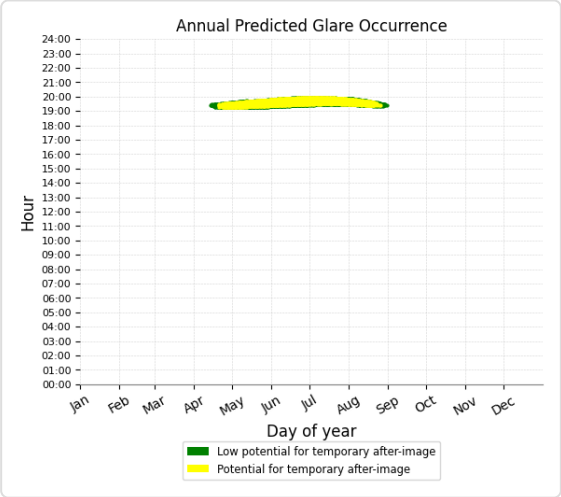


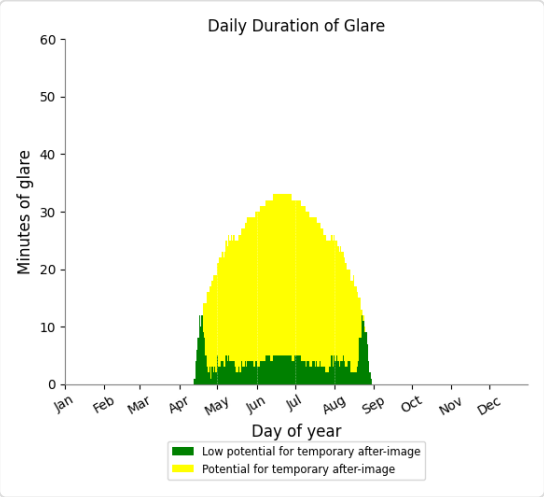


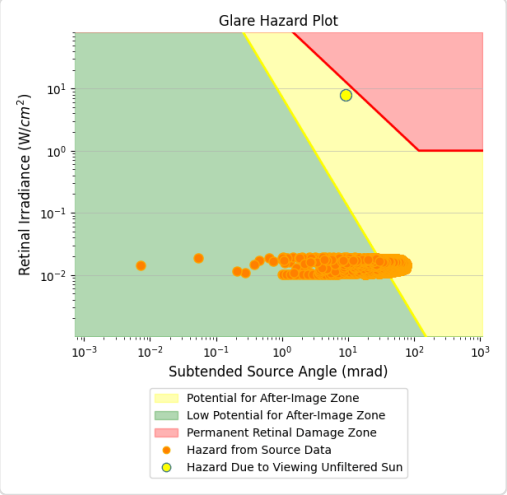
UV-08 and Route: N198 ri west

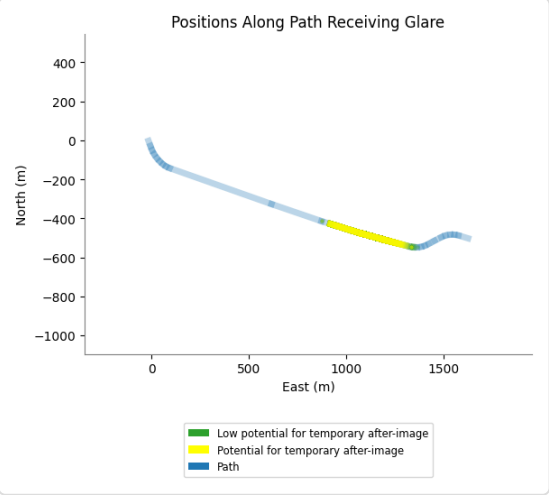
Yellow glare: 2,797 min.

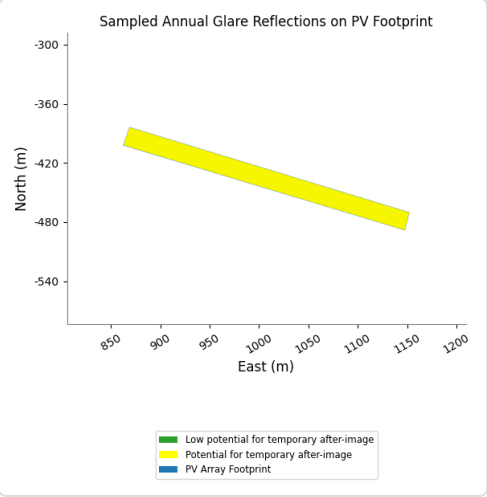
Green glare: 594 min.











UV-08 and Route: N419 ri oost

No glare found

UV-08 and Route: N419 ri west

No glare found

PV: UV-09 potential temporary after-image

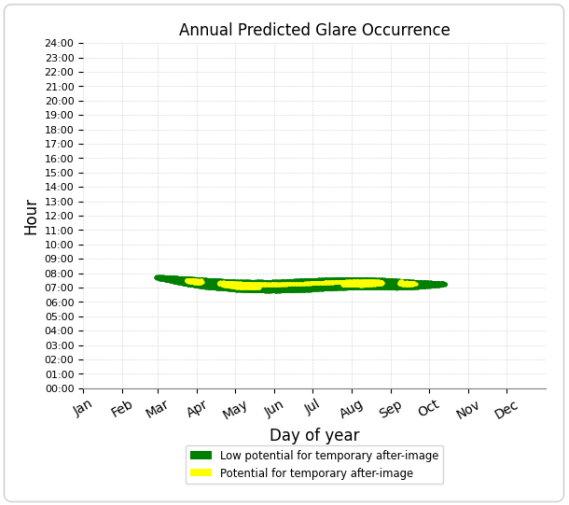
Receptor results ordered by category of glare

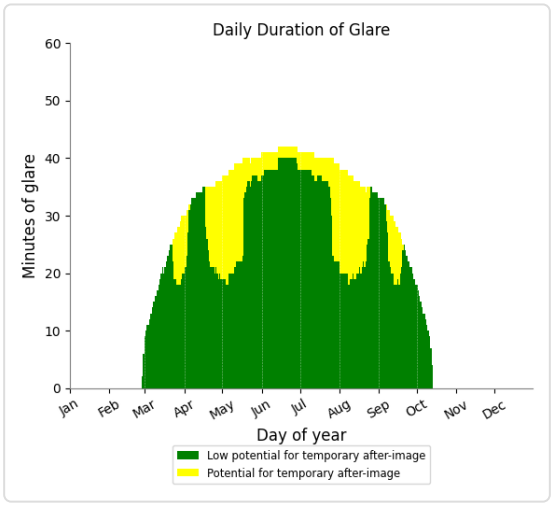
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	6,045	100.8	1,406	23.4
A12 ri west	3,206	53.4	5	0.1
N198 ri oost	2,538	42.3	5,352	89.2
N198 ri west	1,097	18.3	3,019	50.3
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

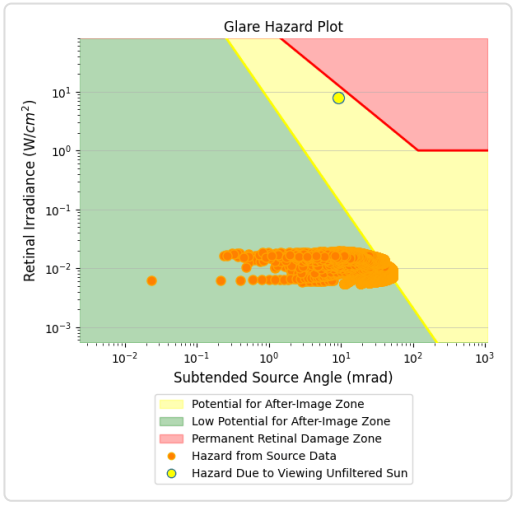
UV-09 and Route: A12 ri oost

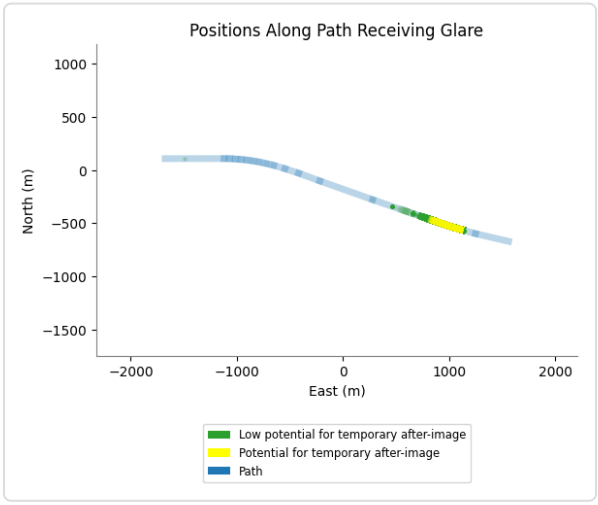
Yellow glare: 1,406 min.

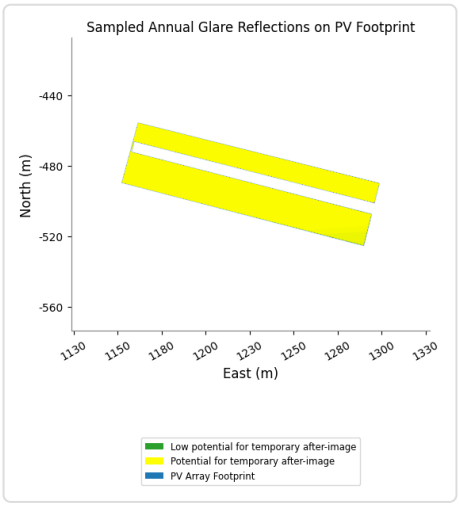
Green glare: 6,045 min.







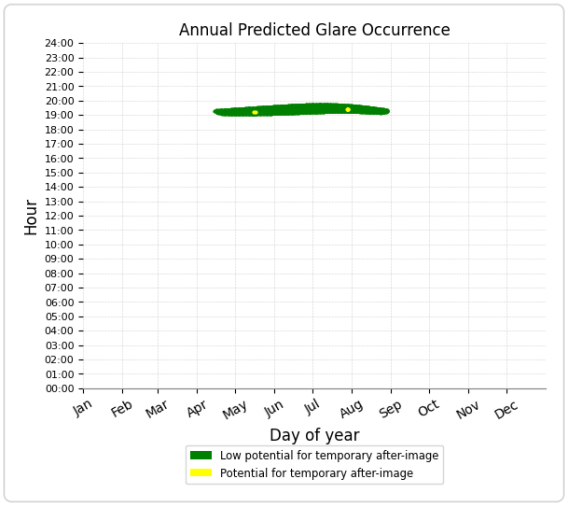


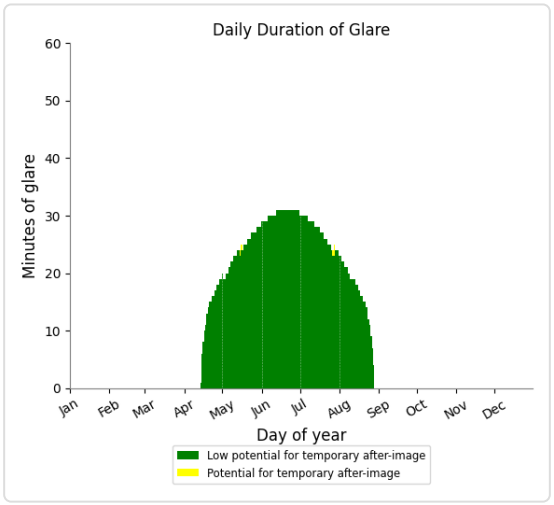


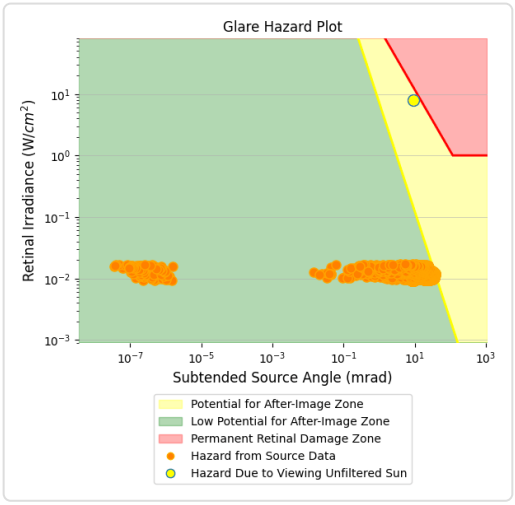
UV-09 and Route: A12 ri west

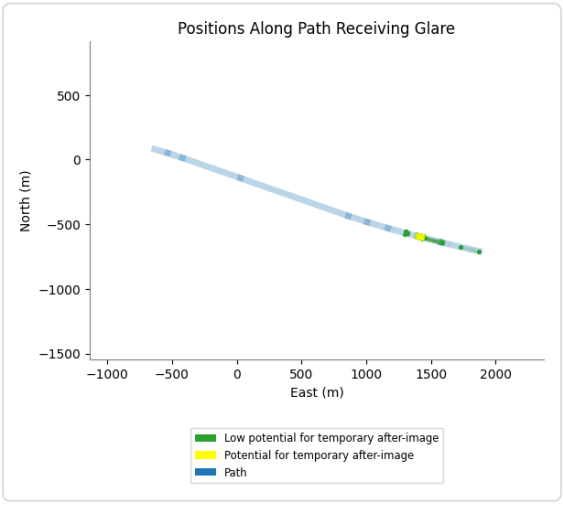
Yellow glare: 5 min.

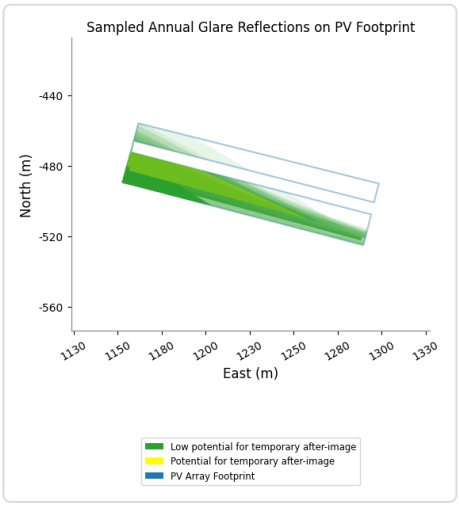
Green glare: 3,206 min.







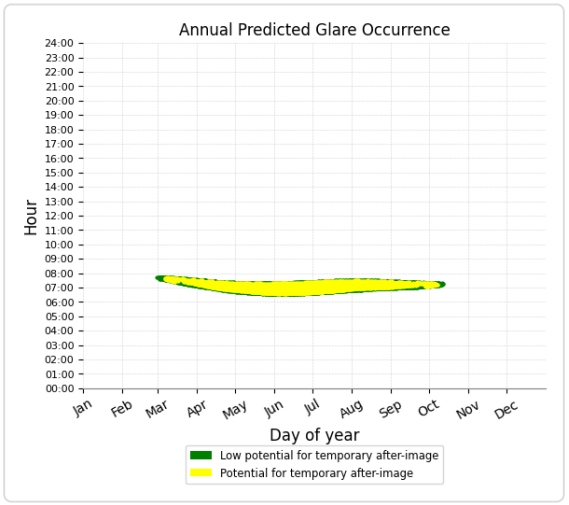


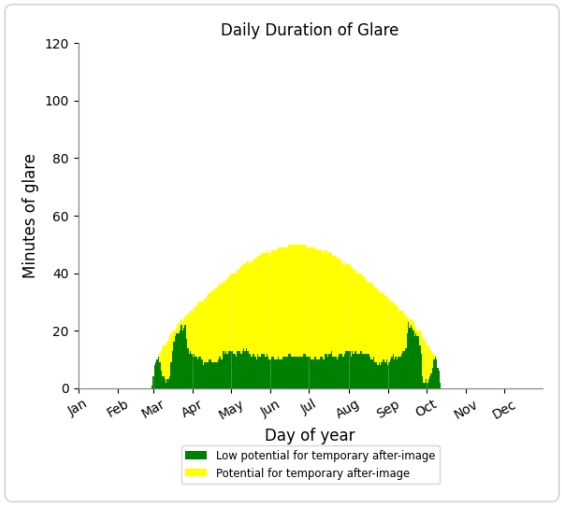


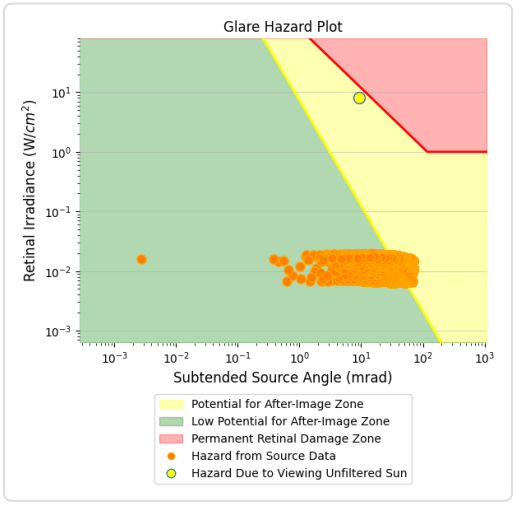
UV-09 and Route: N198 ri oost

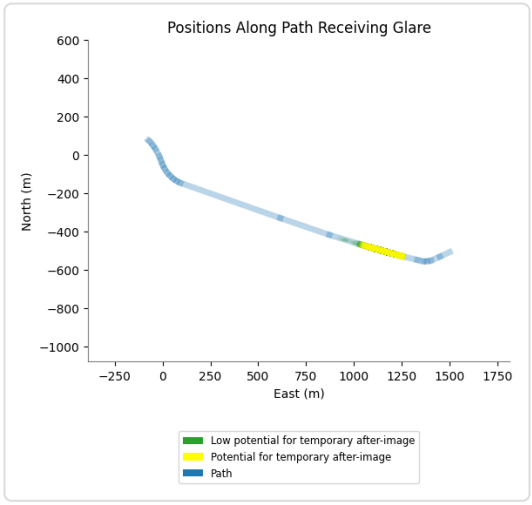
Yellow glare: 5,352 min.

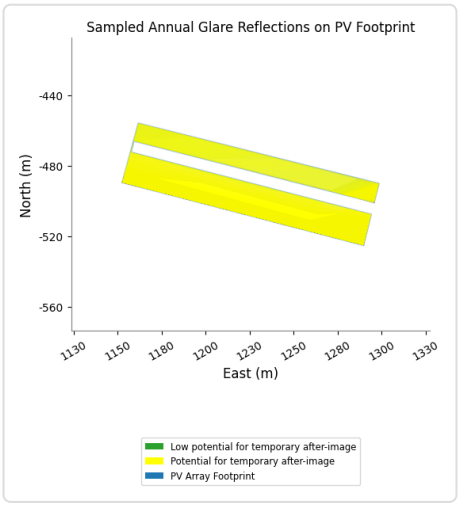
Green glare: 2,538 min.







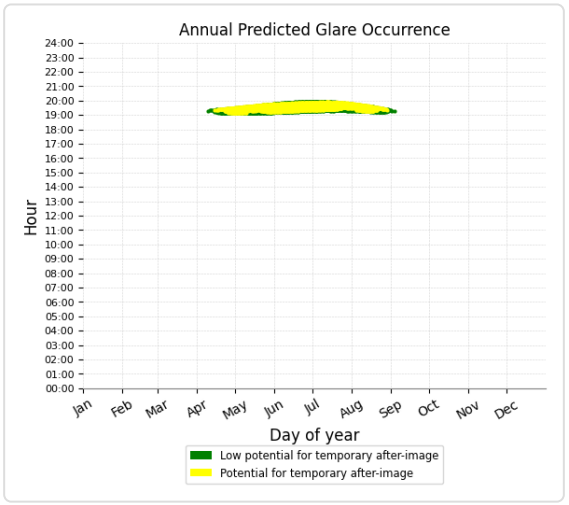


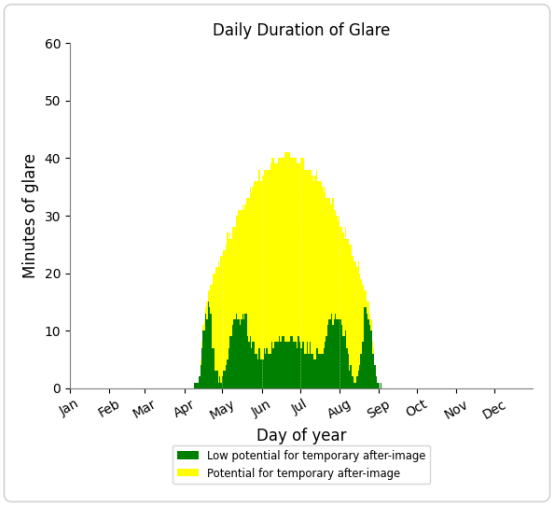


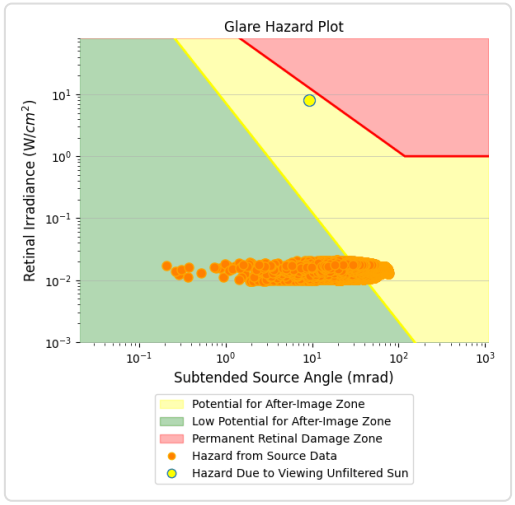
UV-09 and Route: N198 ri west

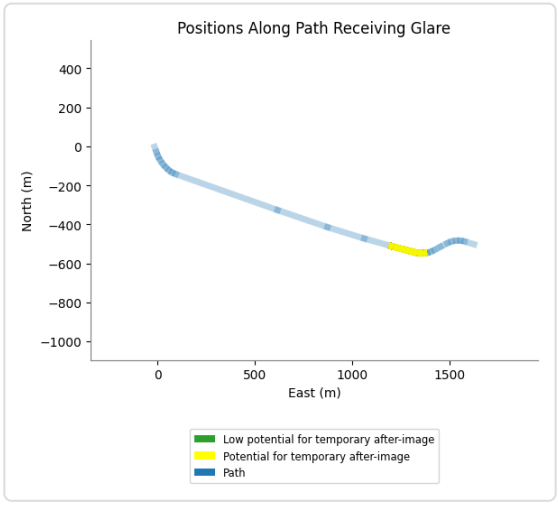
Yellow glare: 3,019 min.

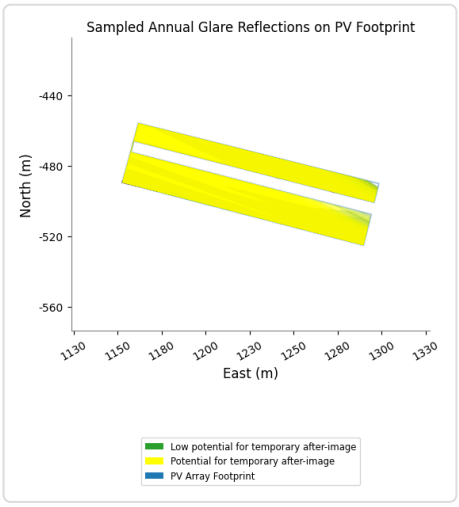
Green glare: 1,097 min.











UV-09 and Route: N419 ri oost

No glare found

UV-09 and Route: N419 ri west

No glare found

PV: UV-10 potential temporary after-image

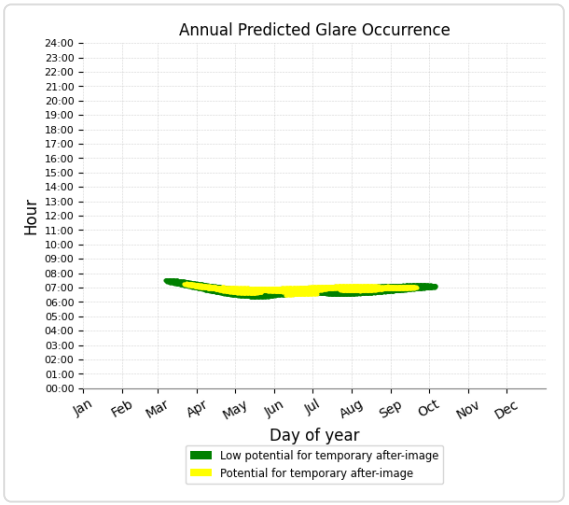
Receptor results ordered by category of glare

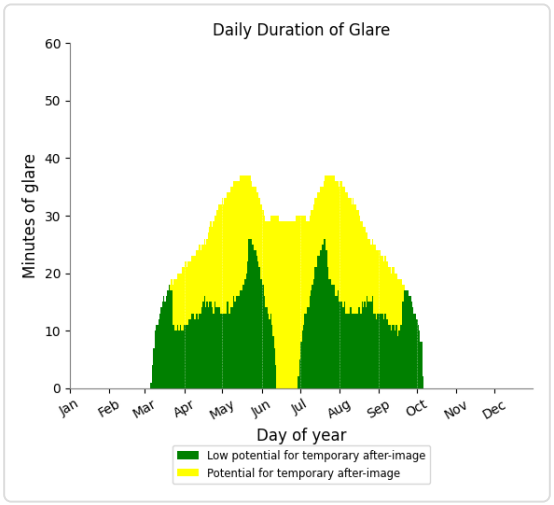
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	2,852	47.5	2,893	48.2
A12 ri oost	7,037	117.3	0	0.0
A12 ri west	2,274	37.9	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

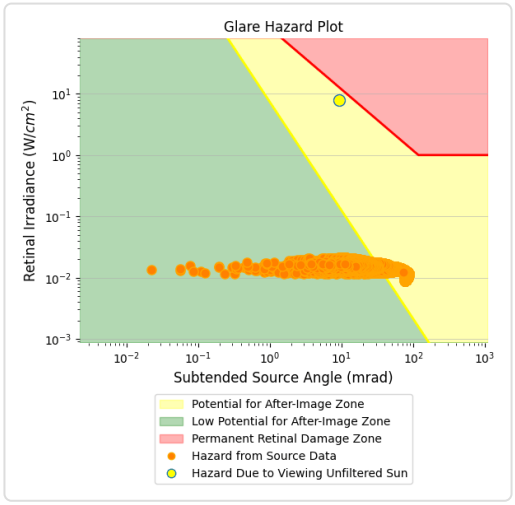
UV-10 and Route: N198 ri oost

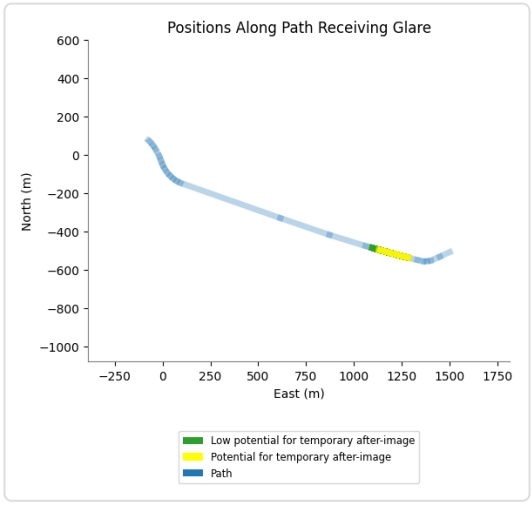
Yellow glare: 2,893 min.

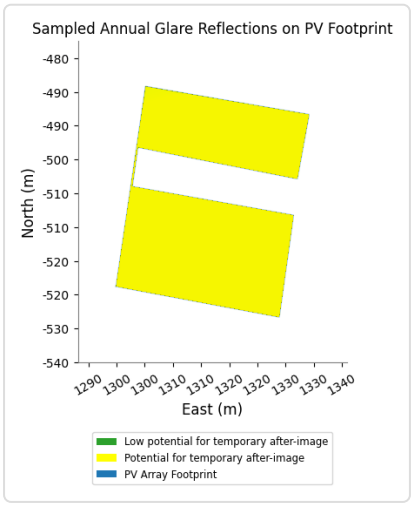
Green glare: 2,852 min.







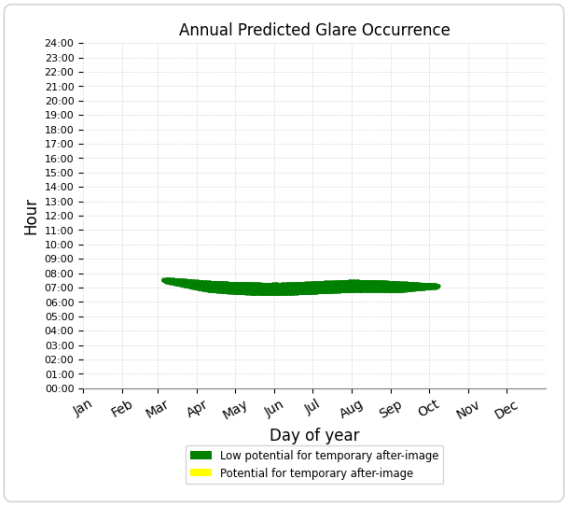


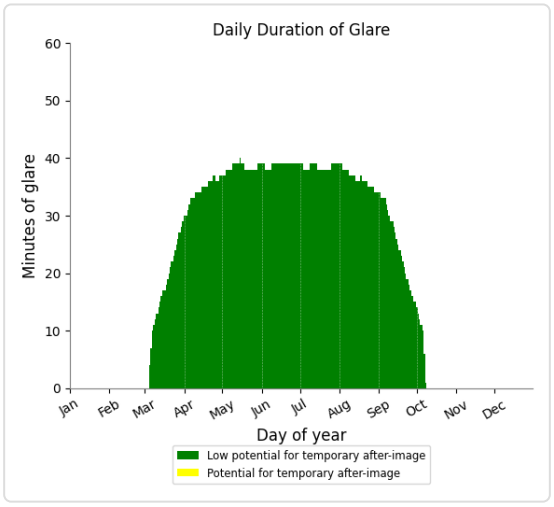


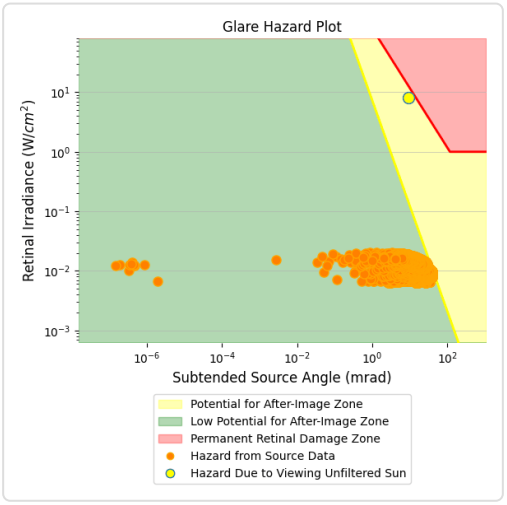
UV-10 and Route: A12 ri oost

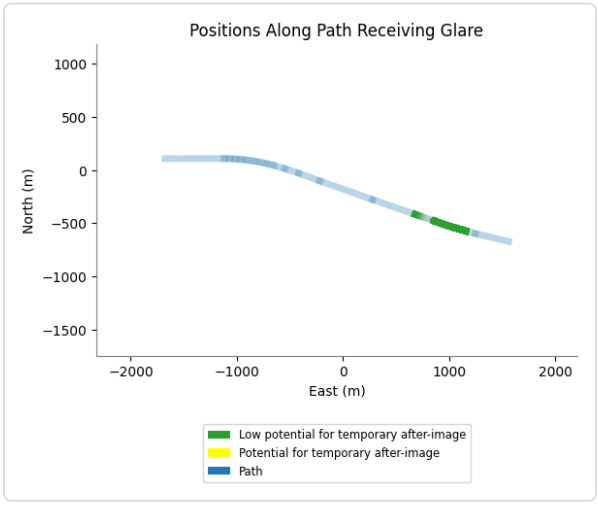
Yellow glare: none

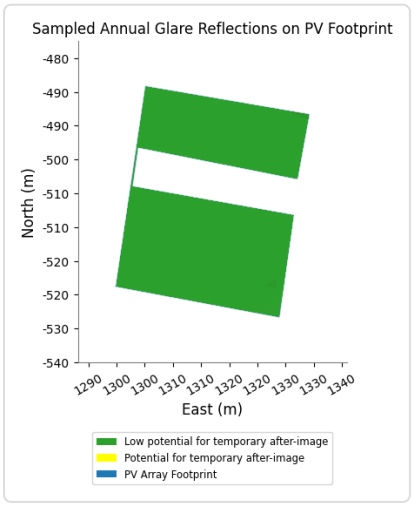
Green glare: 7,037 min.







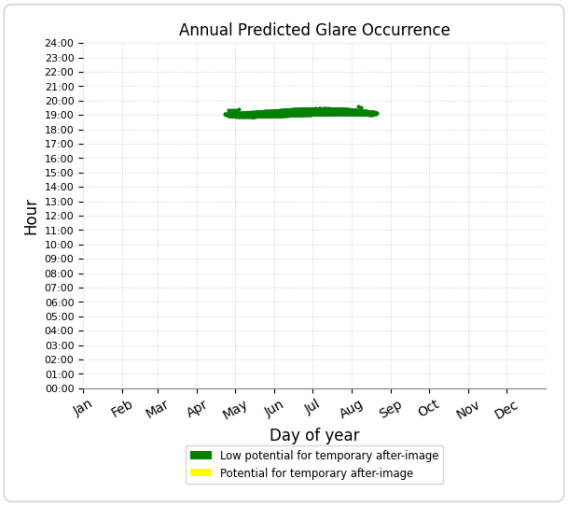


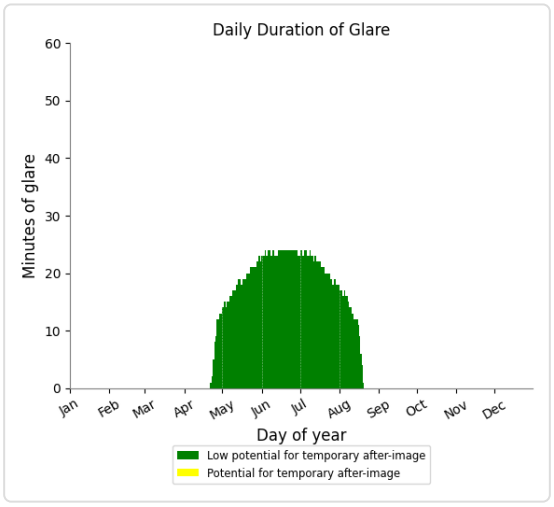


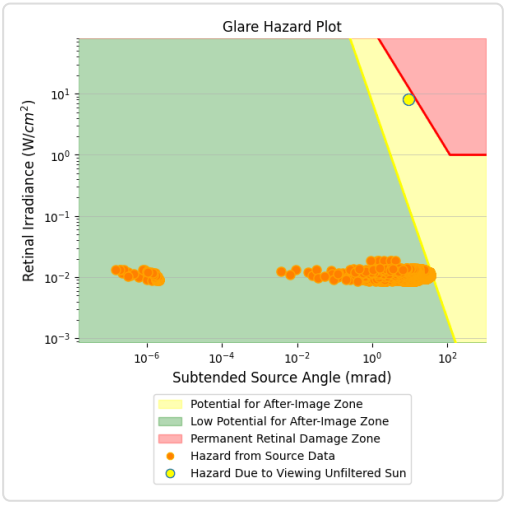
UV-10 and Route: A12 ri west

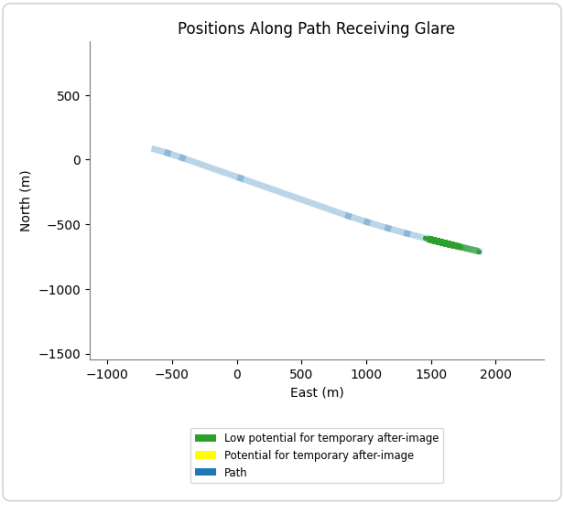
Yellow glare: none

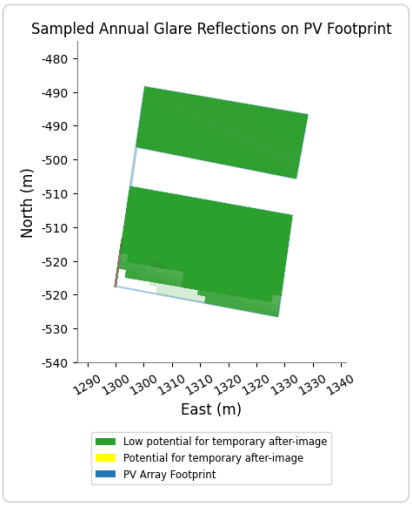
Green glare: 2,274 min.











UV-10 and Route: N198 ri west

No glare found

UV-10 and Route: N419 ri oost

No glare found

UV-10 and Route: N419 ri west

No glare found

PV: UV-11 potential temporary after-image

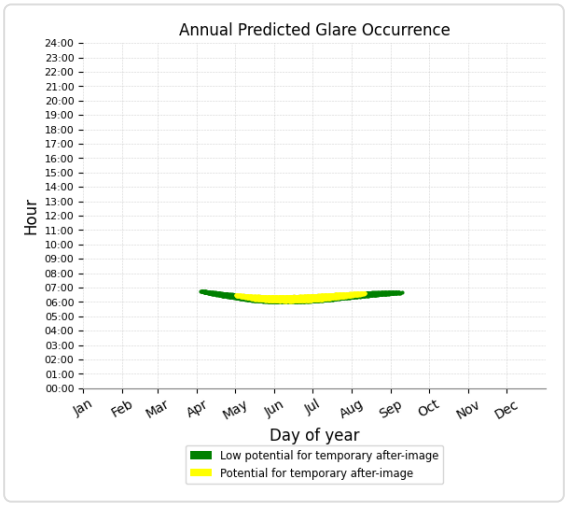
Receptor results ordered by category of glare

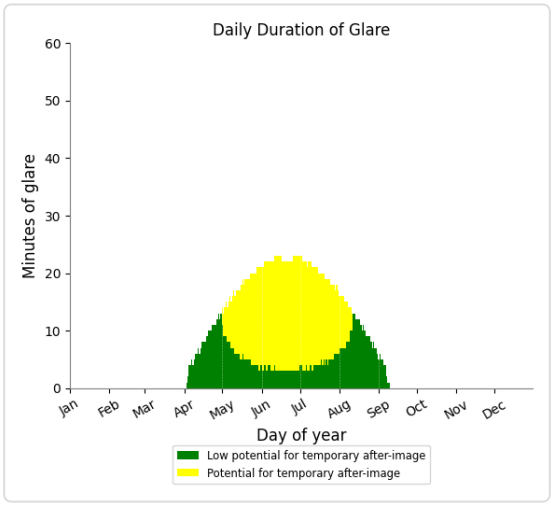
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	948	15.8	1,509	25.1
A12 ri oost	3,987	66.5	0	0.0
A12 ri west	2,497	41.6	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

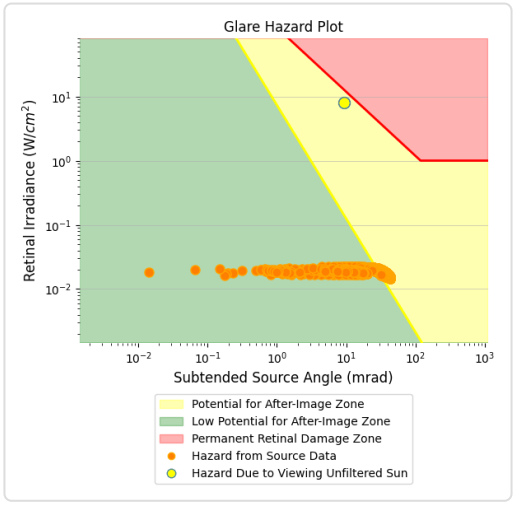
UV-11 and Route: N198 ri oost

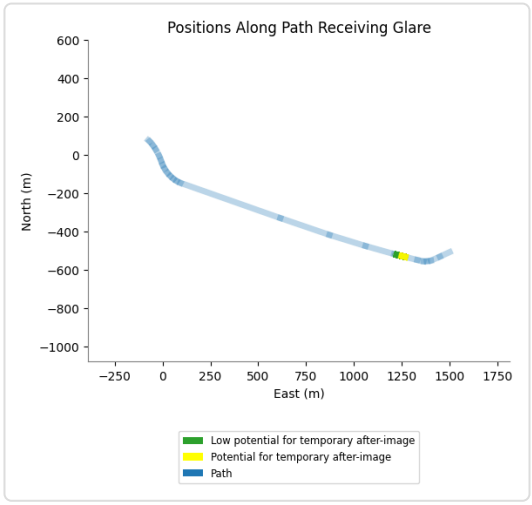
Yellow glare: 1,509 min.

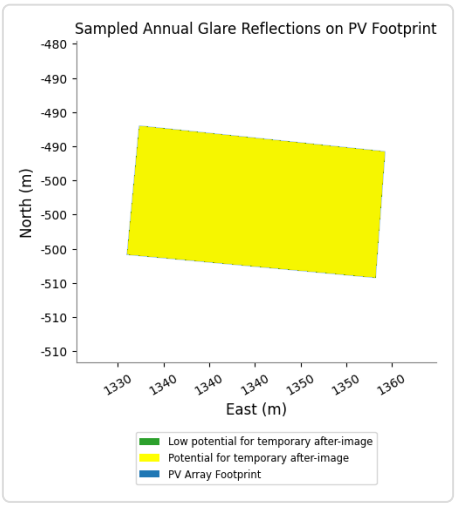
Green glare: 948 min.







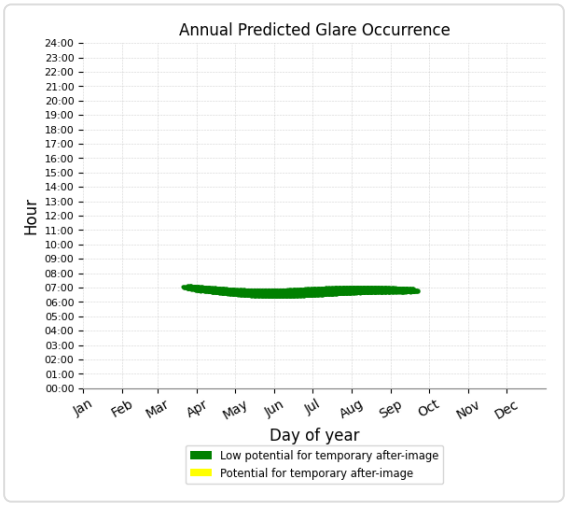


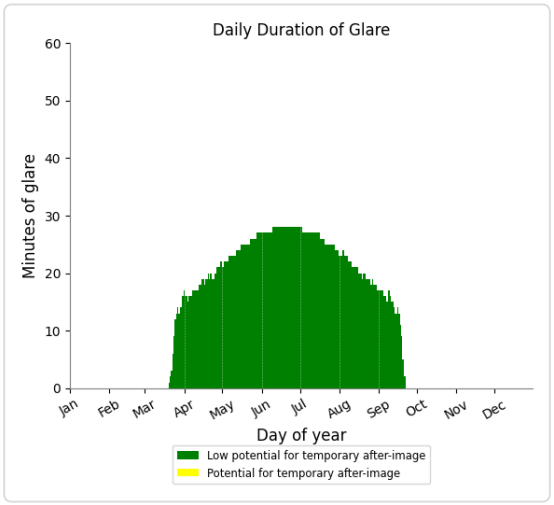


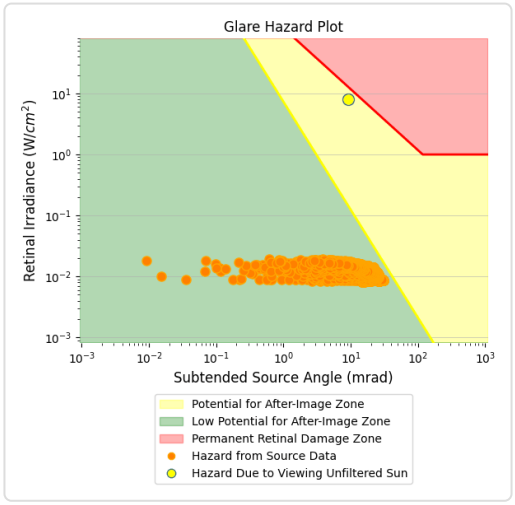
UV-11 and Route: A12 ri oost

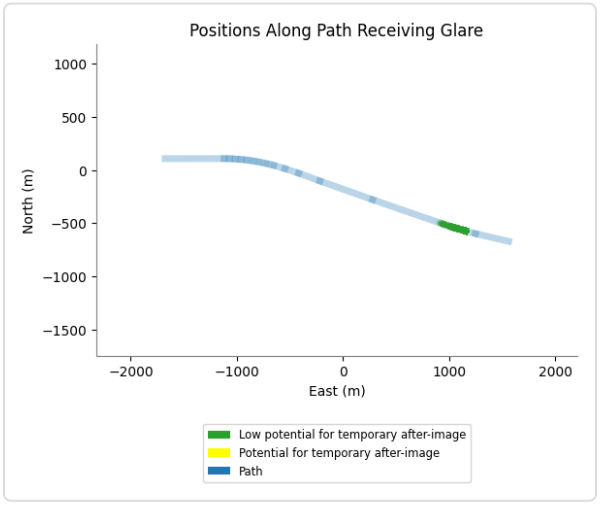
Yellow glare: none

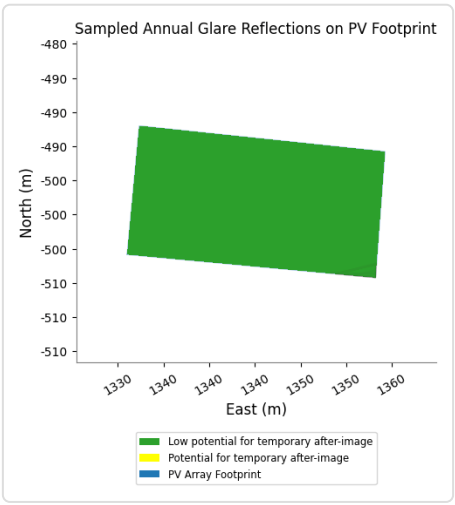
Green glare: 3,987 min.







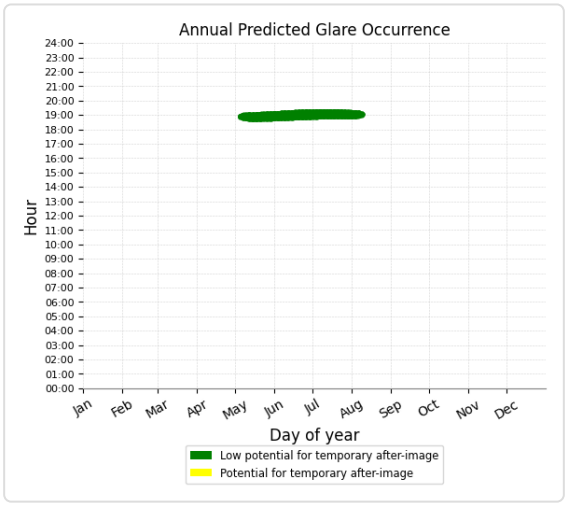


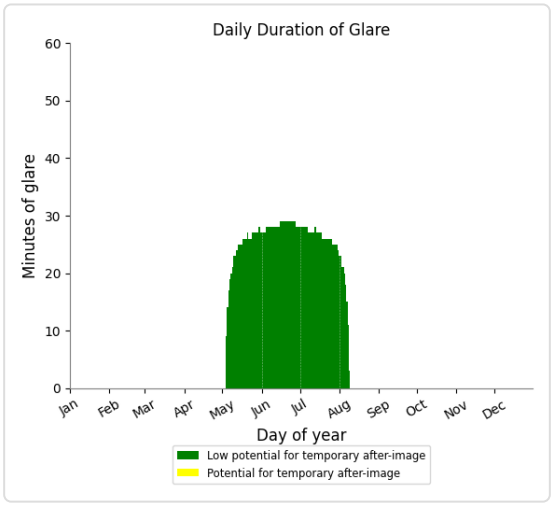


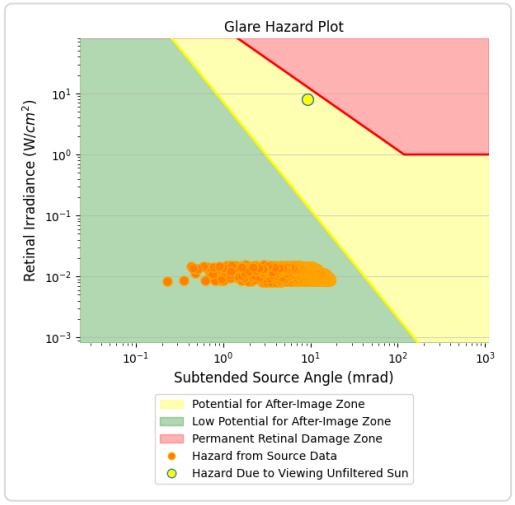
UV-11 and Route: A12 ri west

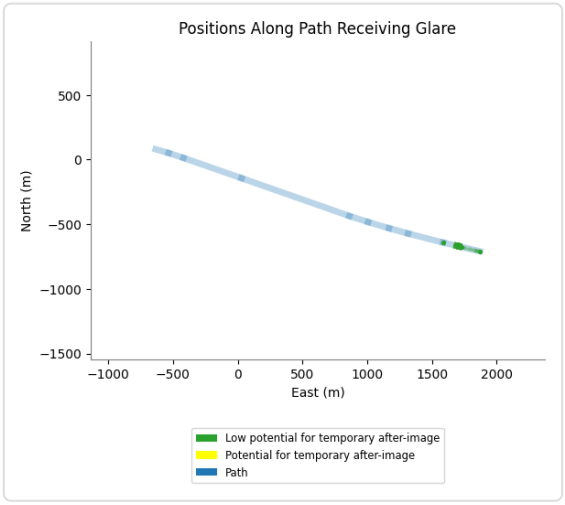
Yellow glare: none

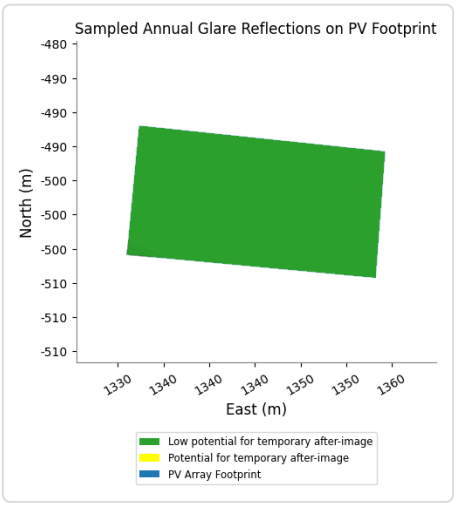
Green glare: 2,497 min.











UV-11 and Route: N198 ri west

No glare found

UV-11 and Route: N419 ri oost

No glare found

UV-11 and Route: N419 ri west

No glare found

PV: UV-12 potential temporary after-image

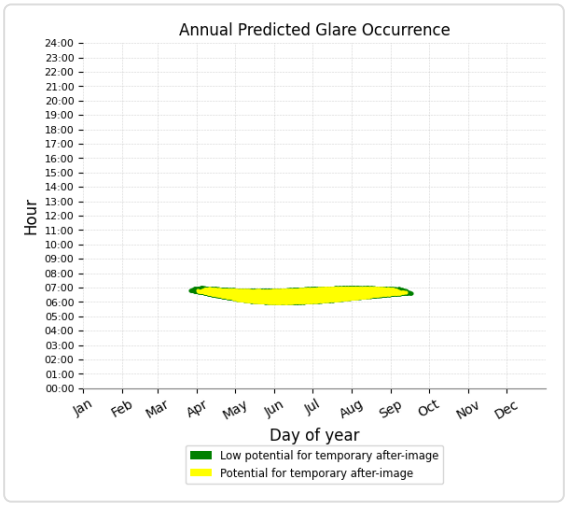
Receptor results ordered by category of glare

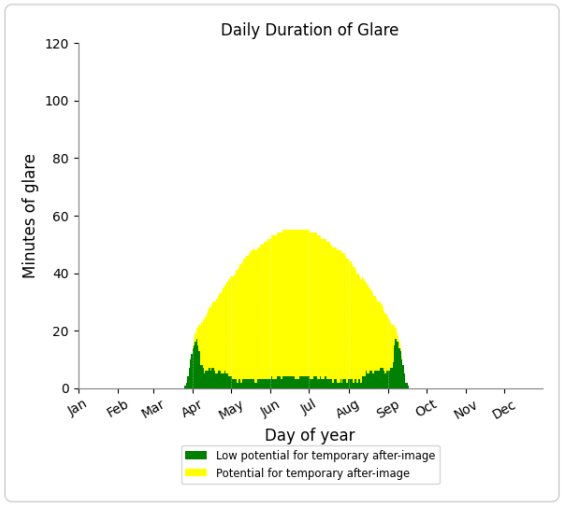
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri oost	855	14.2	6,020	100.3
A12 ri oost	5,619	93.7	0	0.0
A12 ri west	3,101	51.7	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

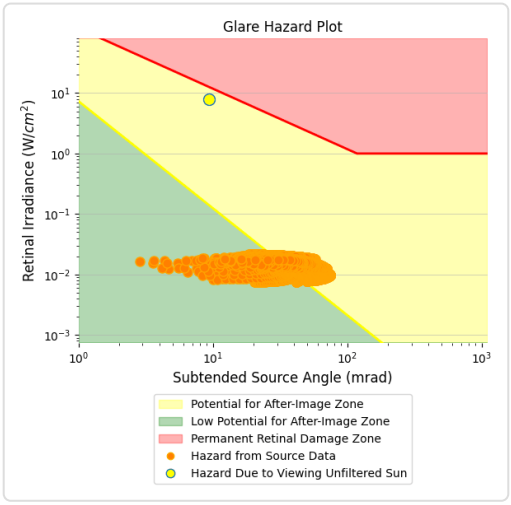
UV-12 and Route: N198 ri oost

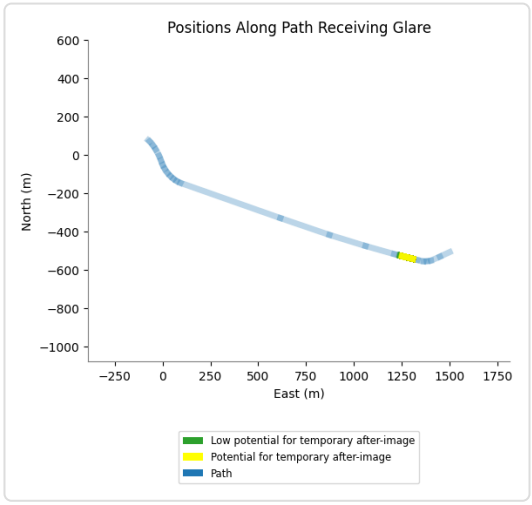
Yellow glare: 6,020 min.

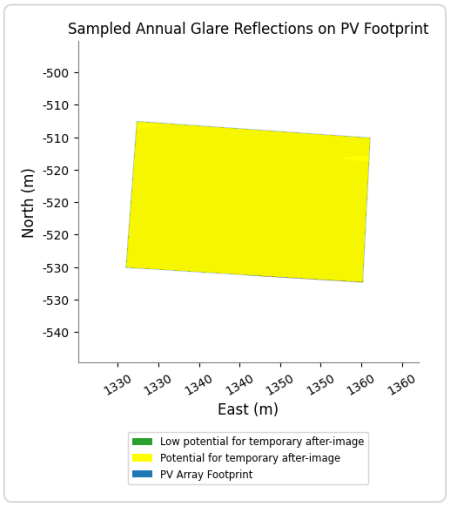
Green glare: 855 min.







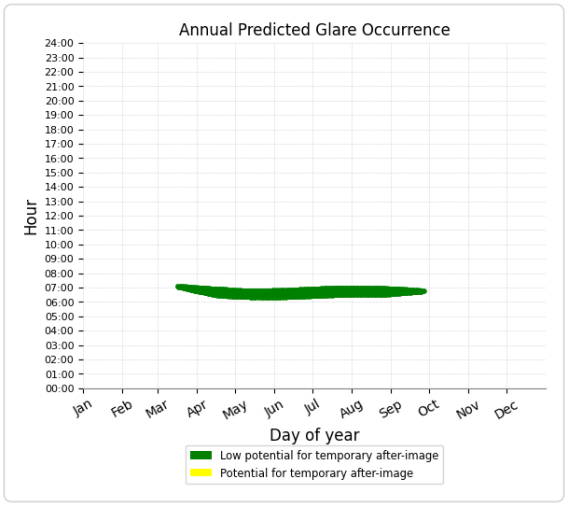


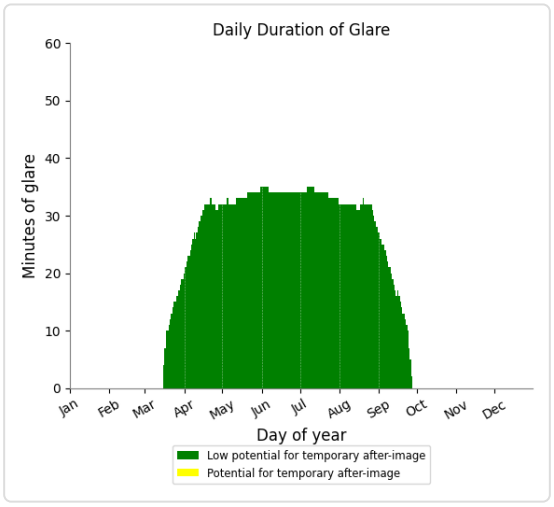


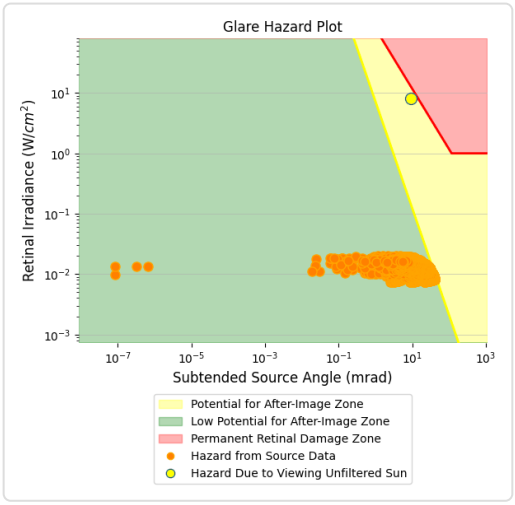
UV-12 and Route: A12 ri oost

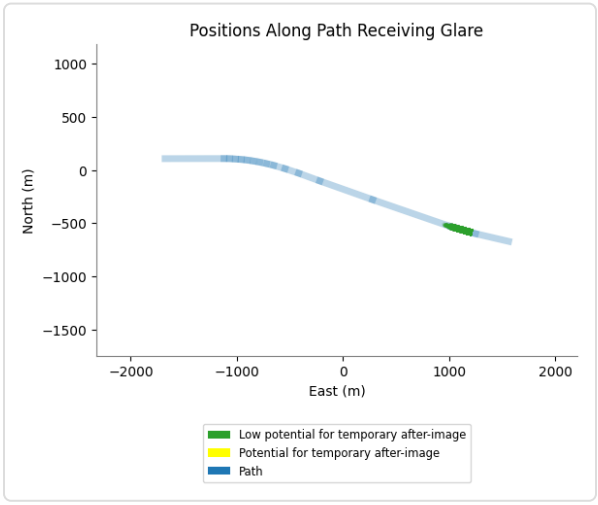
Yellow glare: none

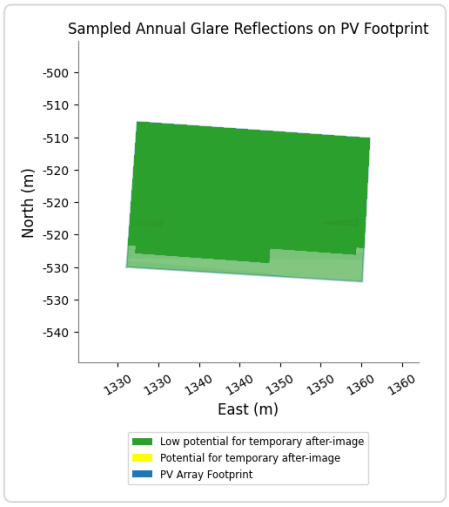
Green glare: 5,619 min.







