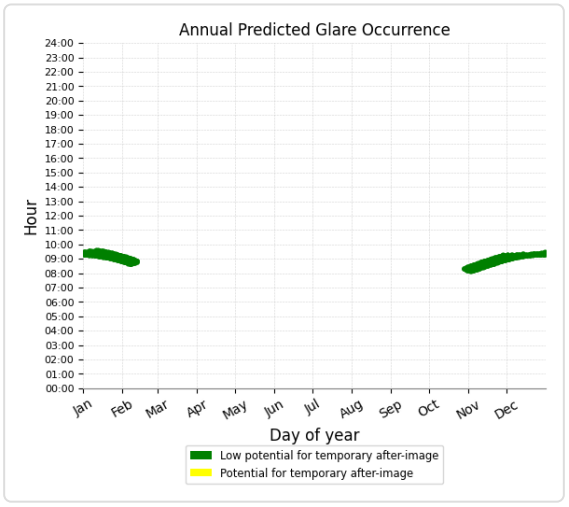
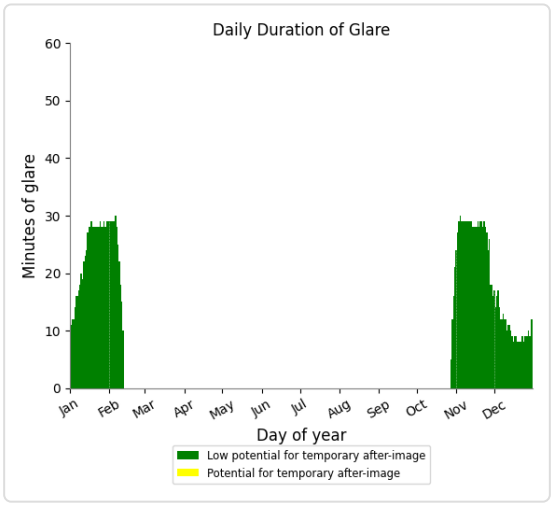
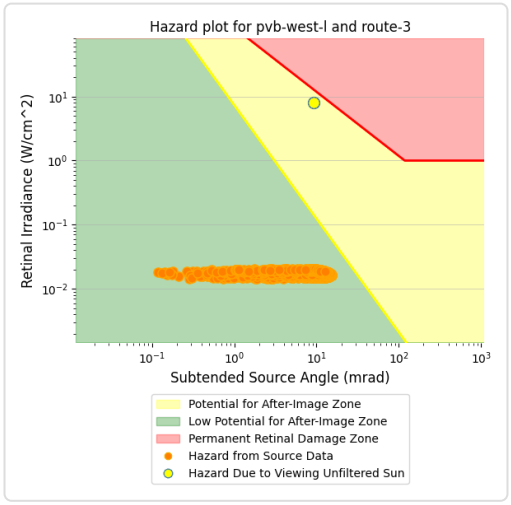
PVB west L and Route: Route 3

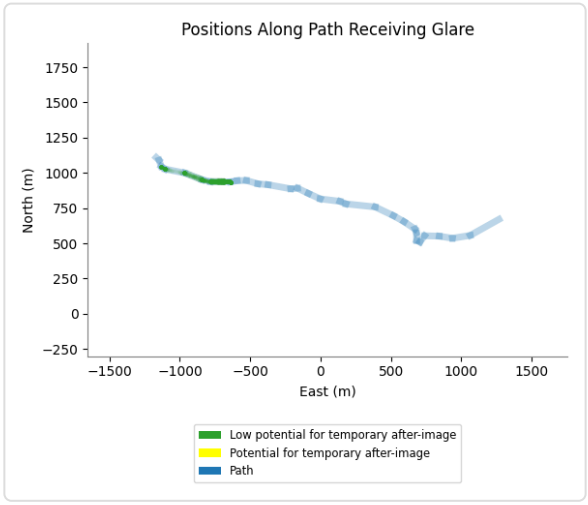
Yellow glare: none

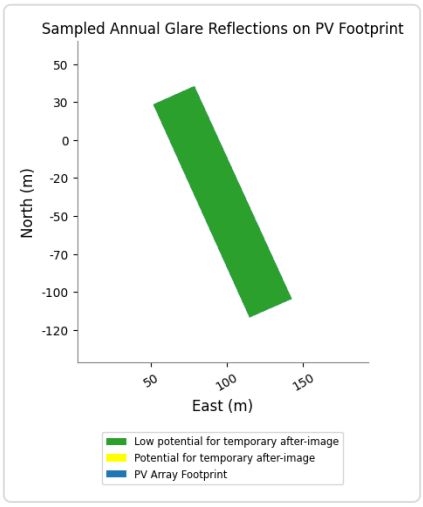
Green glare: 2,210 min.

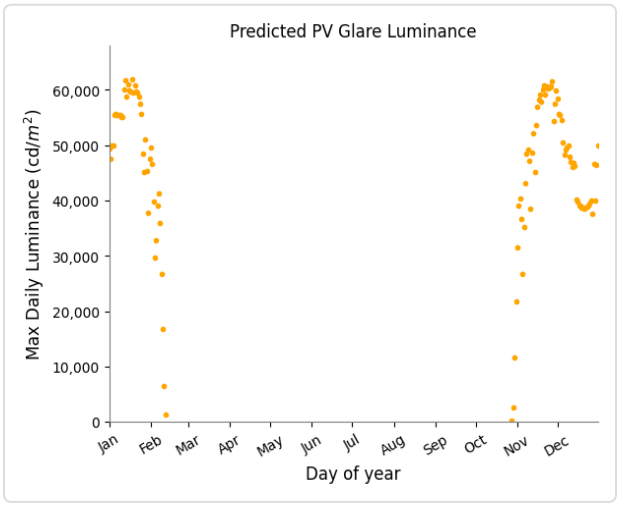












PVB west L and Route: Route 1

No glare found

PVB west L and Route: Route 2

No glare found

PVB west L and Route: Route 4

No glare found

PVB west L and Route: Route 5

No glare found

PVB west L and FP: FP 1

No glare found

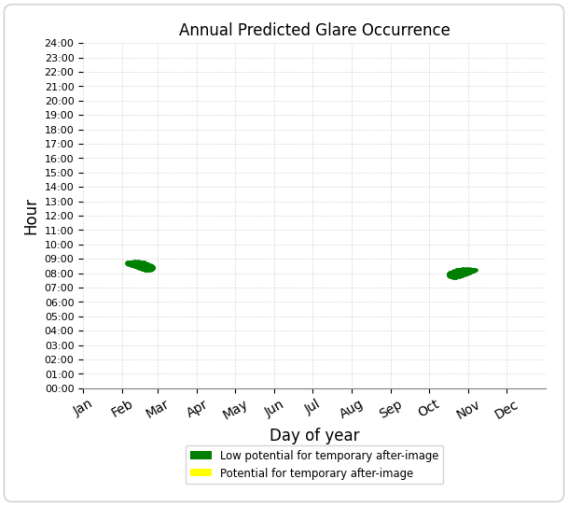
PVB west L and FP: FP 2

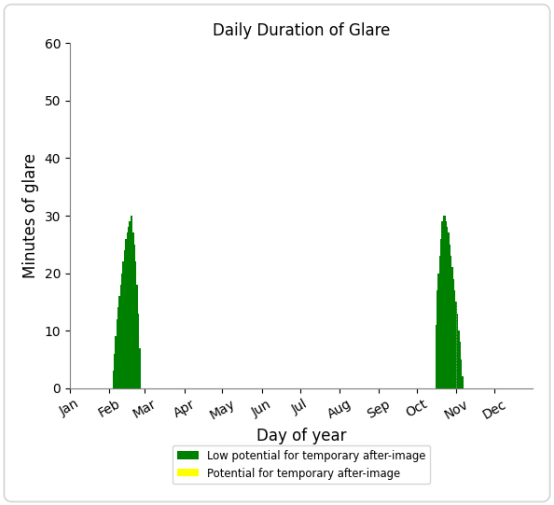
No glare found

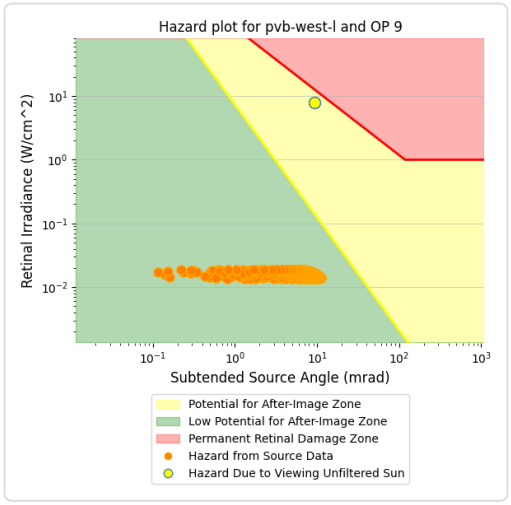
PVB west L and OP 9

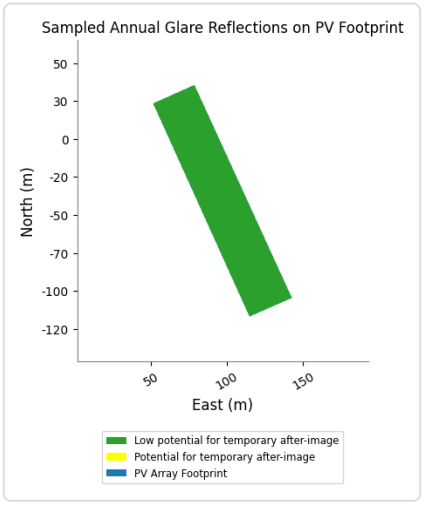
Yellow glare: none

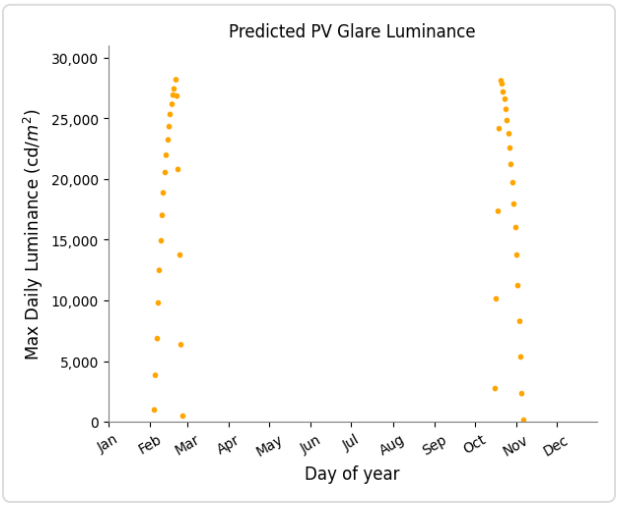
Green glare: 854 min.











PVB west L and OP 1

No glare found

PVB west L and OP 2

No glare found

PVB west L and OP 3

No glare found

PVB west L and OP 4

No glare found

PVB west L and OP 5

No glare found

PVB west L and OP 6

No glare found

PVB west L and OP 7

No glare found

PVB west L and OP 8

No glare found

PVB west L and OP 10

No glare found

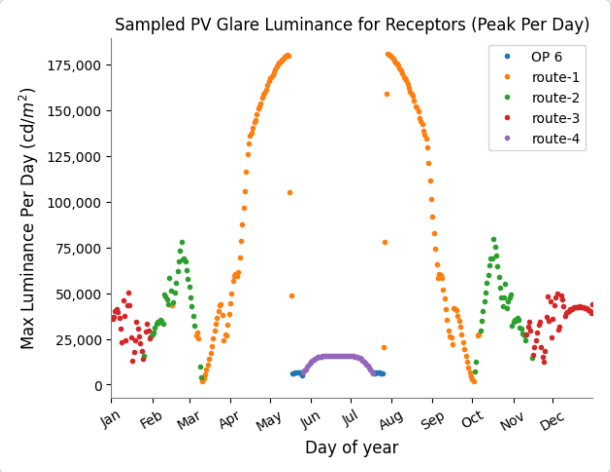
PVB west L and OP 11

No glare found

PV: PVC east H low potential for temporary after-image

Receptor results ordered by category of glare

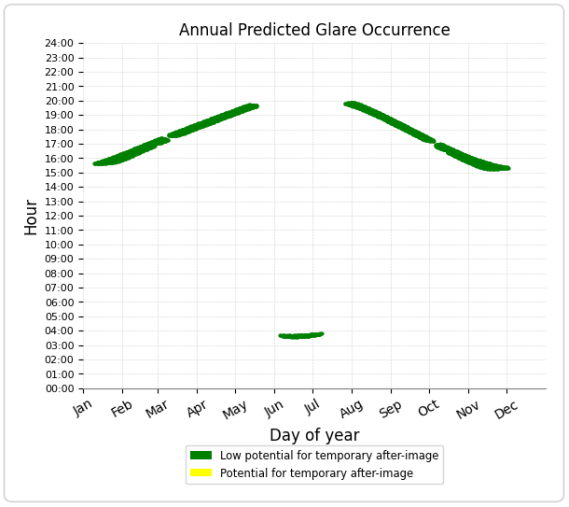
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	4,553	75.9	0	0.0	180,645
Route 2	2,731	45.5	0	0.0	79,425
Route 3	3,074	51.2	0	0.0	50,174
Route 4	1,045	17.4	0	0.0	15,943
Route 5	1,162	19.4	0	0.0	7,192
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 6	898	15.0	0	0.0	6,756
OP 7	595	9.9	0	0.0	5,689
OP 11	1,696	28.3	0	0.0	11,362
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0

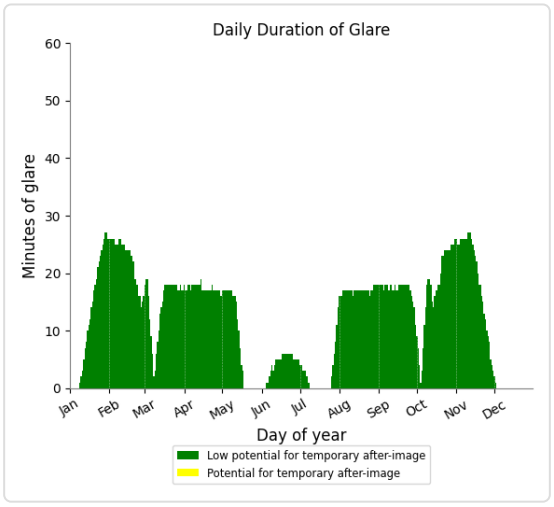


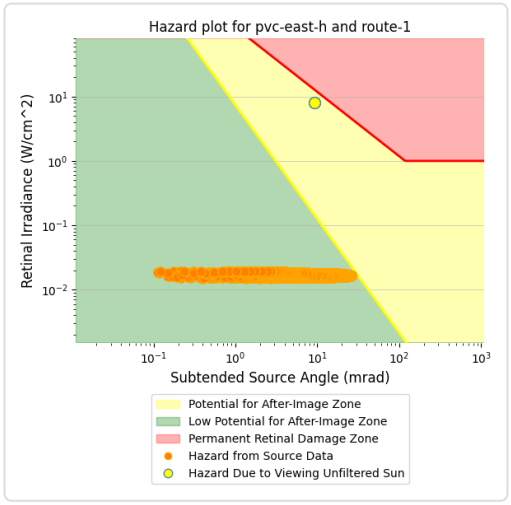
PVC east H and Route: Route 1

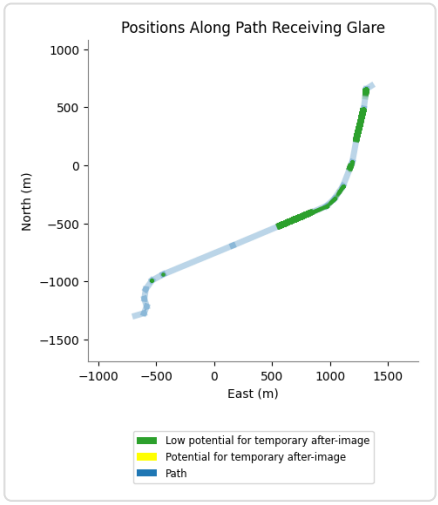
Yellow glare: none

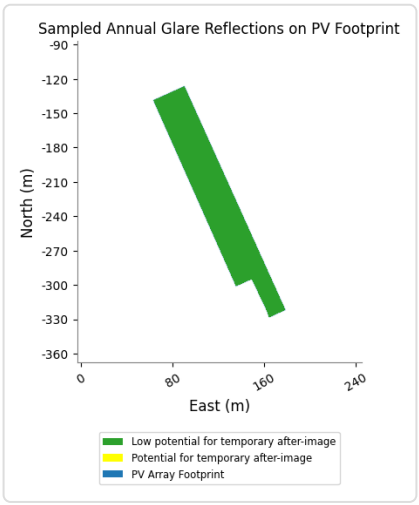
Green glare: 4,553 min.

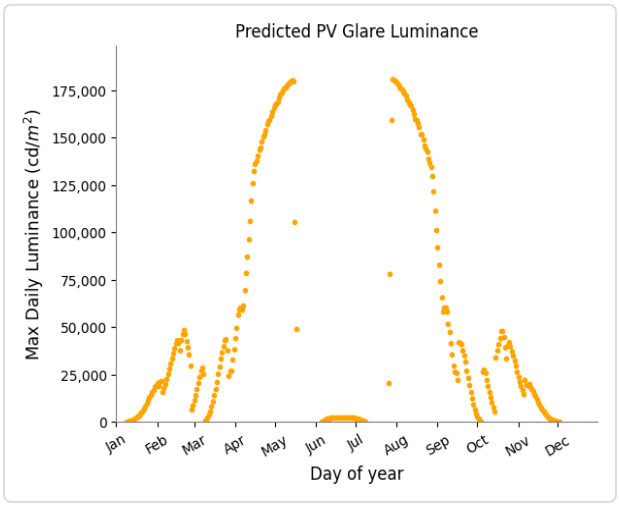








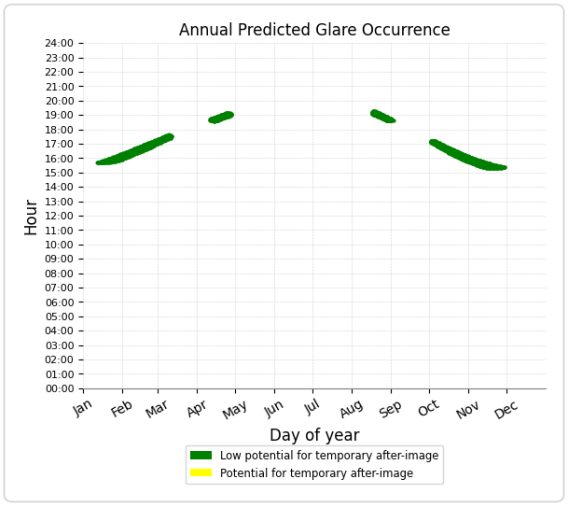


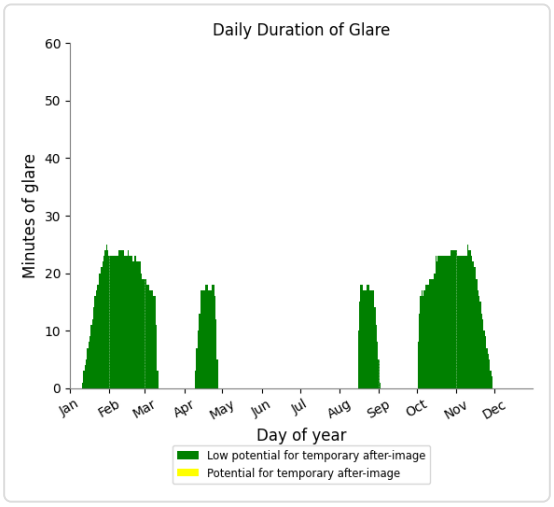


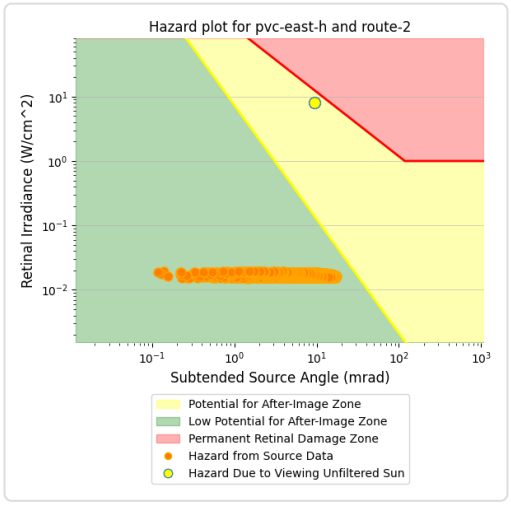
PVC east H and Route: Route 2

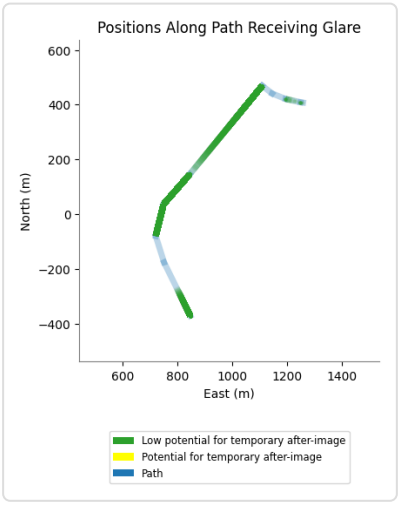
Yellow glare: none

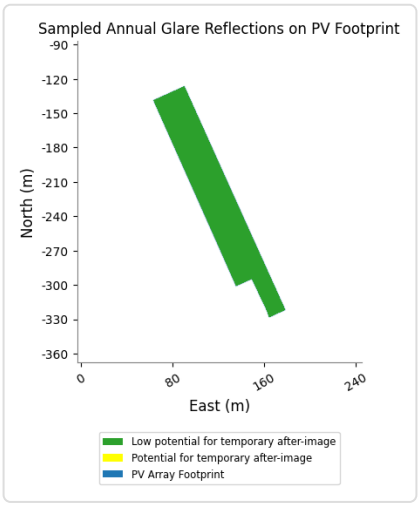
Green glare: 2,731 min.

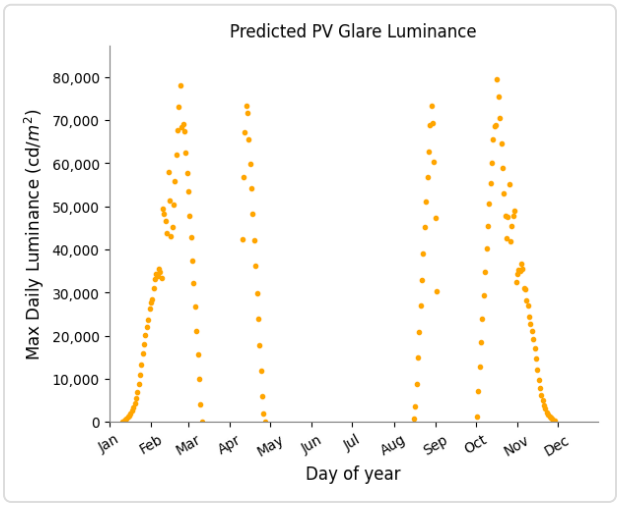








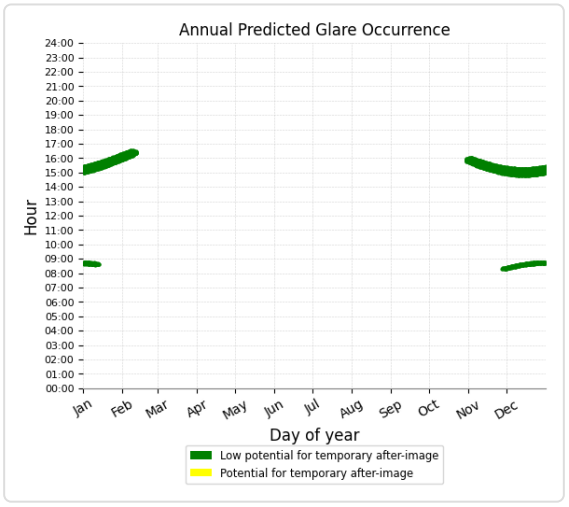


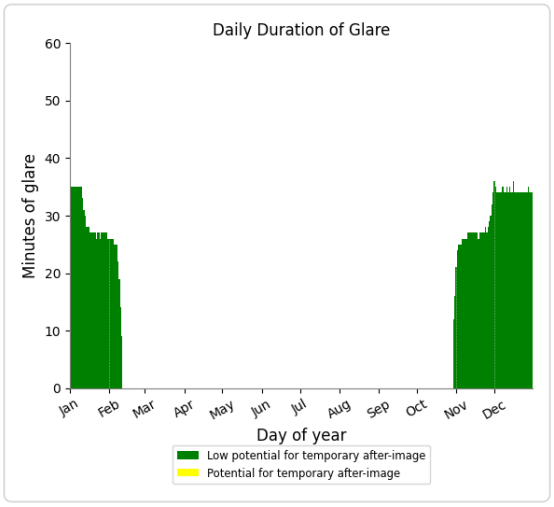


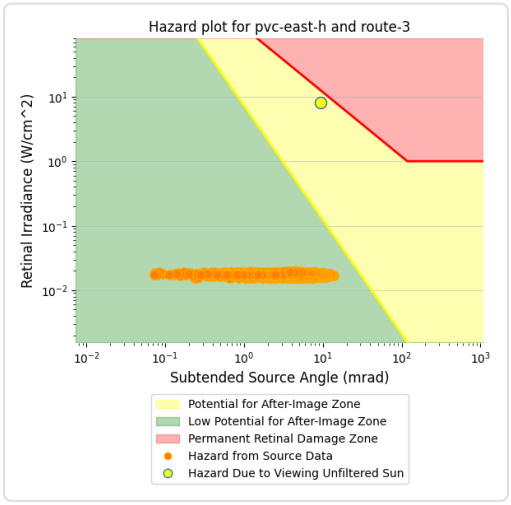
PVC east H and Route: Route 3

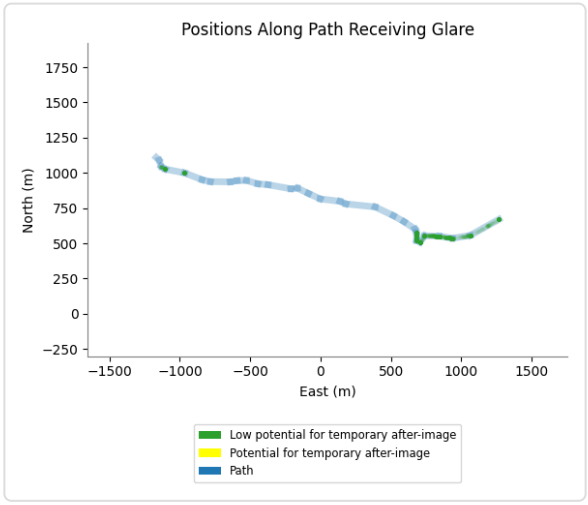
Yellow glare: none

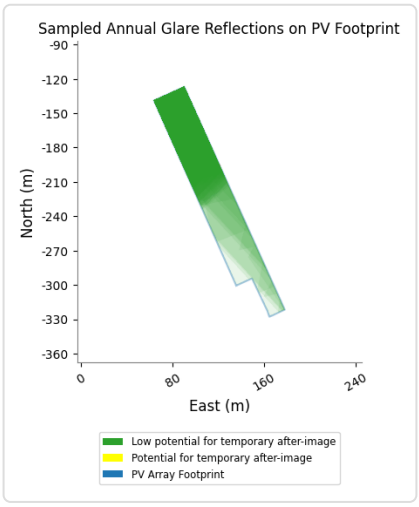
Green glare: 3,074 min.

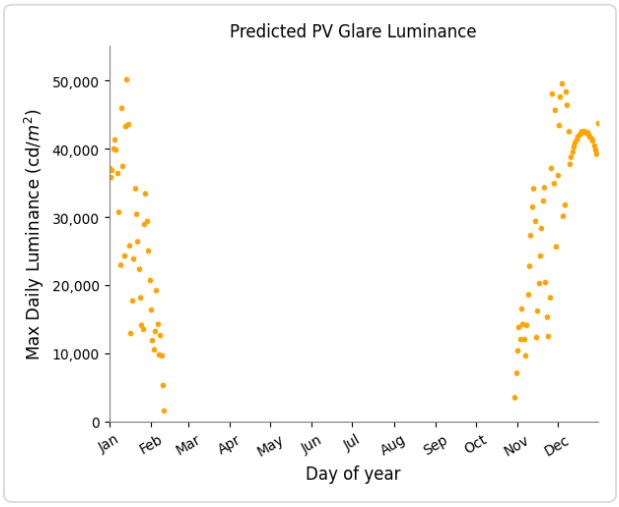








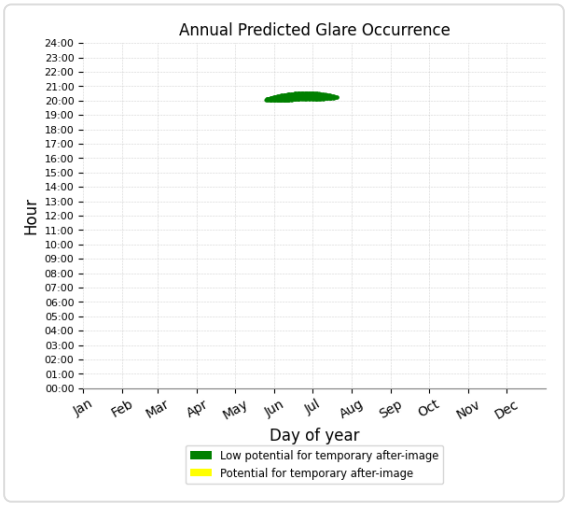


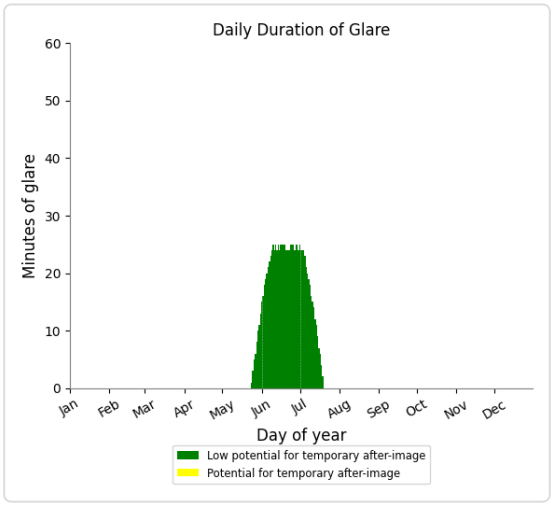


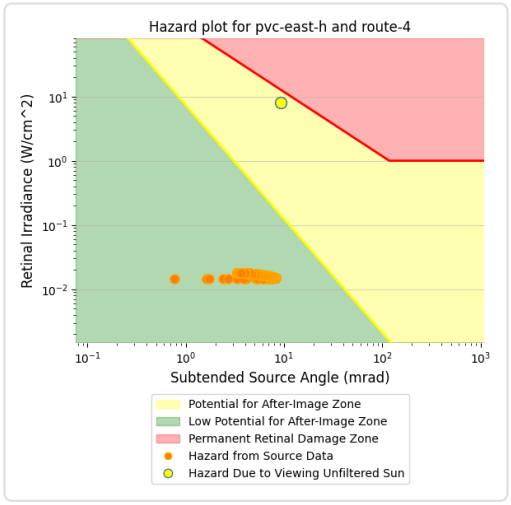
PVC east H and Route: Route 4

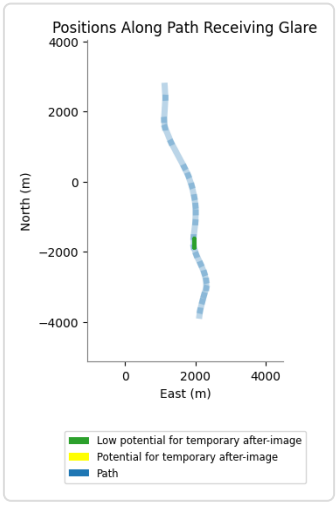
Yellow glare: none

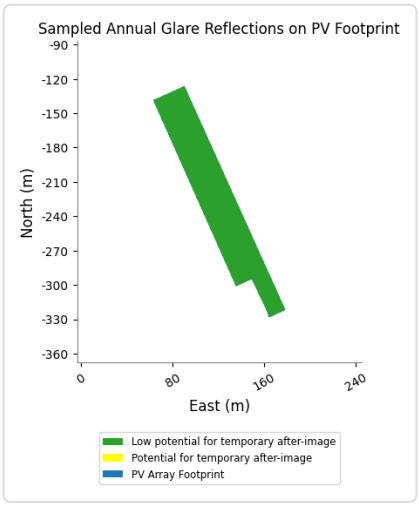
Green glare: 1,045 min.

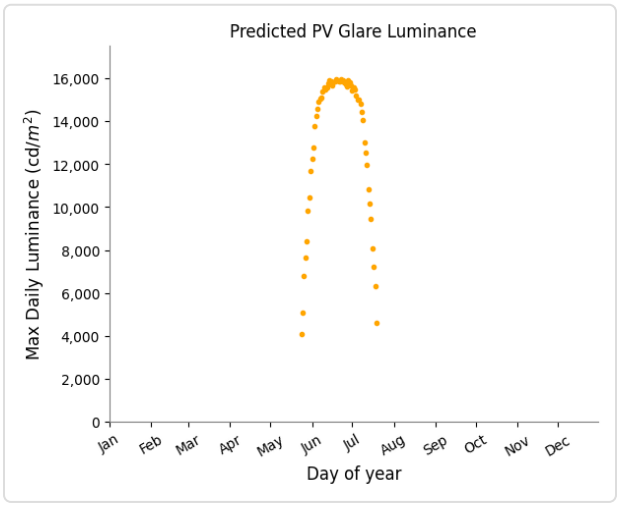








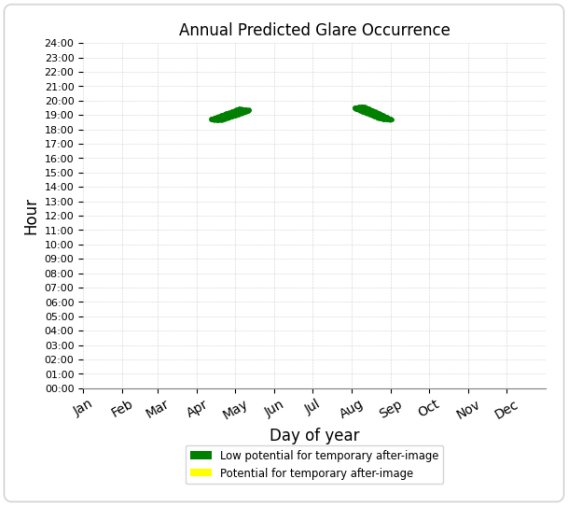


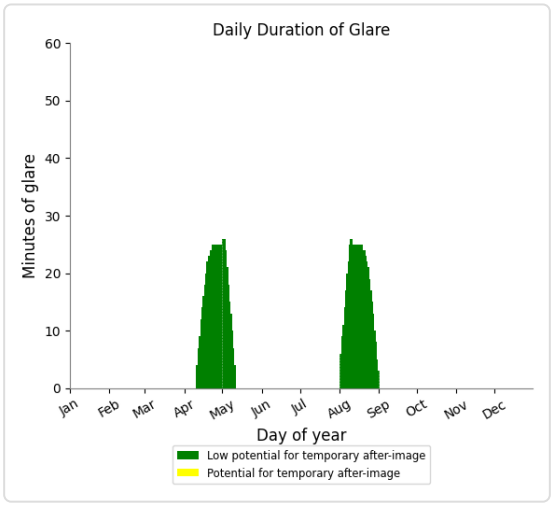


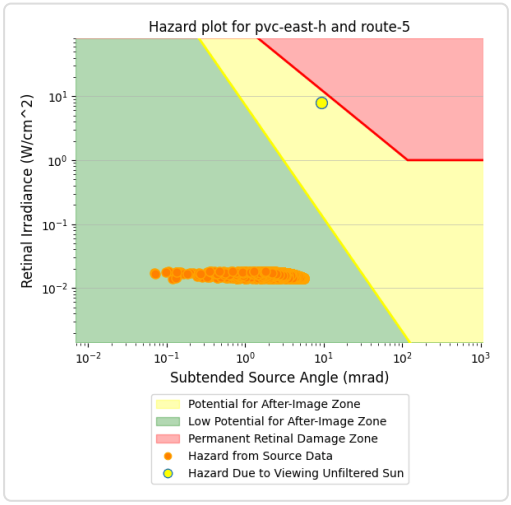
PVC east H and Route: Route 5

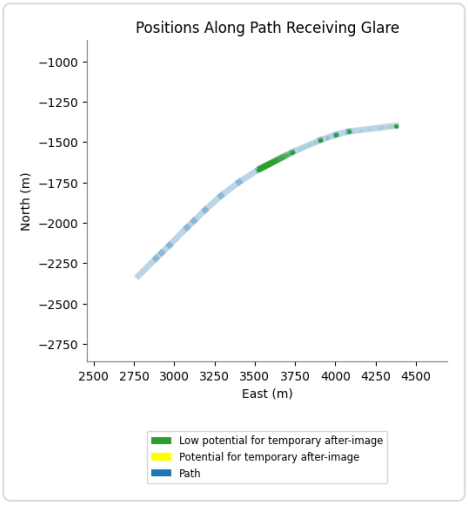
Yellow glare: none

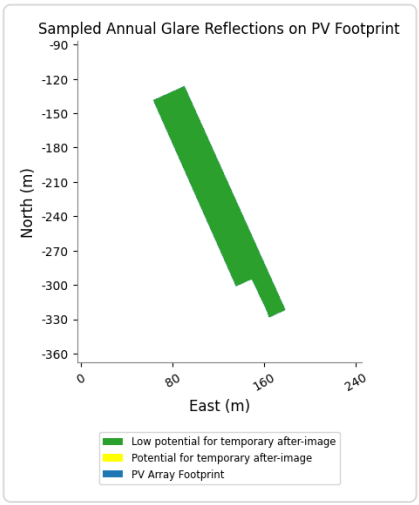
Green glare: 1,162 min.

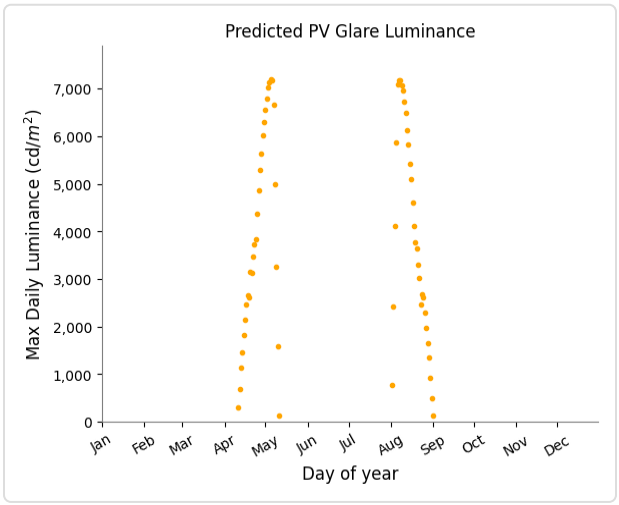












PVC east H and FP: FP 1

No glare found

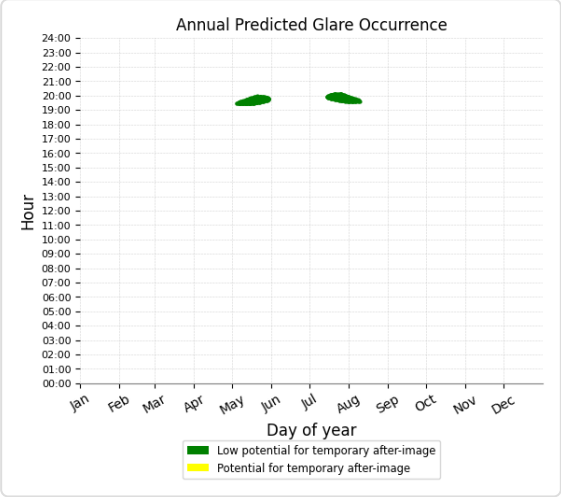
PVC east H and FP: FP 2

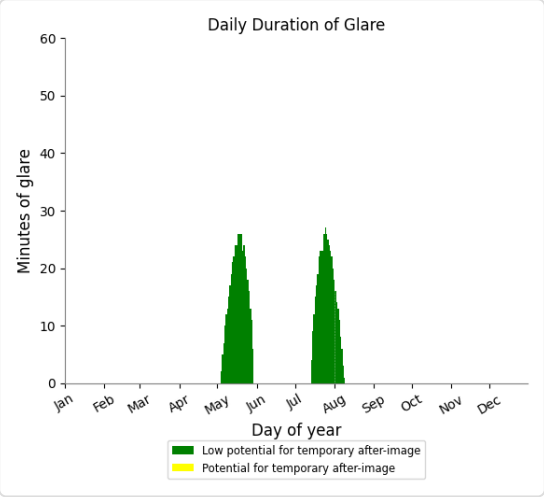
No glare found

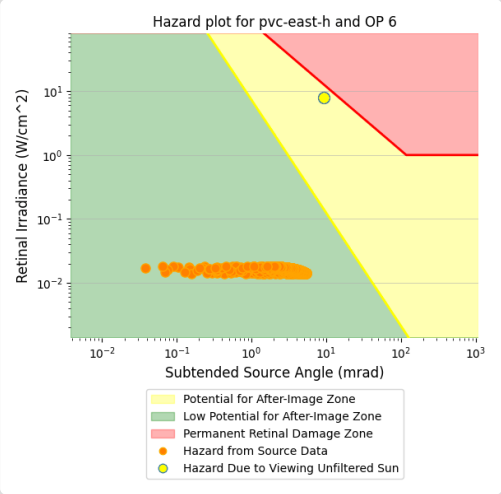
PVC east H and OP 6

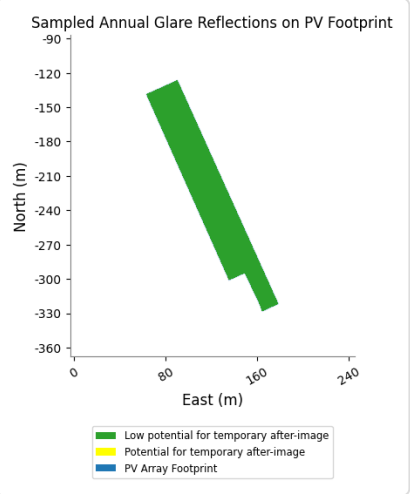
Yellow glare: none

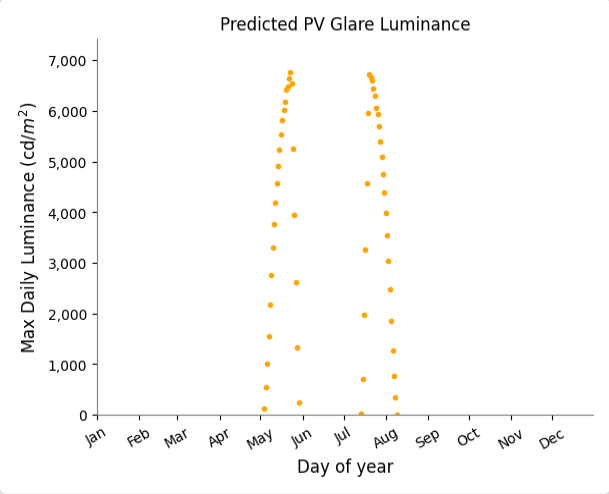
Green glare: 898 min.







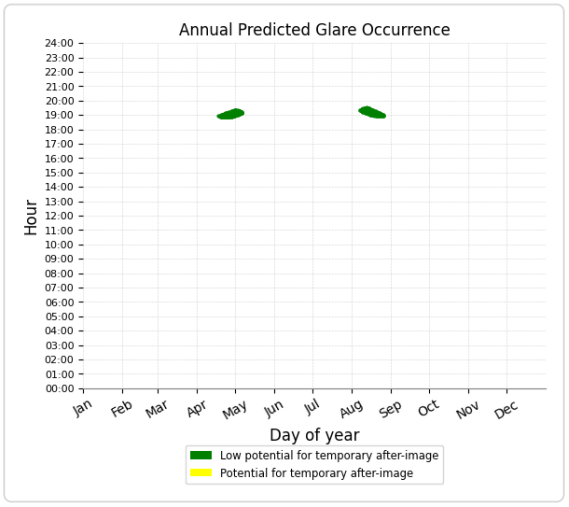


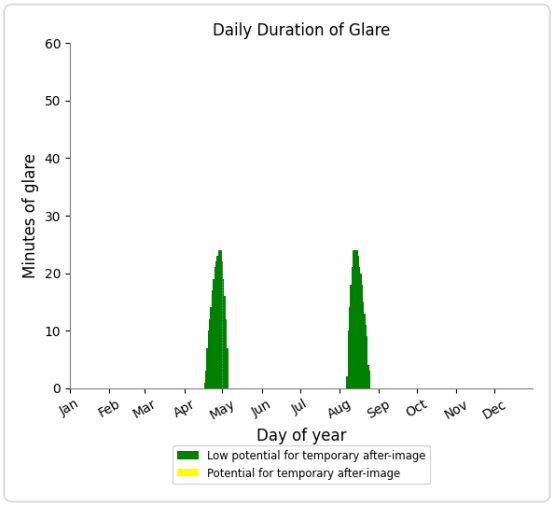


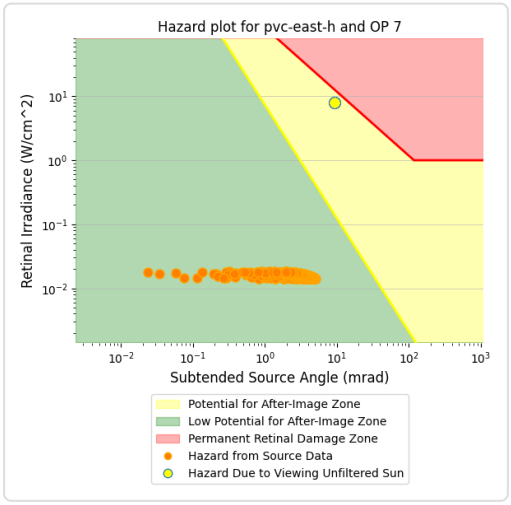
PVC east H and OP 7

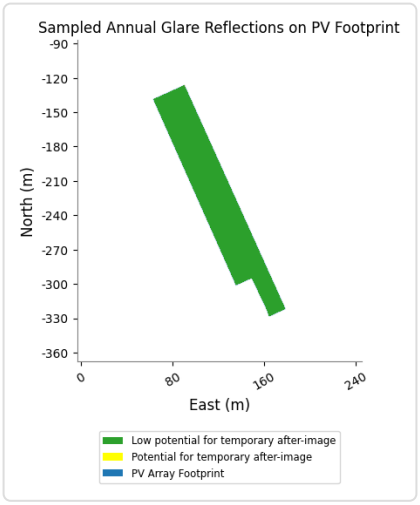
Yellow glare: none

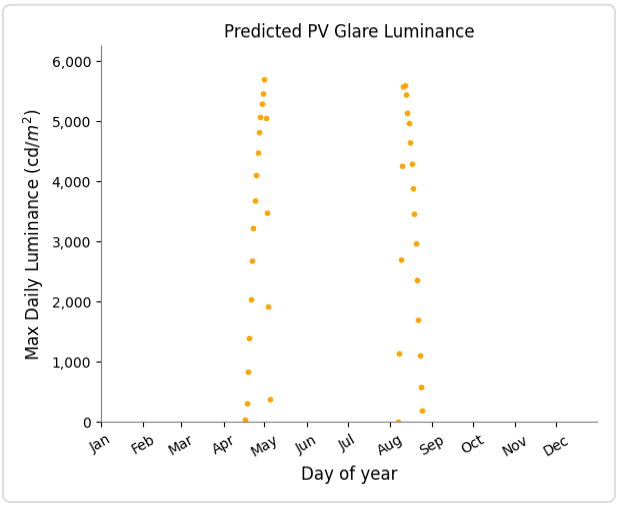
Green glare: 595 min.







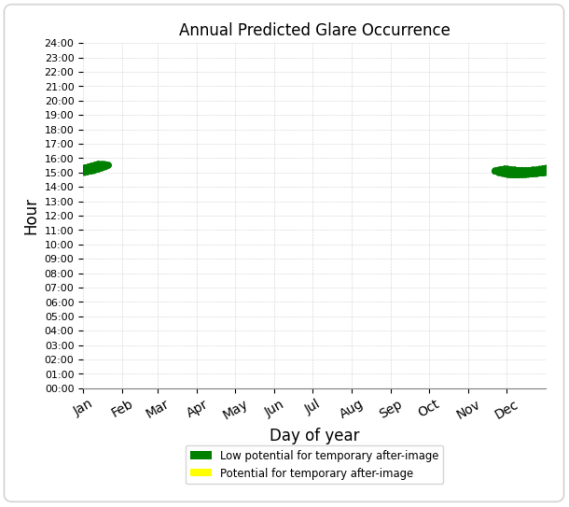


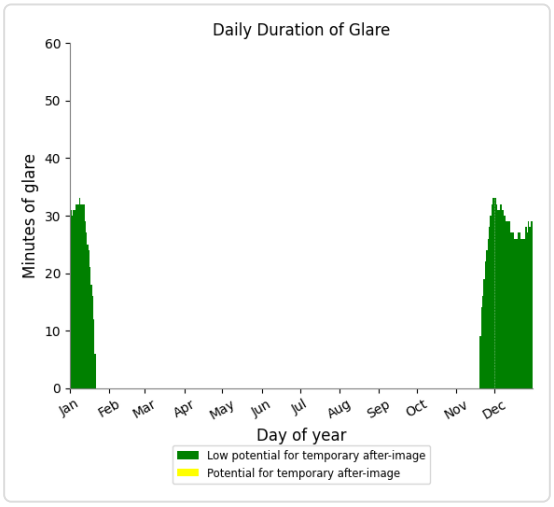


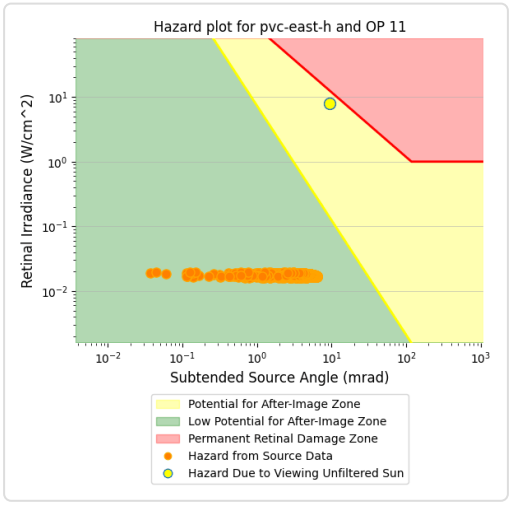
PVC east H and OP 11

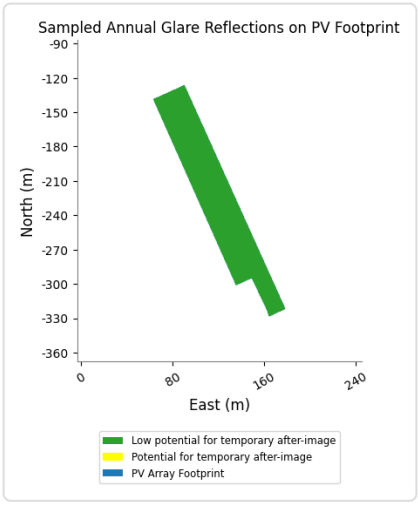
Yellow glare: none

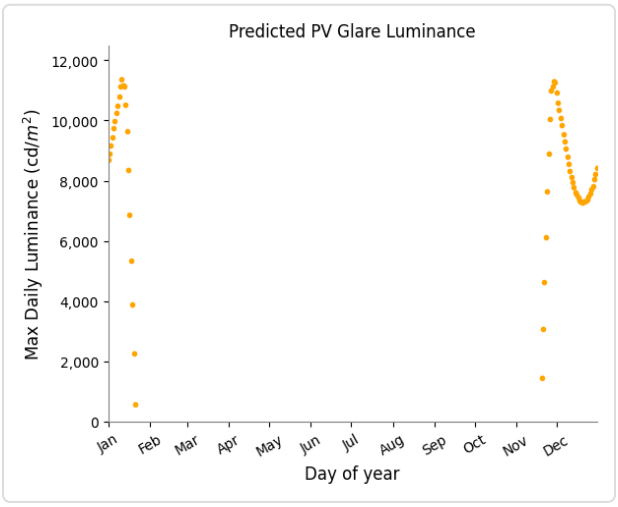
Green glare: 1,696 min.