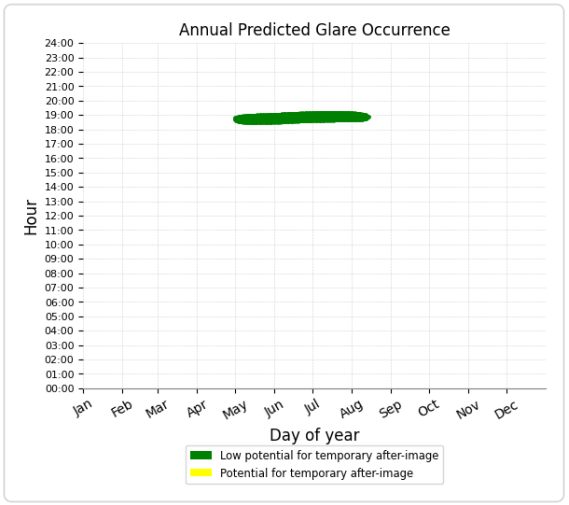


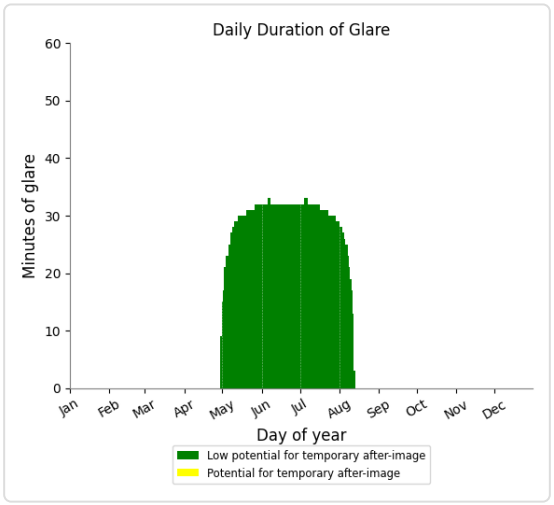


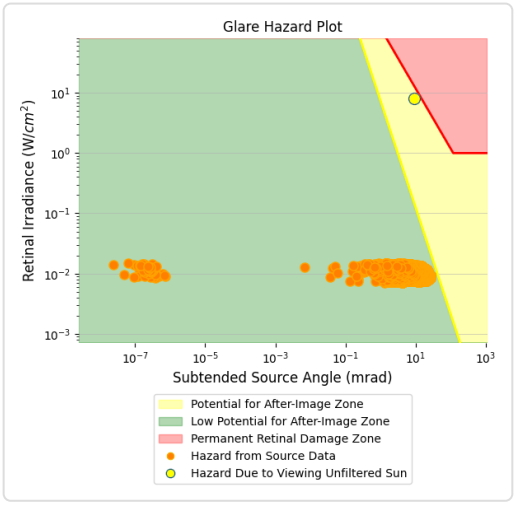
UV-12 and Route: A12 ri west

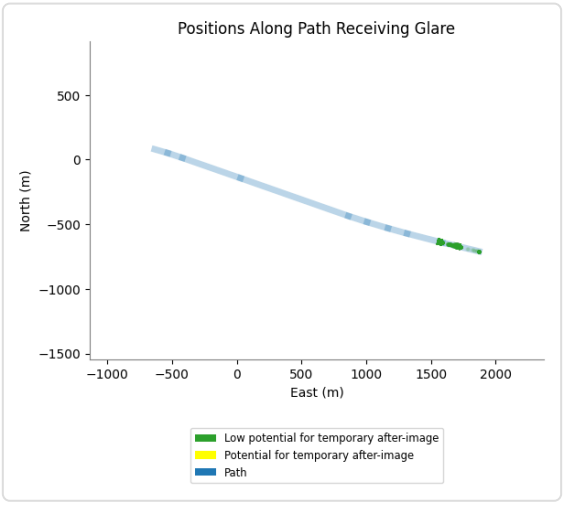
Yellow glare: none

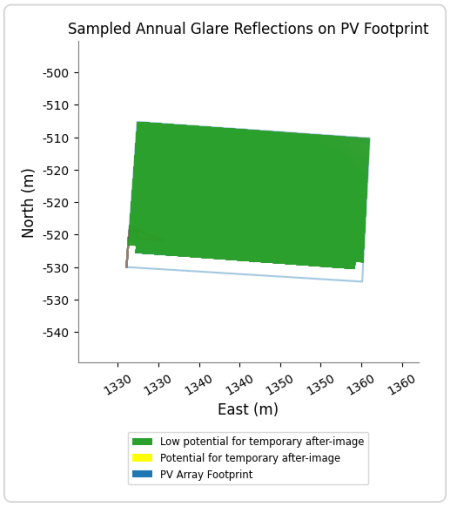
Green glare: 3,101 min.











UV-12 and Route: N198 ri west

No glare found

UV-12 and Route: N419 ri oost

No glare found

UV-12 and Route: N419 ri west

No glare found

PV: UV-13 potential temporary after-image

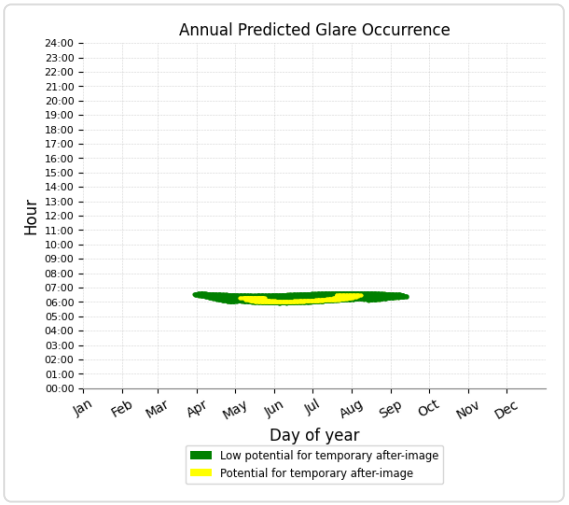
Receptor results ordered by category of glare

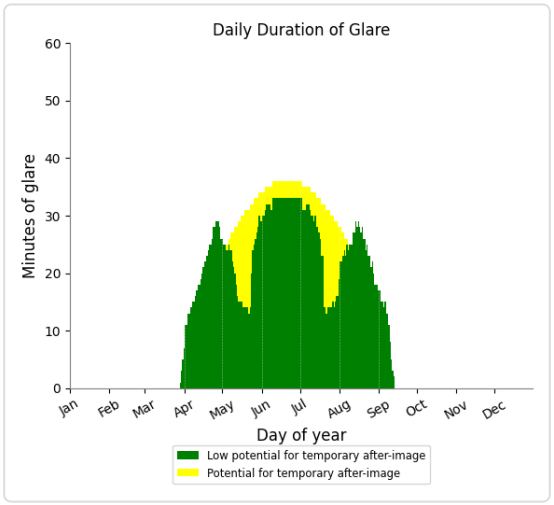
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	3,856	64.3	672	11.2
N198 ri oost	1,250	20.8	3,154	52.6
A12 ri west	2,228	37.1	0	0.0
N198 ri west	61	1.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

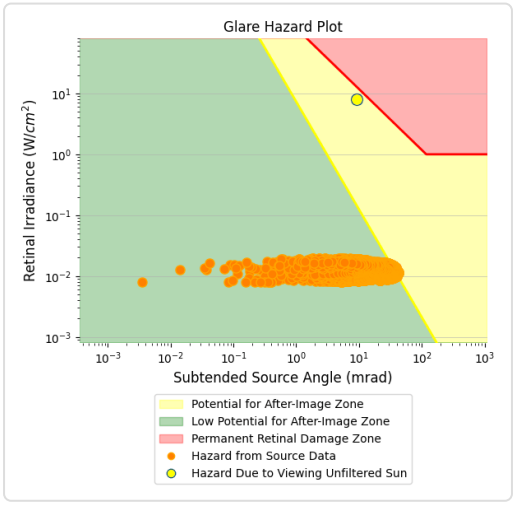
UV-13 and Route: A12 ri oost

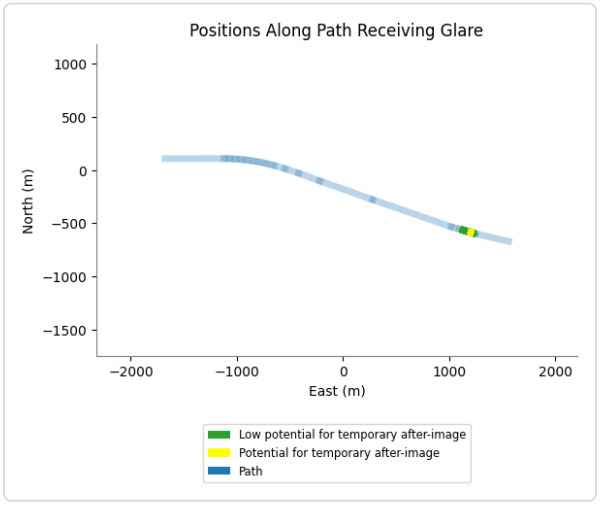
Yellow glare: 672 min.

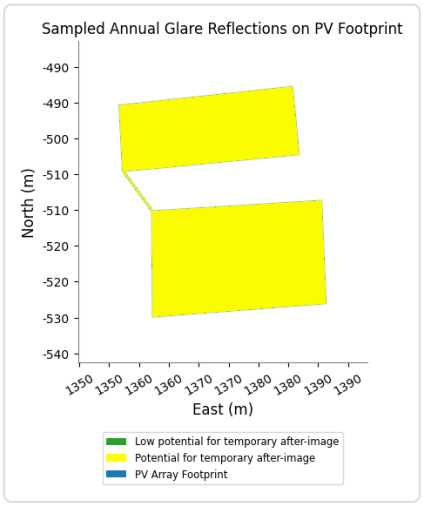
Green glare: 3,856 min.







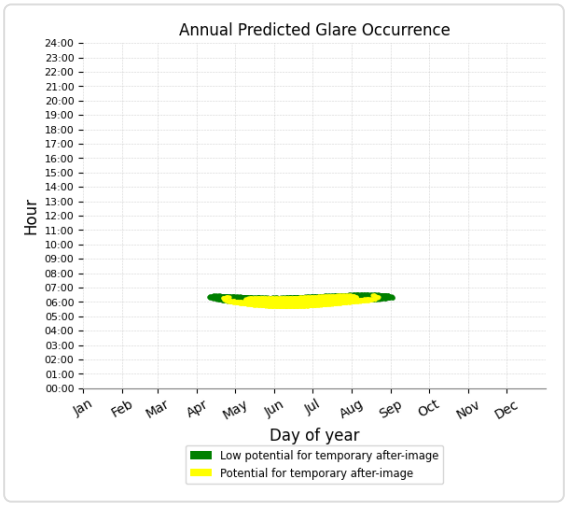


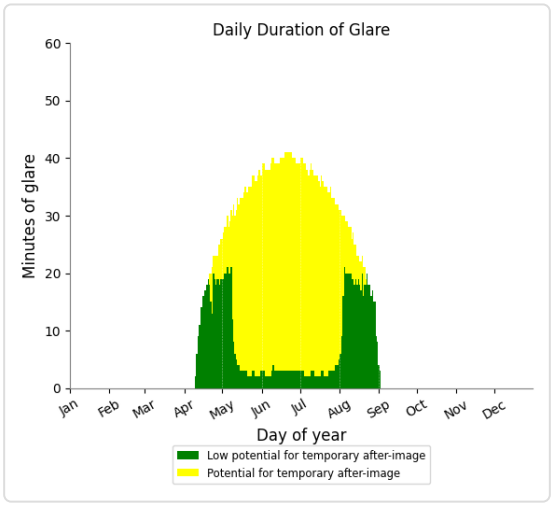


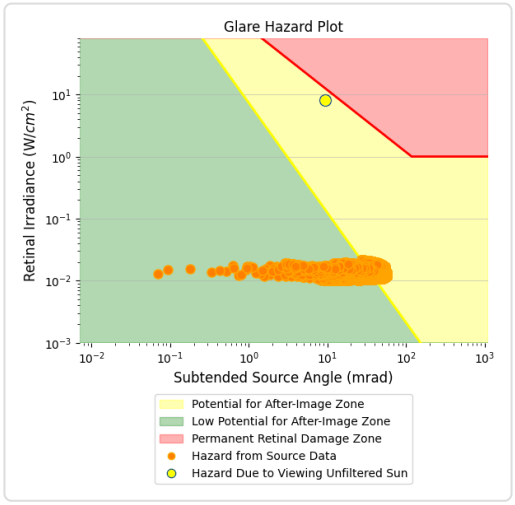
UV-13 and Route: N198 ri oost

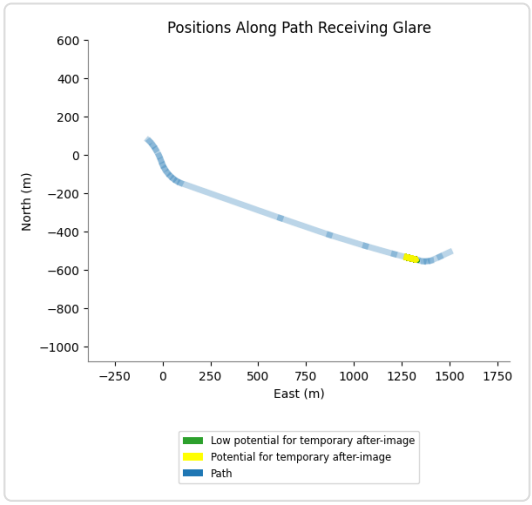
Yellow glare: 3,154 min.

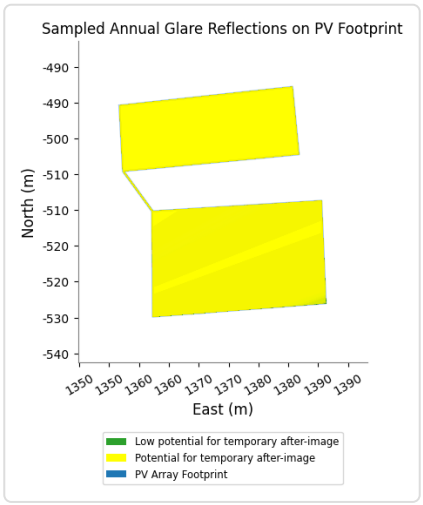
Green glare: 1,250 min.







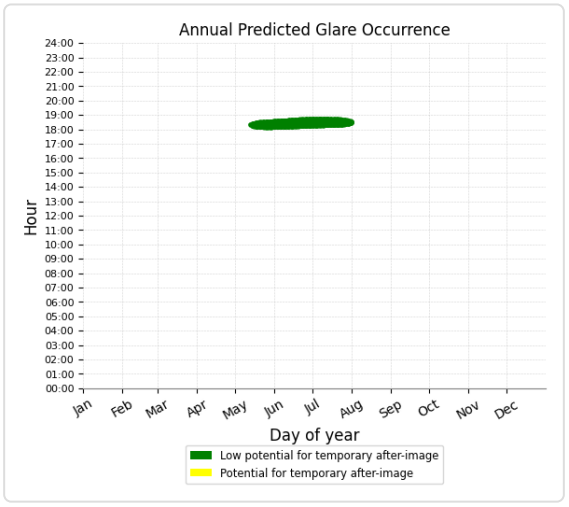


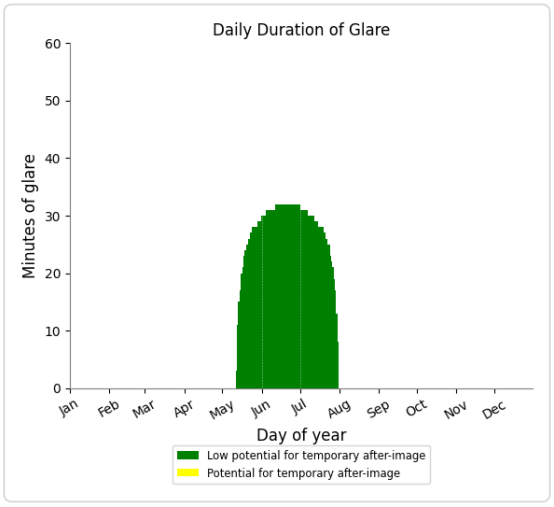


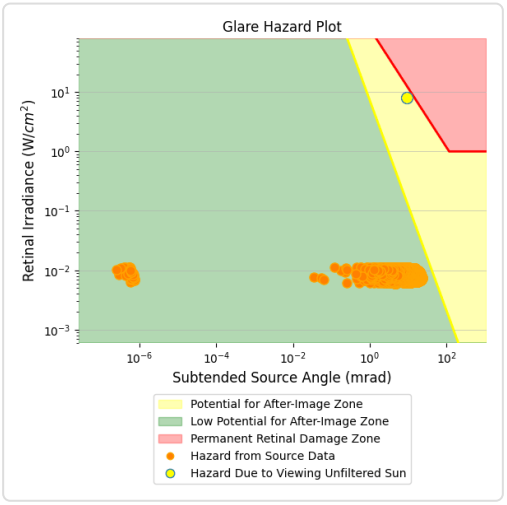
UV-13 and Route: A12 ri west

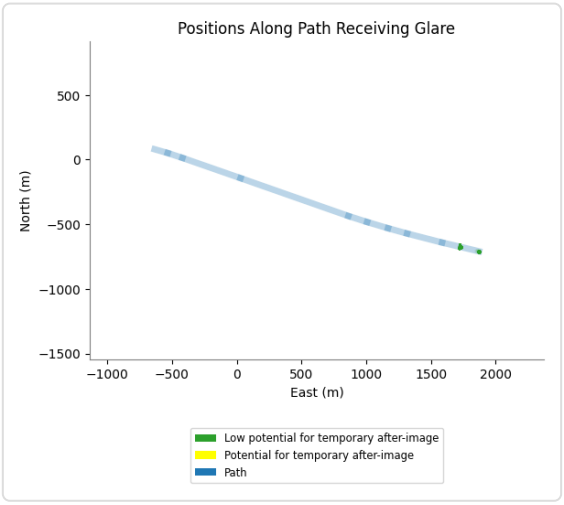
Yellow glare: none

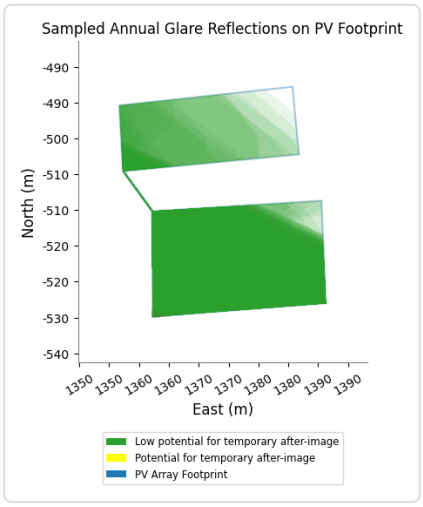
Green glare: 2,228 min.







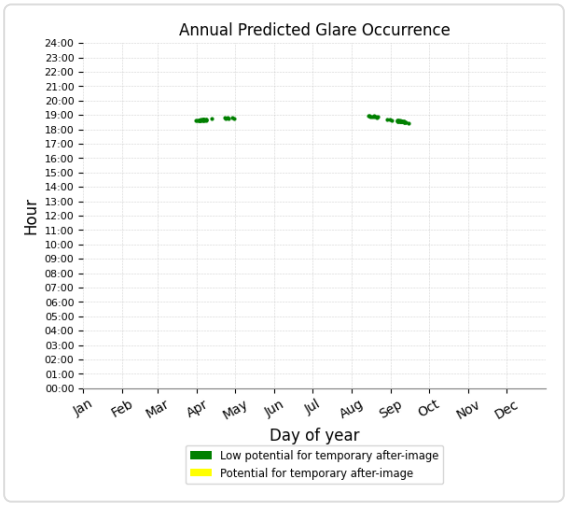


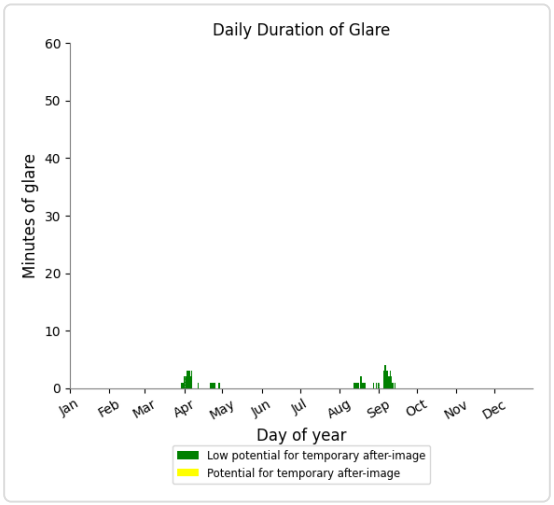


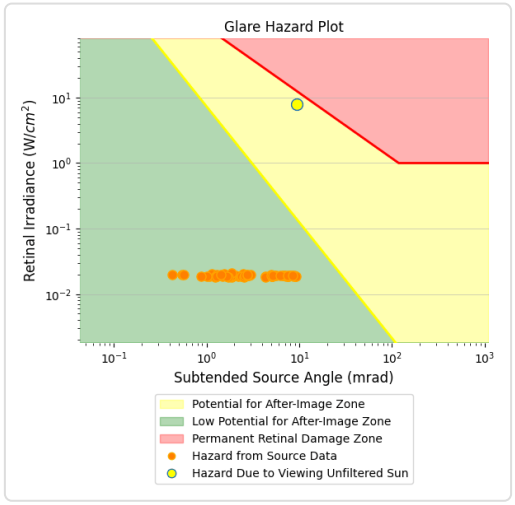
UV-13 and Route: N198 ri west

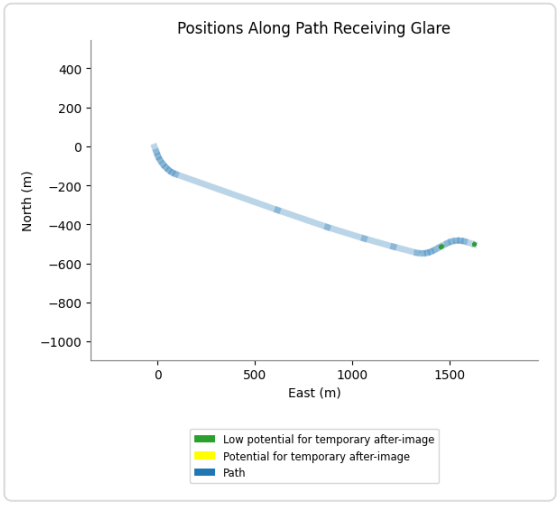
Yellow glare: none

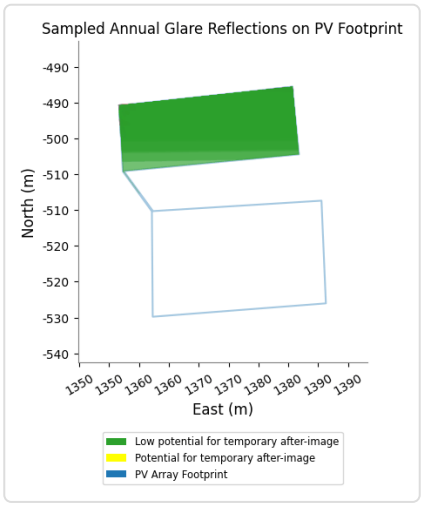
Green glare: 61 min.











UV-13 and Route: N419 ri oost

No glare found

UV-13 and Route: N419 ri west

No glare found

PV: UV-14 potential temporary after-image

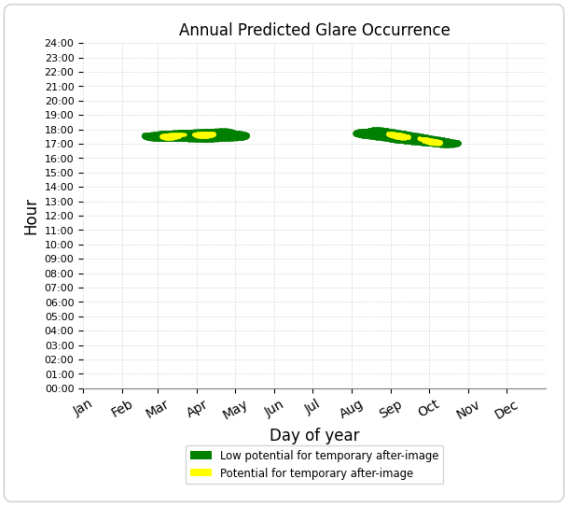
Receptor results ordered by category of glare

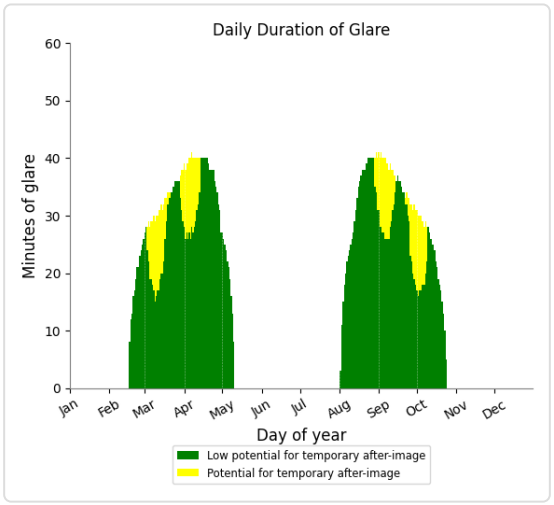
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri west	4,472	74.5	672	11.2
A12 ri oost	800	13.3	0	0.0
N198 ri oost	465	7.8	0	0.0
A12 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

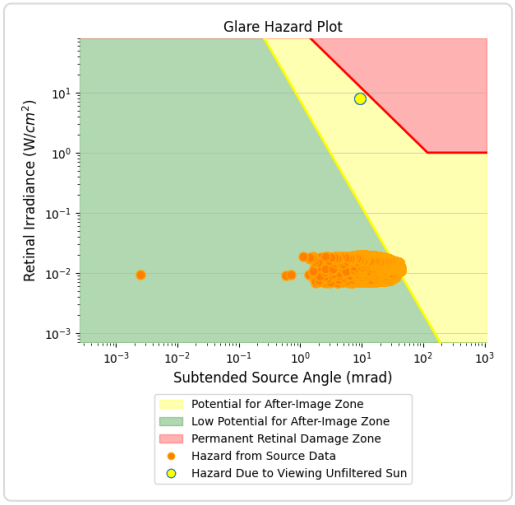
UV-14 and Route: N198 ri west

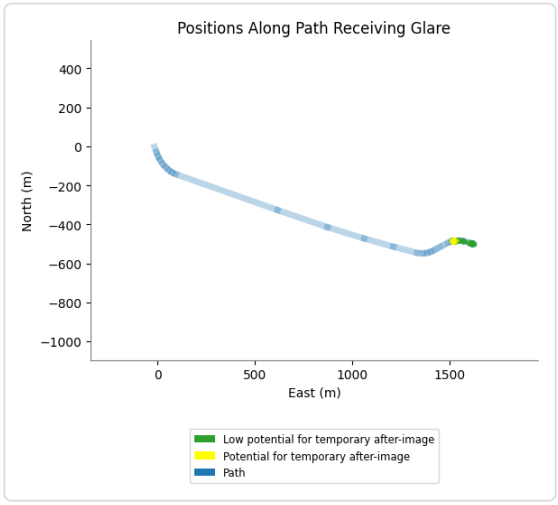
Yellow glare: 672 min.

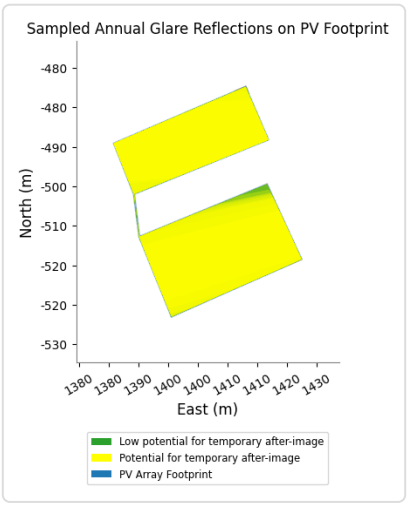
Green glare: 4,472 min.







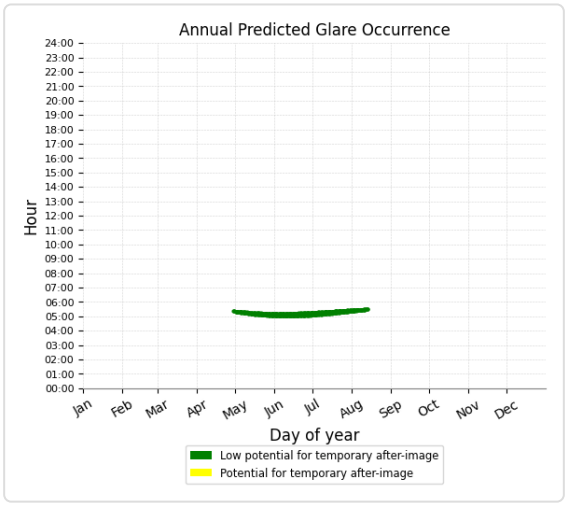


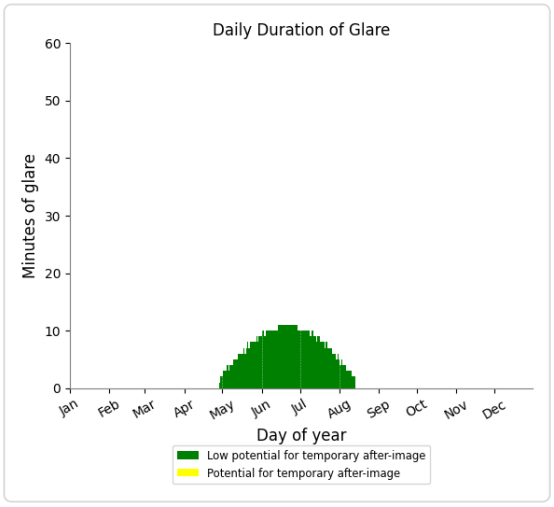


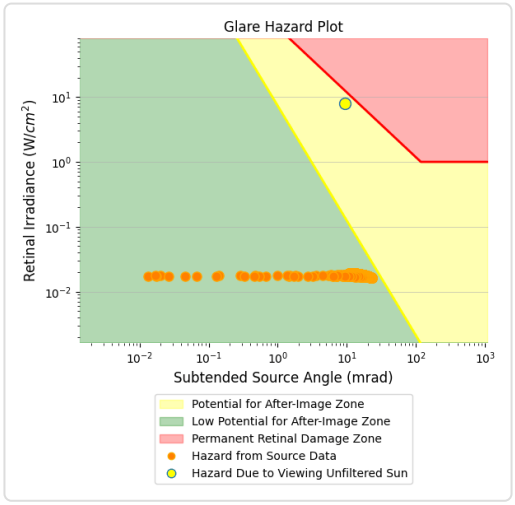
UV-14 and Route: A12 ri oost

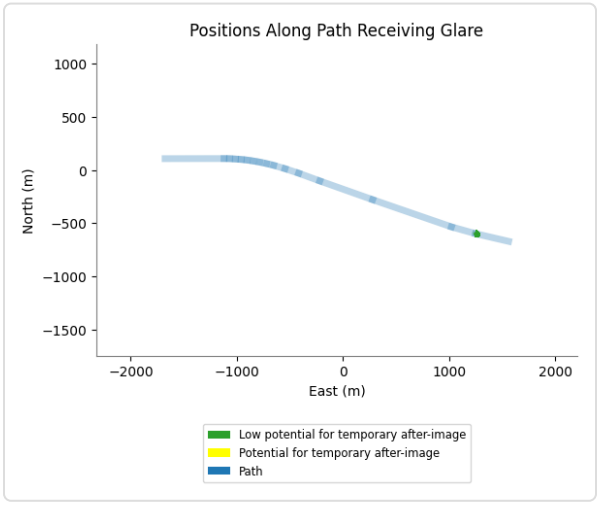
Yellow glare: none

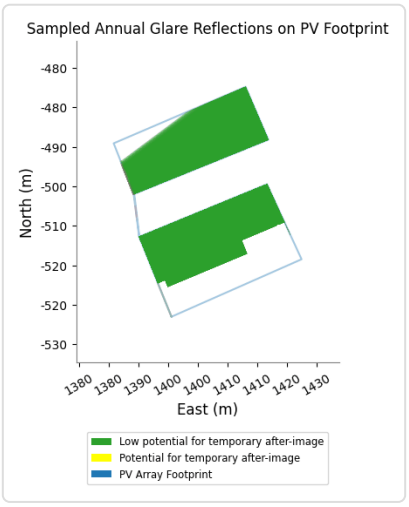
Green glare: 800 min.







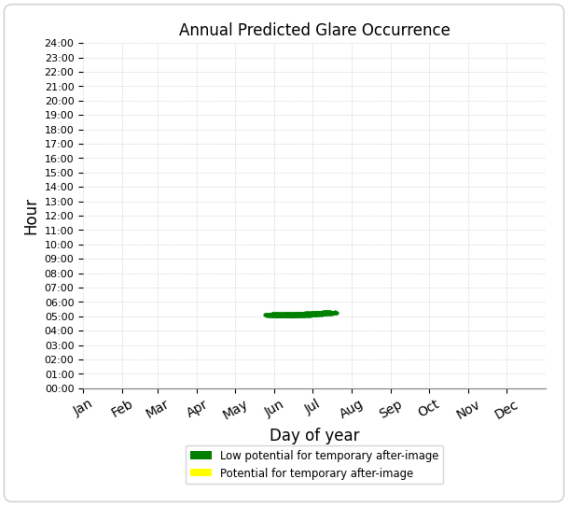


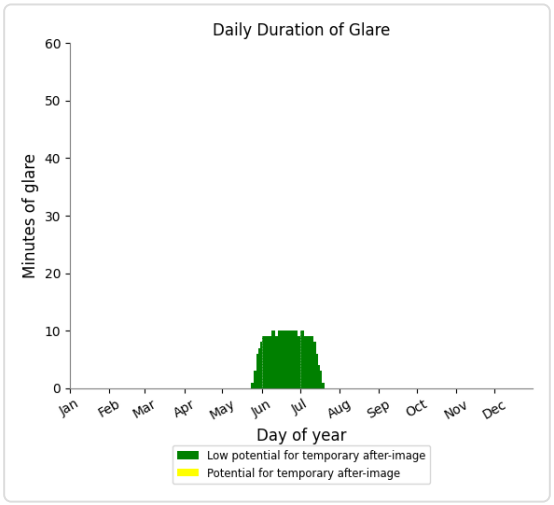


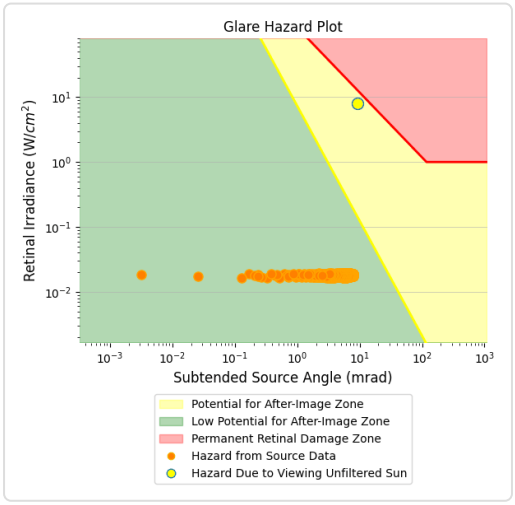
UV-14 and Route: N198 ri oost

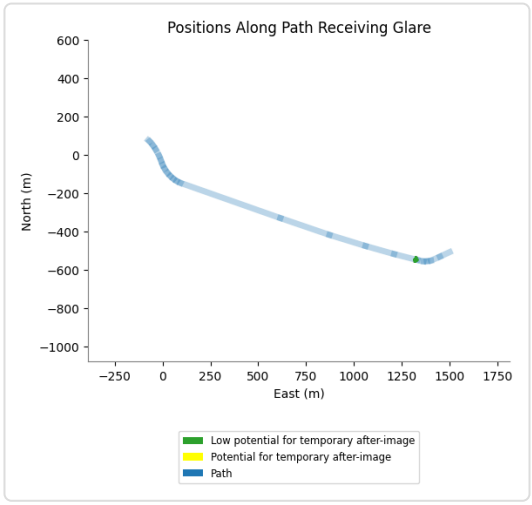
Yellow glare: none

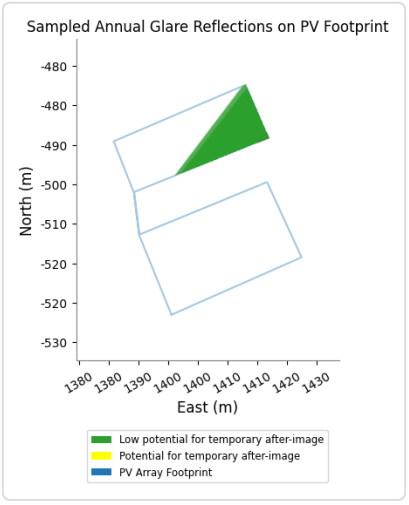
Green glare: 465 min.











UV-14 and Route: A12 ri west

No glare found

UV-14 and Route: N419 ri oost

No glare found

UV-14 and Route: N419 ri west

No glare found

PV: UV-15 potential temporary after-image

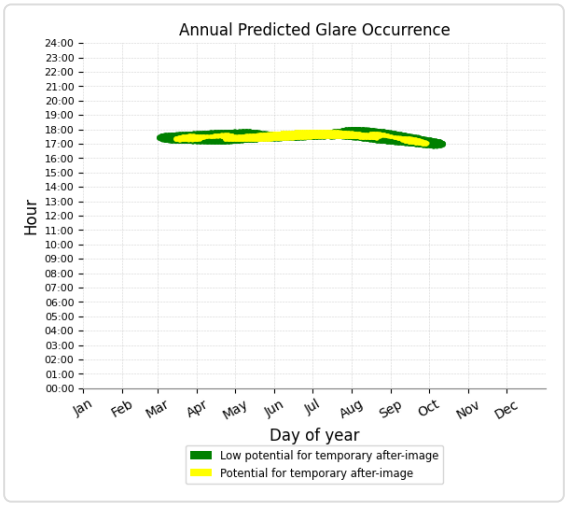
Receptor results ordered by category of glare

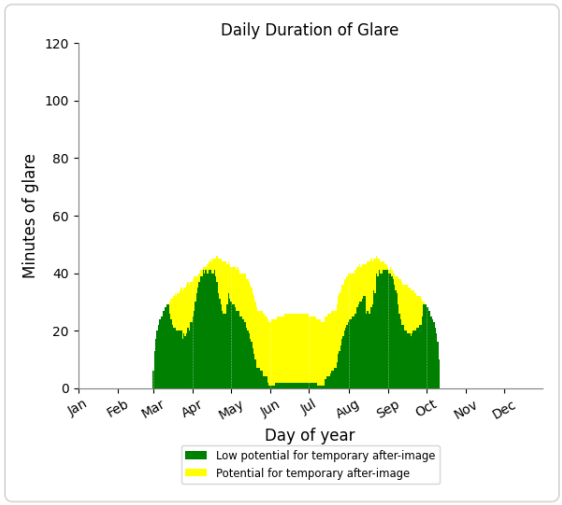
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri west	4,486	74.8	3,041	50.7
A12 ri oost	383	6.4	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

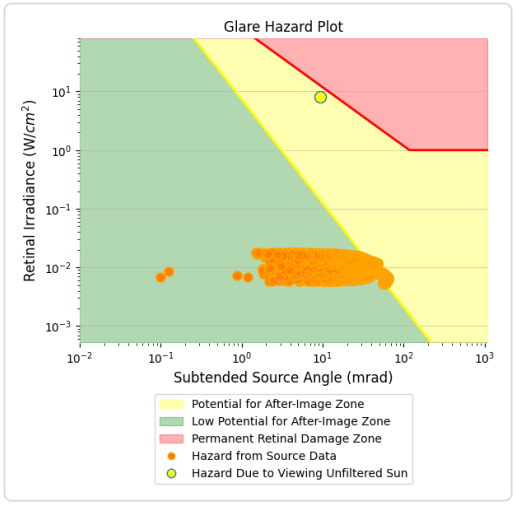
UV-15 and Route: N198 ri west

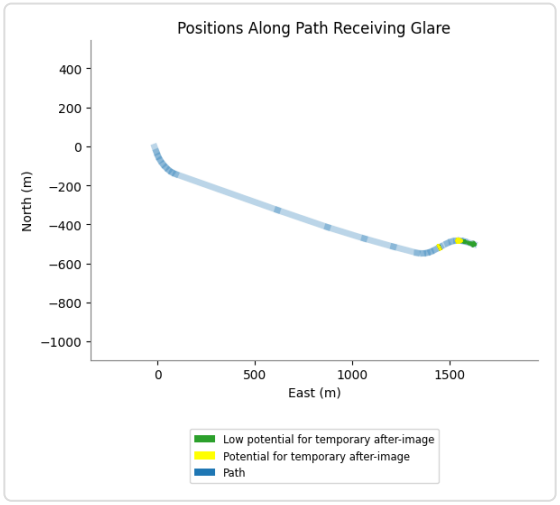
Yellow glare: 3,041 min.

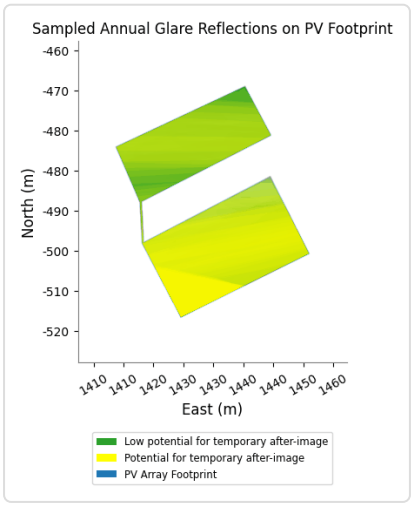
Green glare: 4,486 min.







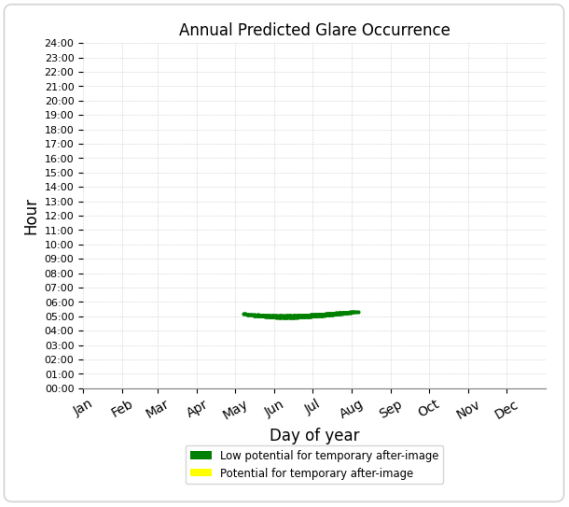


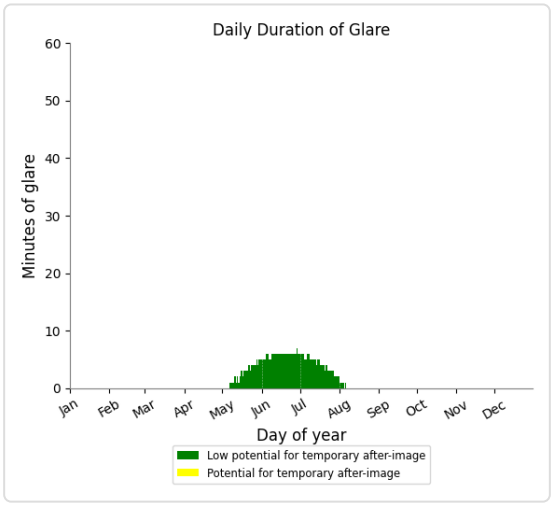


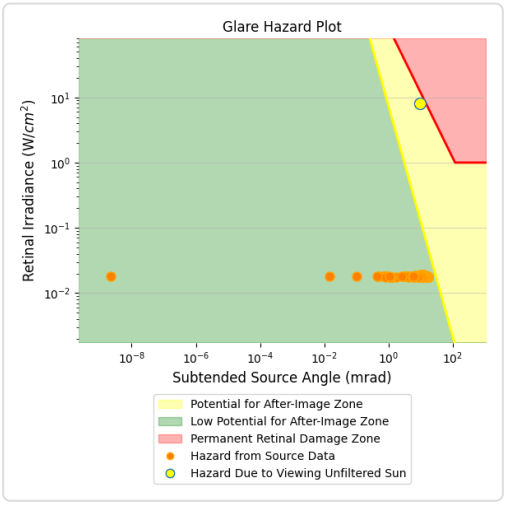
UV-15 and Route: A12 ri oost

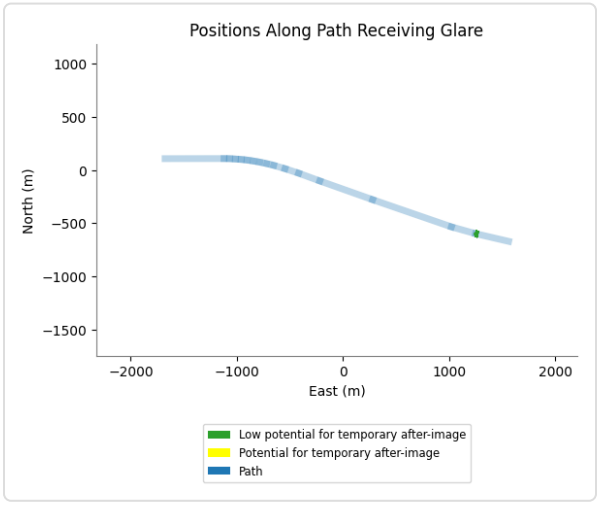
Yellow glare: none

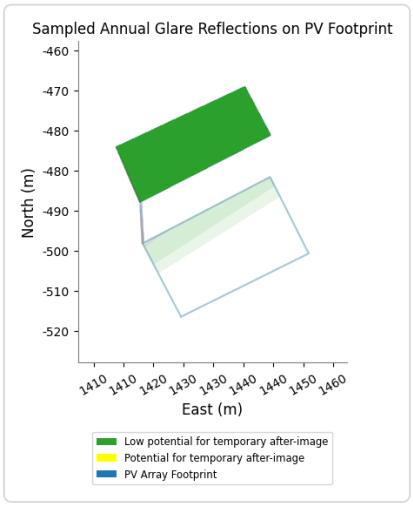
Green glare: 383 min.











UV-15 and Route: A12 ri west

No glare found

UV-15 and Route: N198 ri oost

No glare found

UV-15 and Route: N419 ri oost

No glare found

UV-15 and Route: N419 ri west

No glare found

PV: UV-16 potential temporary after-image

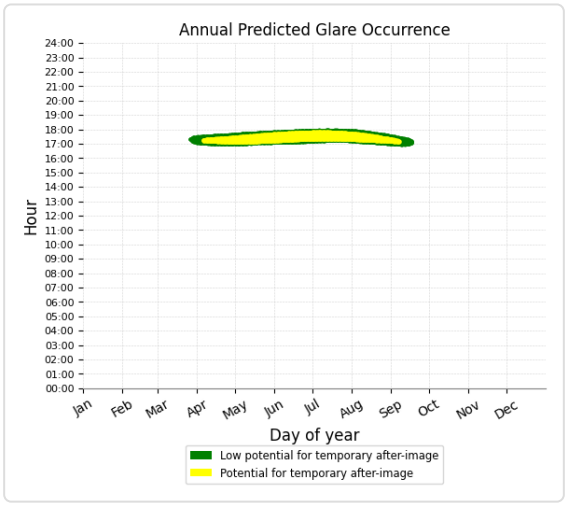
Receptor results ordered by category of glare

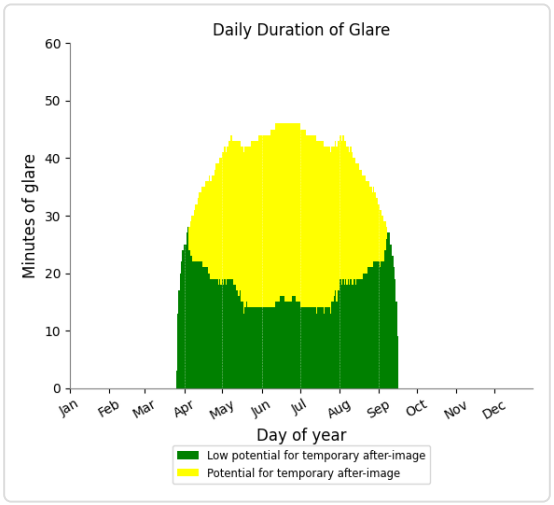
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
N198 ri west	3,083	51.4	3,651	60.9
A12 ri oost	662	11.0	0	0.0
A12 ri west	0	0.0	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

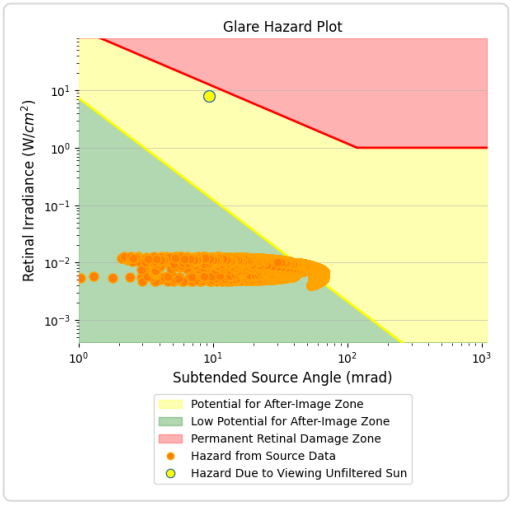
UV-16 and Route: N198 ri west

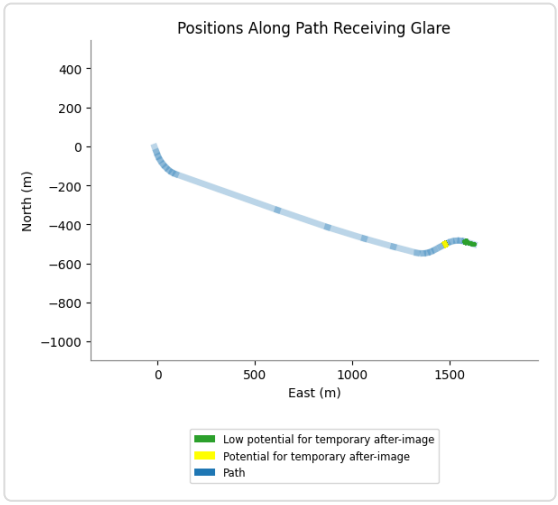
Yellow glare: 3,651 min.

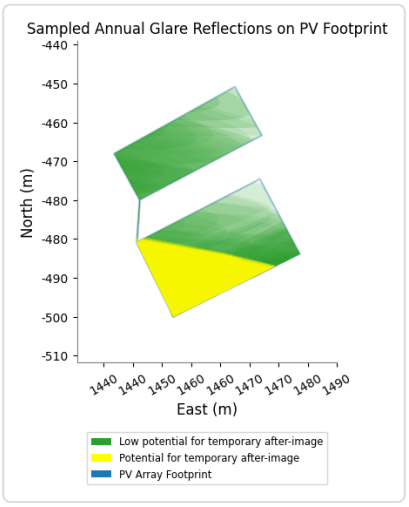
Green glare: 3,083 min.







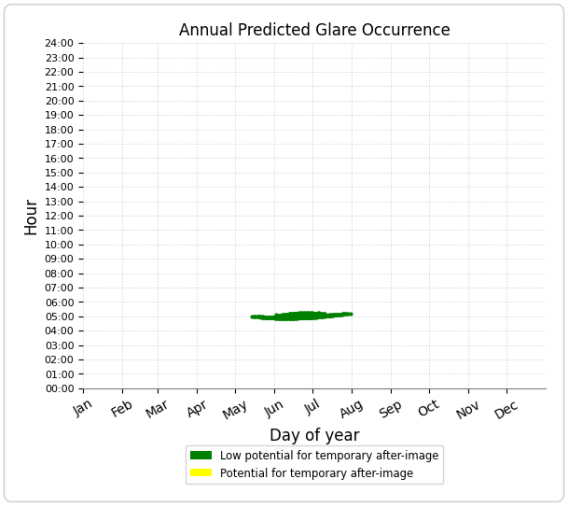


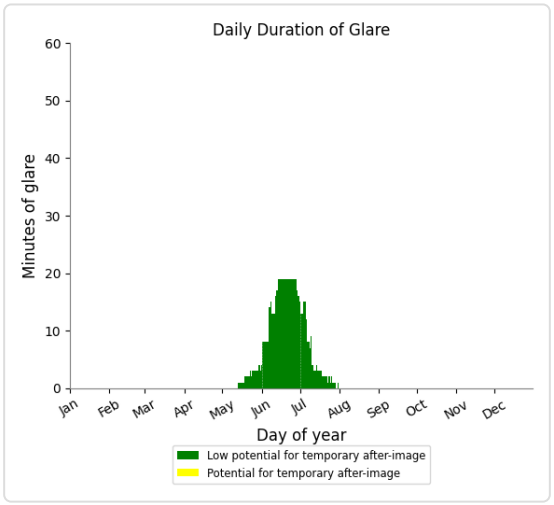


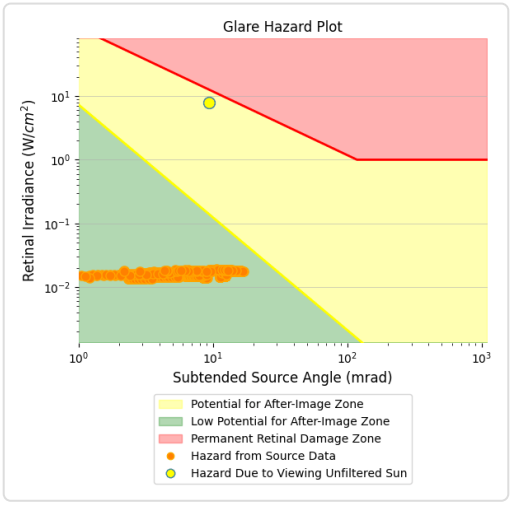
UV-16 and Route: A12 ri oost

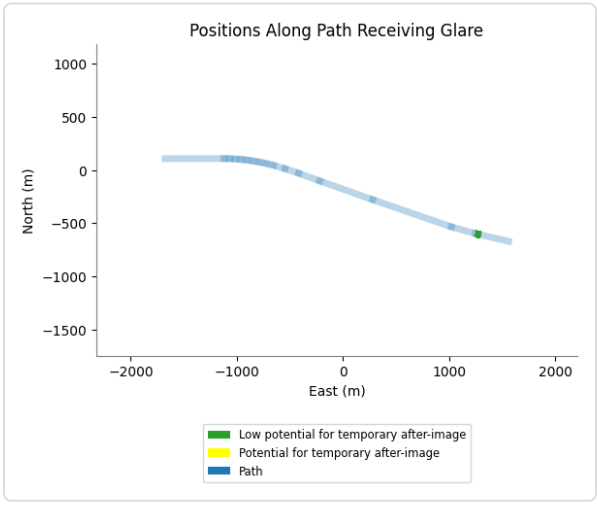
Yellow glare: none

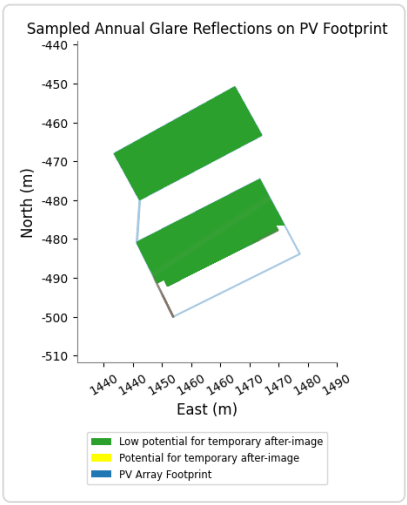
Green glare: 662 min.