PVC east H and OP 1

No glare found

PVC east H and OP 2

No glare found

PVC east H and OP 3

No glare found

PVC east H and OP 4

No glare found

PVC east H and OP 5

No glare found

PVC east H and OP 8

No glare found

PVC east H and OP 9

No glare found

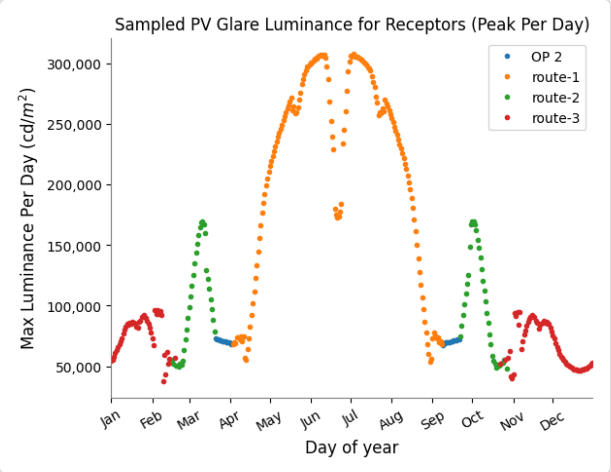
PVC east H and OP 10

No glare found

PV: PVC east L potential temporary after-image

Receptor results ordered by category of glare

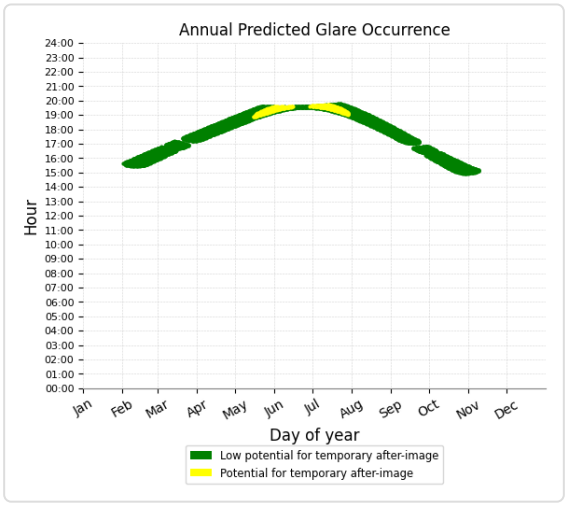
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	8,532	142.2	659	11.0	307,616
Route 2	5,319	88.7	0	0.0	169,816
Route 3	6,562	109.4	0	0.0	96,507
Route 4	3,596	59.9	0	0.0	41,112
Route 5	2,600	43.3	0	0.0	10,653
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 2	2,368	39.5	0	0.0	73,691
OP 3	2,706	45.1	0	0.0	72,104
OP 4	2,261	37.7	0	0.0	63,090
OP 6	2,130	35.5	0	0.0	8,826
OP 7	1,421	23.7	0	0.0	8,438
OP 11	1,819	30.3	0	0.0	19,948
OP 1	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0

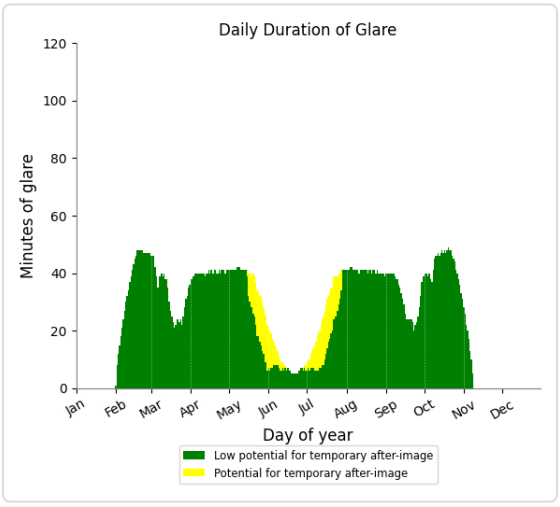


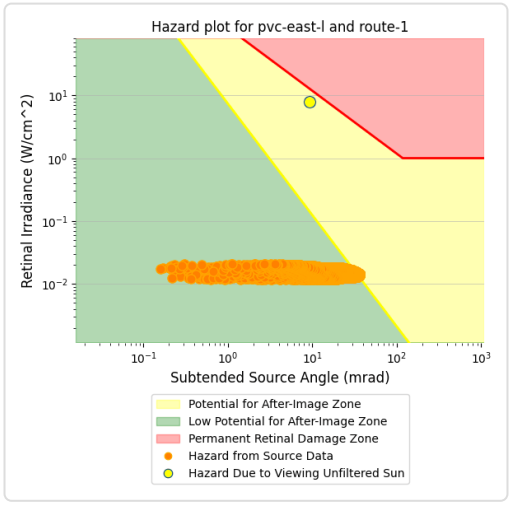
PVC east L and Route: Route 1

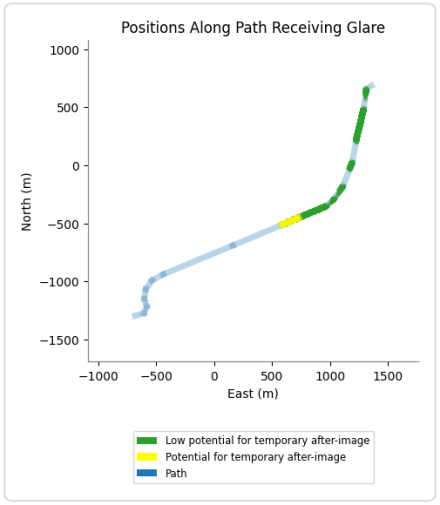
Yellow glare: 659 min.

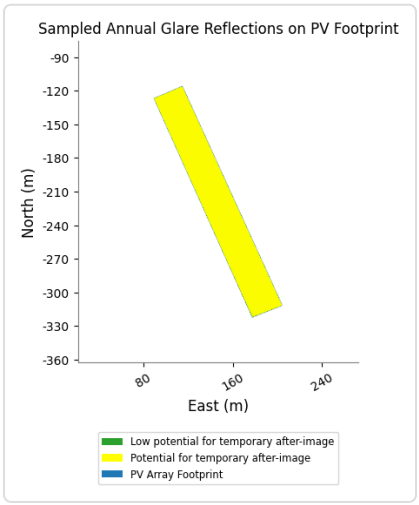
Green glare: 8,532 min.

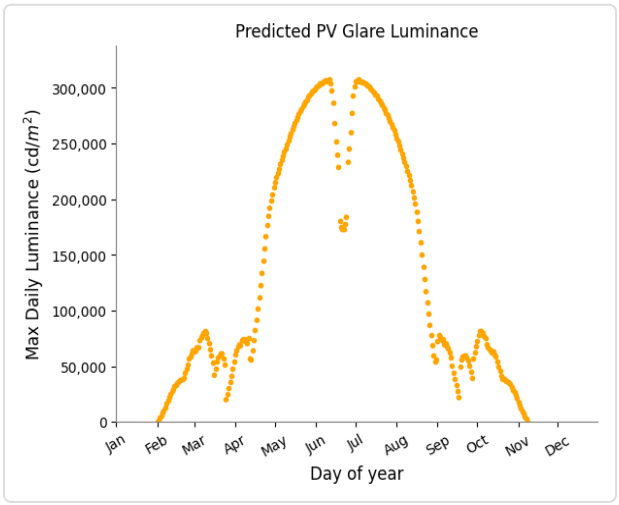








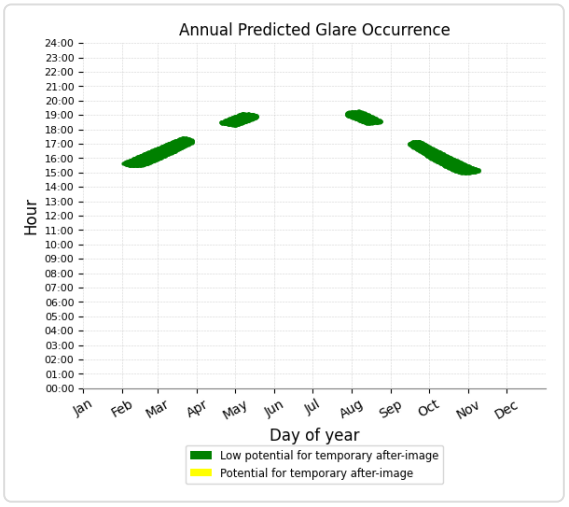


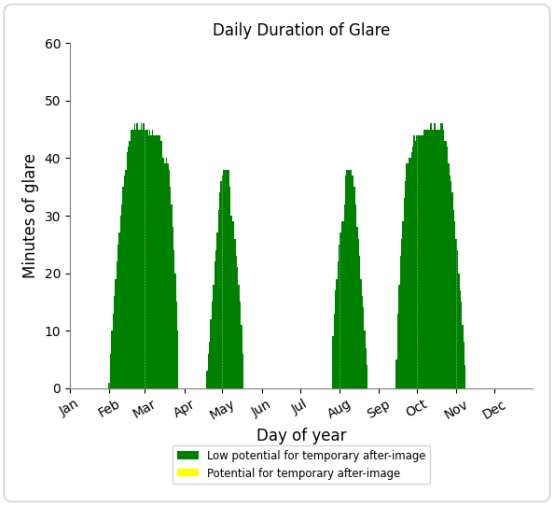


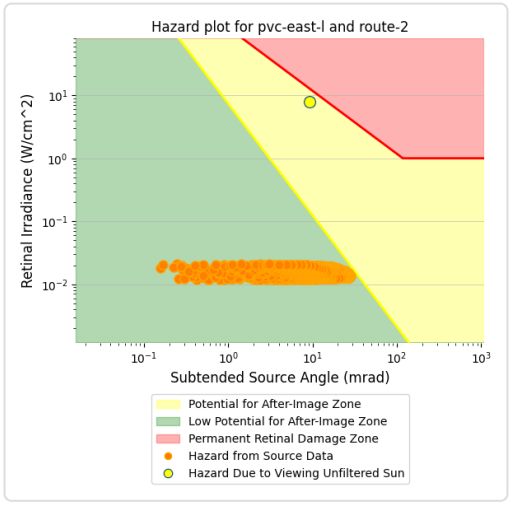
PVC east L and Route: Route 2

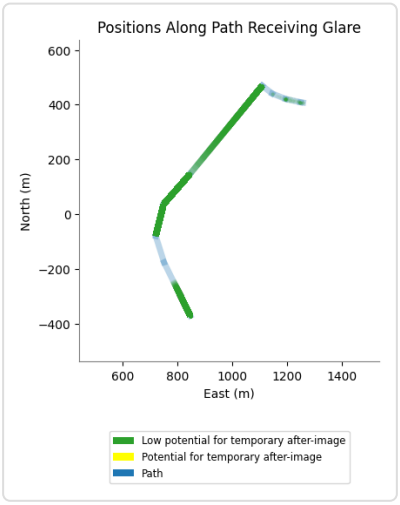
Yellow glare: none

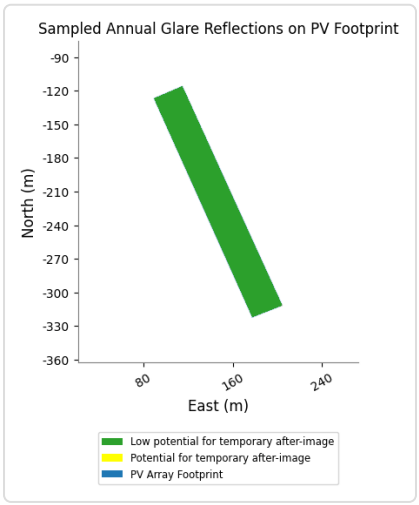
Green glare: 5,319 min.

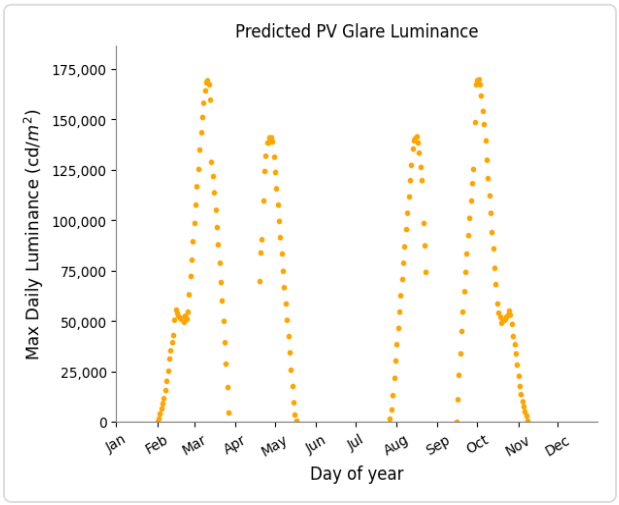








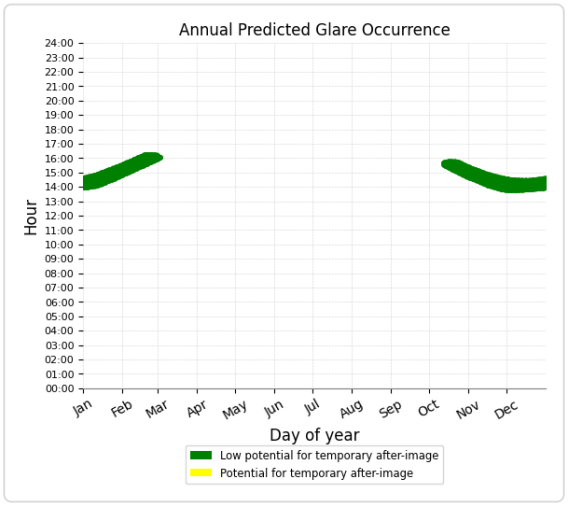


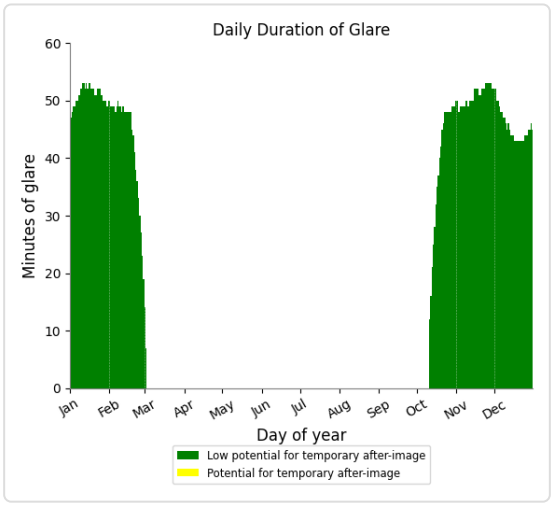


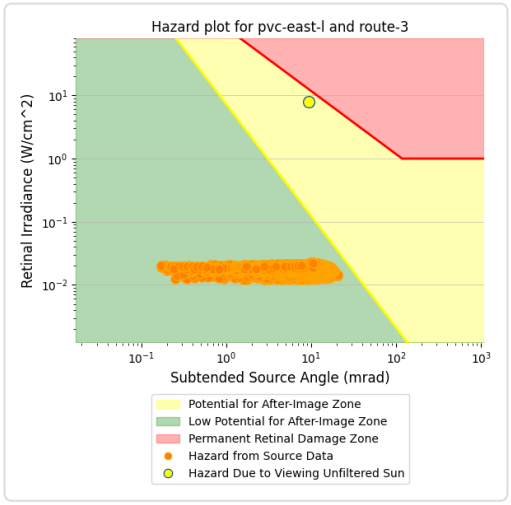
PVC east L and Route: Route 3

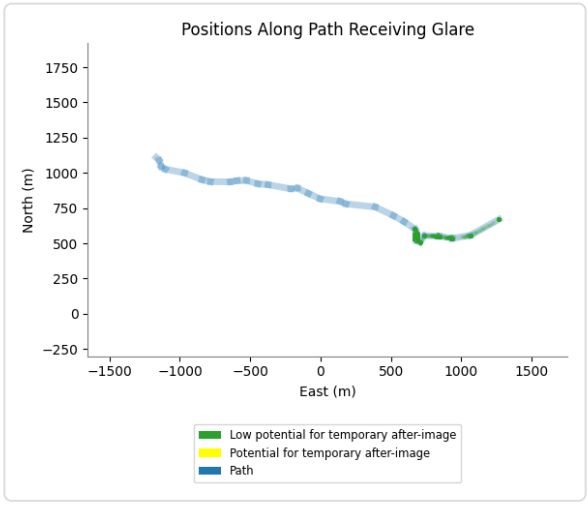
Yellow glare: none

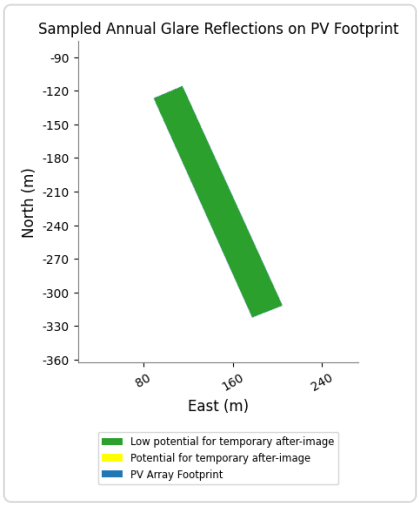
Green glare: 6,562 min.

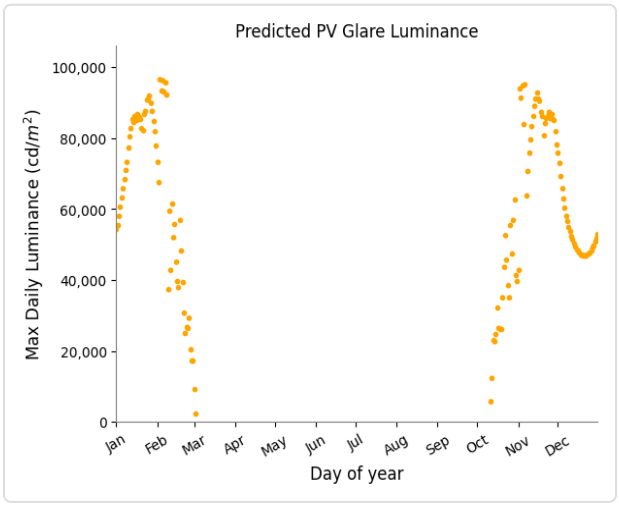








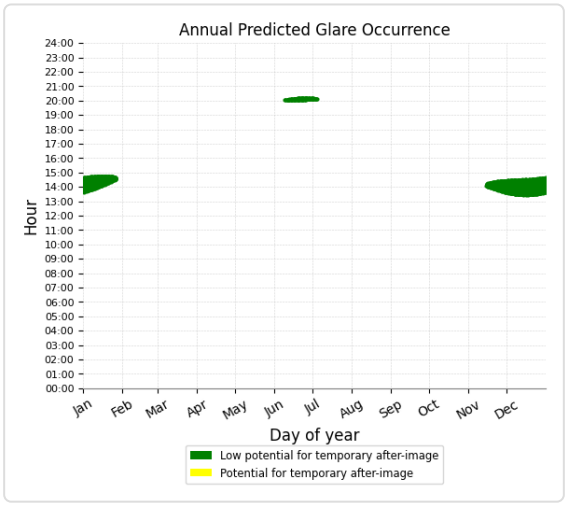


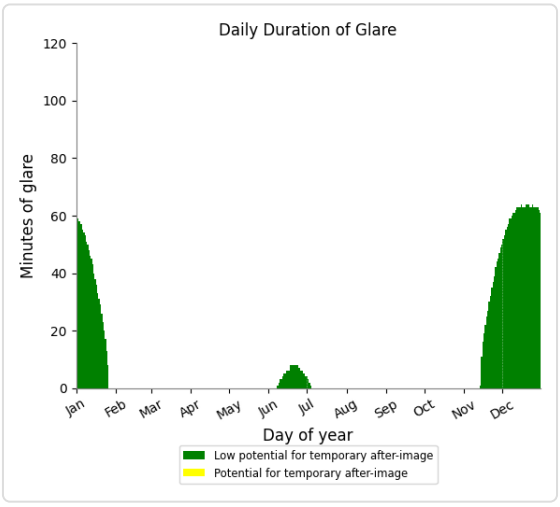


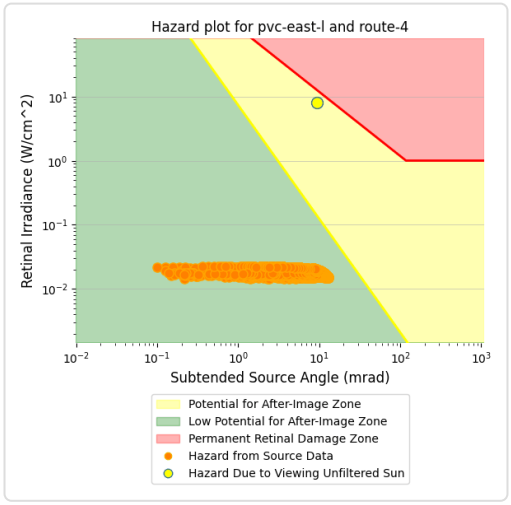
PVC east L and Route: Route 4

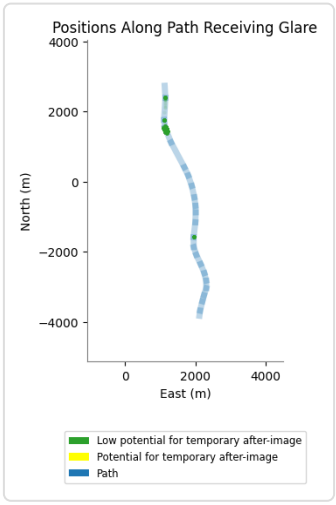
Yellow glare: none

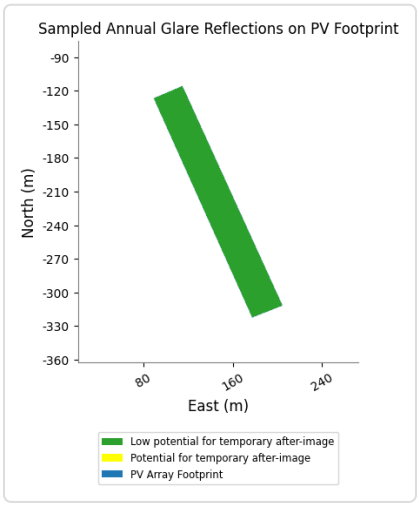
Green glare: 3,596 min.

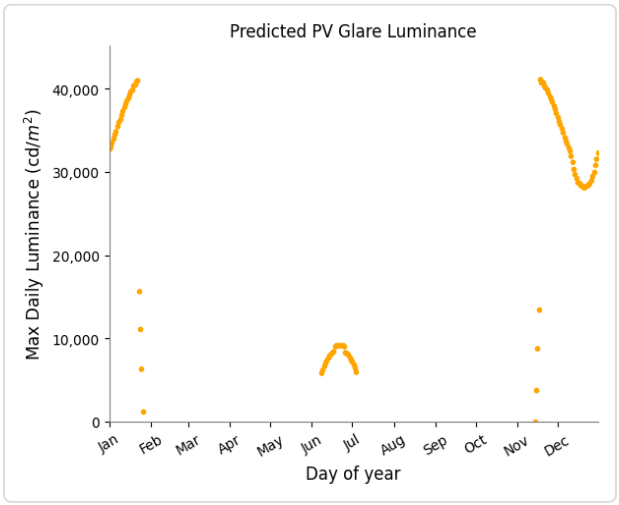








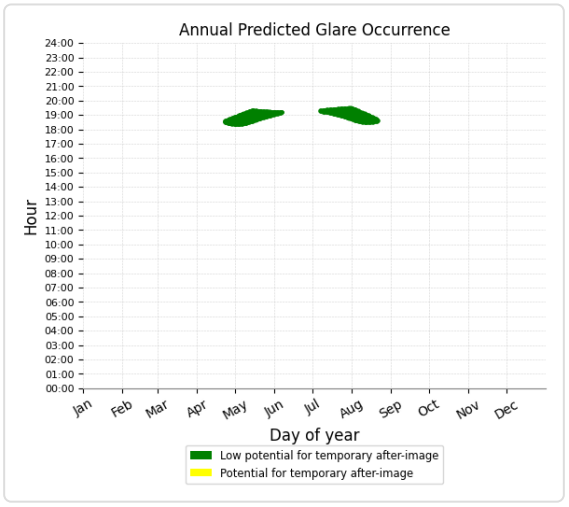


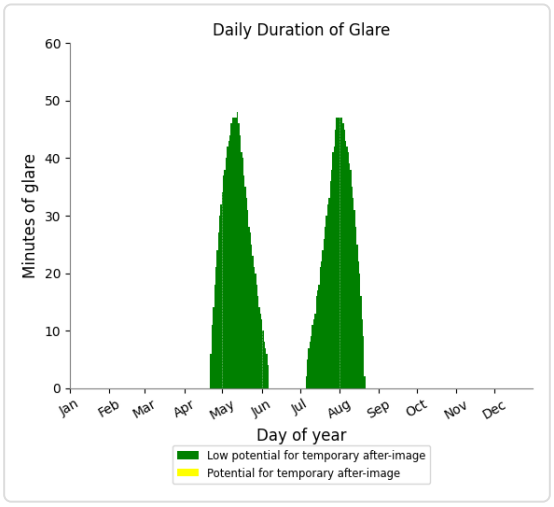


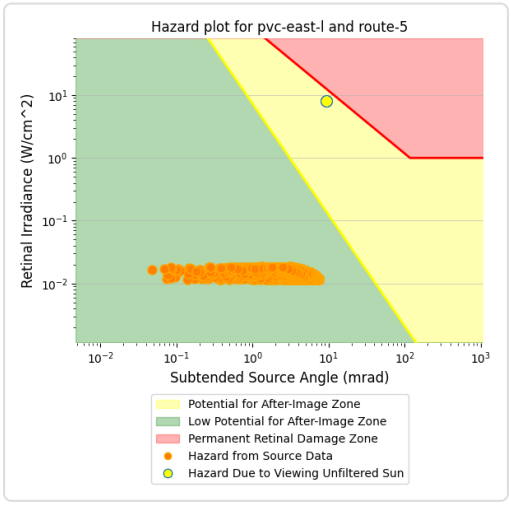
PVC east L and Route: Route 5

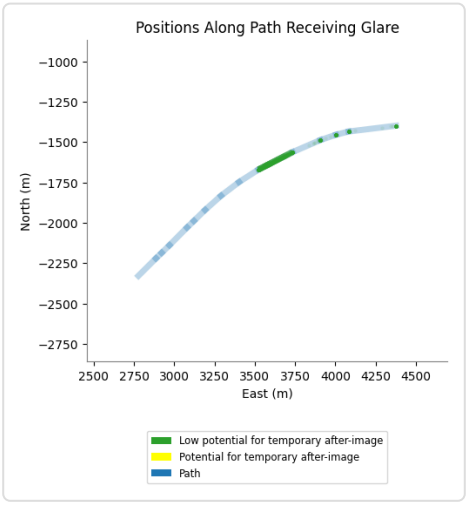
Yellow glare: none

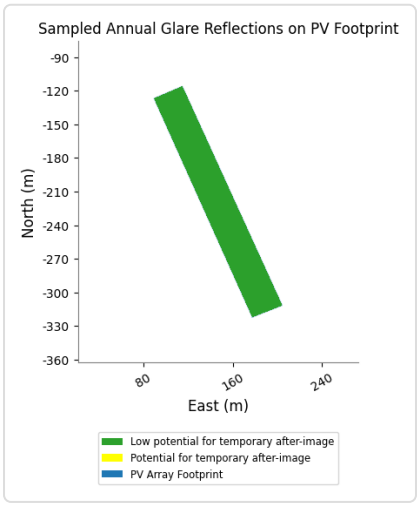
Green glare: 2,600 min.

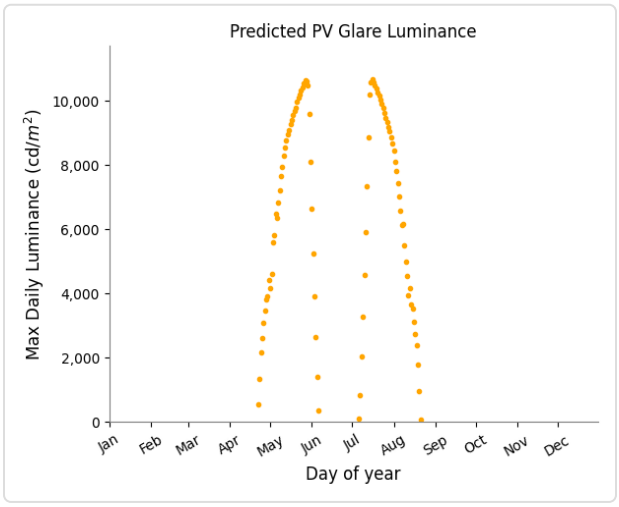












PVC east L and FP: FP 1

No glare found

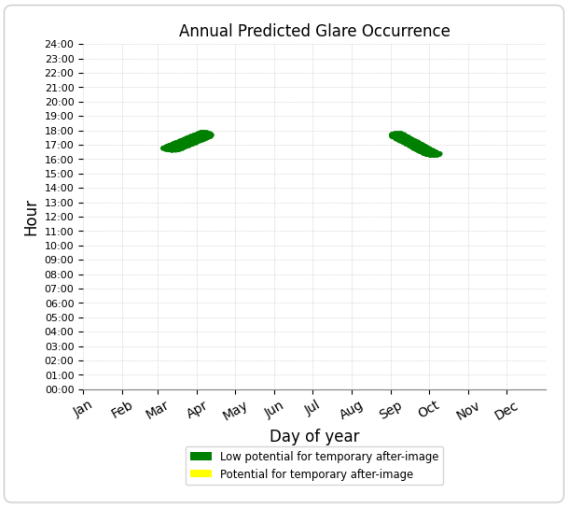
PVC east L and FP: FP 2

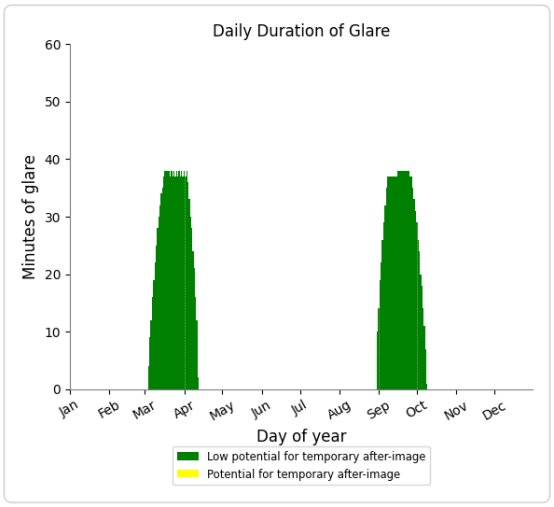
No glare found

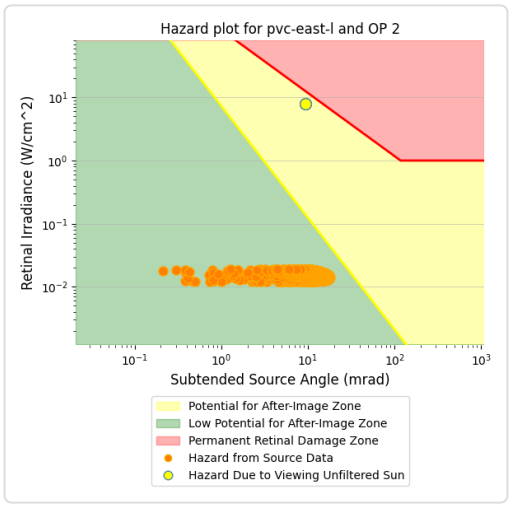
PVC east L and OP 2

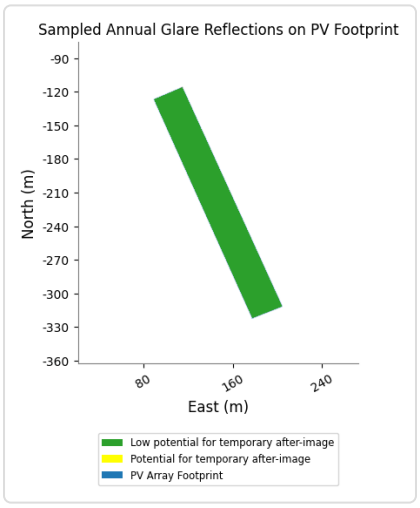
Yellow glare: none

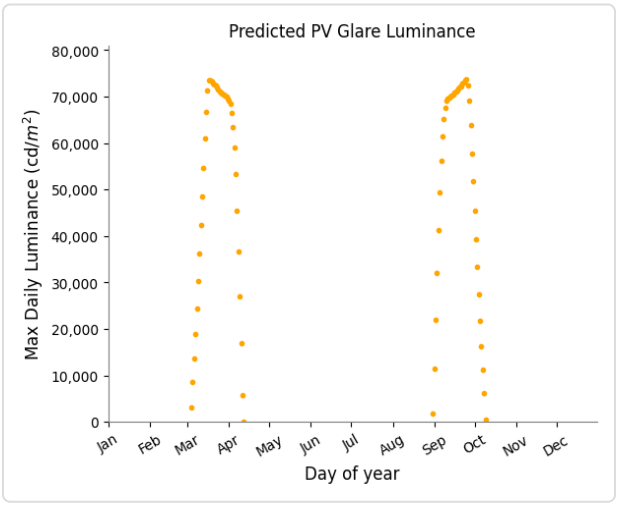
Green glare: 2,368 min.







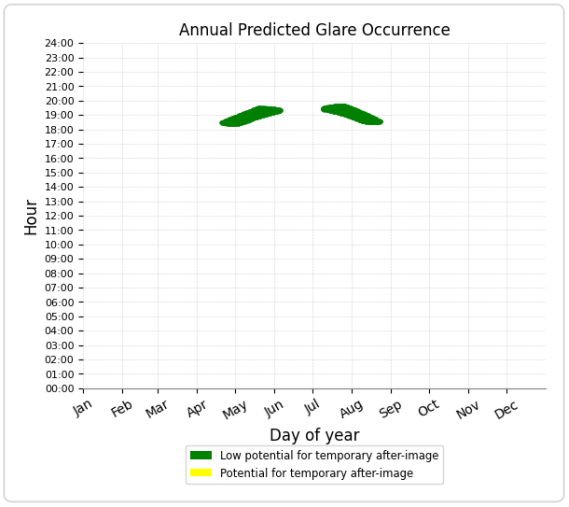


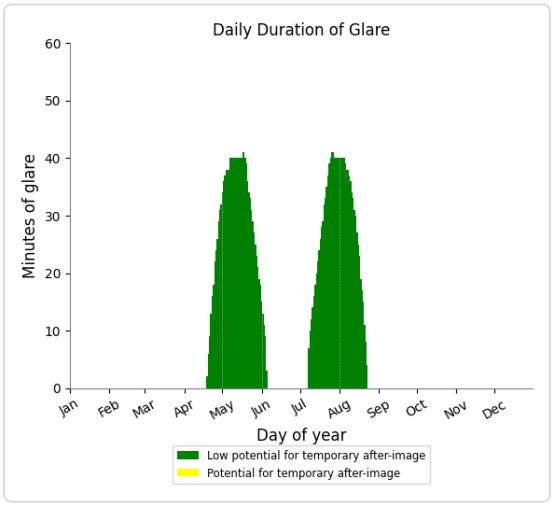


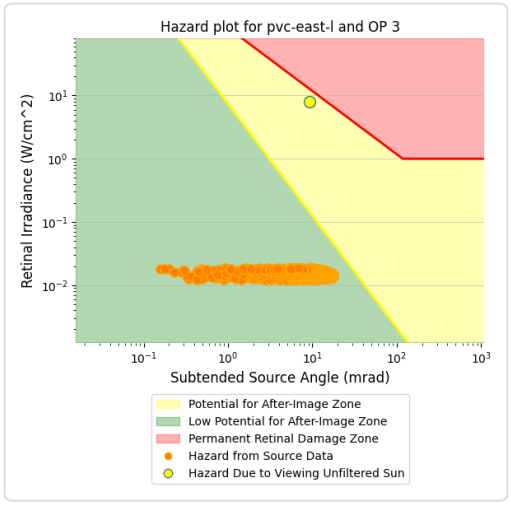
PVC east L and OP 3

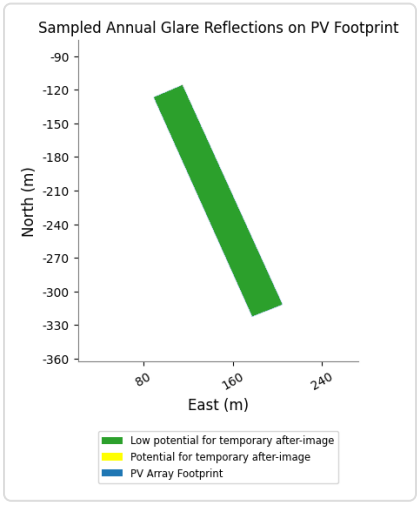
Yellow glare: none

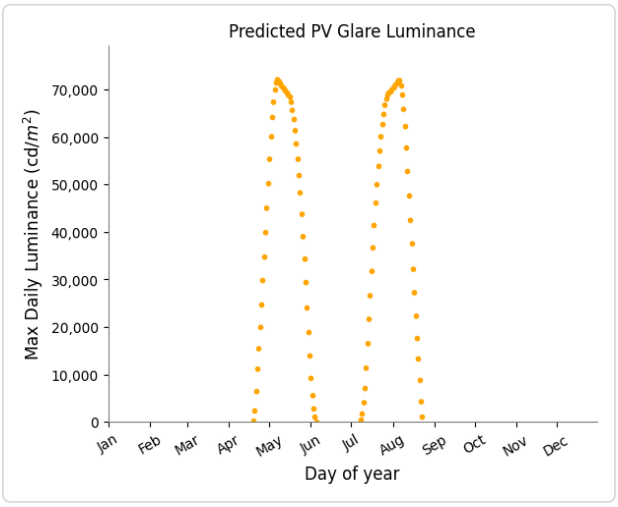
Green glare: 2,706 min.







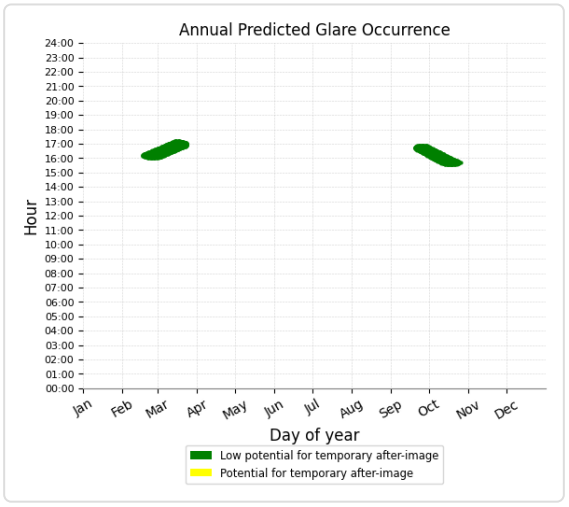


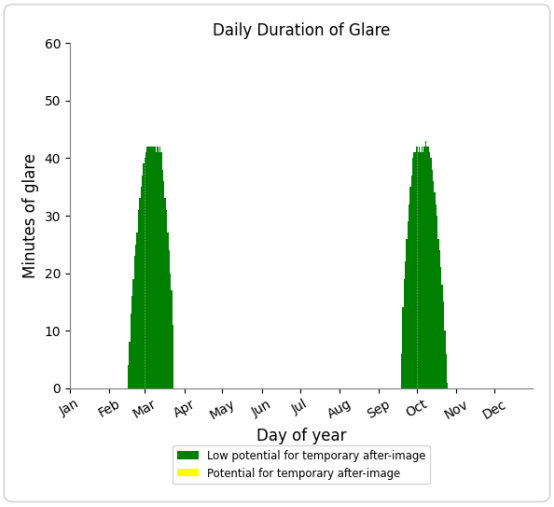


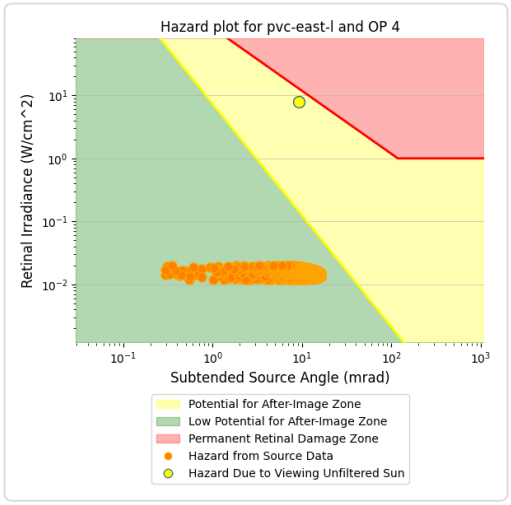
PVC east L and OP 4

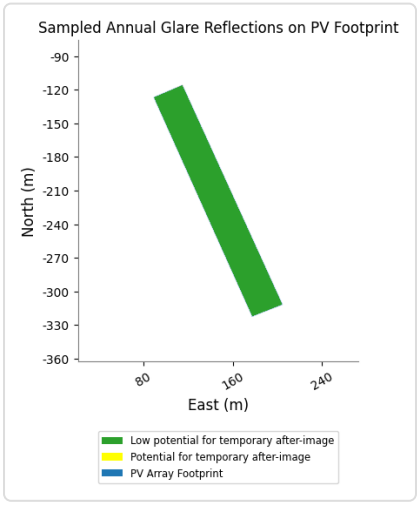
Yellow glare: none

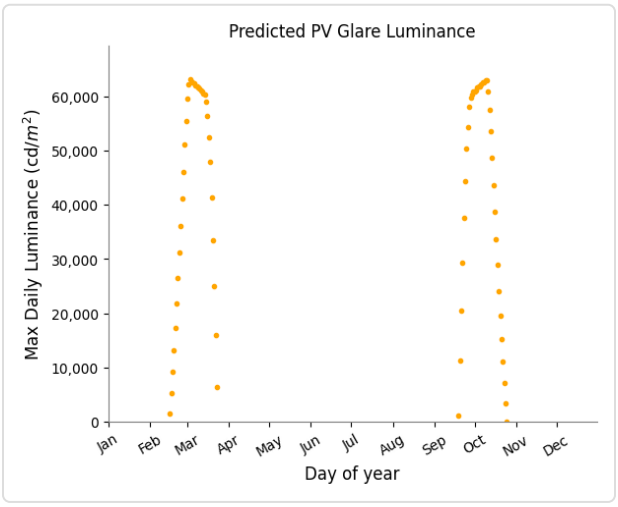
Green glare: 2,261 min.







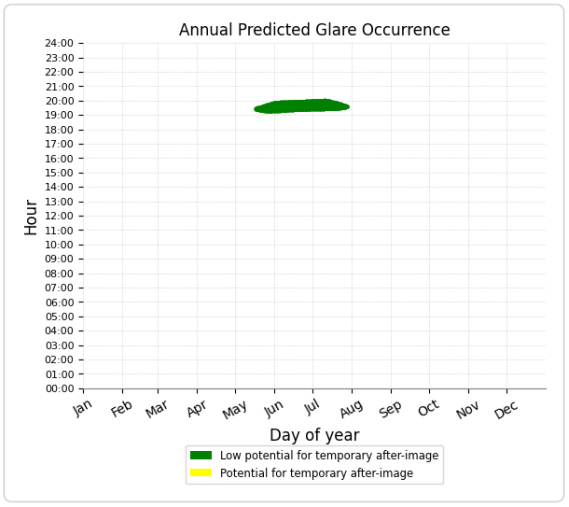


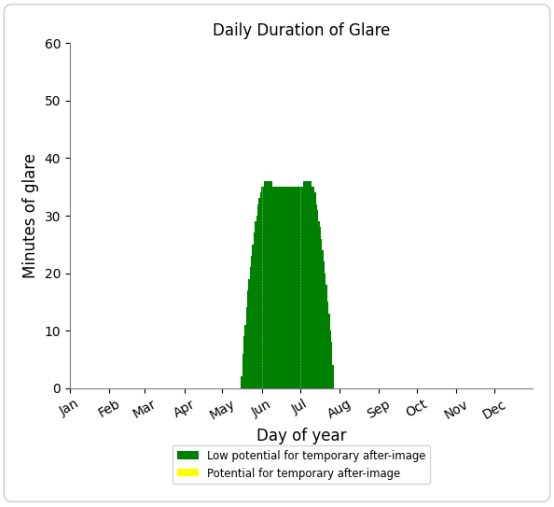


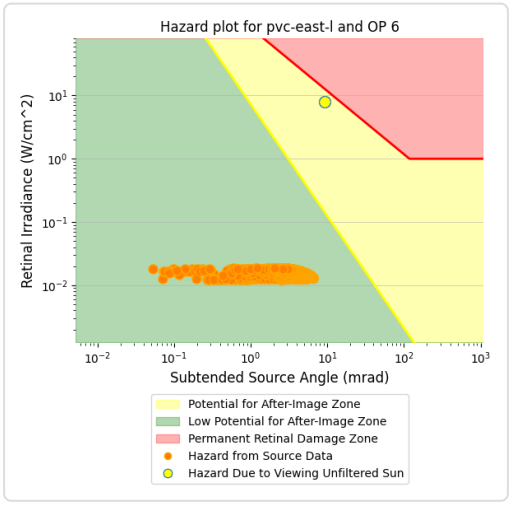
PVC east L and OP 6

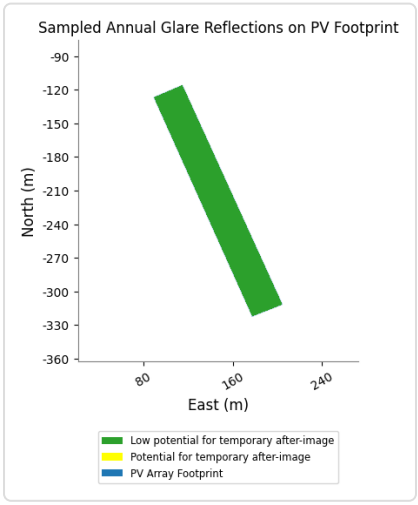
Yellow glare: none

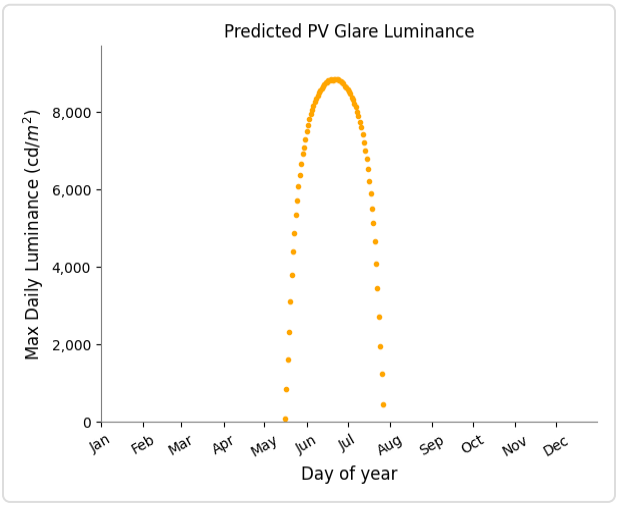
Green glare: 2,130 min.







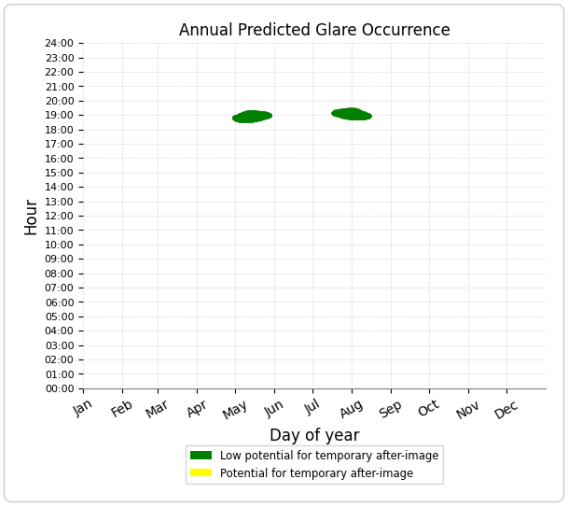


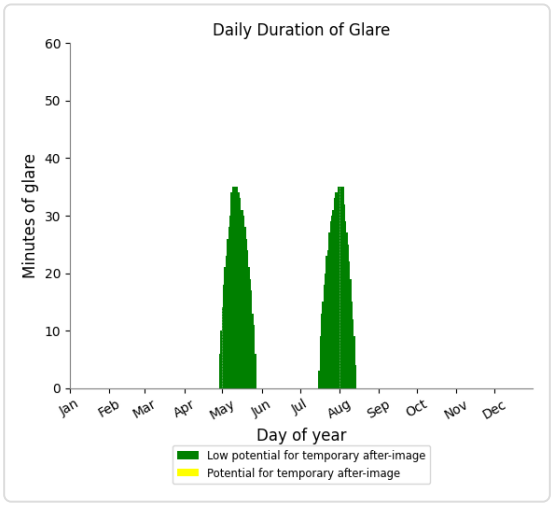


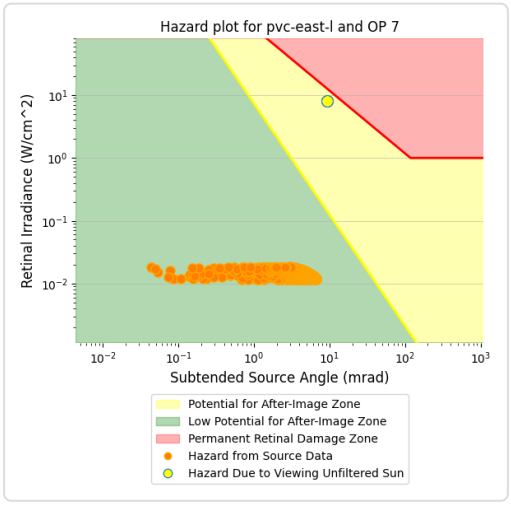
PVC east L and OP 7

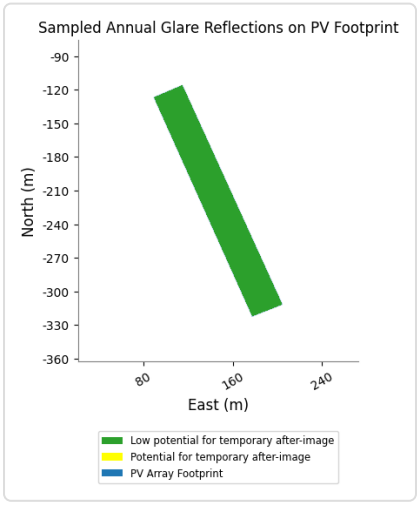
Yellow glare: none

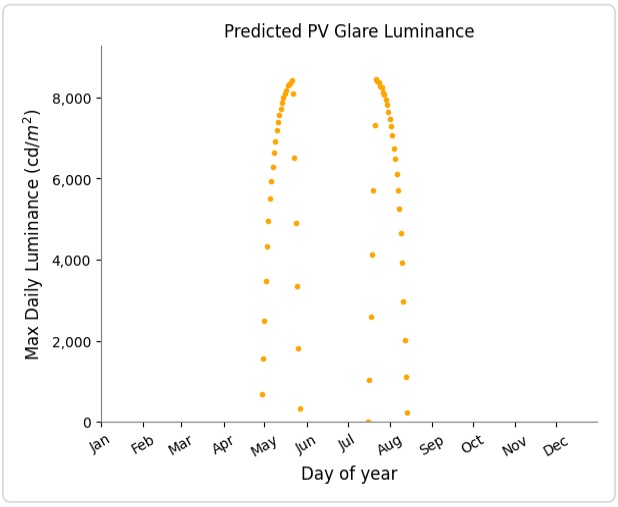
Green glare: 1,421 min.