UV-16 and Route: A12 ri west

No glare found

UV-16 and Route: N198 ri oost

No glare found

UV-16 and Route: N419 ri oost

No glare found

UV-16 and Route: N419 ri west

No glare found

PV: Woerden potential temporary after-image

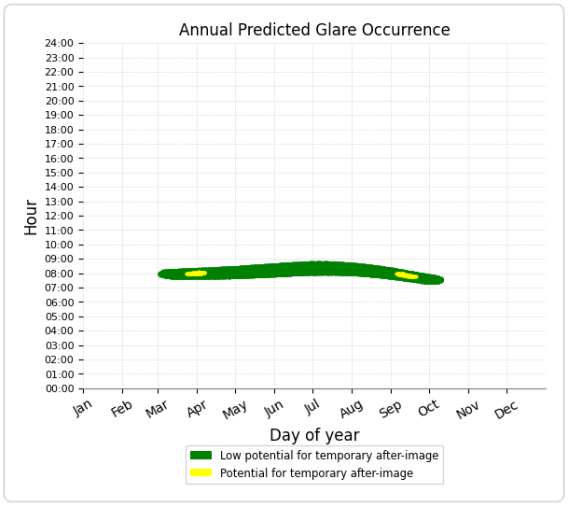
Receptor results ordered by category of glare

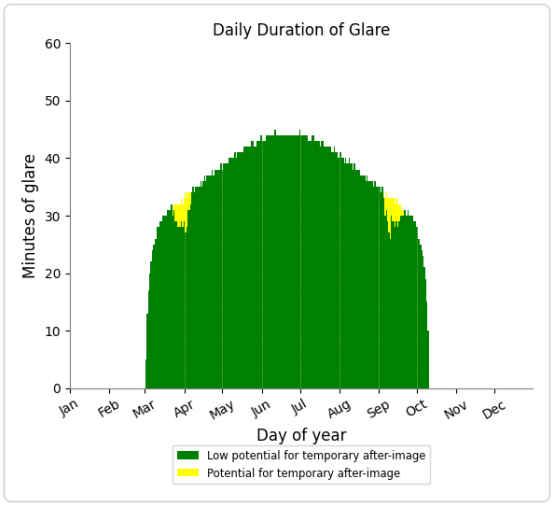
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	8,064	134.4	106	1.8
A12 ri west	2,696	44.9	1,160	19.3
N198 ri west	1,093	18.2	568	9.5
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

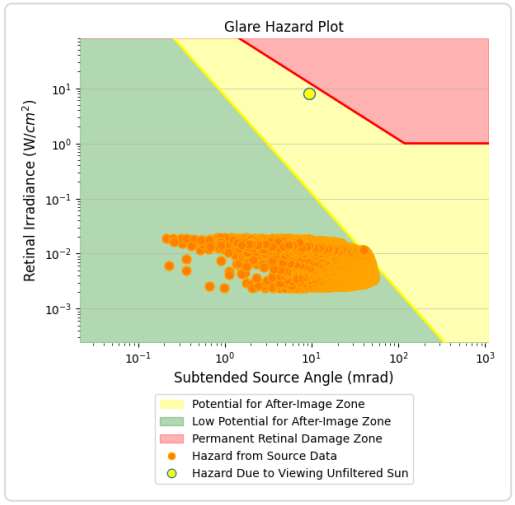
Woerden and Route: A12 ri oost

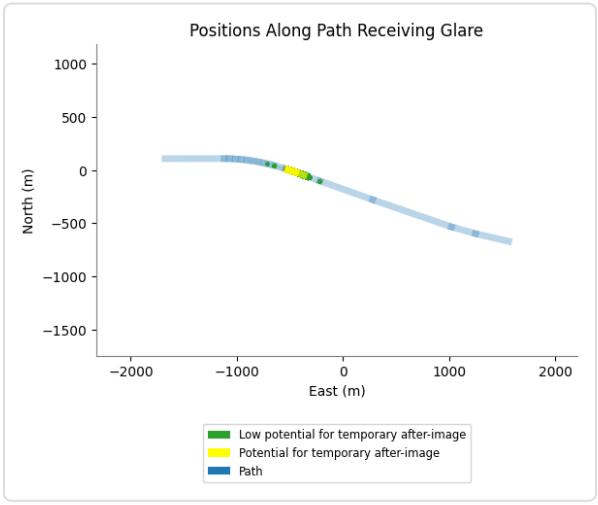
Yellow glare: 106 min.

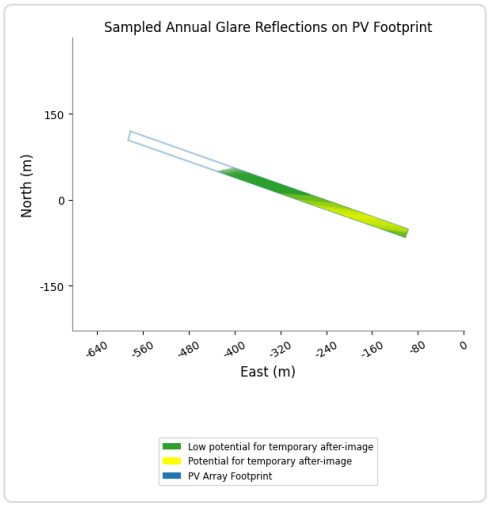
Green glare: 8,064 min.







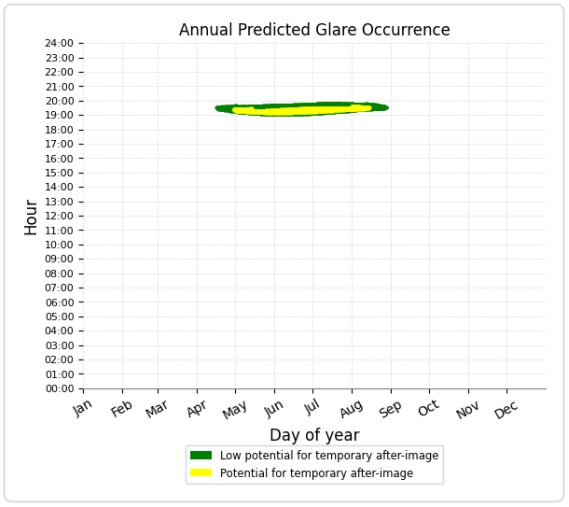


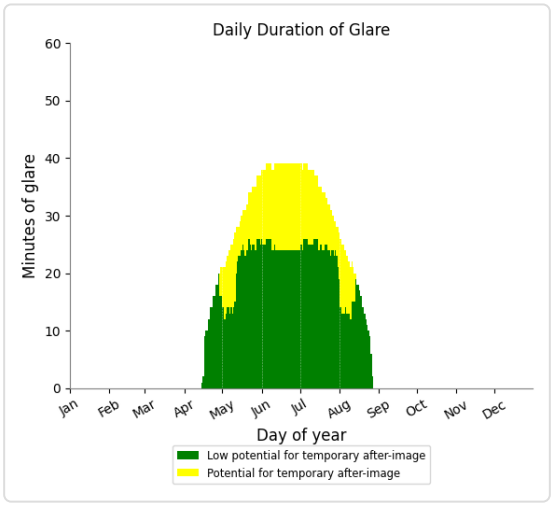


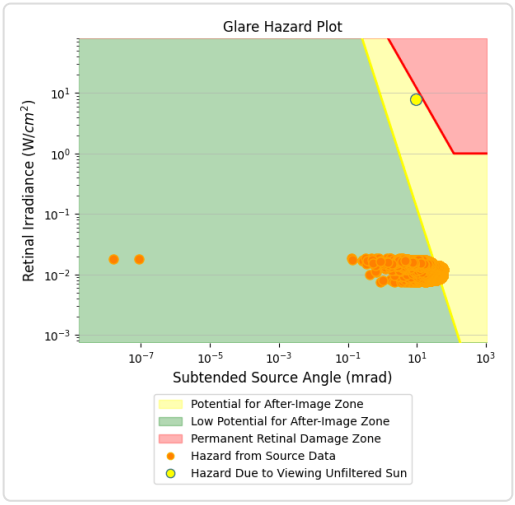
Woerden and Route: A12 ri west

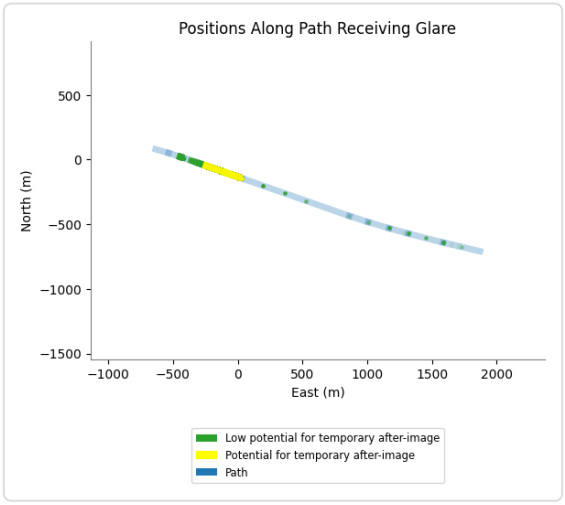
Yellow glare: 1,160 min.

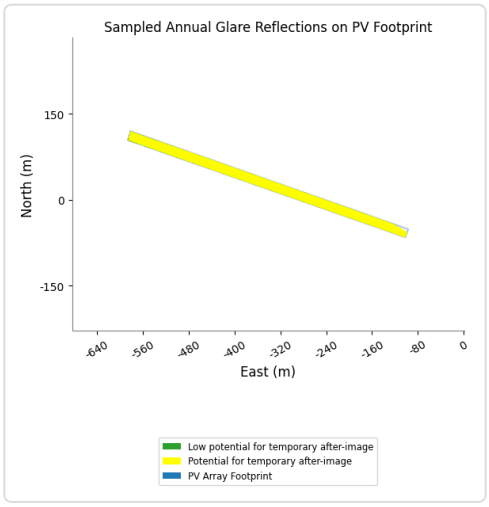
Green glare: 2,696 min.







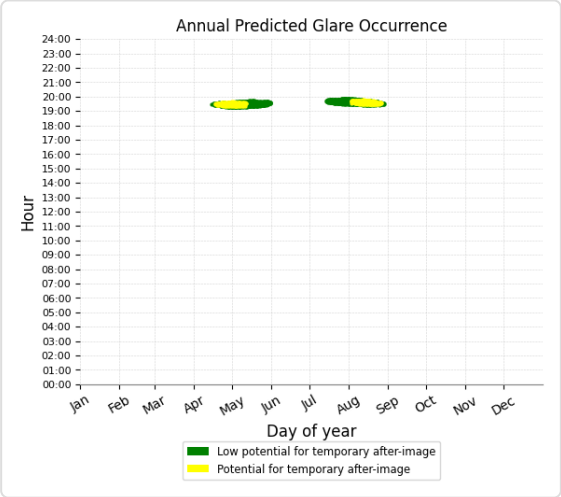


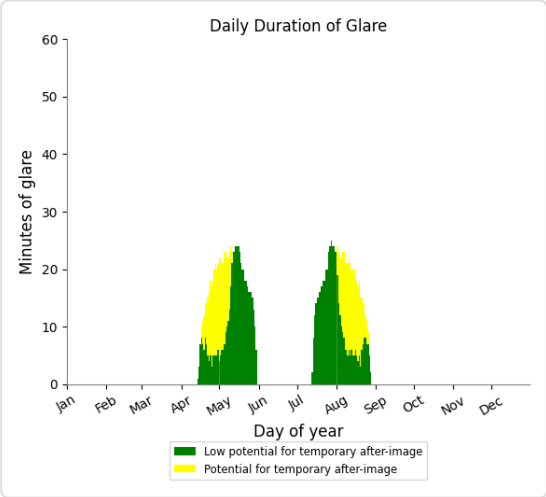


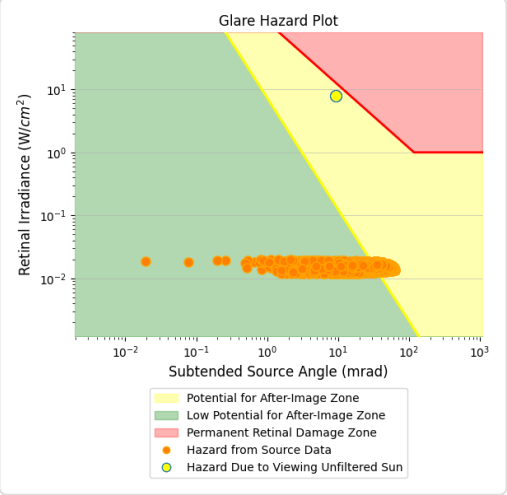
Woerden and Route: N198 ri west

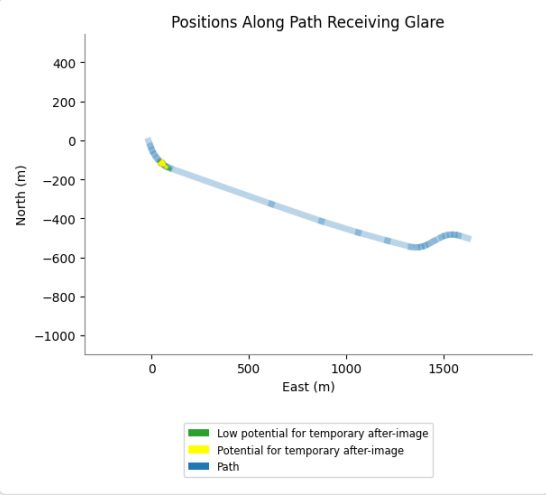
Yellow glare: 568 min.

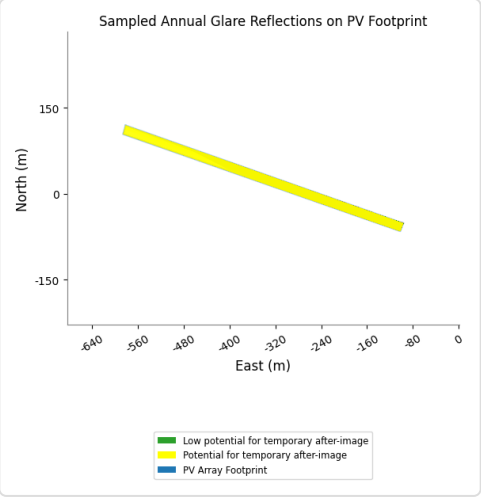
Green glare: 1,093 min.











Woerden and Route: N198 ri oost

No glare found

Woerden and Route: N419 ri oost

No glare found

Woerden and Route: N419 ri west

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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This analysis was conducted using the best available radiometric modeling at the time of generation. Future updates to the modeling methodology may yield different results.

FORGESOLAR GLARE ANALYSIS

Project: **Geluidswal A12**

Sweco heeft plannen voor een zonnepanelen op een geluidswal aangeleverd aan ROM3D. De geluidswal ligt langs de A12, in twee delen nabij Woerden en Utrecht – Veldhuizen. Eventuele reflectiehinder veroorzaakt door dit park kan inzichtelijk worden gemaakt met een reflectiestudie. Er is gevraagd om een dergelijke studie uit te voeren om de schittering te bepalen voor weggebruikers van de A12 en de N198 en de N419. Het te realiseren zonnepark ligt ten noorden van de A12. Voor het reflectieonderzoek zal ROM3D uitgaan van eigenschappen zoals aangeleverd door de opdrachtgever.

Site configuration: **Vrachtwagenchauffeurs - DTG**
Calculated via ForgeSolar Radiometric Physics Engine v3.2.1

Client: Sweco

Created 13 Jul, 2026
Updated 13 Jul, 2026
Time-step 1 minute
Timezone offset UTC1
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 1 MW to 5 MW
Site ID 182855.29739

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Min luminance threshold 5,000 cd/m^2

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	352,673	5,877.9	0	0.0	-
UV-02	25.0	241.68	355,752	5,929.2	0	0.0	-
UV-03	25.0	233.48	302,218	5,037.0	0	0.0	-
UV-04	25.0	225.18	362,021	6,033.7	0	0.0	-
UV-05	25.0	202.75	286,356	4,772.6	0	0.0	-
UV-06	25.0	204.1	287,084	4,784.7	0	0.0	-
UV-07	25.0	197.55	295,376	4,922.9	0	0.0	-
UV-08	25.0	195.26	296,304	4,938.4	0	0.0	-
UV-09	25.0	192.6	278,234	4,637.2	0	0.0	-
UV-10	25.0	189.34	140,183	2,336.4	0	0.0	-
UV-11	25.0	184.09	47,573	792.9	0	0.0	-
UV-12	25.0	181.74	200,399	3,340.0	0	0.0	-
UV-13	25.0	174.0	104,936	1,748.9	0	0.0	-
UV-14	25.0	154.86	123,455	2,057.6	0	0.0	-
UV-15	25.0	152.49	144,377	2,406.3	0	0.0	-
UV-16	25.0	150.5	156,845	2,614.1	0	0.0	-
Woerden	35.0	197.87	199,245	3,320.8	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	987,645	16,460.8	0	0.0
A12 ri west	697,754	11,629.2	0	0.0
N198 ri oost	1,023,579	17,059.7	0	0.0
N198 ri west	562,210	9,370.2	0	0.0
N419 ri oost	423,231	7,053.9	0	0.0
N419 ri west	238,612	3,976.9	0	0.0

Component Data

PV Arrays

Name: UV-01
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 259.2°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079394	5.002834	1.80	1.00	2.80
2	52.079414	5.003086	8.90	1.00	9.90
3	52.079165	5.003165	8.90	1.00	9.90
4	52.079133	5.002909	1.80	1.00	2.80

Name: UV-02
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 241.68°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.079089	5.002938	1.80	1.00	2.80
2	52.079160	5.003172	8.90	1.00	9.90
3	52.078925	5.003359	8.90	1.00	9.90
4	52.078846	5.003115	1.80	1.00	2.80

Name: UV-03
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 233.48°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078921	5.003362	8.90	1.00	9.90
2	52.078714	5.003589	8.90	1.00	9.90
3	52.078621	5.003381	1.80	1.00	2.80
4	52.078821	5.003140	1.80	1.00	2.80

Name: UV-04
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 225.18°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078709	5.003596	8.90	1.00	9.90
2	52.078528	5.003883	8.90	1.00	9.90
3	52.078416	5.003701	1.80	1.00	2.80
4	52.078600	5.003403	1.80	1.00	2.80

Name: UV-05
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 202.75°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078514	5.003900	8.90	1.00	9.90
2	52.078381	5.003765	1.80	1.00	2.80
3	52.078243	5.004127	1.80	1.00	2.80
4	52.078381	5.004253	8.90	1.00	9.90

Name: UV-06
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 204.1°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078369	5.004292	8.90	1.00	9.90
2	52.078224	5.004187	1.80	1.00	2.80
3	52.078116	5.004577	1.80	1.00	2.80
4	52.078262	5.004685	8.90	1.00	9.90

Name: UV-07
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 197.55°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.078252	5.004723	8.90	1.00	9.90
2	52.078105	5.004623	1.80	1.00	2.80
3	52.075796	5.015377	1.80	1.00	2.80
4	52.075952	5.015472	8.90	1.00	9.90

Name: UV-08
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 195.26°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.075783	5.015424	1.80	1.00	2.80
2	52.075941	5.015508	8.90	1.00	9.90
3	52.075166	5.019634	8.90	1.00	9.90
4	52.075013	5.019572	1.80	1.00	2.80

Name: UV-09
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 192.6°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074996	5.019648	1.80	1.00	2.80
2	52.075298	5.019780	13.20	1.00	14.20
3	52.074991	5.021772	13.20	1.00	14.20
4	52.074895	5.021732	10.70	1.00	11.70
5	52.075209	5.019742	10.70	1.00	11.70
6	52.075150	5.019719	8.90	1.00	9.90
7	52.074833	5.021708	8.90	1.00	9.90
8	52.074676	5.021644	1.80	1.00	2.80

Name: UV-10
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 189.34°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074664	5.021722	1.80	1.00	2.80
2	52.074982	5.021799	13.20	1.00	14.20
3	52.074937	5.022221	13.20	1.00	14.20
4	52.074836	5.022191	10.70	1.00	11.70
5	52.074886	5.021778	10.70	1.00	11.70
6	52.074822	5.021763	8.90	1.00	9.90
7	52.074777	5.022181	8.90	1.00	9.90
8	52.074615	5.022144	1.80	1.00	2.80

Name: UV-11
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 184.09°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074834	5.022217	10.70	1.00	11.70
2	52.074935	5.022232	13.20	1.00	14.20
3	52.074915	5.022546	13.20	1.00	14.20
4	52.074816	5.022533	10.70	1.00	11.70

Name: UV-12
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 181.74°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074614	5.022176	1.80	1.00	2.80
2	52.074775	5.022196	8.90	1.00	9.90
3	52.074757	5.022614	8.90	1.00	9.90
4	52.074598	5.022600	1.80	1.00	2.80

Name: UV-13
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 174.0°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074915	5.022550	13.20	1.00	14.20
2	52.074816	5.022559	10.70	1.00	11.70
3	52.074756	5.022630	8.90	1.00	9.90
4	52.074597	5.022632	1.80	1.00	2.80
5	52.074618	5.023055	1.80	1.00	2.80
6	52.074772	5.023044	8.90	1.00	9.90
7	52.074756	5.022633	8.90	1.00	9.90
8	52.074816	5.022561	10.70	1.00	11.70
9	52.074842	5.022989	10.70	1.00	11.70
10	52.074944	5.022973	13.20	1.00	14.20

Name: UV-14
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 154.86°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074628	5.023148	1.80	1.00	2.80
2	52.074774	5.023052	8.90	1.00	9.90
3	52.074852	5.023036	10.70	1.00	11.70
4	52.074944	5.022977	13.20	1.00	14.20
5	52.075047	5.023366	13.20	1.00	14.20
6	52.074951	5.023433	10.70	1.00	11.70
7	52.074852	5.023038	10.70	1.00	11.70
8	52.074774	5.023053	8.90	1.00	9.90
9	52.074870	5.023429	8.90	1.00	9.90
10	52.074733	5.023531	1.80	1.00	2.80

Name: UV-15
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 152.49°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074747	5.023569	1.80	1.00	2.80
2	52.074879	5.023456	8.90	1.00	9.90
3	52.074953	5.023449	10.70	1.00	11.70
4	52.075052	5.023380	13.20	1.00	14.20
5	52.075161	5.023755	13.20	1.00	14.20
6	52.075074	5.023830	10.70	1.00	11.70
7	52.074954	5.023453	10.70	1.00	11.70
8	52.074880	5.023458	8.90	1.00	9.90
9	52.074999	5.023829	8.90	1.00	9.90
10	52.074861	5.023942	1.80	1.00	2.80

Name: UV-16
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 150.5°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074866	5.023959	1.80	1.00	2.80
2	52.075003	5.023849	8.90	1.00	9.90
3	52.075082	5.023858	10.70	1.00	11.70
4	52.075168	5.023782	13.20	1.00	14.20
5	52.075292	5.024144	13.20	1.00	14.20
6	52.075202	5.024226	10.70	1.00	11.70
7	52.075083	5.023860	10.70	1.00	11.70
8	52.075004	5.023851	8.90	1.00	9.90
9	52.075121	5.024220	8.90	1.00	9.90
10	52.074982	5.024340	1.80	1.00	2.80

Name: Woerden
Axis tracking: Fixed (no rotation)
Tilt: 35.0°
Orientation: 197.87°
Rated power: -
Panel material: Deeply textured glass

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080468	4.994350	8.00	1.00	9.00
2	52.080330	4.994286	0.00	1.00	1.00
3	52.078807	5.001345	0.00	1.00	1.00
4	52.078932	5.001420	8.00	1.00	9.00

Route Receptors

Name: A12 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080355	4.978381	1.00	2.50	3.50
2	52.080361	4.986477	1.00	2.50	3.50
3	52.080353	4.987236	1.00	2.50	3.50
4	52.080321	4.988051	1.00	2.50	3.50
5	52.080287	4.988839	1.00	2.50	3.50
6	52.080232	4.989657	1.00	2.50	3.50
7	52.080152	4.990527	1.00	2.50	3.50
8	52.080056	4.991406	1.00	2.50	3.50
9	52.079931	4.992347	1.00	2.50	3.50
10	52.079788	4.993302	1.00	2.50	3.50
11	52.079504	4.994866	1.00	2.50	3.50
12	52.079123	4.996740	1.00	2.50	3.50
13	52.078467	4.999653	1.00	2.50	3.50
14	52.076884	5.006915	1.00	2.50	3.50
15	52.074587	5.017750	1.00	2.50	3.50
16	52.074013	5.021057	1.00	2.50	3.50
17	52.073363	5.025614	2.90	2.50	5.40

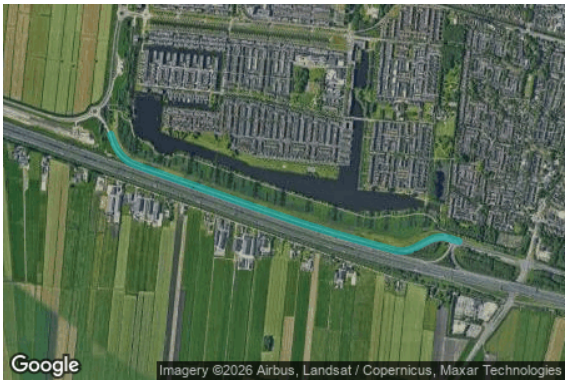
Name: A12 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.073024	5.030141	5.70	2.50	8.20
2	52.073632	5.025983	3.10	2.50	5.60
3	52.074258	5.022036	0.90	2.50	3.40
4	52.074627	5.019886	0.30	2.50	2.80
5	52.075057	5.017533	0.30	2.50	2.80
6	52.075477	5.015418	0.30	2.50	2.80
7	52.078108	5.003266	0.30	2.50	2.80
8	52.079515	4.996721	0.30	2.50	2.80
9	52.079856	4.995053	0.30	2.50	2.80
10	52.080115	4.993585	0.30	2.50	2.80

Name: N198 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.080085	5.001737	-0.10	2.50	2.40
2	52.080033	5.001839	-0.10	2.50	2.40
3	52.079835	5.002108	-0.20	2.50	2.30
4	52.079653	5.002301	-0.20	2.50	2.30
5	52.079353	5.002564	-0.20	2.50	2.30
6	52.079129	5.002711	-0.20	2.50	2.30
7	52.078917	5.002845	-0.20	2.50	2.30
8	52.078747	5.002987	-0.20	2.50	2.30
9	52.078547	5.003213	-0.20	2.50	2.30
10	52.078402	5.003425	-0.20	2.50	2.30
11	52.078270	5.003666	-0.20	2.50	2.30
12	52.078170	5.003902	-0.20	2.50	2.30
13	52.078079	5.004197	-0.20	2.50	2.30
14	52.076426	5.011812	-0.20	2.50	2.30
15	52.075637	5.015559	-0.20	2.50	2.30
16	52.075116	5.018307	-0.20	2.50	2.30
17	52.074736	5.020489	-0.20	2.50	2.30
18	52.074459	5.022255	-0.20	2.50	2.30
19	52.074397	5.022726	0.00	2.50	2.50
20	52.074403	5.022983	0.10	2.50	2.60
21	52.074431	5.023301	0.10	2.50	2.60
22	52.074616	5.023981	0.20	2.50	2.70
23	52.074830	5.024727	0.60	2.50	3.10

Name: N198 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.074878	5.026535	0.80	2.50	3.30
2	52.075013	5.025811	0.90	2.50	3.40
3	52.075044	5.025508	0.90	2.50	3.40
4	52.075046	5.025211	0.90	2.50	3.40
5	52.075008	5.024850	0.90	2.50	3.40
6	52.074927	5.024526	0.70	2.50	3.20
7	52.074765	5.024016	0.30	2.50	2.80
8	52.074624	5.023588	0.00	2.50	2.50
9	52.074537	5.023293	-0.10	2.50	2.40
10	52.074489	5.023027	-0.20	2.50	2.30
11	52.074463	5.022713	-0.20	2.50	2.30
12	52.074483	5.022262	-0.20	2.50	2.30
13	52.074768	5.020499	-0.20	2.50	2.30
14	52.075144	5.018318	-0.20	2.50	2.30
15	52.075667	5.015564	-0.20	2.50	2.30
16	52.076455	5.011826	-0.20	2.50	2.30
17	52.078113	5.004211	-0.20	2.50	2.30
18	52.078192	5.003935	-0.20	2.50	2.30
19	52.078291	5.003707	-0.20	2.50	2.30
20	52.078421	5.003473	-0.20	2.50	2.30
21	52.078568	5.003259	-0.20	2.50	2.30
22	52.078759	5.003042	-0.20	2.50	2.30
23	52.078929	5.002897	-0.20	2.50	2.30
24	52.079136	5.002763	-0.20	2.50	2.30
25	52.079367	5.002623	-0.20	2.50	2.30

Name: N419 ri oost
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

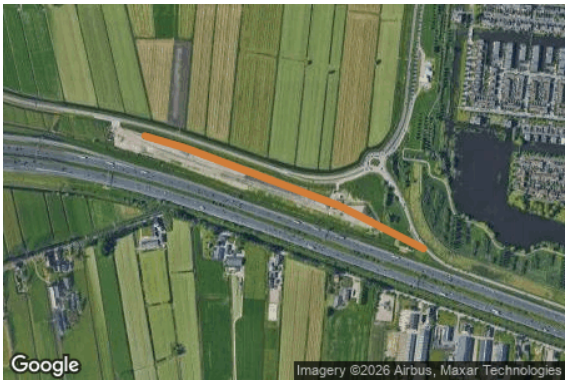
Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081519	4.989885	-0.60	2.50	1.90
2	52.081272	4.992168	-0.60	2.50	1.90
3	52.081193	4.992811	-0.60	2.50	1.90
4	52.080995	4.994115	-0.60	2.50	1.90
5	52.080769	4.995295	-0.60	2.50	1.90
6	52.080146	4.998197	-0.60	2.50	1.90
7	52.080033	4.998680	-0.60	2.50	1.90
8	52.079948	4.999080	-0.60	2.50	1.90
9	52.079892	4.999530	-0.60	2.50	1.90
10	52.079884	4.999975	-0.60	2.50	1.90
11	52.079911	5.000375	-0.60	2.50	1.90
12	52.079943	5.000638	-0.50	2.50	2.00
13	52.080009	5.000952	-0.40	2.50	2.10
14	52.080143	5.001405	-0.10	2.50	2.40
15	52.080123	5.001518	-0.10	2.50	2.40
16	52.080130	5.001668	-0.10	2.50	2.40
17	52.080163	5.001797	-0.10	2.50	2.40
18	52.080229	5.001885	-0.10	2.50	2.40
19	52.080351	5.001901	-0.10	2.50	2.40

Name: N419 ri west
Path type: One-way (toward increasing index)
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	52.081289	5.002510	0.40	2.50	2.90
2	52.081097	5.002414	0.30	2.50	2.80
3	52.080891	5.002242	0.10	2.50	2.60
4	52.080703	5.002033	0.10	2.50	2.60
5	52.080552	5.001832	0.00	2.50	2.50
6	52.080494	5.001684	-0.10	2.50	2.40
7	52.080504	5.001545	-0.10	2.50	2.40
8	52.080487	5.001402	-0.10	2.50	2.40
9	52.080438	5.001298	-0.10	2.50	2.40
10	52.080324	5.001228	-0.10	2.50	2.40
11	52.080262	5.001174	-0.10	2.50	2.40
12	52.080202	5.001043	-0.30	2.50	2.20
13	52.080122	5.000756	-0.40	2.50	2.10
14	52.080047	5.000397	-0.50	2.50	2.00
15	52.080008	5.000016	-0.60	2.50	1.90
16	52.080013	4.999479	-0.60	2.50	1.90
17	52.080052	4.999013	-0.60	2.50	1.90
18	52.080156	4.998334	-0.60	2.50	1.90
19	52.080802	4.995308	-0.60	2.50	1.90
20	52.081030	4.994115	-0.60	2.50	1.90

Obstruction Components

Name: Geluidsscherm I en Talud
Top height: 8.80 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.080881	4.993642	0.00
2	52.080621	4.995064	0.00
3	52.079412	5.000313	0.00
4	52.078512	5.003205	0.00

Name: Geluidsscherm II
Top height: 4.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.074608	5.021008	0.00
2	52.074201	5.023580	0.00
3	52.074150	5.024043	0.00
4	52.074115	5.024569	0.00
5	52.074116	5.024735	0.00
6	52.074144	5.024934	0.00
7	52.074201	5.025140	0.00
8	52.074267	5.025320	0.00
9	52.074389	5.025528	0.00
10	52.074562	5.025741	0.00

Name: Geluidsscherm III
Top height: 7.00 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.073659	5.026506	0.00
2	52.073916	5.024693	0.00

Name: Geluidsscherm IV
Top height: 7.50 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	52.072916	5.031908	0.00
2	52.073542	5.027611	0.00
3	52.073628	5.027161	0.00
4	52.073705	5.026887	0.00
5	52.073862	5.026614	0.00
6	52.073992	5.026453	0.00
7	52.074149	5.026345	0.00
8	52.074236	5.026300	0.00

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
UV-01	25.0	259.2	352,673	5,877.9	0	0.0	-
UV-02	25.0	241.68	355,752	5,929.2	0	0.0	-
UV-03	25.0	233.48	302,218	5,037.0	0	0.0	-
UV-04	25.0	225.18	362,021	6,033.7	0	0.0	-
UV-05	25.0	202.75	286,356	4,772.6	0	0.0	-
UV-06	25.0	204.1	287,084	4,784.7	0	0.0	-
UV-07	25.0	197.55	295,376	4,922.9	0	0.0	-
UV-08	25.0	195.26	296,304	4,938.4	0	0.0	-
UV-09	25.0	192.6	278,234	4,637.2	0	0.0	-
UV-10	25.0	189.34	140,183	2,336.4	0	0.0	-
UV-11	25.0	184.09	47,573	792.9	0	0.0	-
UV-12	25.0	181.74	200,399	3,340.0	0	0.0	-
UV-13	25.0	174.0	104,936	1,748.9	0	0.0	-
UV-14	25.0	154.86	123,455	2,057.6	0	0.0	-
UV-15	25.0	152.49	144,377	2,406.3	0	0.0	-
UV-16	25.0	150.5	156,845	2,614.1	0	0.0	-
Woerden	35.0	197.87	199,245	3,320.8	0	0.0	-

Note: One or more PV arrays use a module profile that produces highly diffuse reflections. The analysis models these as diffuse reflective surfaces with a beam divergence cap of 120°, which is the limit of the analytical projection method.

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	987,645	16,460.8	0	0.0
A12 ri west	697,754	11,629.2	0	0.0
N198 ri oost	1,023,579	17,059.7	0	0.0
N198 ri west	562,210	9,370.2	0	0.0
N419 ri oost	423,231	7,053.9	0	0.0
N419 ri west	238,612	3,976.9	0	0.0

PV: UV-01 low potential for temporary after-image

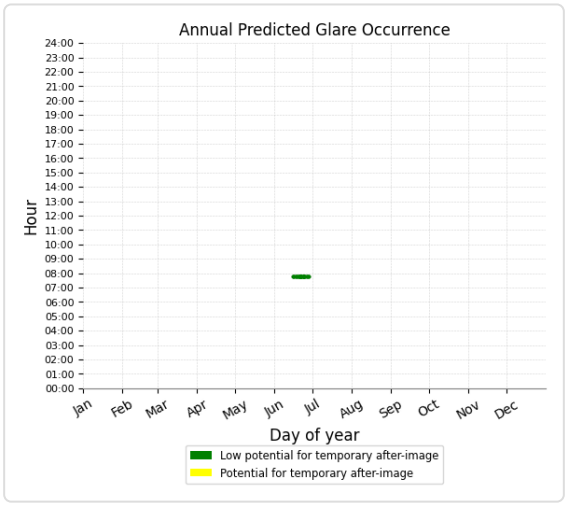
Receptor results ordered by category of glare

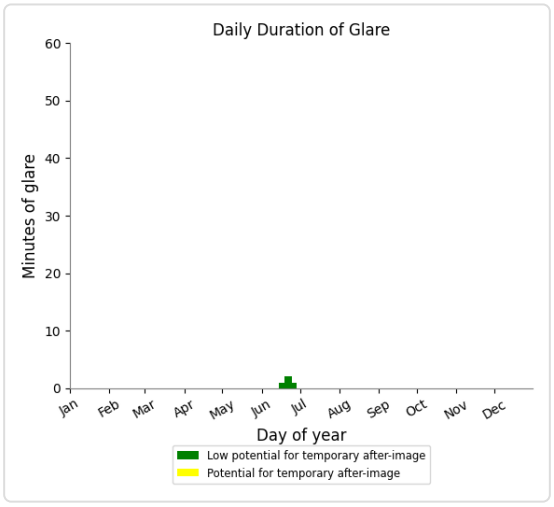
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	20	0.3	0	0.0
N198 ri oost	115,308	1,921.8	0	0.0
N198 ri west	6,783	113.0	0	0.0
N419 ri oost	114,976	1,916.3	0	0.0
N419 ri west	115,586	1,926.4	0	0.0
A12 ri west	0	0.0	0	0.0

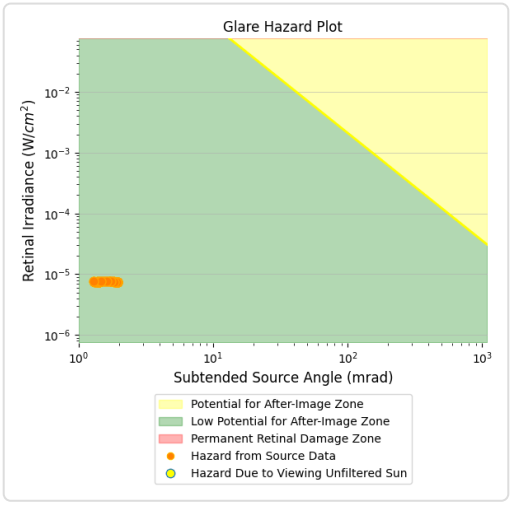
UV-01 and Route: A12 ri oost

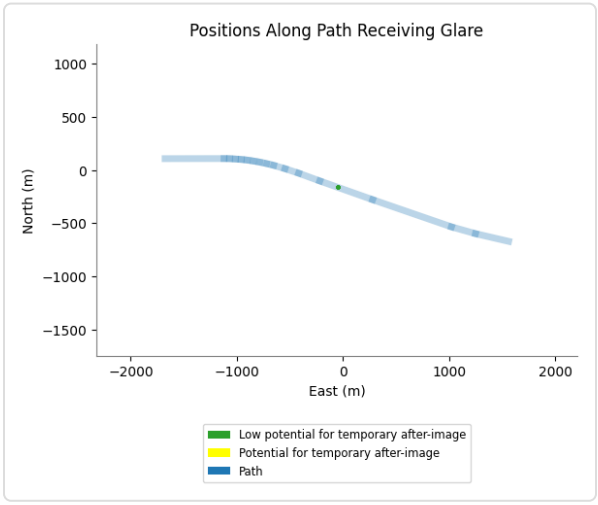
Yellow glare: none

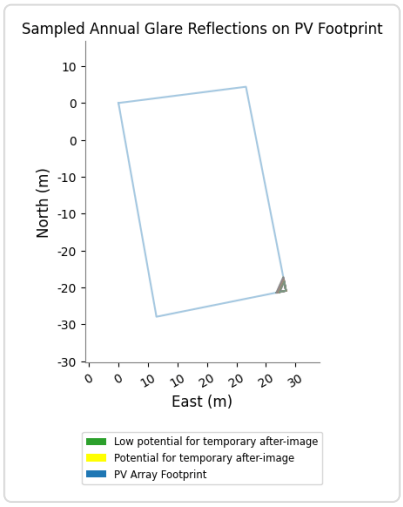
Green glare: 20 min.







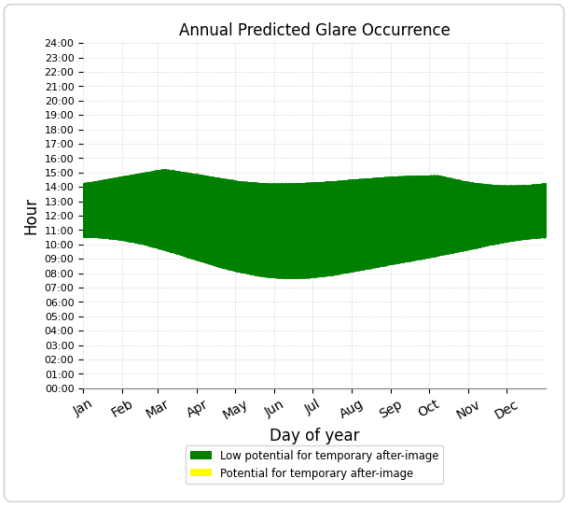


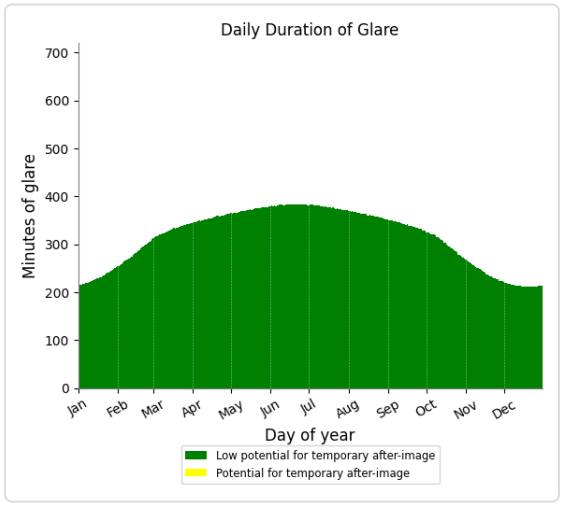


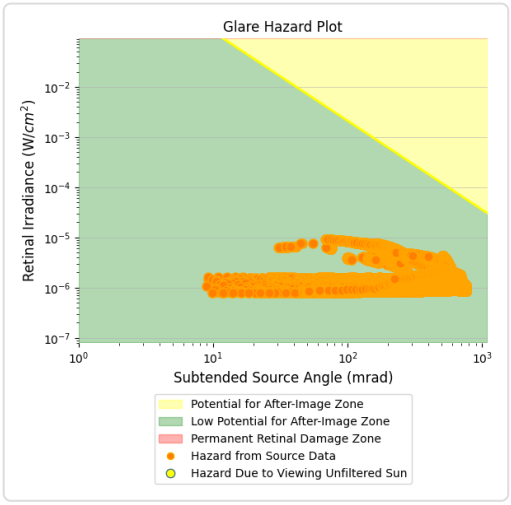
UV-01 and Route: N198 ri oost

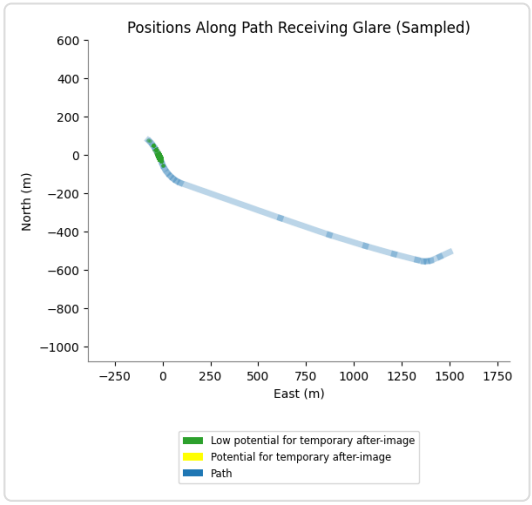
Yellow glare: none

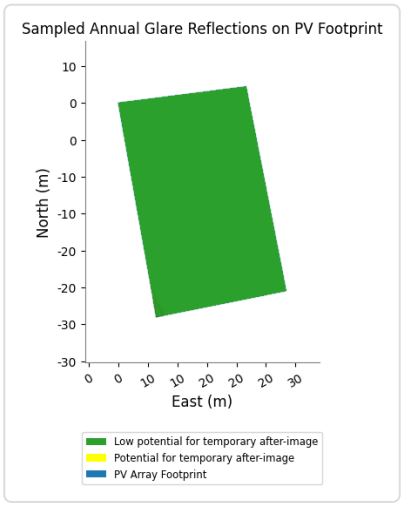
Green glare: 115,308 min.







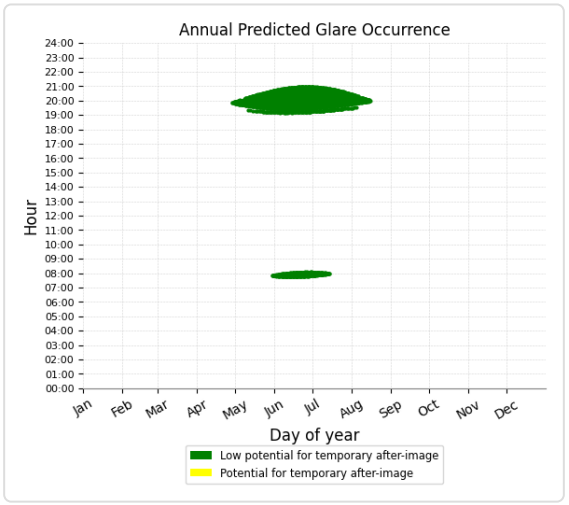


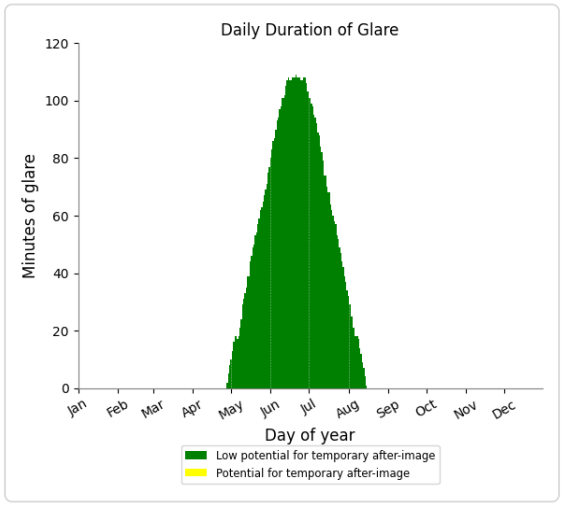


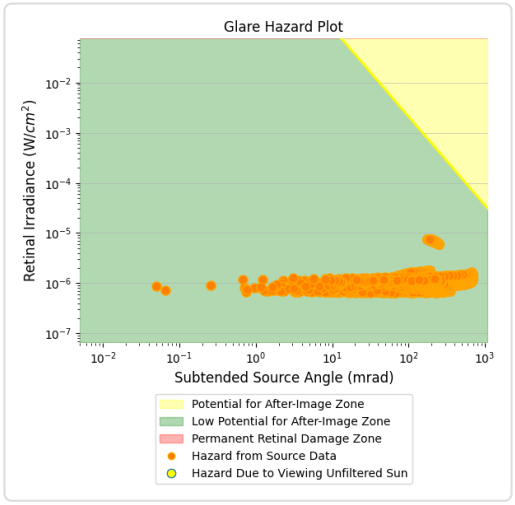
UV-01 and Route: N198 ri west

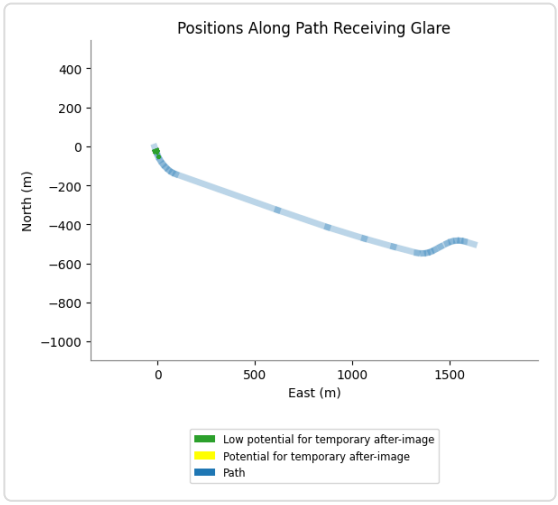
Yellow glare: none

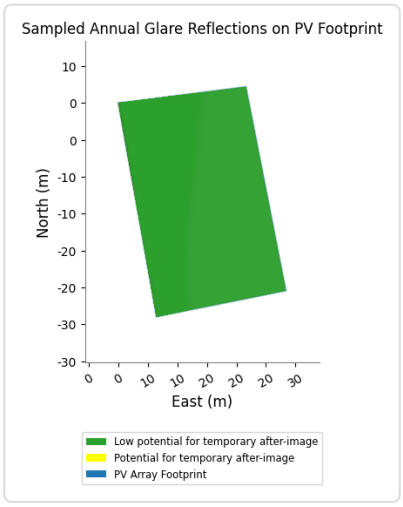
Green glare: 6,783 min.







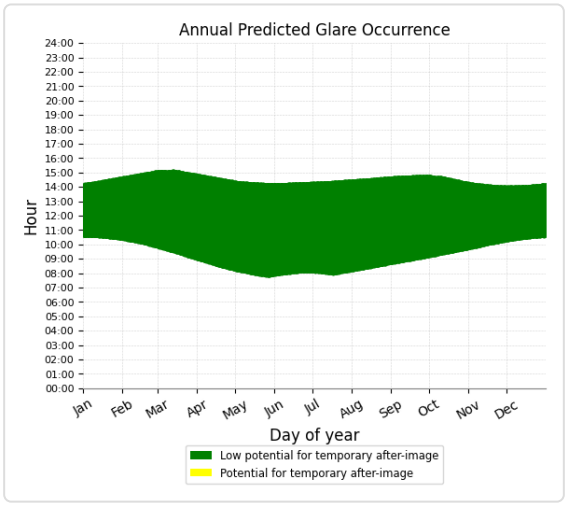


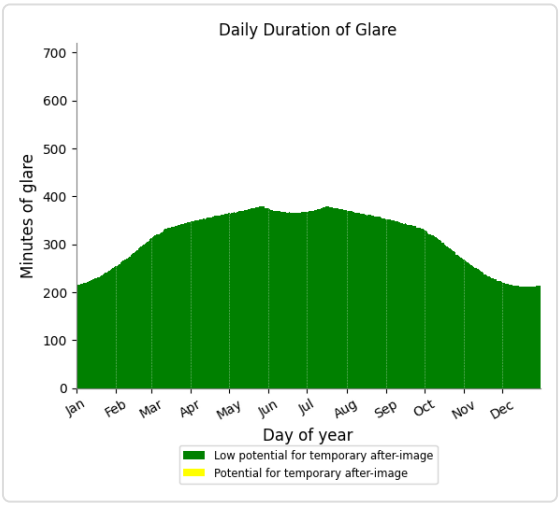


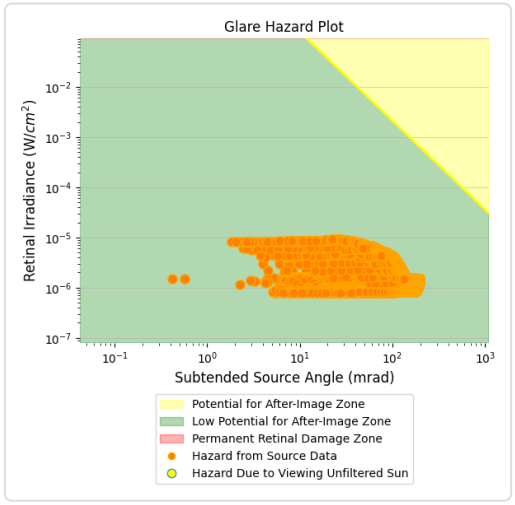
UV-01 and Route: N419 ri oost

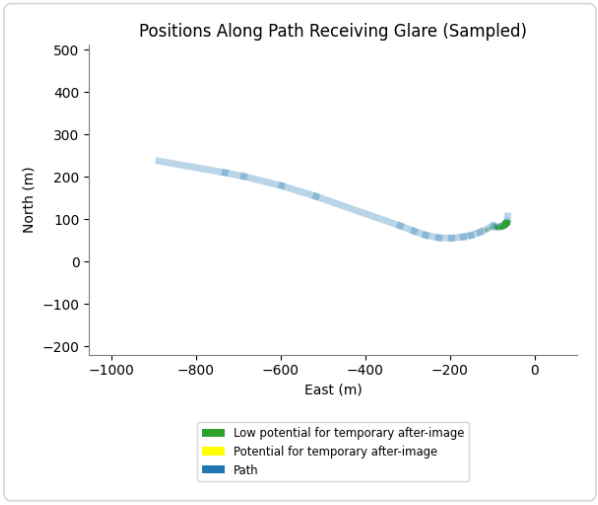
Yellow glare: none

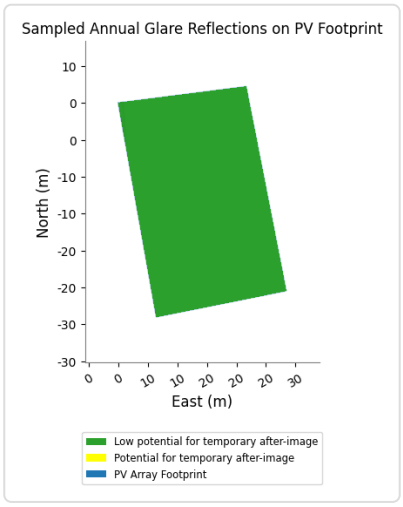
Green glare: 114,976 min.







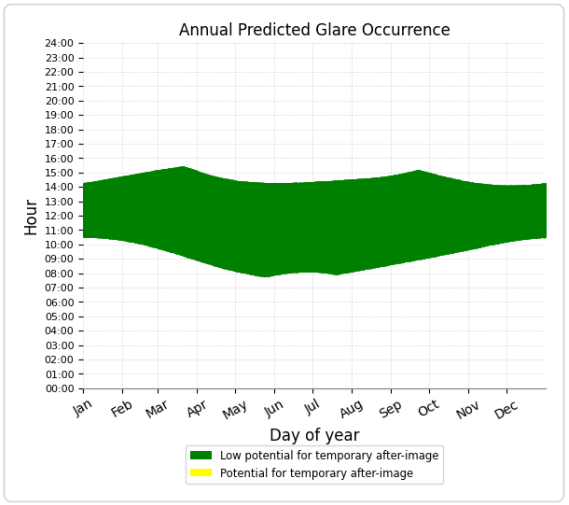


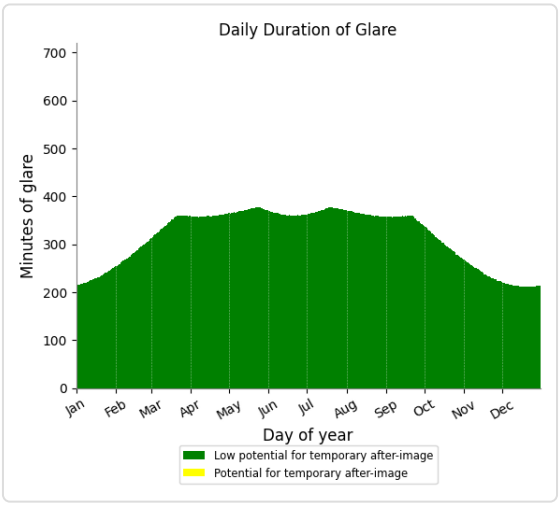


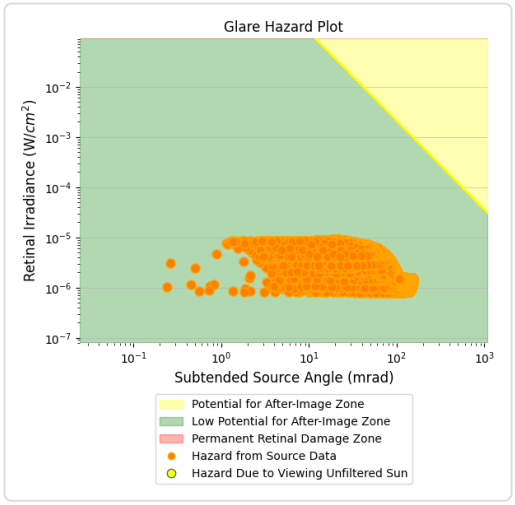
UV-01 and Route: N419 ri west

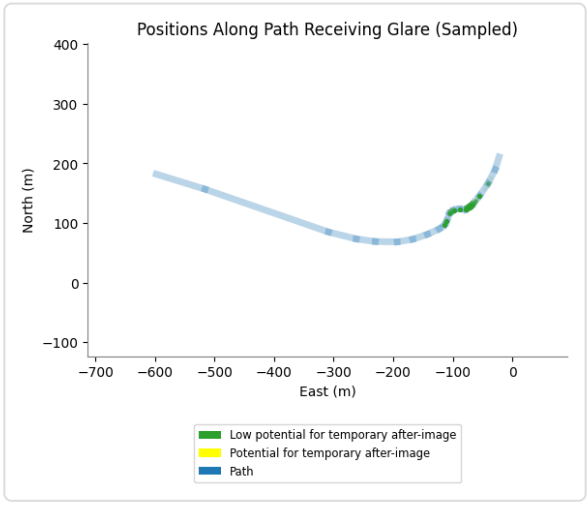
Yellow glare: none

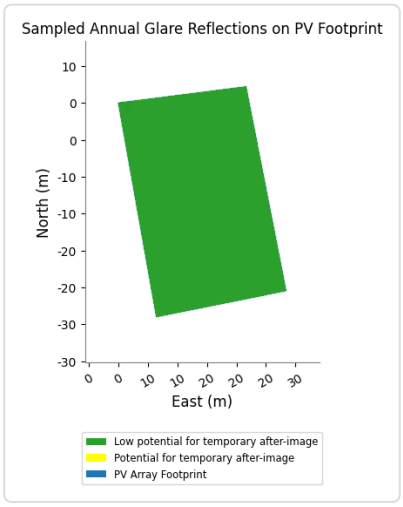
Green glare: 115,586 min.











UV-01 and Route: A12 ri west

No glare found

PV: UV-02 low potential for temporary after-image

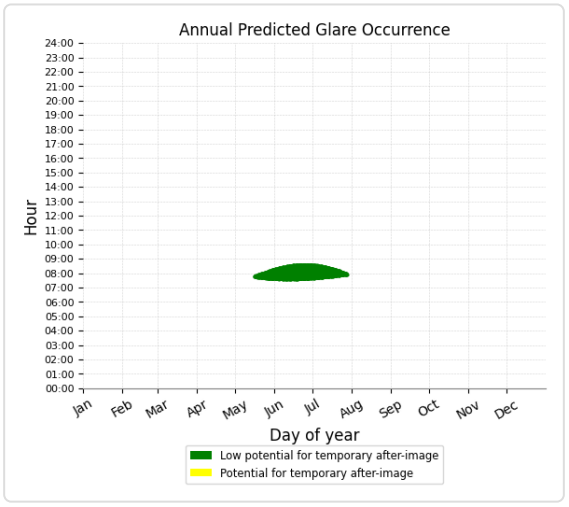
Receptor results ordered by category of glare

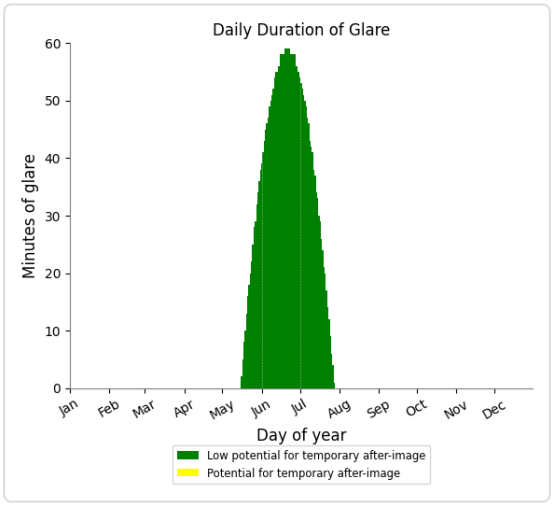
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	2,826	47.1	0	0.0
A12 ri west	18,378	306.3	0	0.0
N198 ri oost	114,537	1,909.0	0	0.0
N198 ri west	19,928	332.1	0	0.0
N419 ri oost	113,181	1,886.3	0	0.0
N419 ri west	86,902	1,448.4	0	0.0

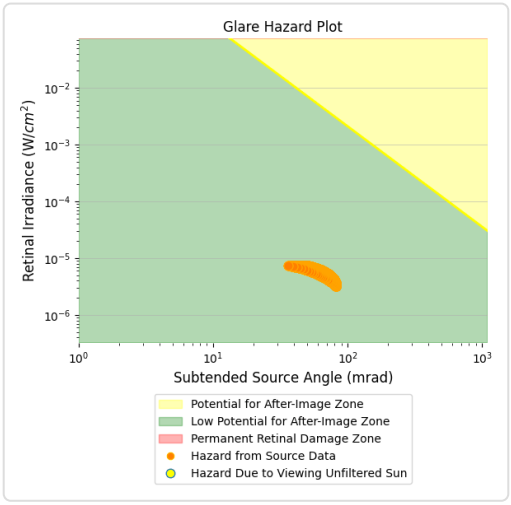
UV-02 and Route: A12 ri oost

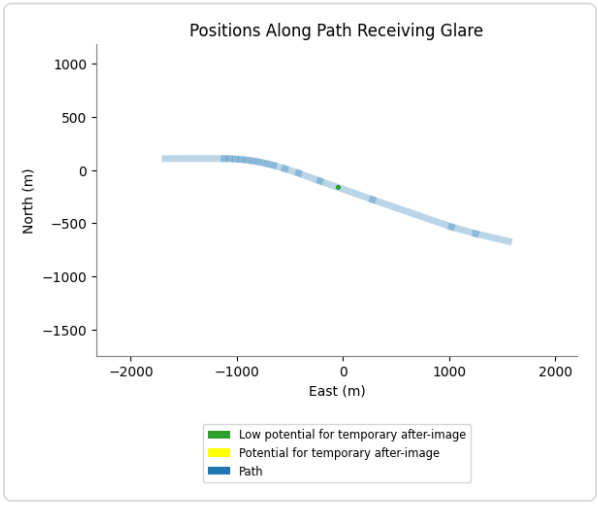
Yellow glare: none

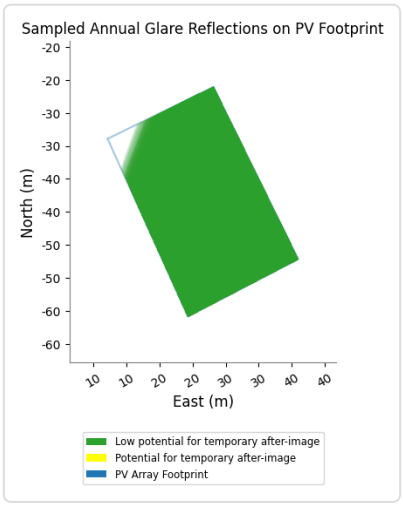
Green glare: 2,826 min.







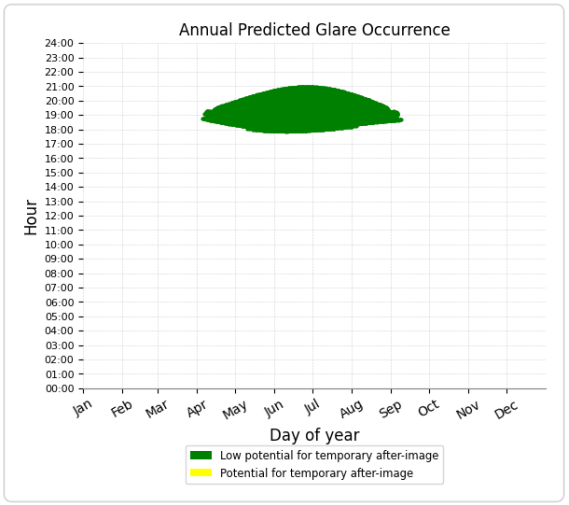


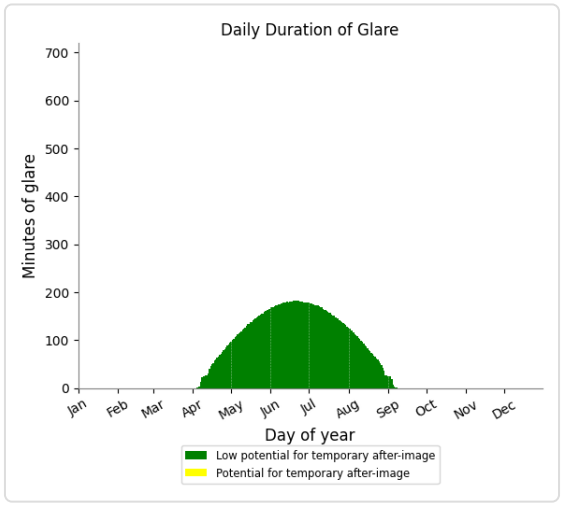


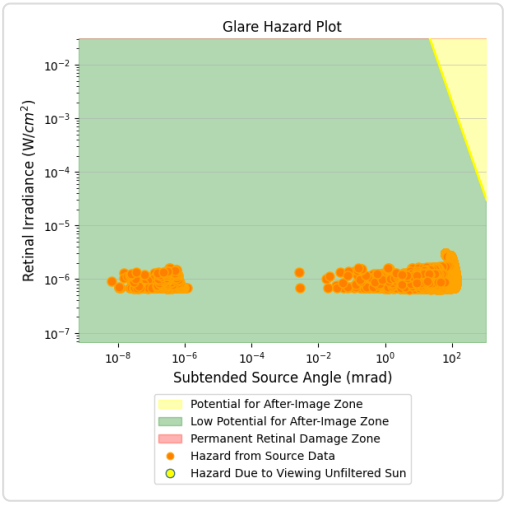
UV-02 and Route: A12 ri west

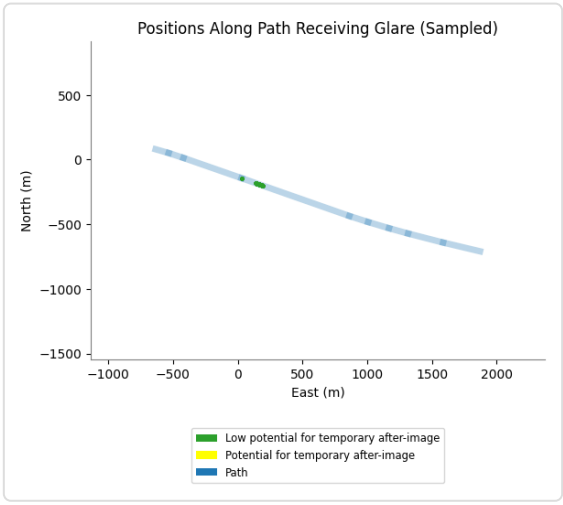
Yellow glare: none

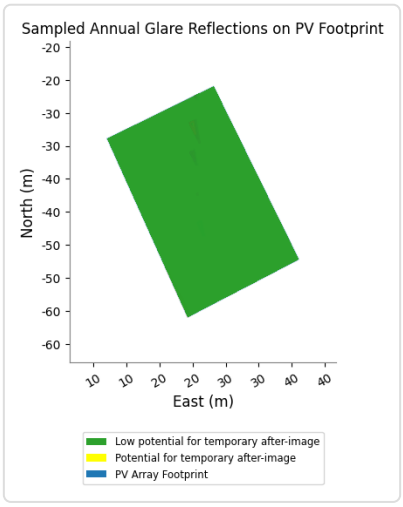
Green glare: 18,378 min.







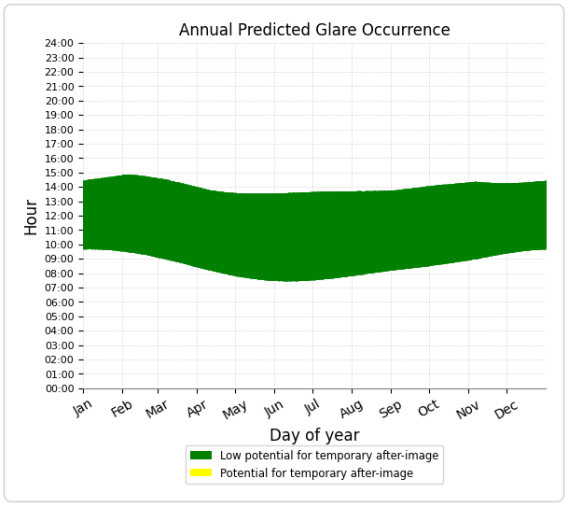


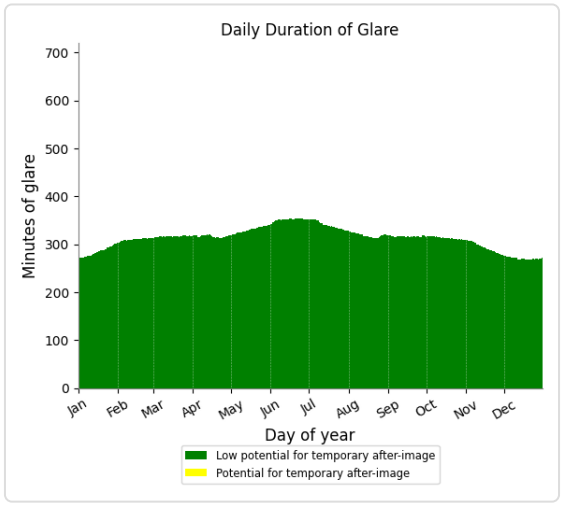


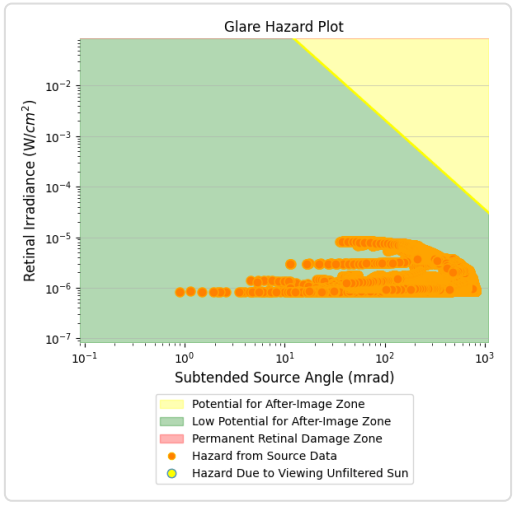
UV-02 and Route: N198 ri oost

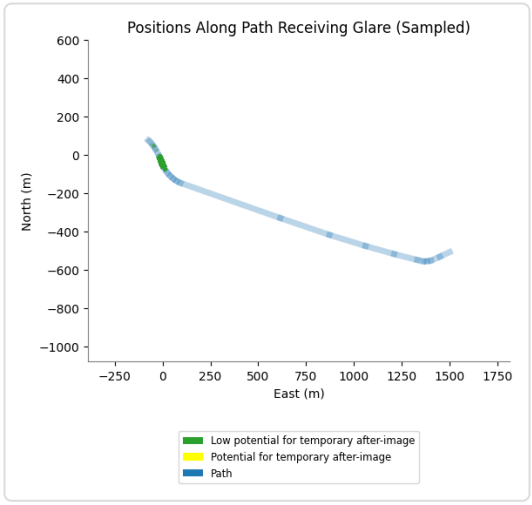
Yellow glare: none

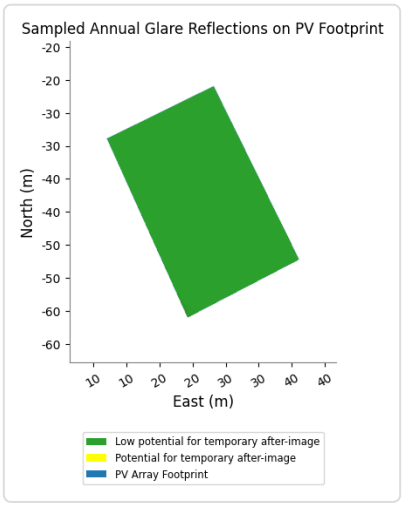
Green glare: 114,537 min.







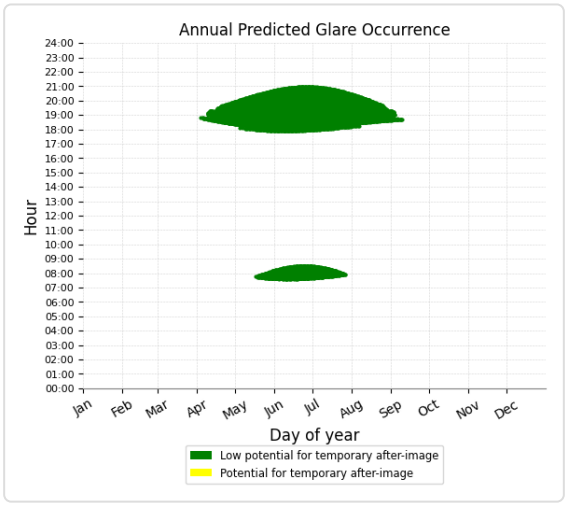


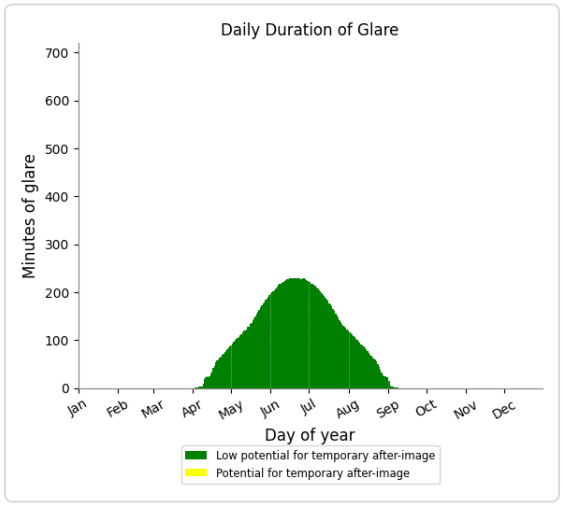


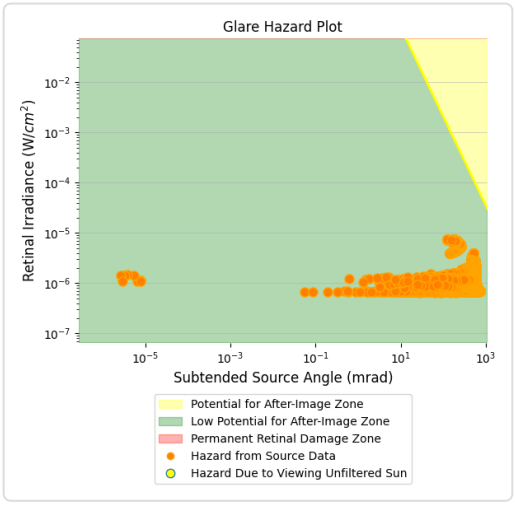
UV-02 and Route: N198 ri west

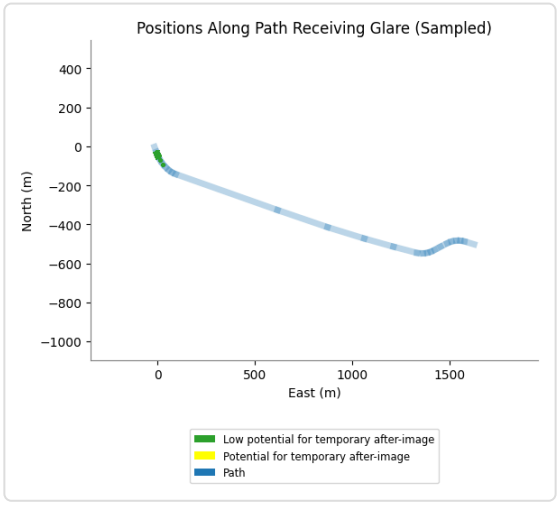
Yellow glare: none

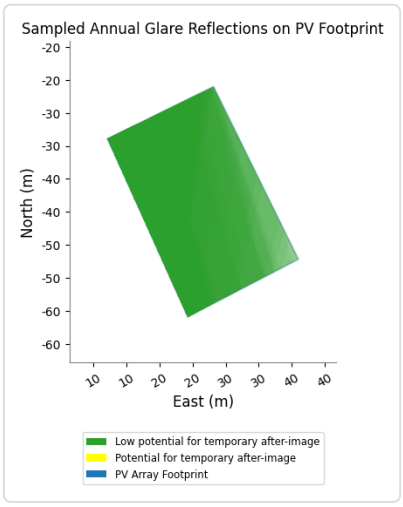
Green glare: 19,928 min.







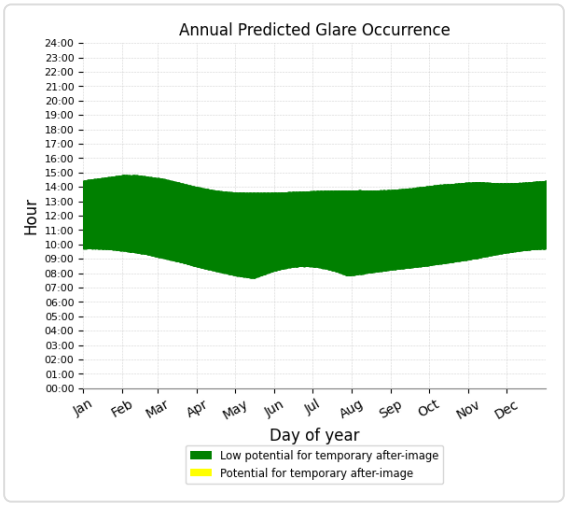


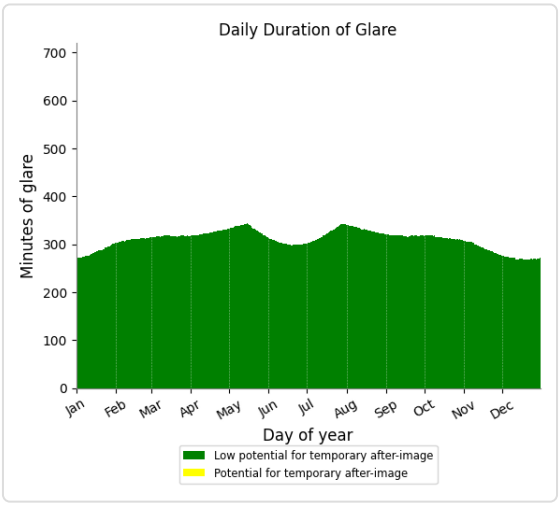


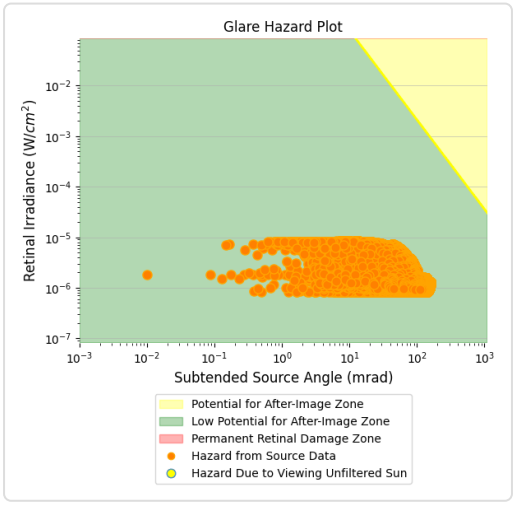
UV-02 and Route: N419 ri oost

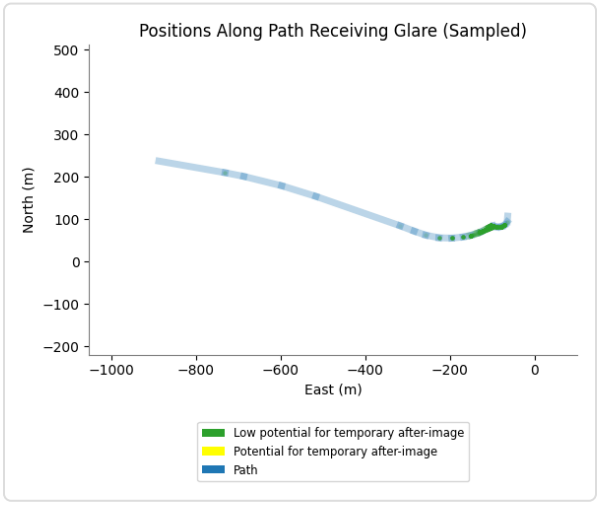
Yellow glare: none

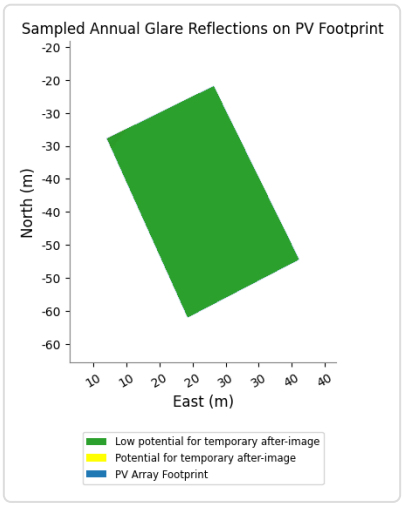
Green glare: 113,181 min.







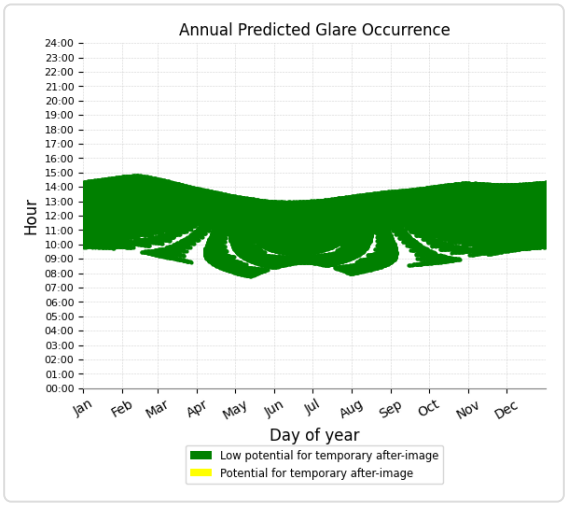


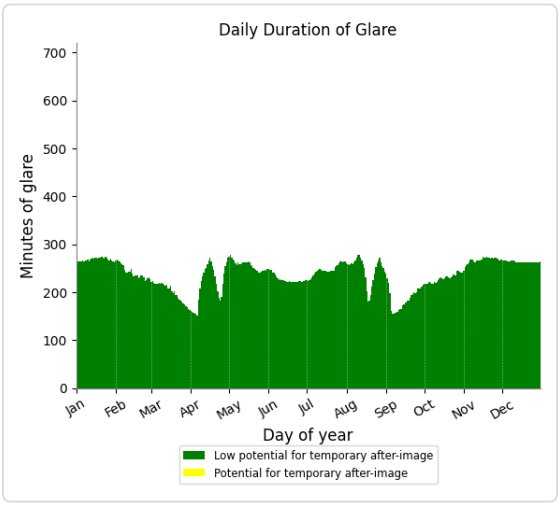


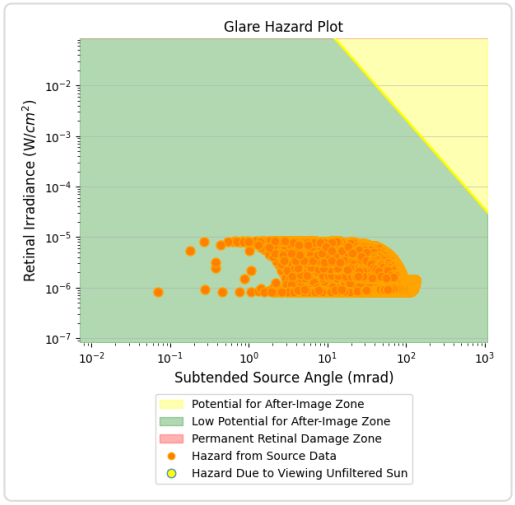
UV-02 and Route: N419 ri west

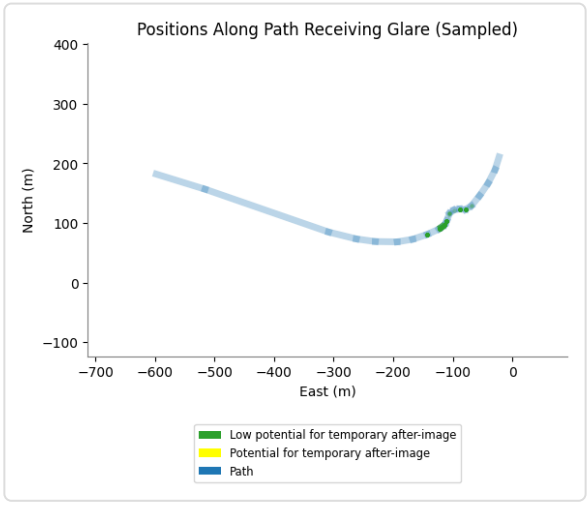
Yellow glare: none

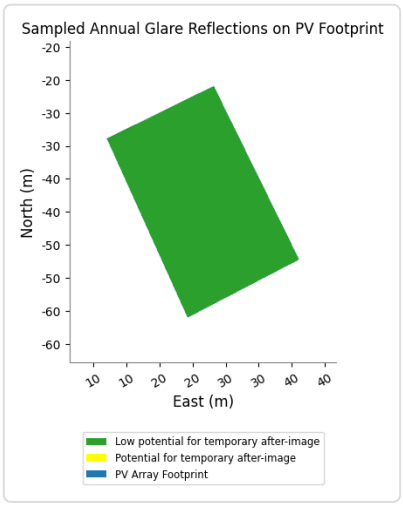
Green glare: 86,902 min.











PV: UV-03 low potential for temporary after-image

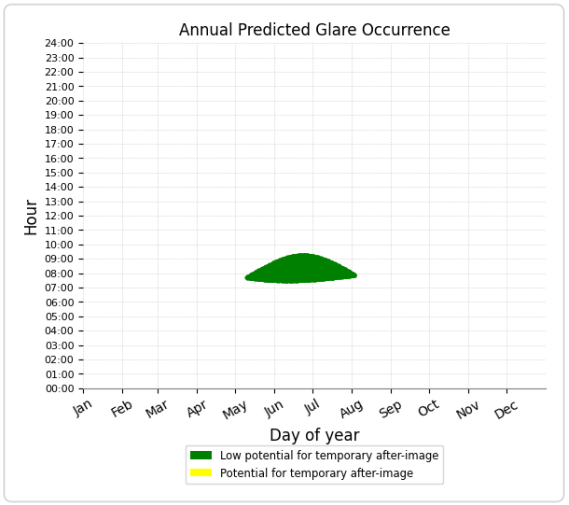
Receptor results ordered by category of glare

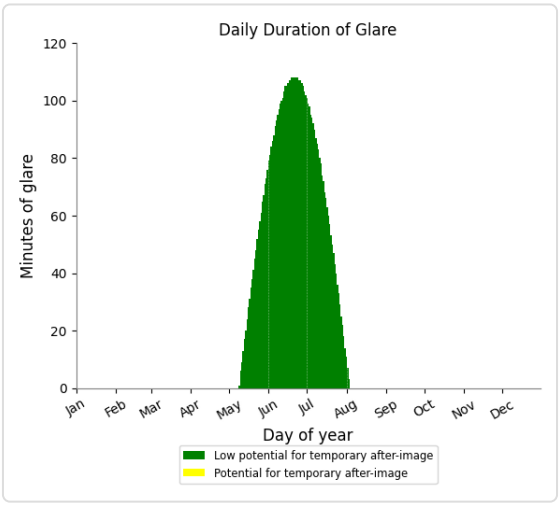
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	5,912	98.5	0	0.0
A12 ri west	25,646	427.4	0	0.0
N198 ri oost	111,685	1,861.4	0	0.0
N198 ri west	24,670	411.2	0	0.0
N419 ri oost	106,080	1,768.0	0	0.0
N419 ri west	28,225	470.4	0	0.0

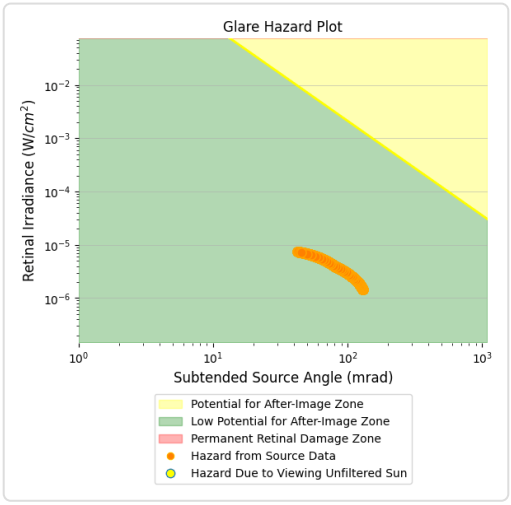
UV-03 and Route: A12 ri oost

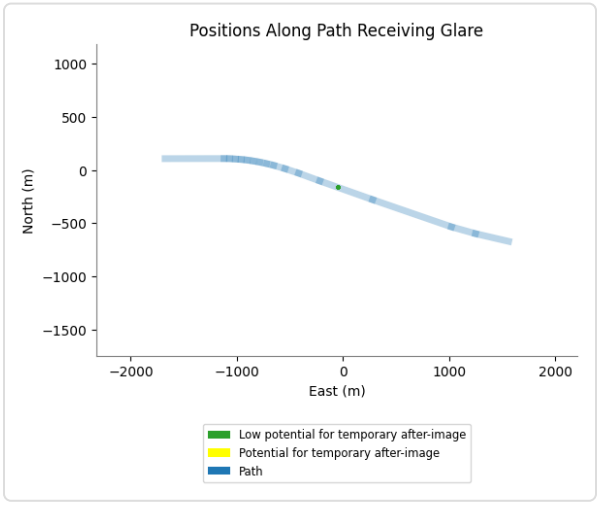
Yellow glare: none

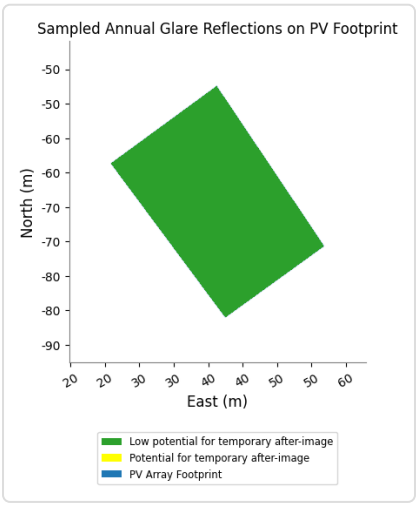
Green glare: 5,912 min.







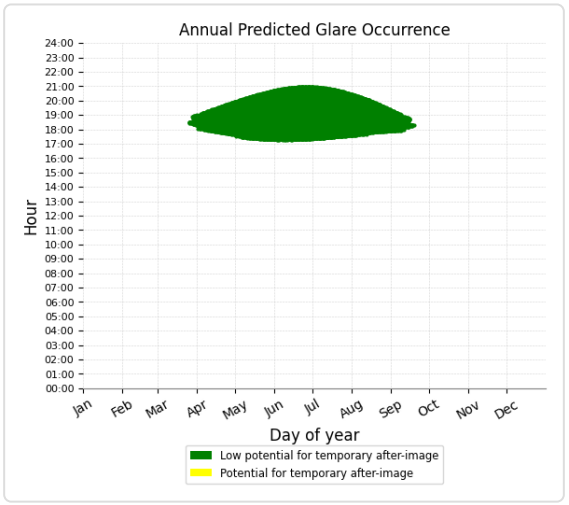


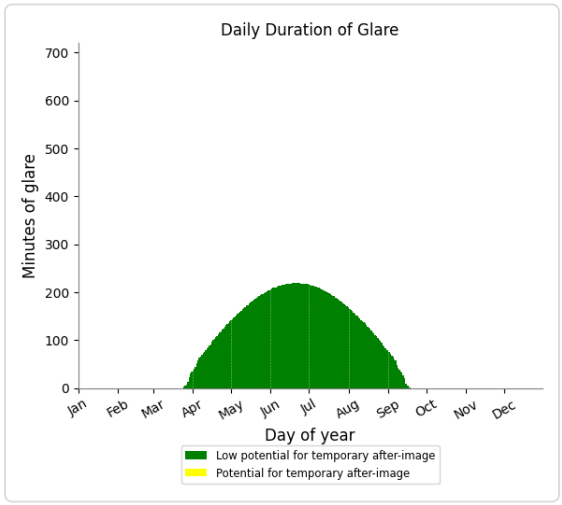


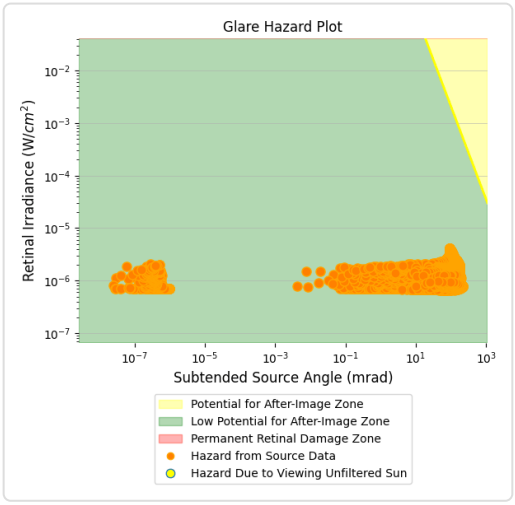
UV-03 and Route: A12 ri west

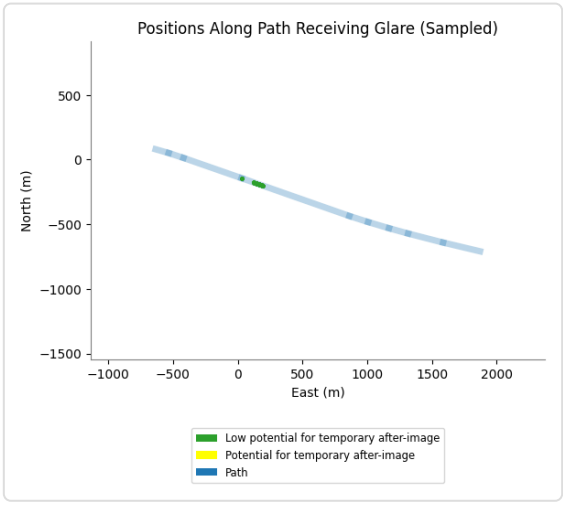
Yellow glare: none

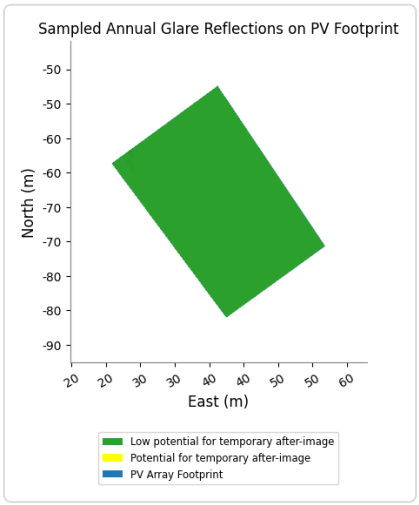
Green glare: 25,646 min.







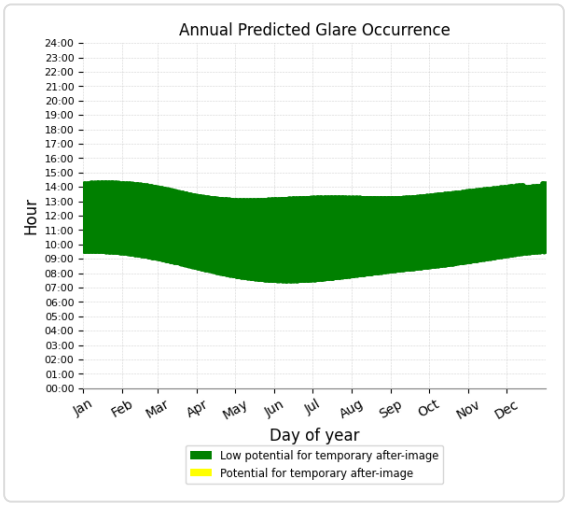


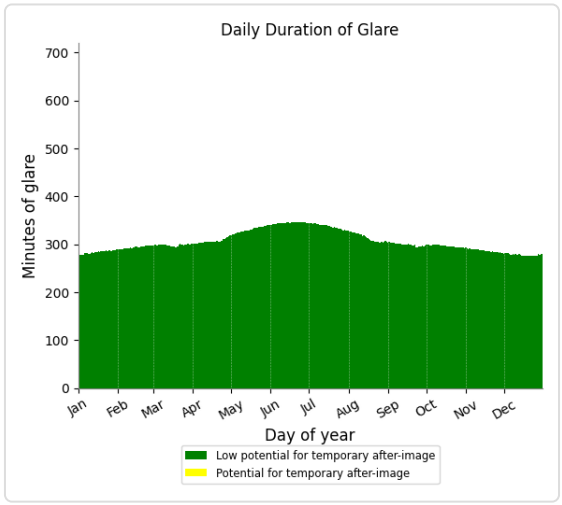


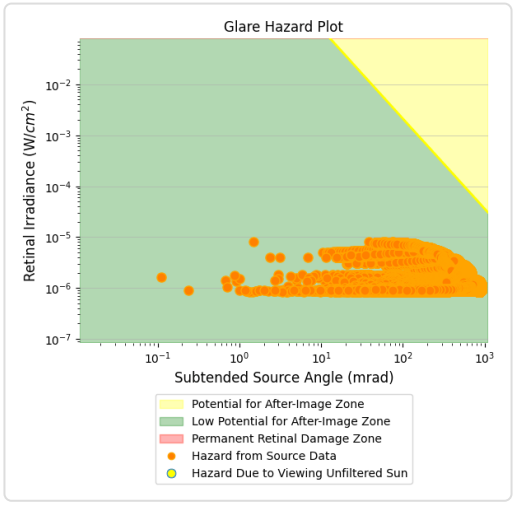
UV-03 and Route: N198 ri oost

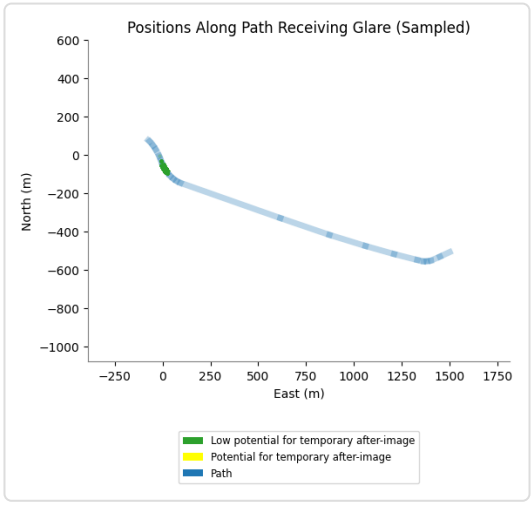
Yellow glare: none

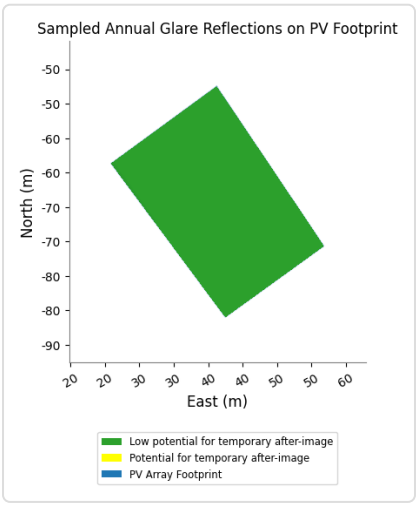
Green glare: 111,685 min.







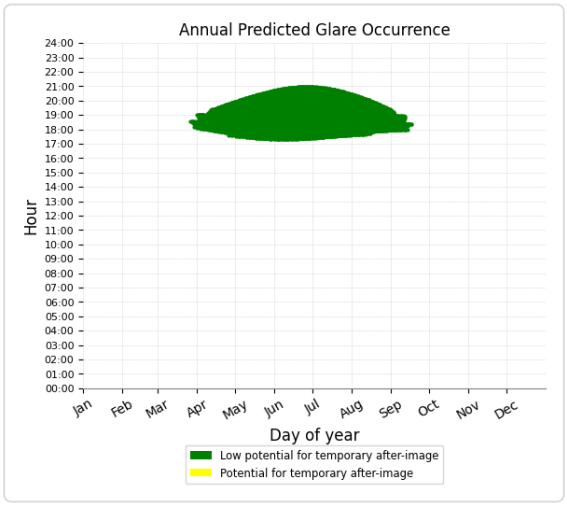


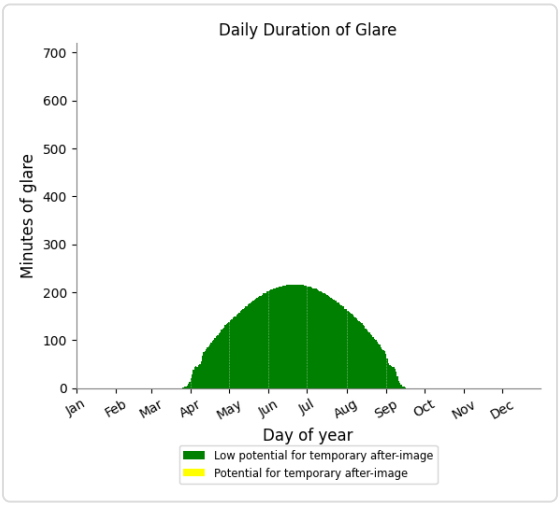


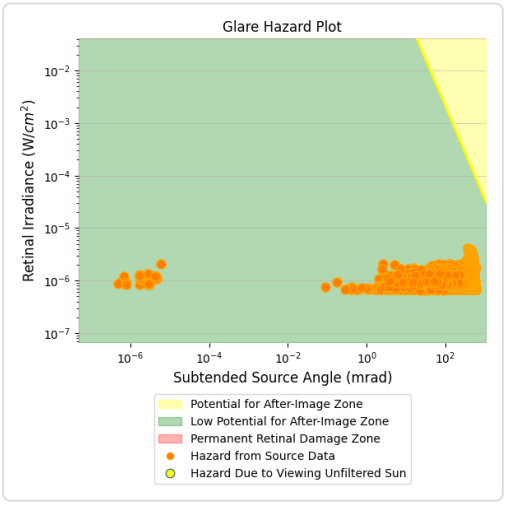
UV-03 and Route: N198 ri west

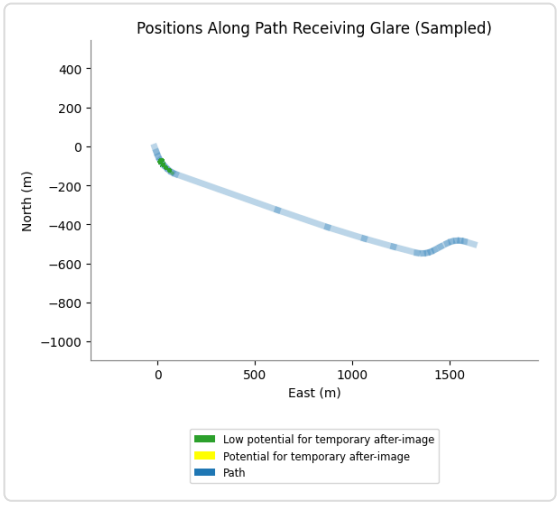
Yellow glare: none

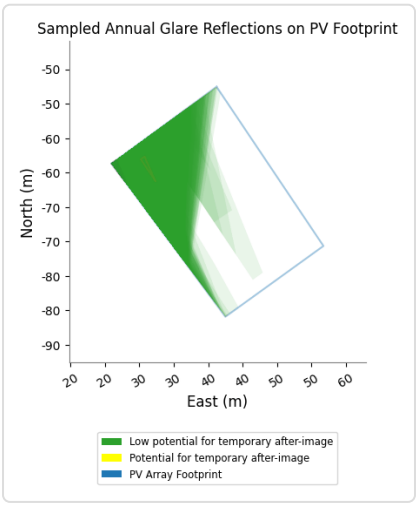
Green glare: 24,670 min.







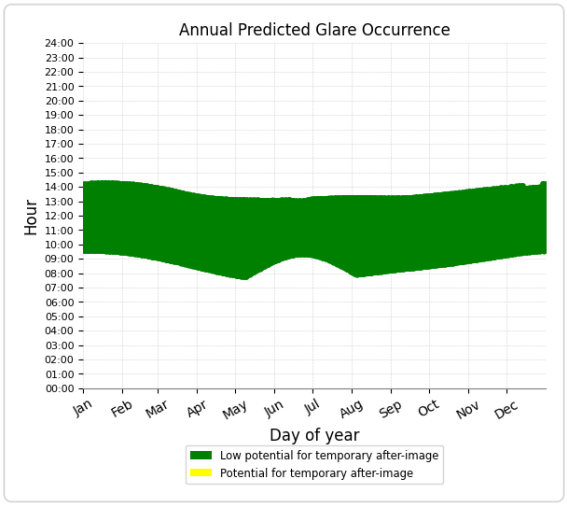


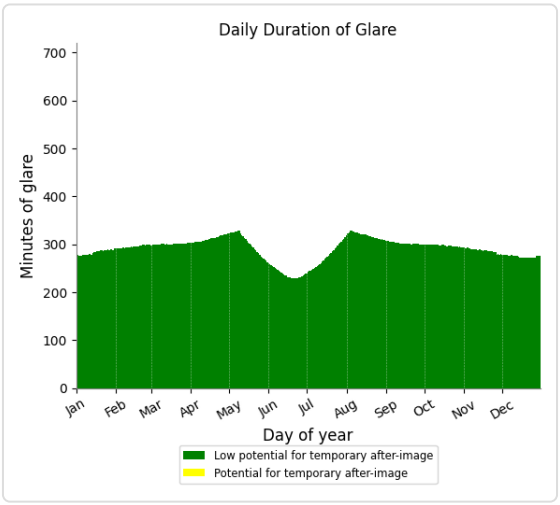


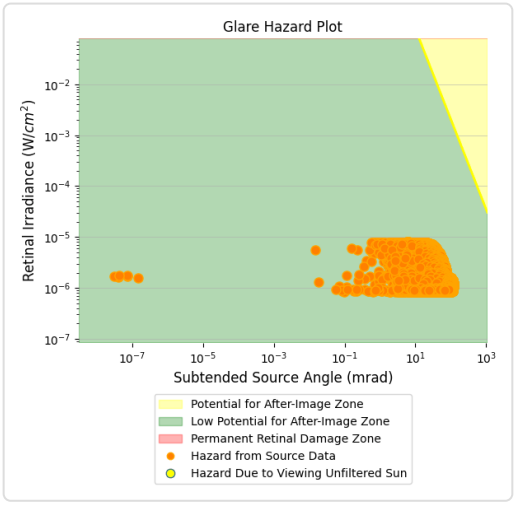
UV-03 and Route: N419 ri oost

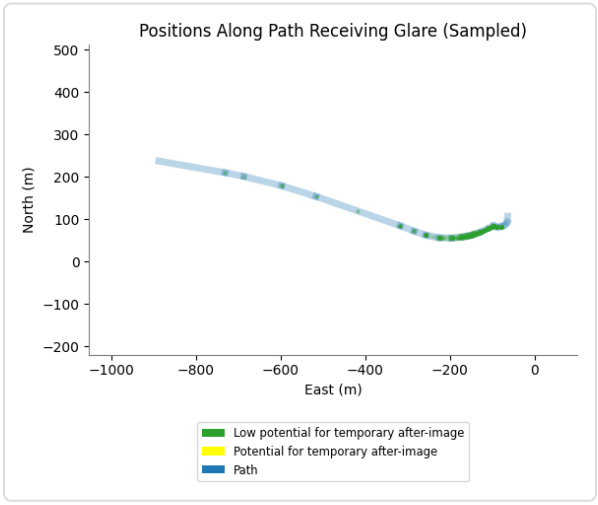
Yellow glare: none

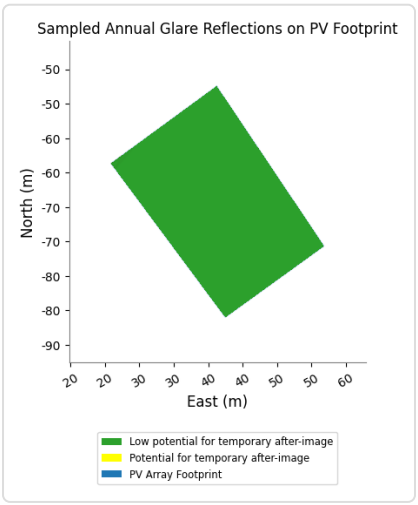
Green glare: 106,080 min.







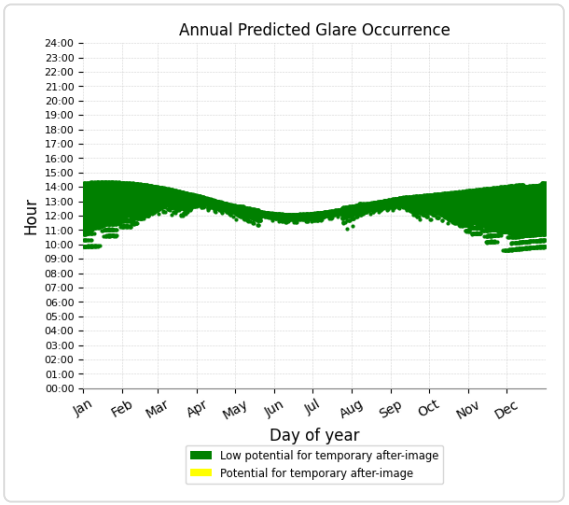


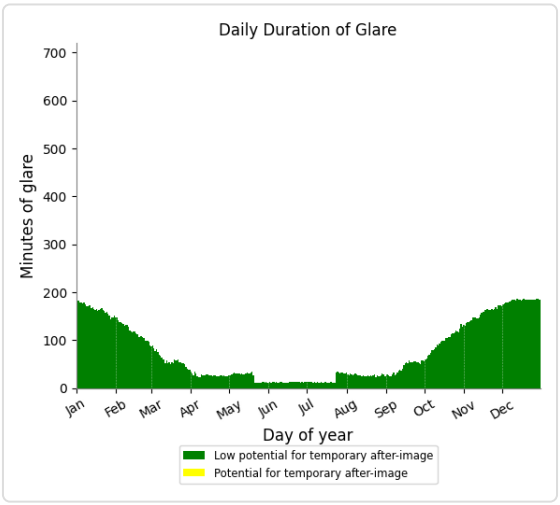


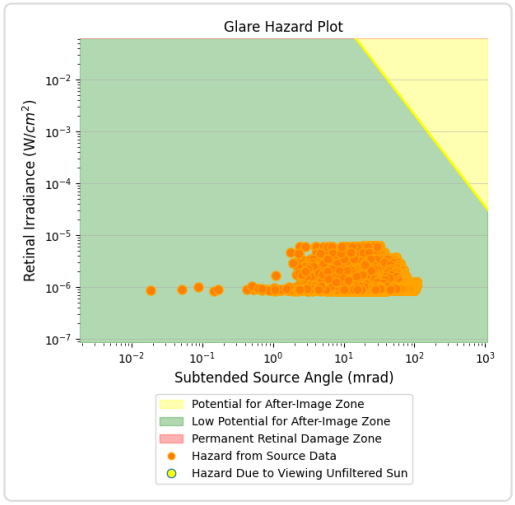
UV-03 and Route: N419 ri west

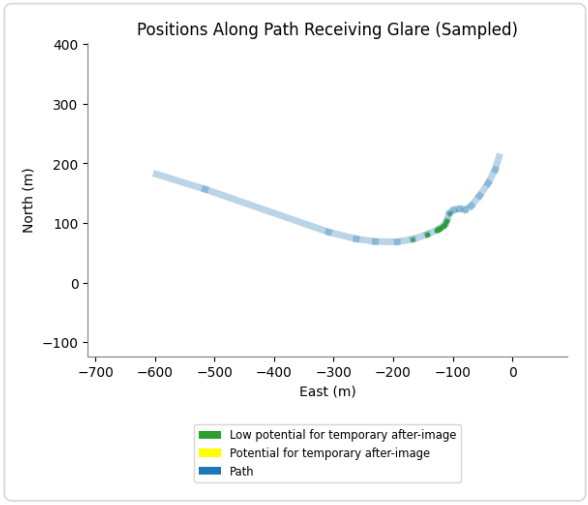
Yellow glare: none

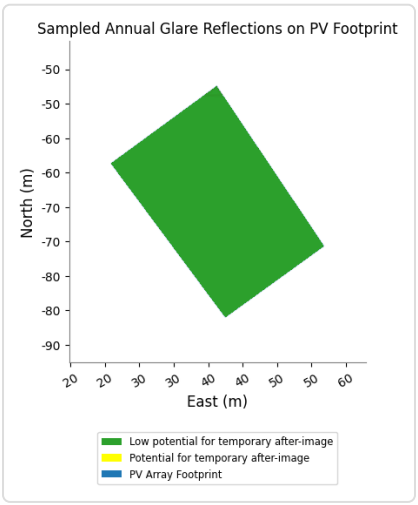
Green glare: 28,225 min.











PV: UV-04 low potential for temporary after-image

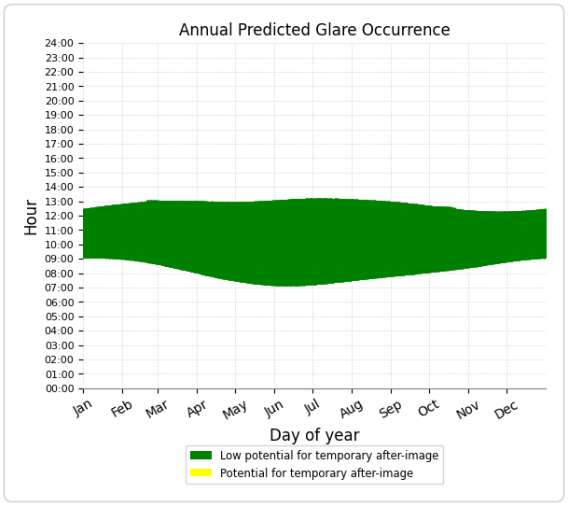
Receptor results ordered by category of glare

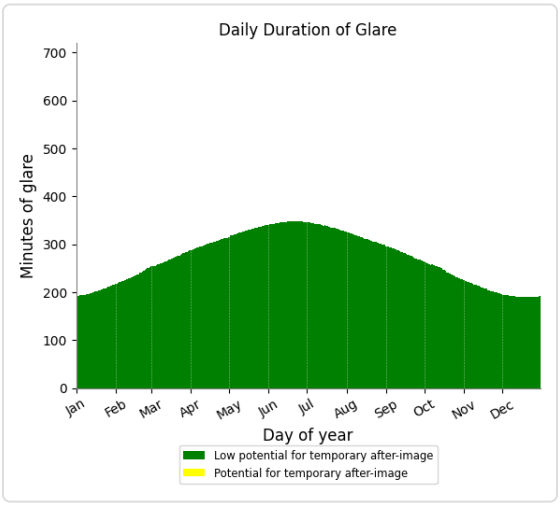
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	99,276	1,654.6	0	0.0
A12 ri west	33,809	563.5	0	0.0
N198 ri oost	105,583	1,759.7	0	0.0
N198 ri west	33,022	550.4	0	0.0
N419 ri oost	82,432	1,373.9	0	0.0
N419 ri west	7,899	131.7	0	0.0

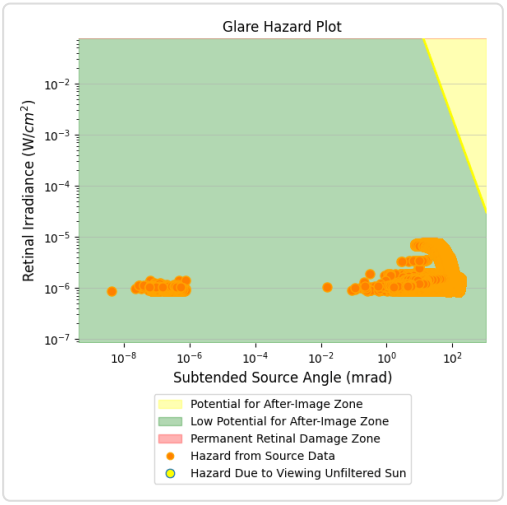
UV-04 and Route: A12 ri oost

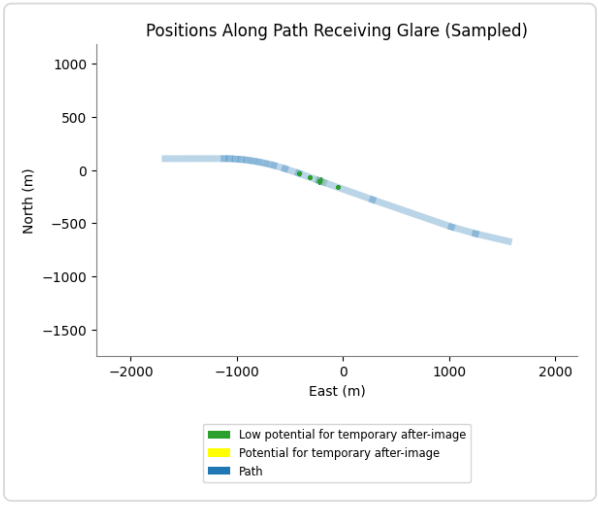
Yellow glare: none

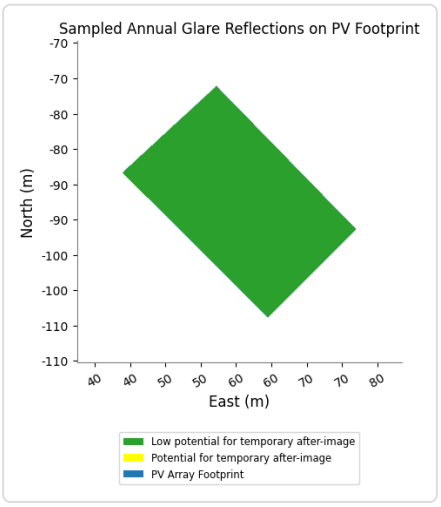
Green glare: 99,276 min.







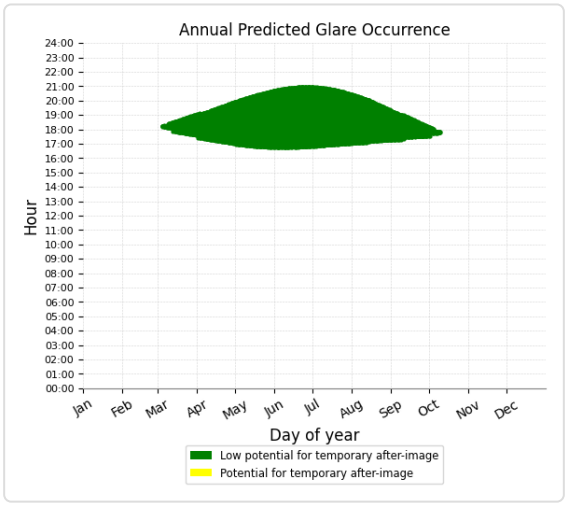


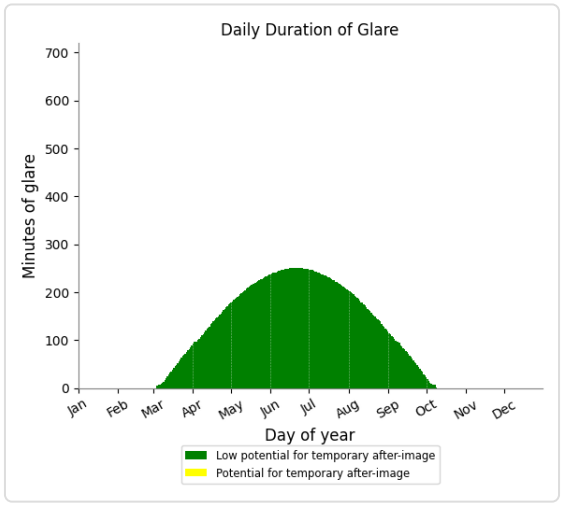


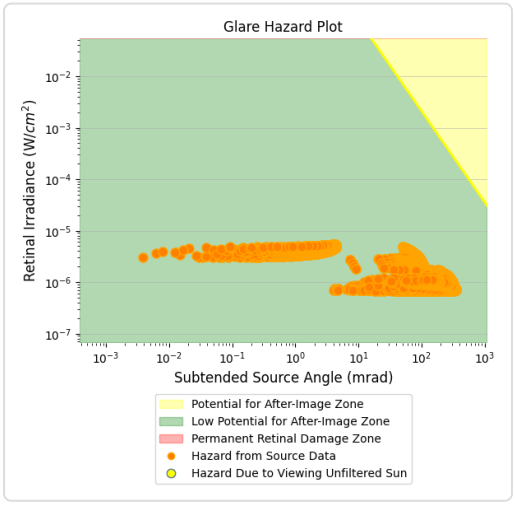
UV-04 and Route: A12 ri west

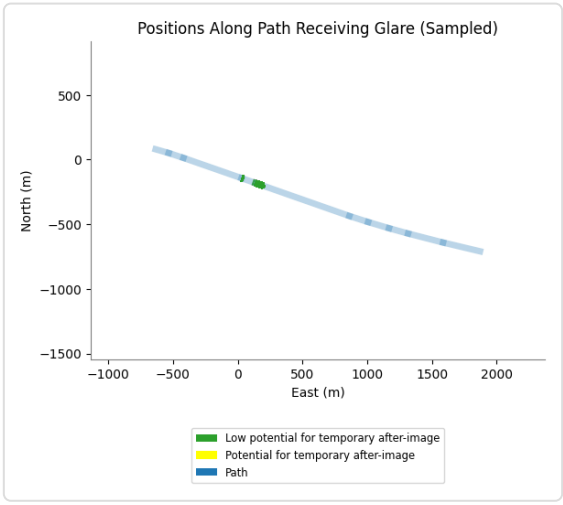
Yellow glare: none

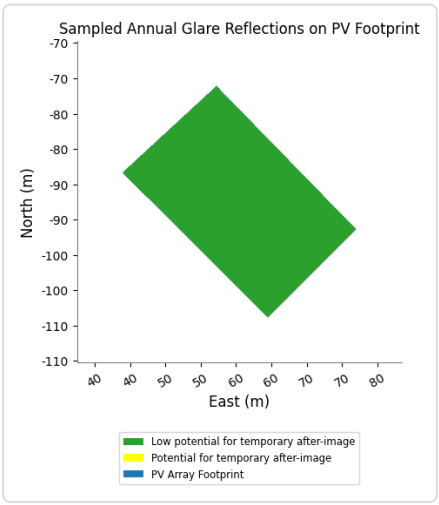
Green glare: 33,809 min.