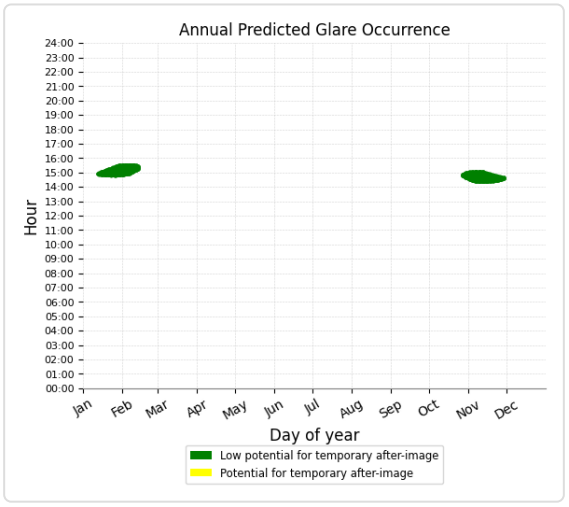


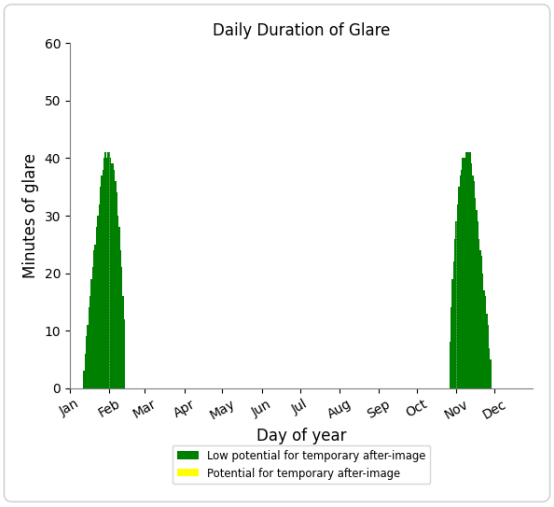


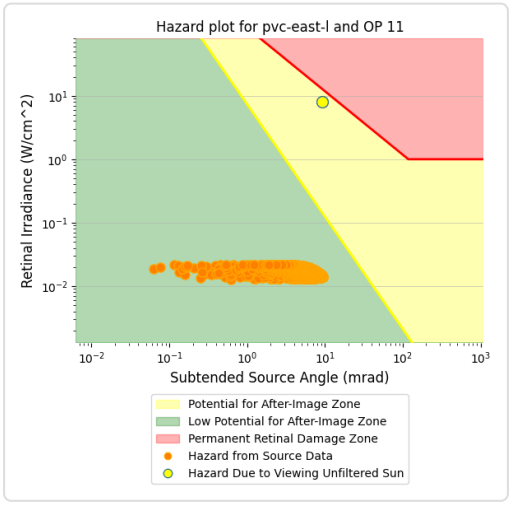
PVC east L and OP 11

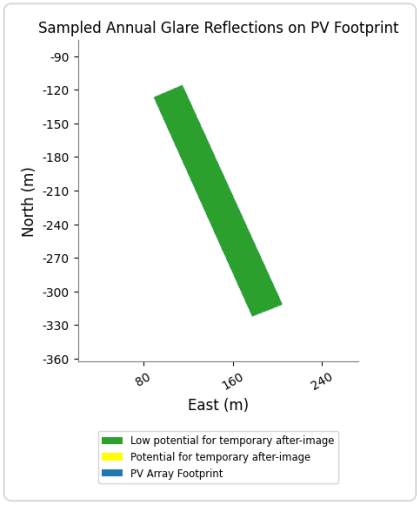
Yellow glare: none

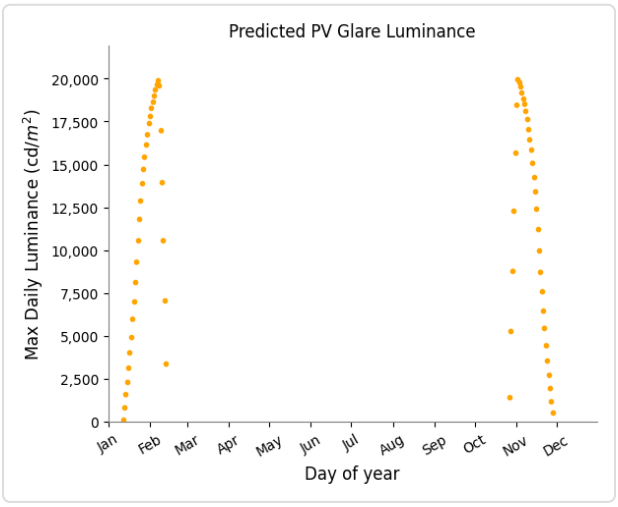
Green glare: 1,819 min.











PVC east L and OP 1

No glare found

PVC east L and OP 5

No glare found

PVC east L and OP 8

No glare found

PVC east L and OP 9

No glare found

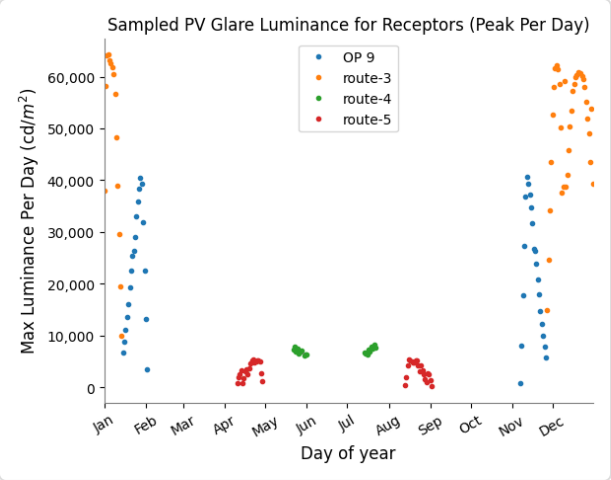
PVC east L and OP 10

No glare found

PV: PVC west H low potential for temporary after-image

Receptor results ordered by category of glare

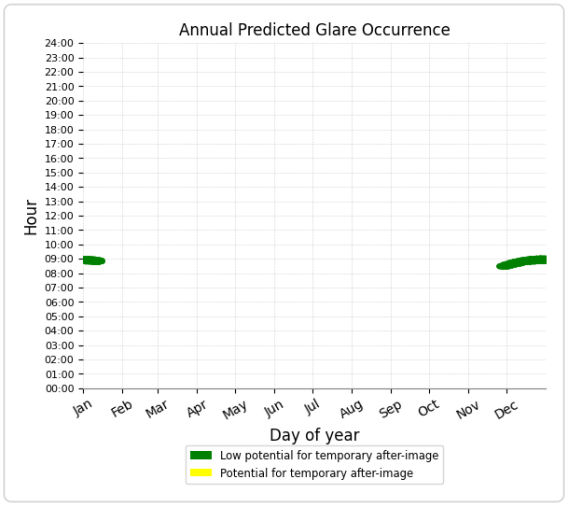
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	1,017	16.9	0	0.0	64,228
Route 4	21	0.3	0	0.0	8,303
Route 5	123	2.0	0	0.0	5,299
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 9	591	9.8	0	0.0	40,660
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0

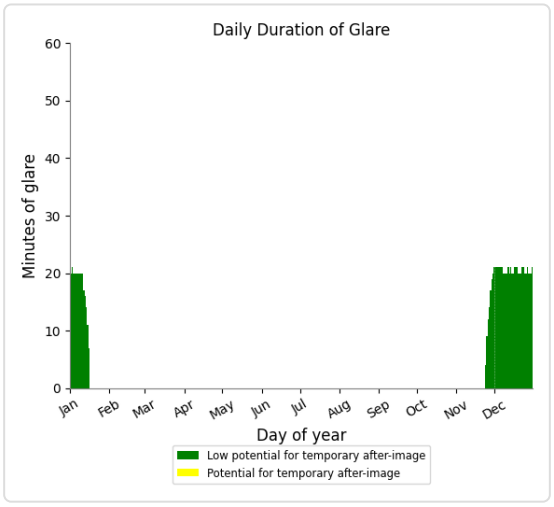


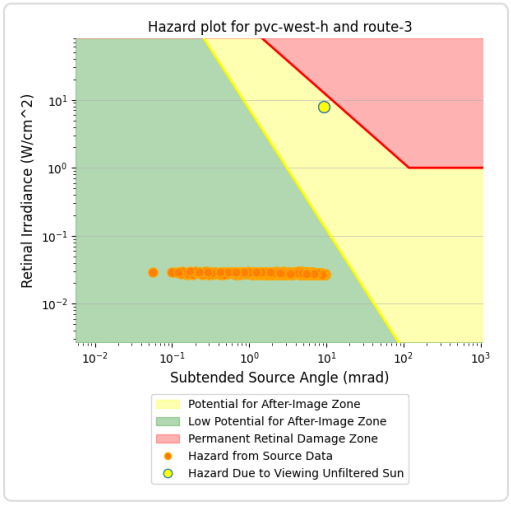
PVC west H and Route: Route 3

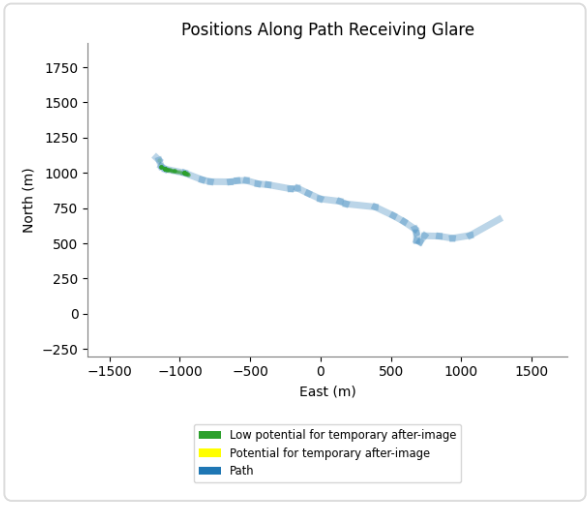
Yellow glare: none

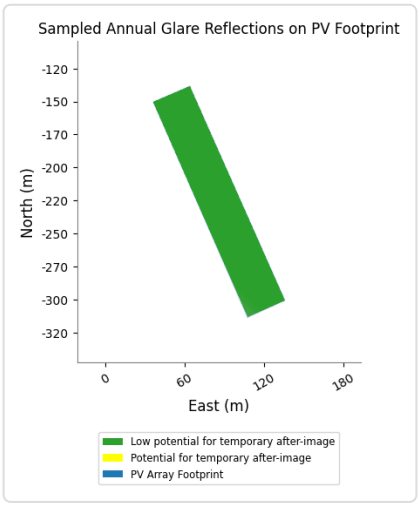
Green glare: 1,017 min.

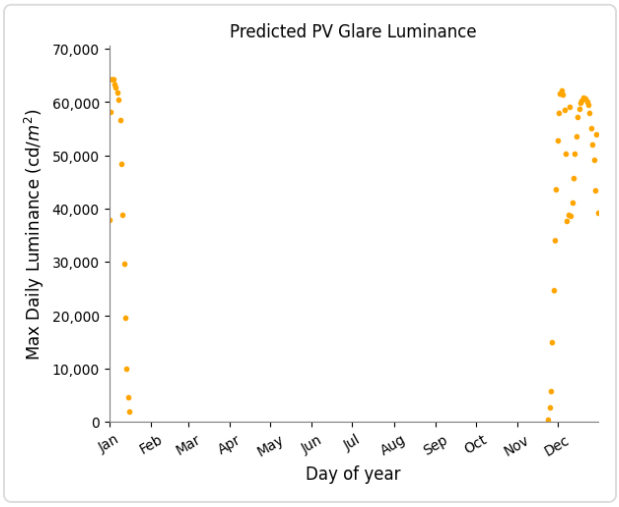








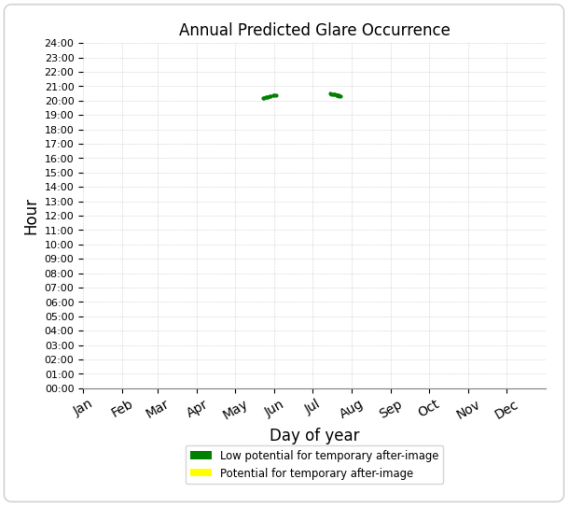


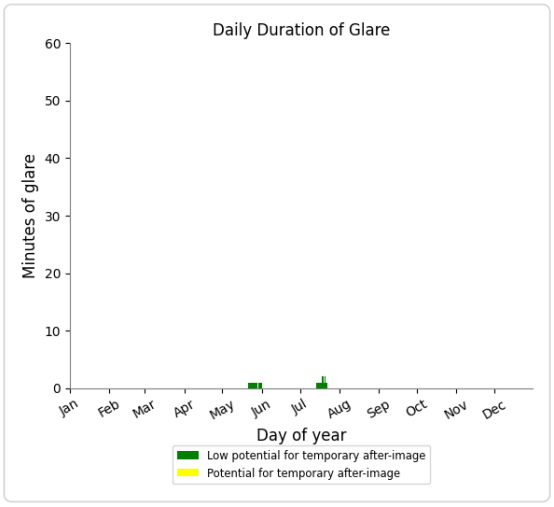


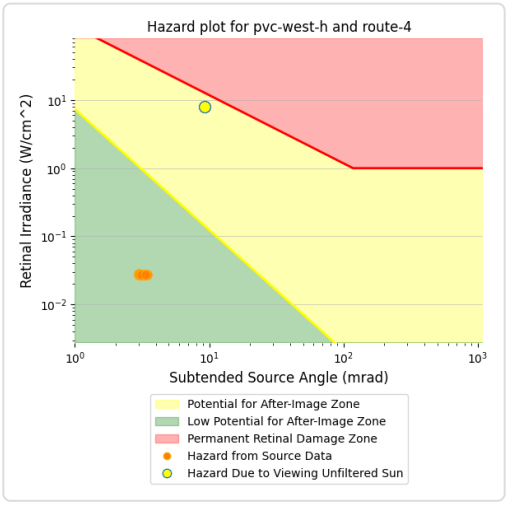
PVC west H and Route: Route 4

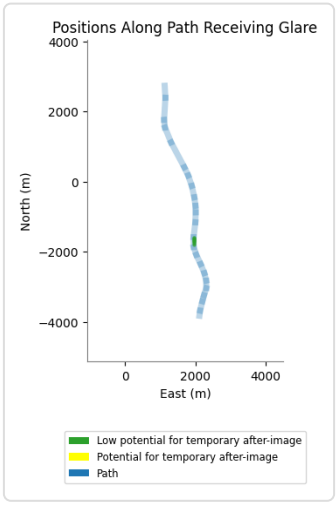
Yellow glare: none

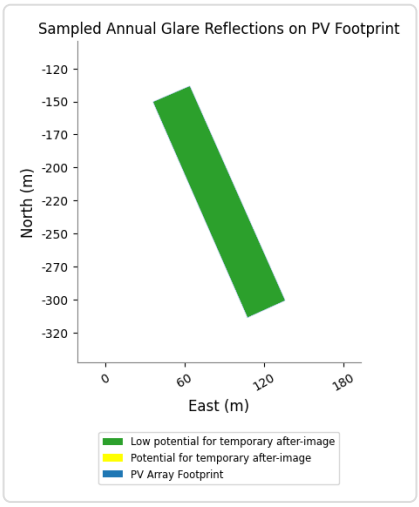
Green glare: 21 min.

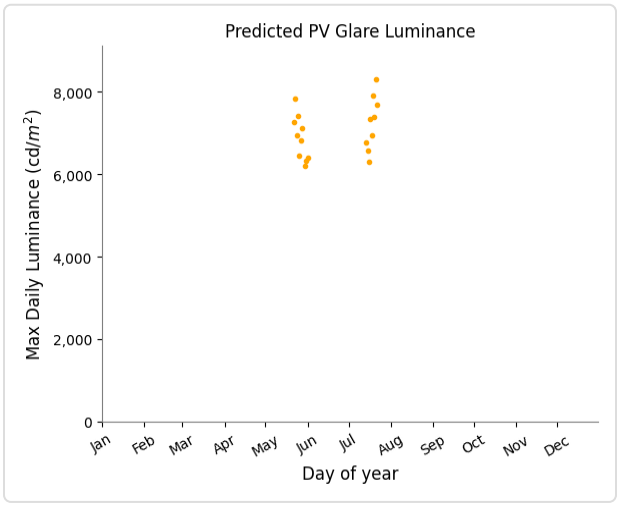








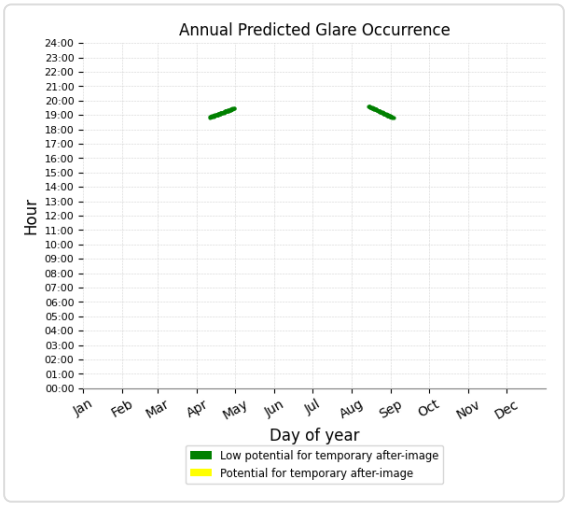


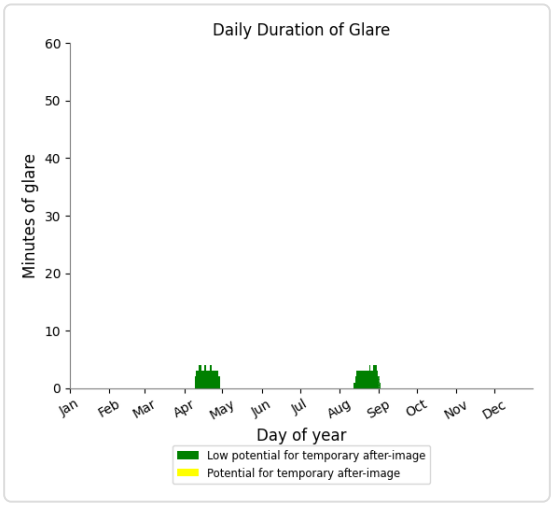


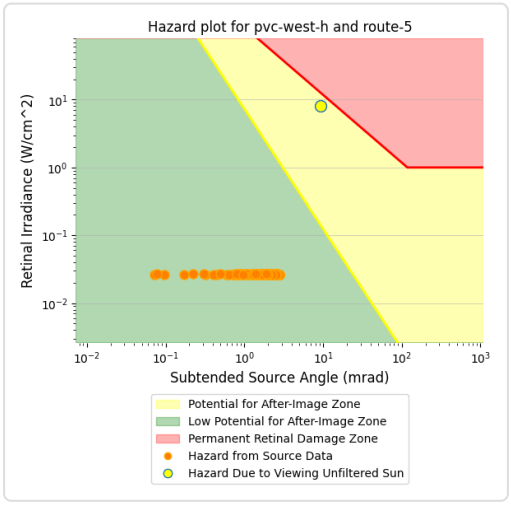
PVC west H and Route: Route 5

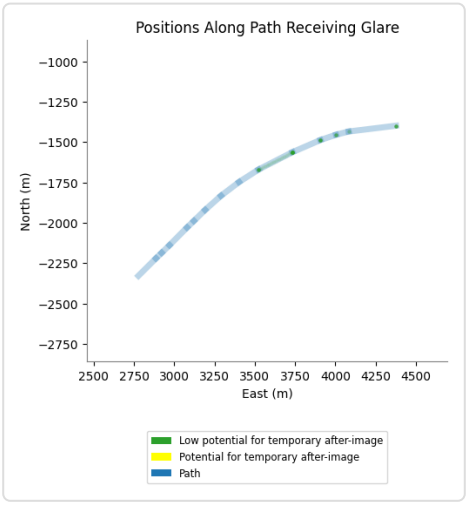
Yellow glare: none

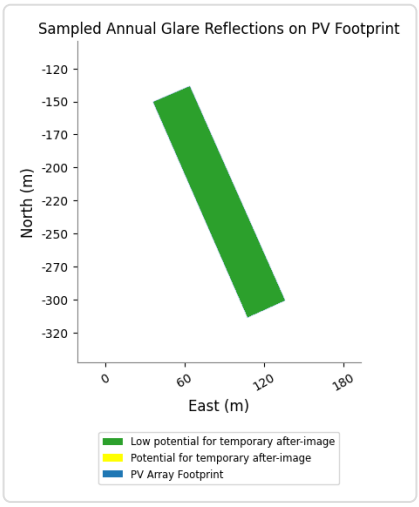
Green glare: 123 min.

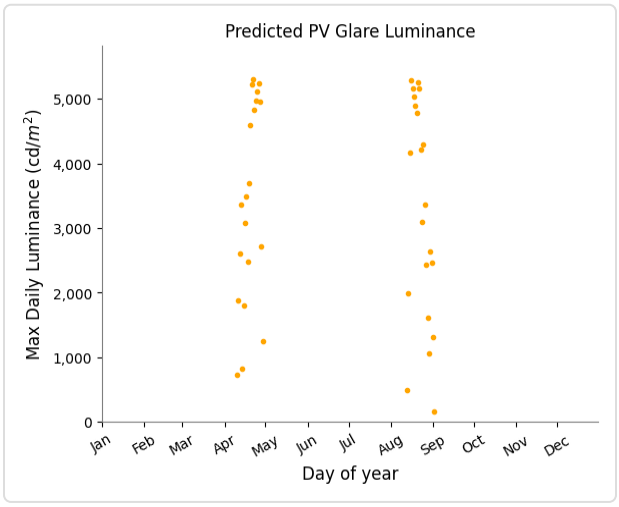












PVC west H and Route: Route 1

No glare found

PVC west H and Route: Route 2

No glare found

PVC west H and FP: FP 1

No glare found

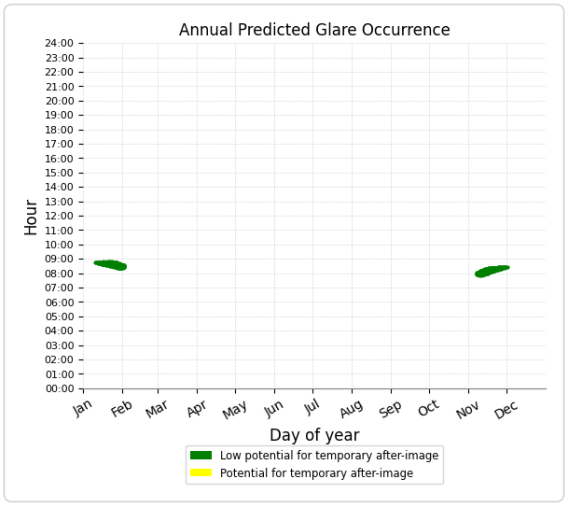
PVC west H and FP: FP 2

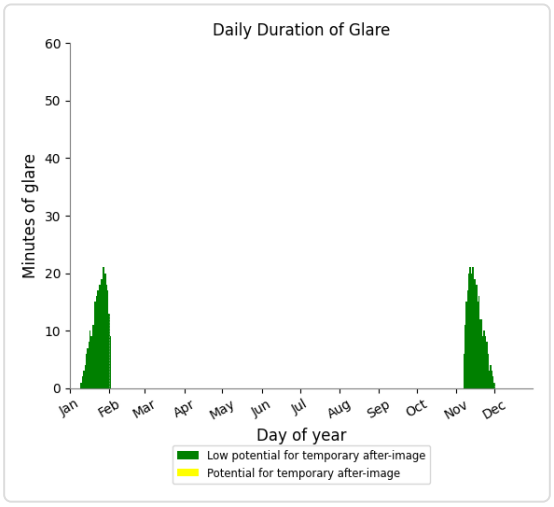
No glare found

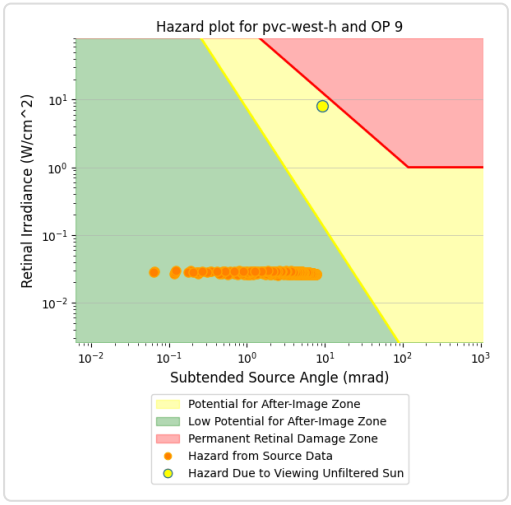
PVC west H and OP 9

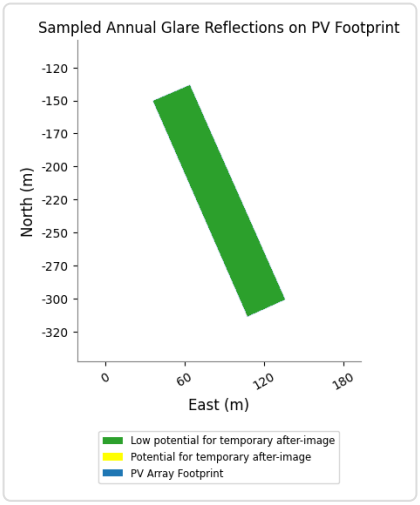
Yellow glare: none

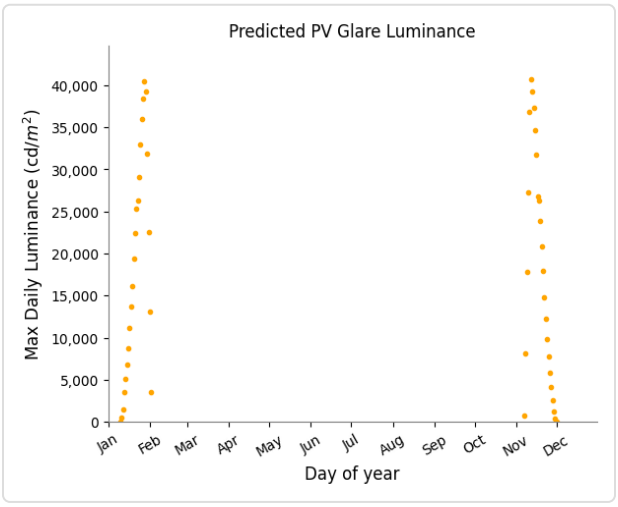
Green glare: 591 min.











PVC west H and OP 1

No glare found

PVC west H and OP 2

No glare found

PVC west H and OP 3

No glare found

PVC west H and OP 4

No glare found

PVC west H and OP 5

No glare found

PVC west H and OP 6

No glare found

PVC west H and OP 7

No glare found

PVC west H and OP 8

No glare found

PVC west H and OP 10

No glare found

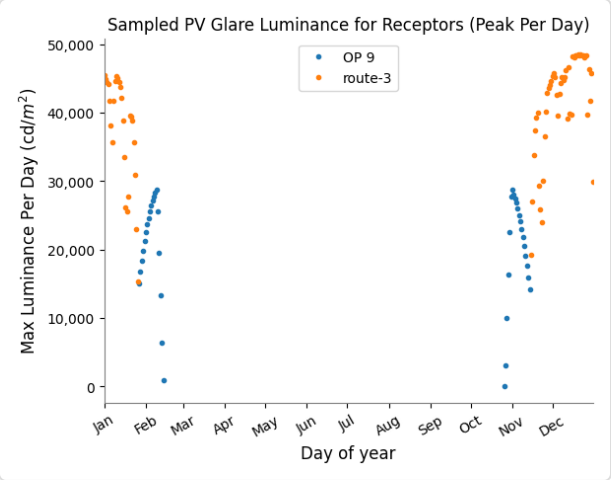
PVC west H and OP 11

No glare found

PV: PVC west L low potential for temporary after-image

Receptor results ordered by category of glare

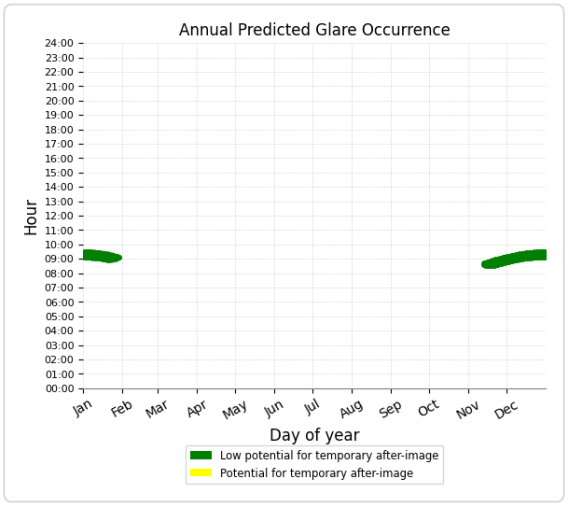
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	2,138	35.6	0	0.0	48,470
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Route 4	0	0.0	0	0.0	0
Route 5	0	0.0	0	0.0	0
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 9	1,068	17.8	0	0.0	28,763
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0

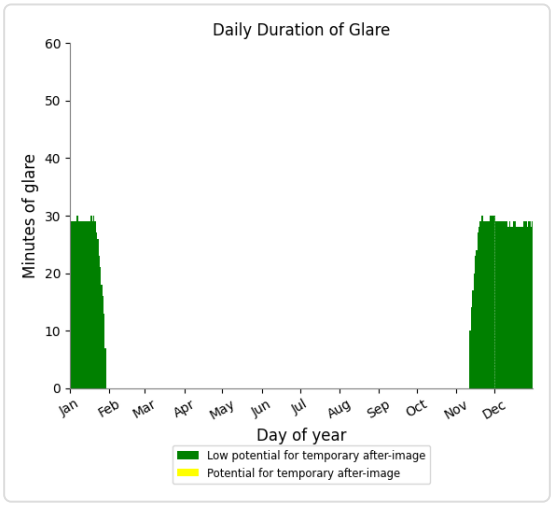


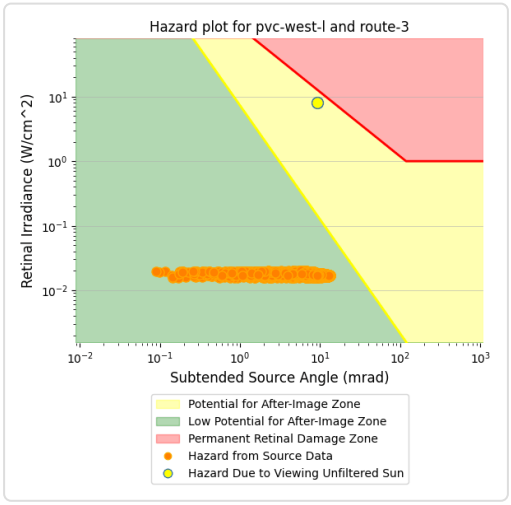
PVC west L and Route: Route 3

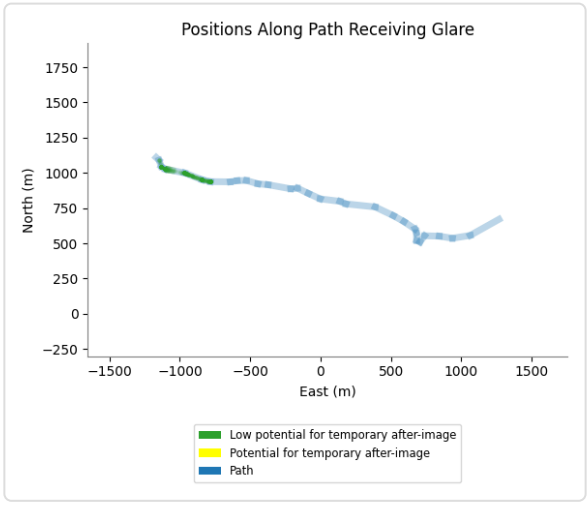
Yellow glare: none

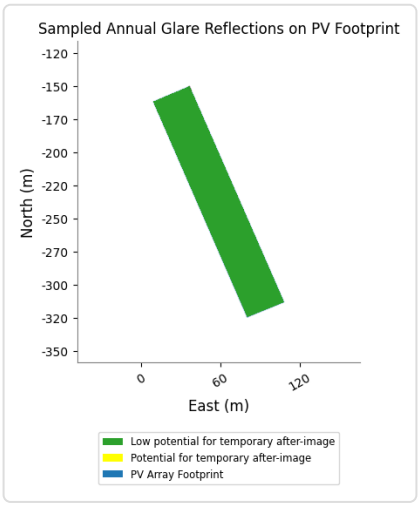
Green glare: 2,138 min.

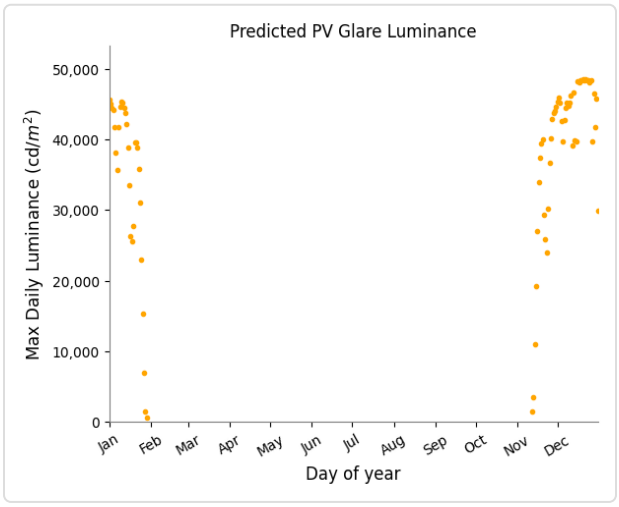












PVC west L and Route: Route 1

No glare found

PVC west L and Route: Route 2

No glare found

PVC west L and Route: Route 4

No glare found

PVC west L and Route: Route 5

No glare found

PVC west L and FP: FP 1

No glare found

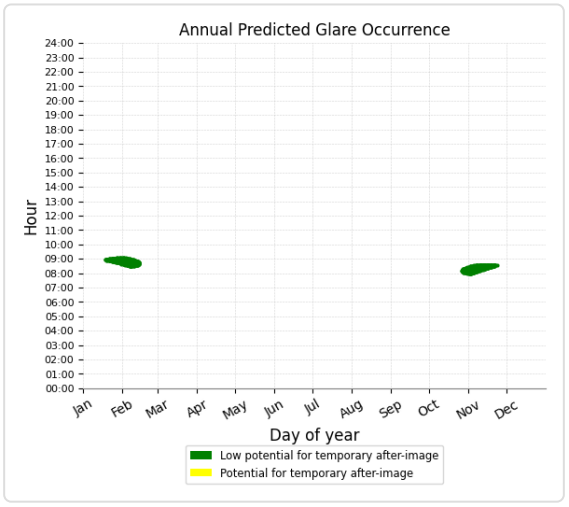
PVC west L and FP: FP 2

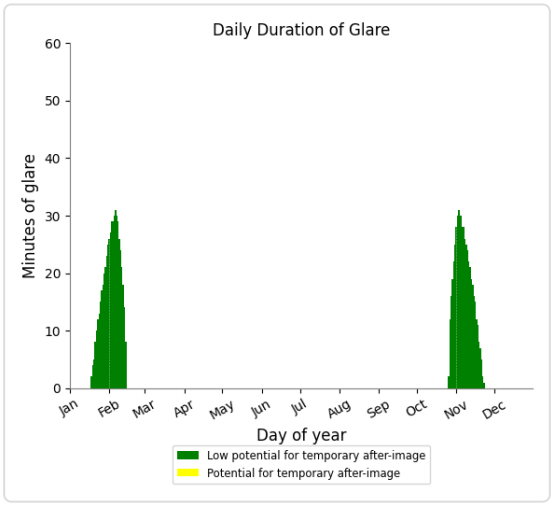
No glare found

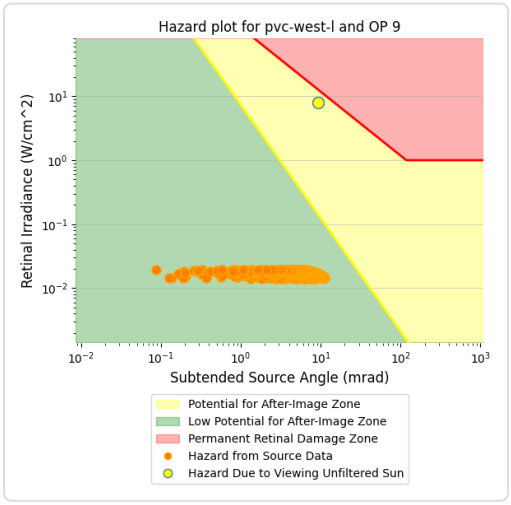
PVC west L and OP 9

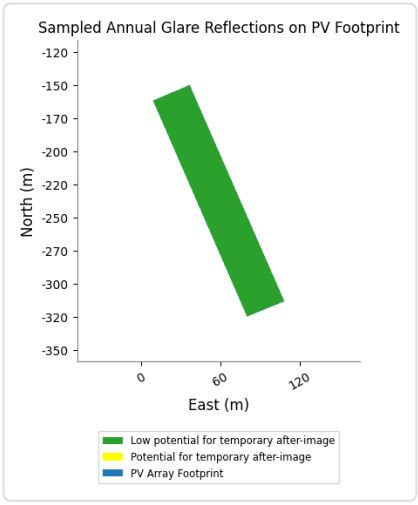
Yellow glare: none

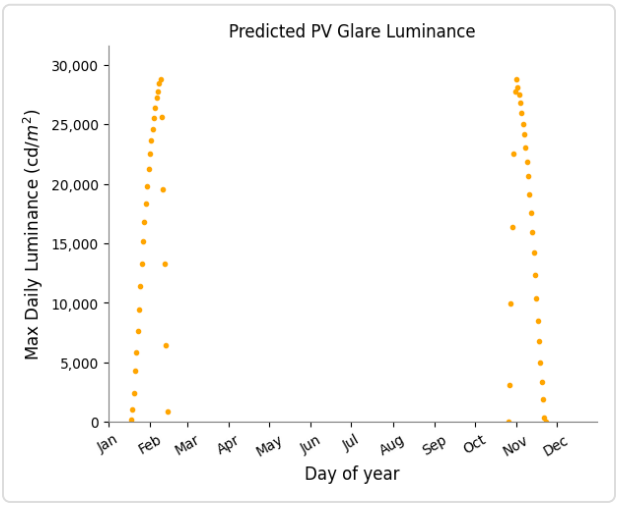
Green glare: 1,068 min.











PVC west L and OP 1

No glare found

PVC west L and OP 2

No glare found

PVC west L and OP 3

No glare found

PVC west L and OP 4

No glare found

PVC west L and OP 5

No glare found

PVC west L and OP 6

No glare found

PVC west L and OP 7

No glare found

PVC west L and OP 8

No glare found

PVC west L and OP 10

No glare found

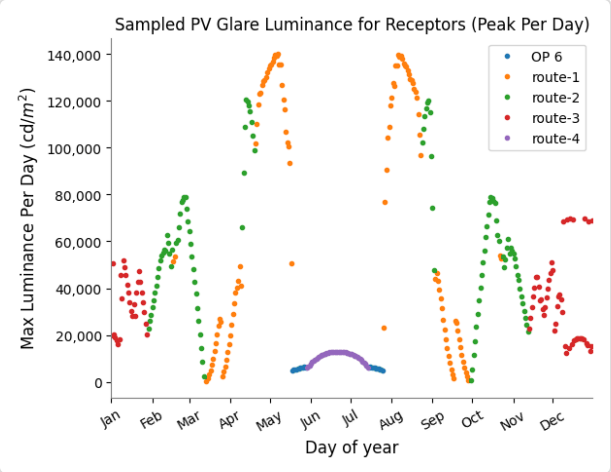
PVC west L and OP 11

No glare found

PV: PVD east H low potential for temporary after-image

Receptor results ordered by category of glare

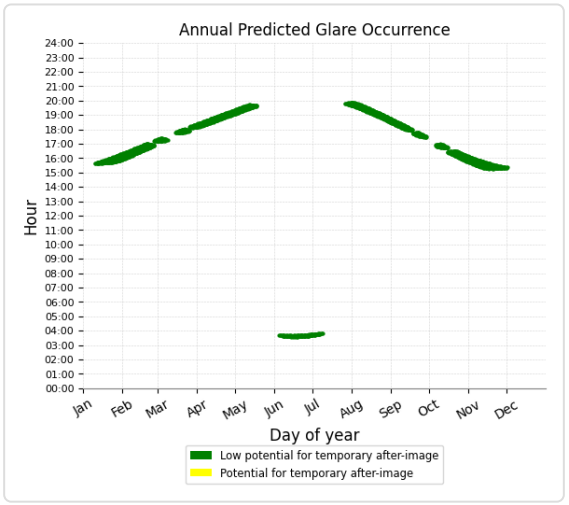
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	3,863	64.4	0	0.0	139,963
Route 2	2,832	47.2	0	0.0	120,569
Route 3	2,565	42.8	0	0.0	69,606
Route 4	979	16.3	0	0.0	12,956
Route 5	1,067	17.8	0	0.0	6,776
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 6	970	16.2	0	0.0	6,315
OP 7	592	9.9	0	0.0	5,359
OP 11	1,577	26.3	0	0.0	11,510
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0

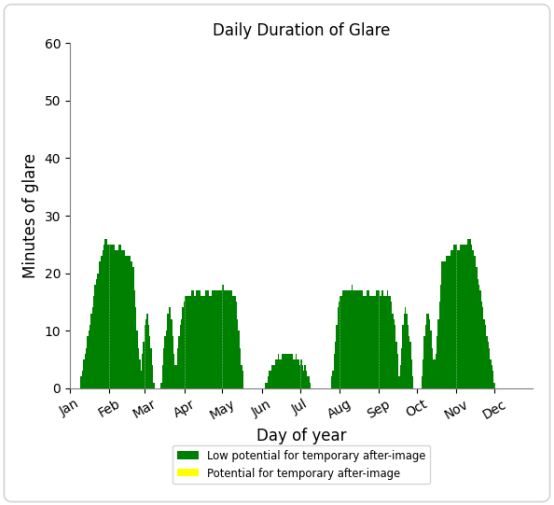


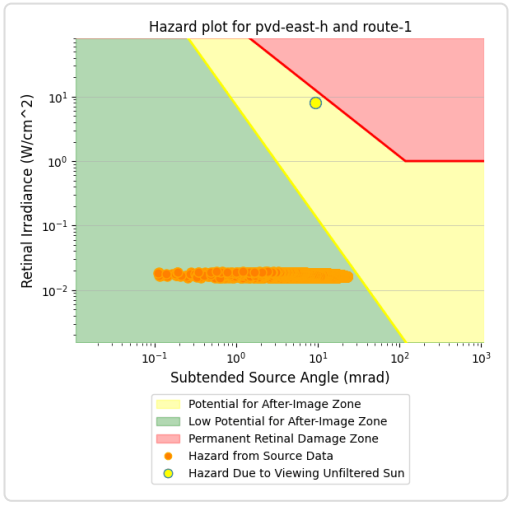
PVD east H and Route: Route 1

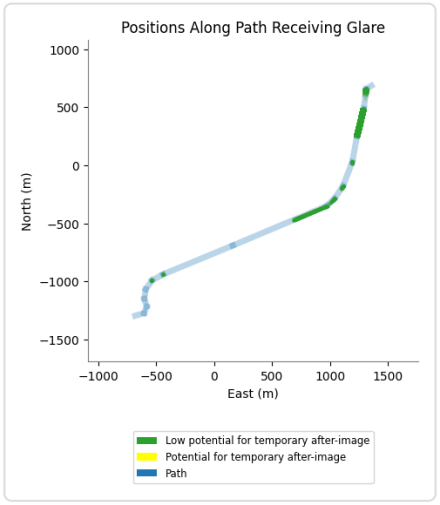
Yellow glare: none

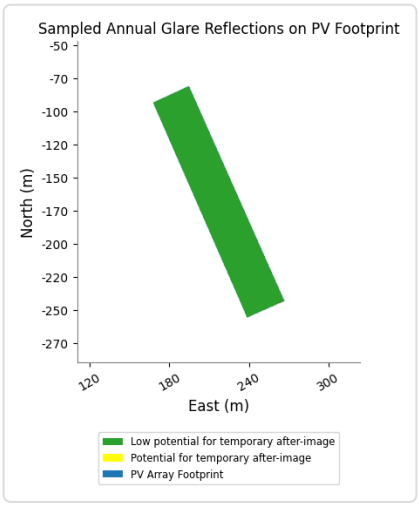
Green glare: 3,863 min.

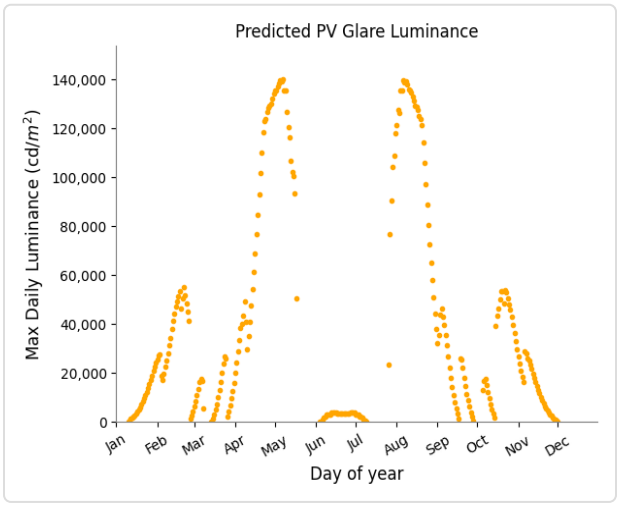








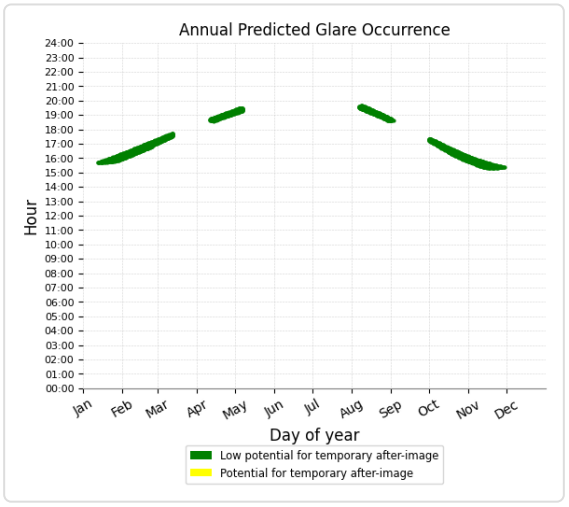


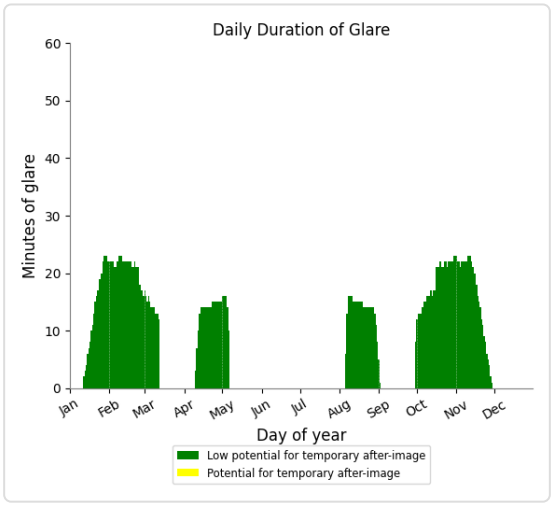


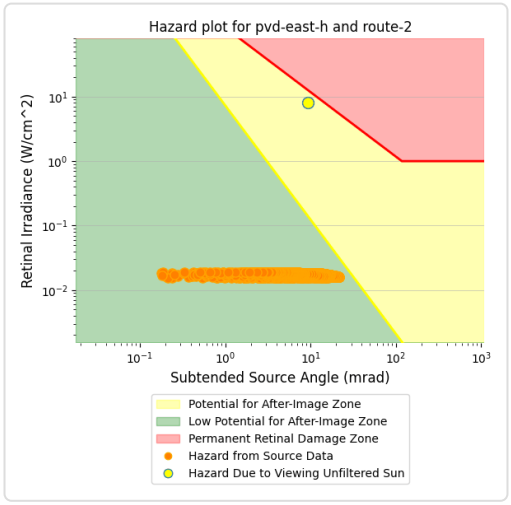
PVD east H and Route: Route 2

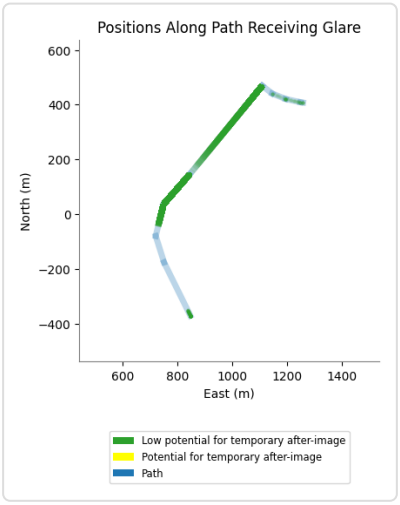
Yellow glare: none

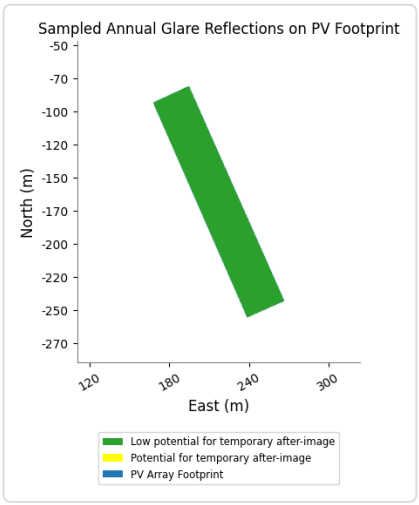
Green glare: 2,832 min.

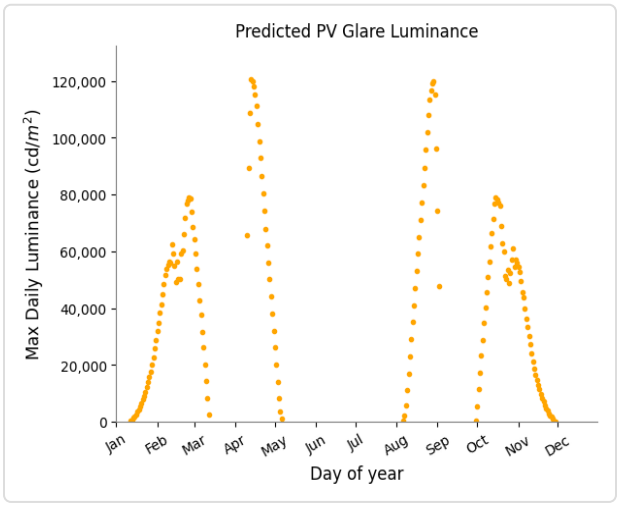








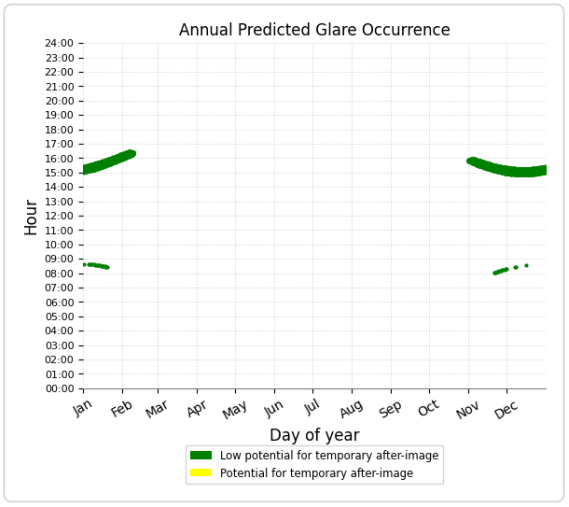


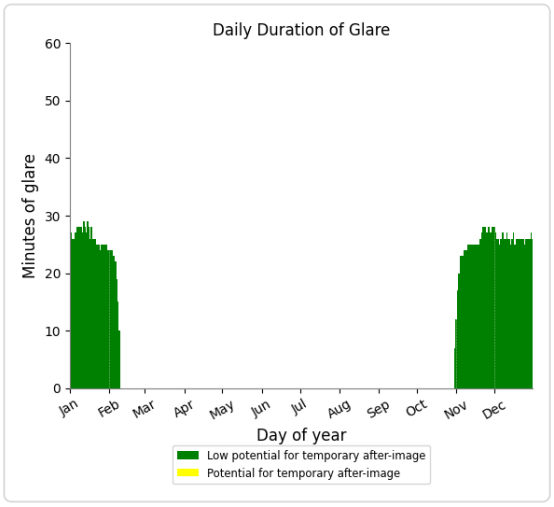


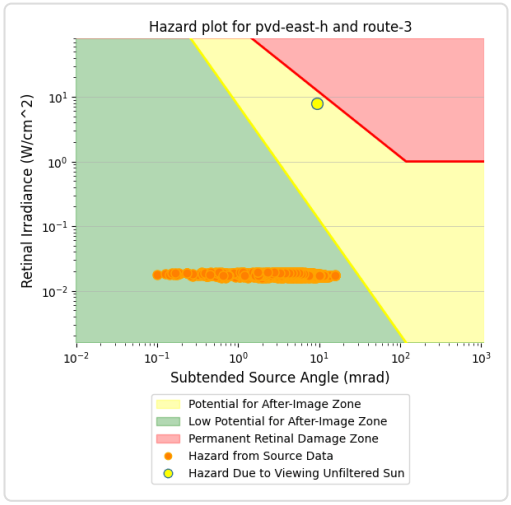
PVD east H and Route: Route 3

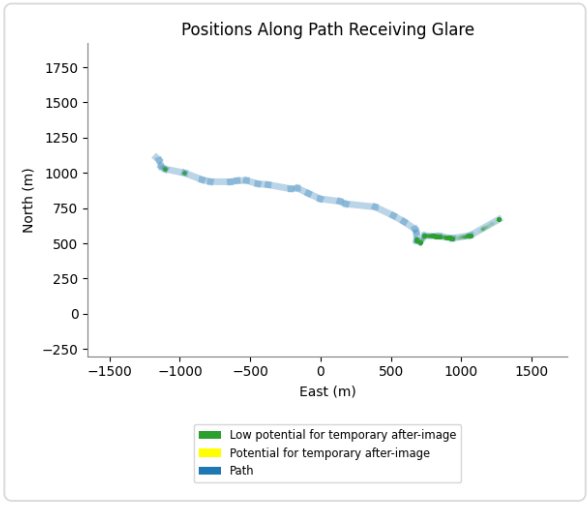
Yellow glare: none

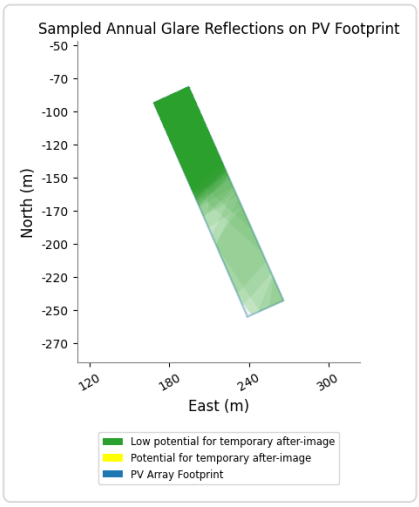
Green glare: 2,565 min.

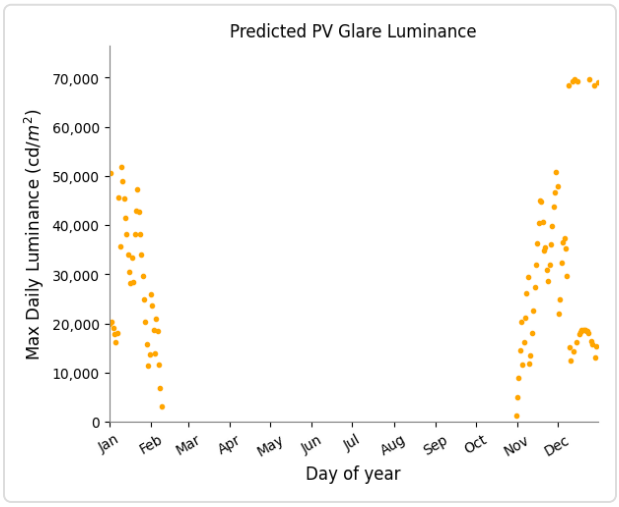








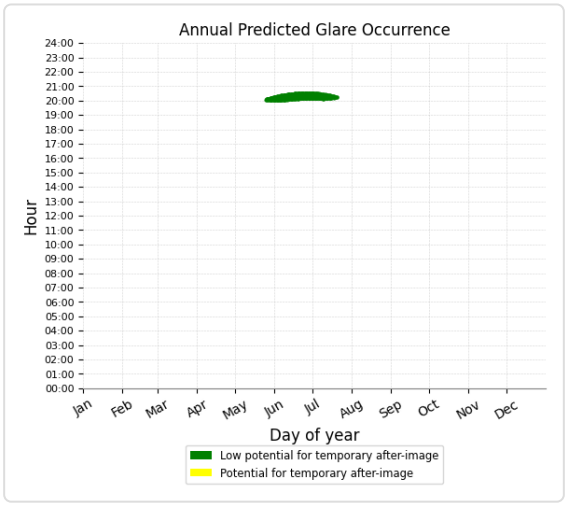


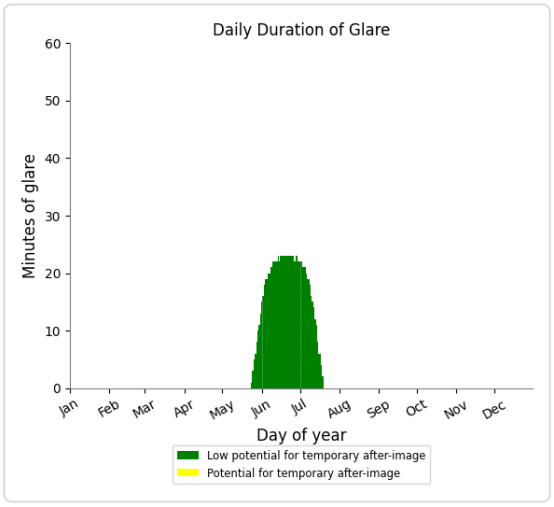


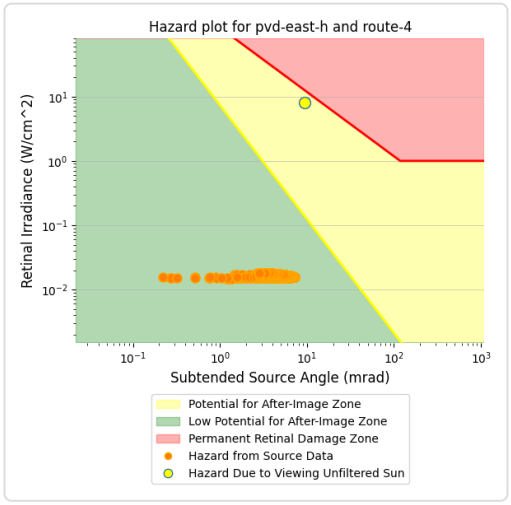
PVD east H and Route: Route 4

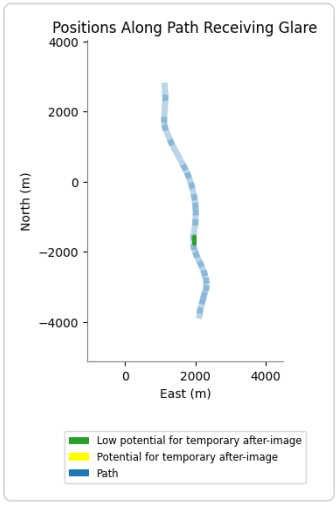
Yellow glare: none

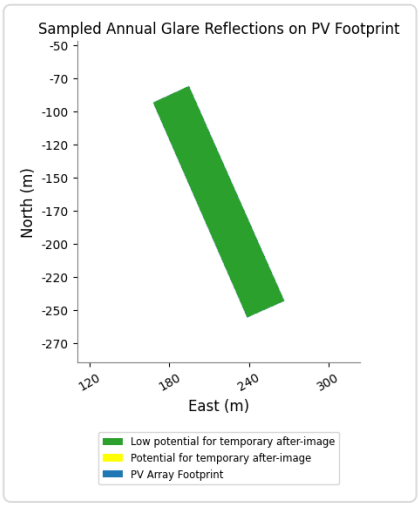
Green glare: 979 min.

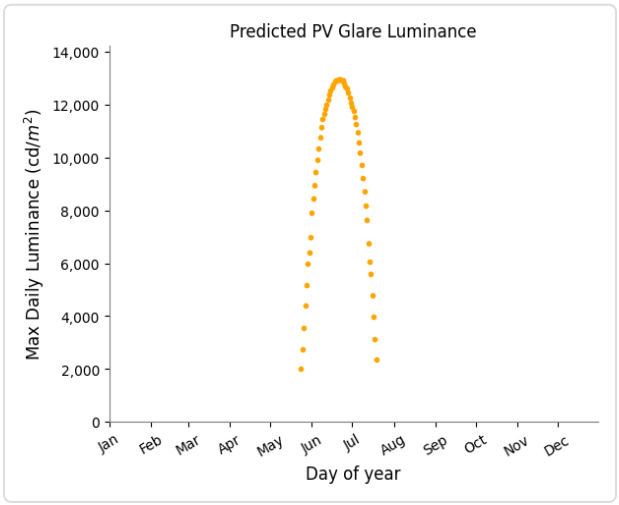








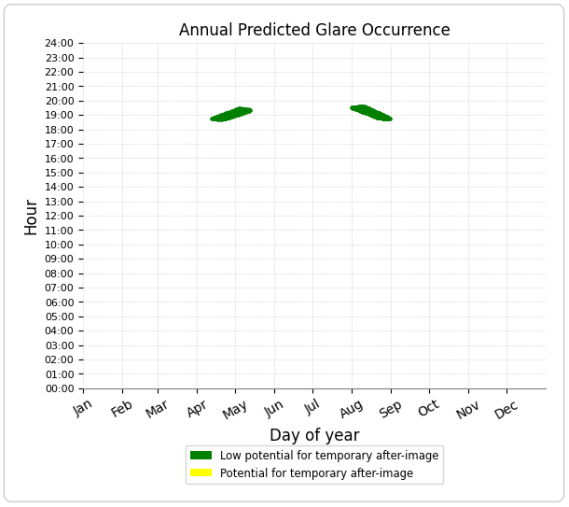


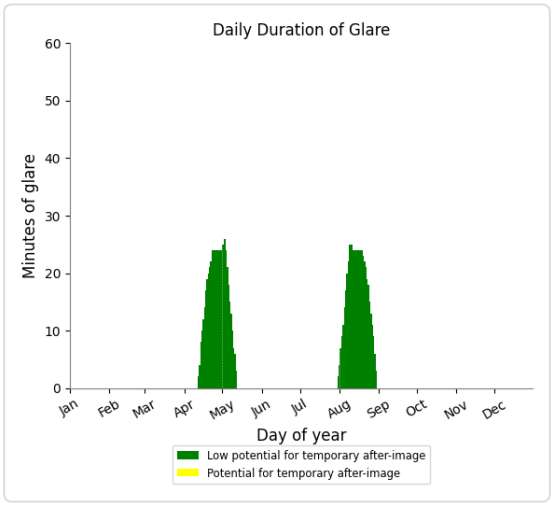


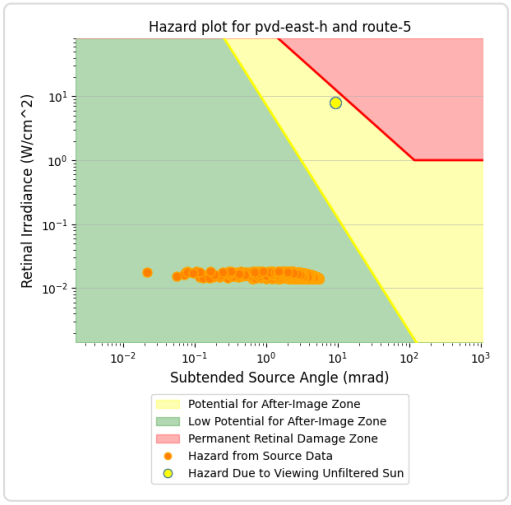
PVD east H and Route: Route 5

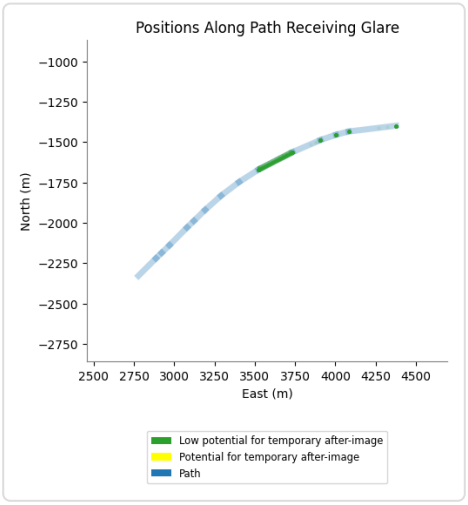
Yellow glare: none

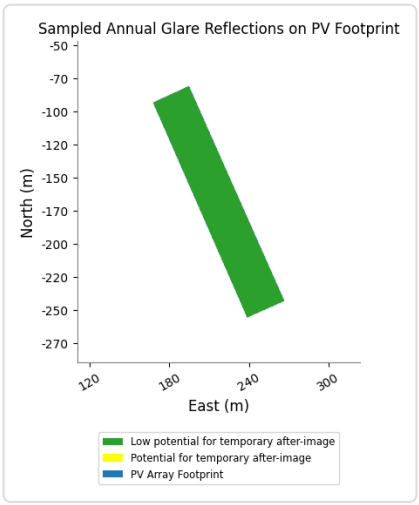
Green glare: 1,067 min.

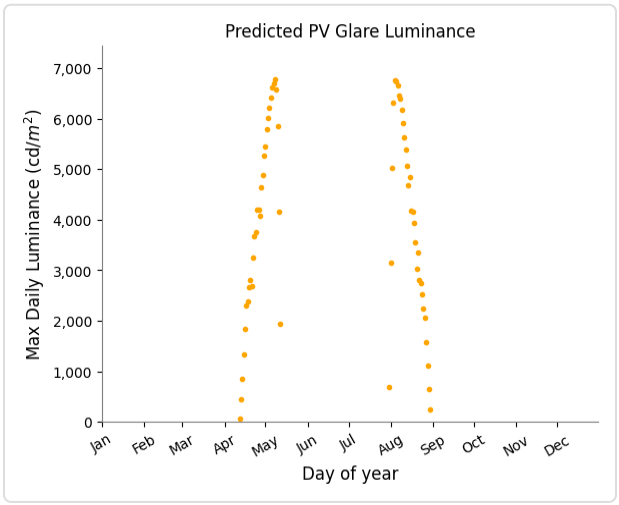












PVD east H and FP: FP 1

No glare found

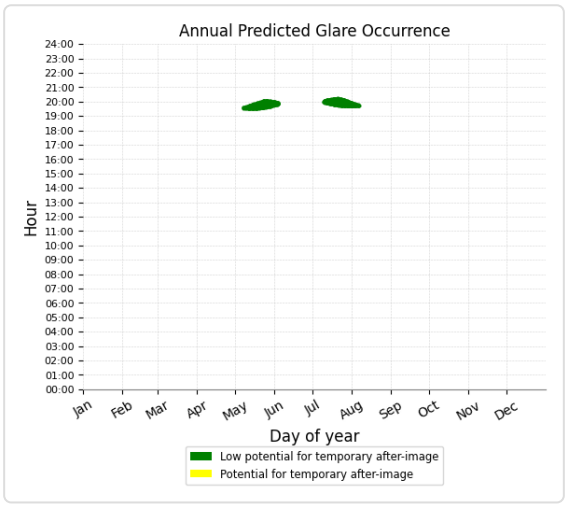
PVD east H and FP: FP 2

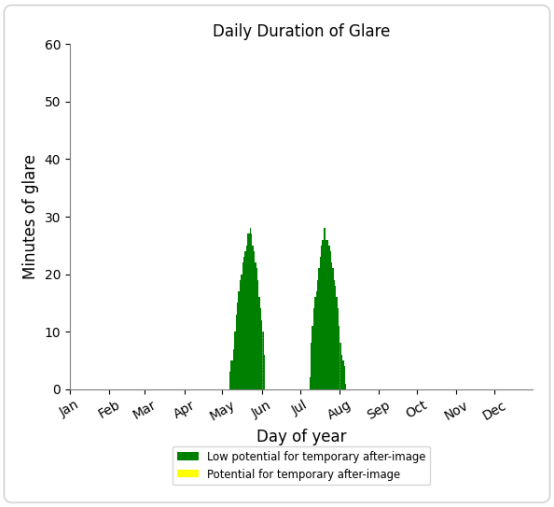
No glare found

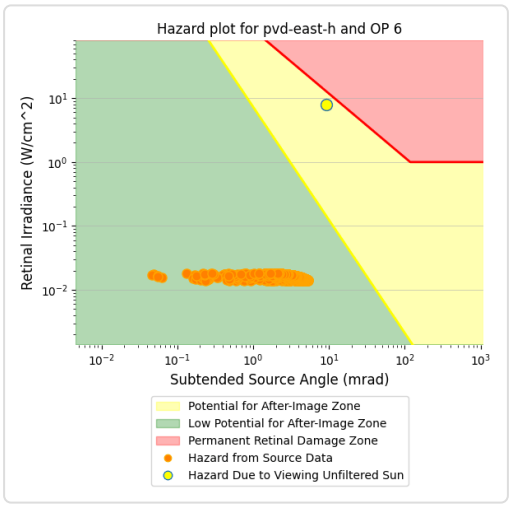
PVD east H and OP 6

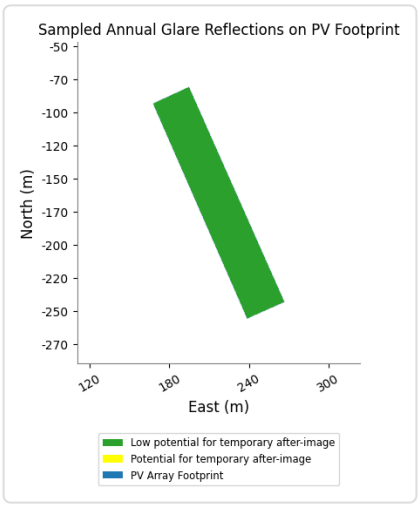
Yellow glare: none

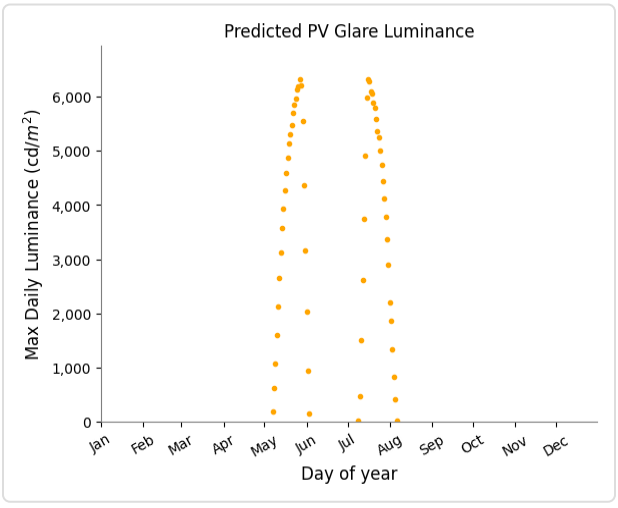
Green glare: 970 min.







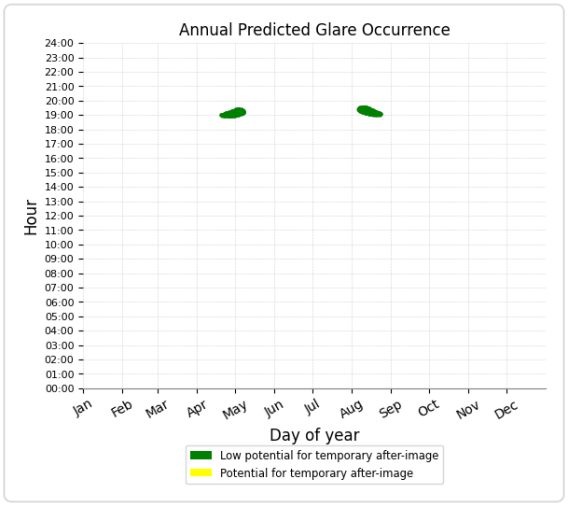


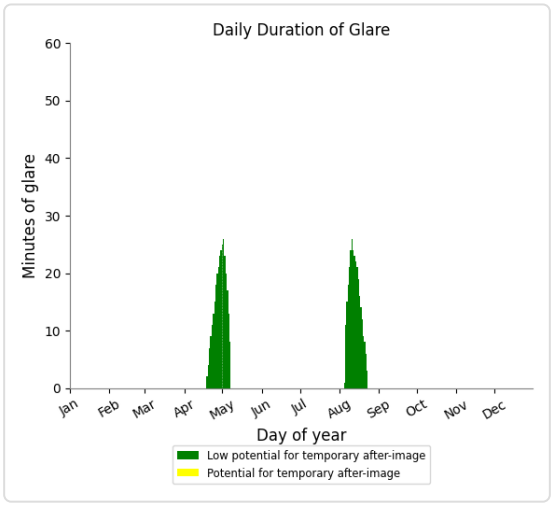


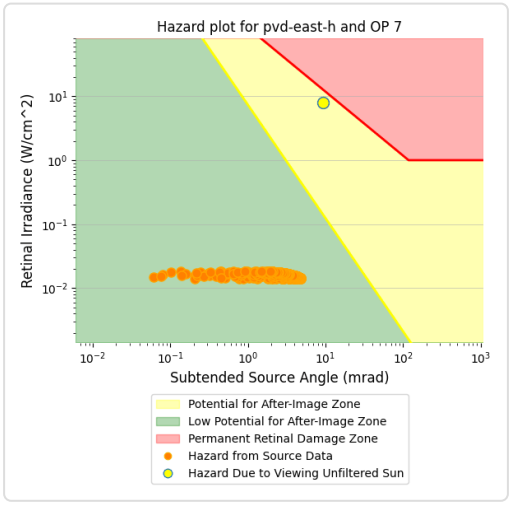
PVD east H and OP 7

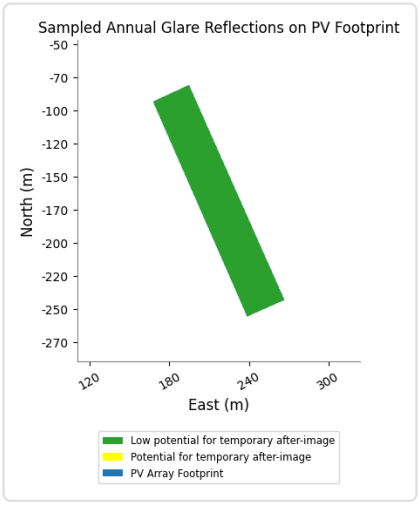
Yellow glare: none

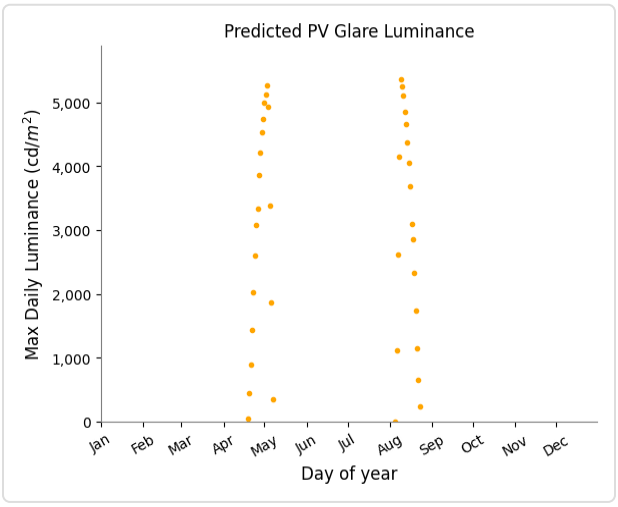
Green glare: 592 min.







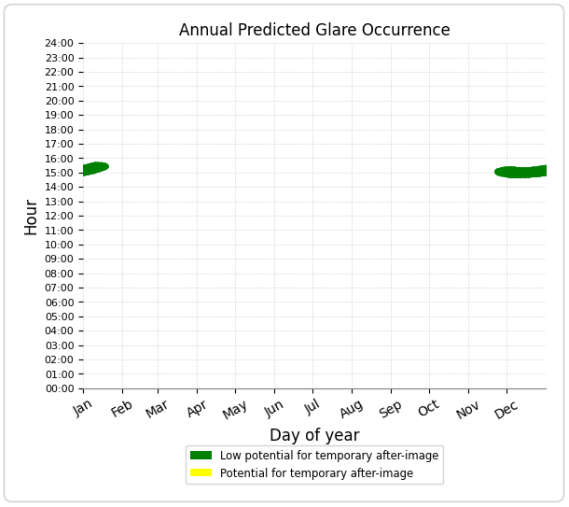


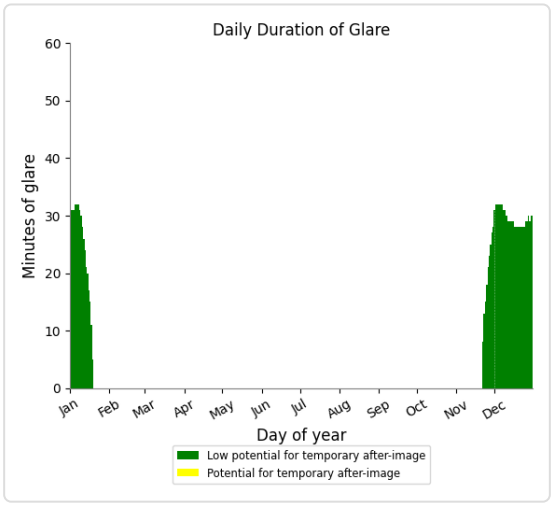


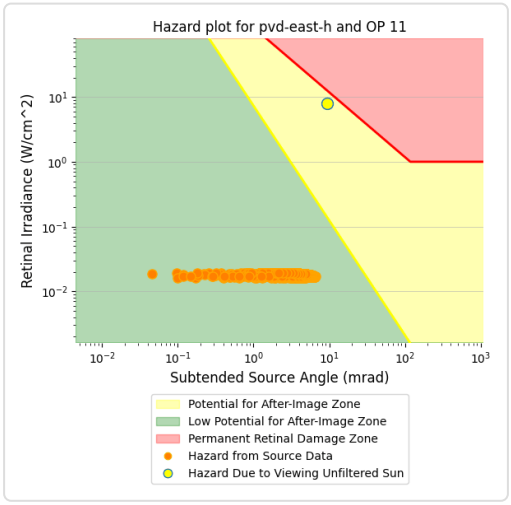
PVD east H and OP 11

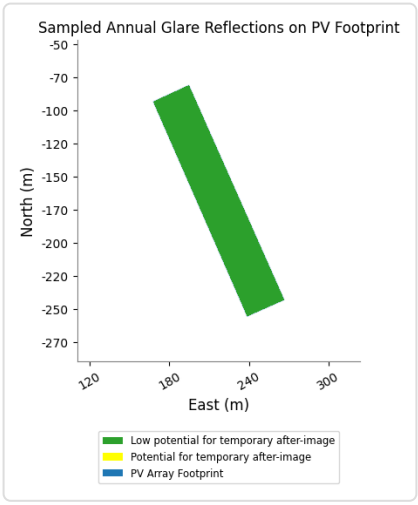
Yellow glare: none

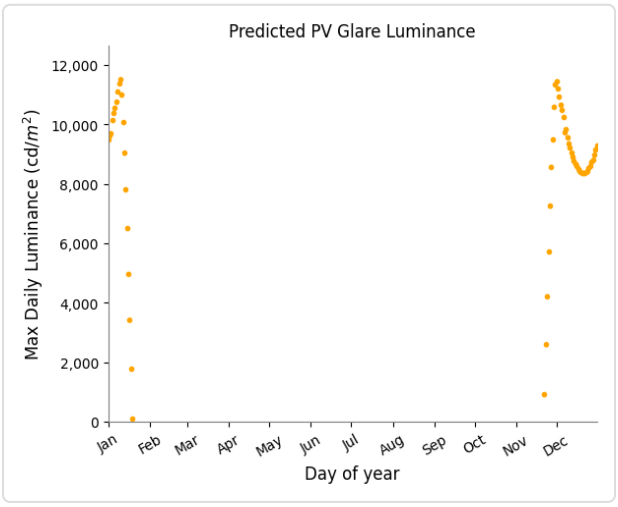
Green glare: 1,577 min.











PVD east H and OP 1

No glare found

PVD east H and OP 2

No glare found

PVD east H and OP 3

No glare found

PVD east H and OP 4

No glare found

PVD east H and OP 5

No glare found

PVD east H and OP 8

No glare found

PVD east H and OP 9

No glare found

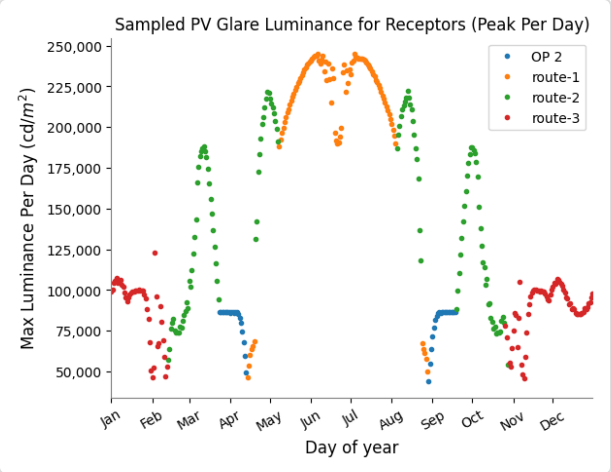
PVD east H and OP 10

No glare found

PV: PVD east L low potential for temporary after-image

Receptor results ordered by category of glare

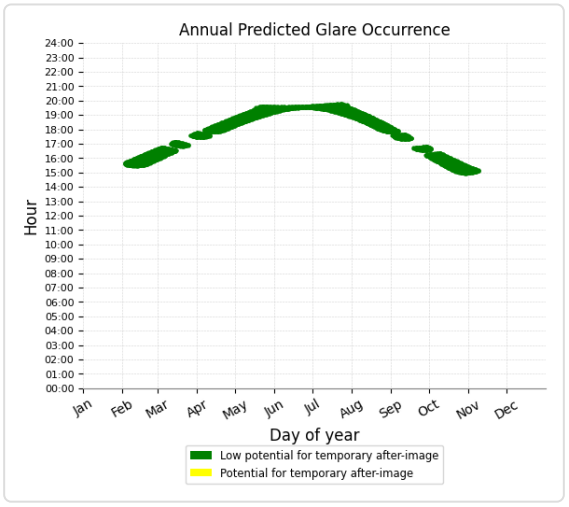
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	7,663	127.7	0	0.0	244,791
Route 2	5,968	99.5	0	0.0	222,248
Route 3	6,657	111.0	0	0.0	123,178
Route 4	2,883	48.0	0	0.0	42,284
Route 5	2,315	38.6	0	0.0	9,828
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 2	2,142	35.7	0	0.0	86,507
OP 3	3,032	50.5	0	0.0	83,493
OP 4	2,063	34.4	0	0.0	73,969
OP 6	1,651	27.5	0	0.0	7,596
OP 7	1,375	22.9	0	0.0	7,896
OP 11	1,762	29.4	0	0.0	19,771
OP 1	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0

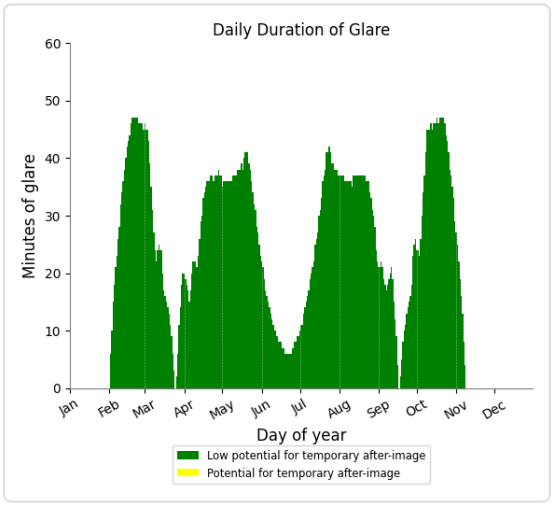


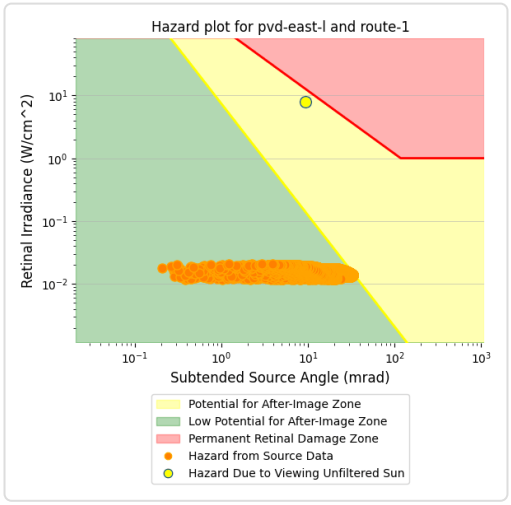
PVD east L and Route: Route 1

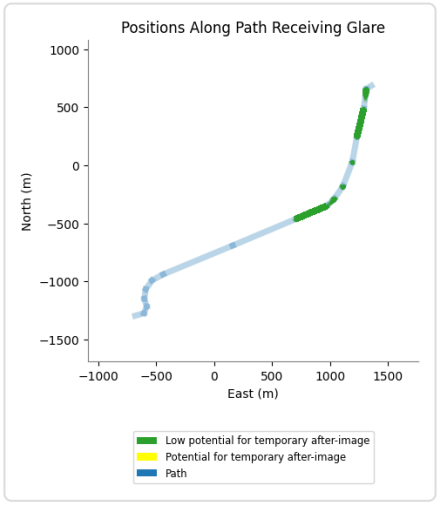
Yellow glare: none

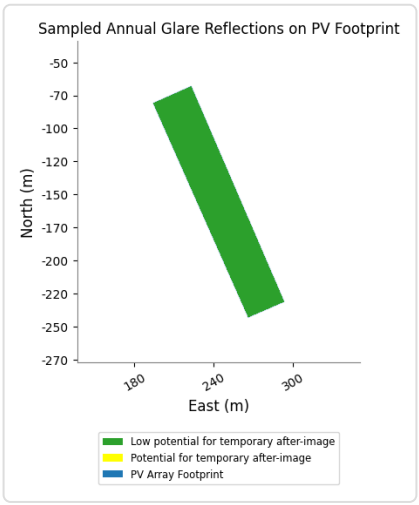
Green glare: 7,663 min.

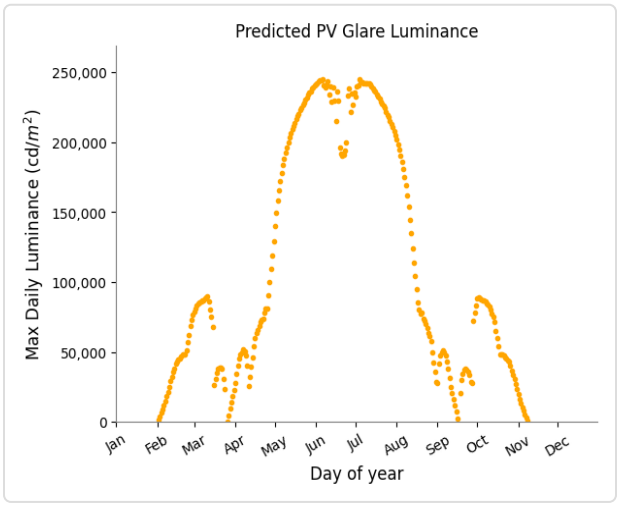








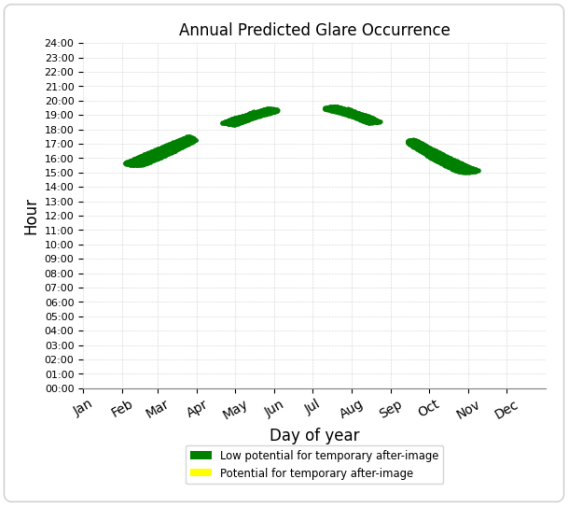


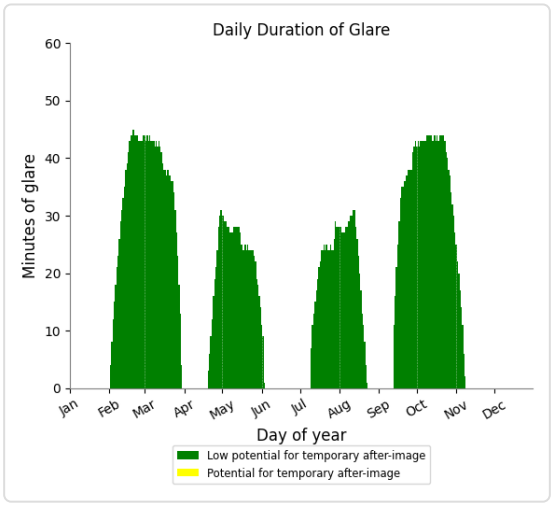


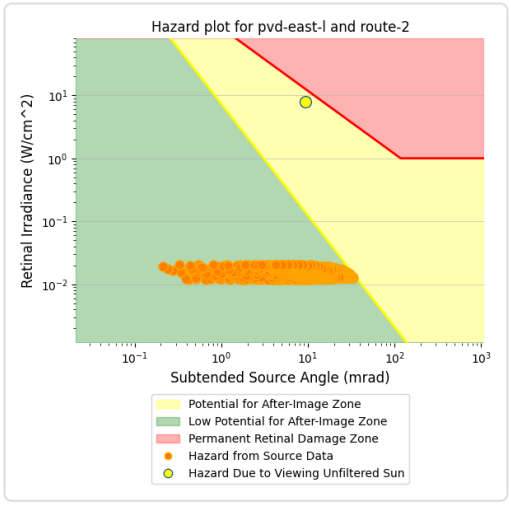
PVD east L and Route: Route 2

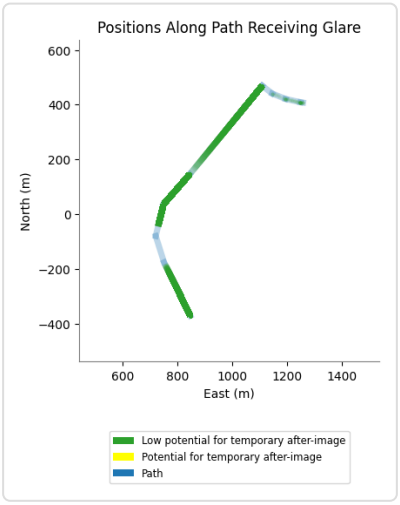
Yellow glare: none

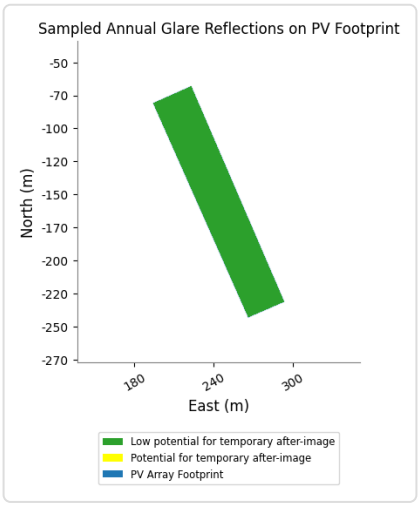
Green glare: 5,968 min.

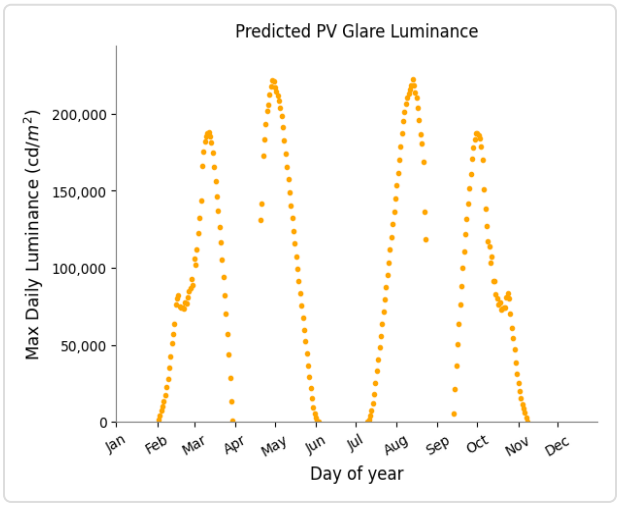








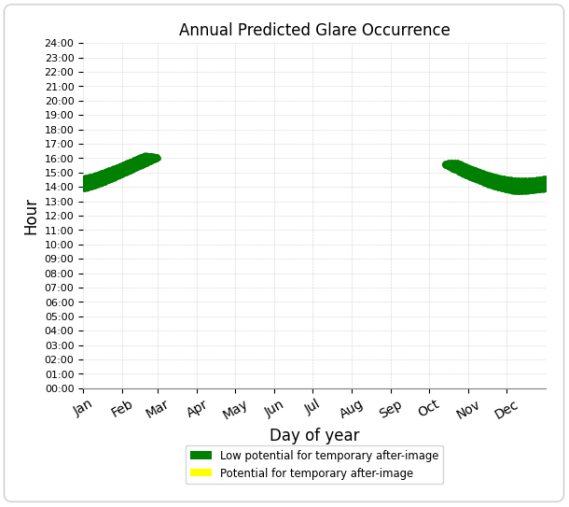


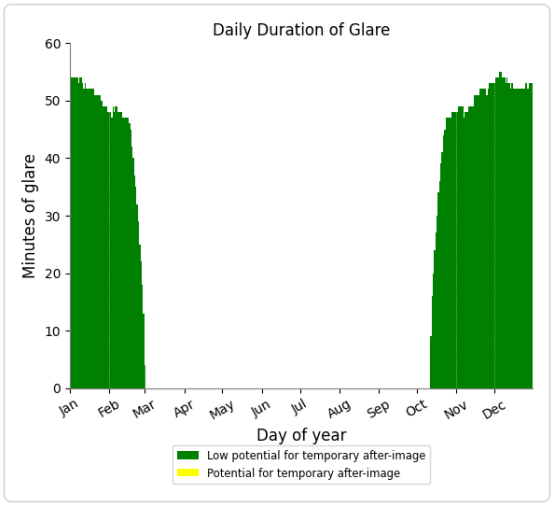


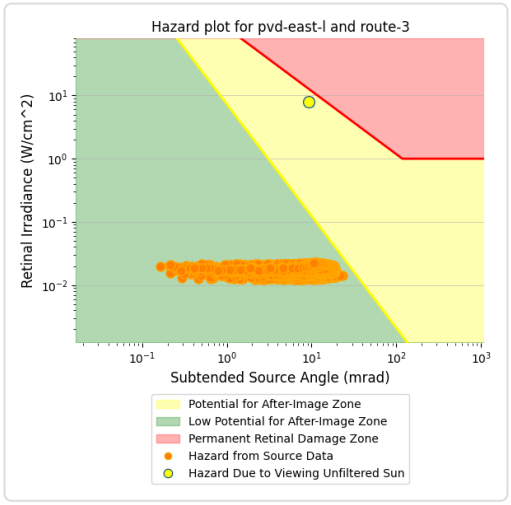
PVD east L and Route: Route 3

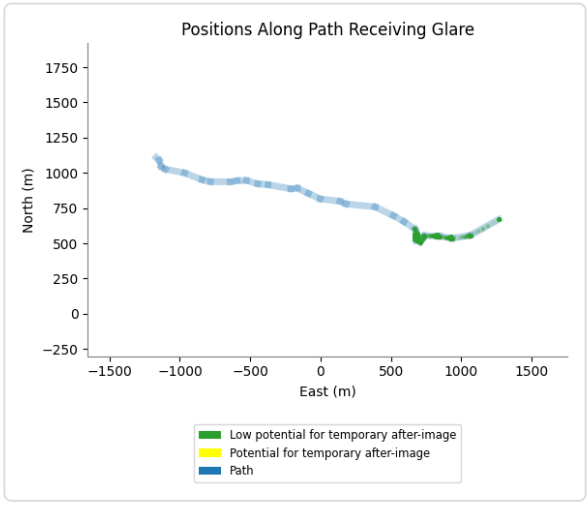
Yellow glare: none

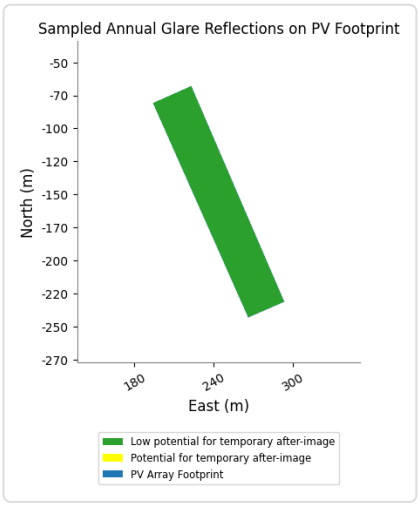
Green glare: 6,657 min.

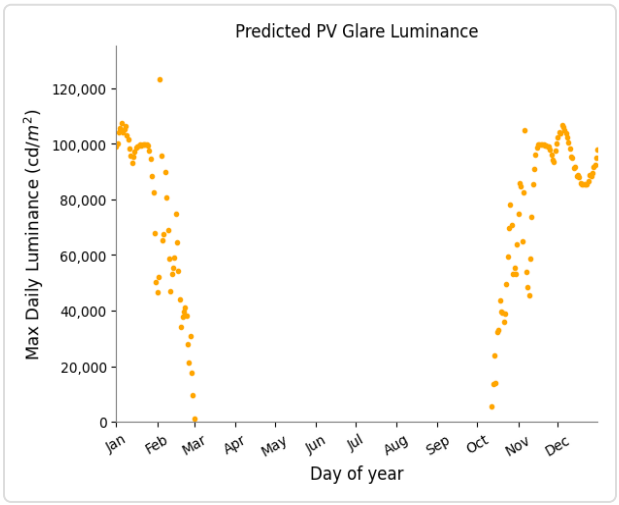








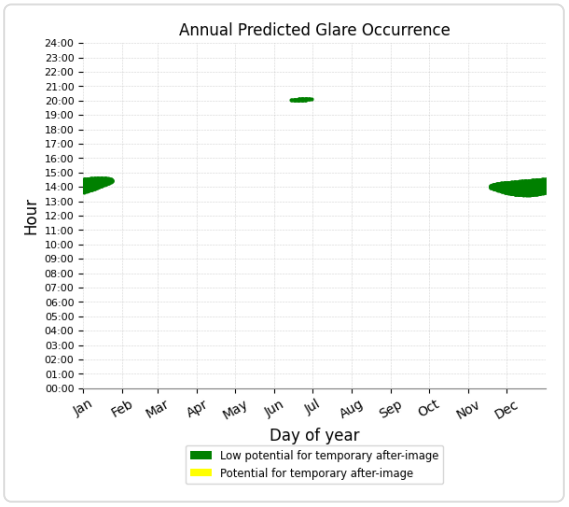


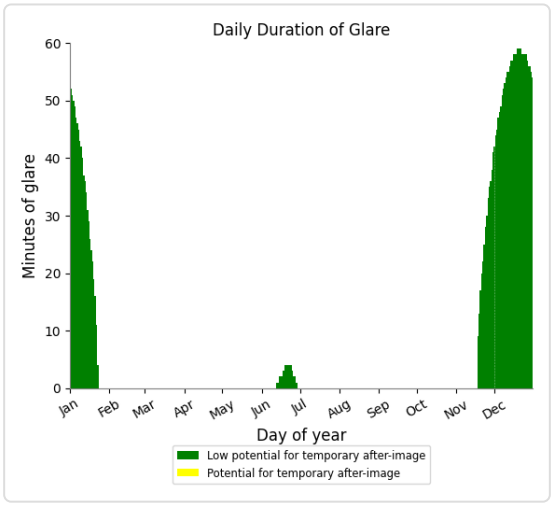


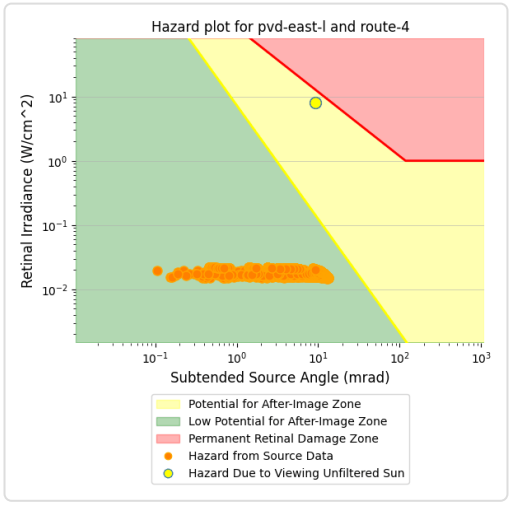
PVD east L and Route: Route 4

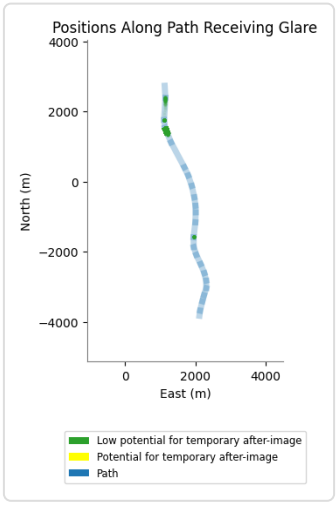
Yellow glare: none

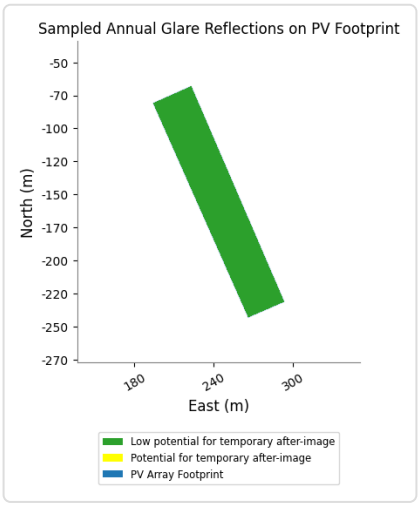
Green glare: 2,883 min.