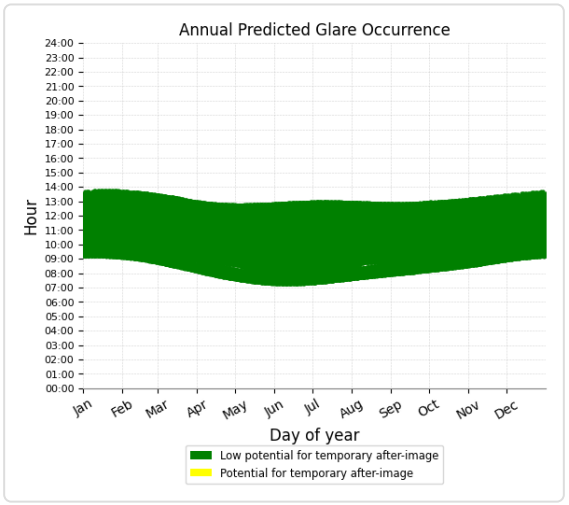


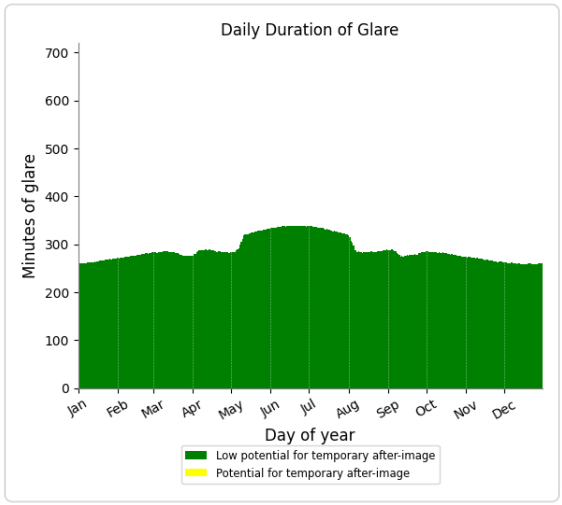


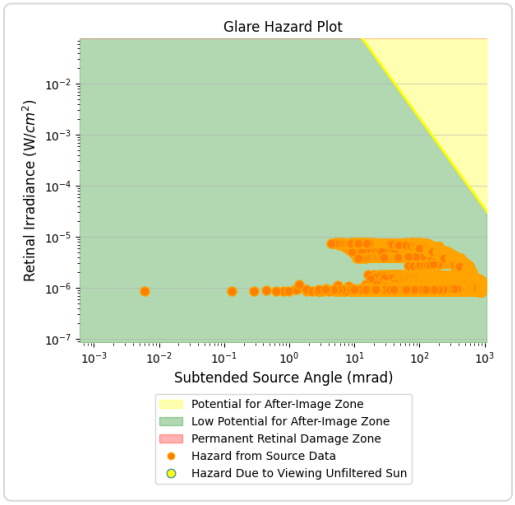
UV-04 and Route: N198 ri oost

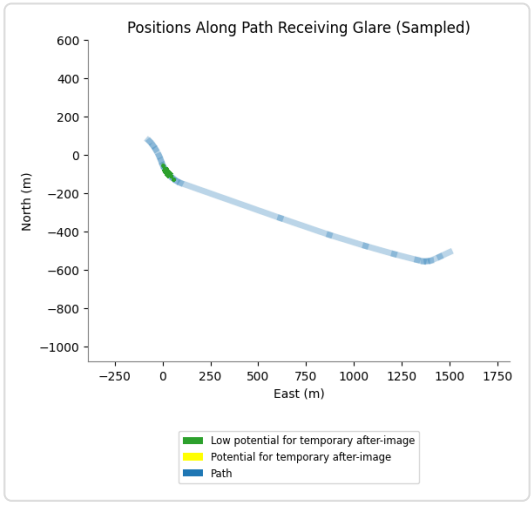
Yellow glare: none

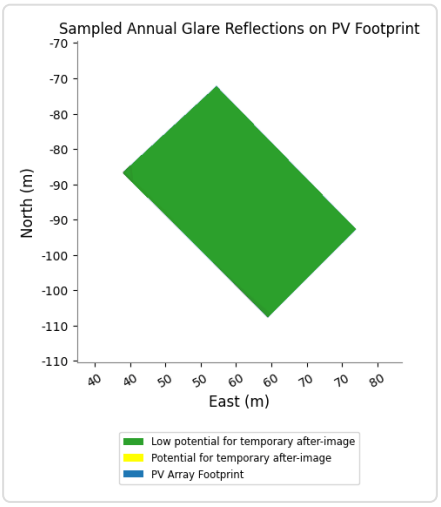
Green glare: 105,583 min.







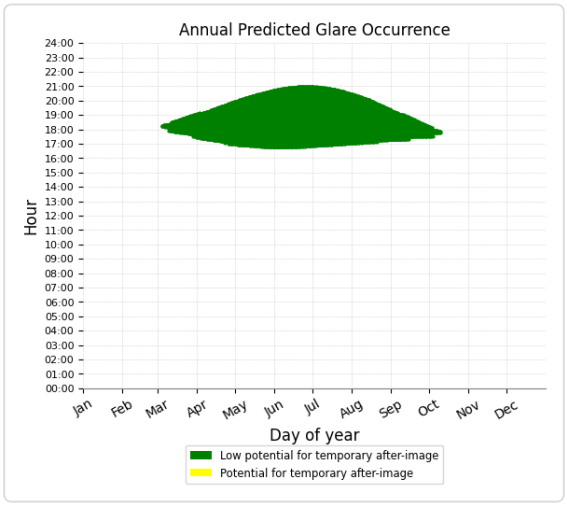


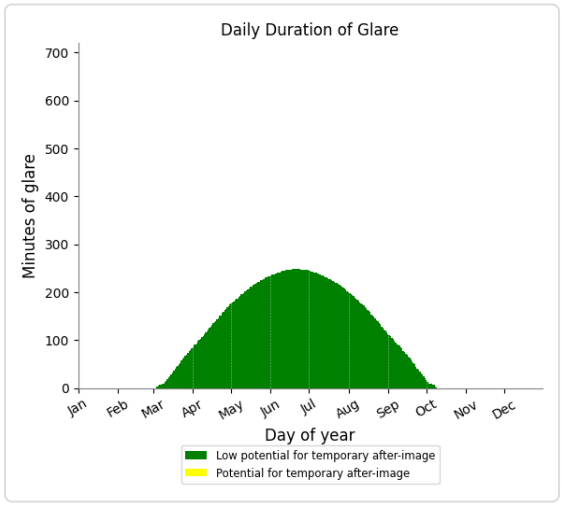


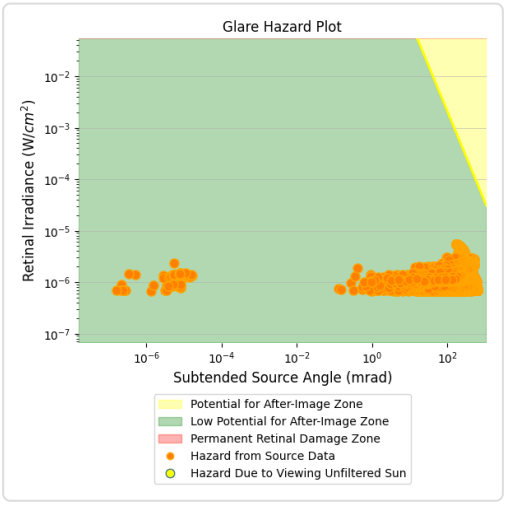
UV-04 and Route: N198 ri west

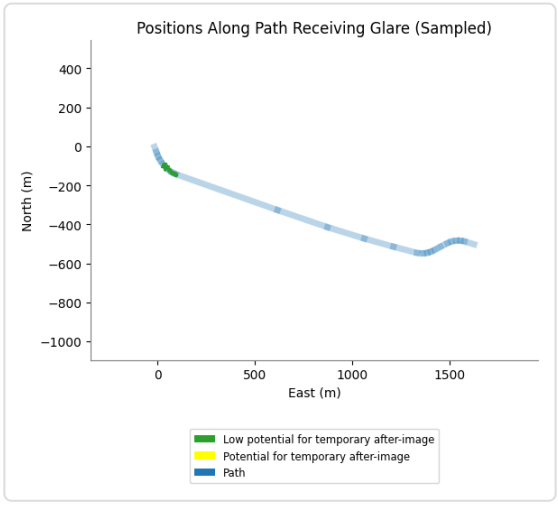
Yellow glare: none

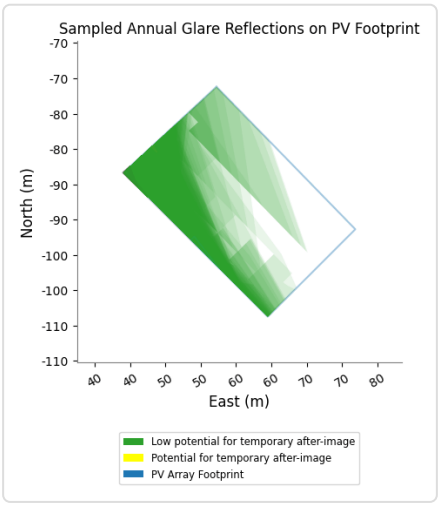
Green glare: 33,022 min.







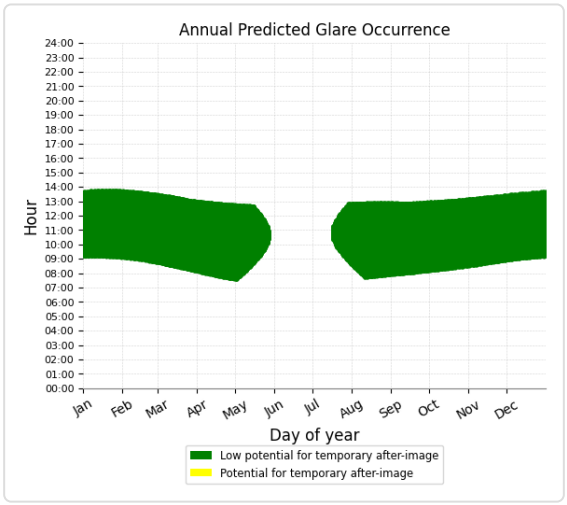


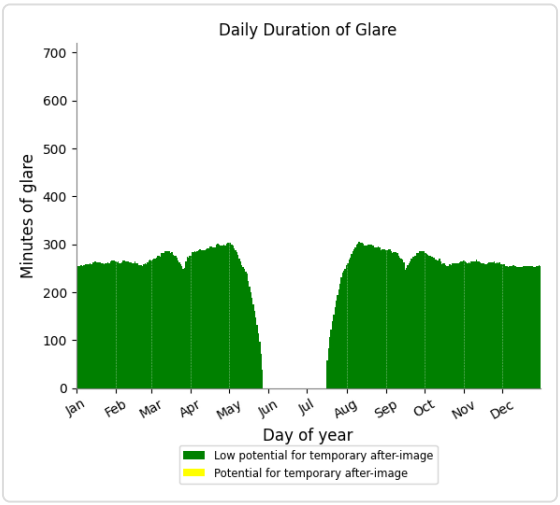


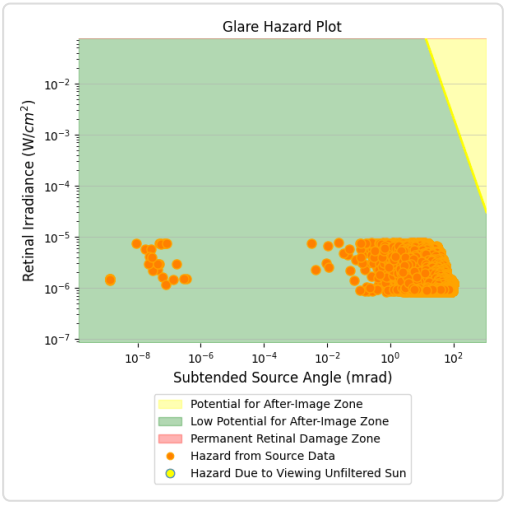
UV-04 and Route: N419 ri oost

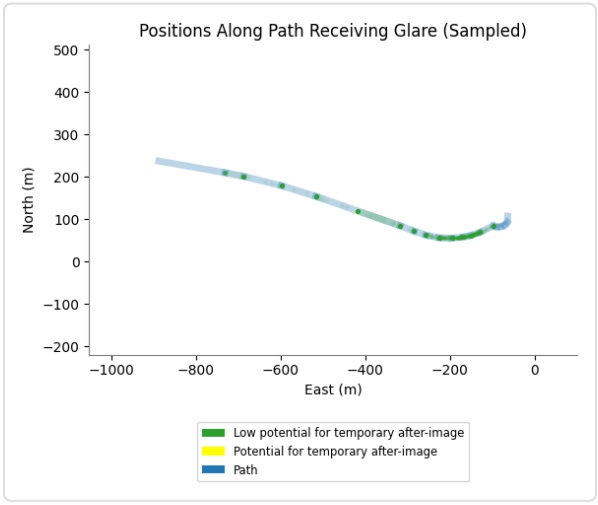
Yellow glare: none

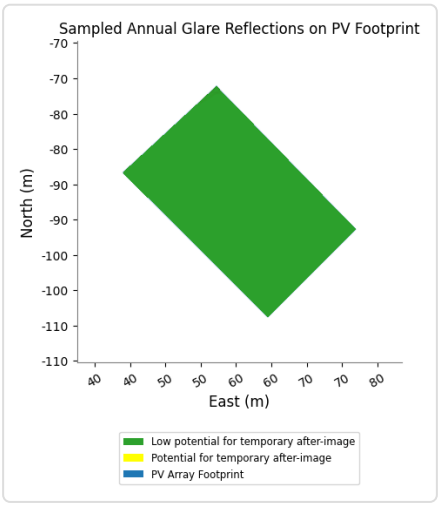
Green glare: 82,432 min.







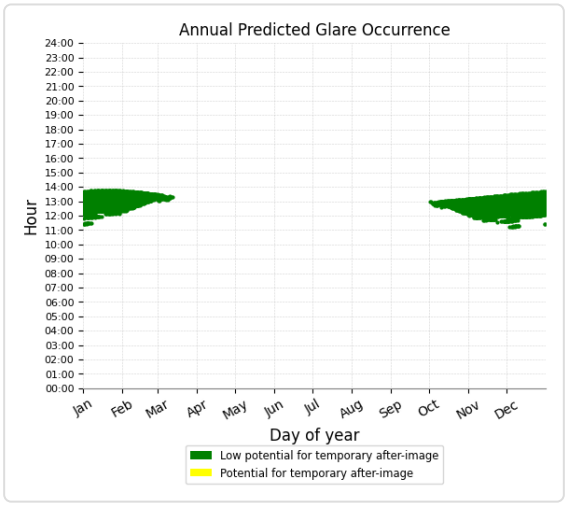


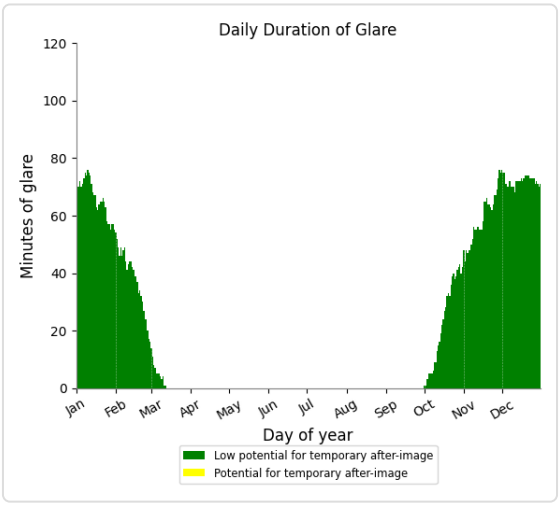


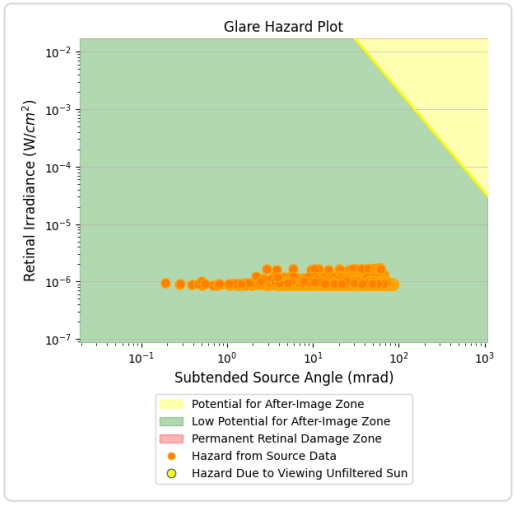
UV-04 and Route: N419 ri west

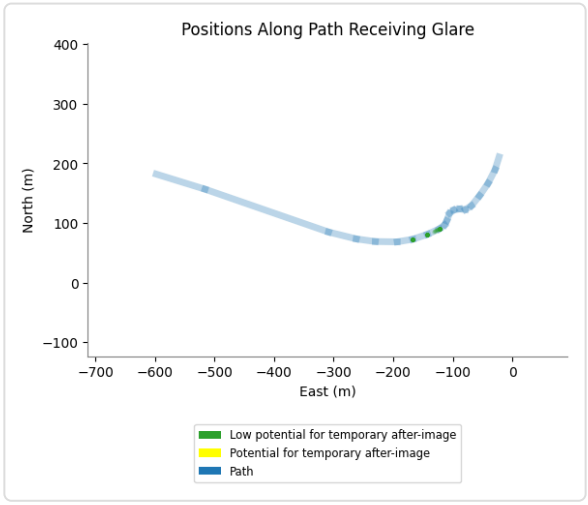
Yellow glare: none

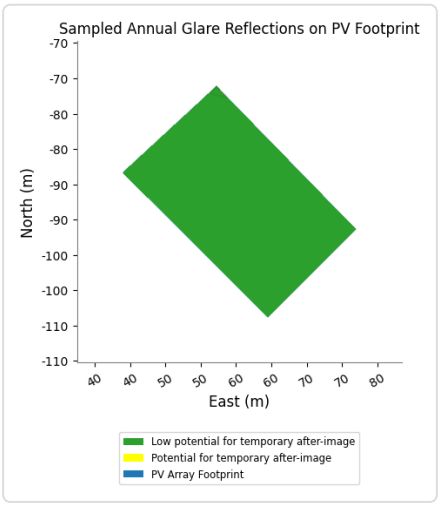
Green glare: 7,899 min.











PV: UV-05 low potential for temporary after-image

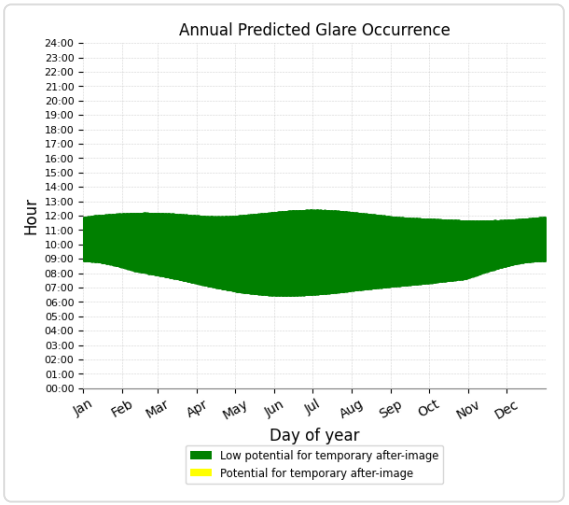
Receptor results ordered by category of glare

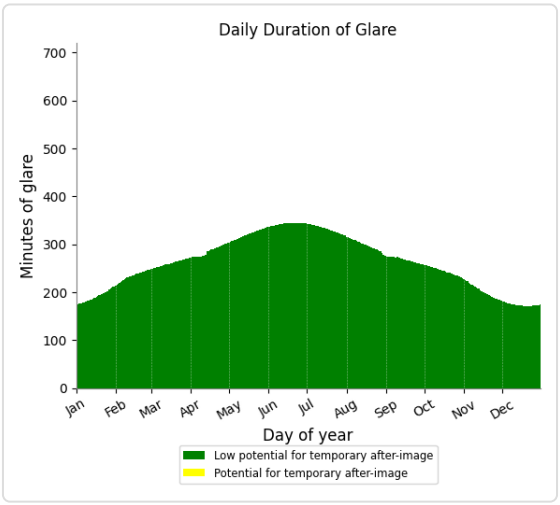
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	95,989	1,599.8	0	0.0
A12 ri west	45,493	758.2	0	0.0
N198 ri oost	94,993	1,583.2	0	0.0
N198 ri west	45,700	761.7	0	0.0
N419 ri oost	4,181	69.7	0	0.0
N419 ri west	0	0.0	0	0.0

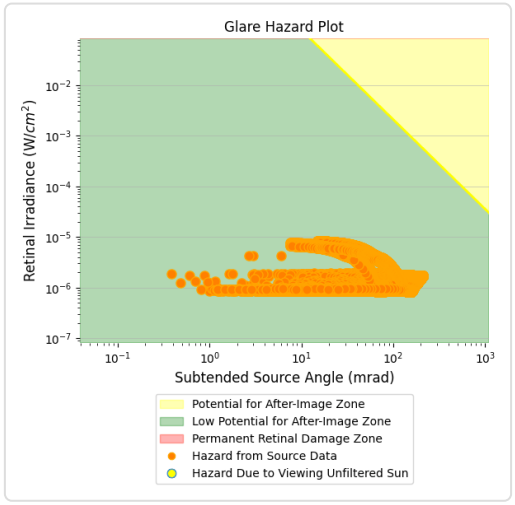
UV-05 and Route: A12 ri oost

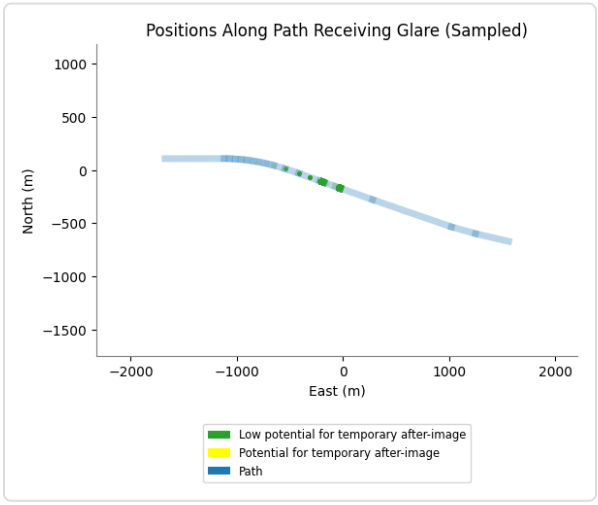
Yellow glare: none

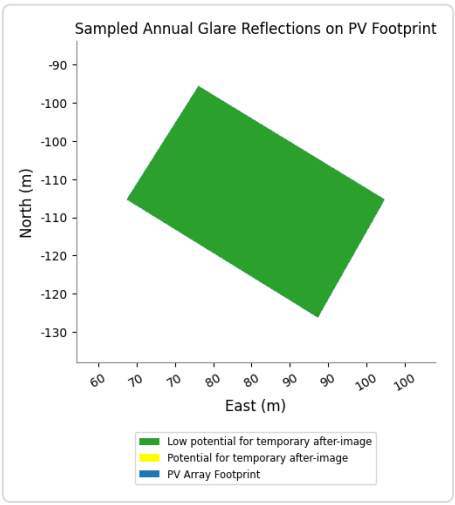
Green glare: 95,989 min.







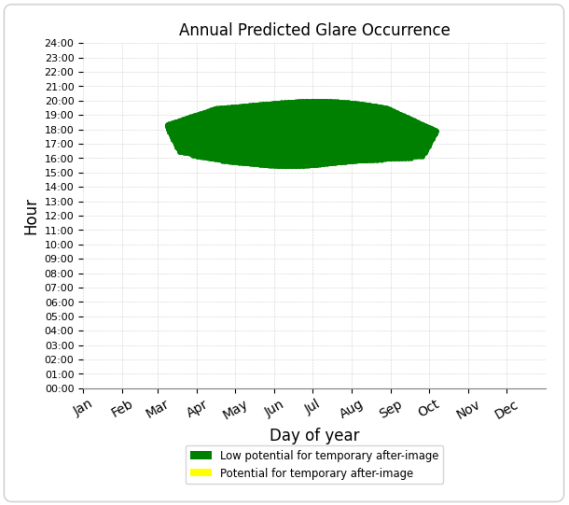


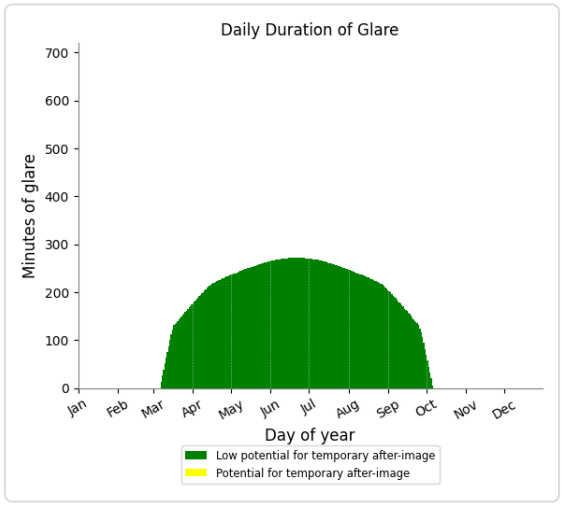


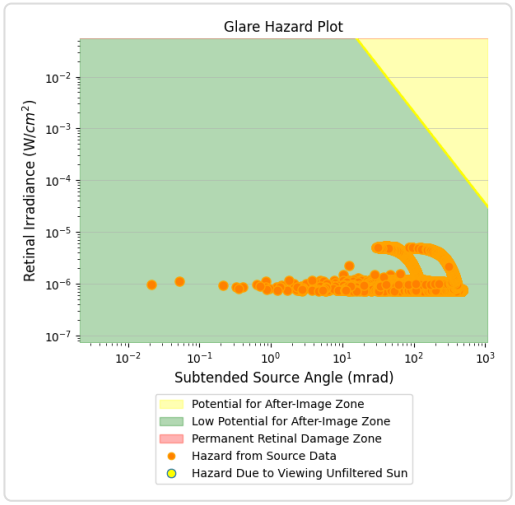
UV-05 and Route: A12 ri west

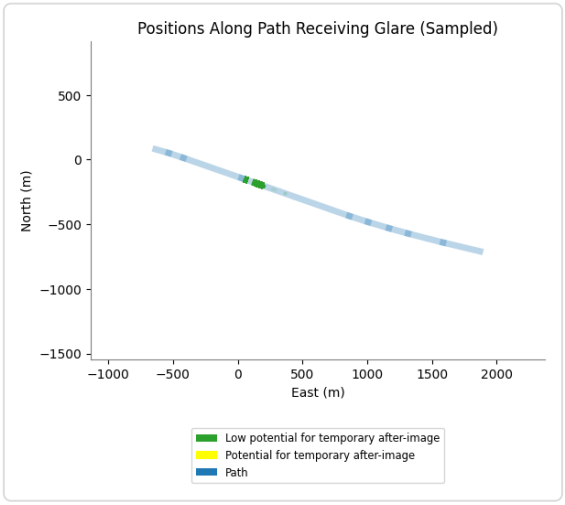
Yellow glare: none

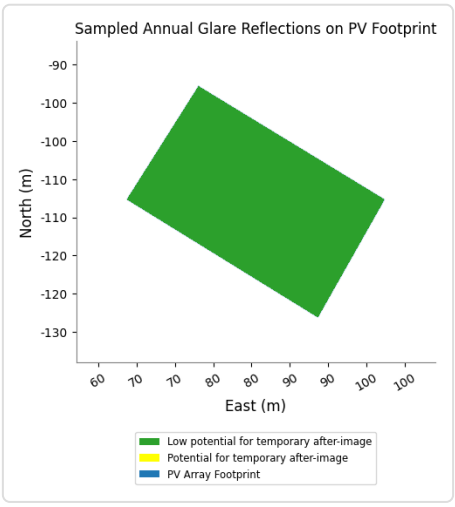
Green glare: 45,493 min.







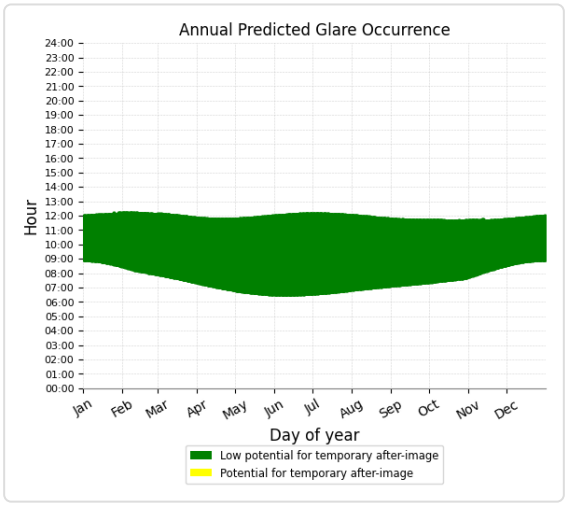


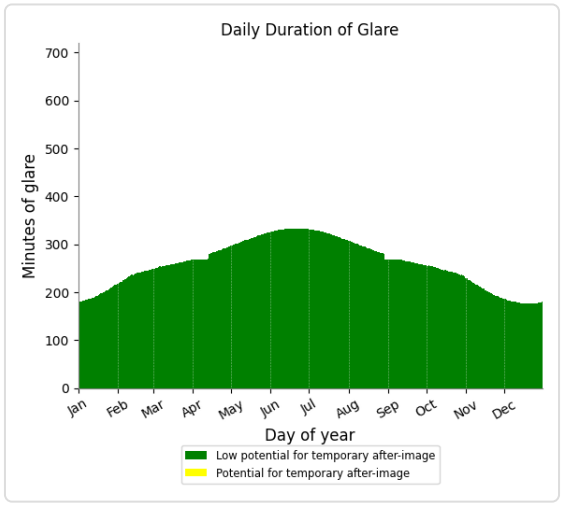


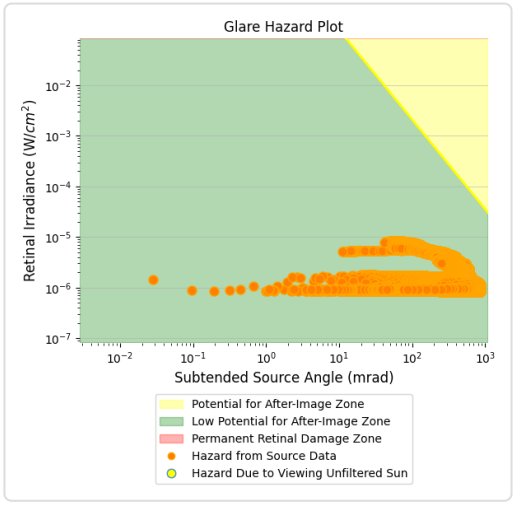
UV-05 and Route: N198 ri oost

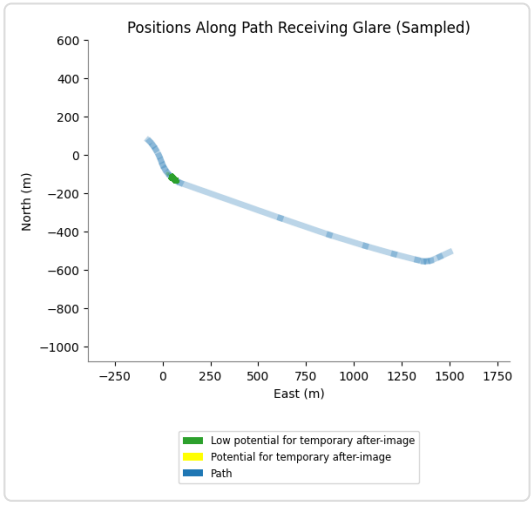
Yellow glare: none

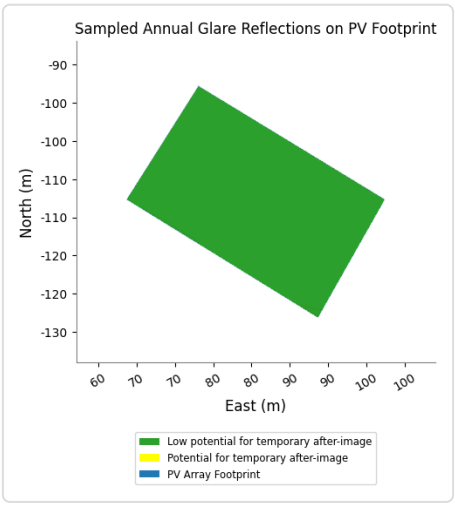
Green glare: 94,993 min.







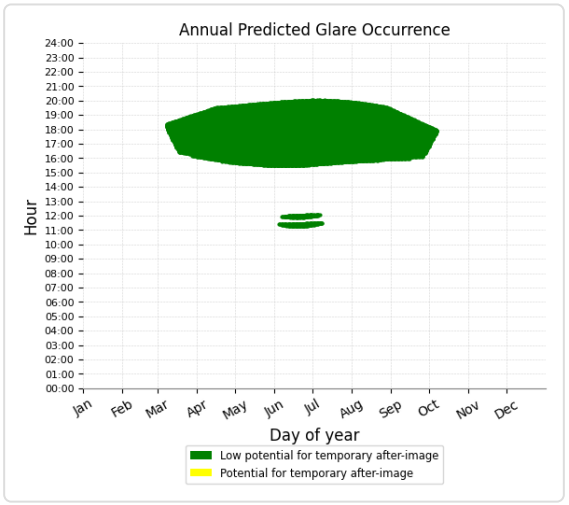


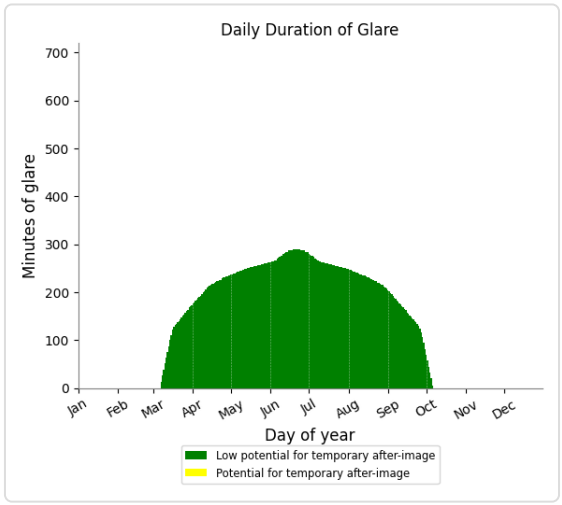


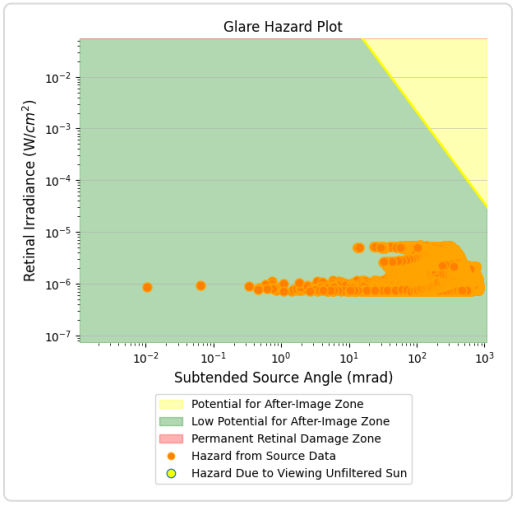
UV-05 and Route: N198 ri west

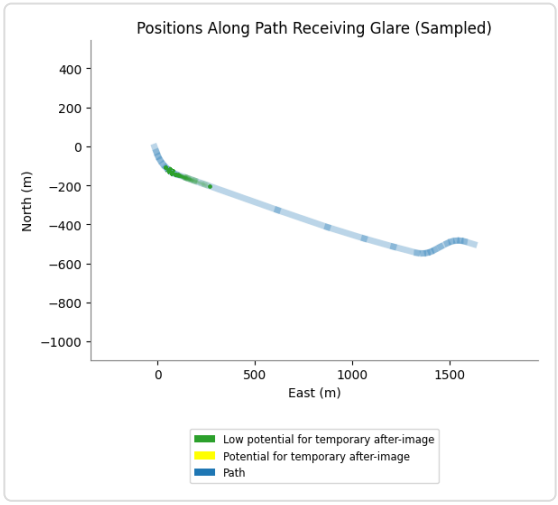
Yellow glare: none

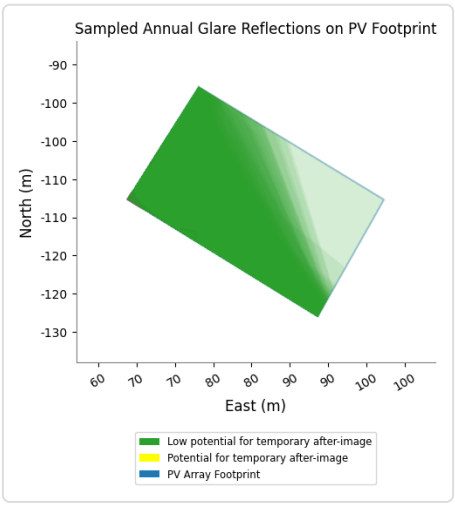
Green glare: 45,700 min.







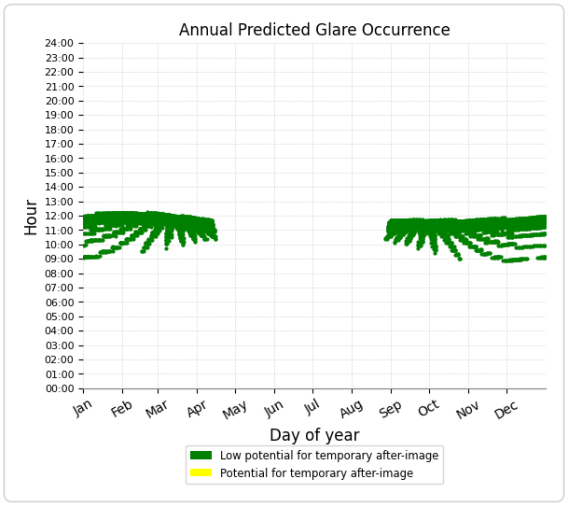


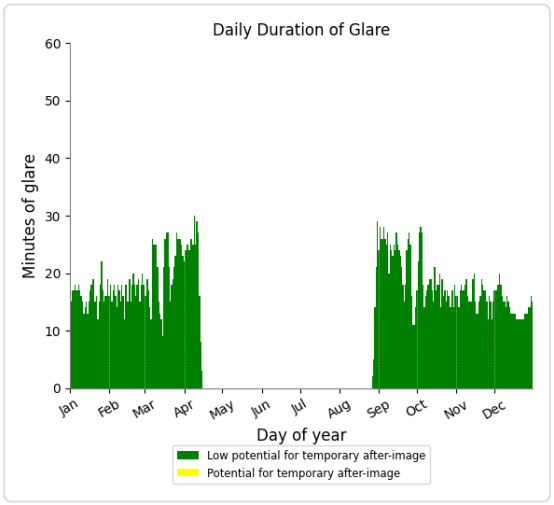


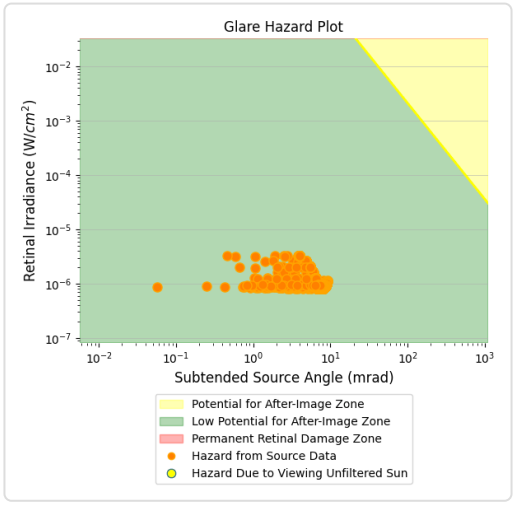
UV-05 and Route: N419 ri oost

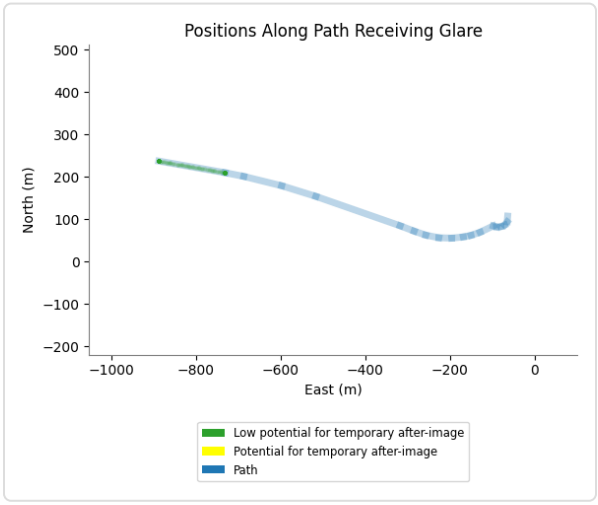
Yellow glare: none

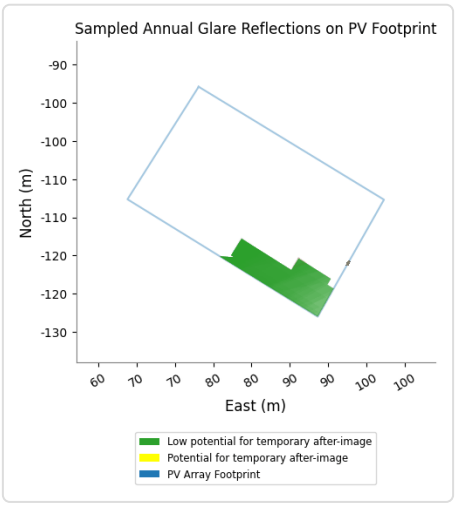
Green glare: 4,181 min.











UV-05 and Route: N419 ri west

No glare found

PV: UV-06 low potential for temporary after-image

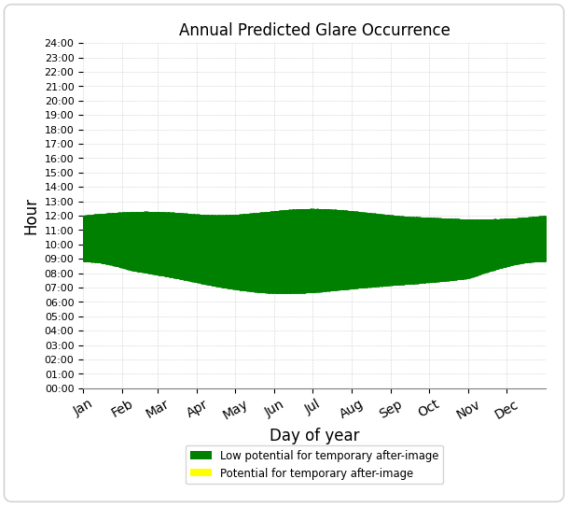
Receptor results ordered by category of glare

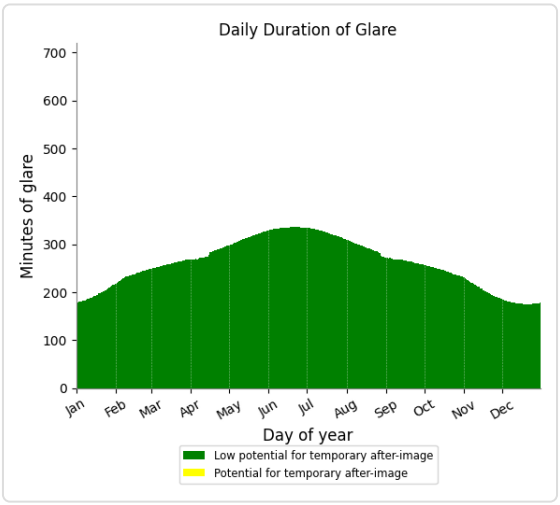
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	95,314	1,588.6	0	0.0
A12 ri west	47,437	790.6	0	0.0
N198 ri oost	94,907	1,581.8	0	0.0
N198 ri west	47,045	784.1	0	0.0
N419 ri oost	2,381	39.7	0	0.0
N419 ri west	0	0.0	0	0.0

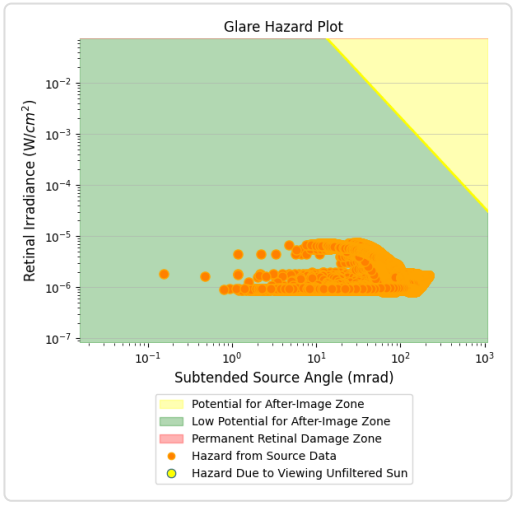
UV-06 and Route: A12 ri oost

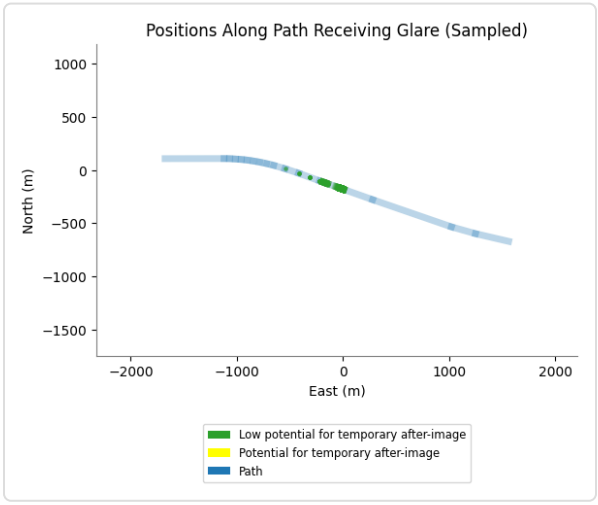
Yellow glare: none

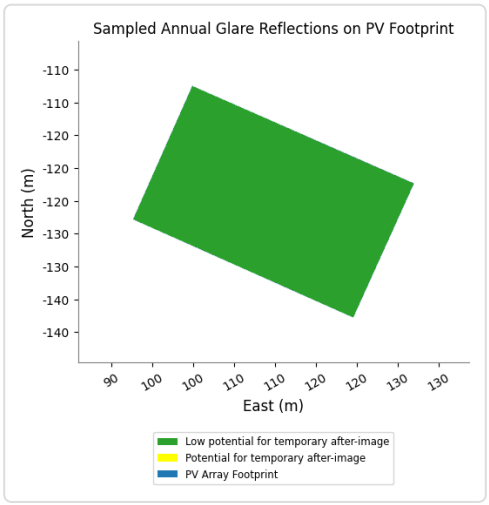
Green glare: 95,314 min.







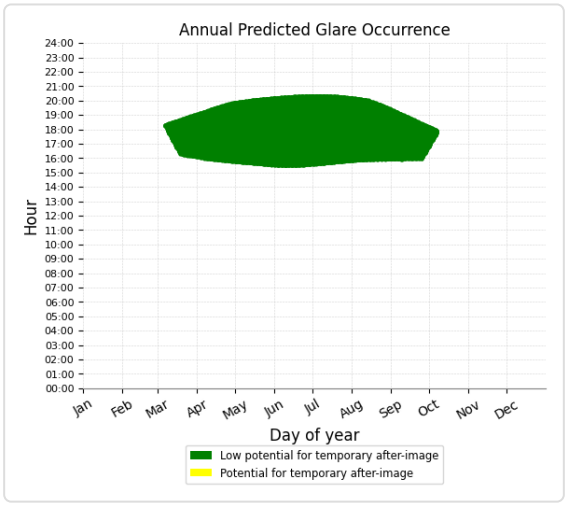


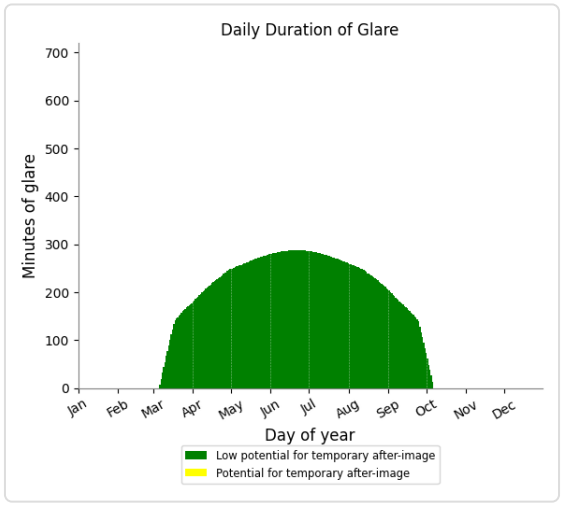


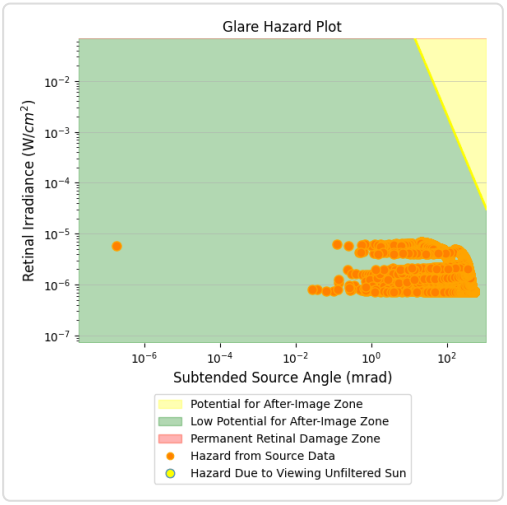
UV-06 and Route: A12 ri west

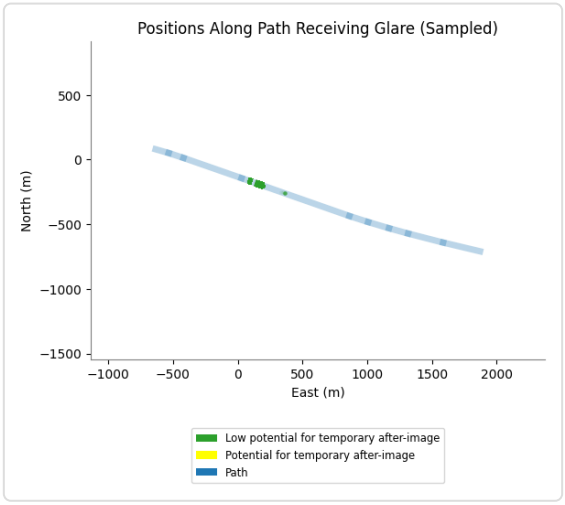
Yellow glare: none

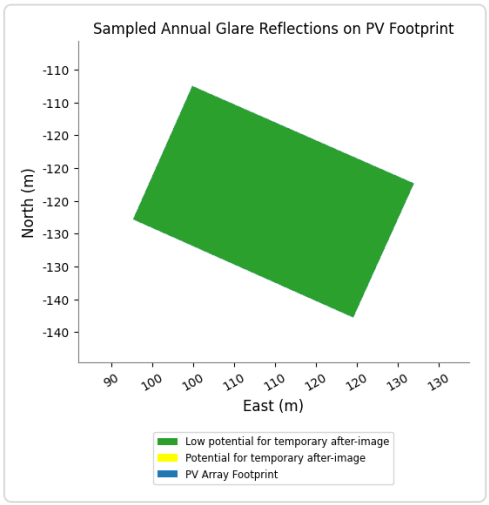
Green glare: 47,437 min.







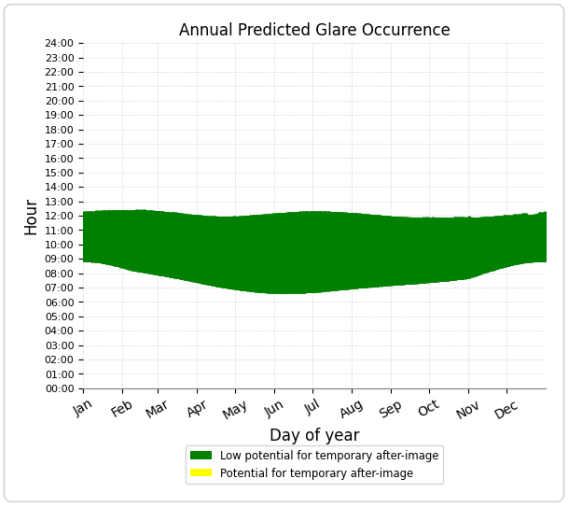


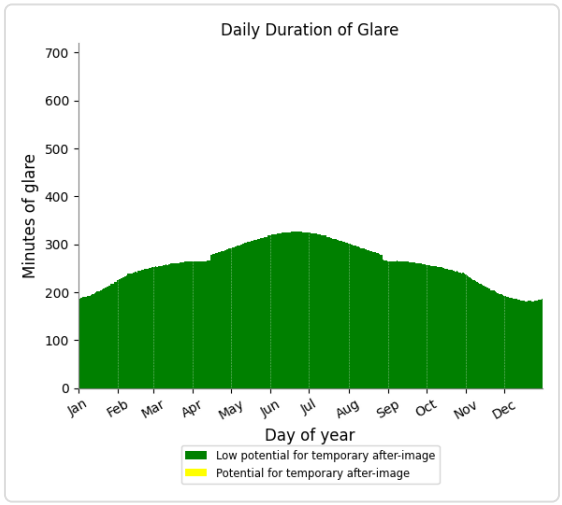


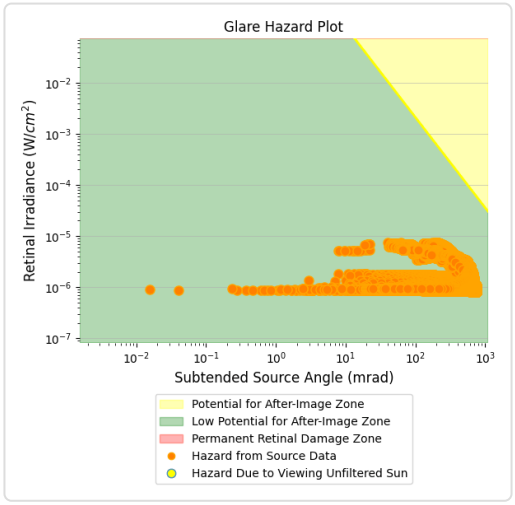
UV-06 and Route: N198 ri oost

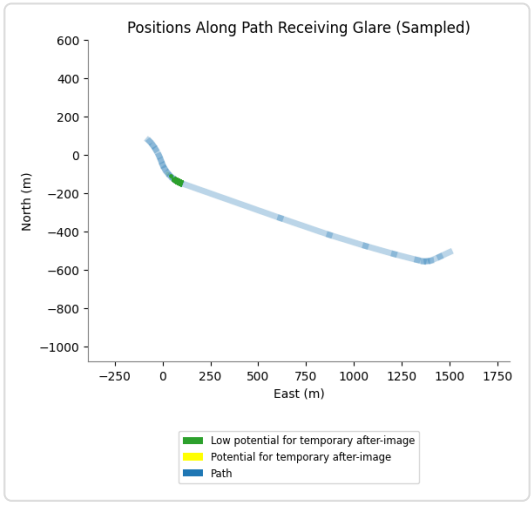
Yellow glare: none

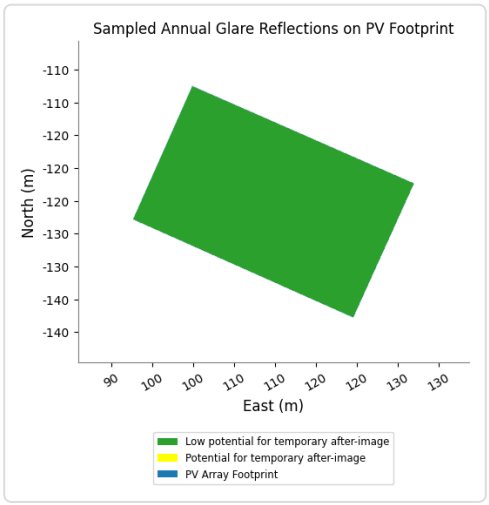
Green glare: 94,907 min.