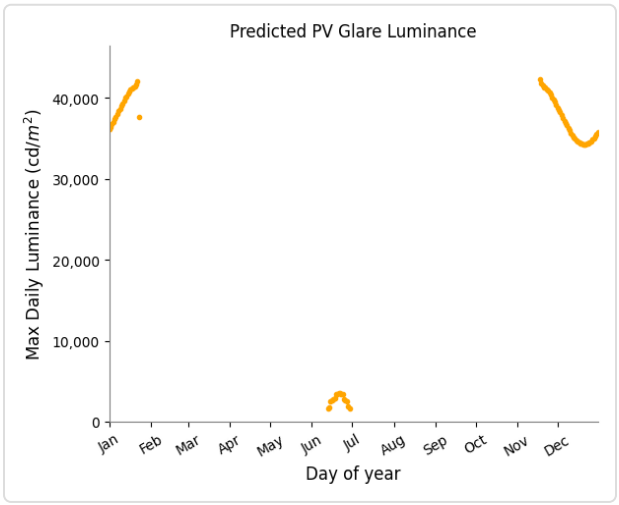








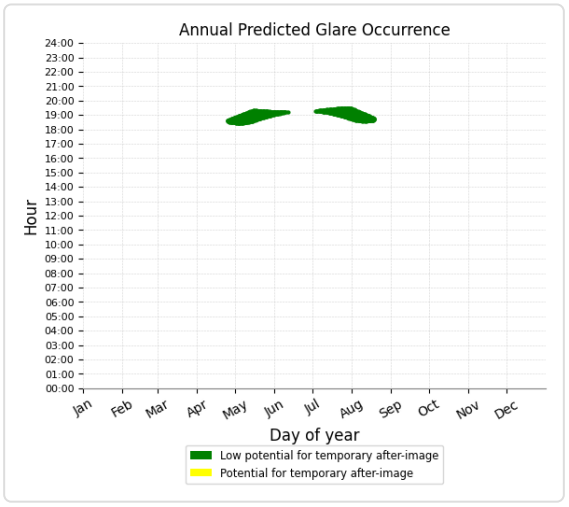


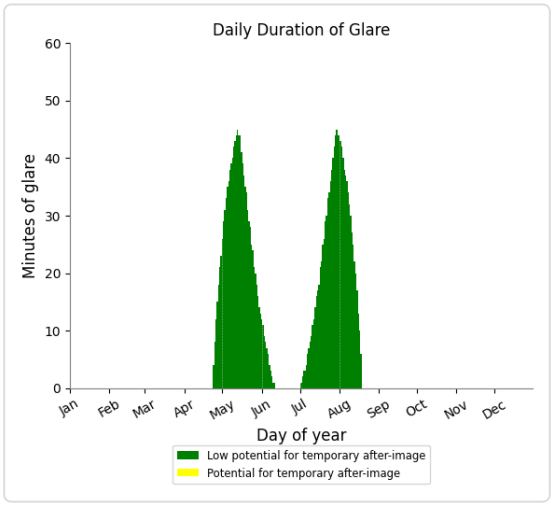


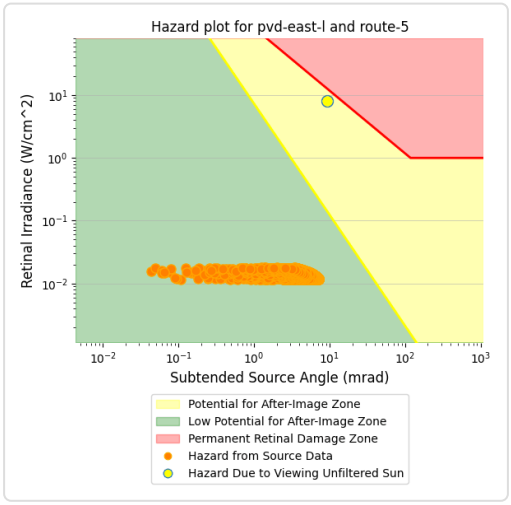
PVD east L and Route: Route 5

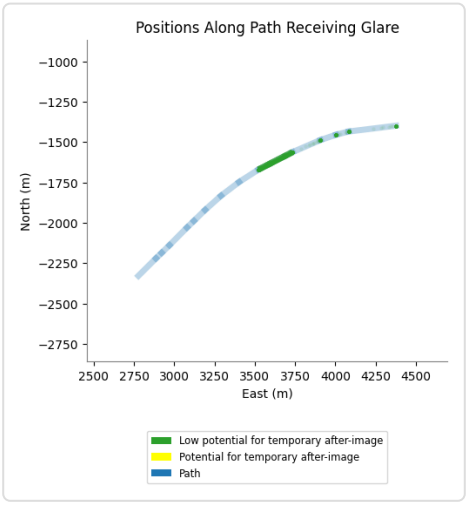
Yellow glare: none

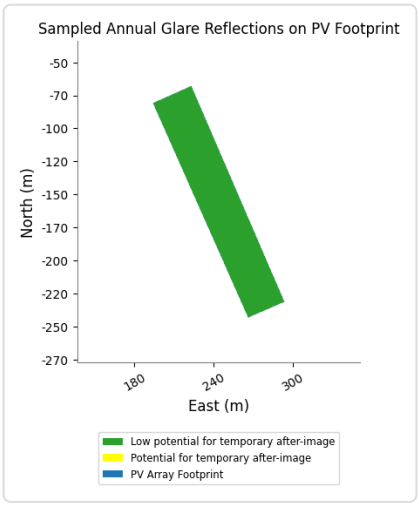
Green glare: 2,315 min.

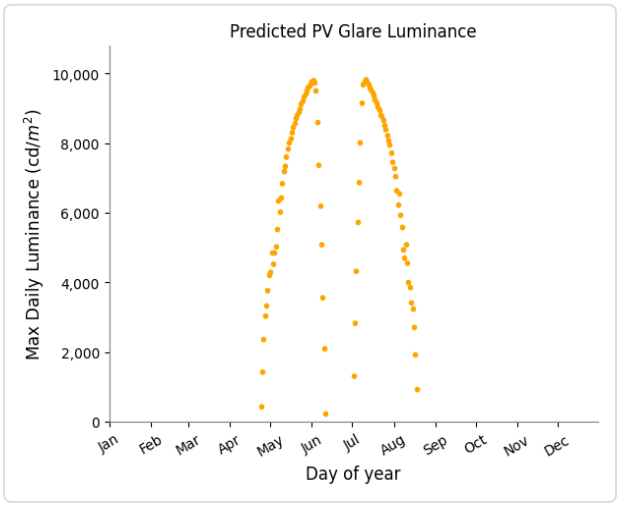












PVD east L and FP: FP 1

No glare found

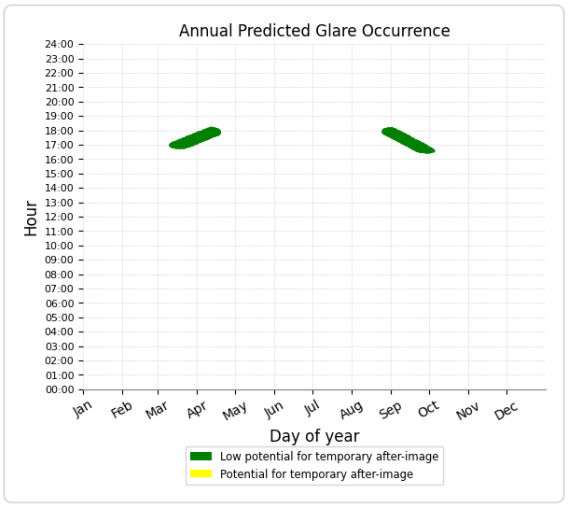
PVD east L and FP: FP 2

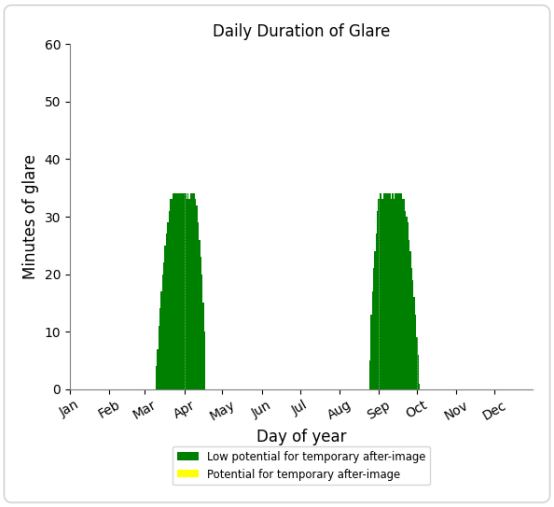
No glare found

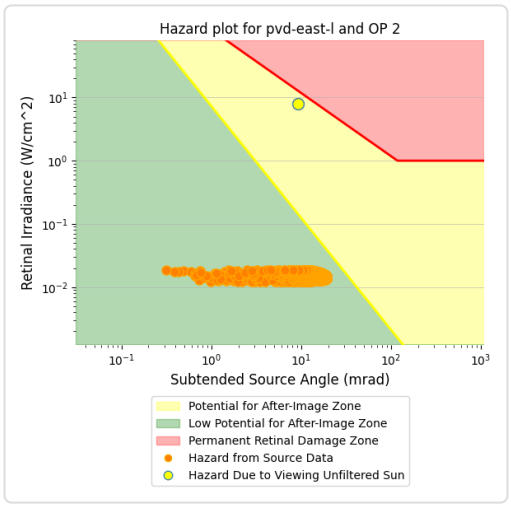
PVD east L and OP 2

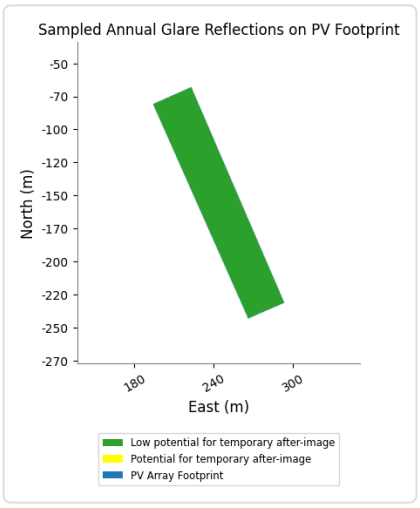
Yellow glare: none

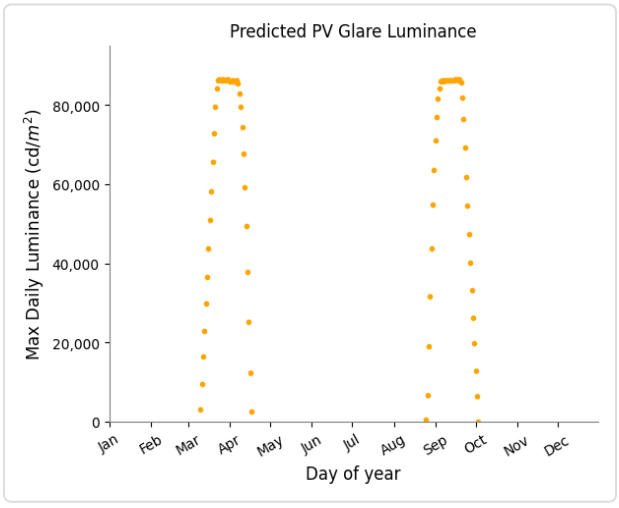
Green glare: 2,142 min.







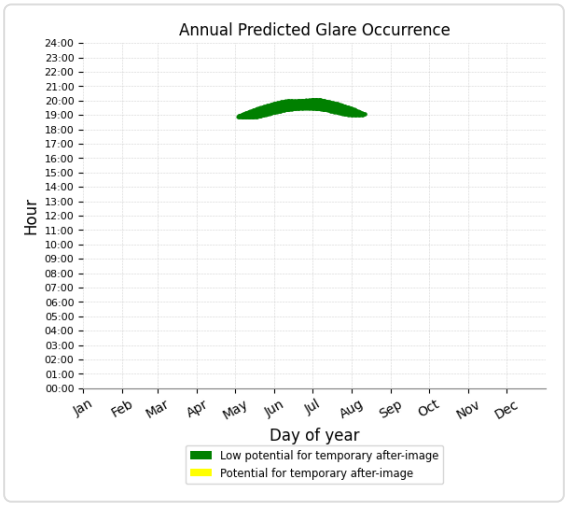


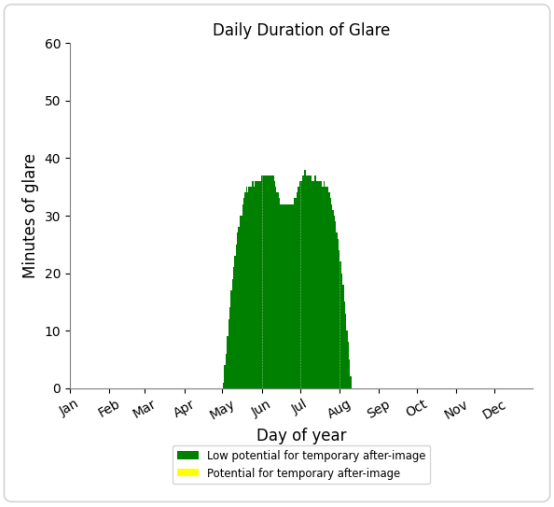


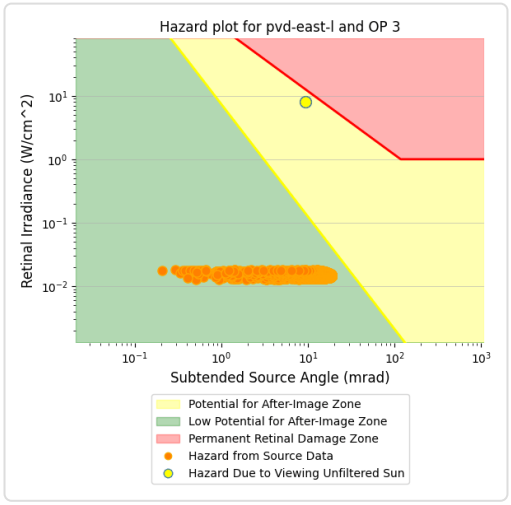
PVD east L and OP 3

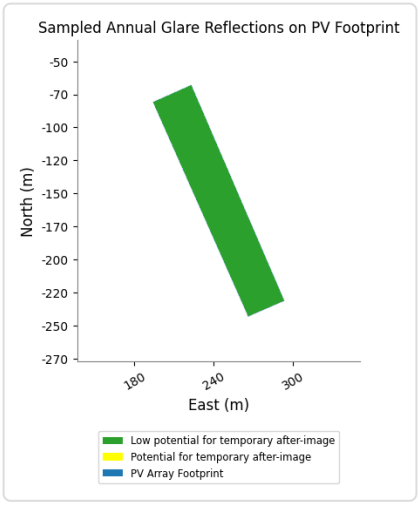
Yellow glare: none

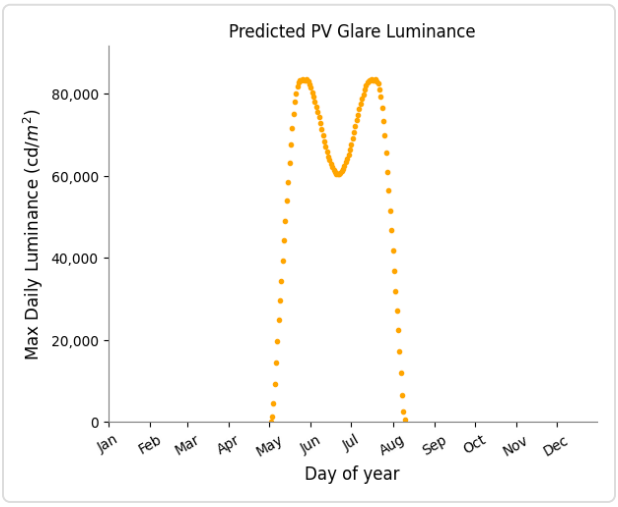
Green glare: 3,032 min.







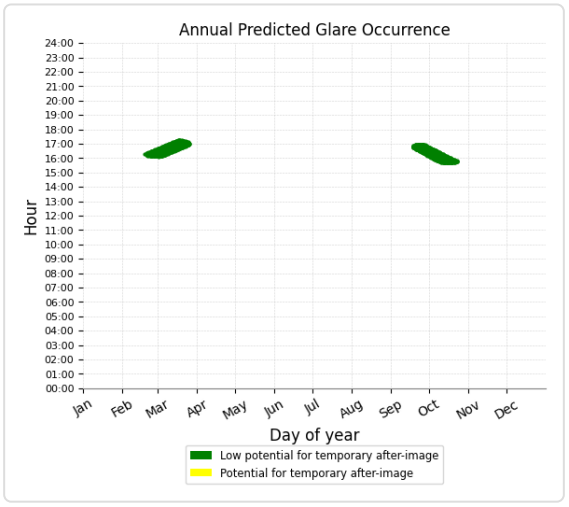


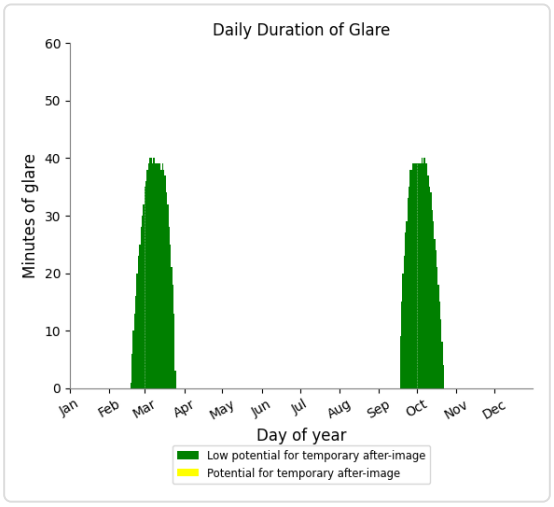


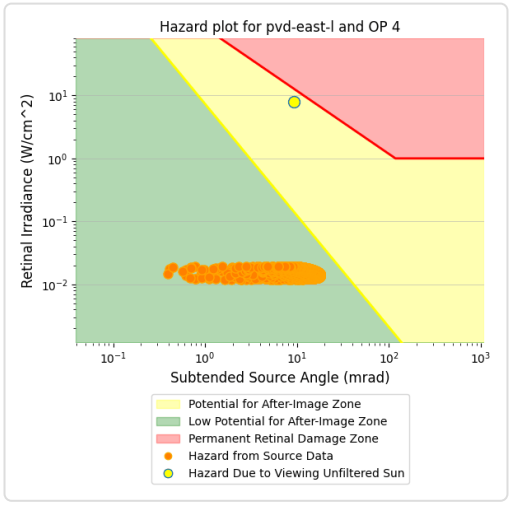
PVD east L and OP 4

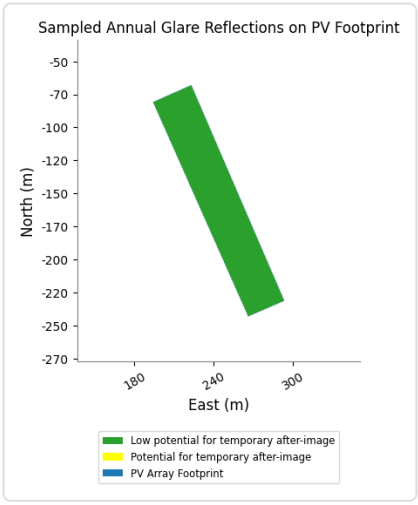
Yellow glare: none

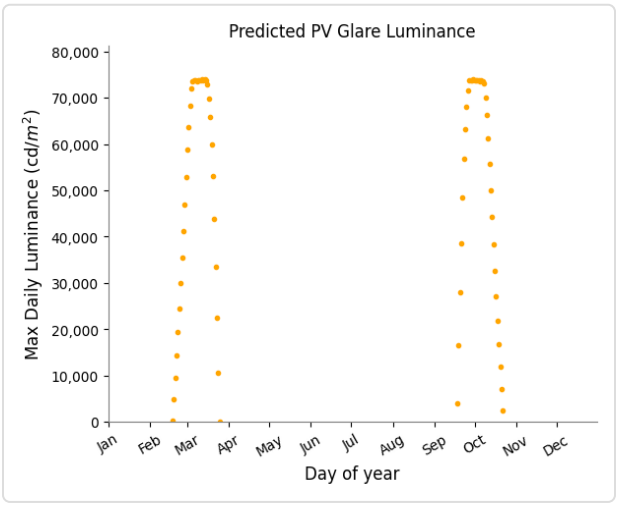
Green glare: 2,063 min.







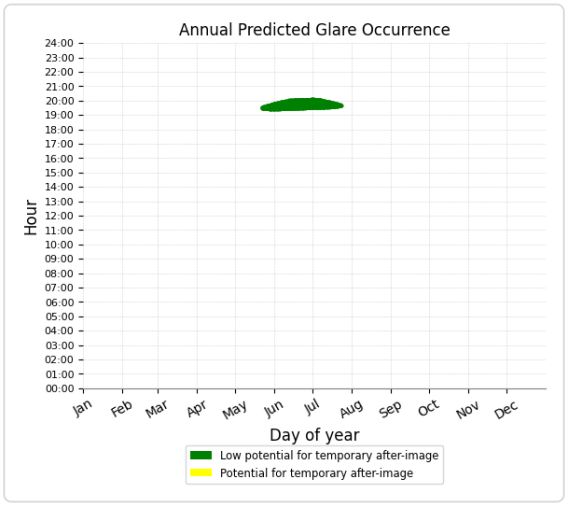


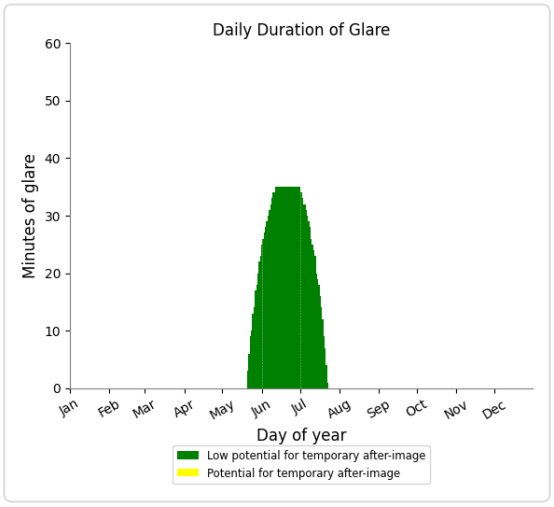


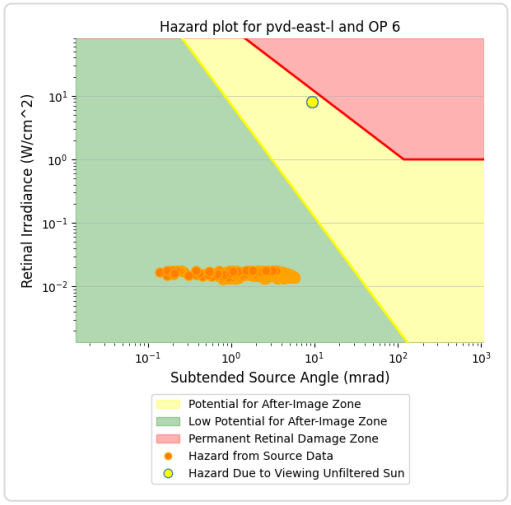
PVD east L and OP 6

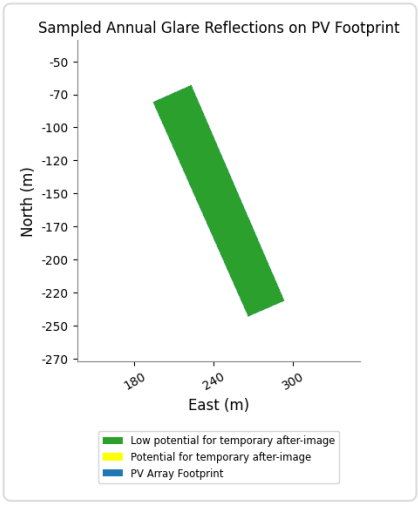
Yellow glare: none

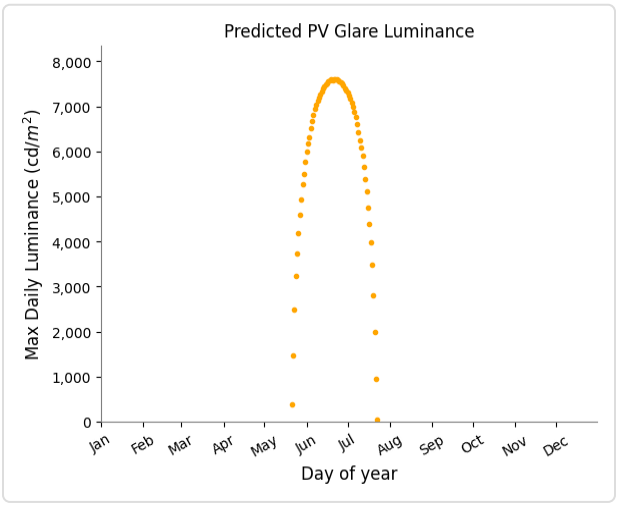
Green glare: 1,651 min.







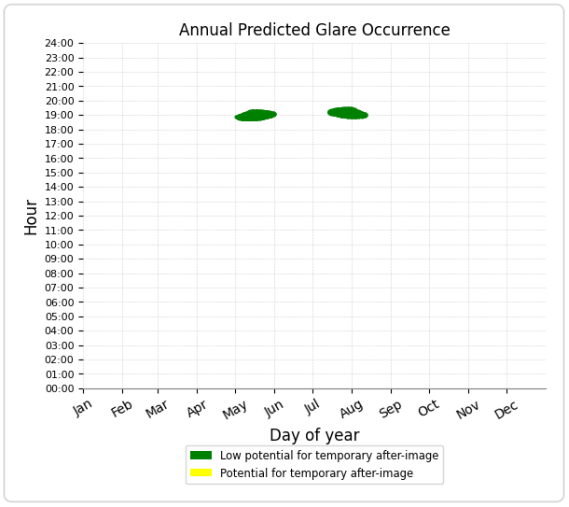


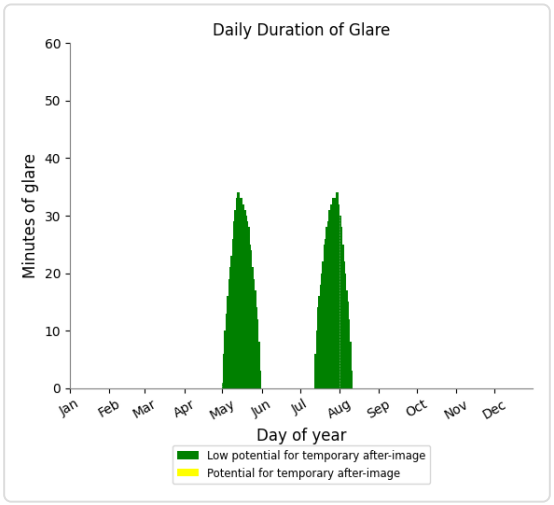


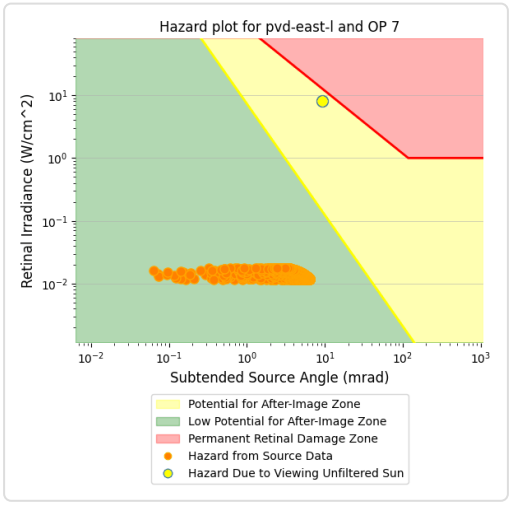
PVD east L and OP 7

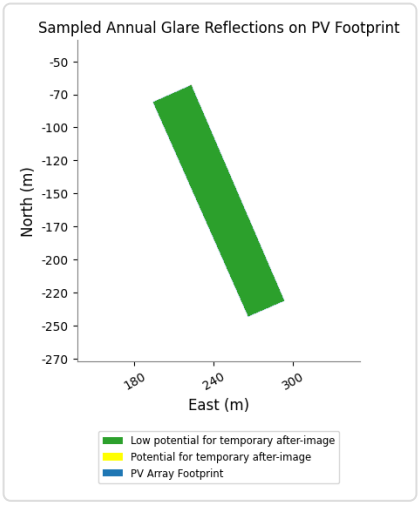
Yellow glare: none

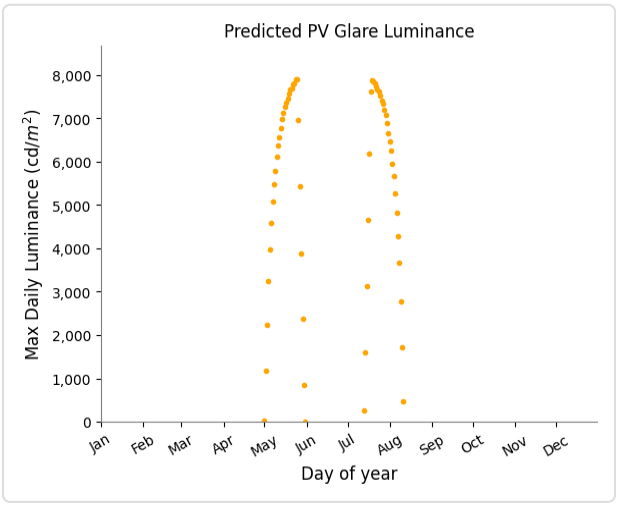
Green glare: 1,375 min.







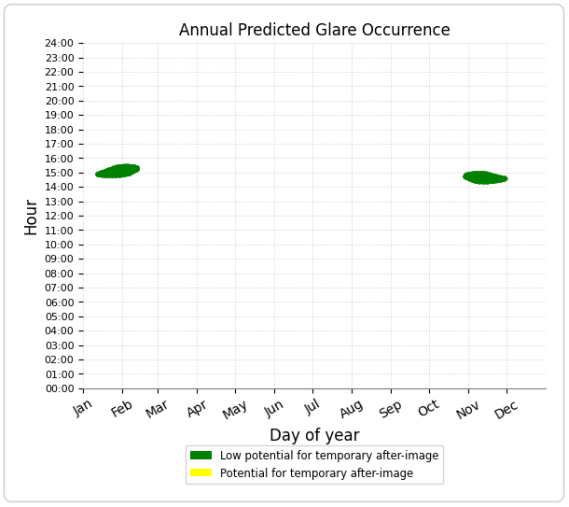


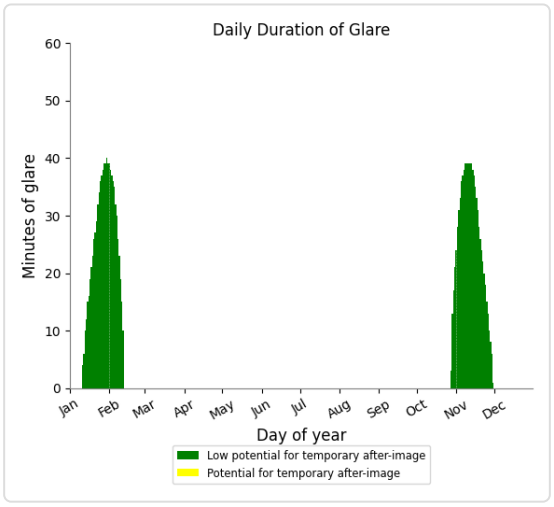


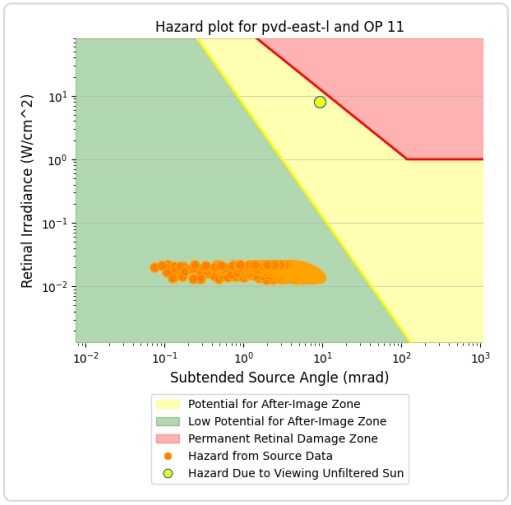
PVD east L and OP 11

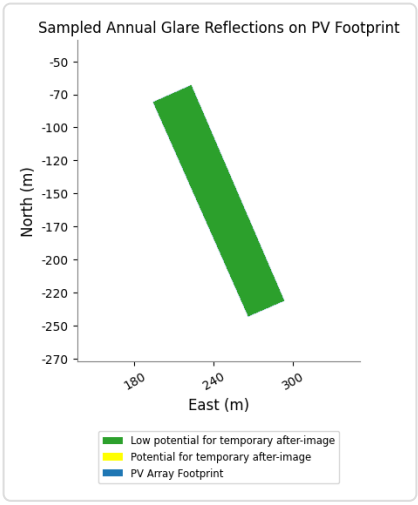
Yellow glare: none

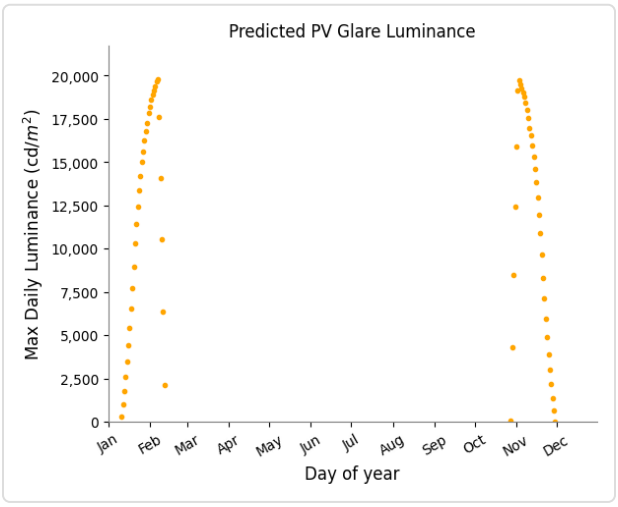
Green glare: 1,762 min.











PVD east L and OP 1

No glare found

PVD east L and OP 5

No glare found

PVD east L and OP 8

No glare found

PVD east L and OP 9

No glare found

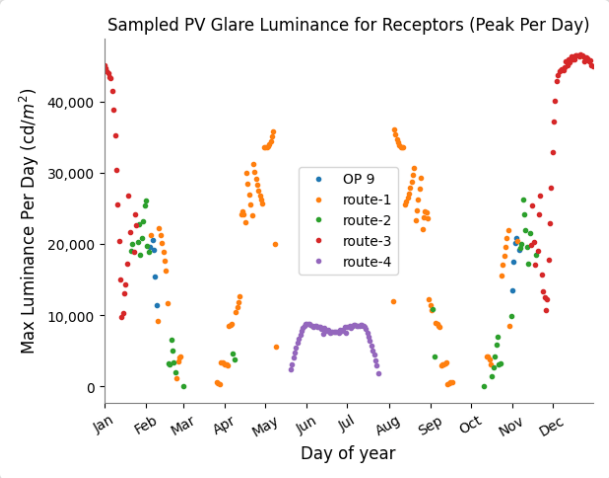
PVD east L and OP 10

No glare found

PV: PVD west H low potential for temporary after-image

Receptor results ordered by category of glare

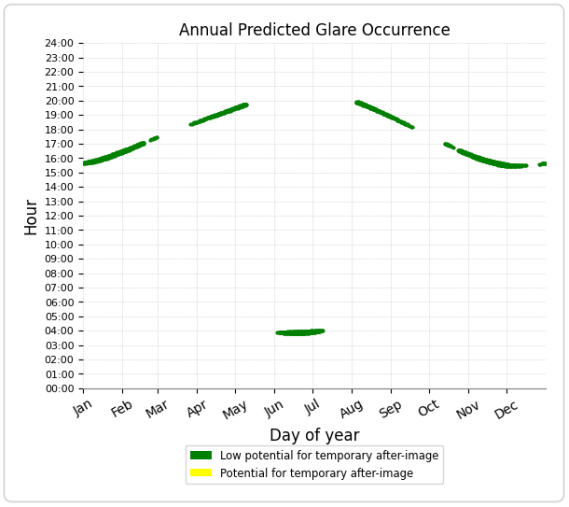
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	1,324	22.1	0	0.0	36,141
Route 2	618	10.3	0	0.0	26,177
Route 3	3,125	52.1	0	0.0	46,555
Route 4	709	11.8	0	0.0	8,817
Route 5	372	6.2	0	0.0	3,971
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 9	927	15.4	0	0.0	20,896
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0

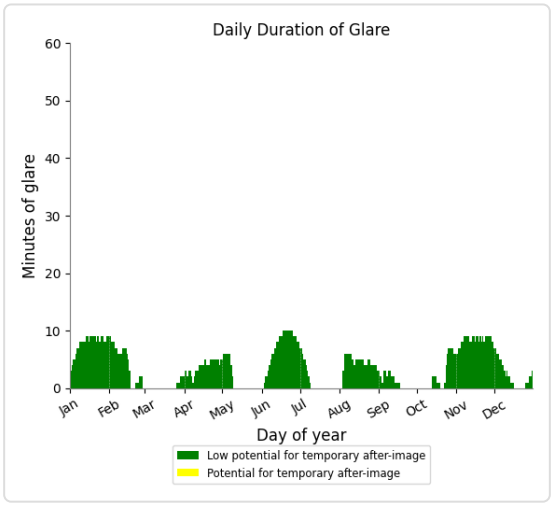


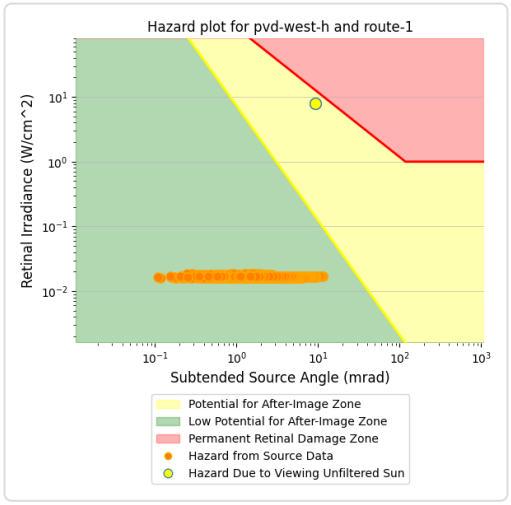
PVD west H and Route: Route 1

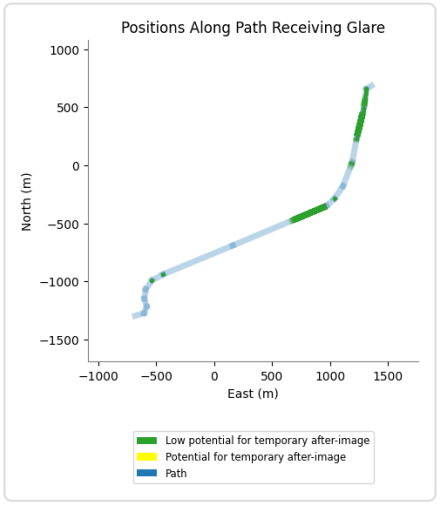
Yellow glare: none

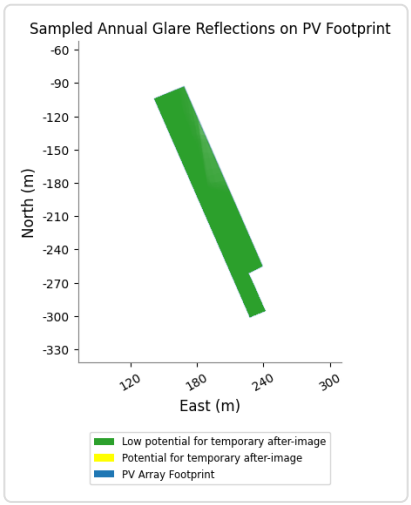
Green glare: 1,324 min.

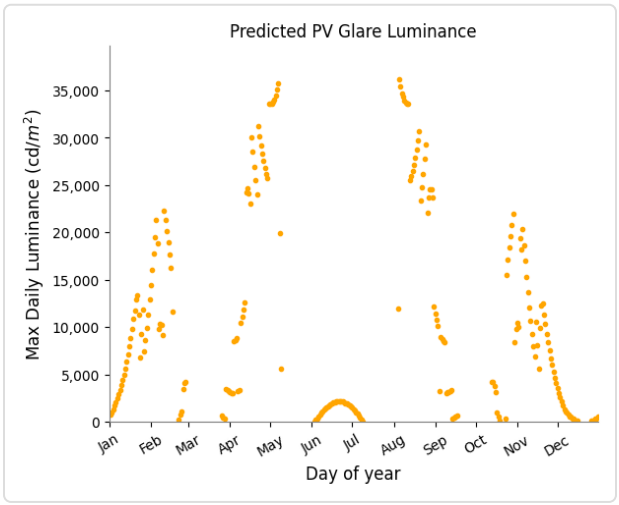








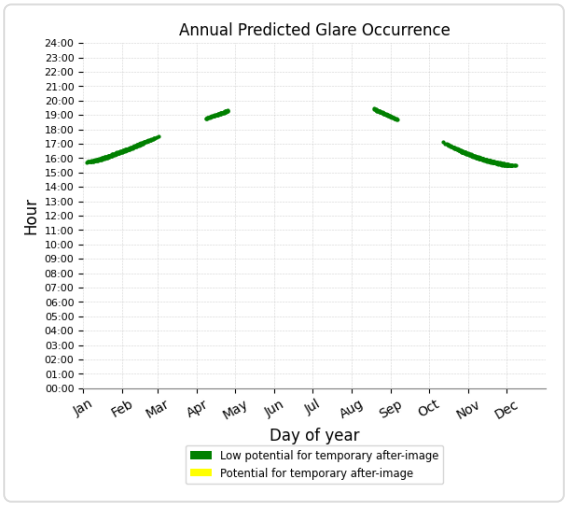


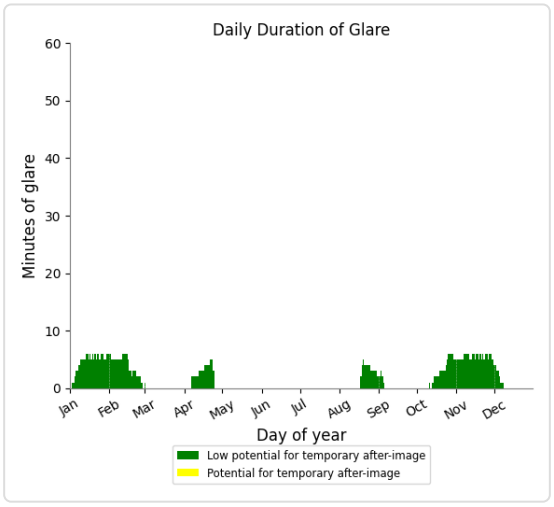


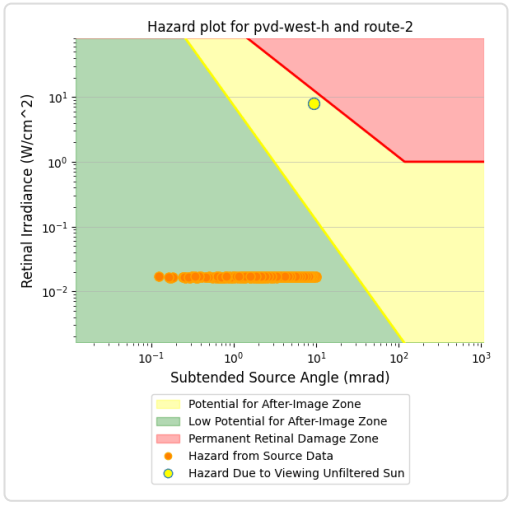
PVD west H and Route: Route 2

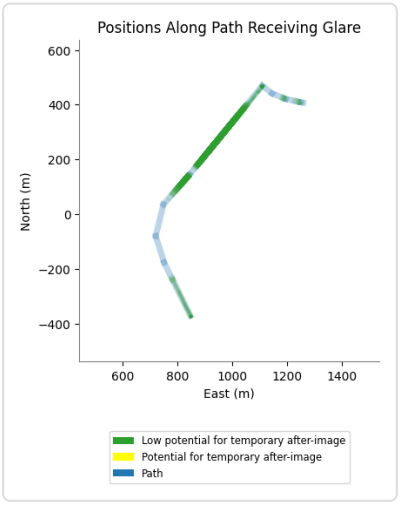
Yellow glare: none

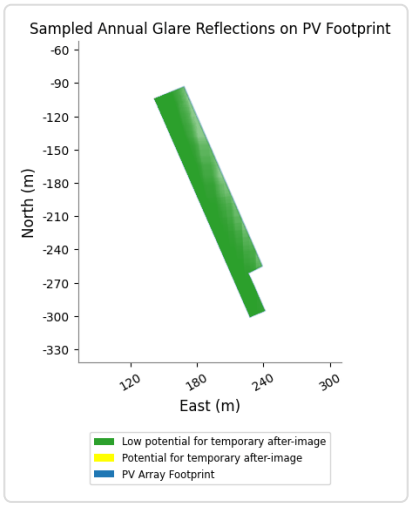
Green glare: 618 min.

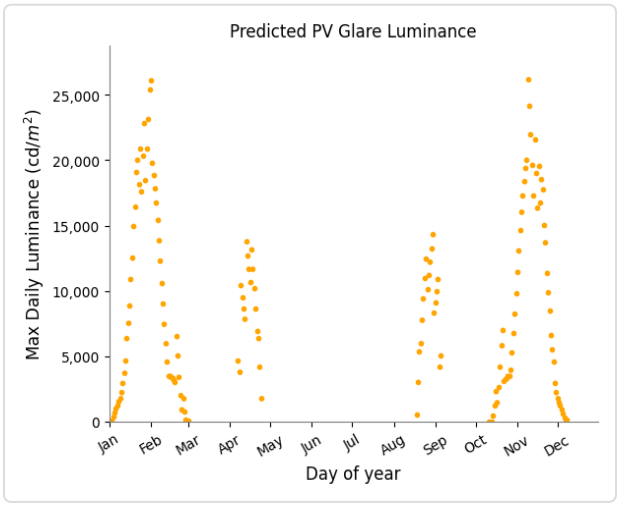








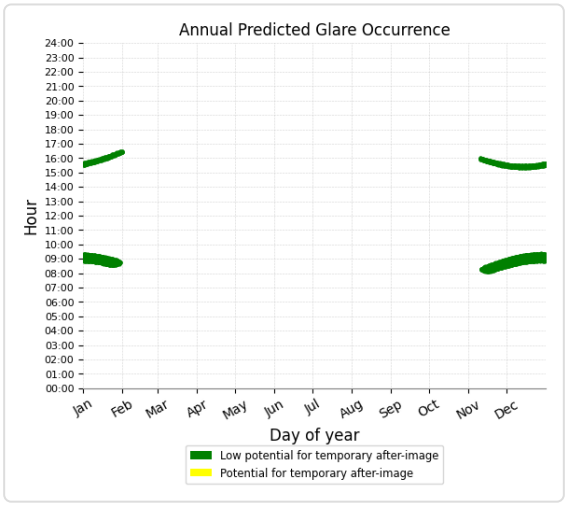


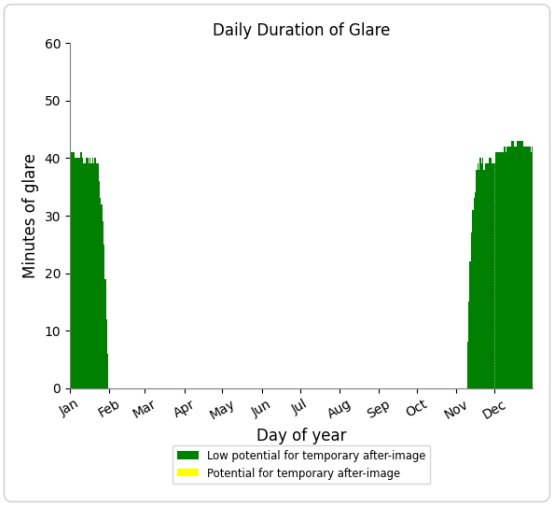


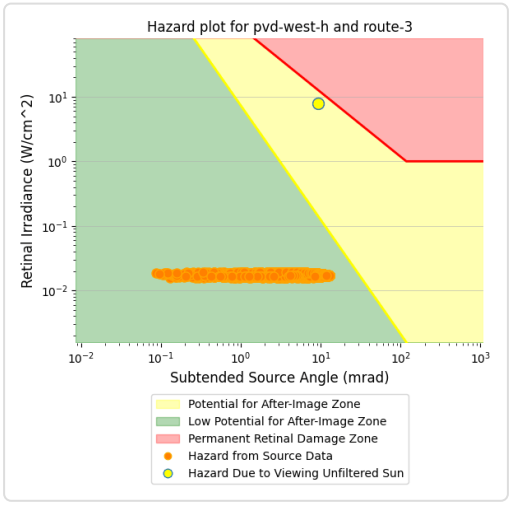
PVD west H and Route: Route 3

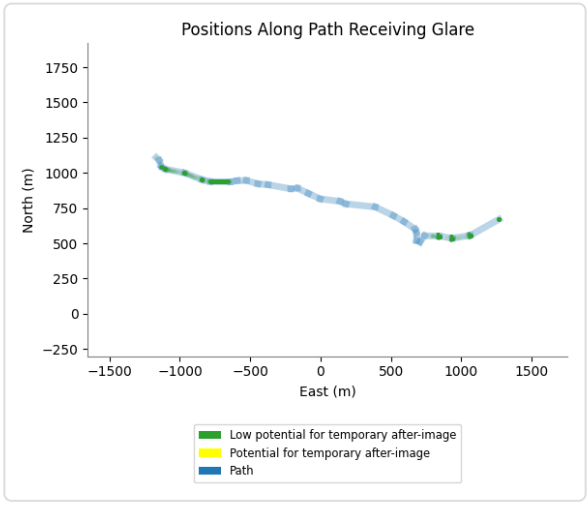
Yellow glare: none

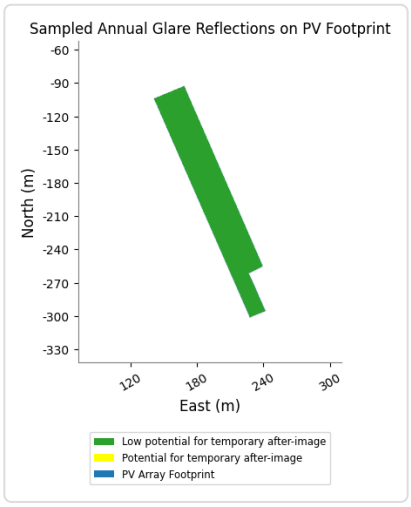
Green glare: 3,125 min.

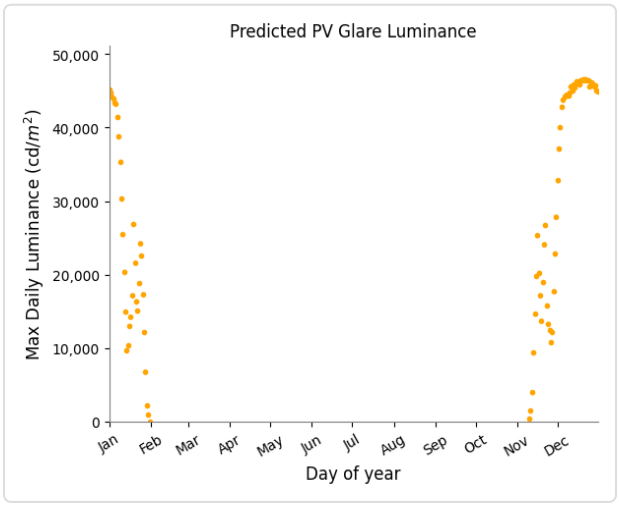








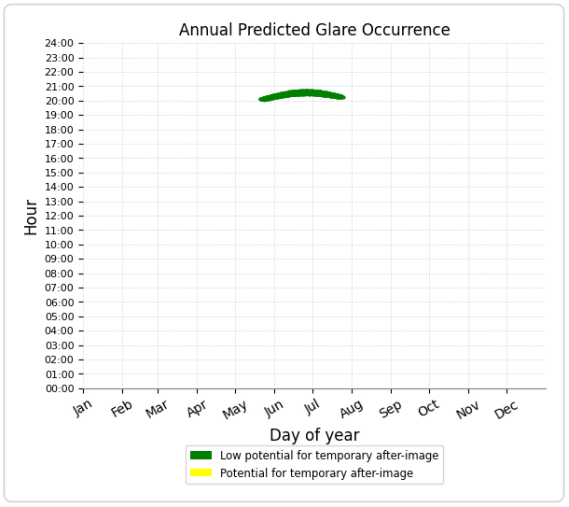


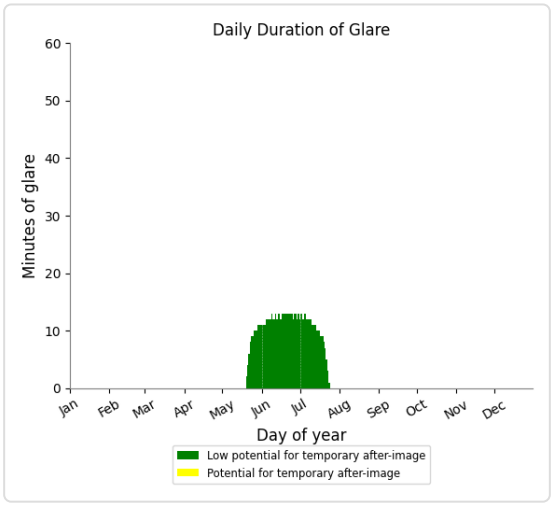


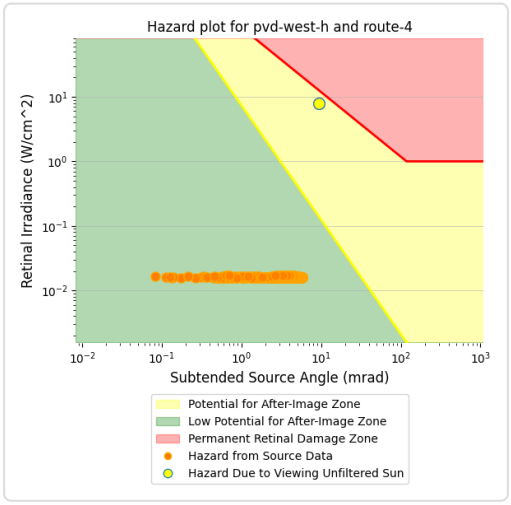
PVD west H and Route: Route 4

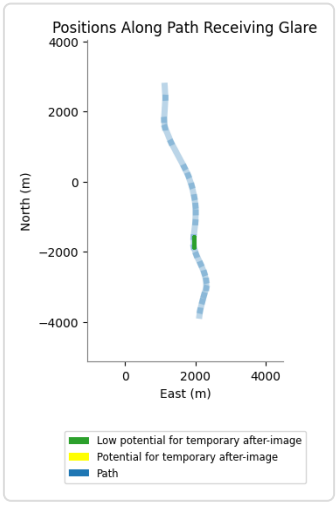
Yellow glare: none

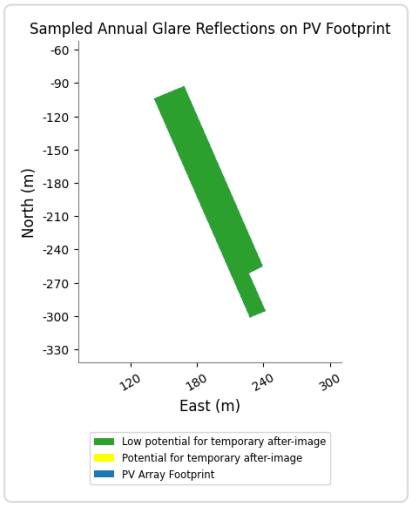
Green glare: 709 min.

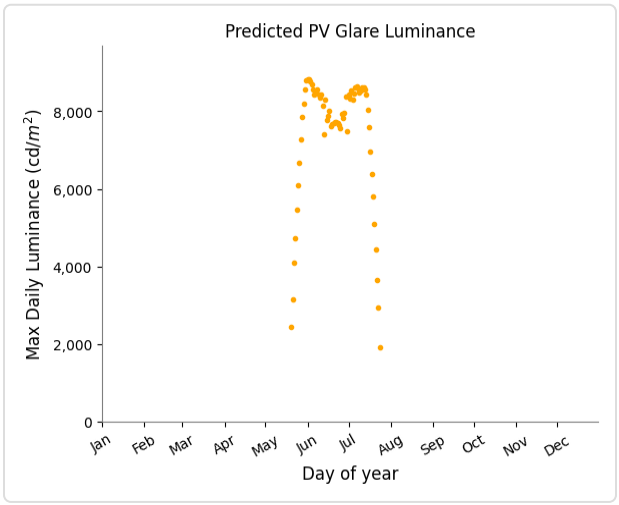








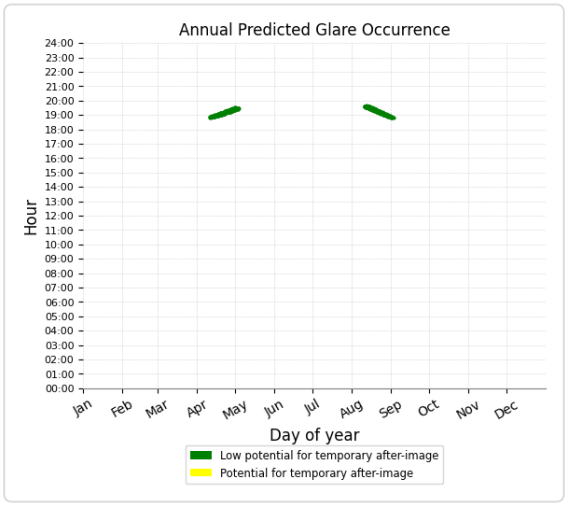


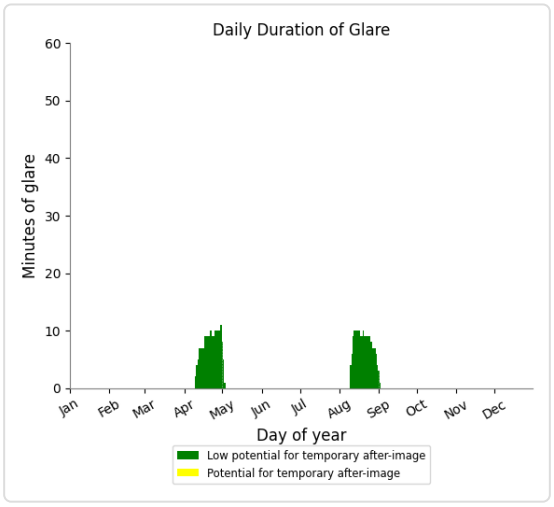


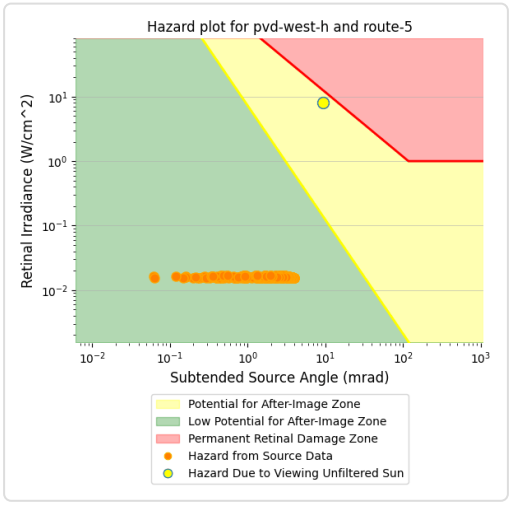
PVD west H and Route: Route 5

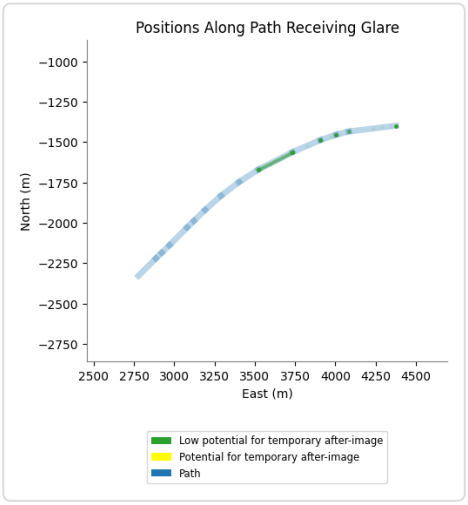
Yellow glare: none

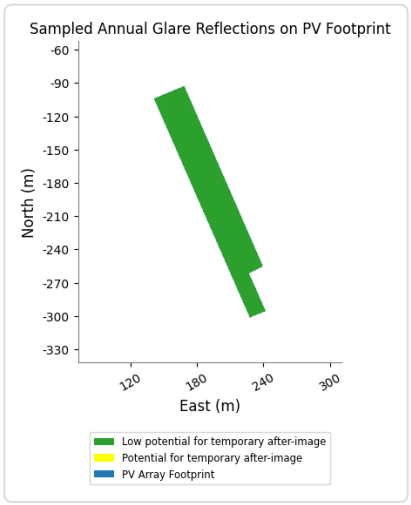
Green glare: 372 min.

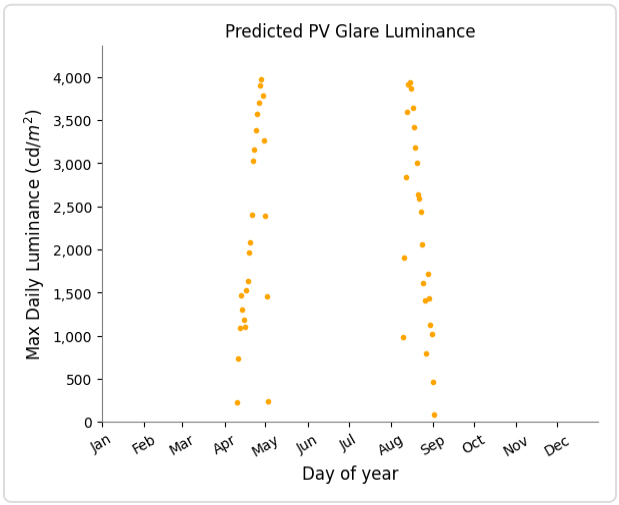












PVD west H and FP: FP 1

No glare found

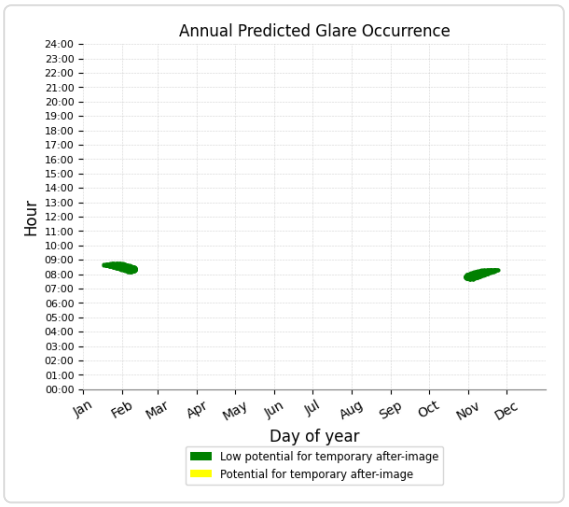
PVD west H and FP: FP 2

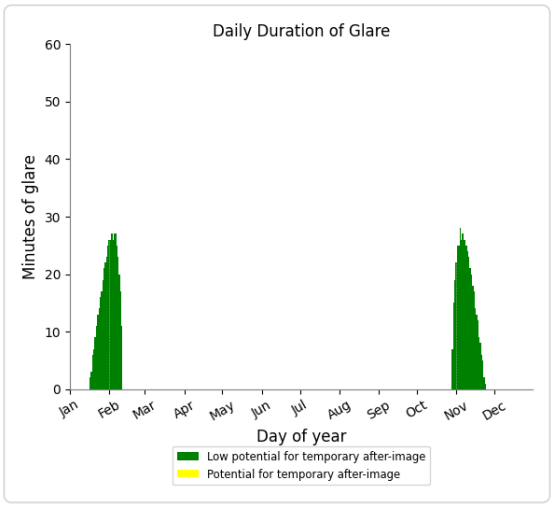
No glare found

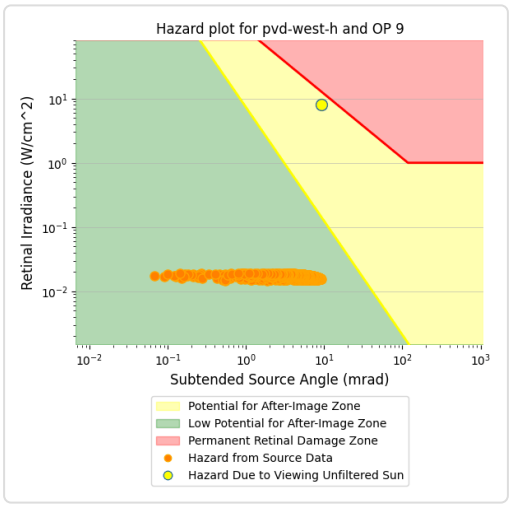
PVD west H and OP 9

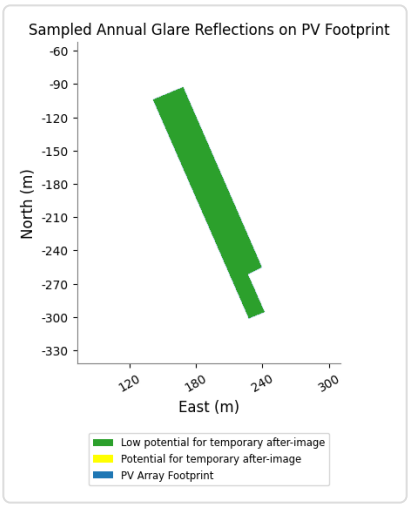
Yellow glare: none

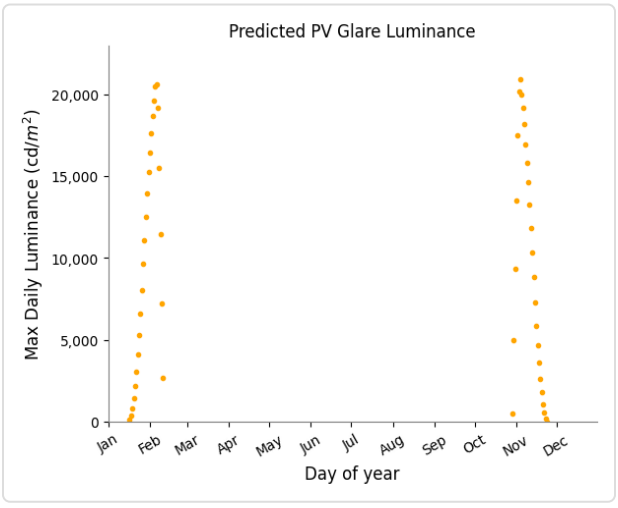
Green glare: 927 min.











PVD west H and OP 1

No glare found

PVD west H and OP 2

No glare found

PVD west H and OP 3

No glare found

PVD west H and OP 4

No glare found

PVD west H and OP 5

No glare found

PVD west H and OP 6

No glare found

PVD west H and OP 7

No glare found

PVD west H and OP 8

No glare found

PVD west H and OP 10

No glare found

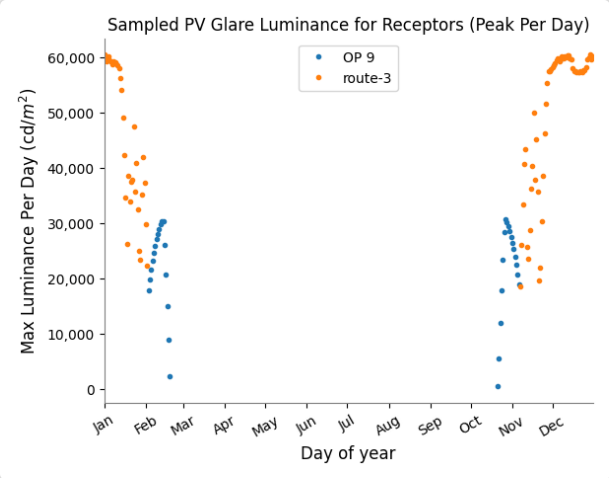
PVD west H and OP 11

No glare found

PV: PVD west L low potential for temporary after-image

Receptor results ordered by category of glare

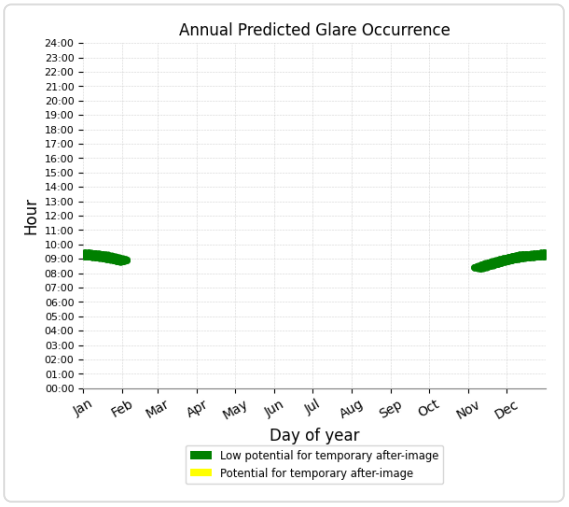
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	2,592	43.2	0	0.0	60,419
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Route 4	0	0.0	0	0.0	0
Route 5	0	0.0	0	0.0	0
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 9	1,088	18.1	0	0.0	30,697
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0

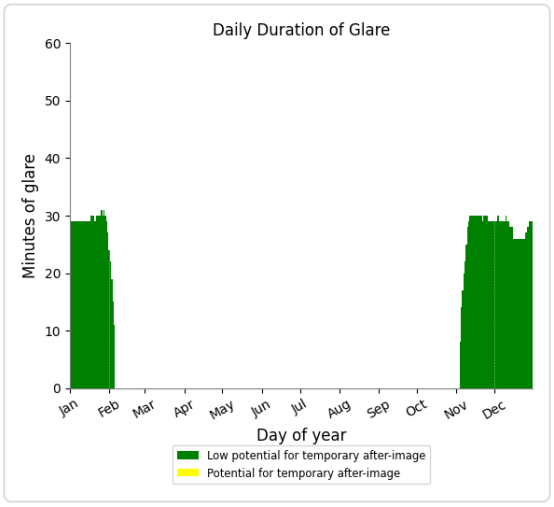


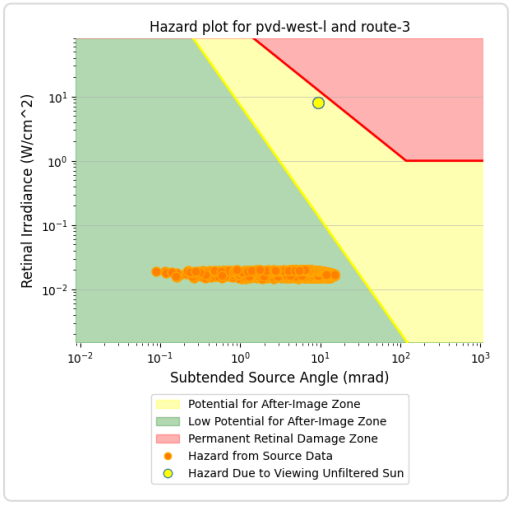
PVD west L and Route: Route 3

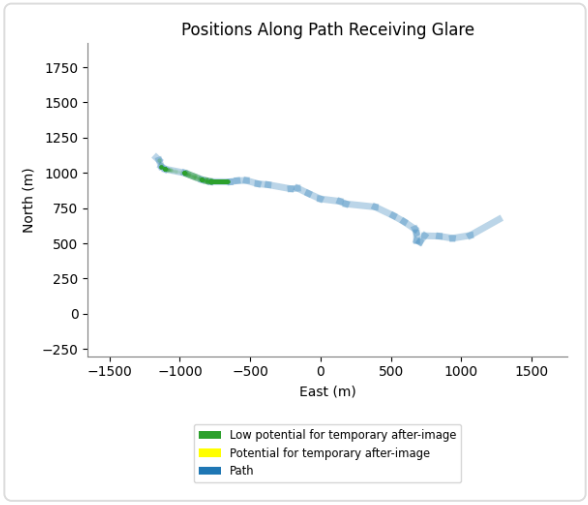
Yellow glare: none

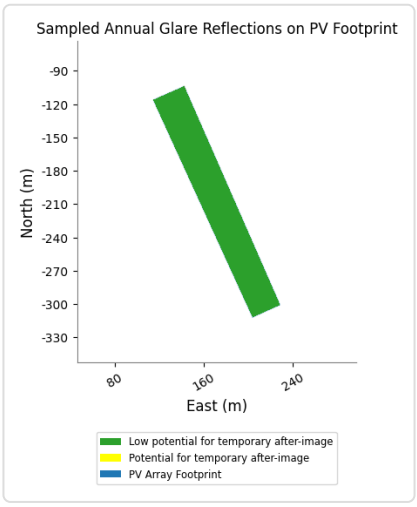
Green glare: 2,592 min.

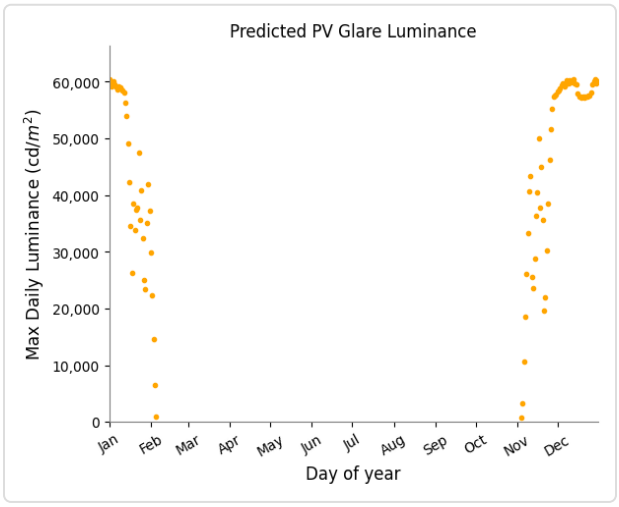












PVD west L and Route: Route 1

No glare found

PVD west L and Route: Route 2

No glare found

PVD west L and Route: Route 4

No glare found

PVD west L and Route: Route 5

No glare found

PVD west L and FP: FP 1

No glare found

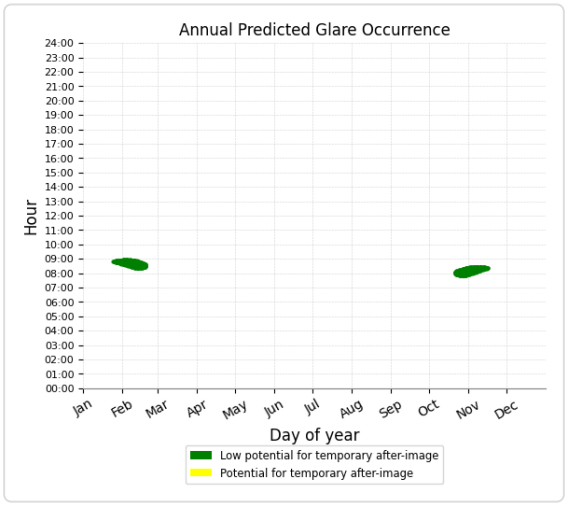
PVD west L and FP: FP 2

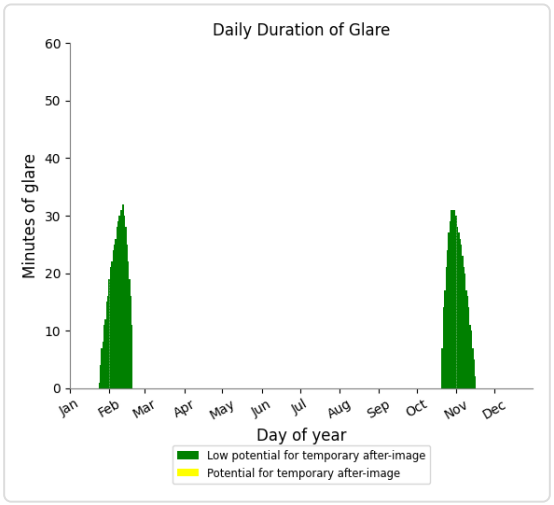
No glare found

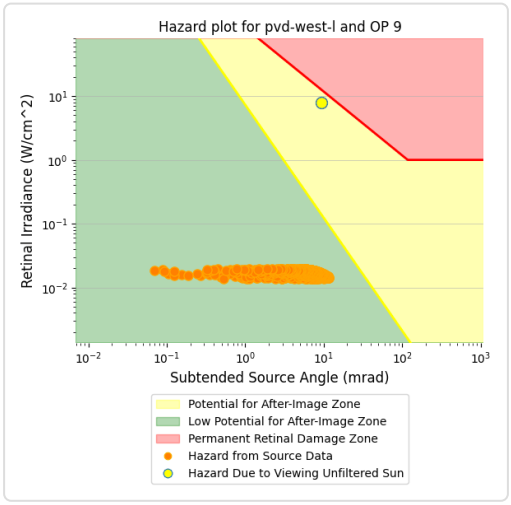
PVD west L and OP 9

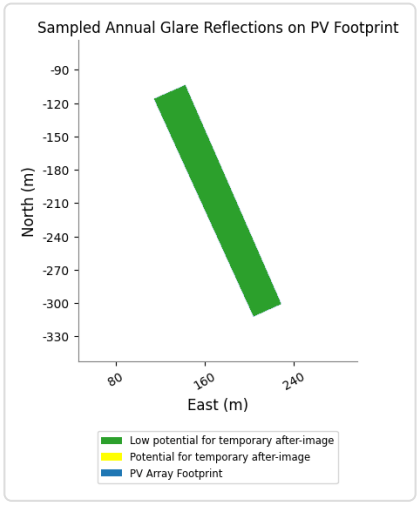
Yellow glare: none

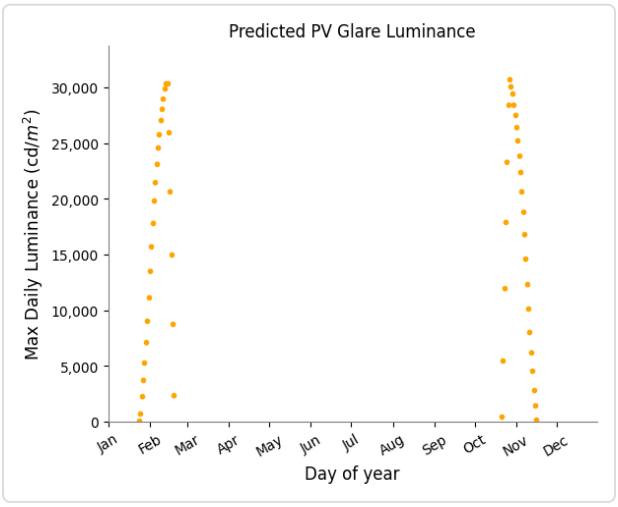
Green glare: 1,088 min.











PVD west L and OP 1

No glare found

PVD west L and OP 2

No glare found

PVD west L and OP 3

No glare found

PVD west L and OP 4

No glare found

PVD west L and OP 5

No glare found

PVD west L and OP 6

No glare found

PVD west L and OP 7

No glare found

PVD west L and OP 8

No glare found

PVD west L and OP 10

No glare found

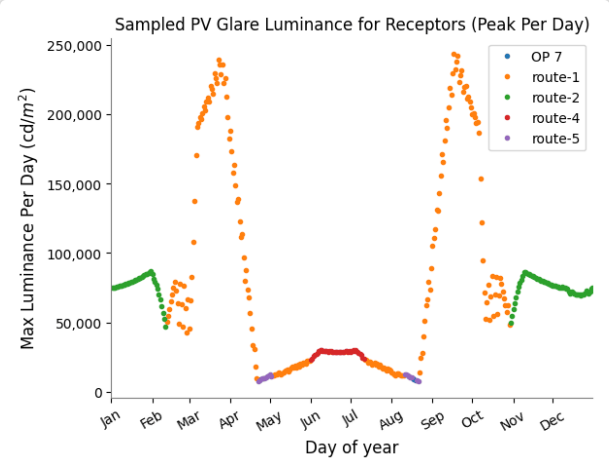
PVD west L and OP 11

No glare found

PV: PW east H low potential for temporary after-image

Receptor results ordered by category of glare

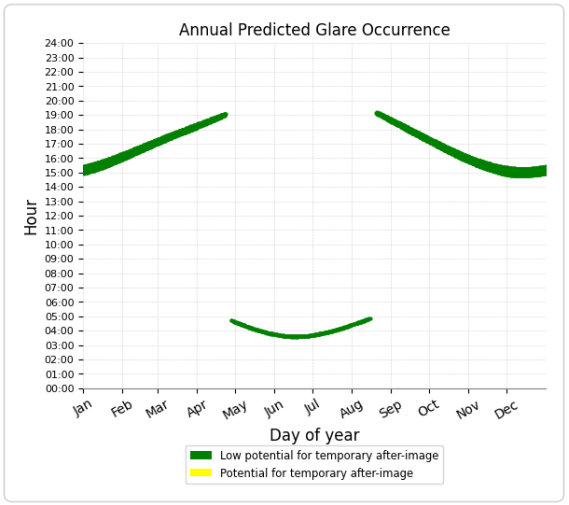
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	5,482	91.4	0	0.0	243,356
Route 2	2,825	47.1	0	0.0	86,710
Route 3	1,991	33.2	0	0.0	63,284
Route 4	1,063	17.7	0	0.0	30,108
Route 5	1,236	20.6	0	0.0	12,554
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 6	732	12.2	0	0.0	11,939
OP 7	644	10.7	0	0.0	9,640
OP 11	789	13.2	0	0.0	13,269
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0

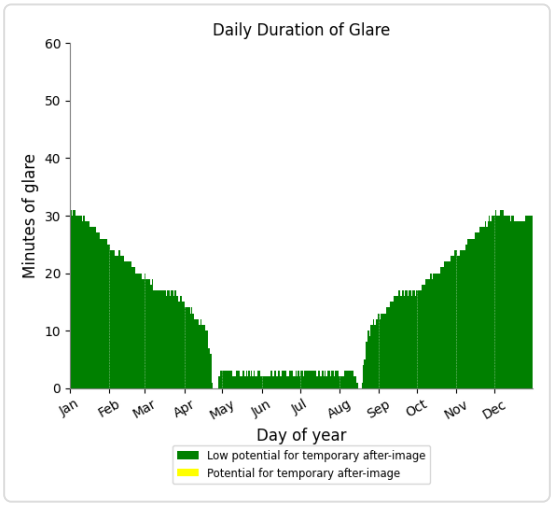


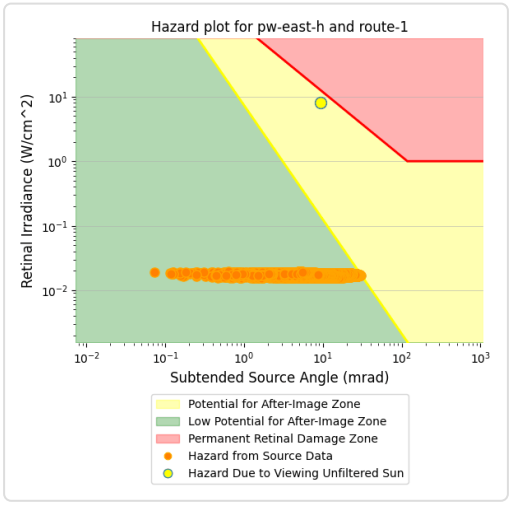
PW east H and Route: Route 1

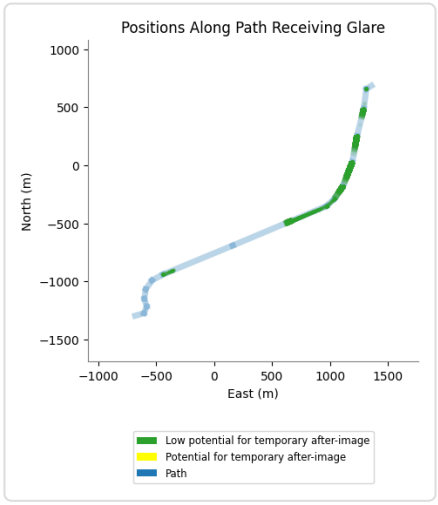
Yellow glare: none

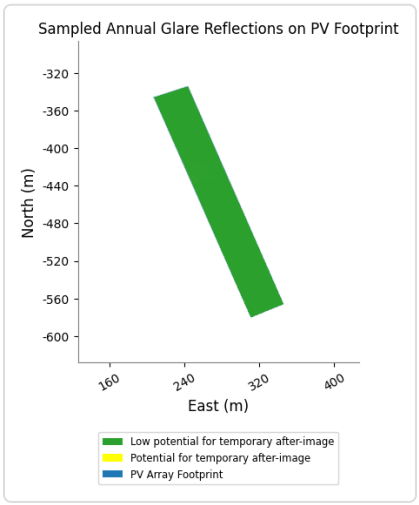
Green glare: 5,482 min.

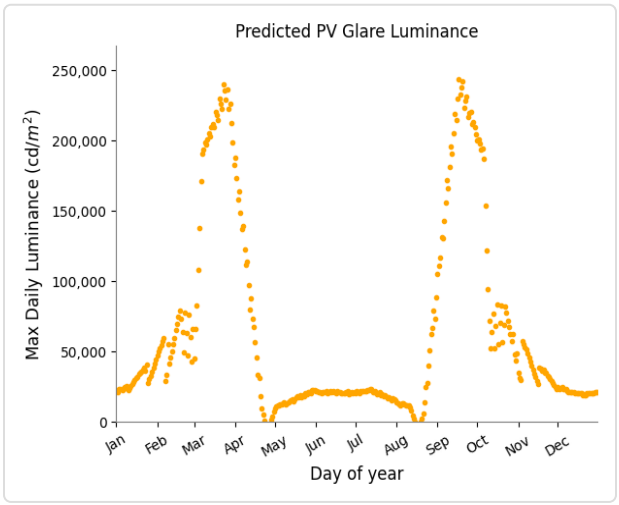








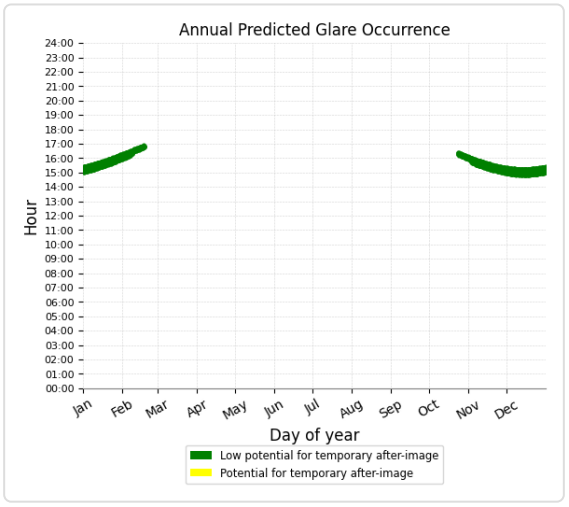


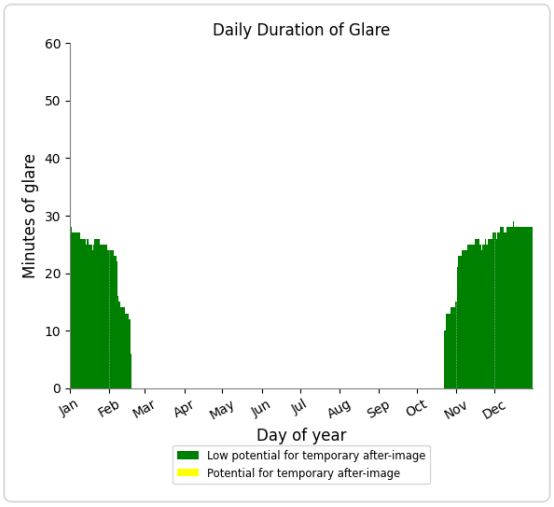


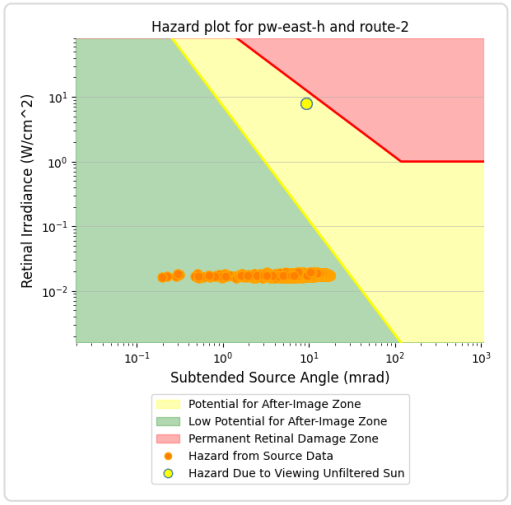
PW east H and Route: Route 2

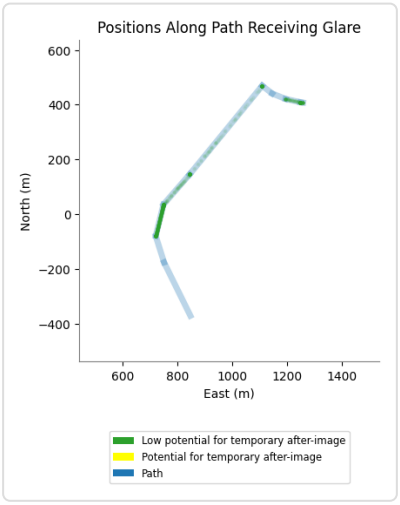
Yellow glare: none

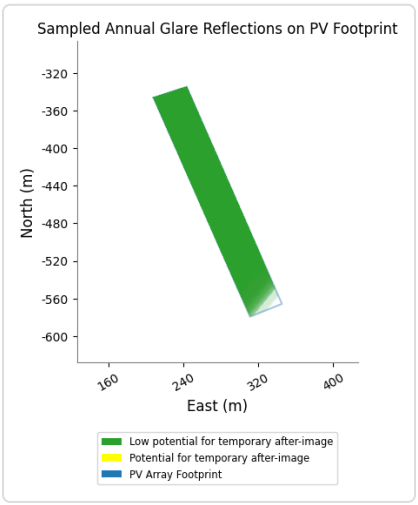
Green glare: 2,825 min.

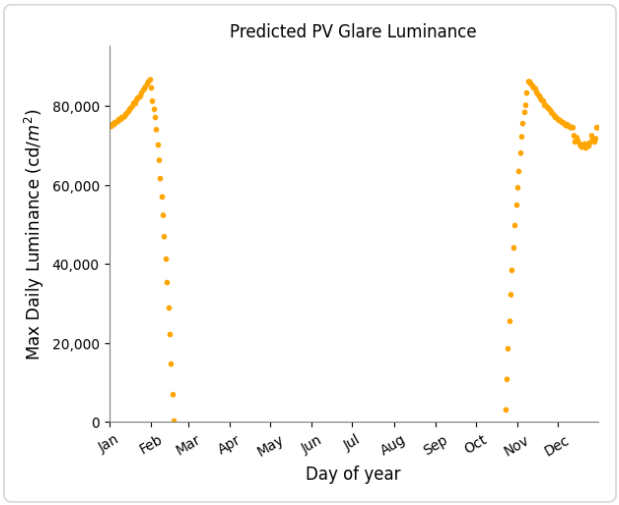








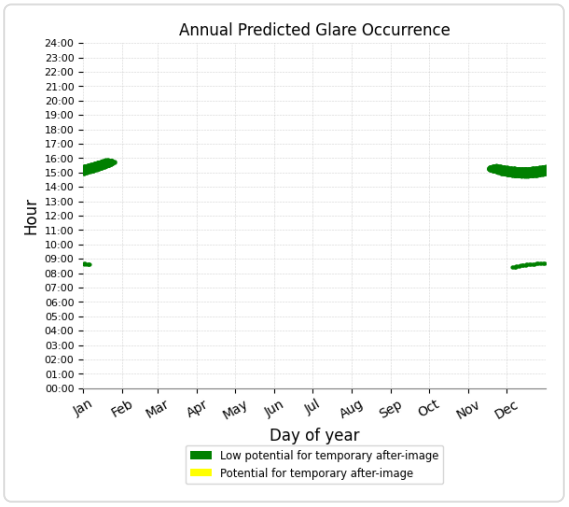


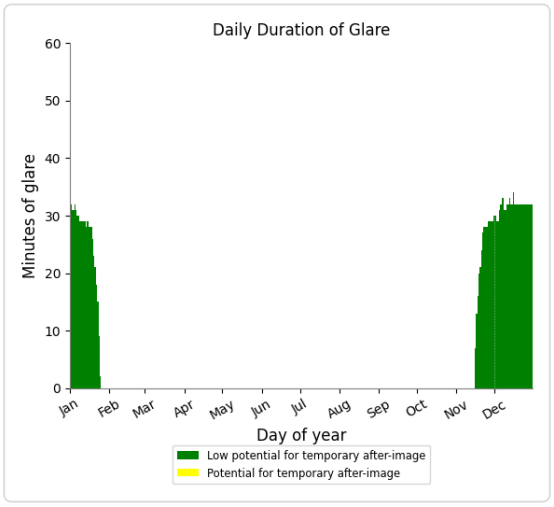


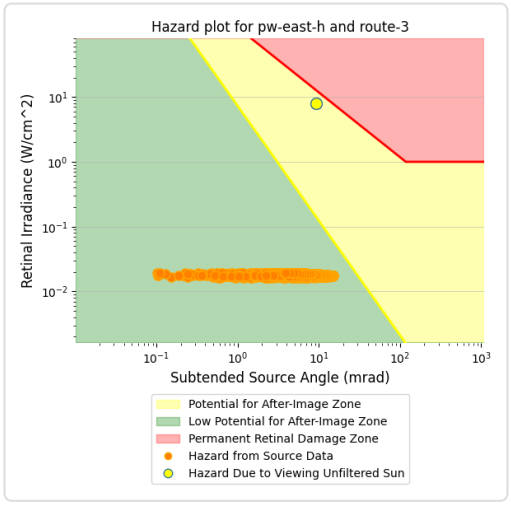
PW east H and Route: Route 3

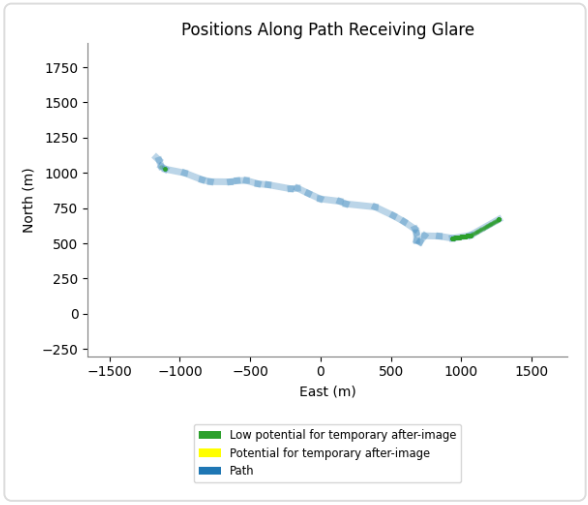
Yellow glare: none

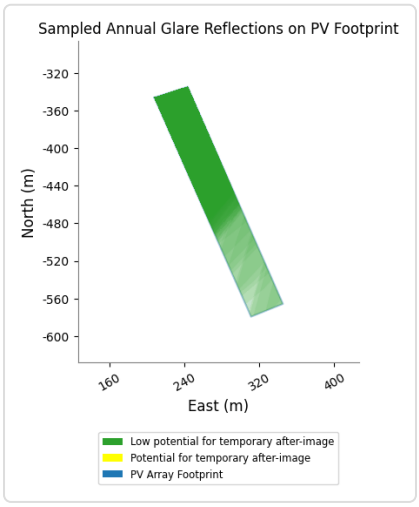
Green glare: 1,991 min.

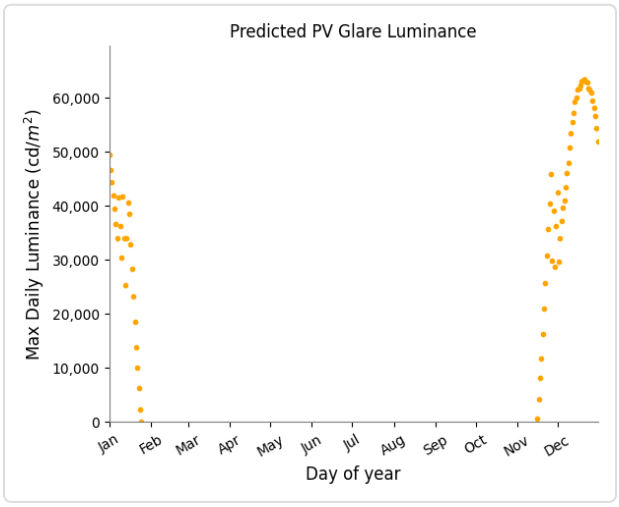








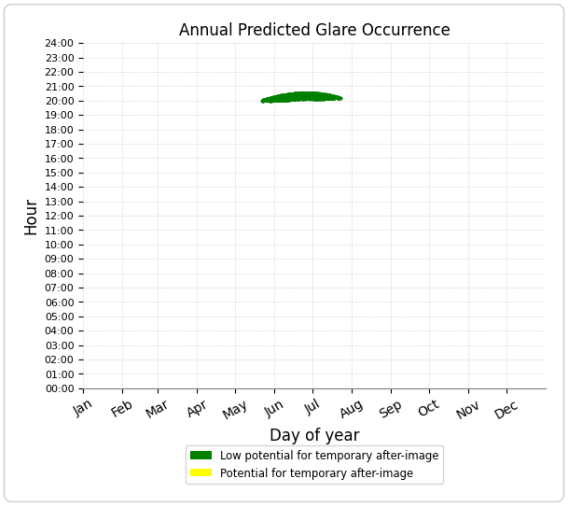


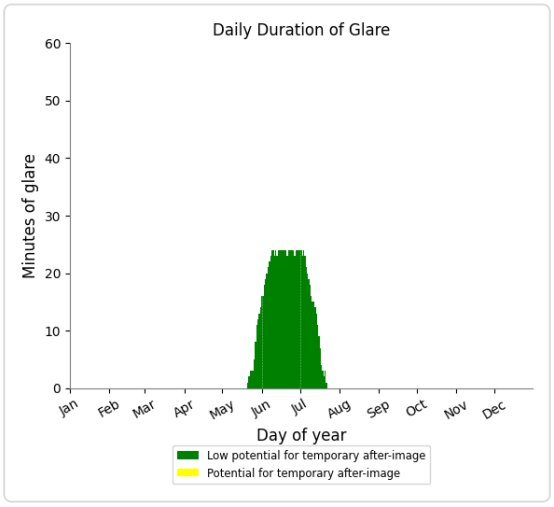


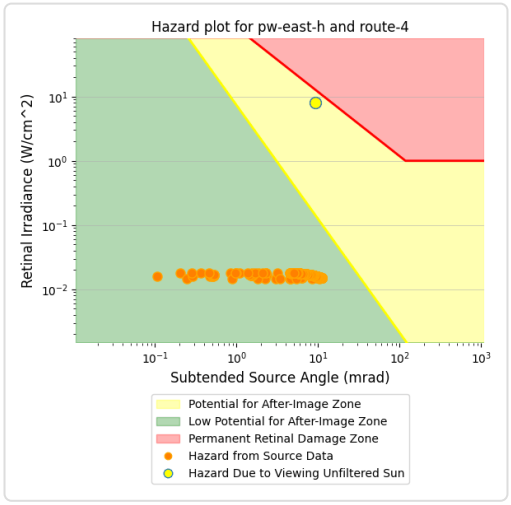
PW east H and Route: Route 4

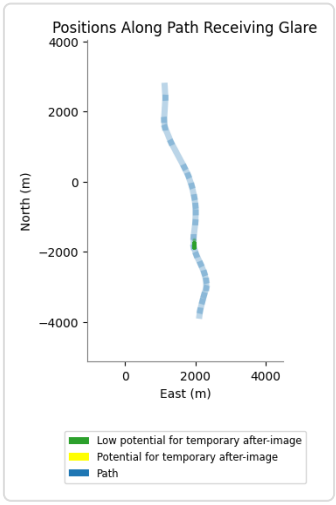
Yellow glare: none

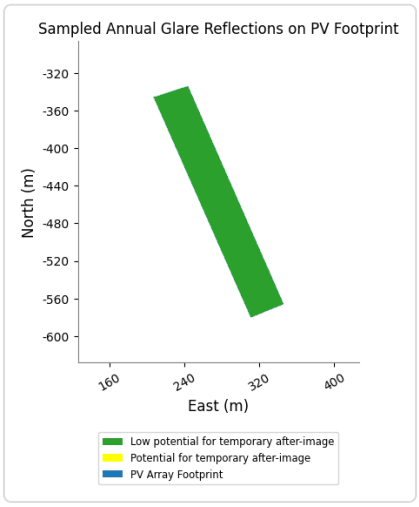
Green glare: 1,063 min.

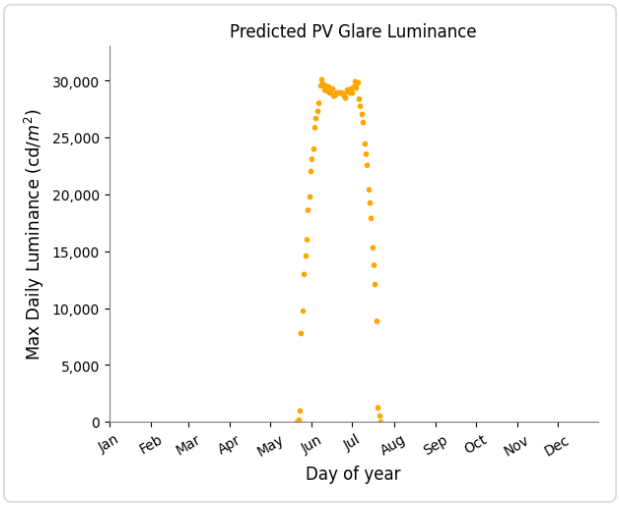








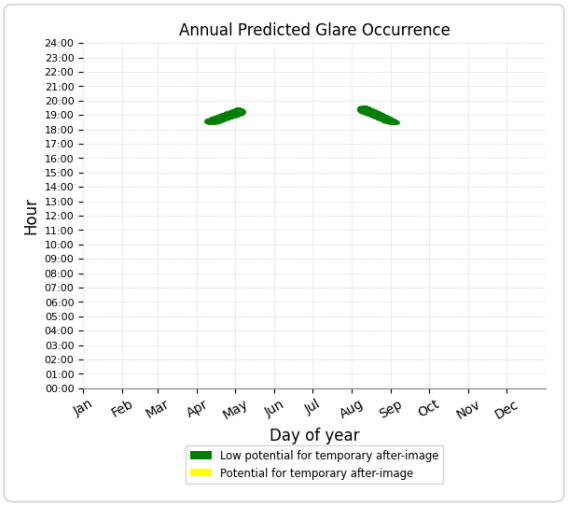


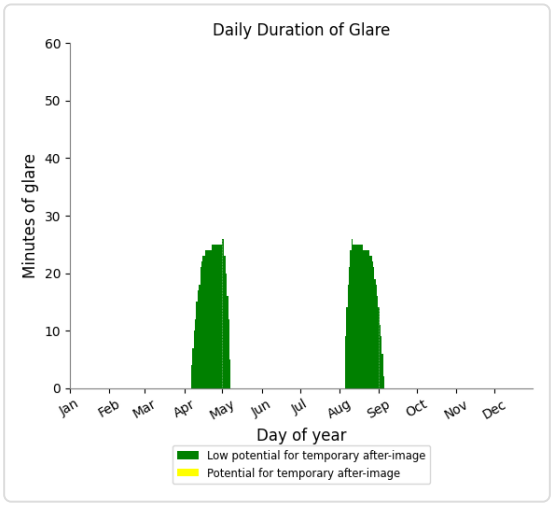


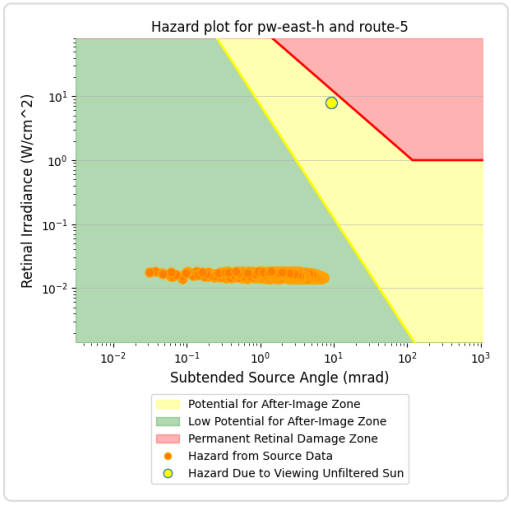
PW east H and Route: Route 5

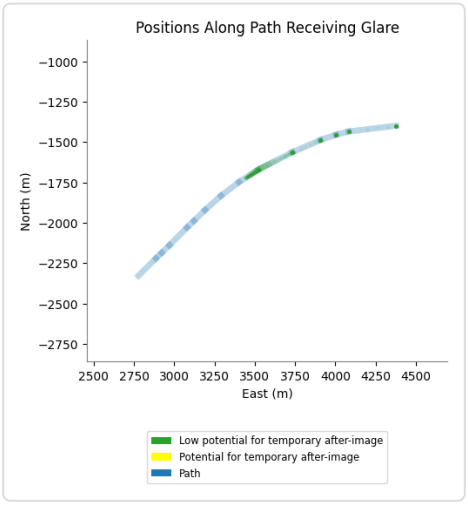
Yellow glare: none

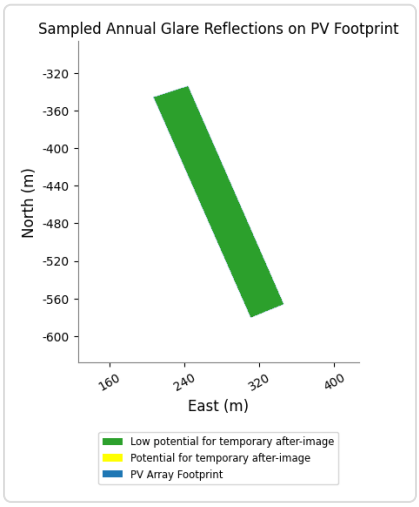
Green glare: 1,236 min.