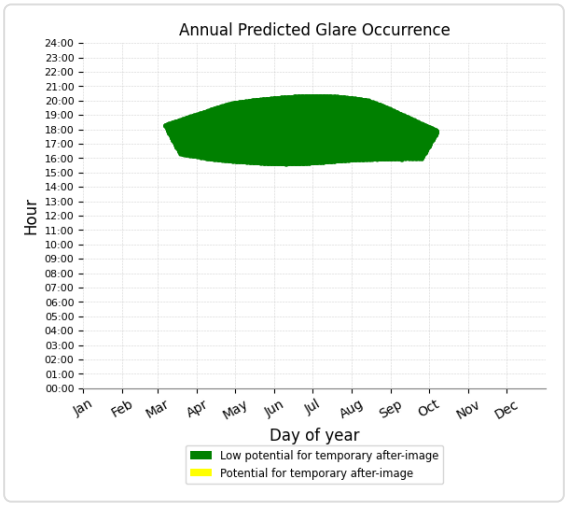


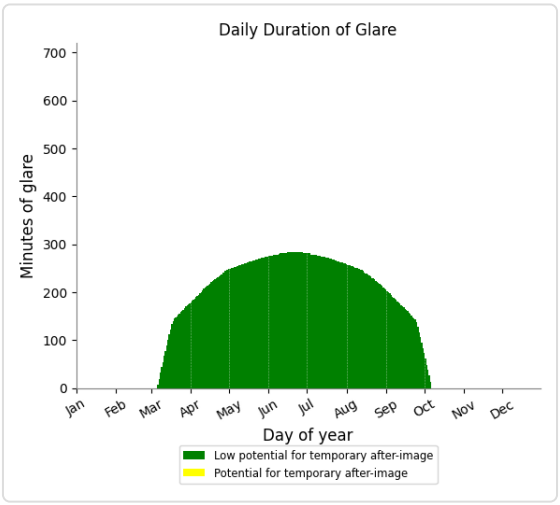


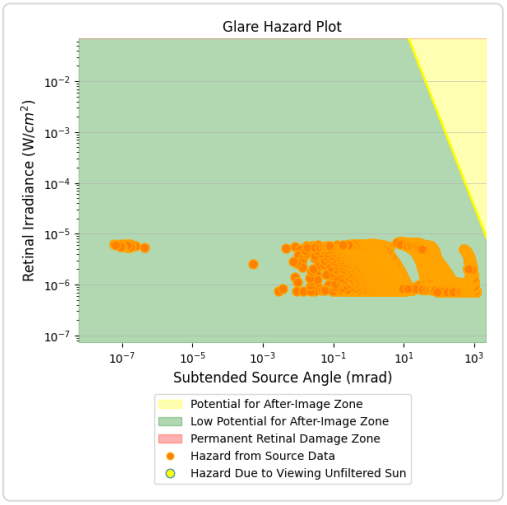
UV-06 and Route: N198 ri west

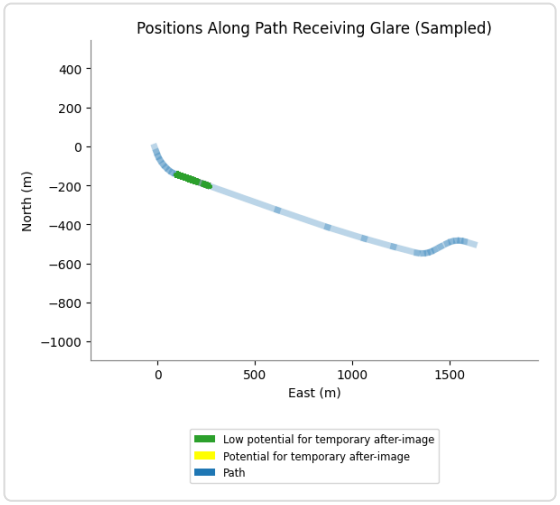
Yellow glare: none

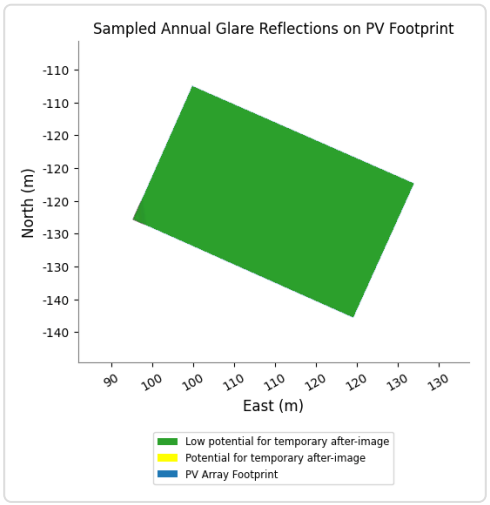
Green glare: 47,045 min.







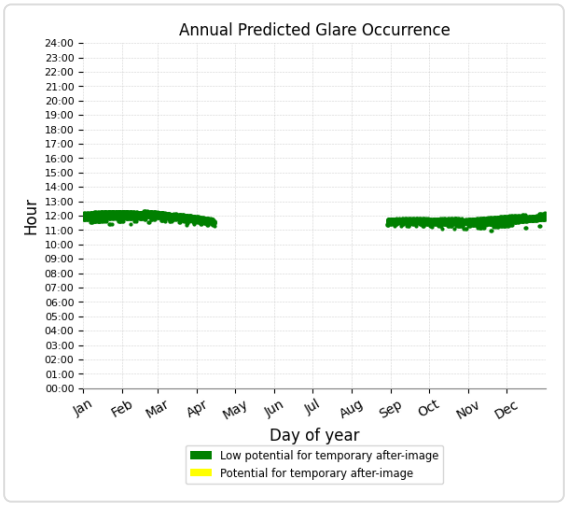


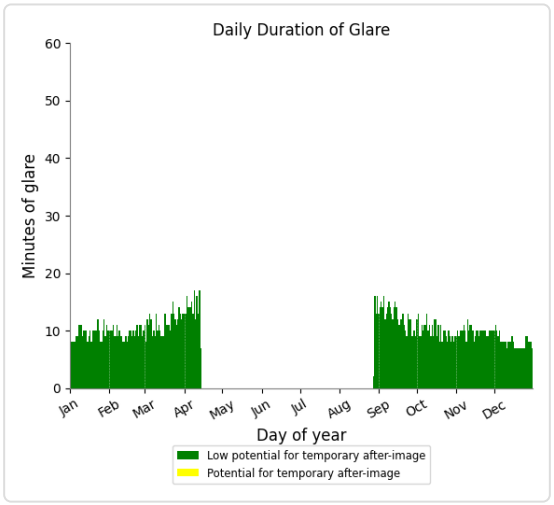


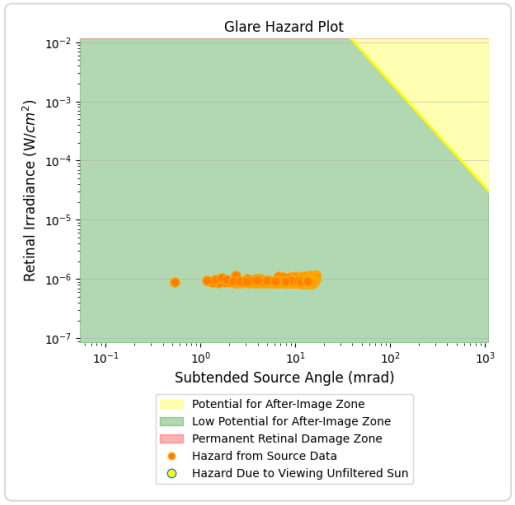
UV-06 and Route: N419 ri oost

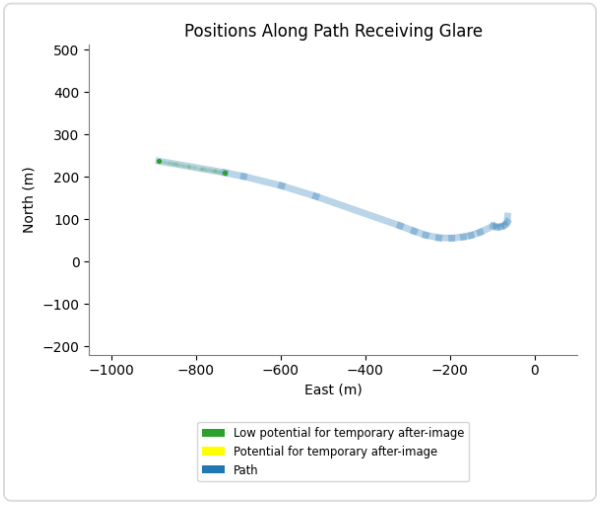
Yellow glare: none

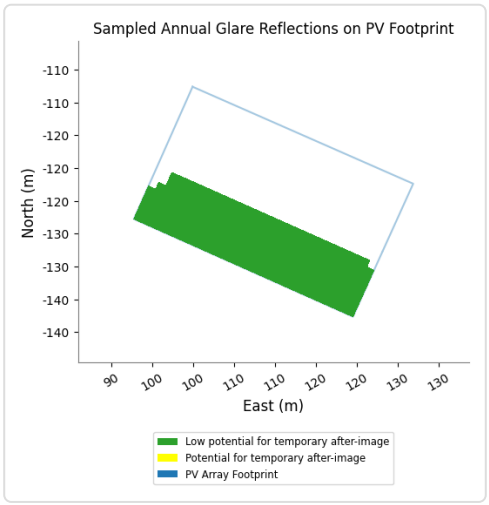
Green glare: 2,381 min.











UV-06 and Route: N419 ri west

No glare found

PV: UV-07 low potential for temporary after-image

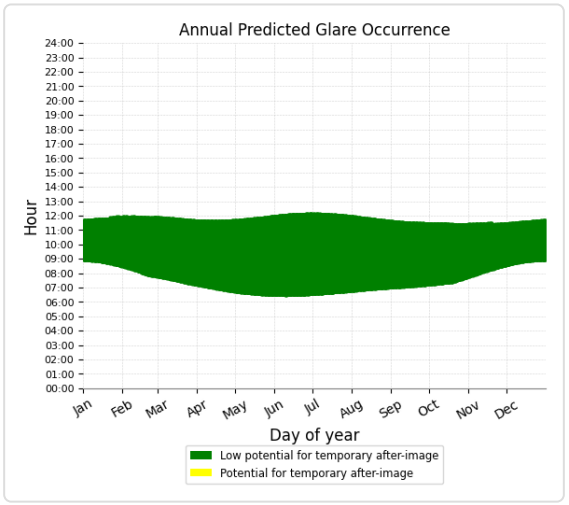
Receptor results ordered by category of glare

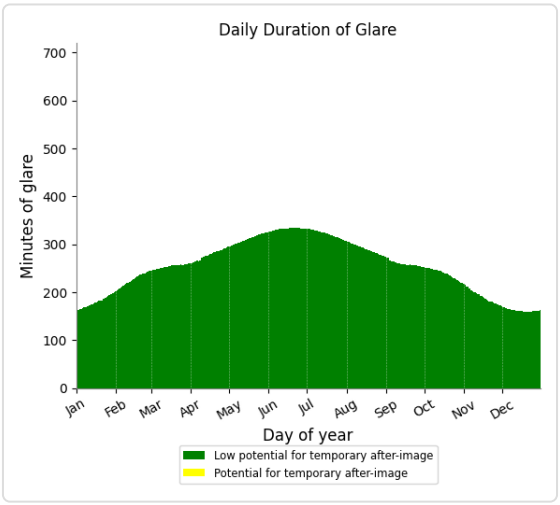
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	92,668	1,544.5	0	0.0
A12 ri west	58,019	967.0	0	0.0
N198 ri oost	87,500	1,458.3	0	0.0
N198 ri west	57,189	953.1	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

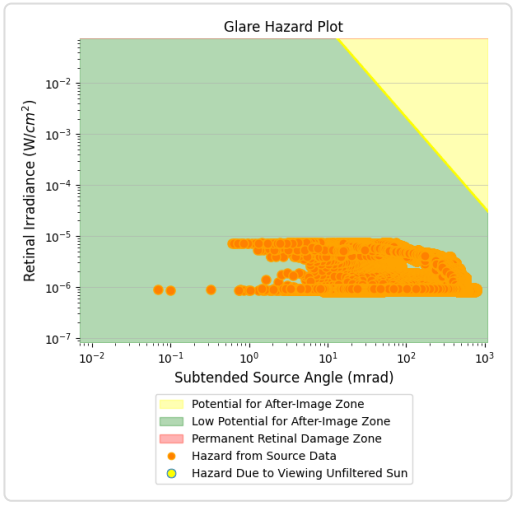
UV-07 and Route: A12 ri oost

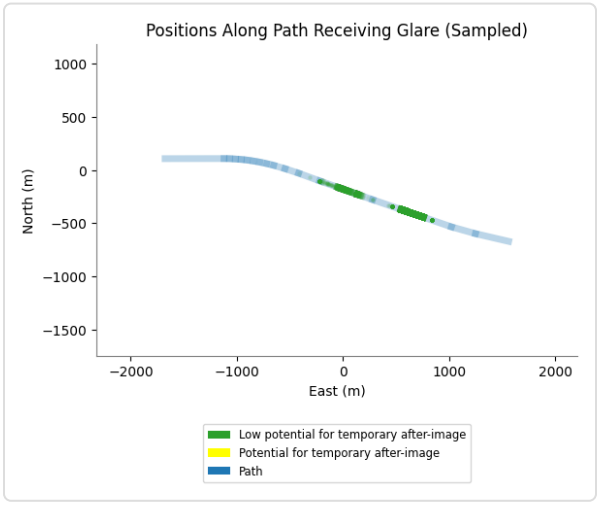
Yellow glare: none

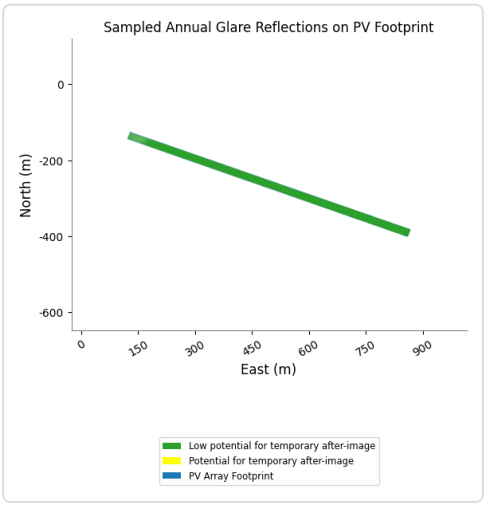
Green glare: 92,668 min.







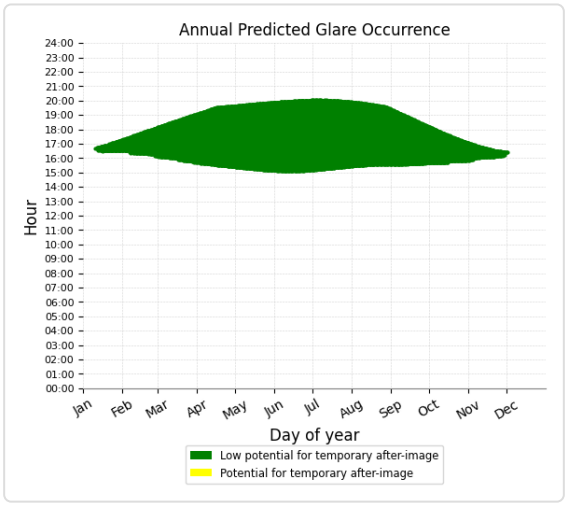


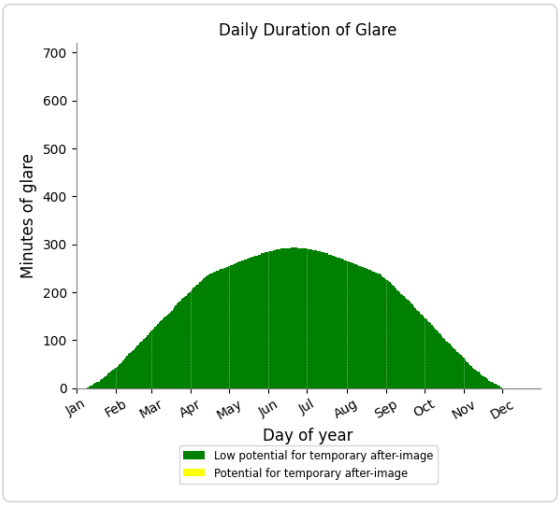


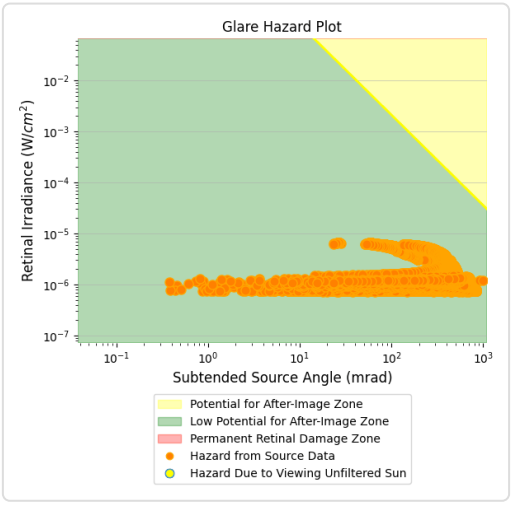
UV-07 and Route: A12 ri west

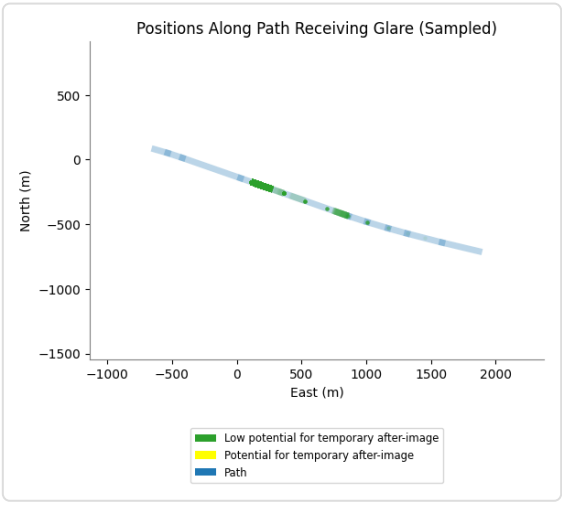
Yellow glare: none

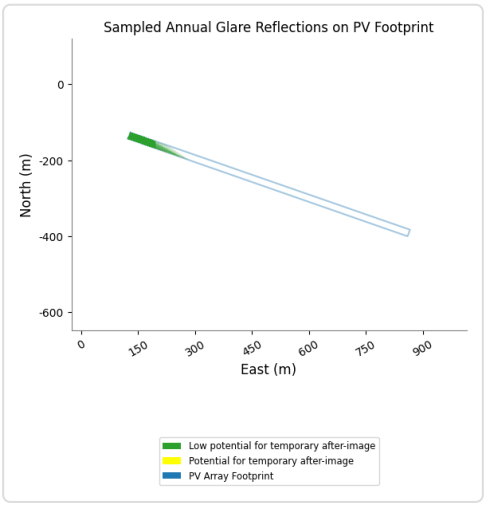
Green glare: 58,019 min.







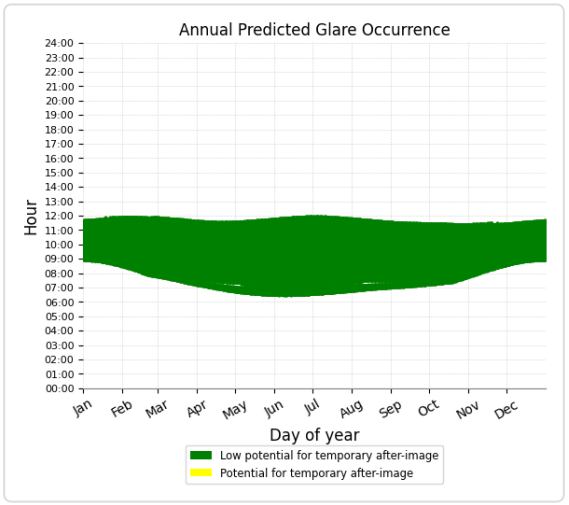


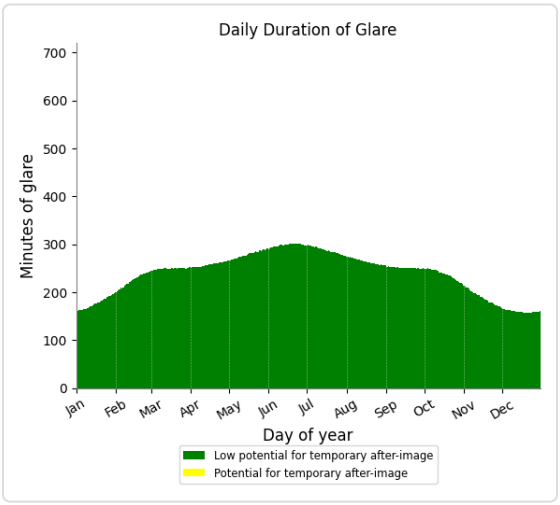


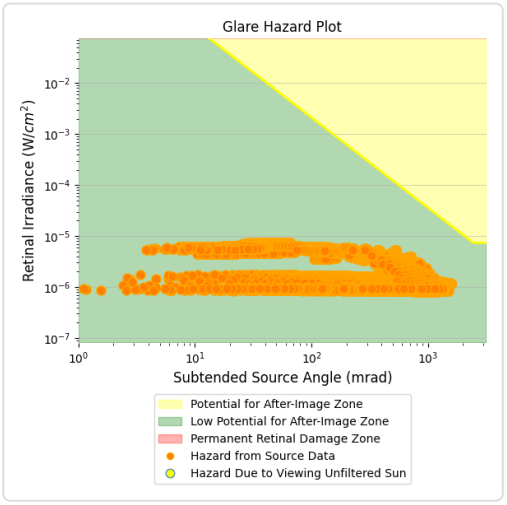
UV-07 and Route: N198 ri oost

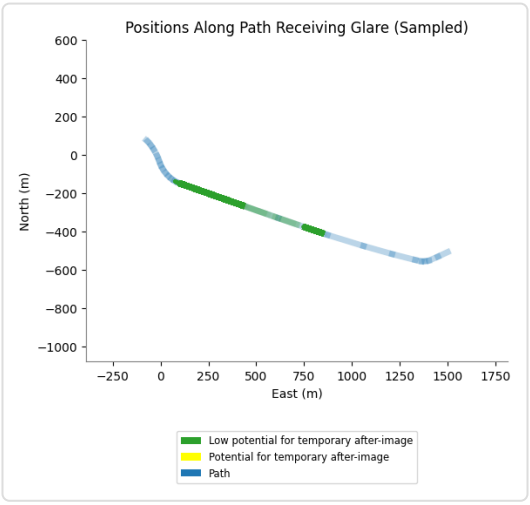
Yellow glare: none

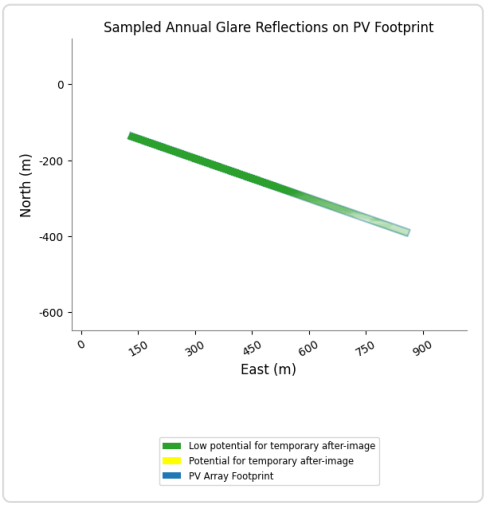
Green glare: 87,500 min.







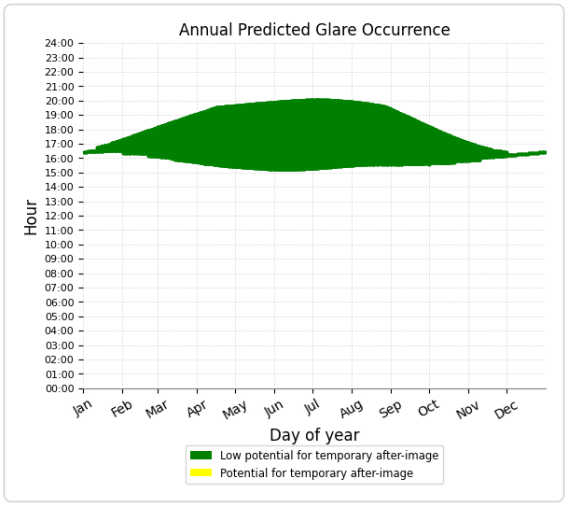


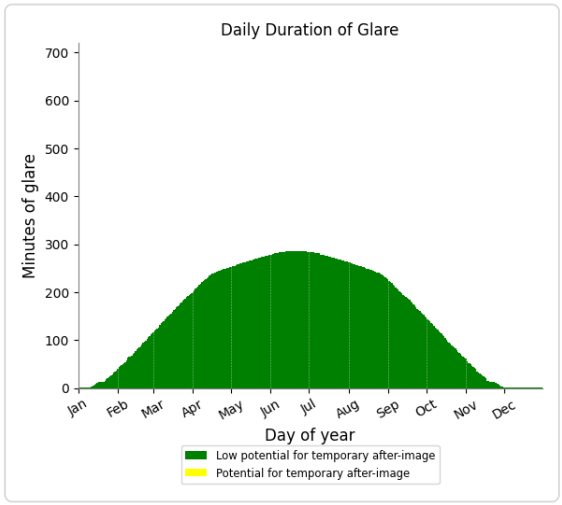


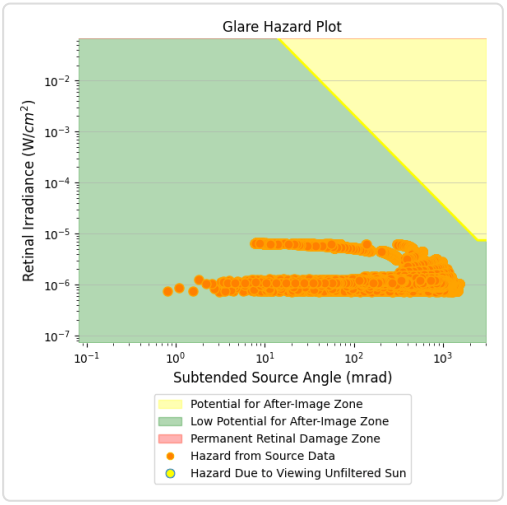
UV-07 and Route: N198 ri west

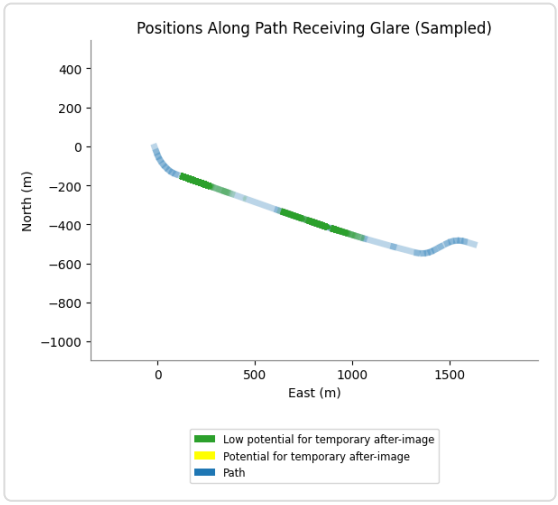
Yellow glare: none

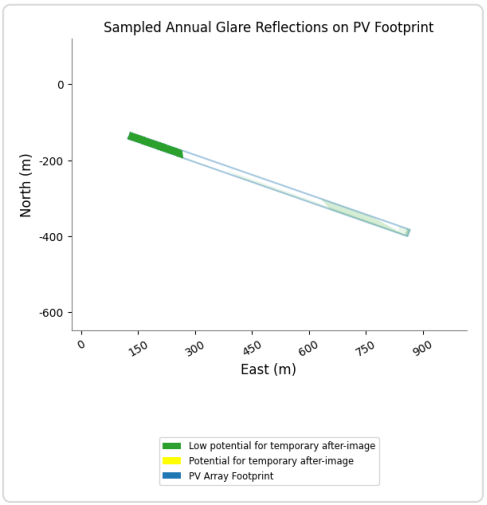
Green glare: 57,189 min.











UV-07 and Route: N419 ri oost

No glare found

UV-07 and Route: N419 ri west

No glare found

PV: UV-08 low potential for temporary after-image

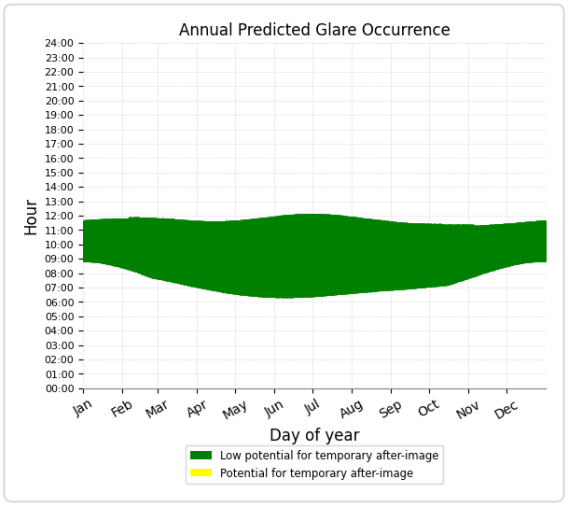
Receptor results ordered by category of glare

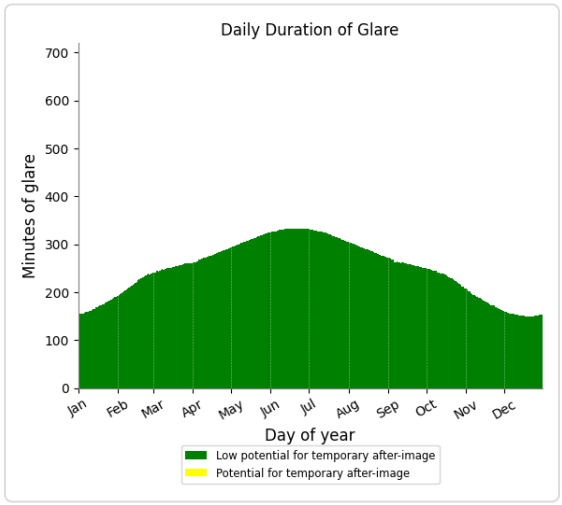
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	91,211	1,520.2	0	0.0
A12 ri west	59,864	997.7	0	0.0
N198 ri oost	85,743	1,429.0	0	0.0
N198 ri west	59,486	991.4	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

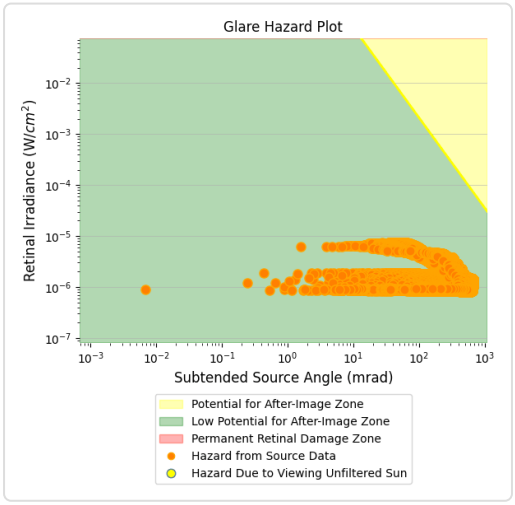
UV-08 and Route: A12 ri oost

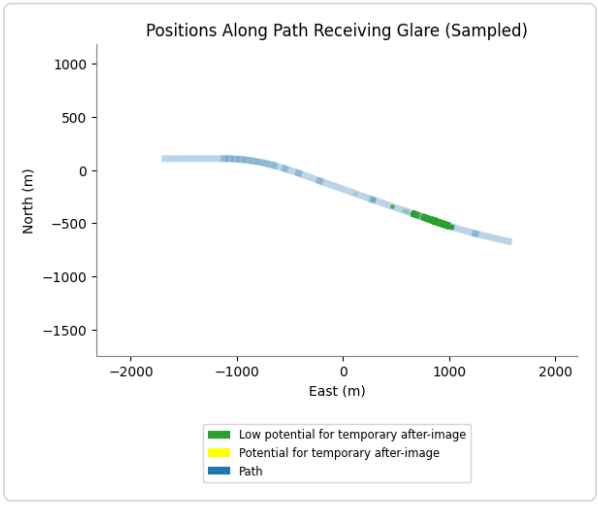
Yellow glare: none

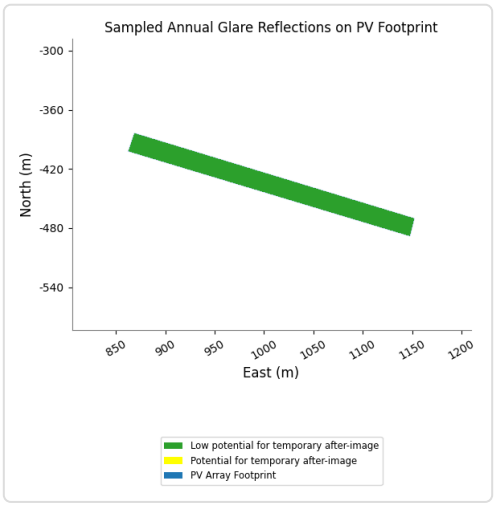
Green glare: 91,211 min.







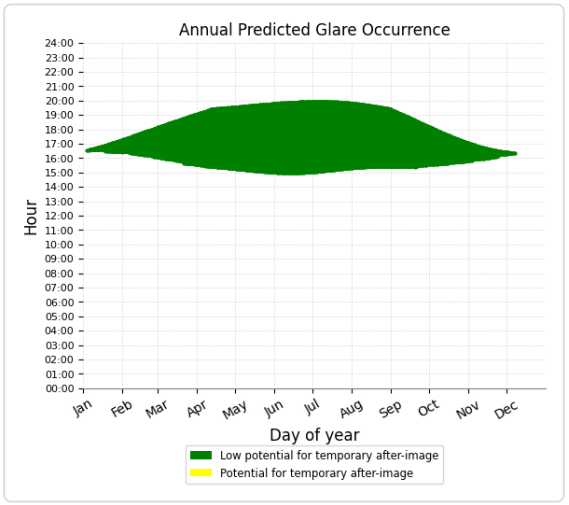


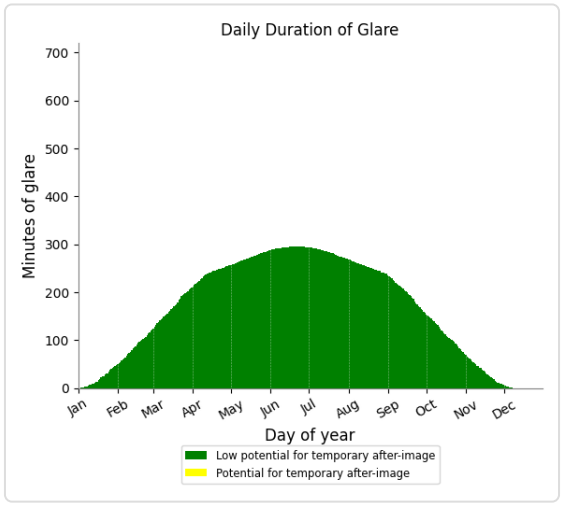


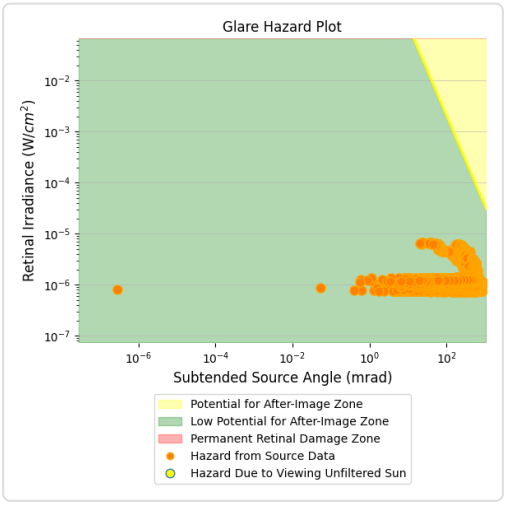
UV-08 and Route: A12 ri west

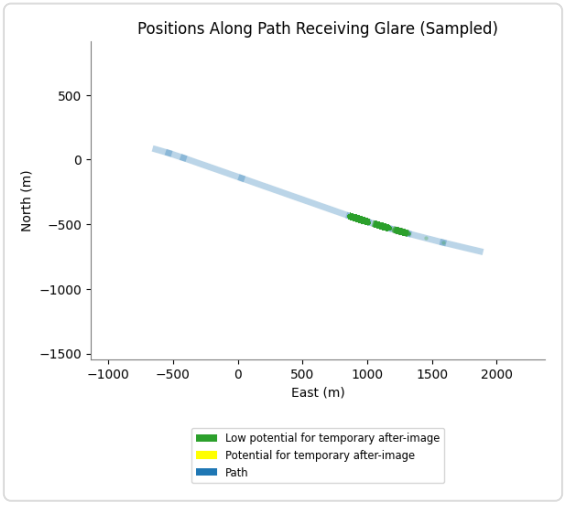
Yellow glare: none

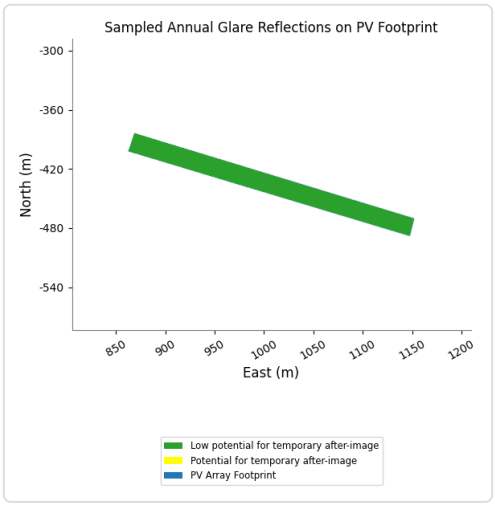
Green glare: 59,864 min.







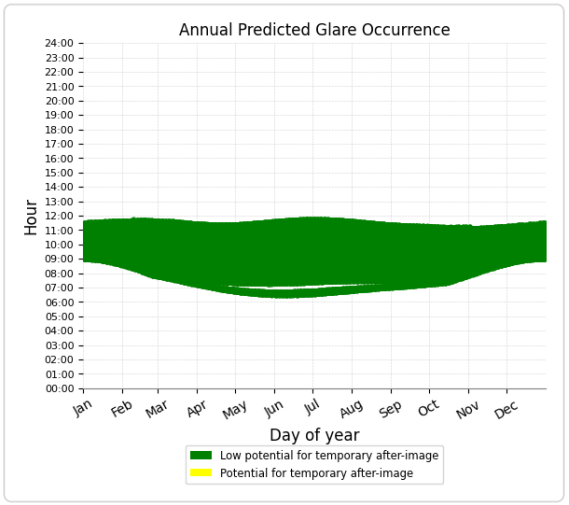


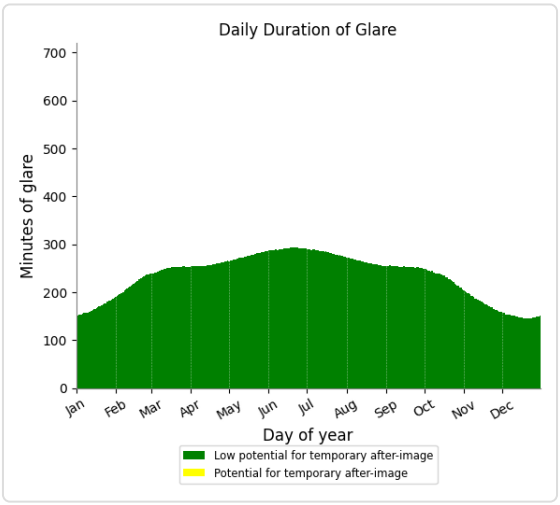


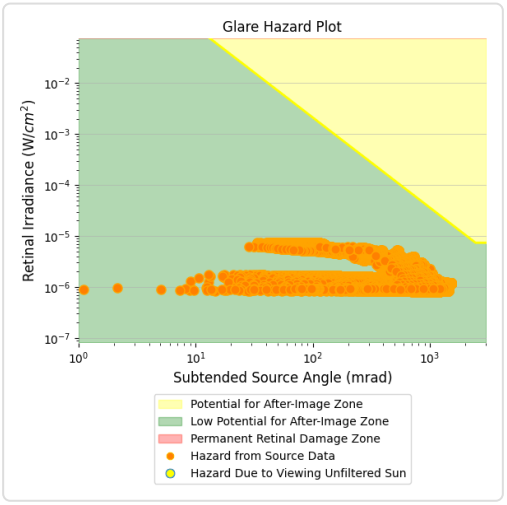
UV-08 and Route: N198 ri oost

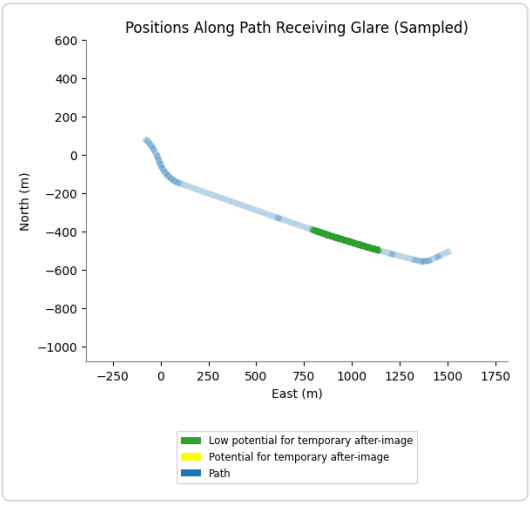
Yellow glare: none

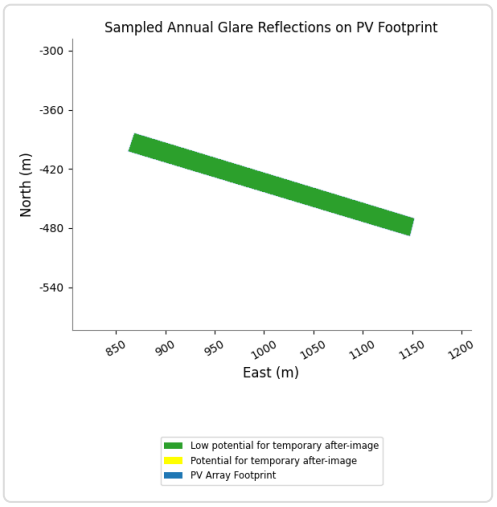
Green glare: 85,743 min.







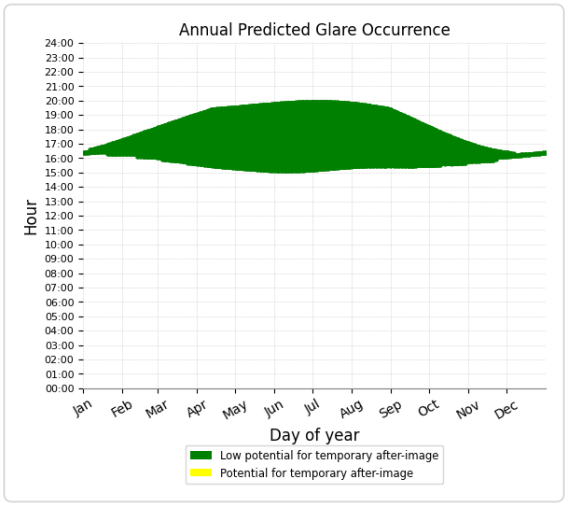


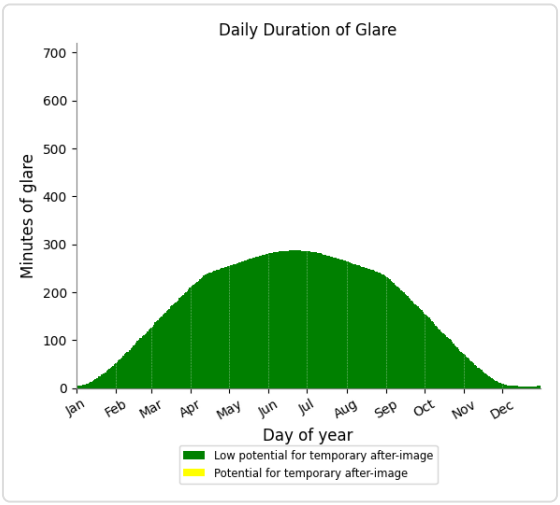


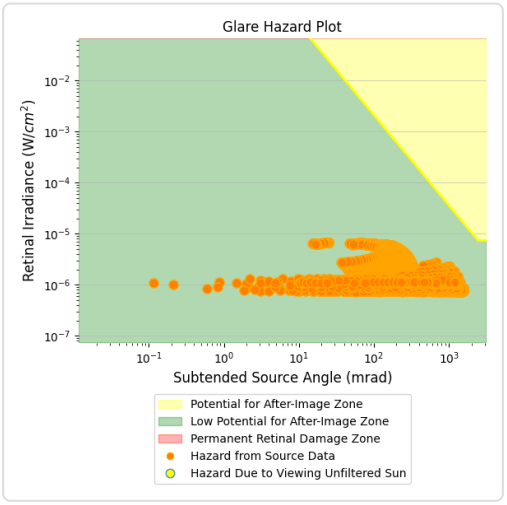
UV-08 and Route: N198 ri west

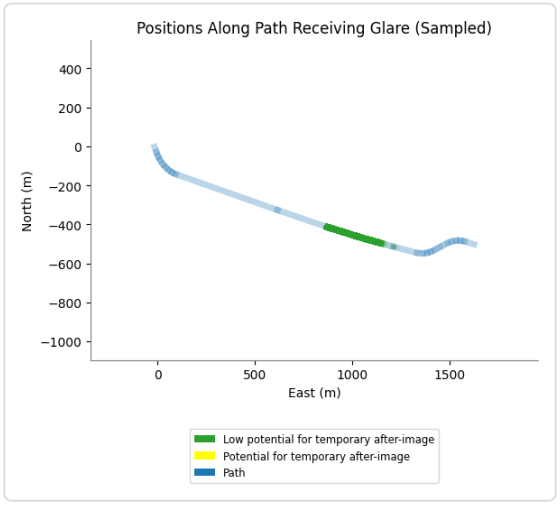
Yellow glare: none

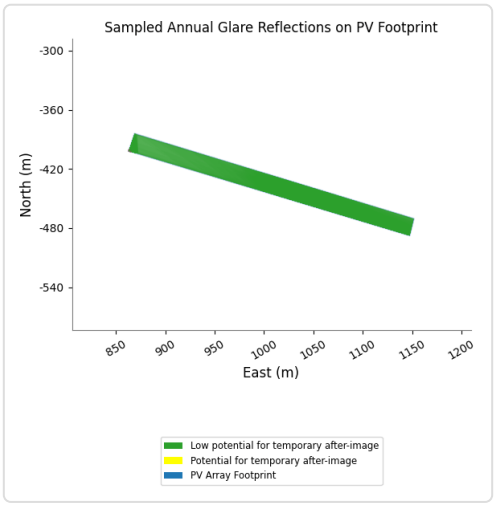
Green glare: 59,486 min.











UV-08 and Route: N419 ri oost

No glare found

UV-08 and Route: N419 ri west

No glare found

PV: UV-09 low potential for temporary after-image

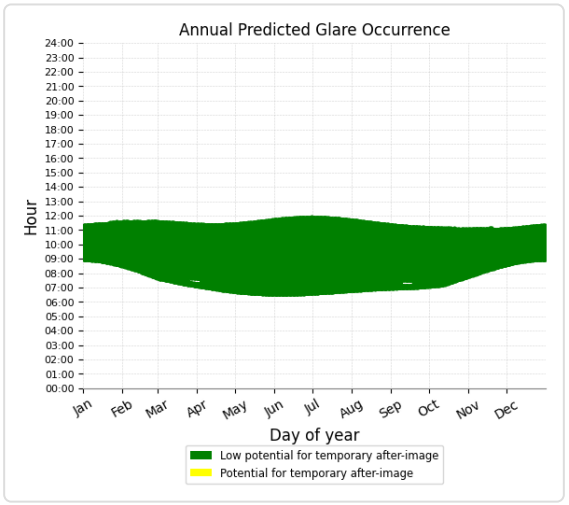
Receptor results ordered by category of glare

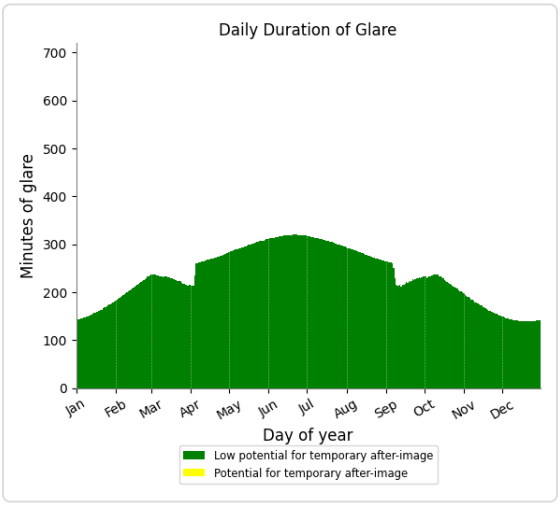
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	86,145	1,435.8	0	0.0
A12 ri west	49,483	824.7	0	0.0
N198 ri oost	82,915	1,381.9	0	0.0
N198 ri west	59,691	994.9	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

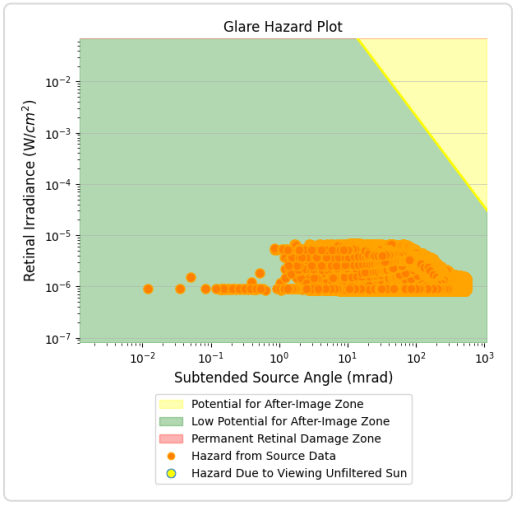
UV-09 and Route: A12 ri oost

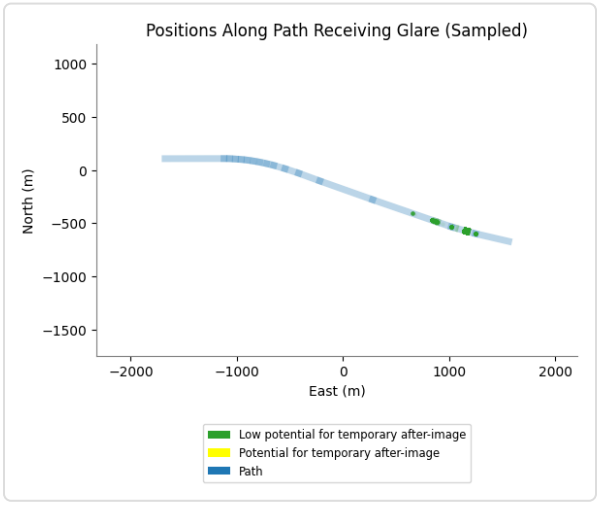
Yellow glare: none

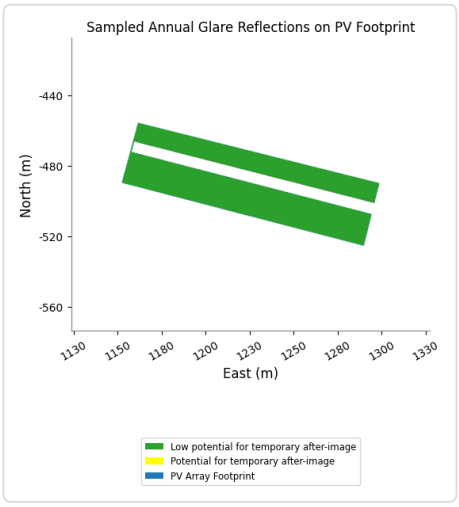
Green glare: 86,145 min.







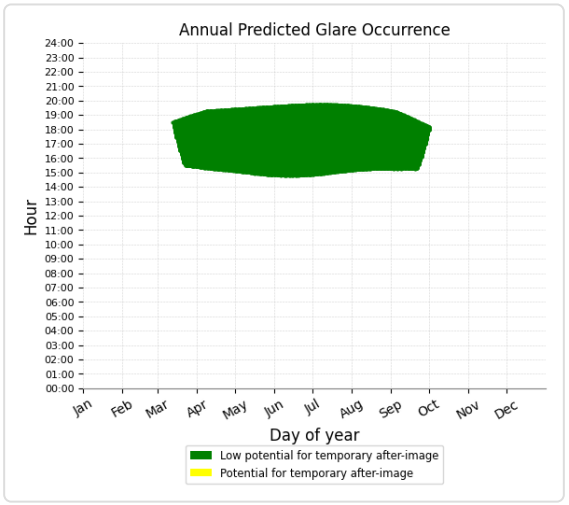


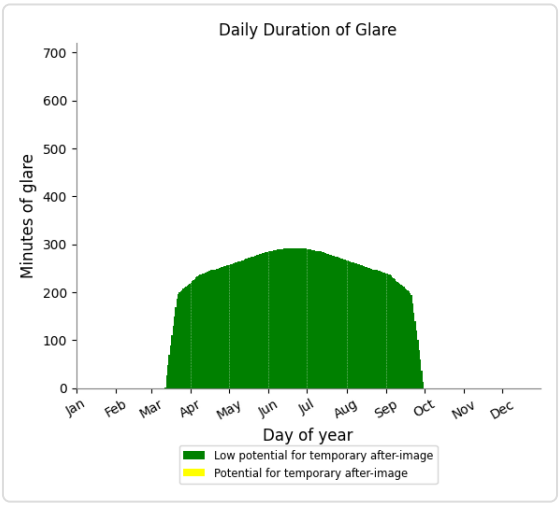


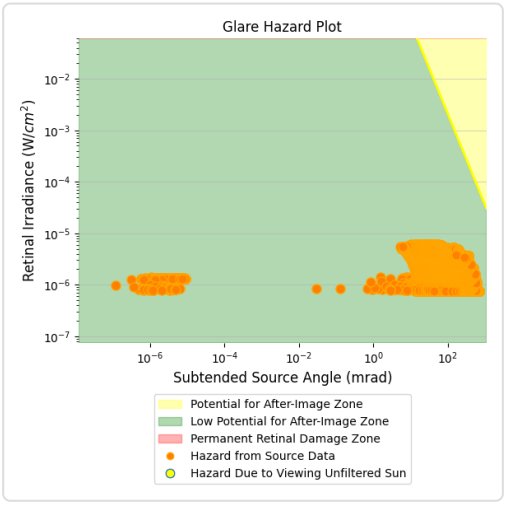
UV-09 and Route: A12 ri west

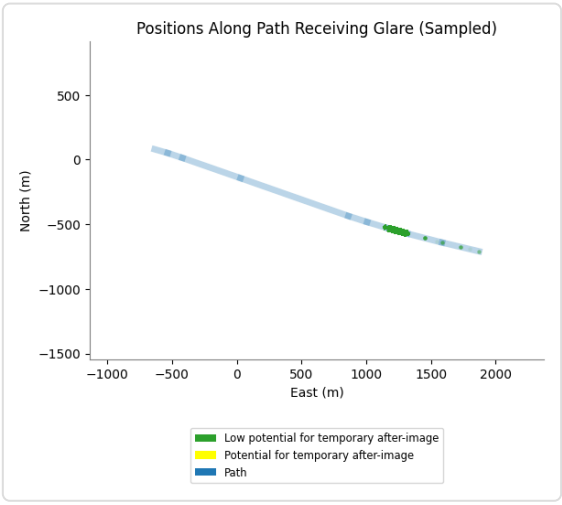
Yellow glare: none

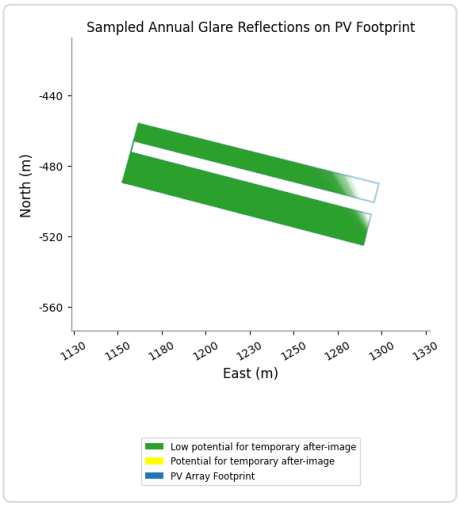
Green glare: 49,483 min.







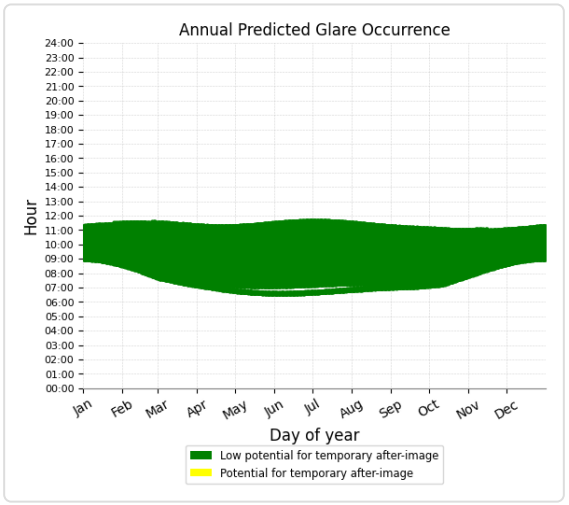


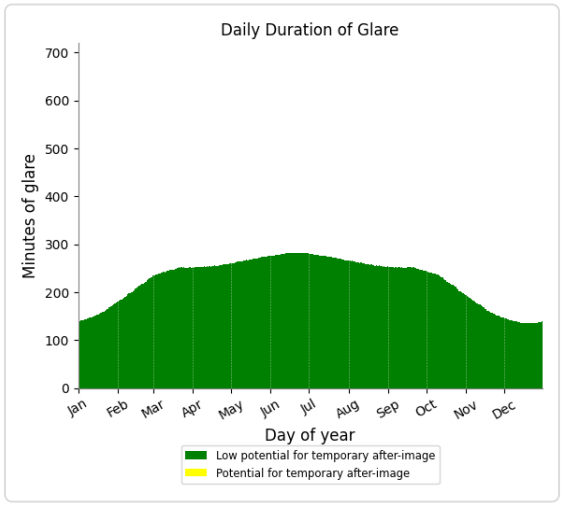


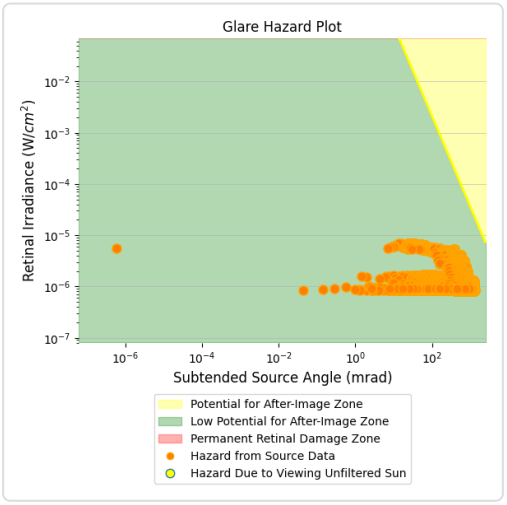
UV-09 and Route: N198 ri oost

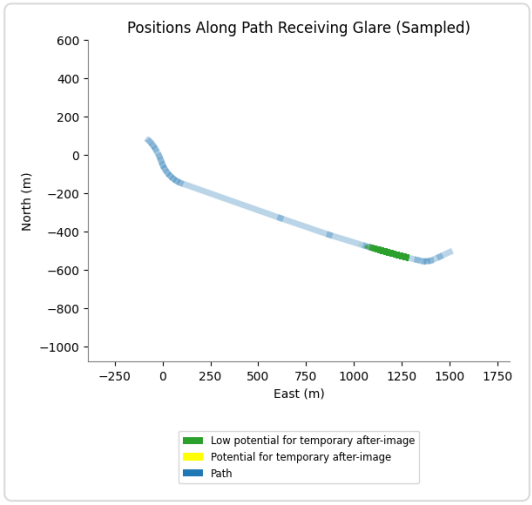
Yellow glare: none

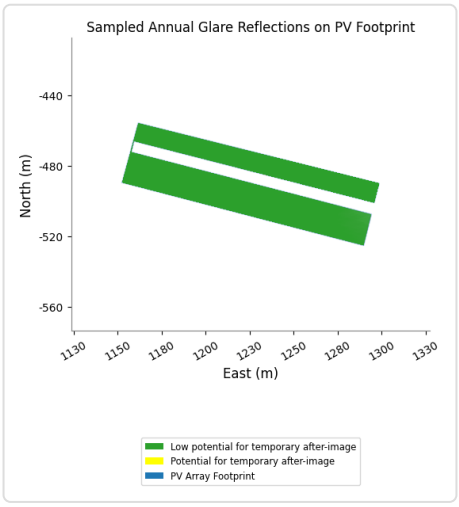
Green glare: 82,915 min.