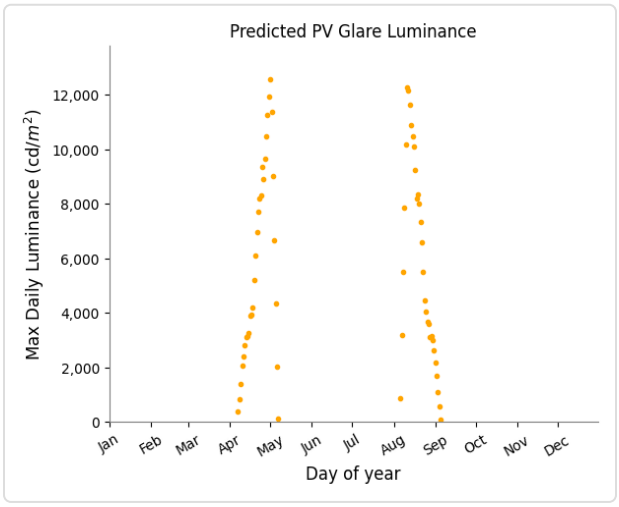












PW east H and FP: FP 1

No glare found

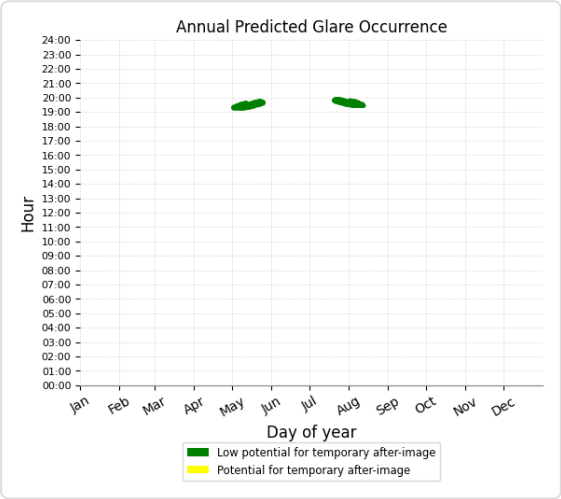
PW east H and FP: FP 2

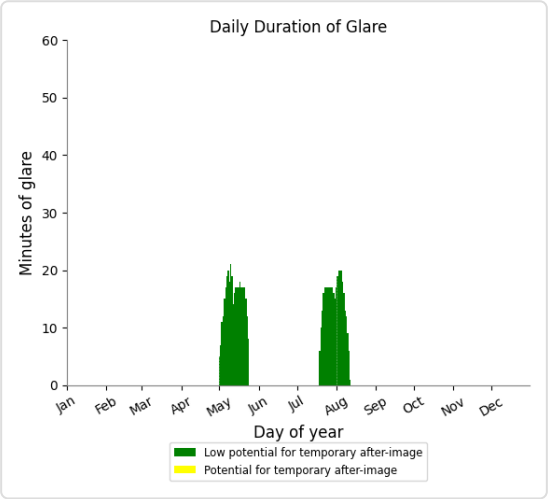
No glare found

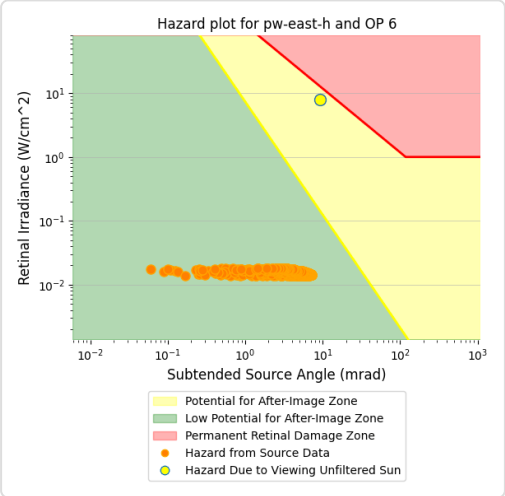
PW east H and OP 6

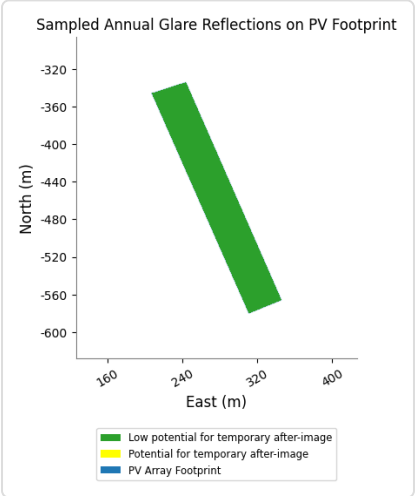
Yellow glare: none

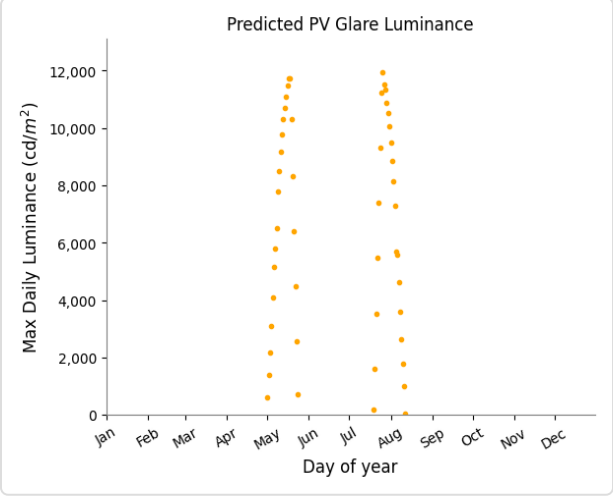
Green glare: 732 min.







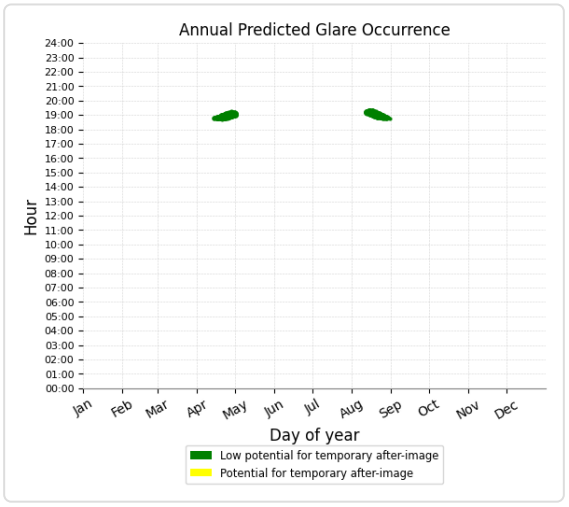


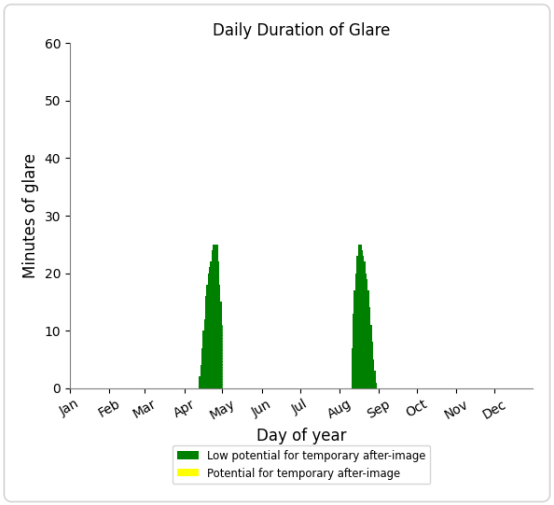


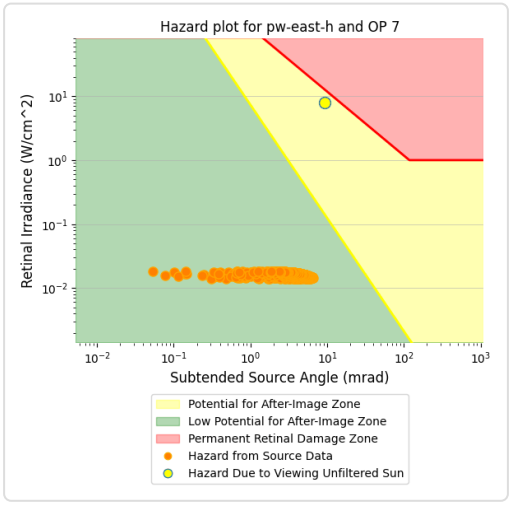
PW east H and OP 7

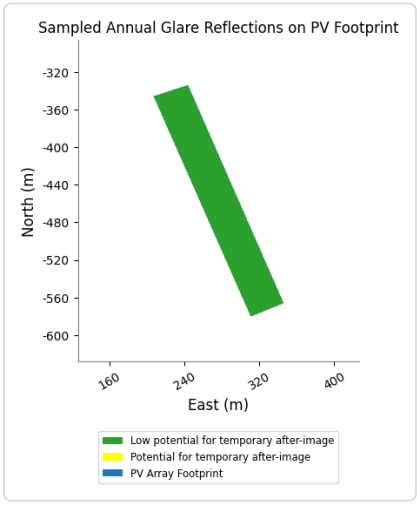
Yellow glare: none

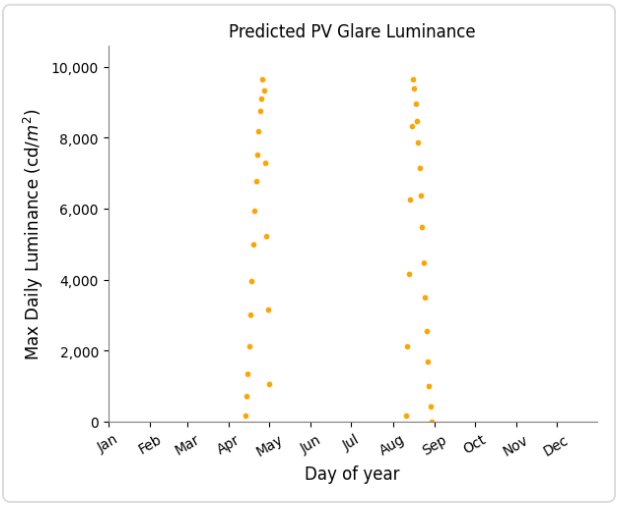
Green glare: 644 min.







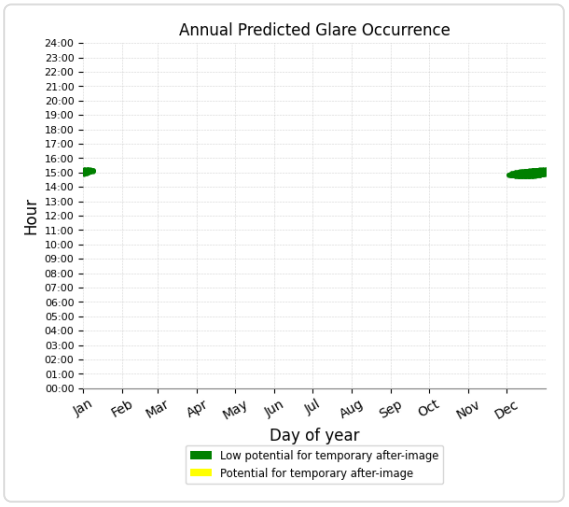


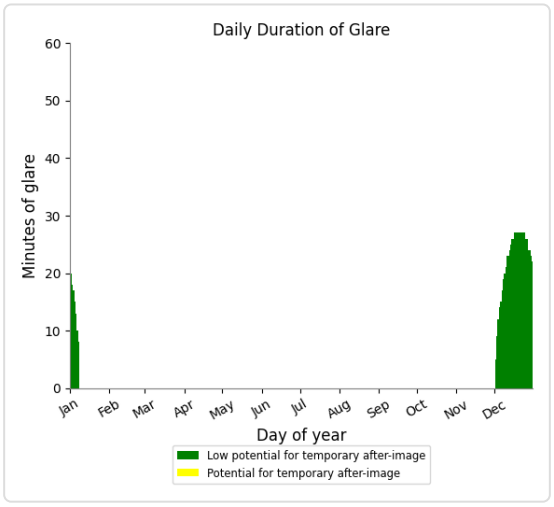


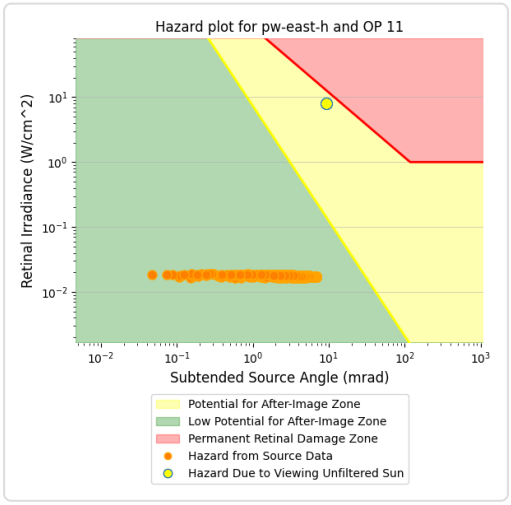
PW east H and OP 11

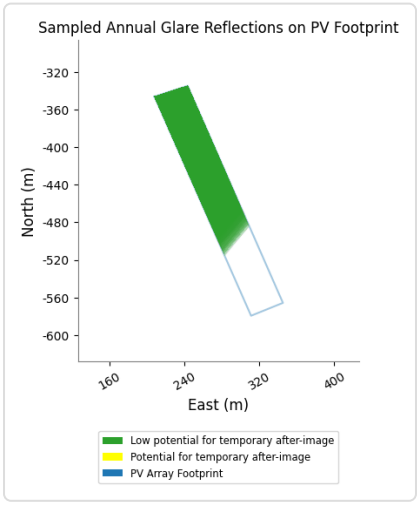
Yellow glare: none

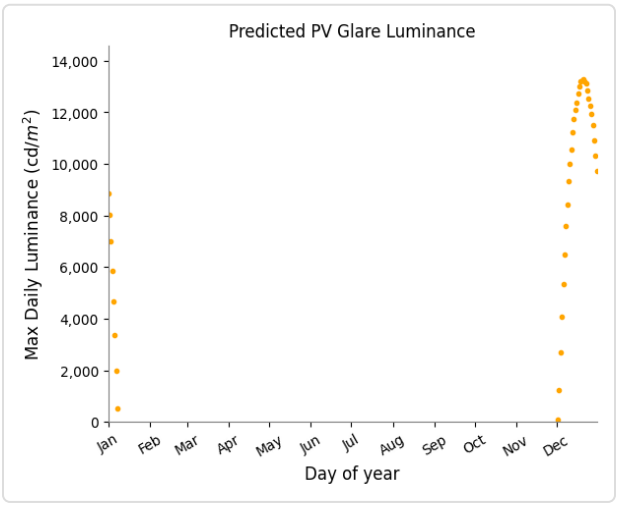
Green glare: 789 min.











PW east H and OP 1

No glare found

PW east H and OP 2

No glare found

PW east H and OP 3

No glare found

PW east H and OP 4

No glare found

PW east H and OP 5

No glare found

PW east H and OP 8

No glare found

PW east H and OP 9

No glare found

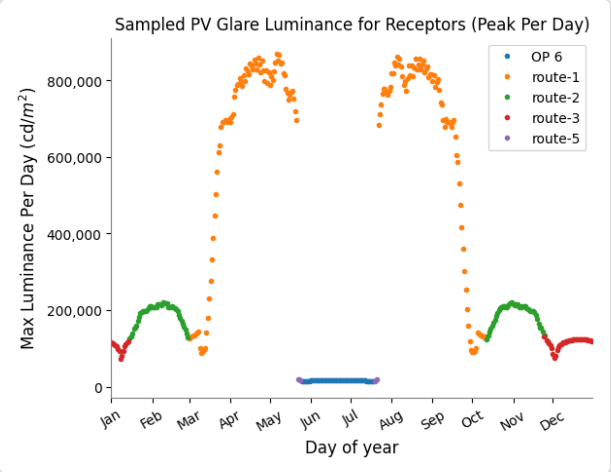
PW east H and OP 10

No glare found

PV: PW east L potential temporary after-image

Receptor results ordered by category of glare

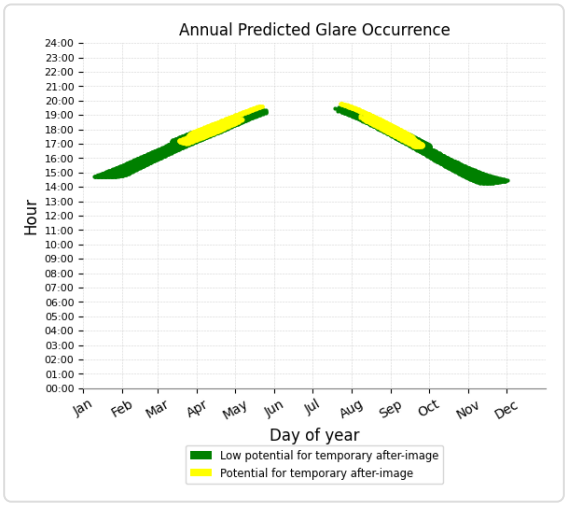
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	6,653	110.9	3,395	56.6	868,955
Route 2	4,932	82.2	0	0.0	219,851
Route 3	5,012	83.5	0	0.0	149,586
Route 4	2,296	38.3	0	0.0	69,578
Route 5	2,617	43.6	0	0.0	19,796
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 2	2,948	49.1	0	0.0	115,019
OP 3	2,824	47.1	0	0.0	116,812
OP 4	2,806	46.8	0	0.0	95,542
OP 6	2,408	40.1	0	0.0	17,369
OP 7	1,375	22.9	0	0.0	15,501
OP 11	2,205	36.8	0	0.0	31,466
OP 1	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0

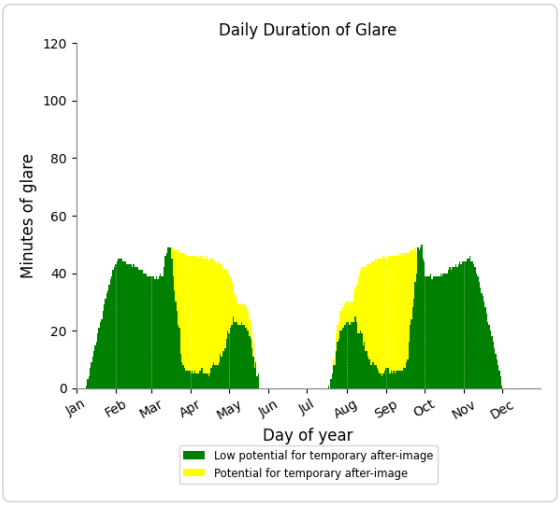


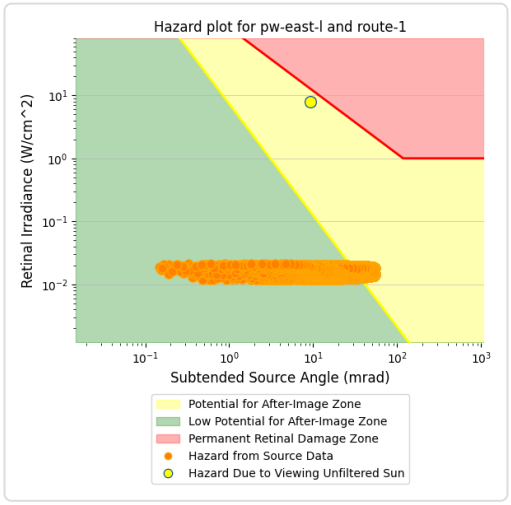
PW east L and Route: Route 1

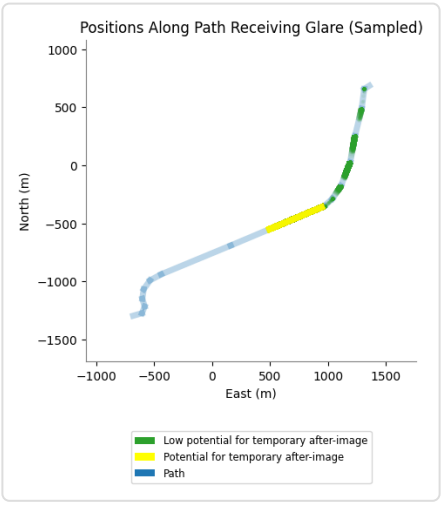
Yellow glare: 3,395 min.

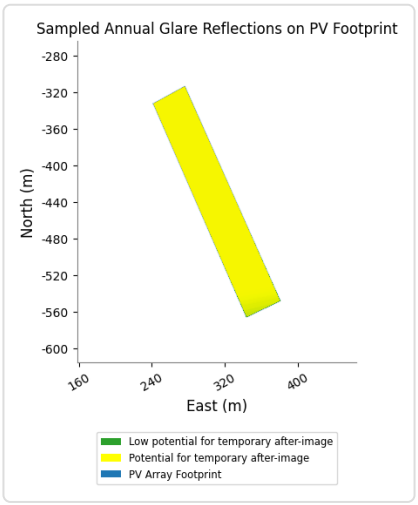
Green glare: 6,653 min.

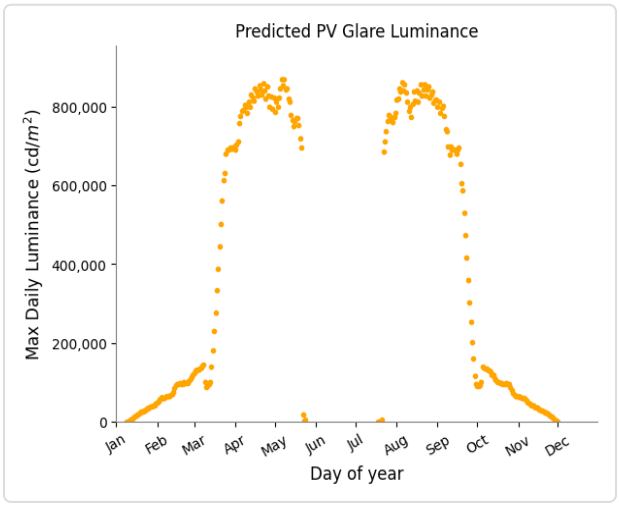








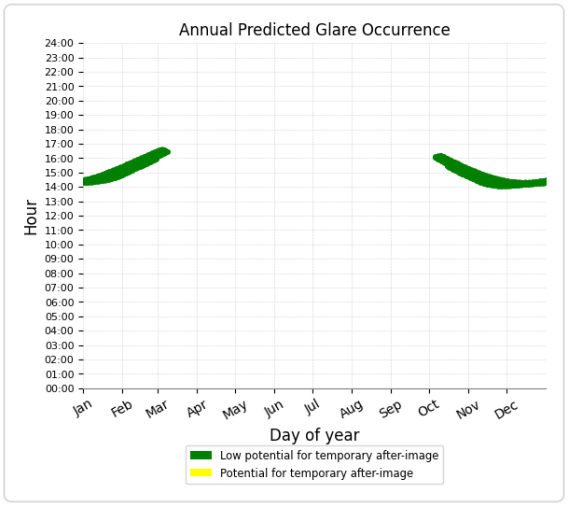


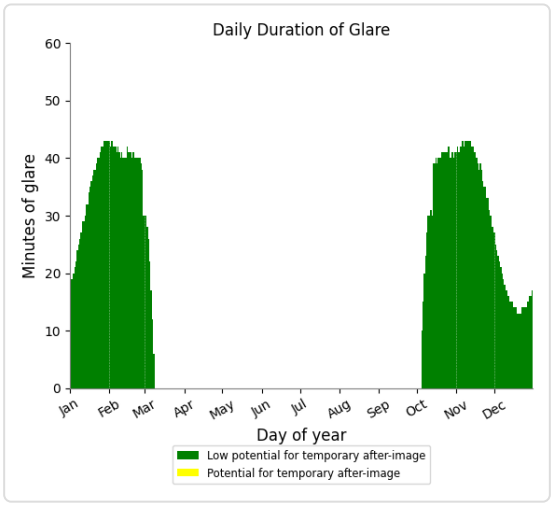


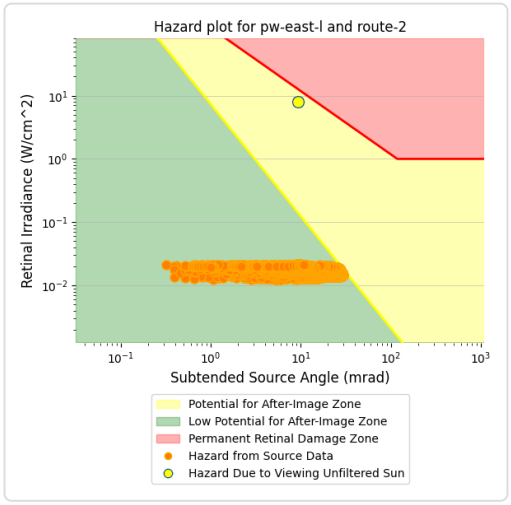
PW east L and Route: Route 2

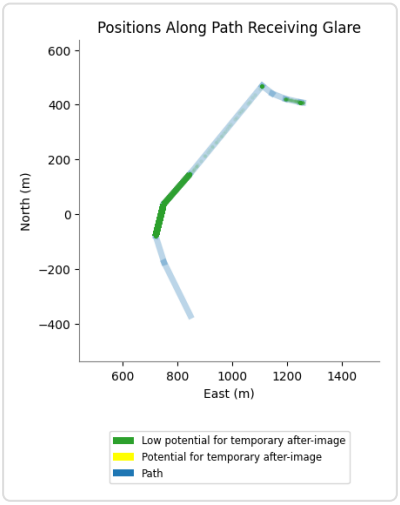
Yellow glare: none

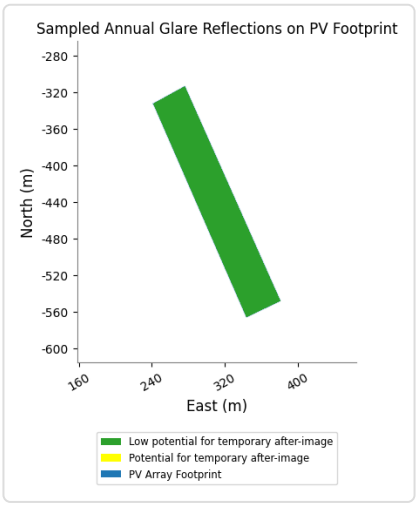
Green glare: 4,932 min.

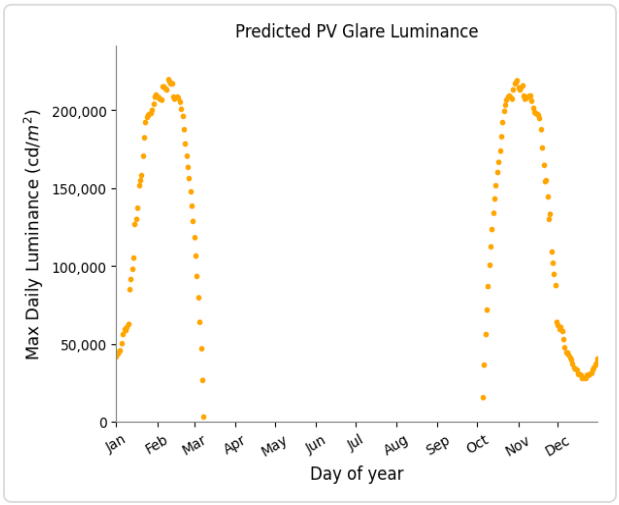








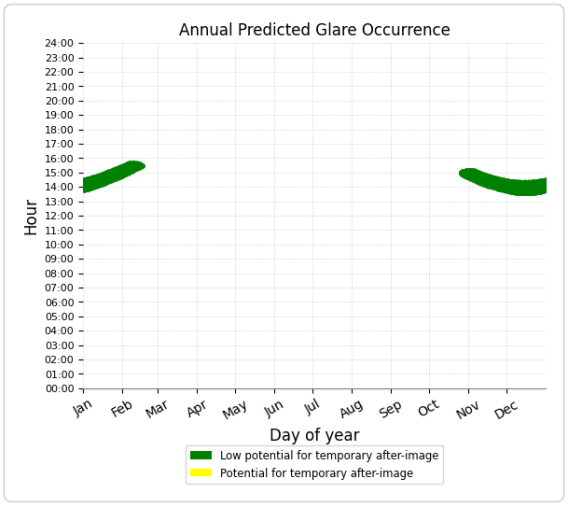


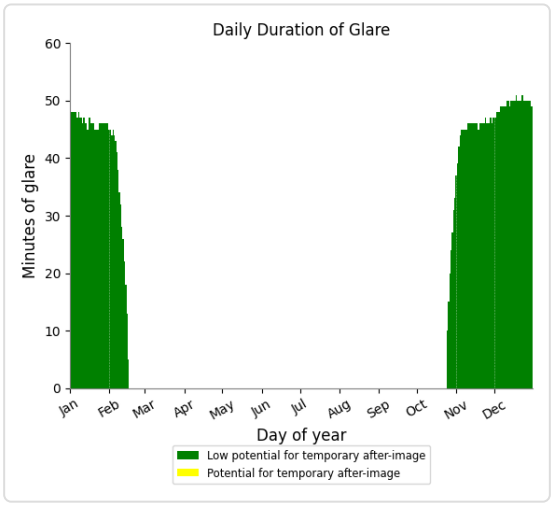


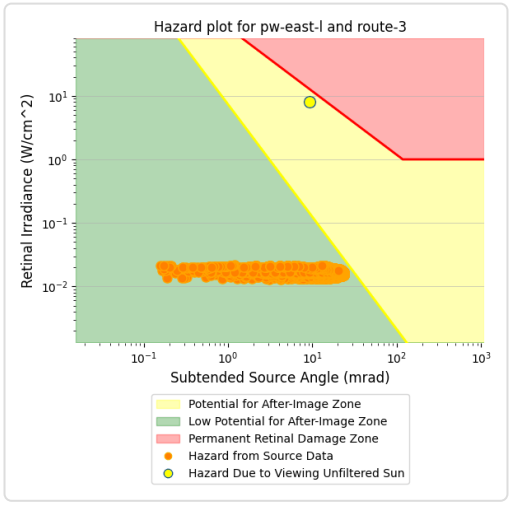
PW east L and Route: Route 3

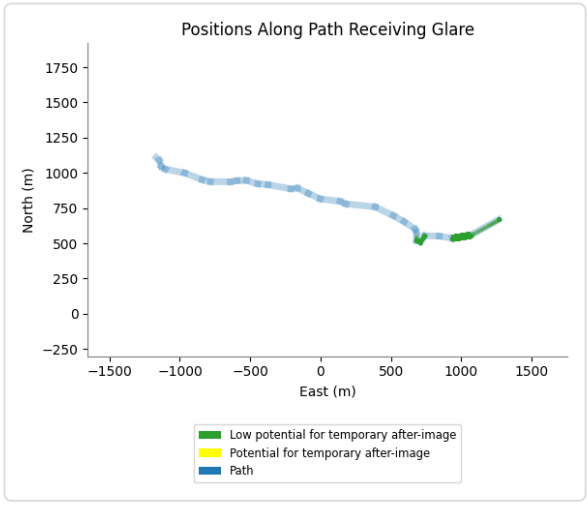
Yellow glare: none

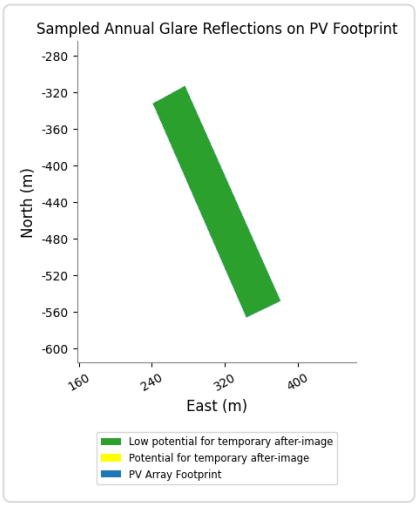
Green glare: 5,012 min.

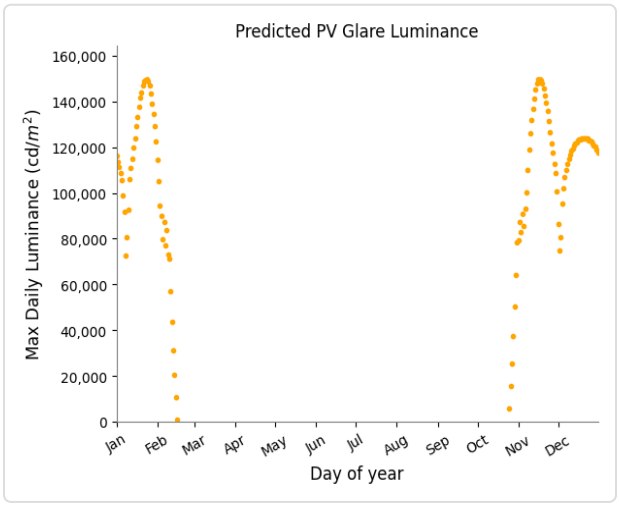








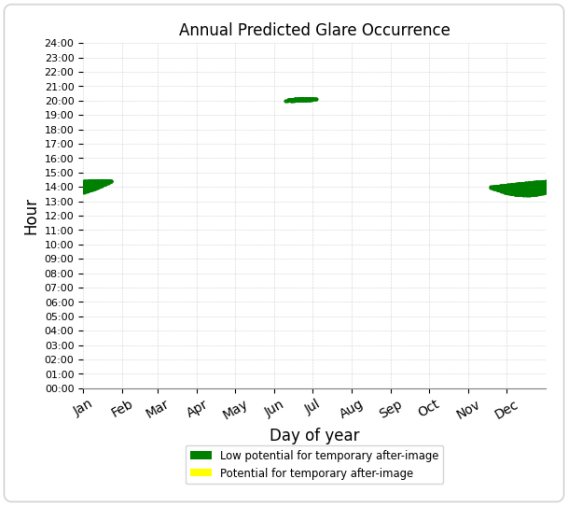


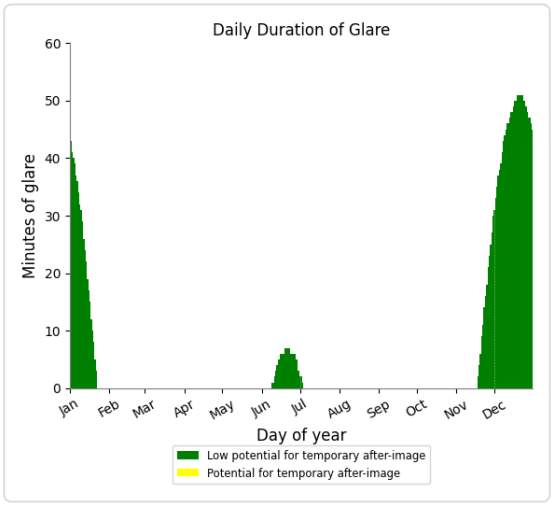


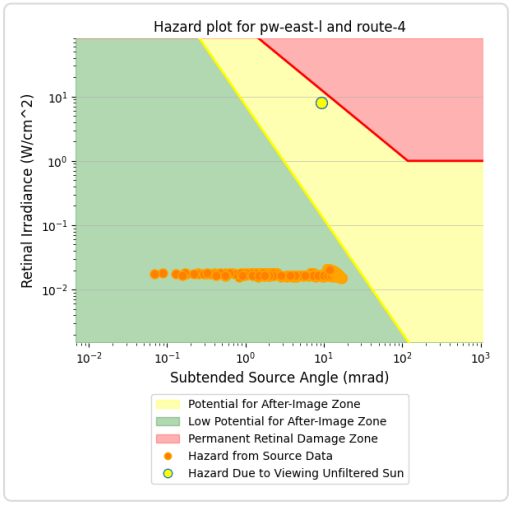
PW east L and Route: Route 4

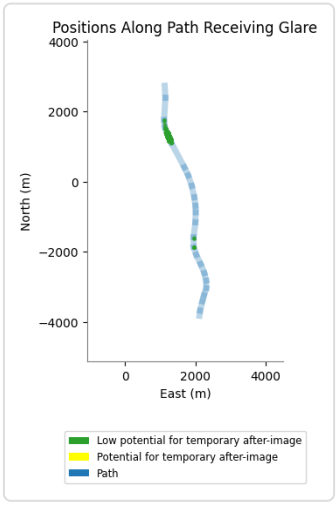
Yellow glare: none

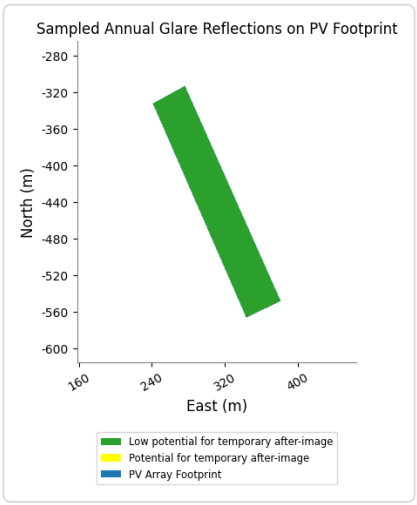
Green glare: 2,296 min.

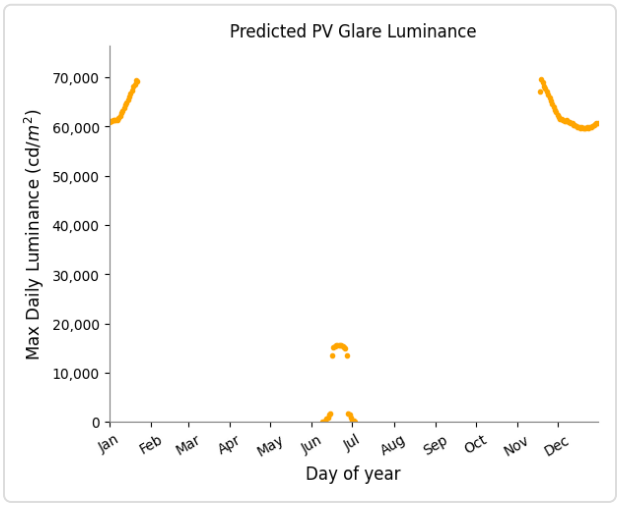








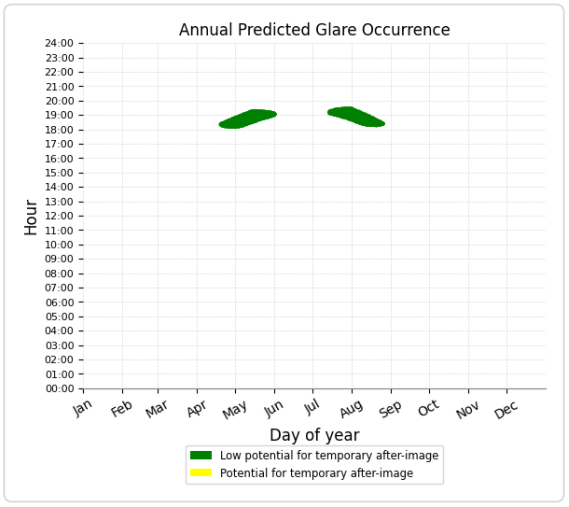


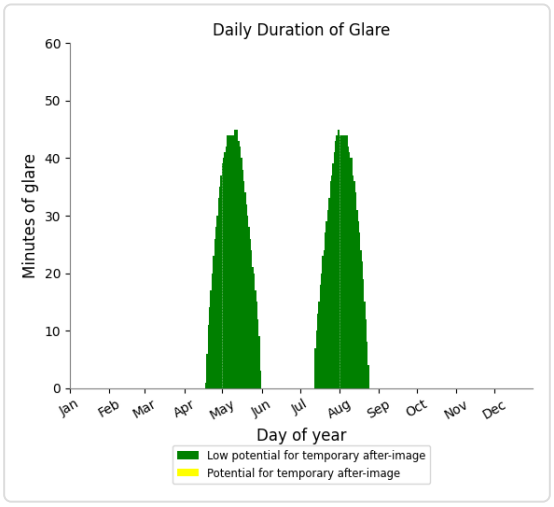


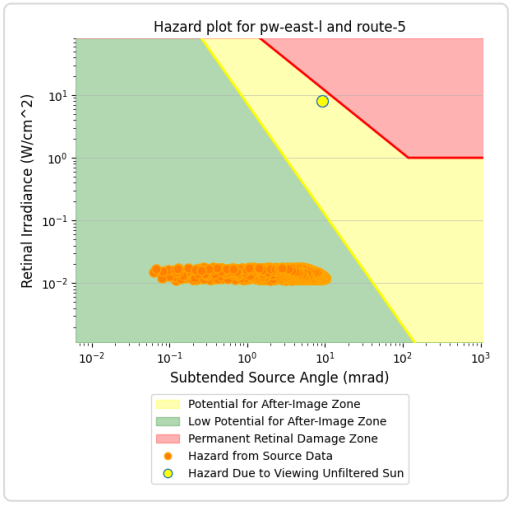
PW east L and Route: Route 5

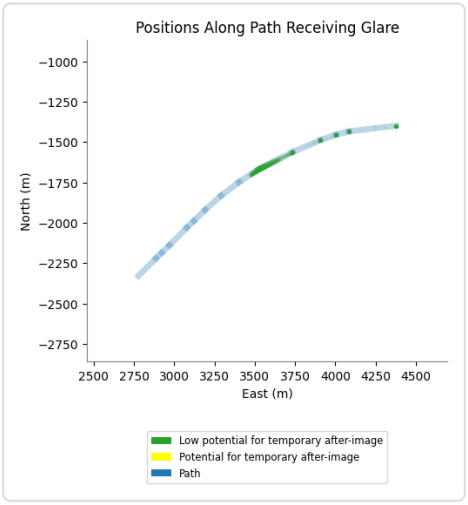
Yellow glare: none

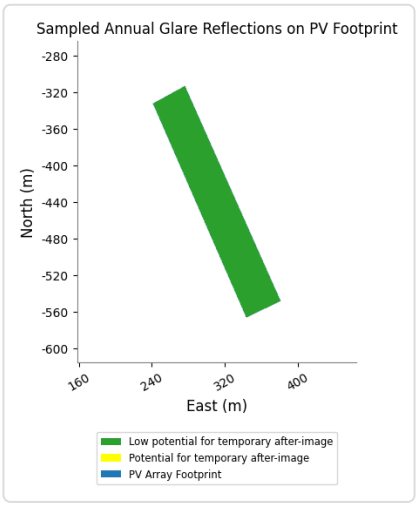
Green glare: 2,617 min.

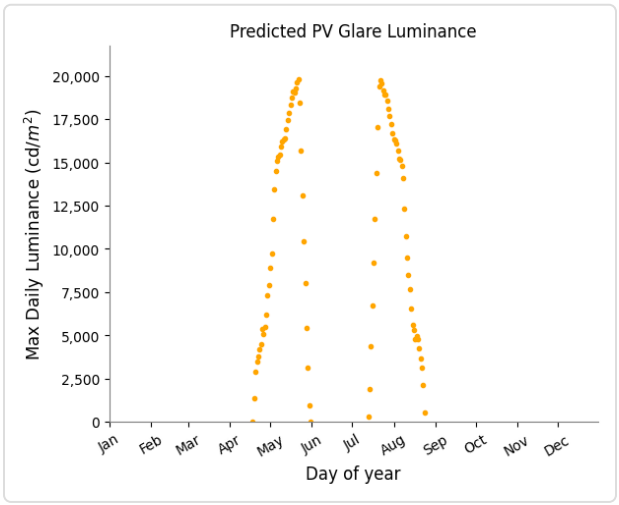












PW east L and FP: FP 1

No glare found

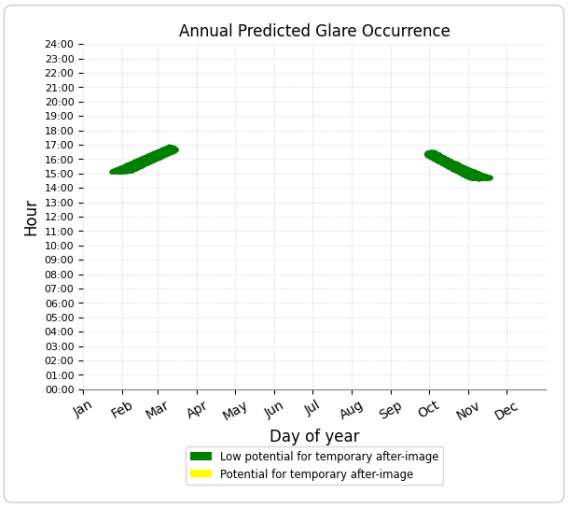
PW east L and FP: FP 2

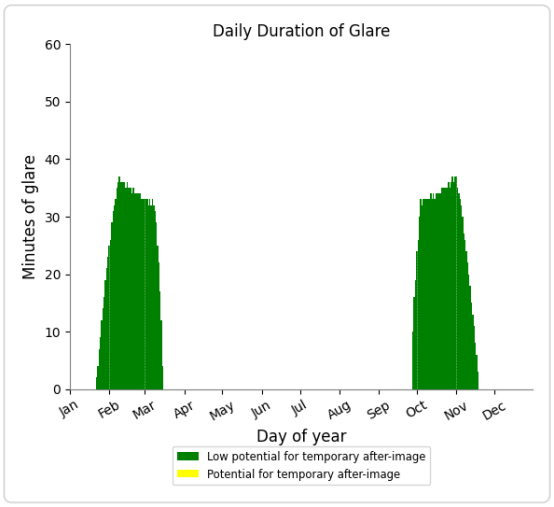
No glare found

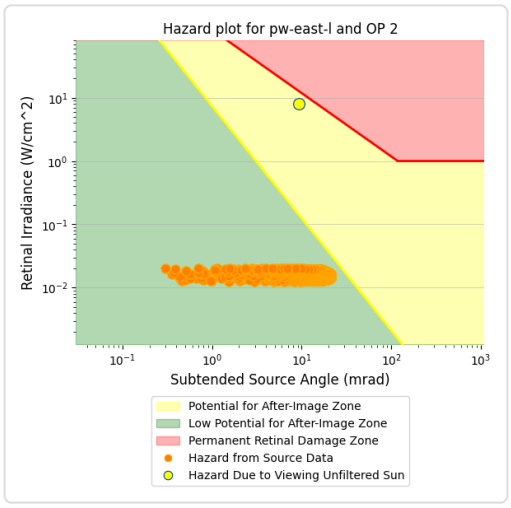
PW east L and OP 2

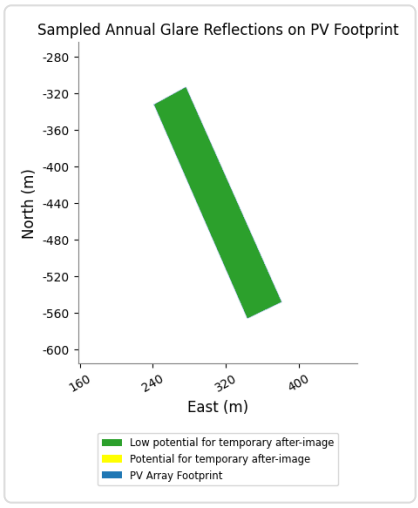
Yellow glare: none

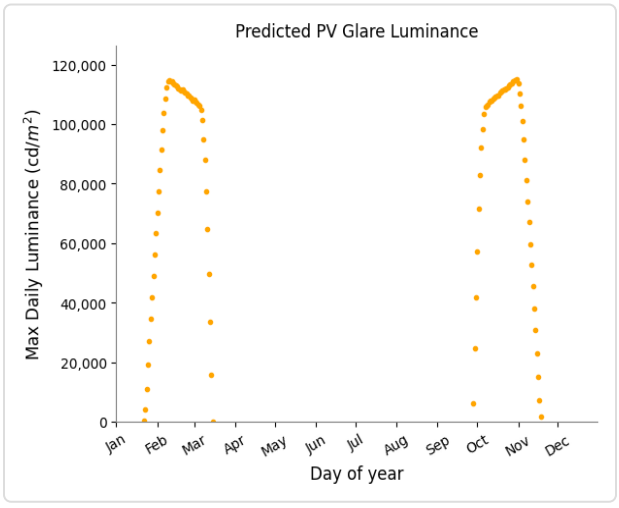
Green glare: 2,948 min.







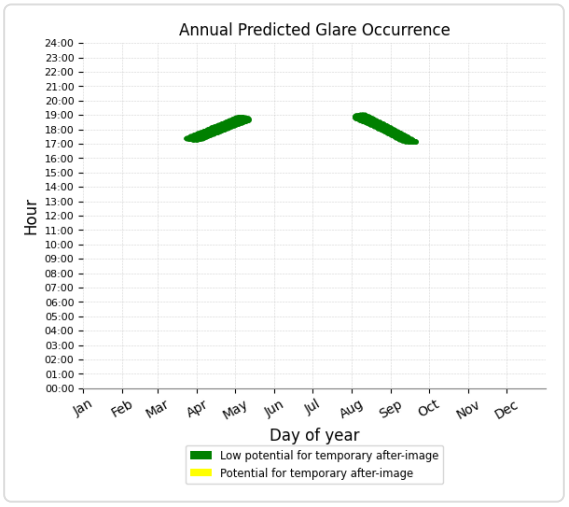


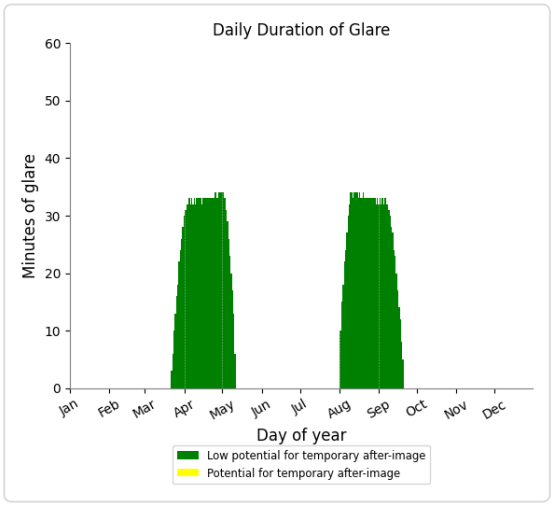


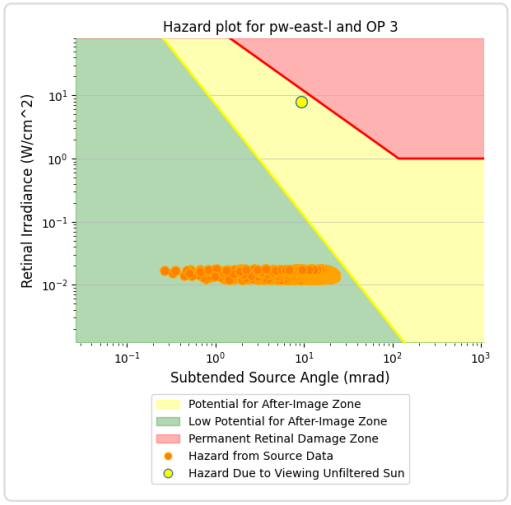
PW east L and OP 3

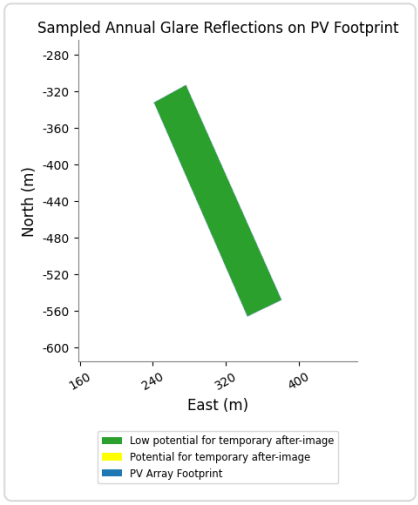
Yellow glare: none

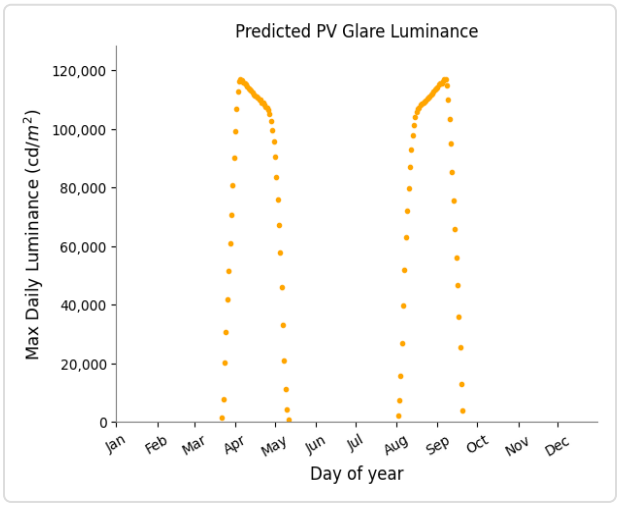
Green glare: 2,824 min.