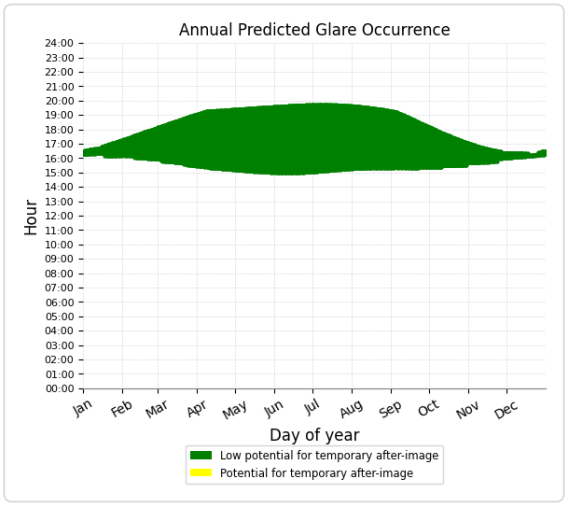


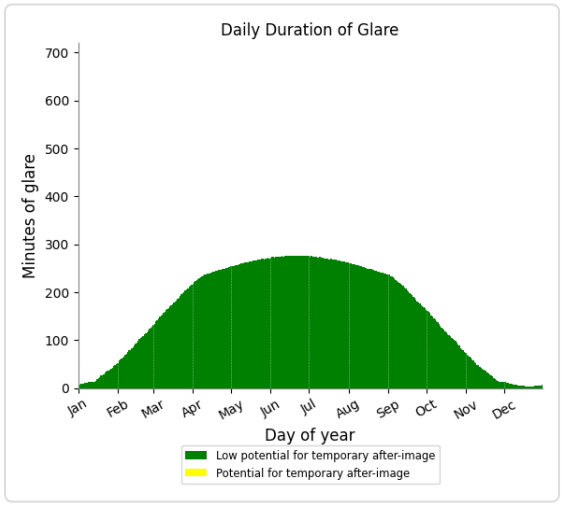


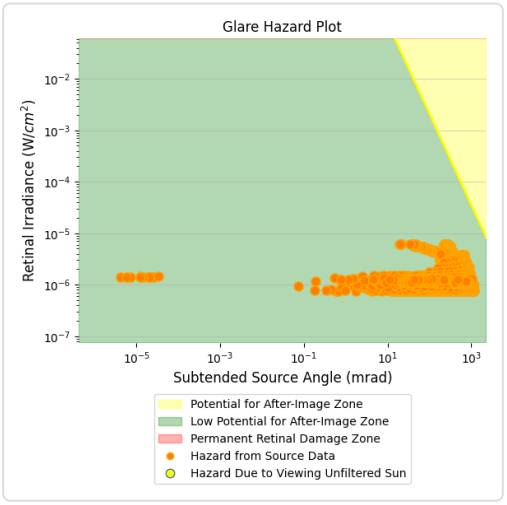
UV-09 and Route: N198 ri west

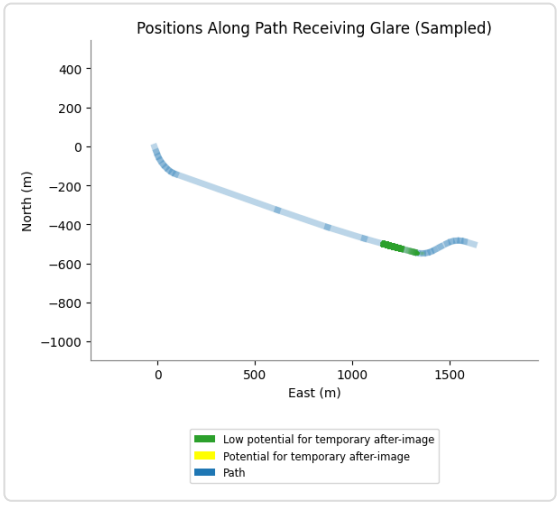
Yellow glare: none

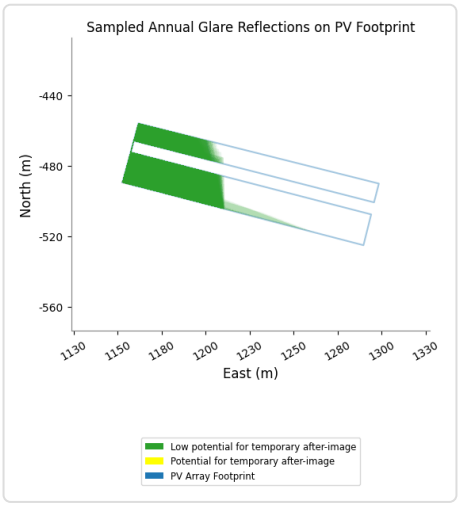
Green glare: 59,691 min.











UV-09 and Route: N419 ri oost

No glare found

UV-09 and Route: N419 ri west

No glare found

PV: UV-10 low potential for temporary after-image

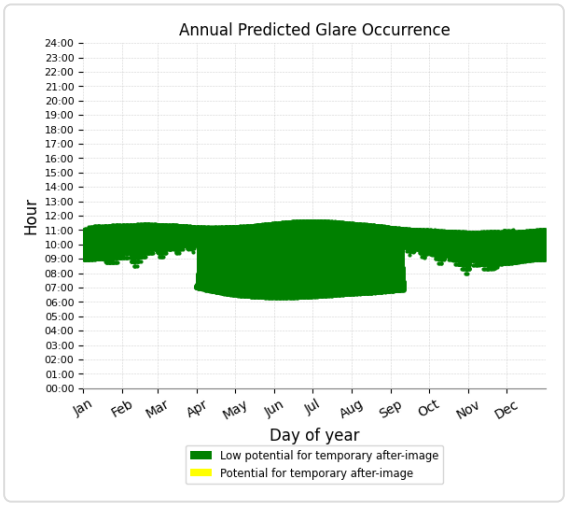
Receptor results ordered by category of glare

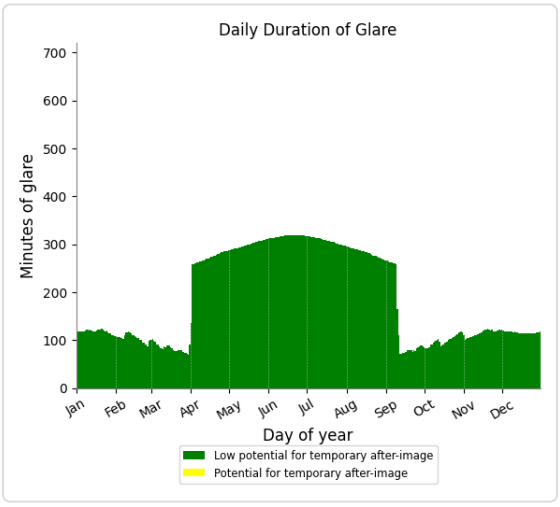
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	68,672	1,144.5	0	0.0
A12 ri west	47,761	796.0	0	0.0
N198 ri oost	23,750	395.8	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

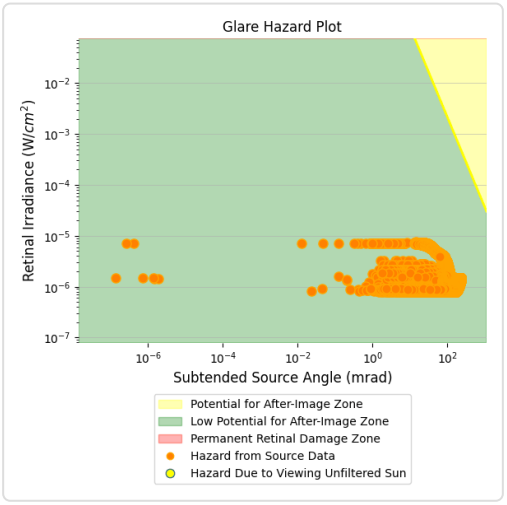
UV-10 and Route: A12 ri oost

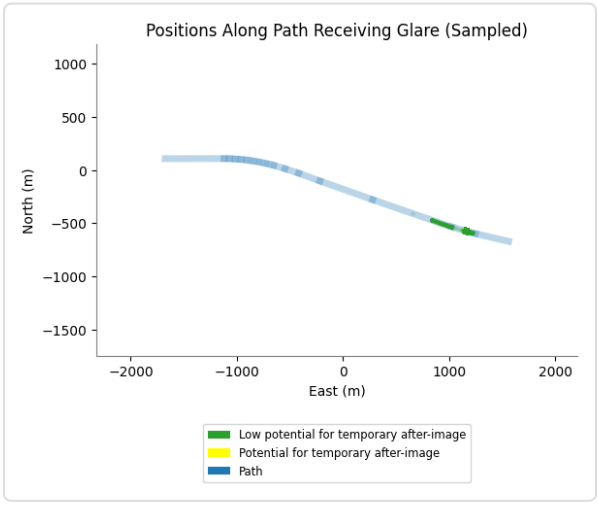
Yellow glare: none

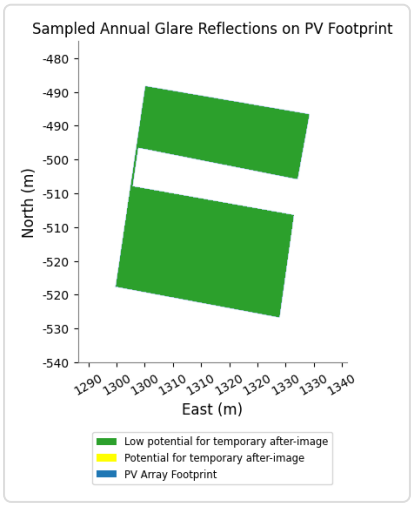
Green glare: 68,672 min.







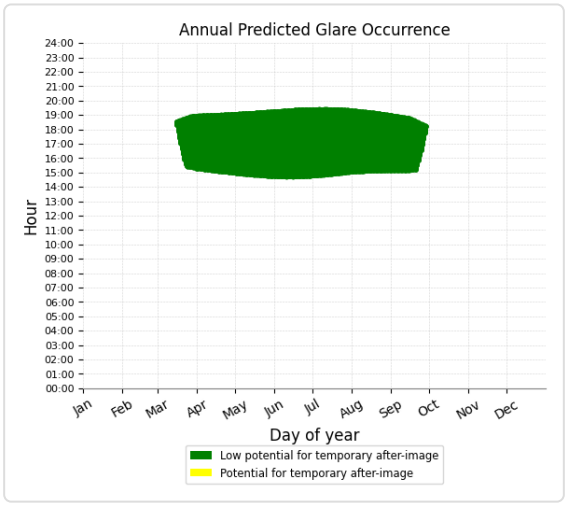


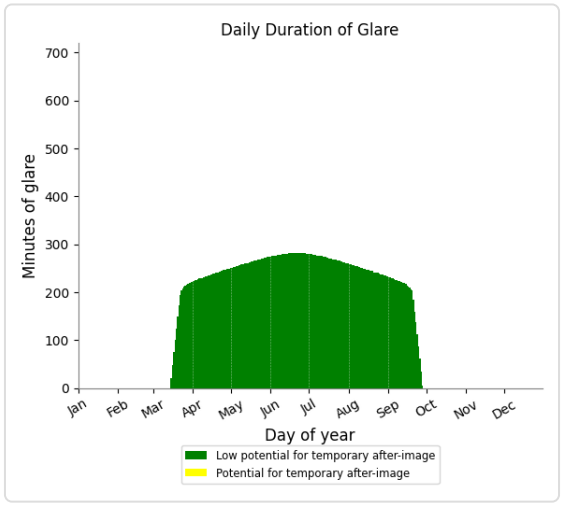


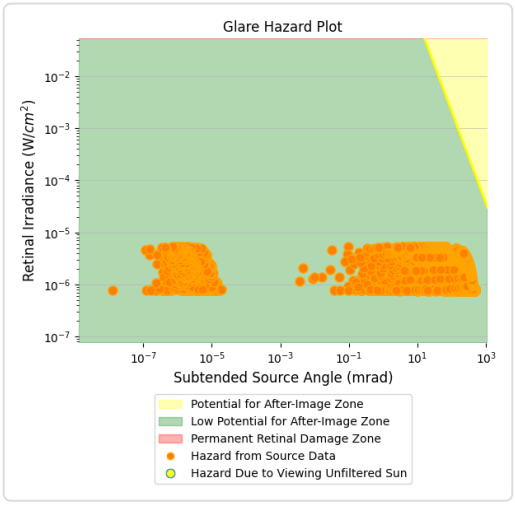
UV-10 and Route: A12 ri west

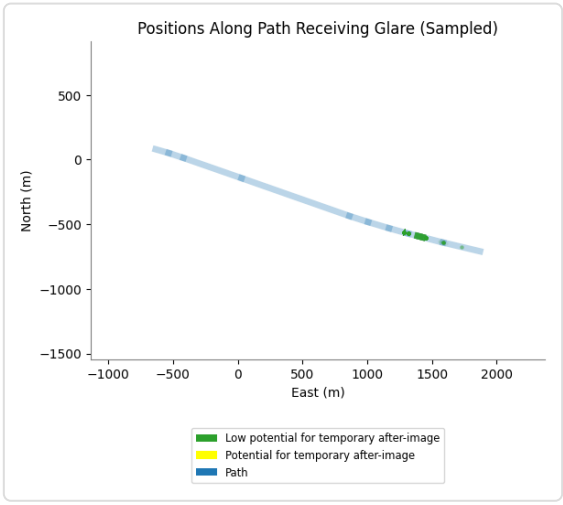
Yellow glare: none

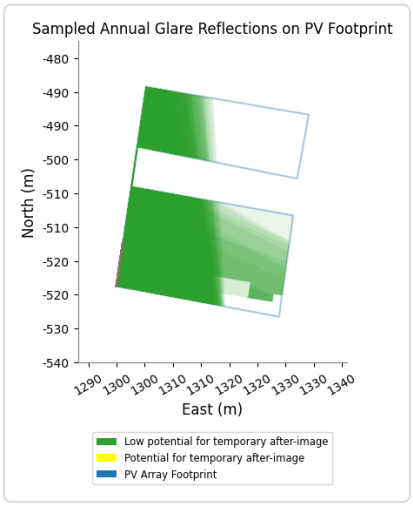
Green glare: 47,761 min.







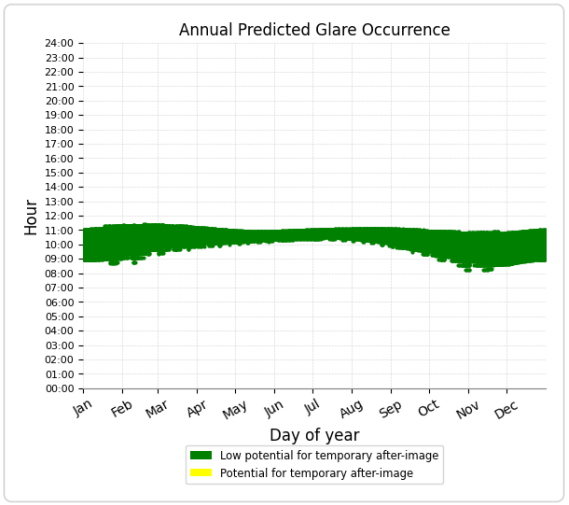


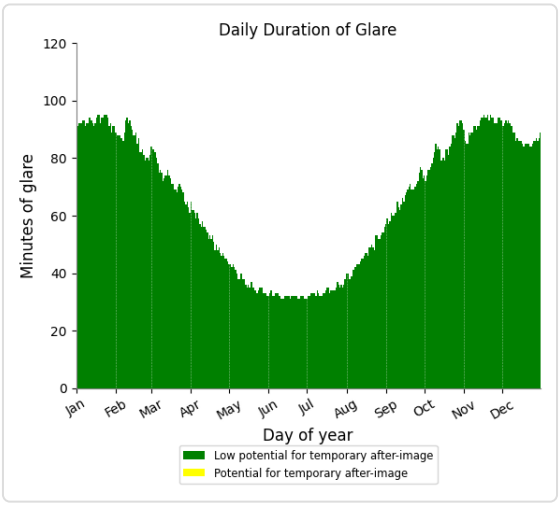


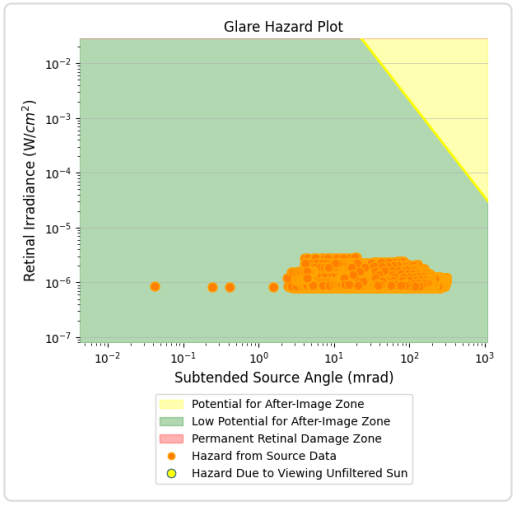
UV-10 and Route: N198 ri oost

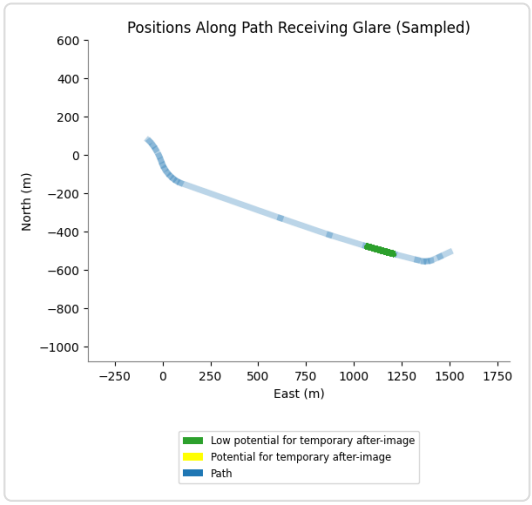
Yellow glare: none

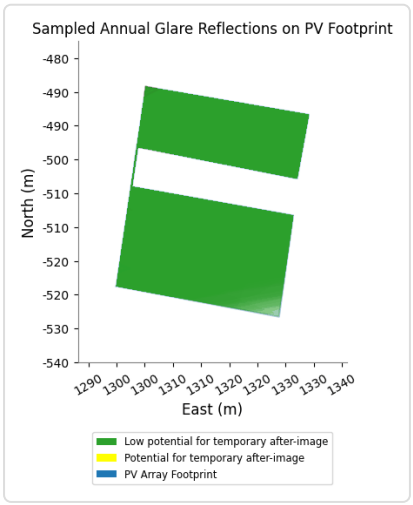
Green glare: 23,750 min.











UV-10 and Route: N198 ri west

No glare found

UV-10 and Route: N419 ri oost

No glare found

UV-10 and Route: N419 ri west

No glare found

PV: UV-11 low potential for temporary after-image

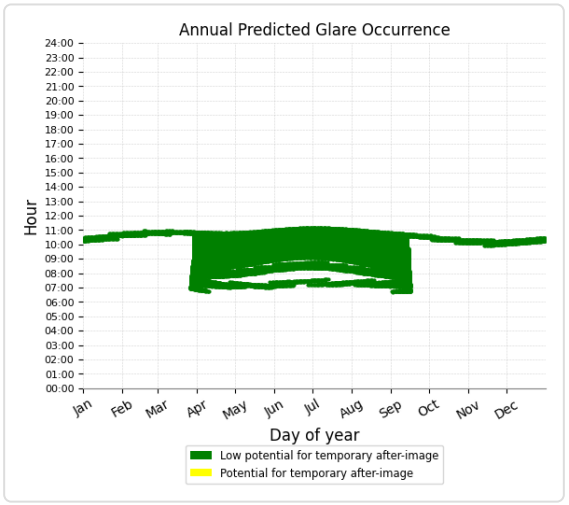
Receptor results ordered by category of glare

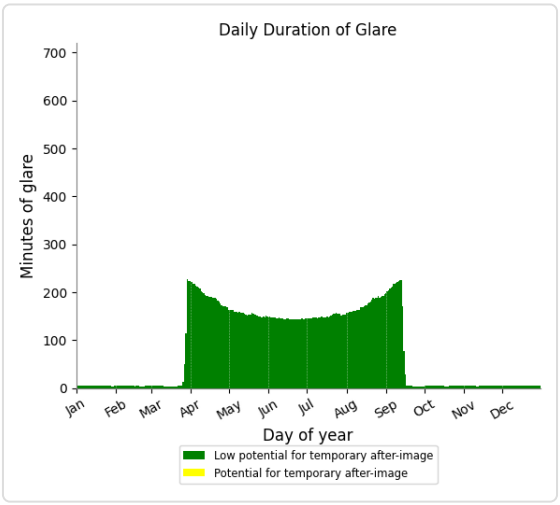
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	29,889	498.1	0	0.0
A12 ri west	17,684	294.7	0	0.0
N198 ri oost	0	0.0	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

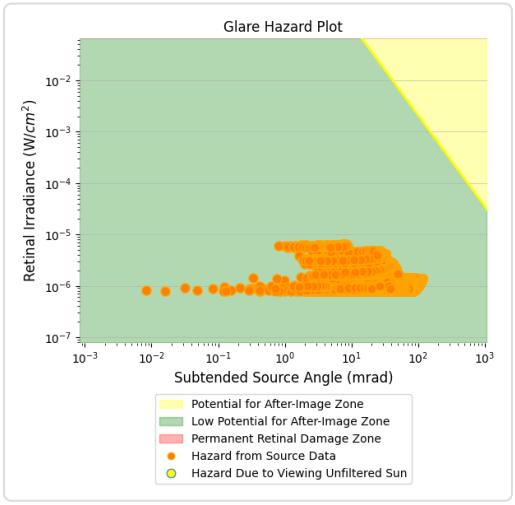
UV-11 and Route: A12 ri oost

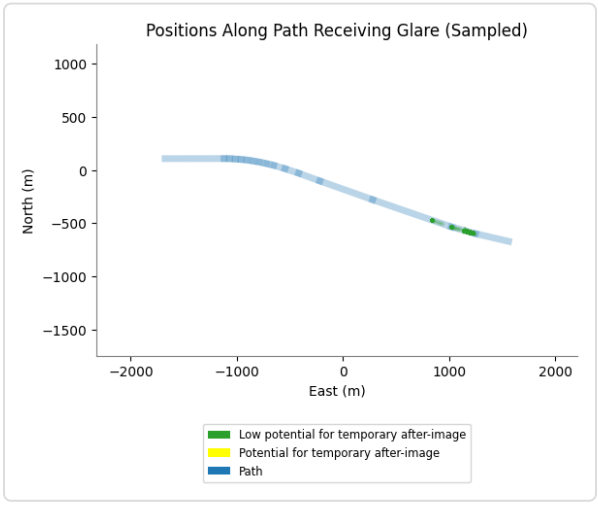
Yellow glare: none

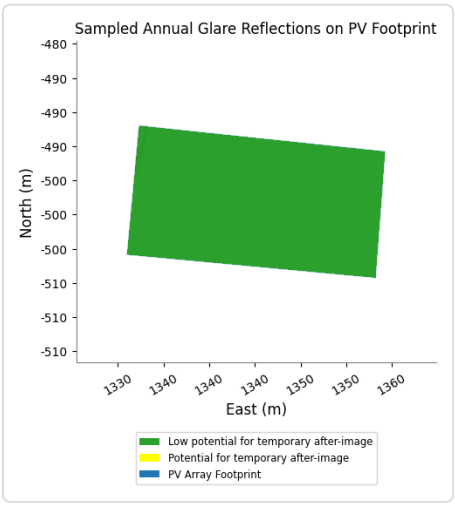
Green glare: 29,889 min.







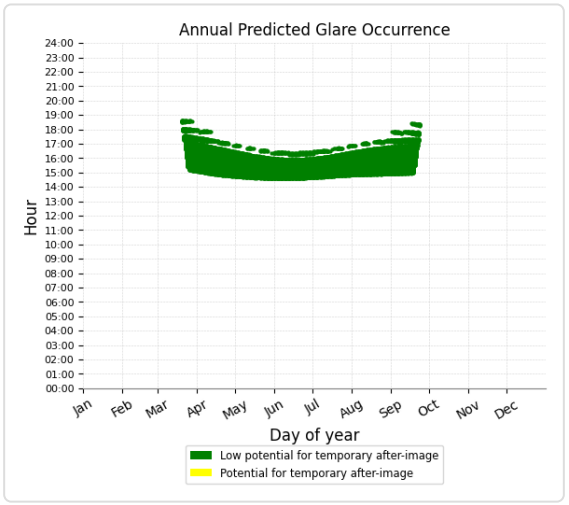


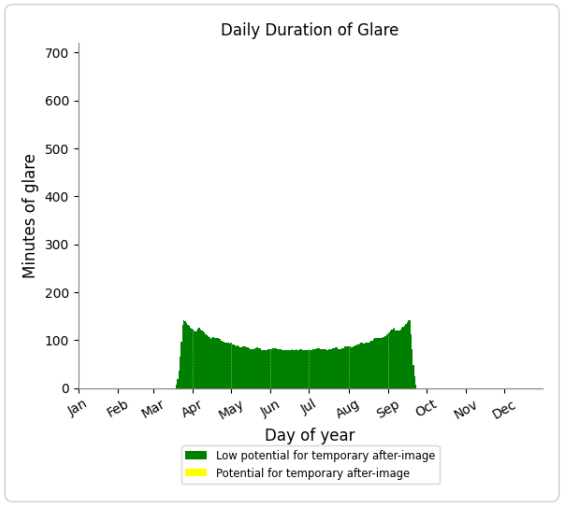


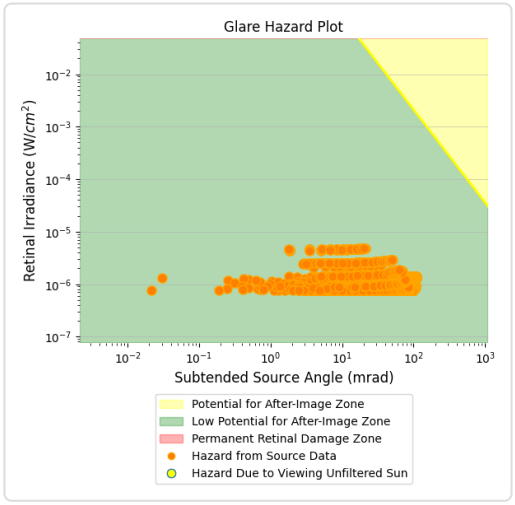
UV-11 and Route: A12 ri west

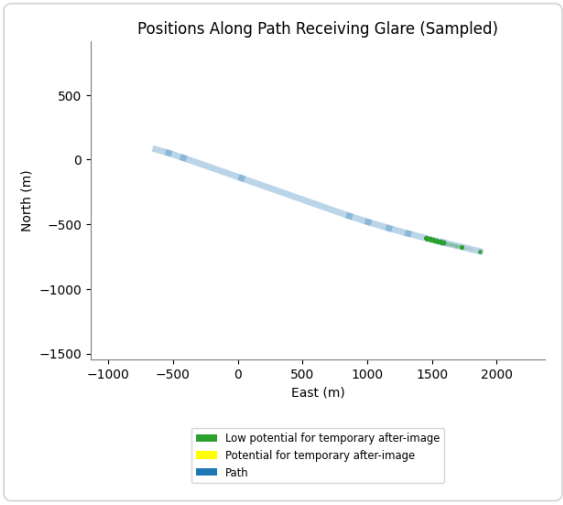
Yellow glare: none

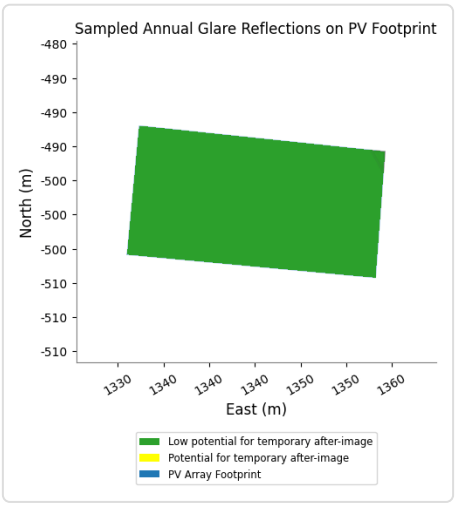
Green glare: 17,684 min.











UV-11 and Route: N198 ri oost

No glare found

UV-11 and Route: N198 ri west

No glare found

UV-11 and Route: N419 ri oost

No glare found

UV-11 and Route: N419 ri west

No glare found

PV: UV-12 low potential for temporary after-image

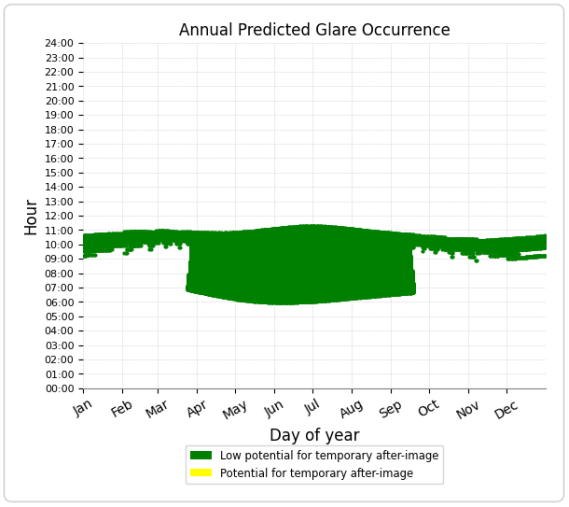
Receptor results ordered by category of glare

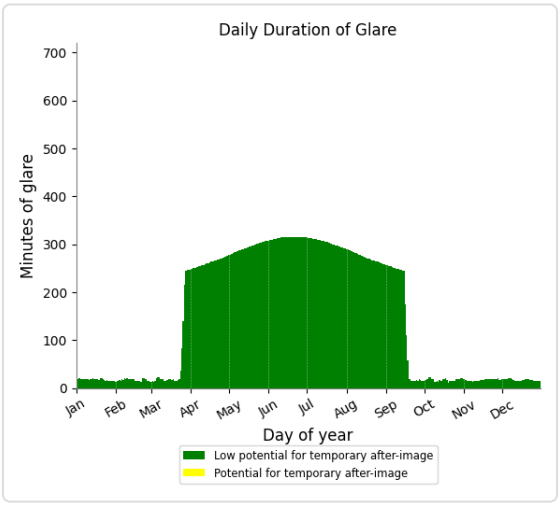
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	53,087	884.8	0	0.0
A12 ri west	49,876	831.3	0	0.0
N198 ri oost	72,977	1,216.3	0	0.0
N198 ri west	24,459	407.6	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

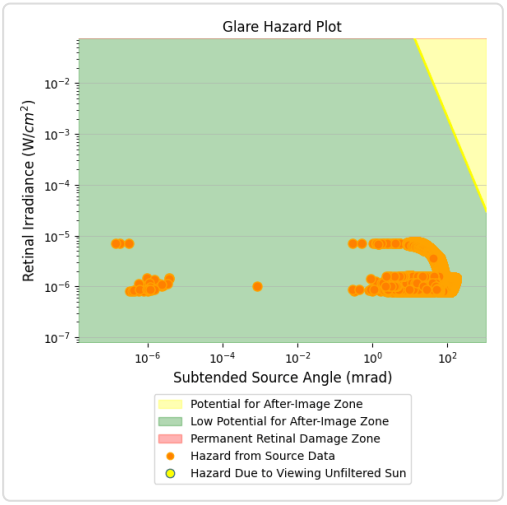
UV-12 and Route: A12 ri oost

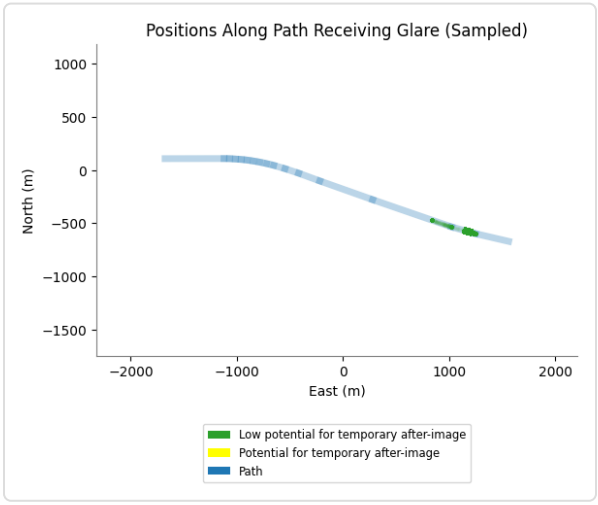
Yellow glare: none

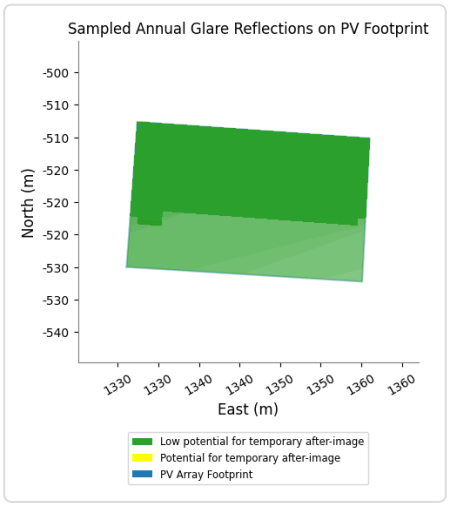
Green glare: 53,087 min.







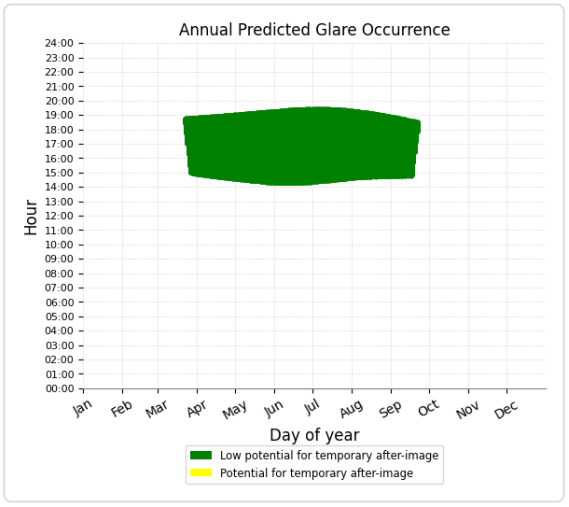


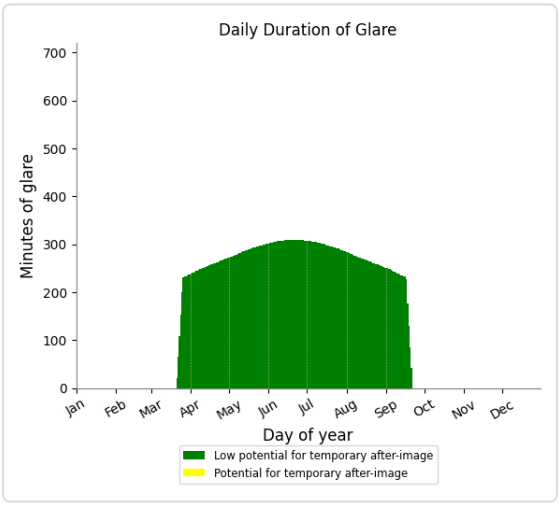


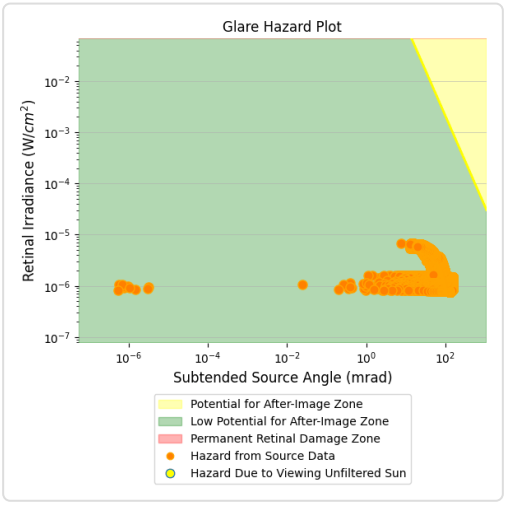
UV-12 and Route: A12 ri west

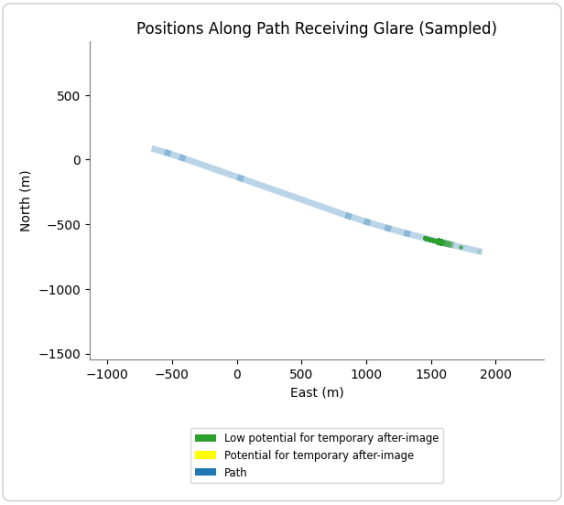
Yellow glare: none

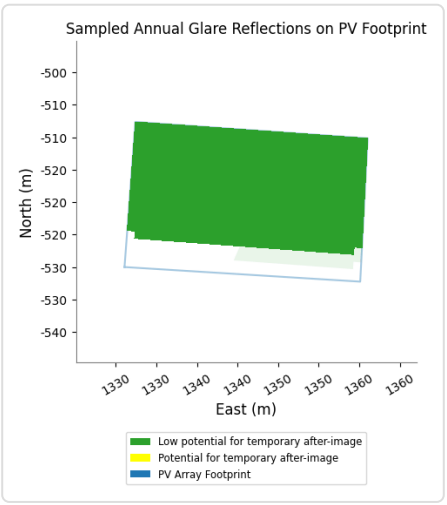
Green glare: 49,876 min.







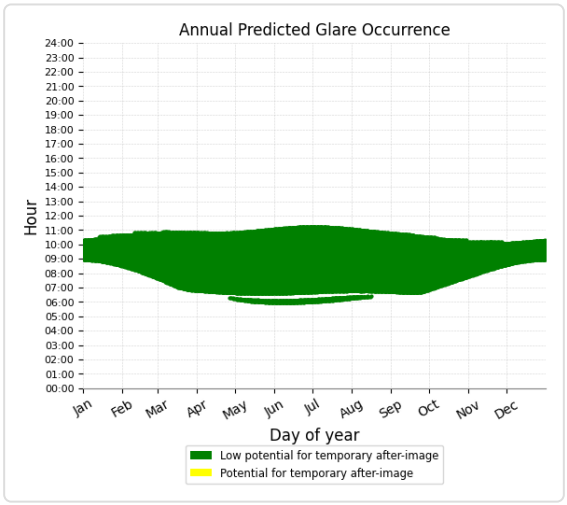


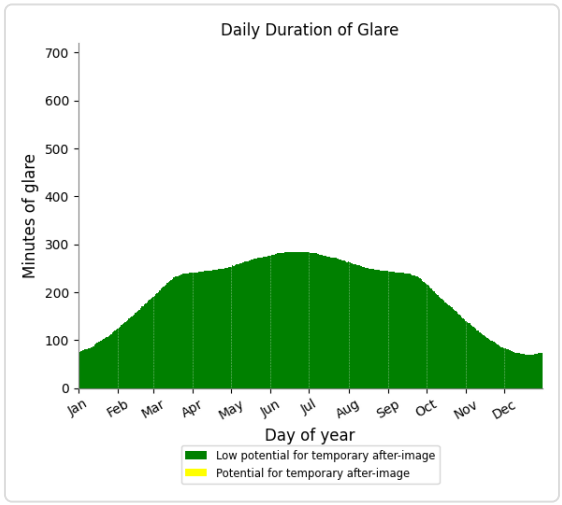


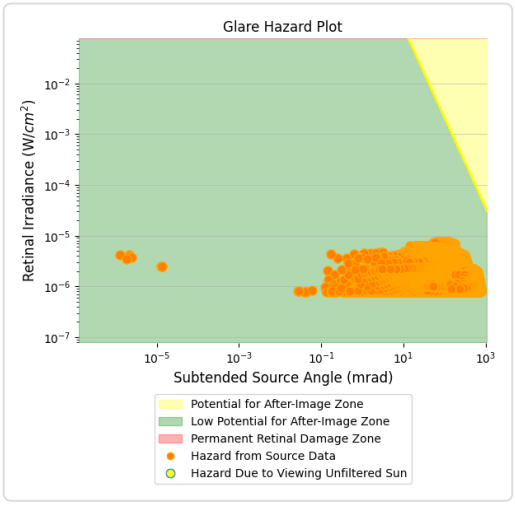
UV-12 and Route: N198 ri oost

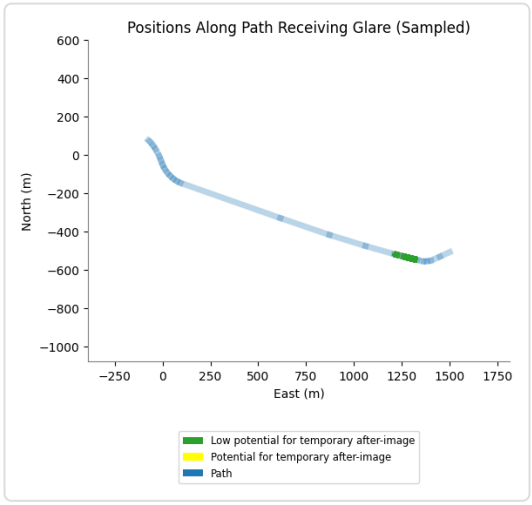
Yellow glare: none

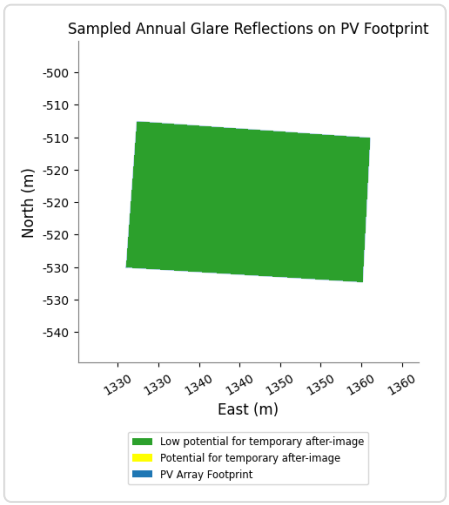
Green glare: 72,977 min.







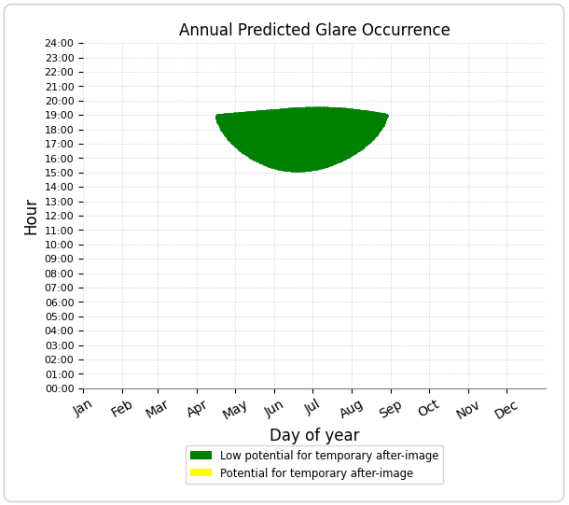


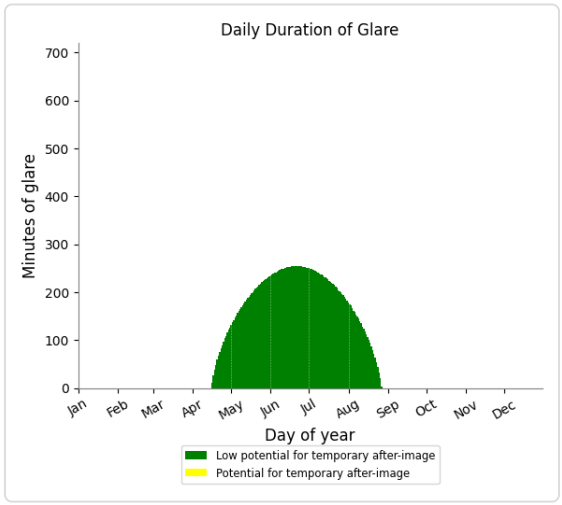


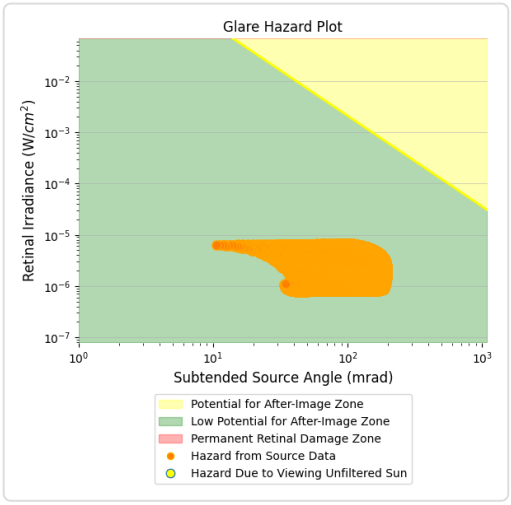
UV-12 and Route: N198 ri west

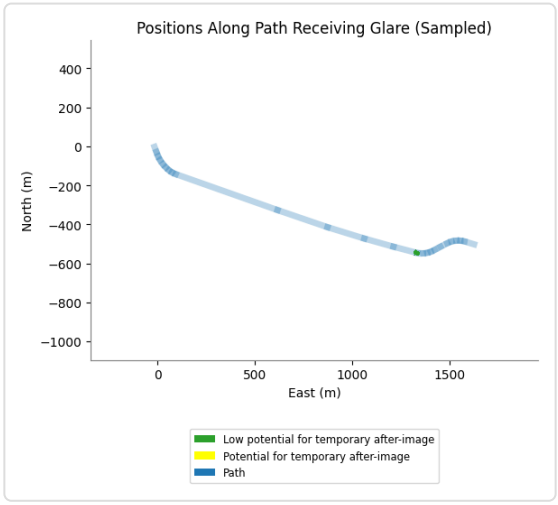
Yellow glare: none

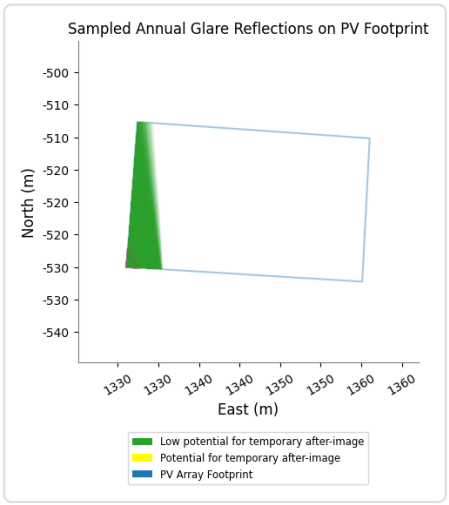
Green glare: 24,459 min.











UV-12 and Route: N419 ri oost

No glare found

UV-12 and Route: N419 ri west

No glare found

PV: UV-13 low potential for temporary after-image

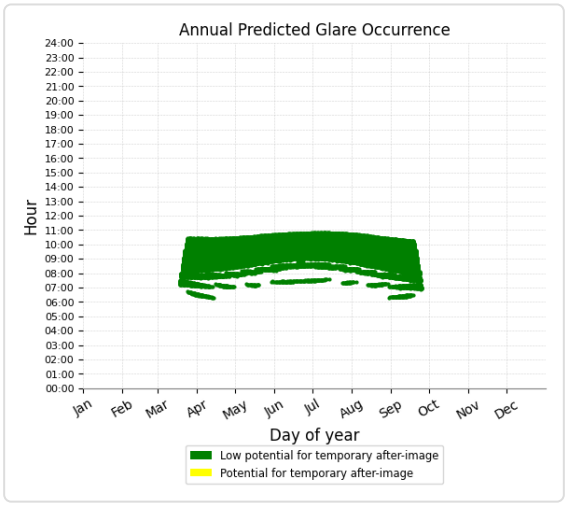
Receptor results ordered by category of glare

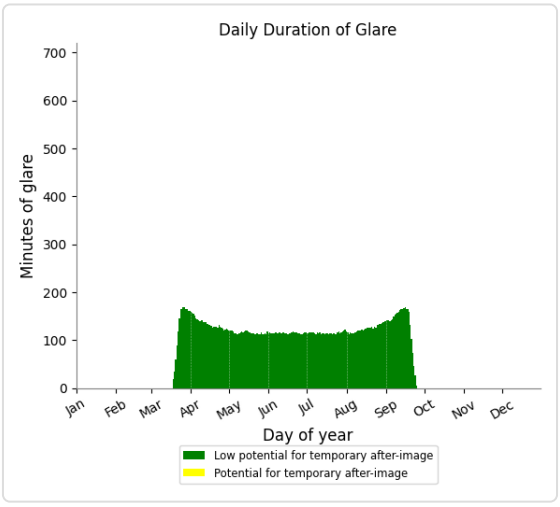
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	23,650	394.2	0	0.0
A12 ri west	47,605	793.4	0	0.0
N198 ri oost	33,681	561.4	0	0.0
N198 ri west	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

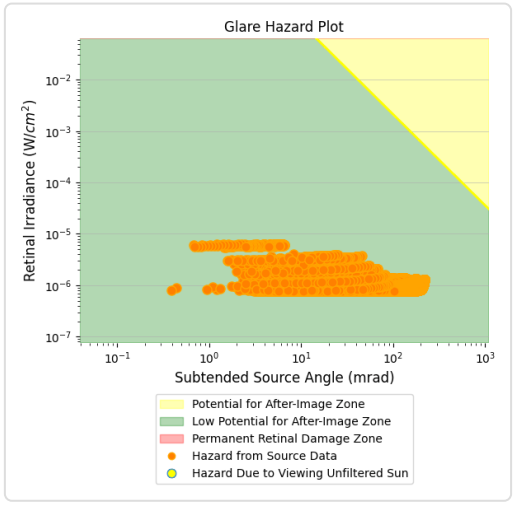
UV-13 and Route: A12 ri oost

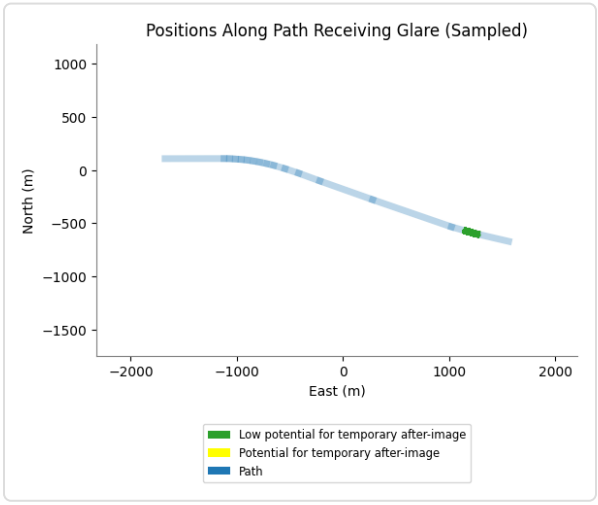
Yellow glare: none

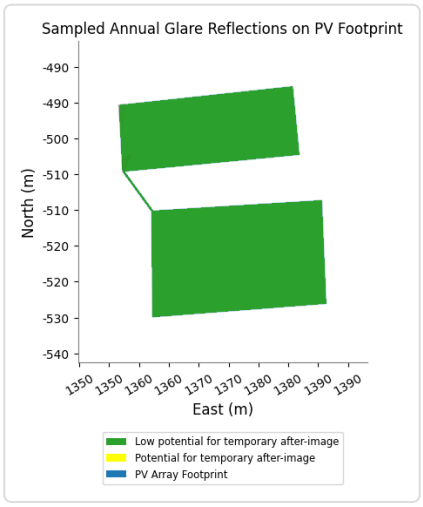
Green glare: 23,650 min.







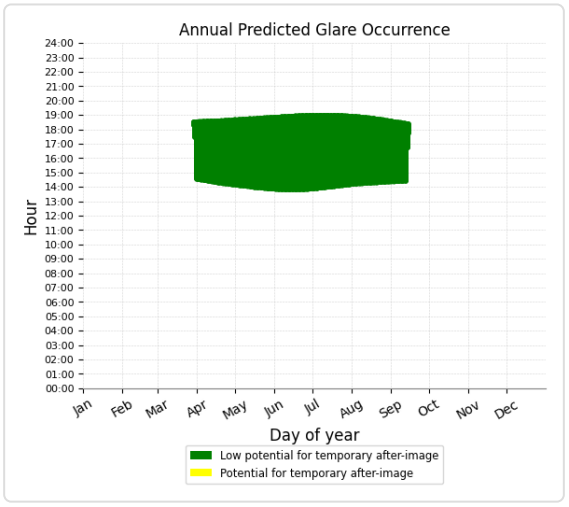


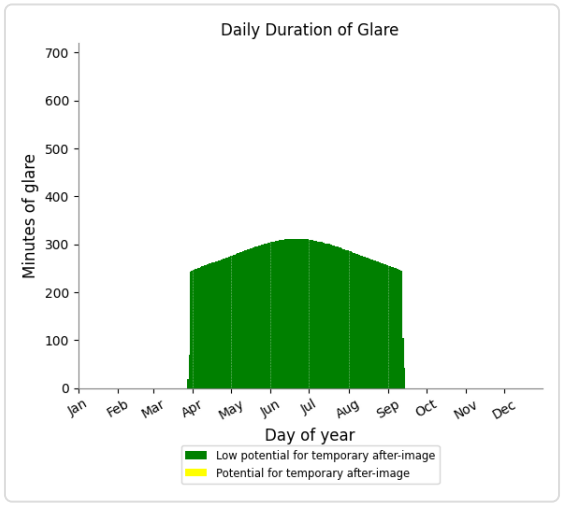


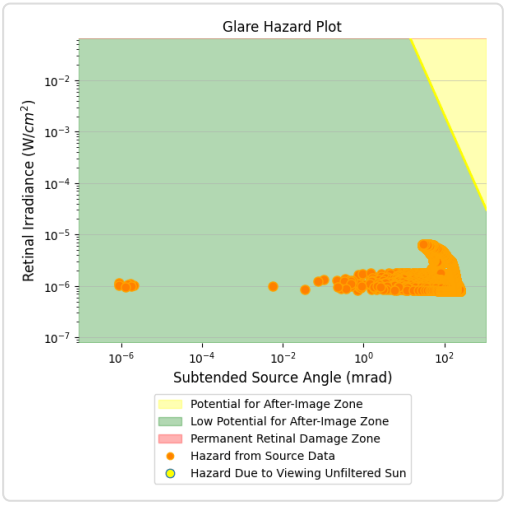
UV-13 and Route: A12 ri west

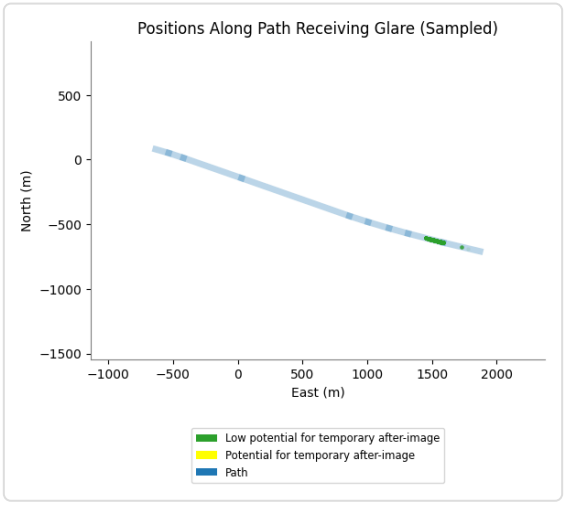
Yellow glare: none

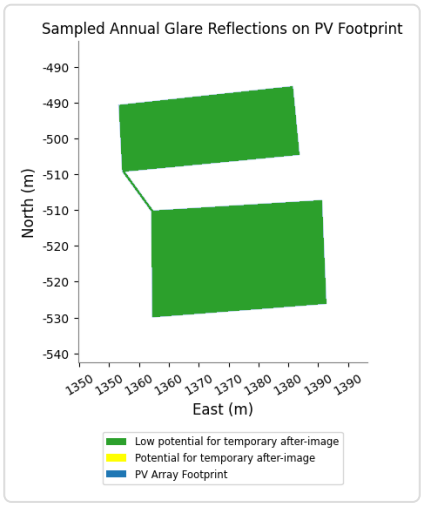
Green glare: 47,605 min.







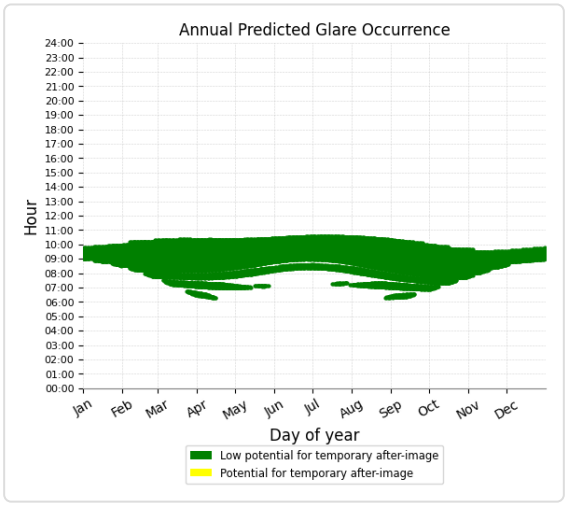


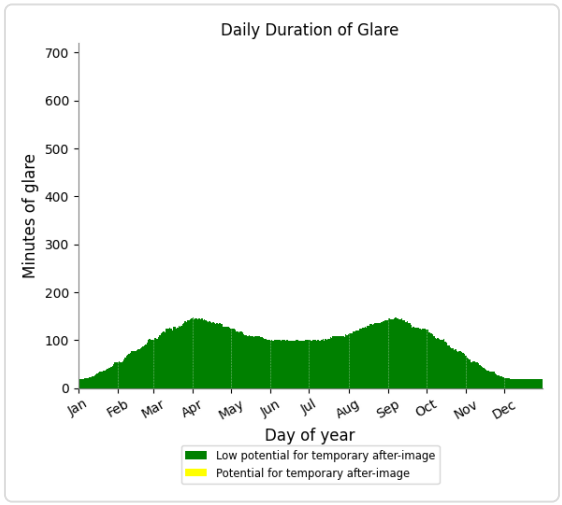


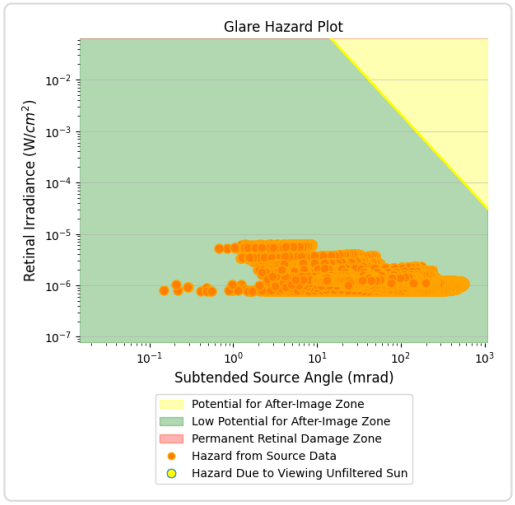
UV-13 and Route: N198 ri oost

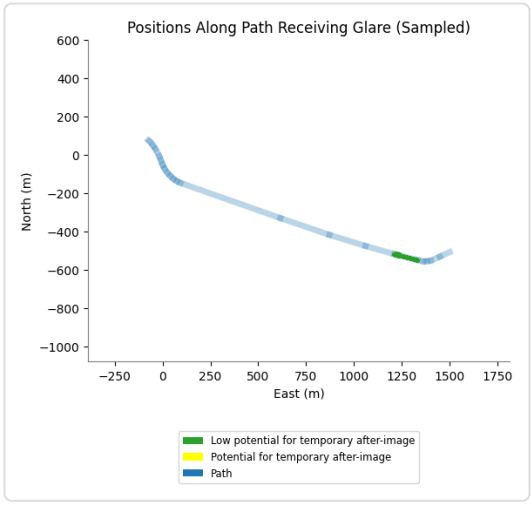
Yellow glare: none

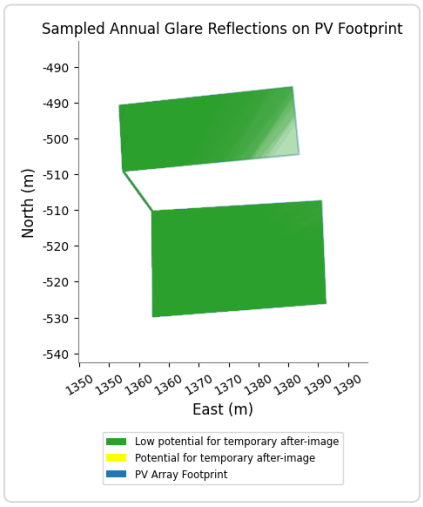
Green glare: 33,681 min.











UV-13 and Route: N198 ri west

No glare found

UV-13 and Route: N419 ri oost

No glare found

UV-13 and Route: N419 ri west

No glare found

PV: UV-14 low potential for temporary after-image

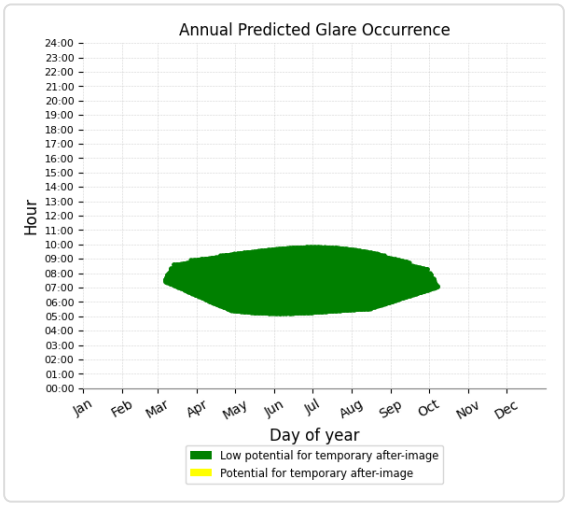
Receptor results ordered by category of glare

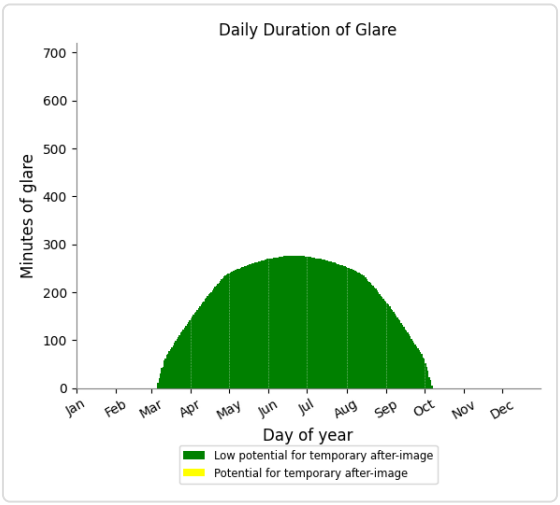
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	43,560	726.0	0	0.0
A12 ri west	38,987	649.8	0	0.0
N198 ri west	40,908	681.8	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

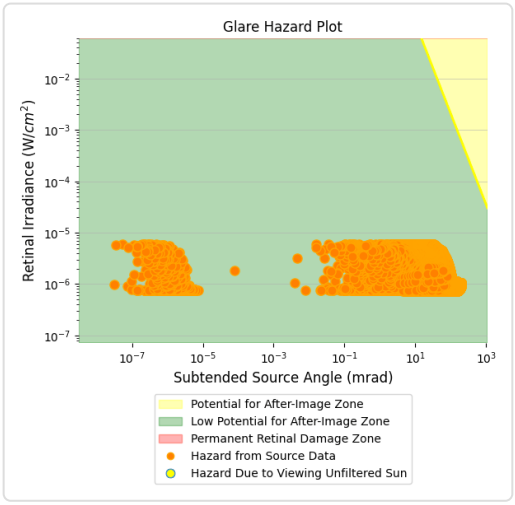
UV-14 and Route: A12 ri oost

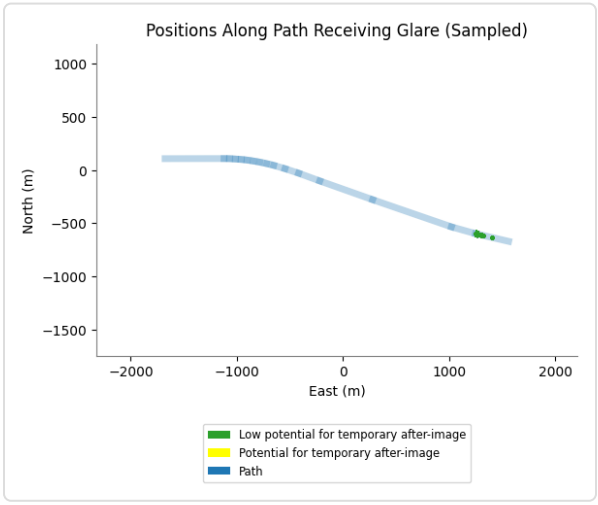
Yellow glare: none

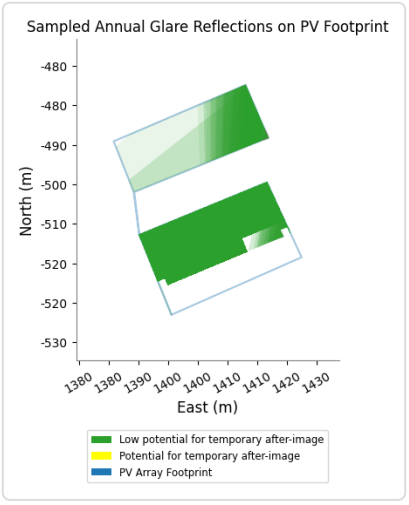
Green glare: 43,560 min.







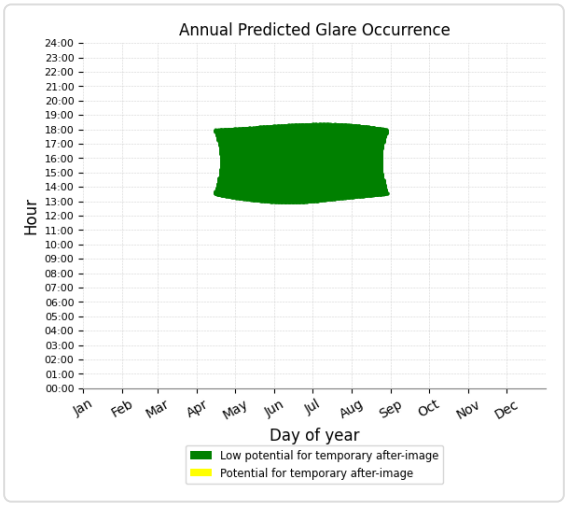


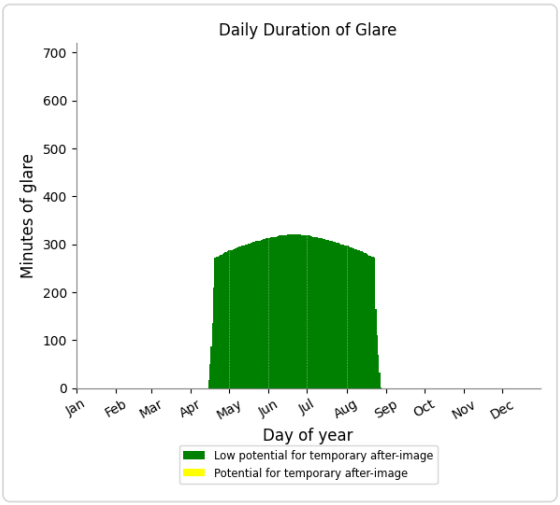


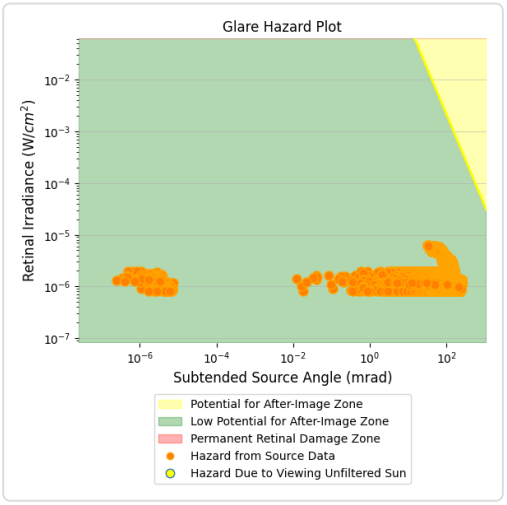
UV-14 and Route: A12 ri west

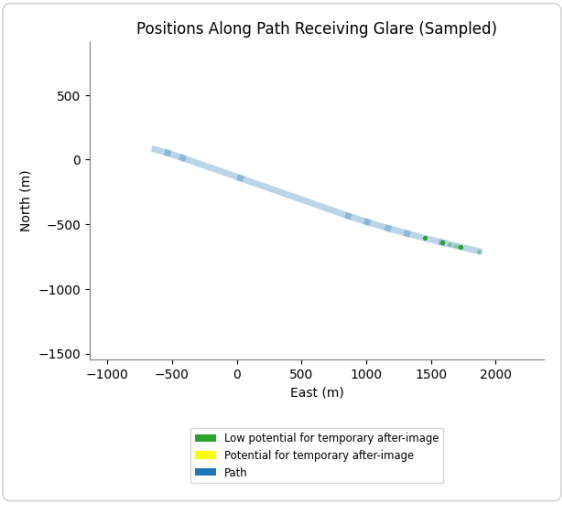
Yellow glare: none

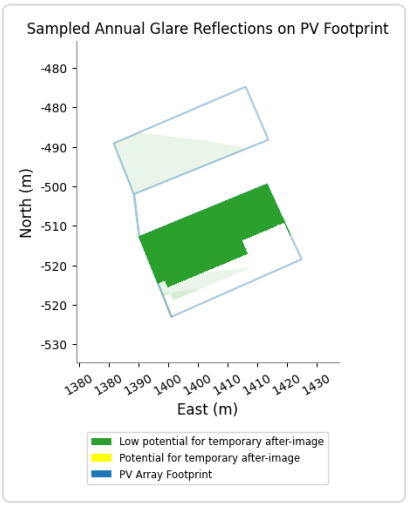
Green glare: 38,987 min.







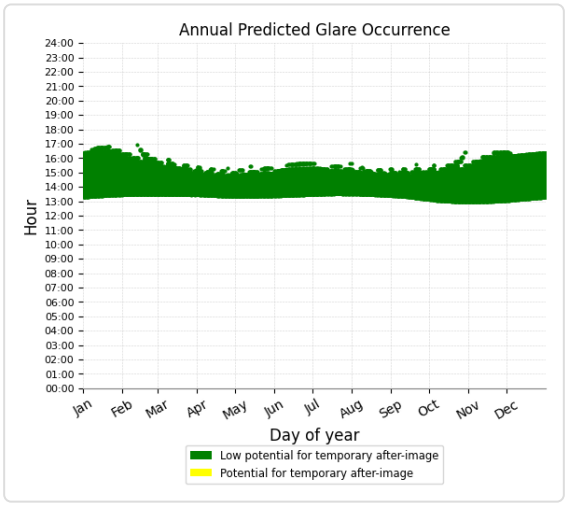


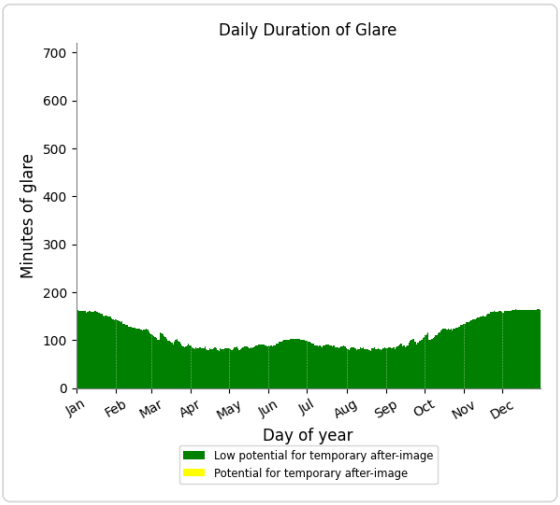


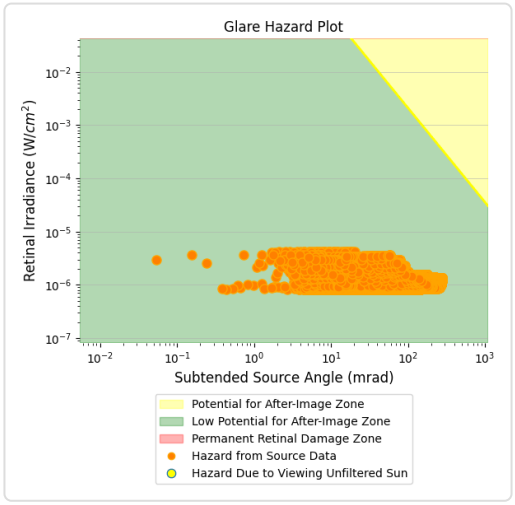
UV-14 and Route: N198 ri west

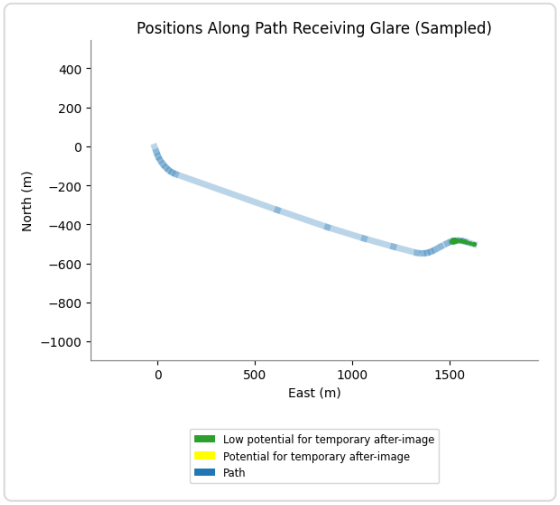
Yellow glare: none

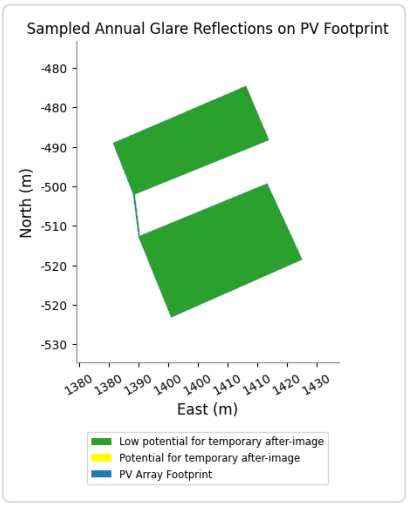
Green glare: 40,908 min.











UV-14 and Route: N198 ri oost

No glare found

UV-14 and Route: N419 ri oost

No glare found

UV-14 and Route: N419 ri west

No glare found

PV: UV-15 low potential for temporary after-image

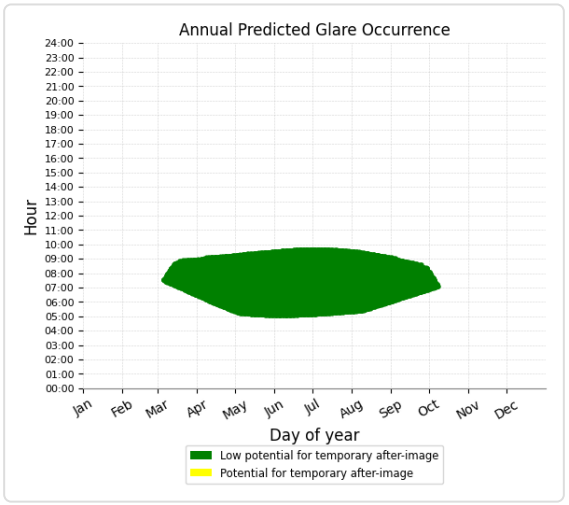
Receptor results ordered by category of glare

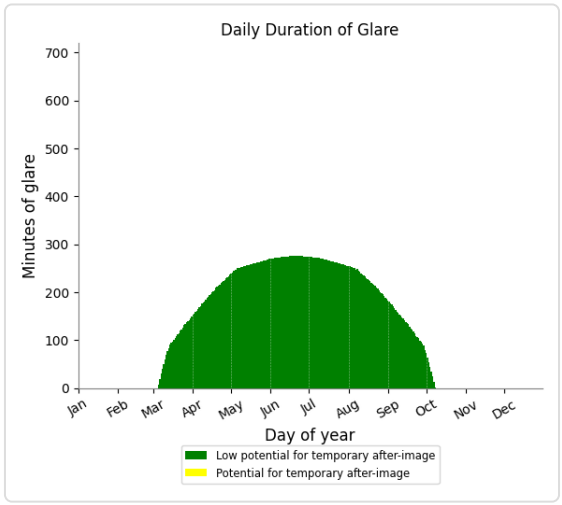
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	44,352	739.2	0	0.0
A12 ri west	37,452	624.2	0	0.0
N198 ri west	62,573	1,042.9	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

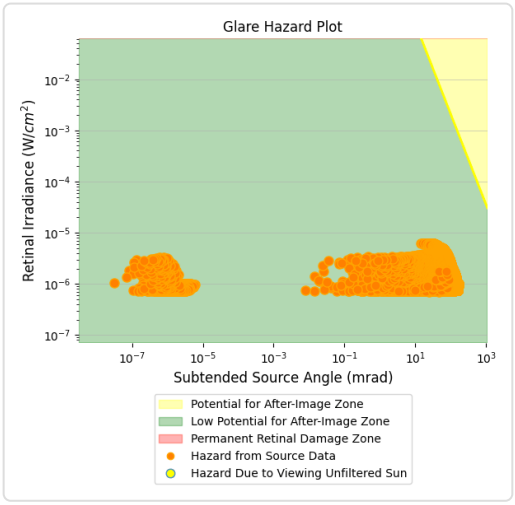
UV-15 and Route: A12 ri oost

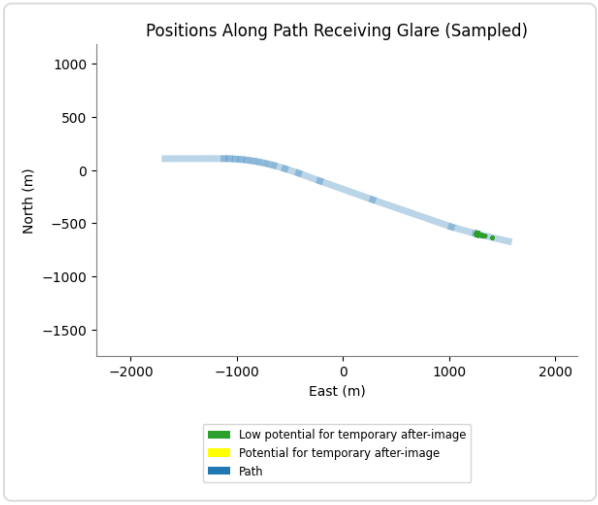
Yellow glare: none

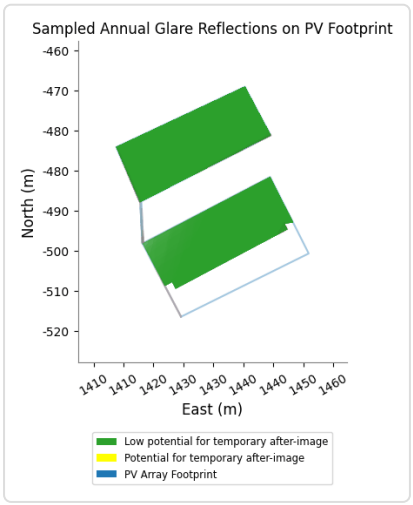
Green glare: 44,352 min.







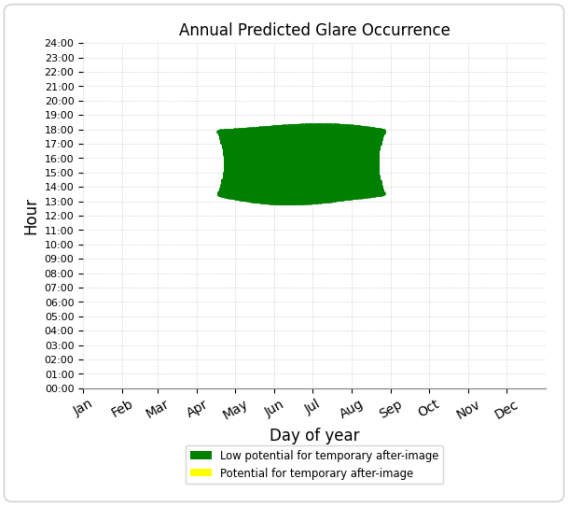


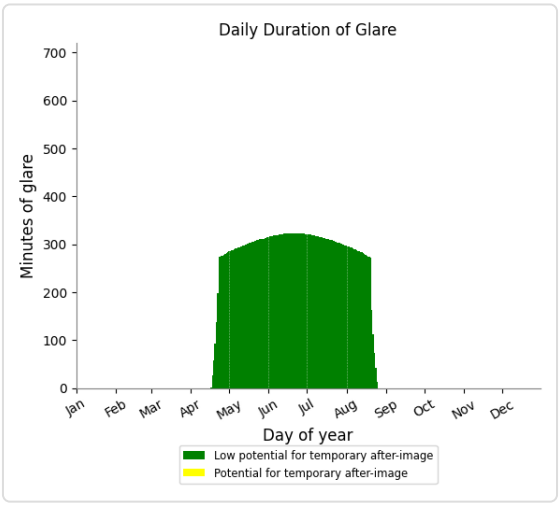


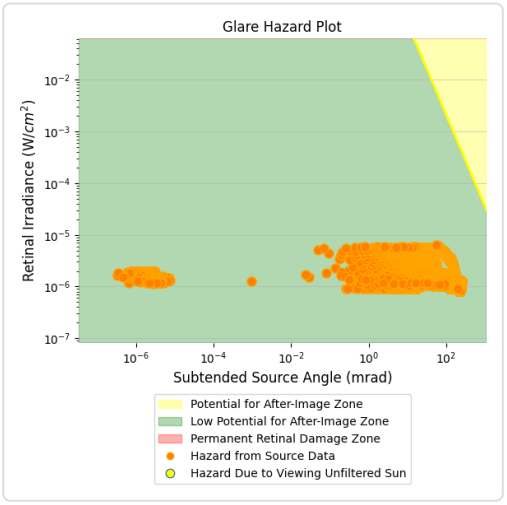
UV-15 and Route: A12 ri west

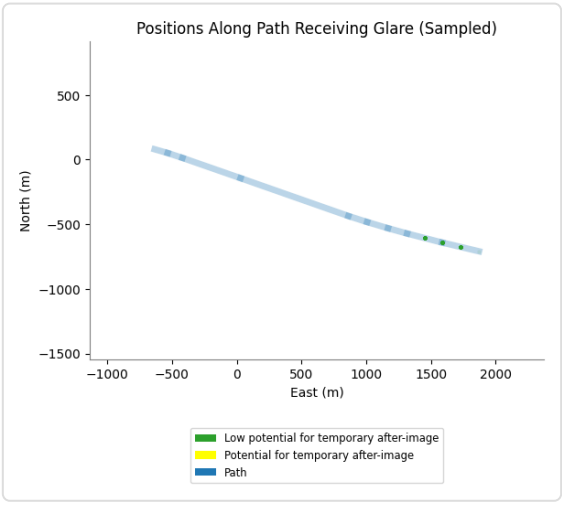
Yellow glare: none

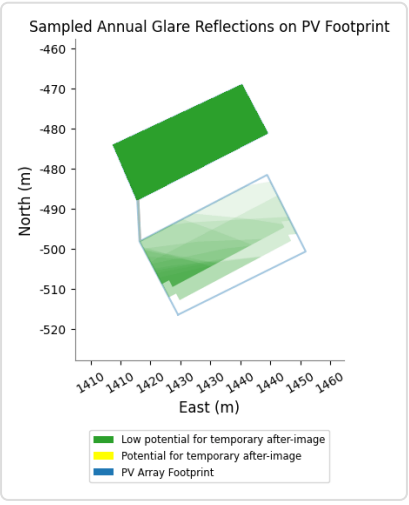
Green glare: 37,452 min.







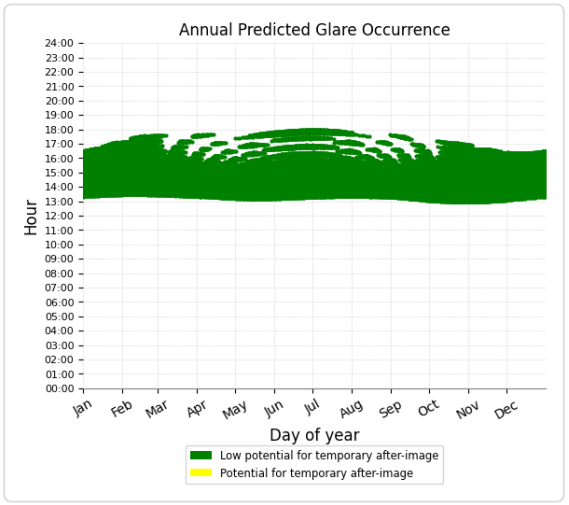


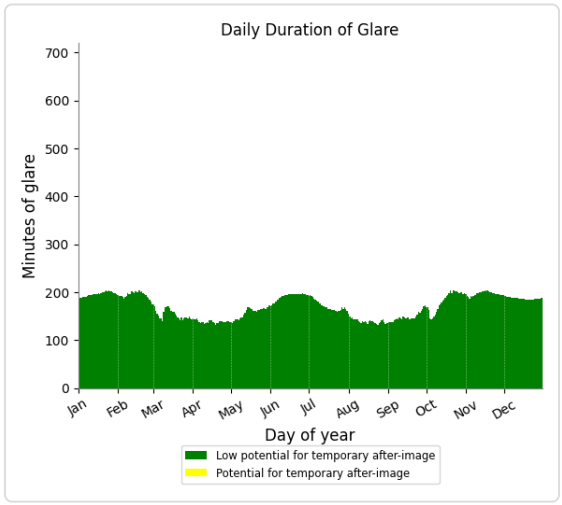


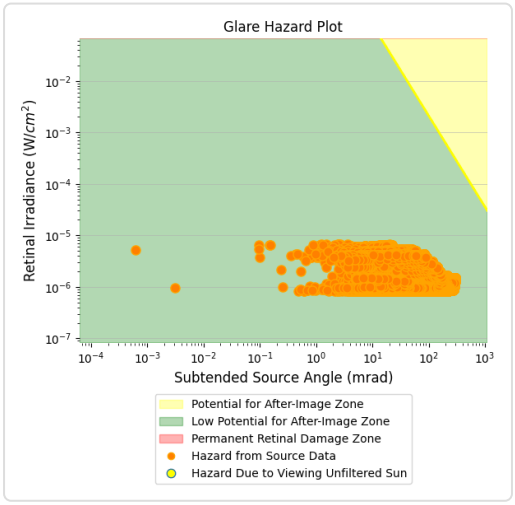
UV-15 and Route: N198 ri west

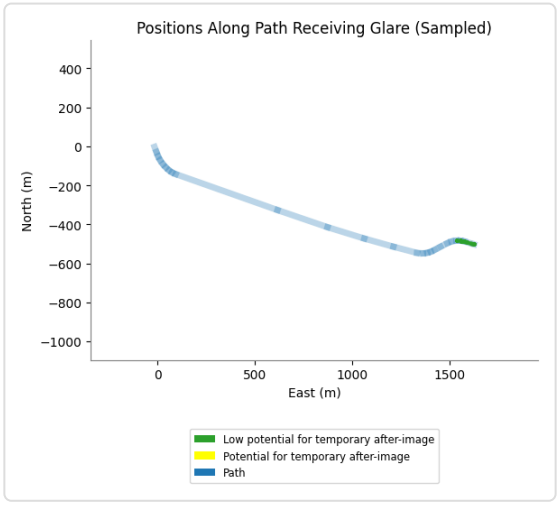
Yellow glare: none

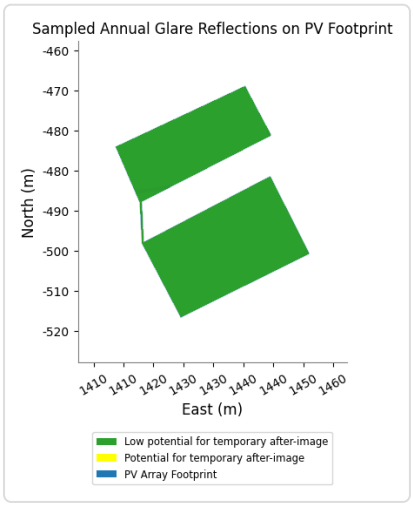
Green glare: 62,573 min.











UV-15 and Route: N198 ri oost

No glare found

UV-15 and Route: N419 ri oost

No glare found

UV-15 and Route: N419 ri west

No glare found

PV: UV-16 low potential for temporary after-image

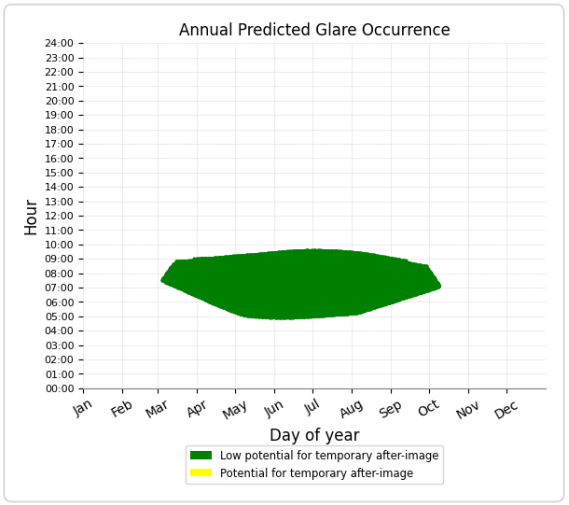
Receptor results ordered by category of glare

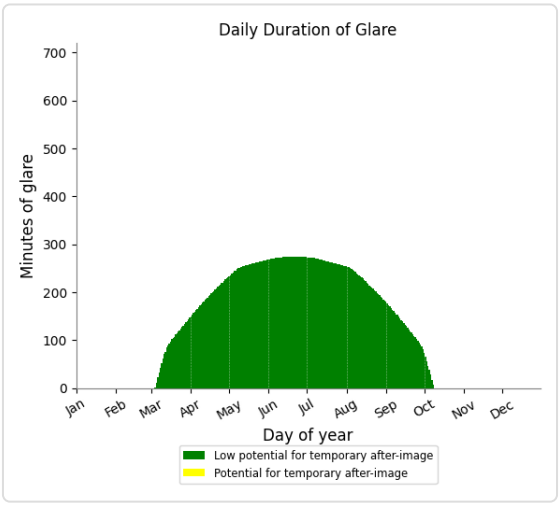
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	43,905	731.8	0	0.0
A12 ri west	35,899	598.3	0	0.0
N198 ri west	77,041	1,284.0	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

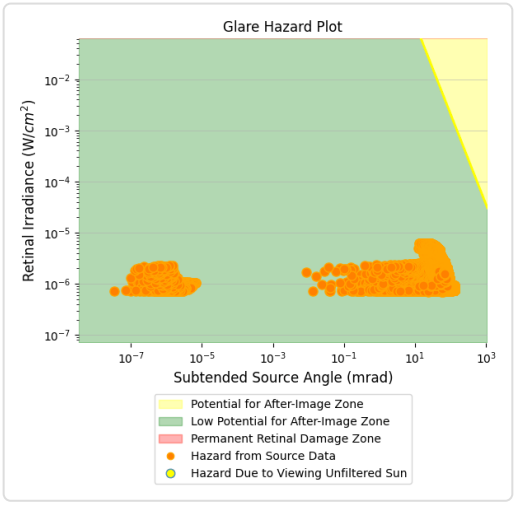
UV-16 and Route: A12 ri oost

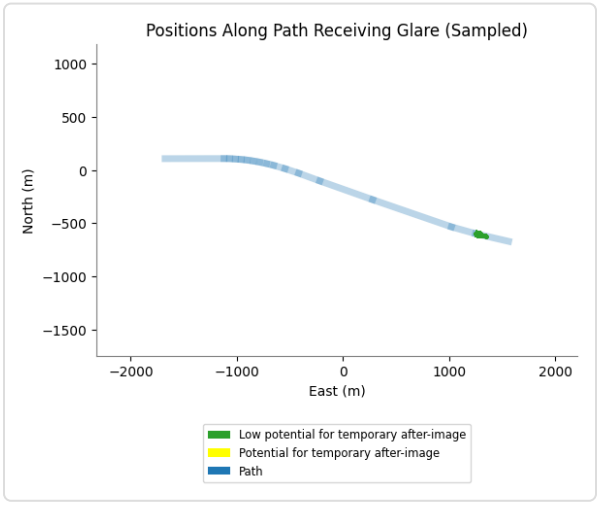
Yellow glare: none

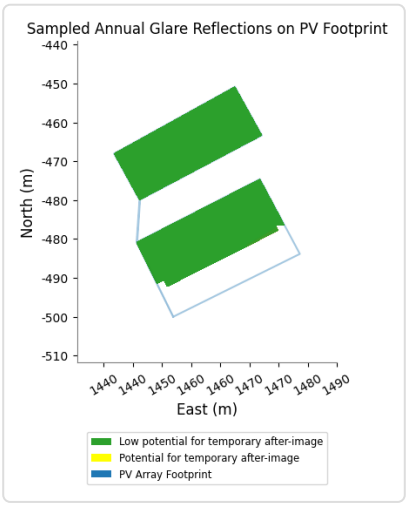
Green glare: 43,905 min.







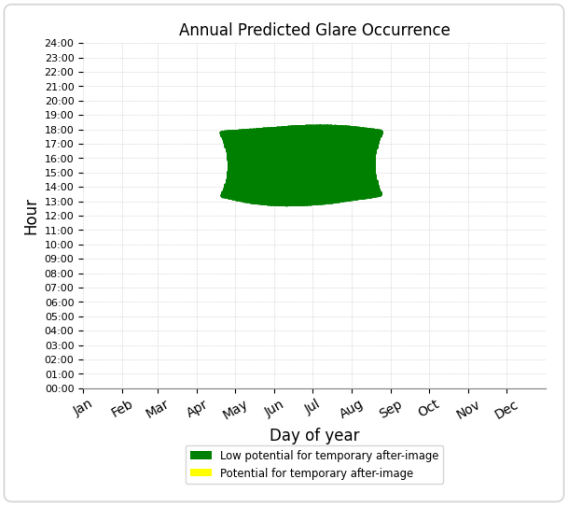


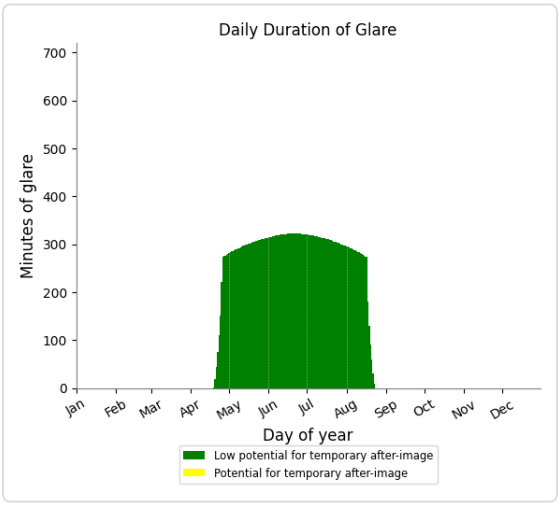


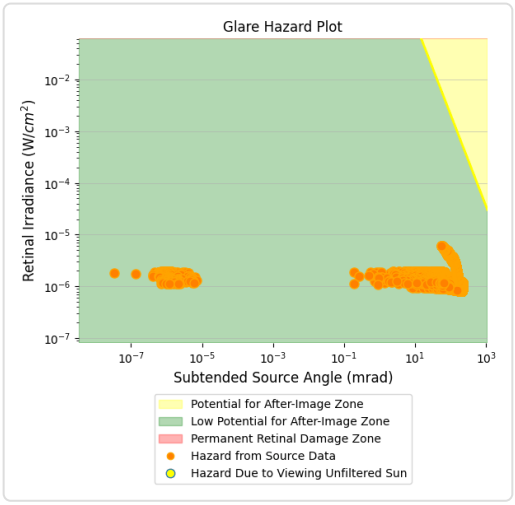
UV-16 and Route: A12 ri west

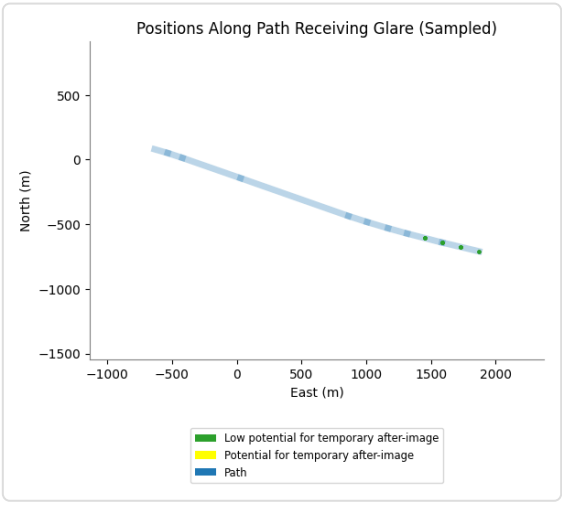
Yellow glare: none

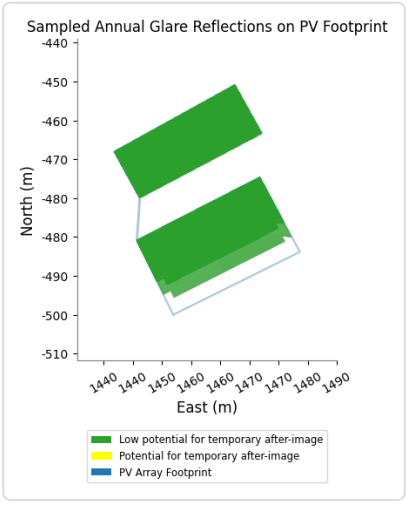
Green glare: 35,899 min.







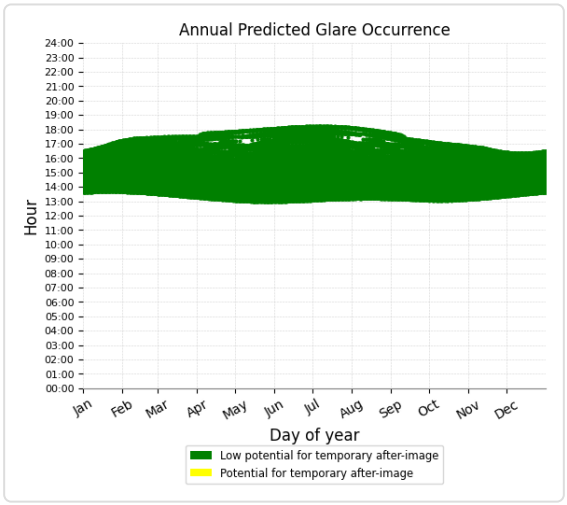


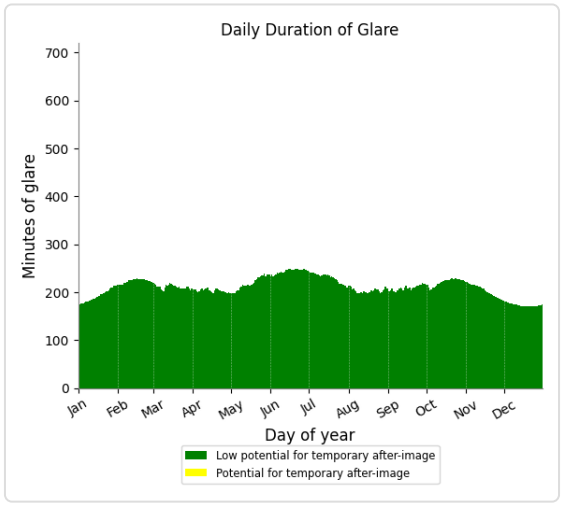


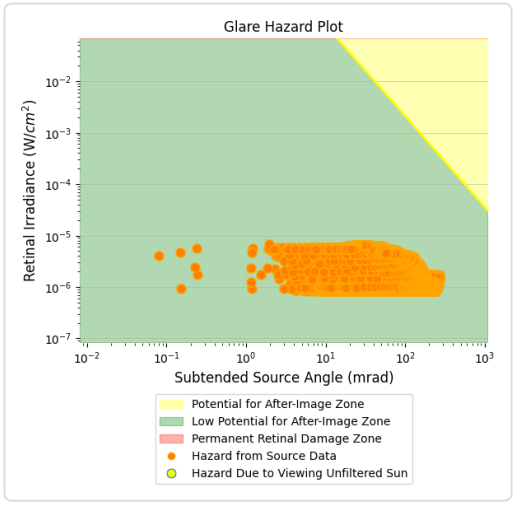
UV-16 and Route: N198 ri west

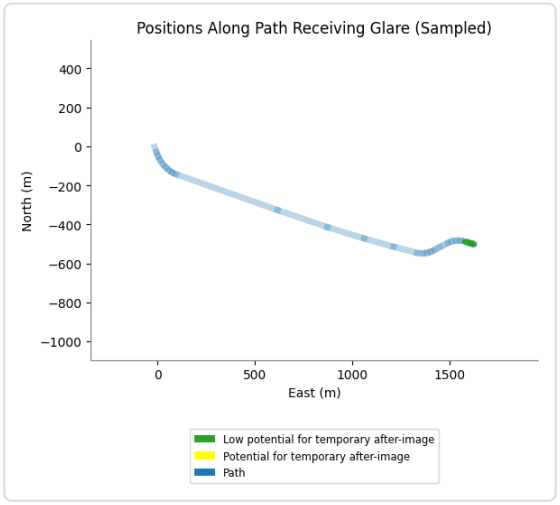
Yellow glare: none

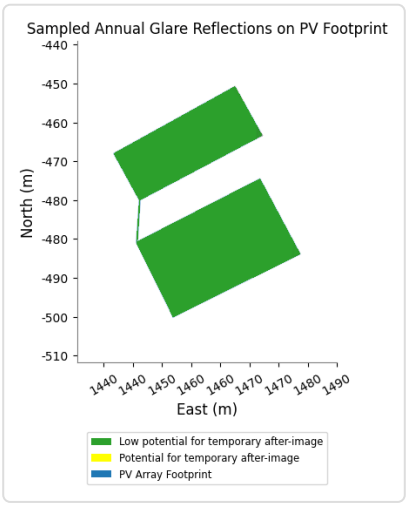
Green glare: 77,041 min.











UV-16 and Route: N198 ri oost

No glare found

UV-16 and Route: N419 ri oost

No glare found

UV-16 and Route: N419 ri west

No glare found

PV: Woerden low potential for temporary after-image

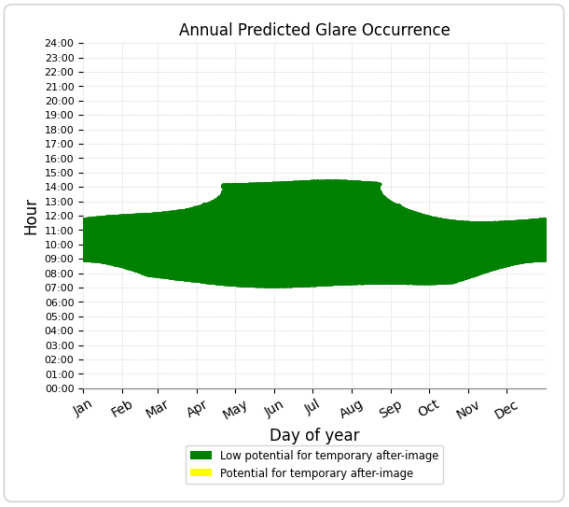
Receptor results ordered by category of glare

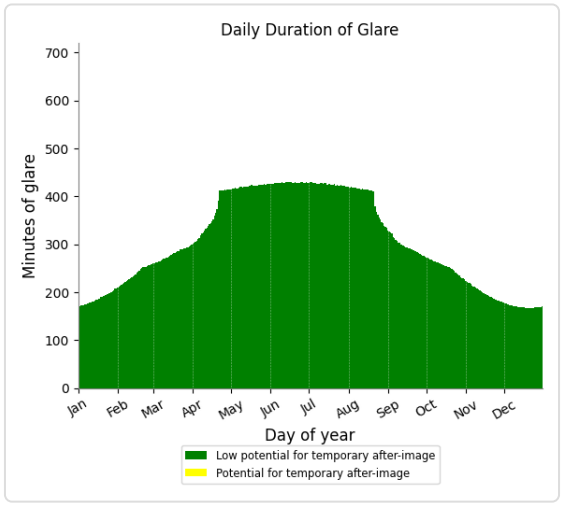
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
A12 ri oost	111,169	1,852.8	0	0.0
A12 ri west	84,361	1,406.0	0	0.0
N198 ri west	3,715	61.9	0	0.0
N198 ri oost	0	0.0	0	0.0
N419 ri oost	0	0.0	0	0.0
N419 ri west	0	0.0	0	0.0

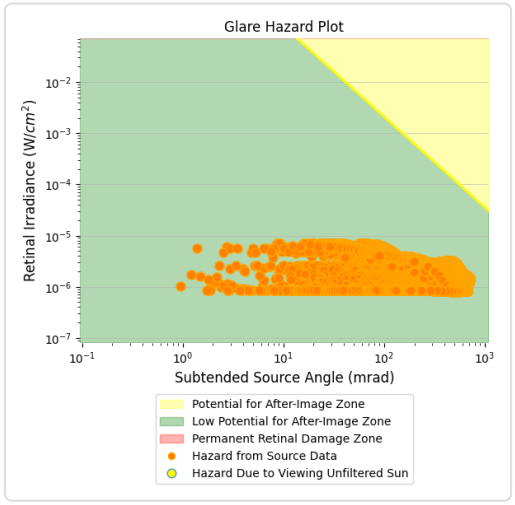
Woerden and Route: A12 ri oost

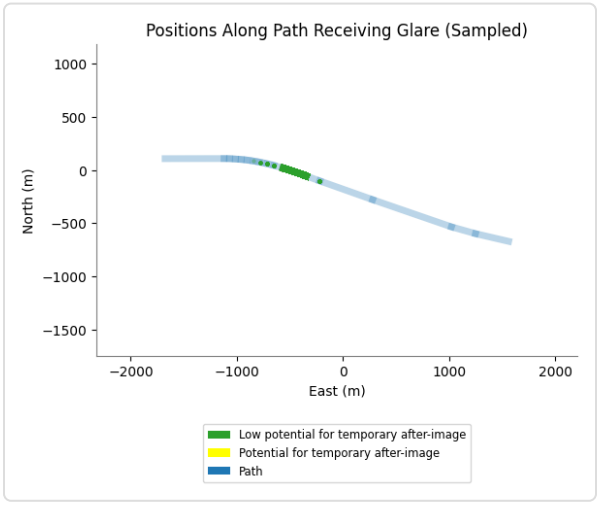
Yellow glare: none

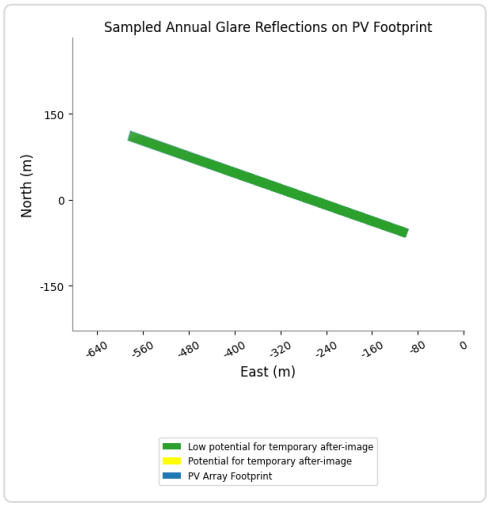
Green glare: 111,169 min.







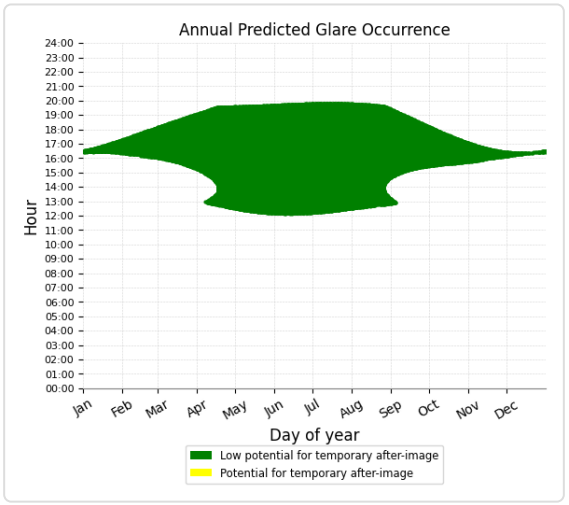


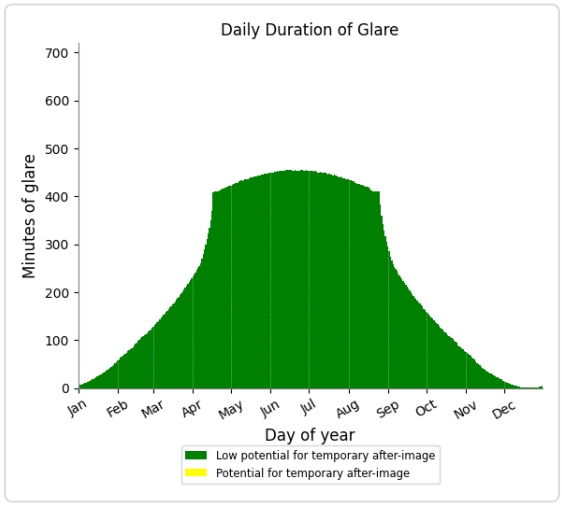


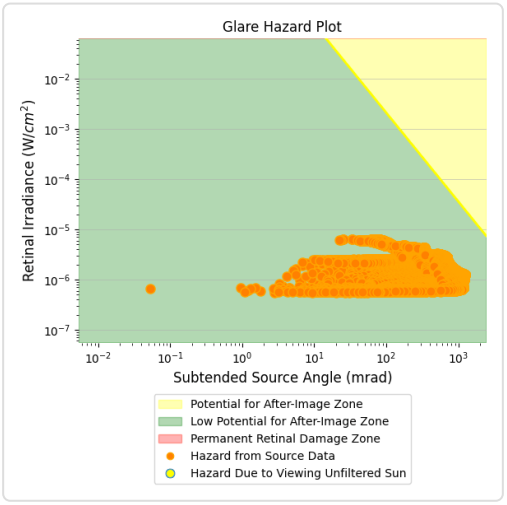
Woerden and Route: A12 ri west

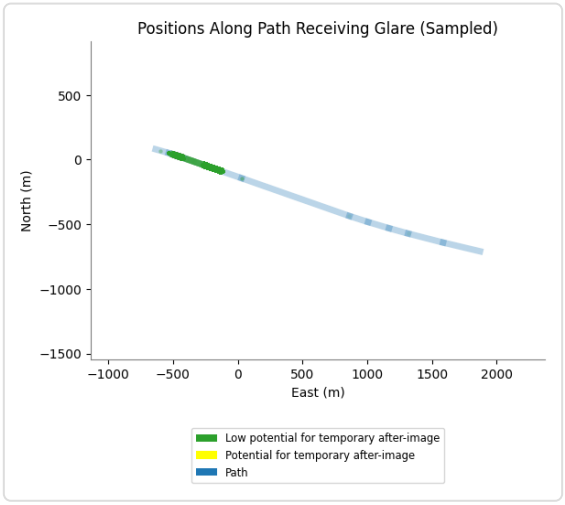
Yellow glare: none

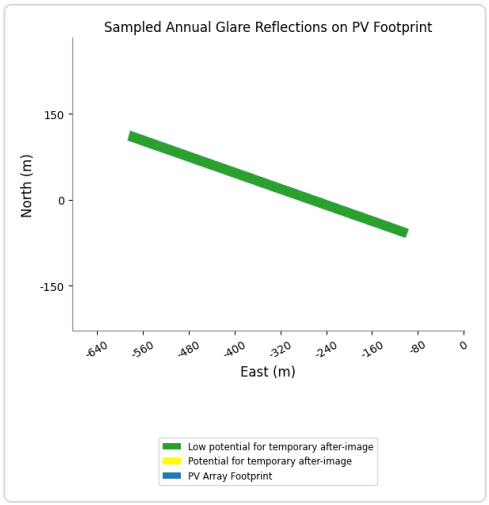
Green glare: 84,361 min.







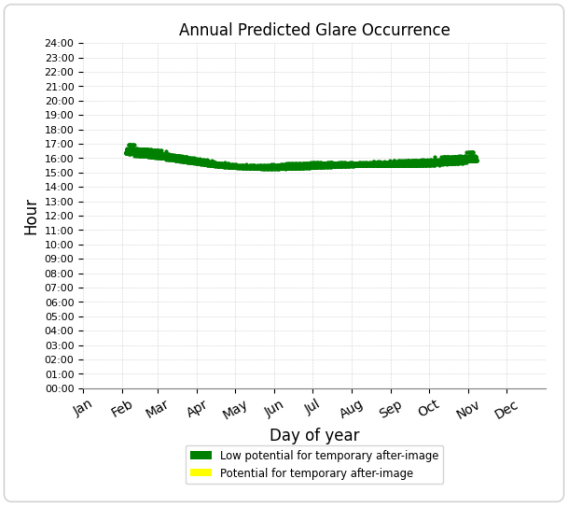


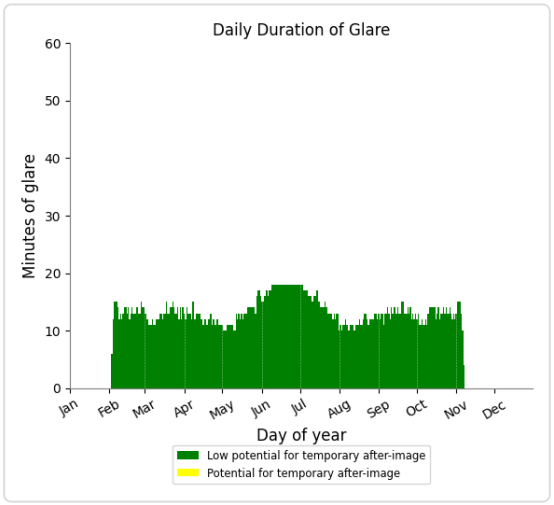


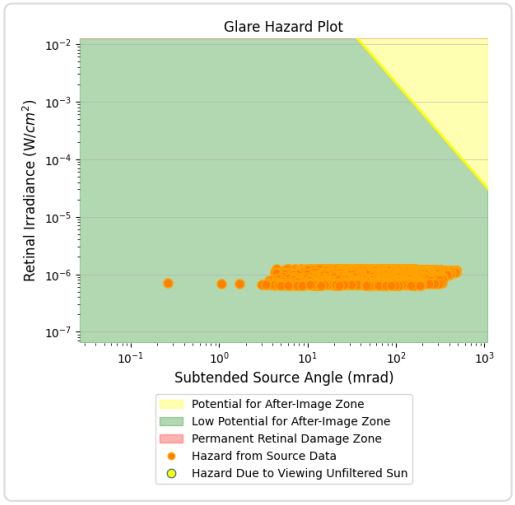
Woerden and Route: N198 ri west

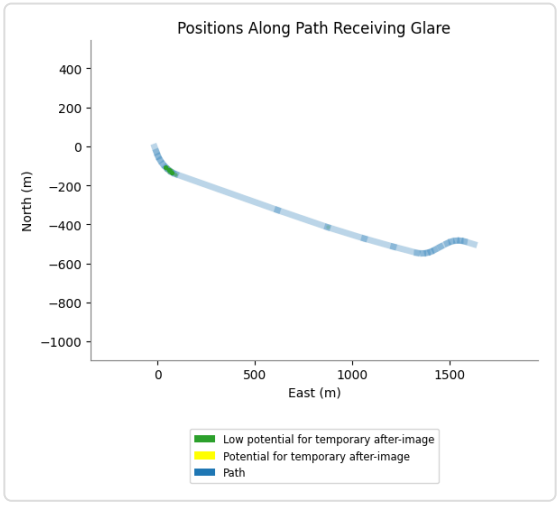
Yellow glare: none

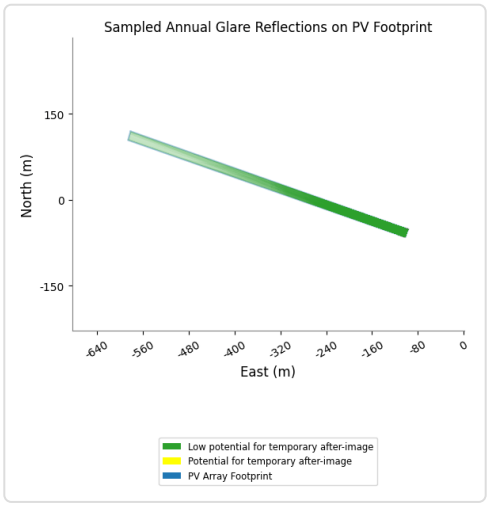
Green glare: 3,715 min.











Woerden and Route: N198 ri oost

No glare found

Woerden and Route: N419 ri oost

No glare found

Woerden and Route: N419 ri west

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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This analysis was conducted using the best available radiometric modeling at the time of generation. Future updates to the modeling methodology may yield different results.