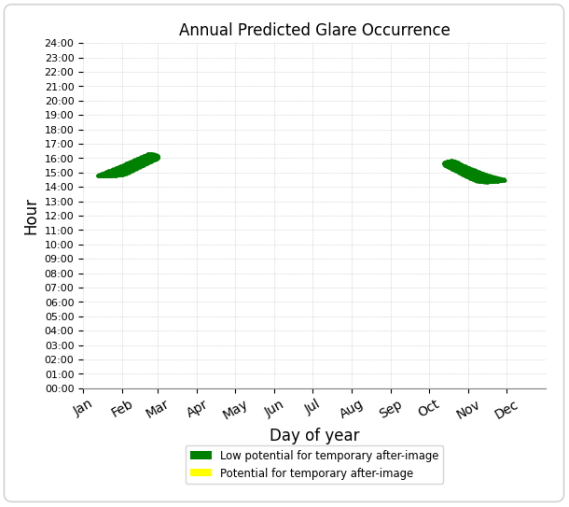


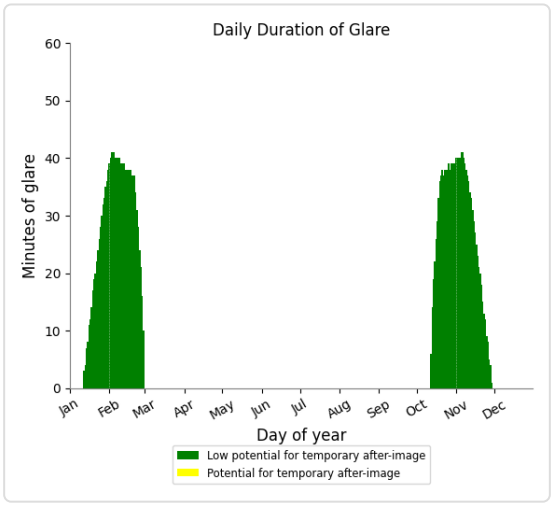


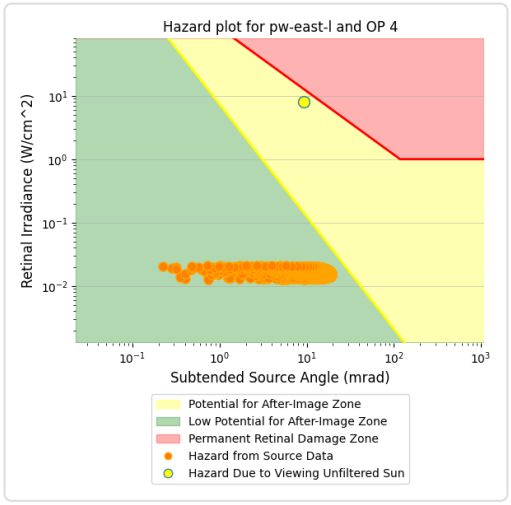
PW east L and OP 4

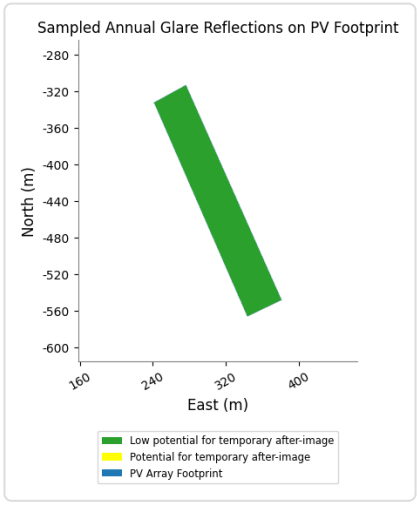
Yellow glare: none

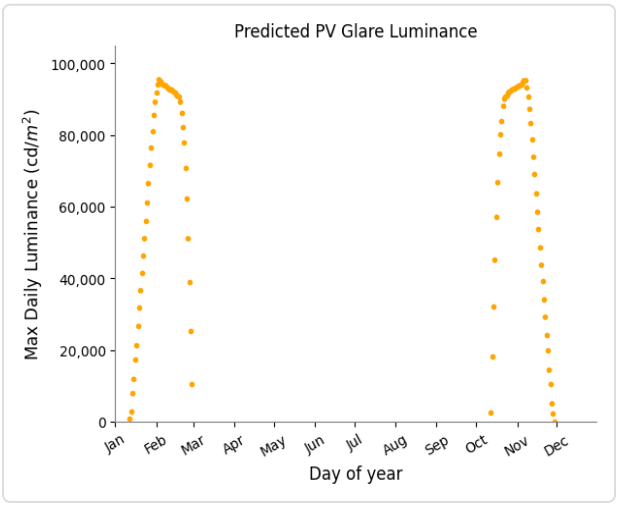
Green glare: 2,806 min.







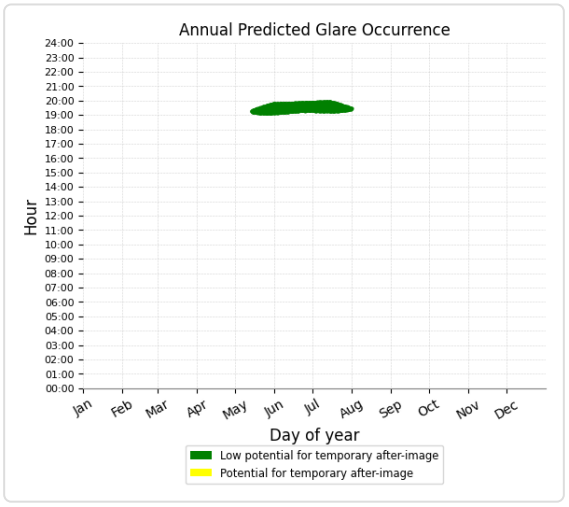


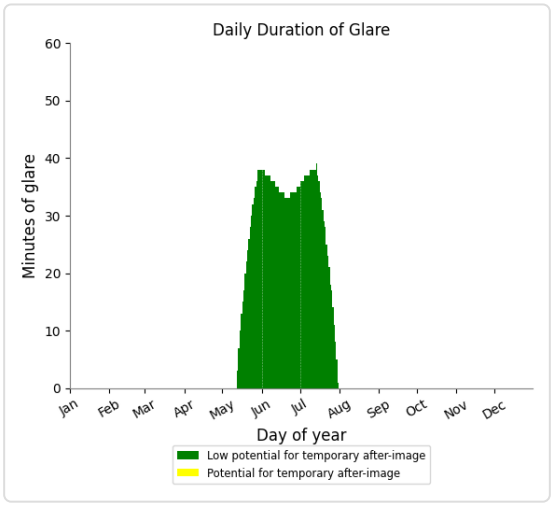


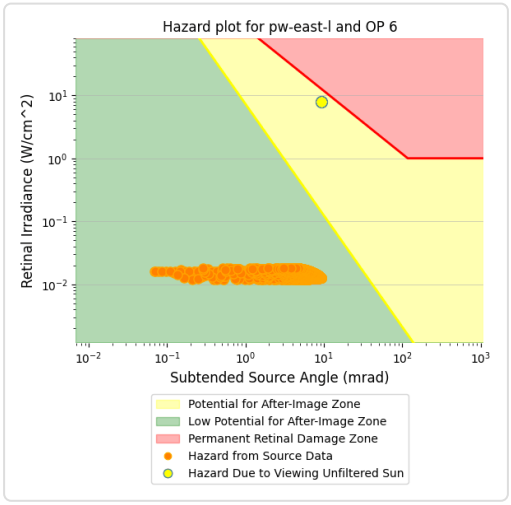
PW east L and OP 6

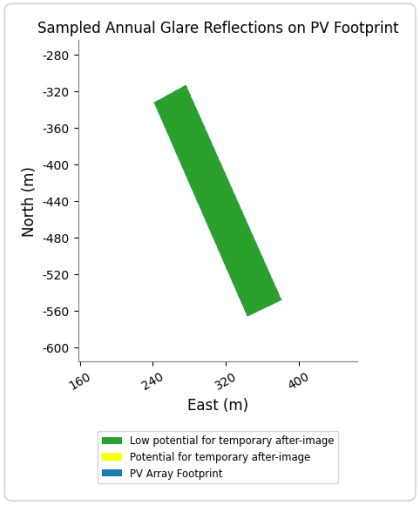
Yellow glare: none

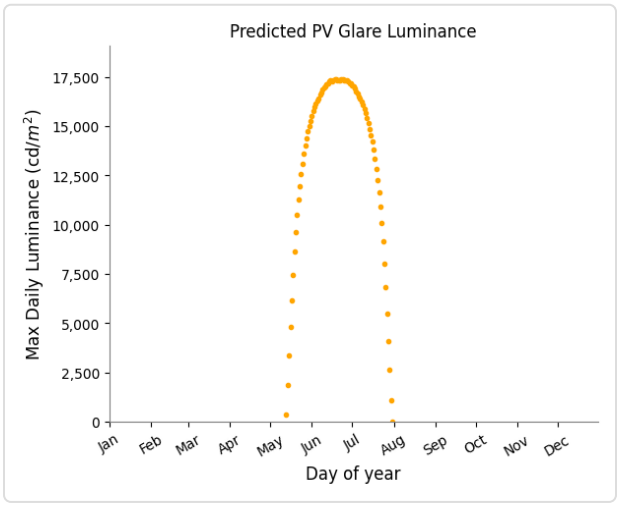
Green glare: 2,408 min.







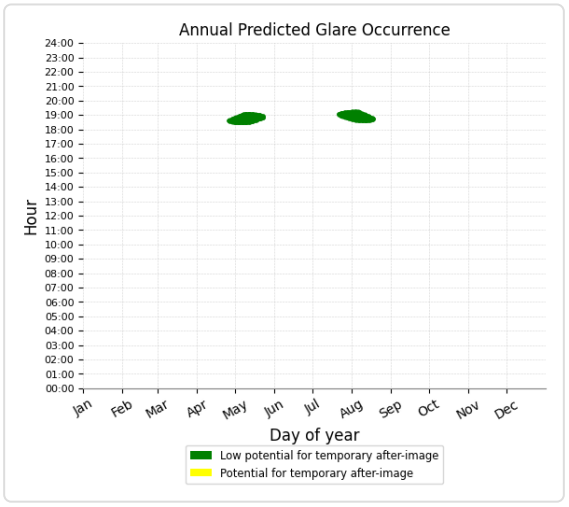


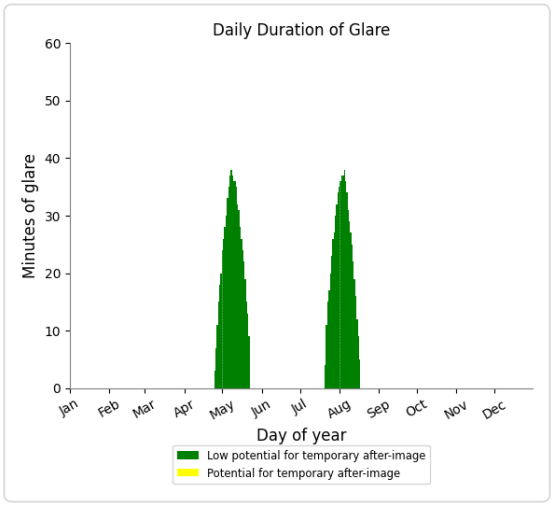


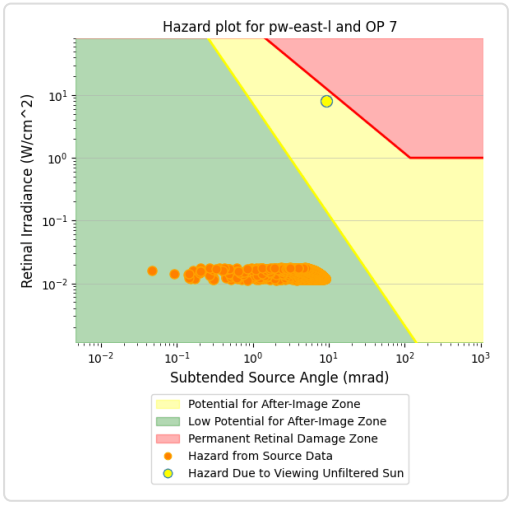
PW east L and OP 7

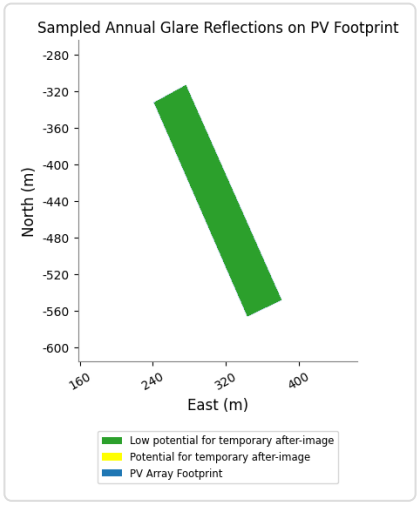
Yellow glare: none

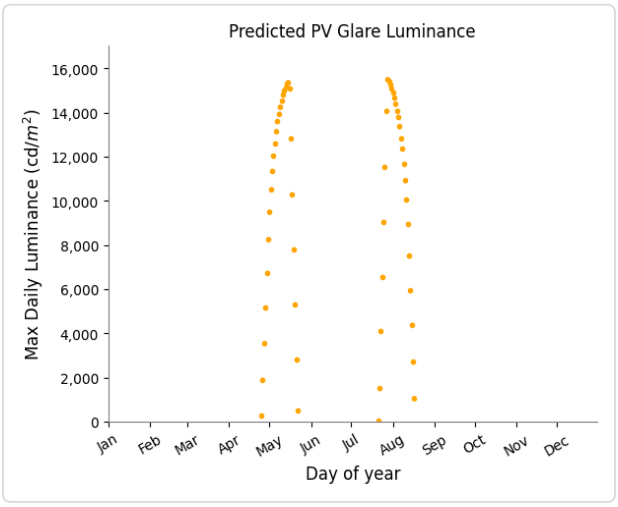
Green glare: 1,375 min.







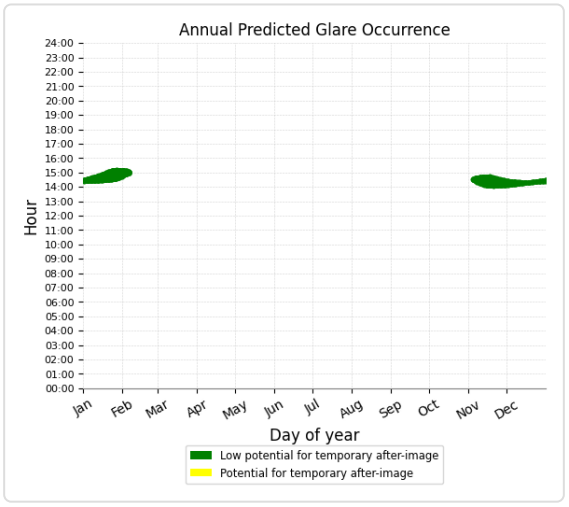


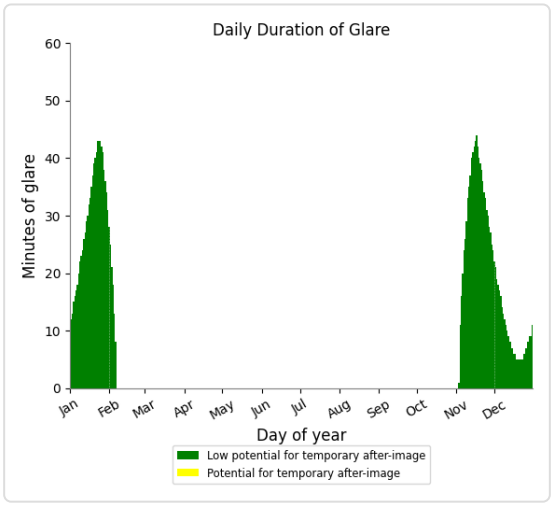


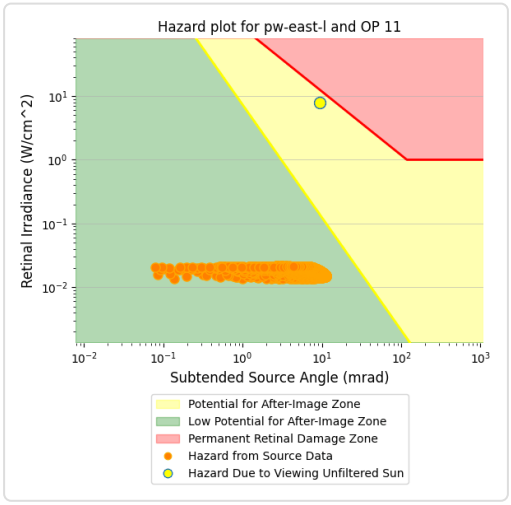
PW east L and OP 11

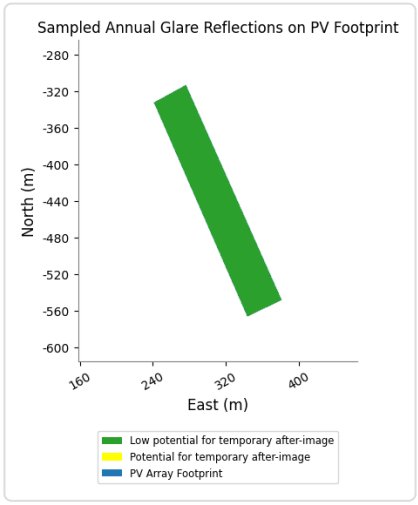
Yellow glare: none

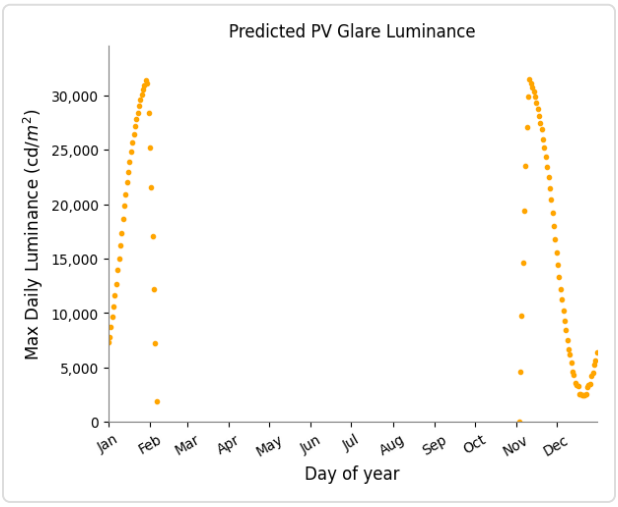
Green glare: 2,205 min.











PW east L and OP 1

No glare found

PW east L and OP 5

No glare found

PW east L and OP 8

No glare found

PW east L and OP 9

No glare found

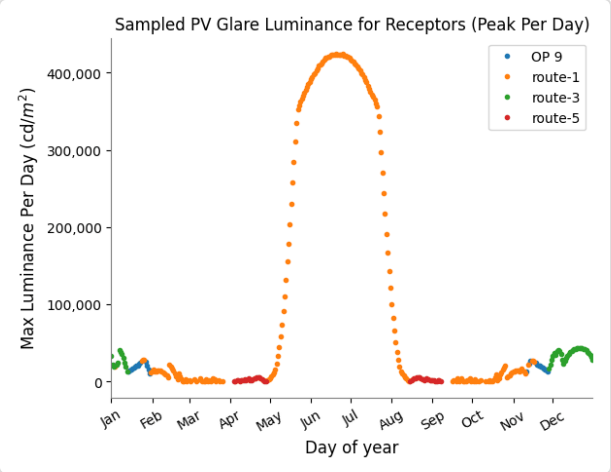
PW east L and OP 10

No glare found

PV: PW west H potential temporary after-image

Receptor results ordered by category of glare

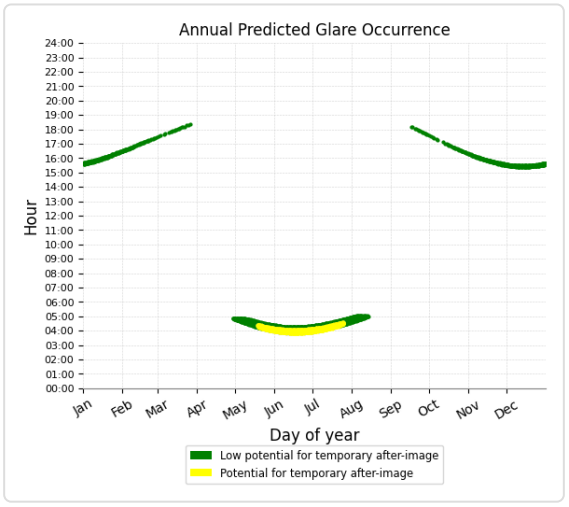
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	2,168	36.1	984	16.4	424,100
Route 2	382	6.4	0	0.0	17,496
Route 3	1,587	26.4	0	0.0	43,208
Route 4	124	2.1	0	0.0	8,822
Route 5	234	3.9	0	0.0	5,202
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 9	894	14.9	0	0.0	27,193
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0

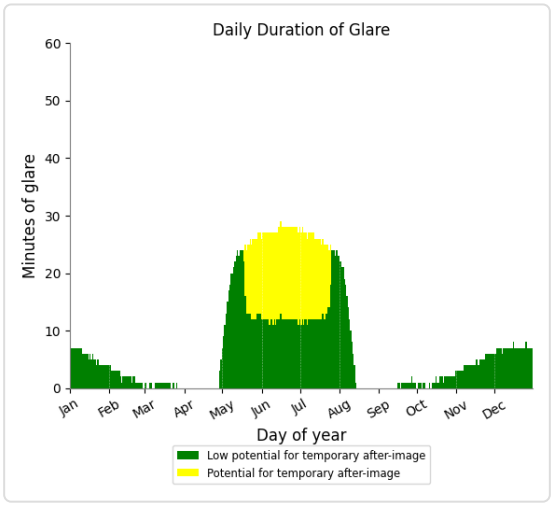


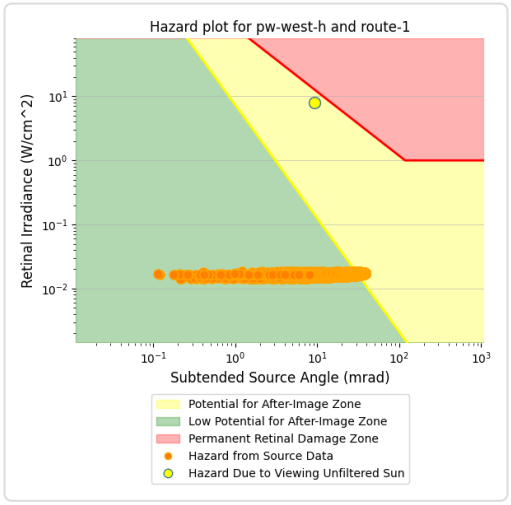
PW west H and Route: Route 1

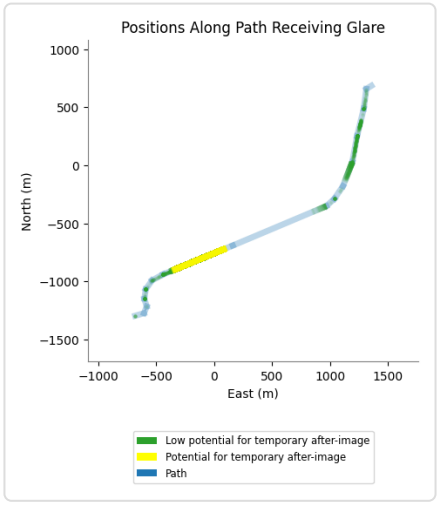
Yellow glare: 984 min.

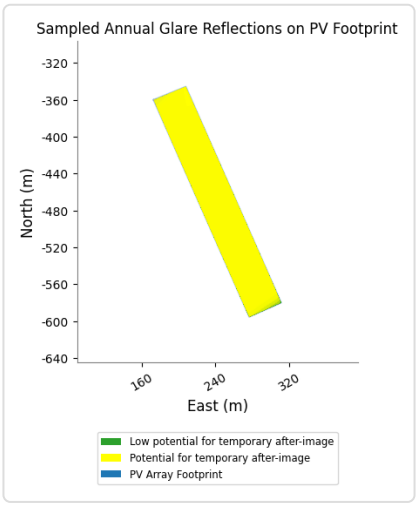
Green glare: 2,168 min.

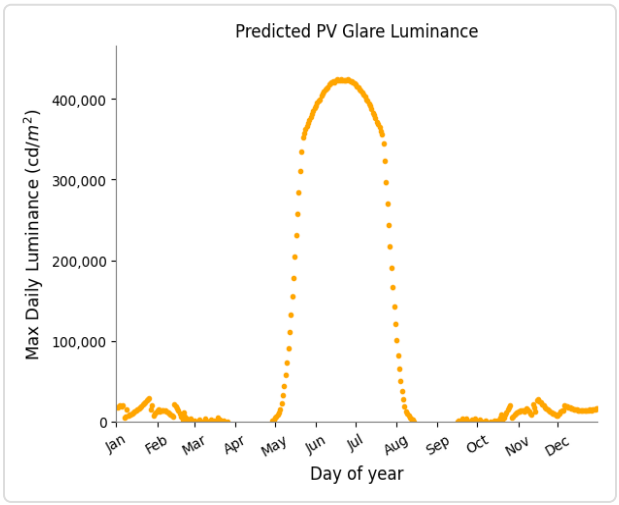








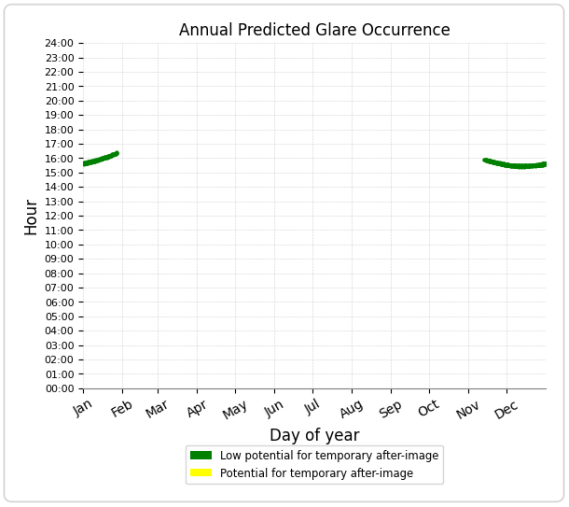


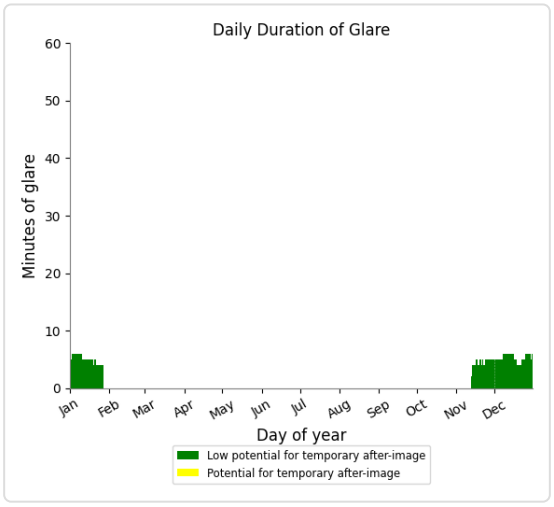


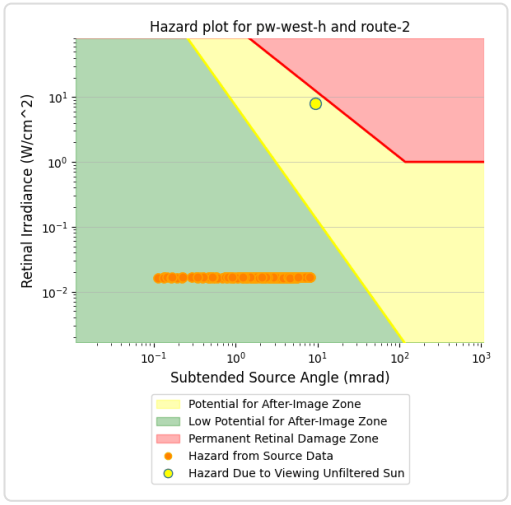
PW west H and Route: Route 2

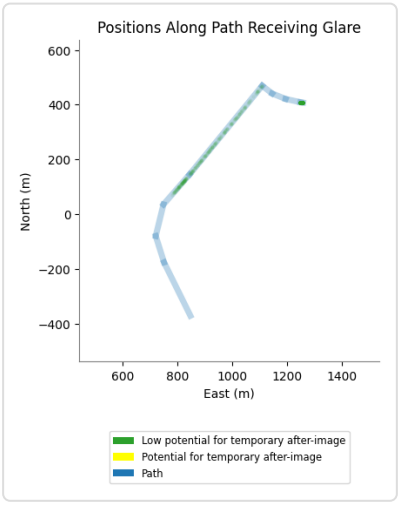
Yellow glare: none

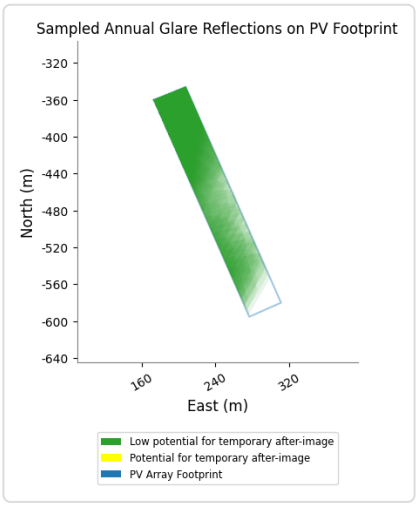
Green glare: 382 min.

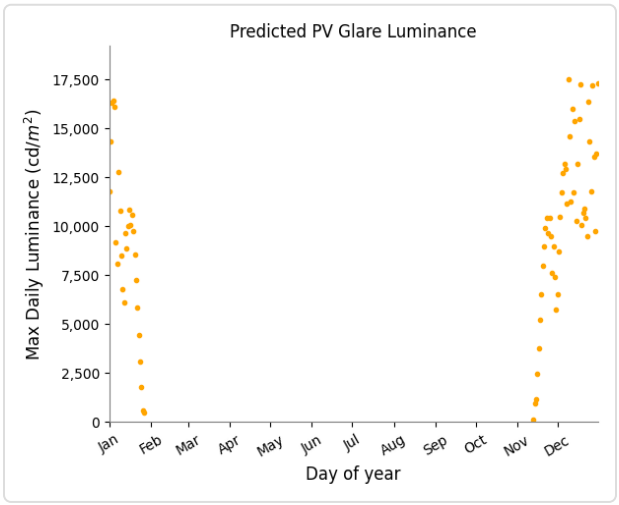








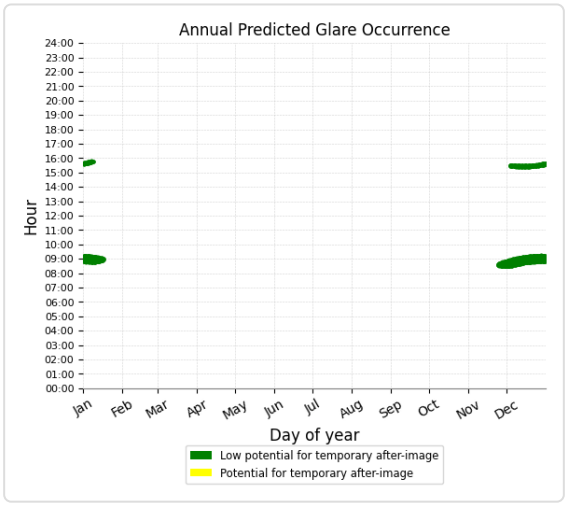


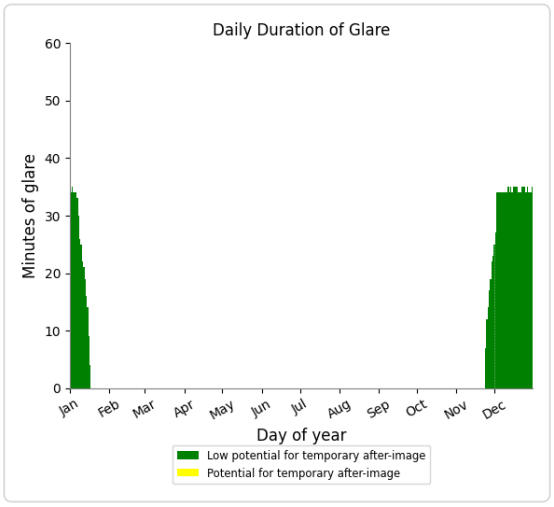


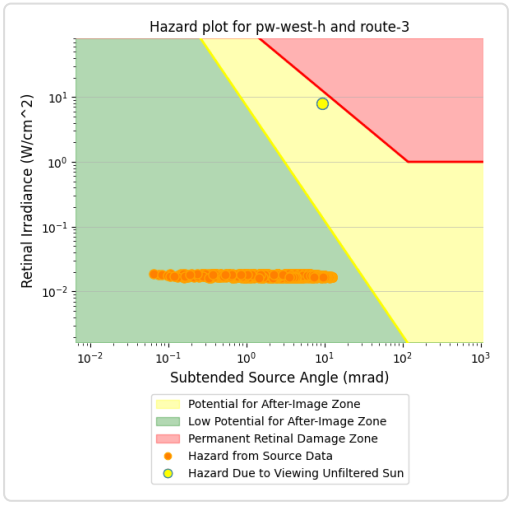
PW west H and Route: Route 3

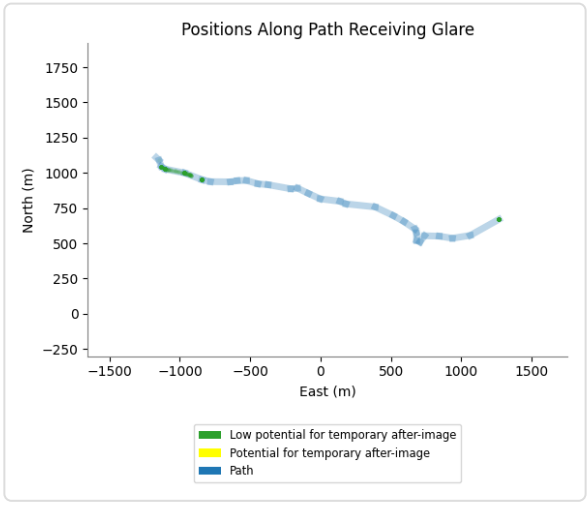
Yellow glare: none

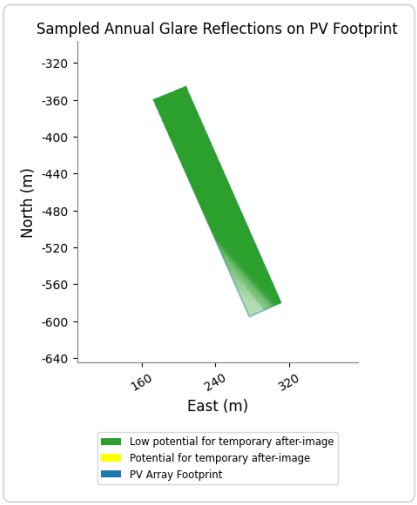
Green glare: 1,587 min.

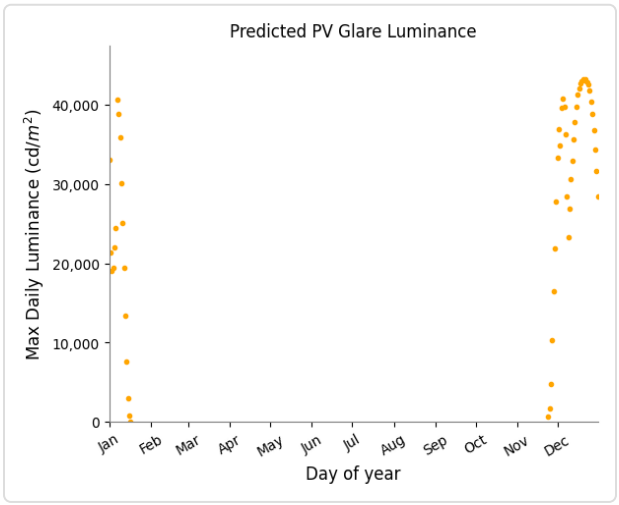








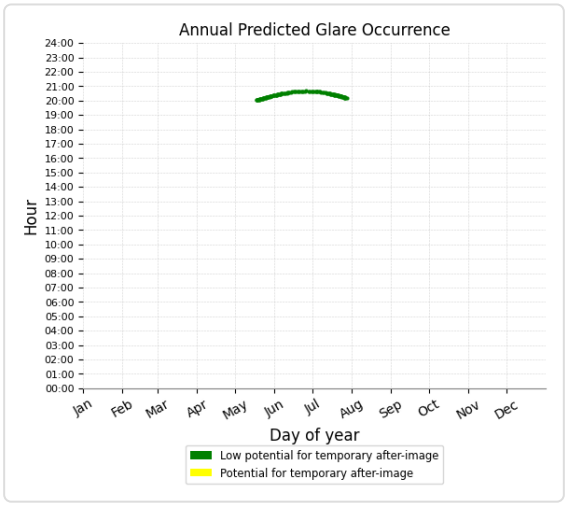


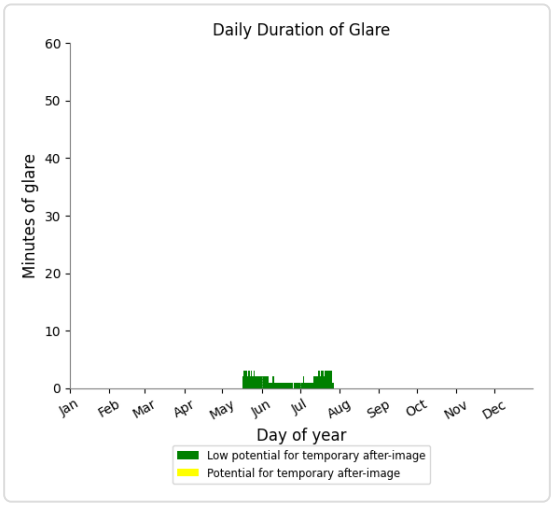


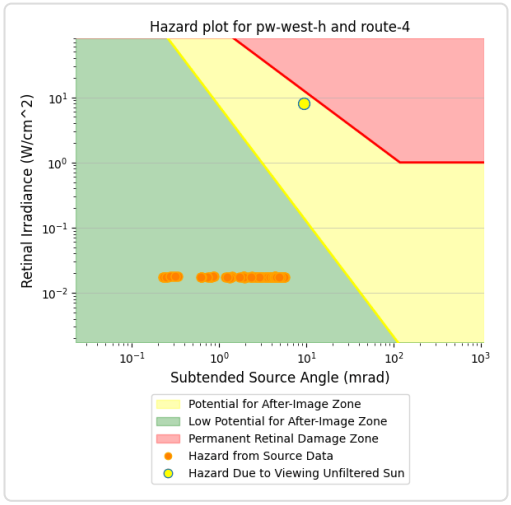
PW west H and Route: Route 4

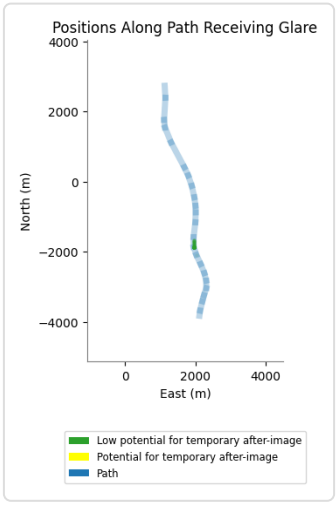
Yellow glare: none

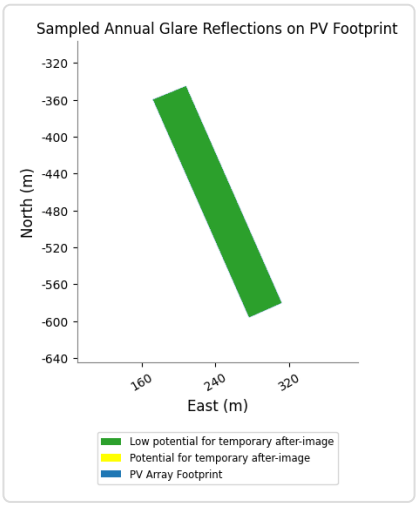
Green glare: 124 min.

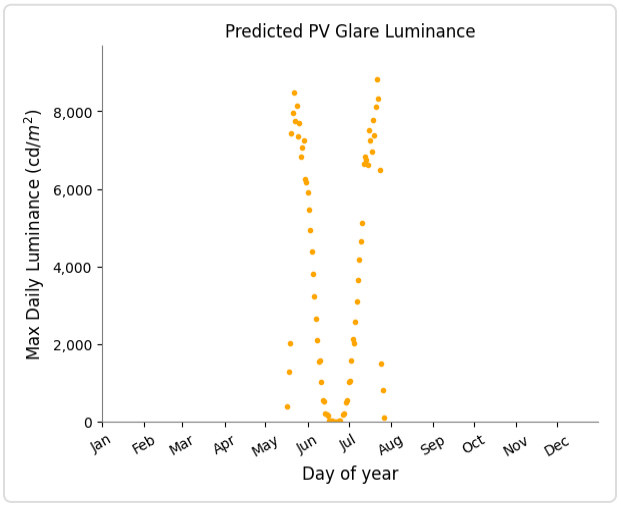








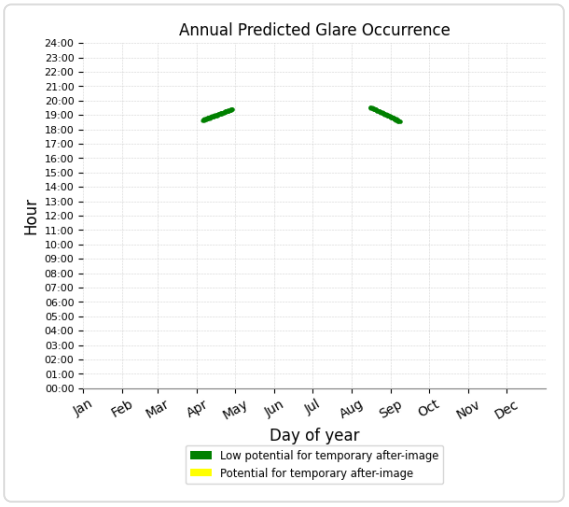


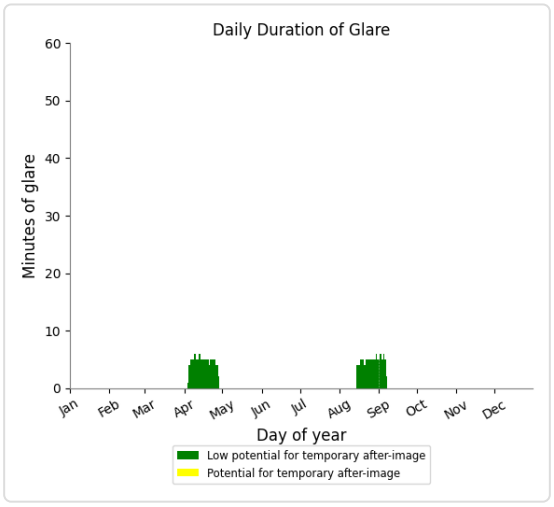


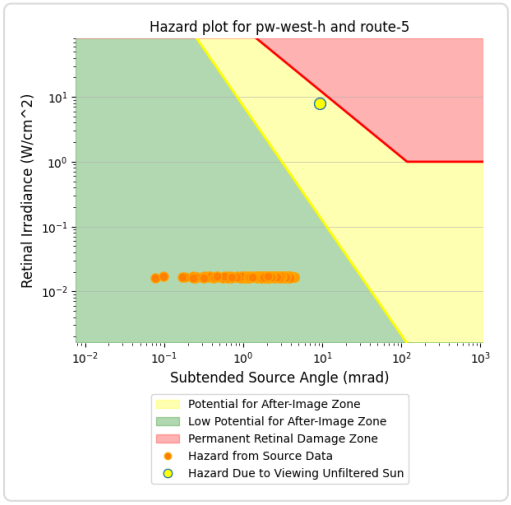
PW west H and Route: Route 5

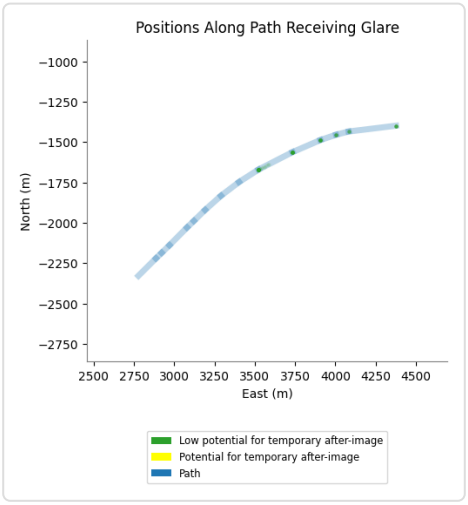
Yellow glare: none

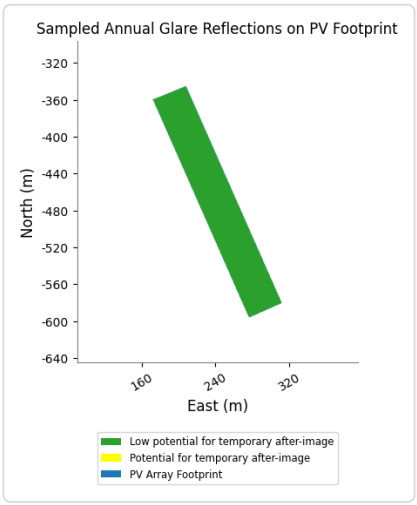
Green glare: 234 min.

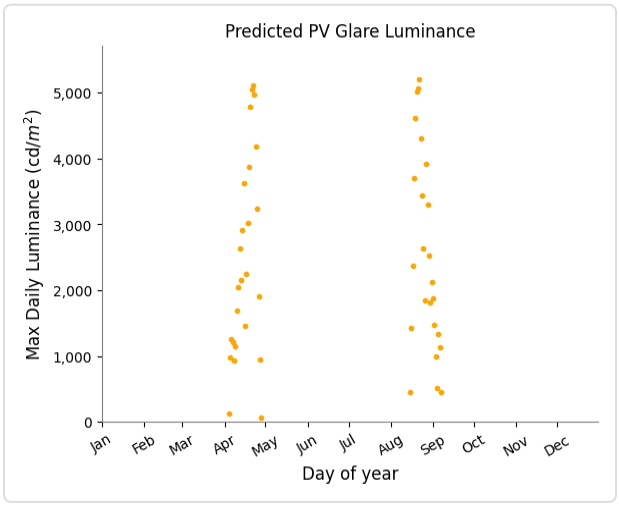












PW west H and FP: FP 1

No glare found

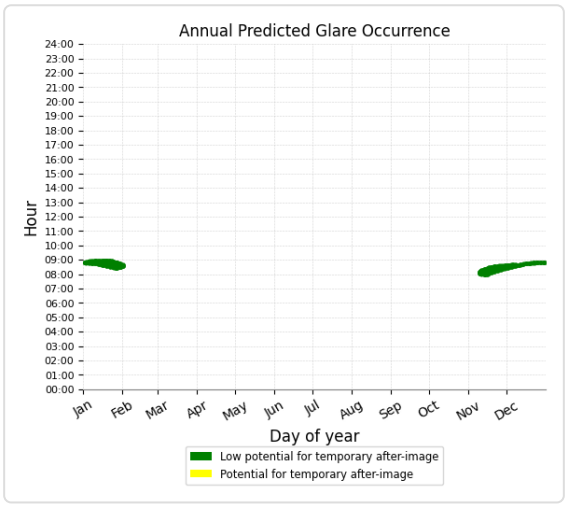
PW west H and FP: FP 2

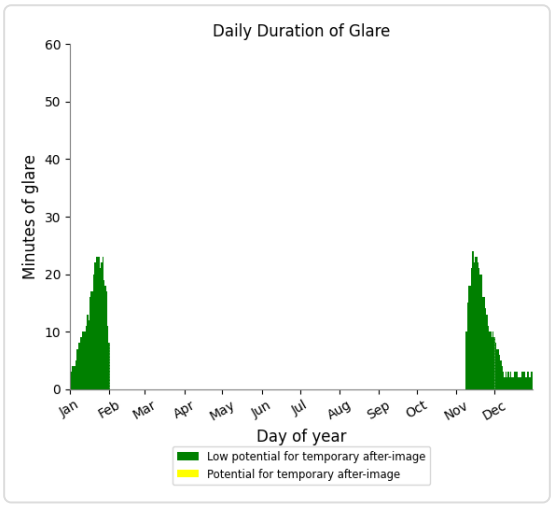
No glare found

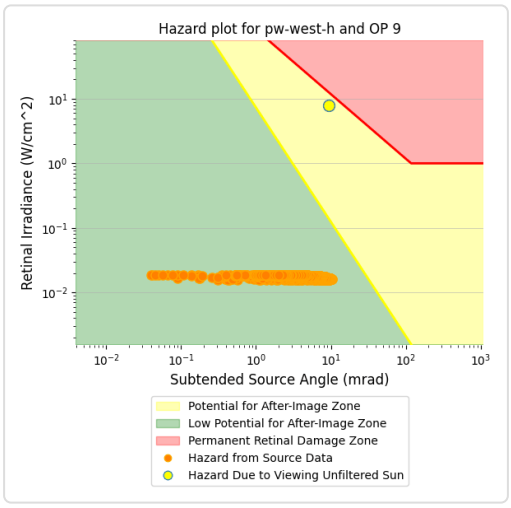
PW west H and OP 9

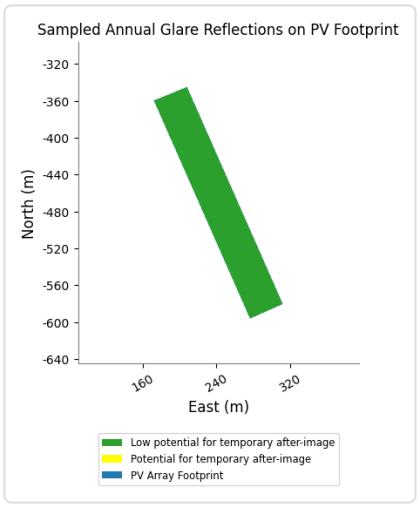
Yellow glare: none

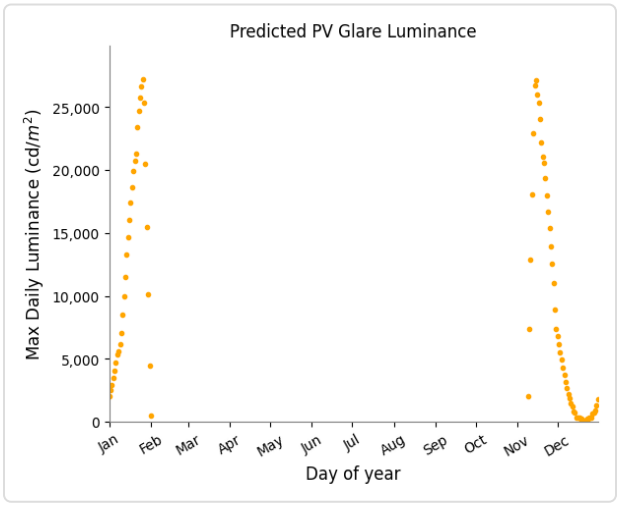
Green glare: 894 min.











PW west H and OP 1

No glare found

PW west H and OP 2

No glare found

PW west H and OP 3

No glare found

PW west H and OP 4

No glare found

PW west H and OP 5

No glare found

PW west H and OP 6

No glare found

PW west H and OP 7

No glare found

PW west H and OP 8

No glare found

PW west H and OP 10

No glare found

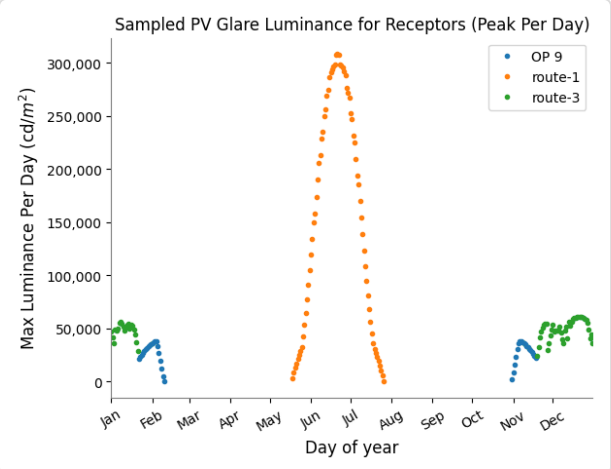
PW west H and OP 11

No glare found

PV: PW west L potential temporary after-image

Receptor results ordered by category of glare

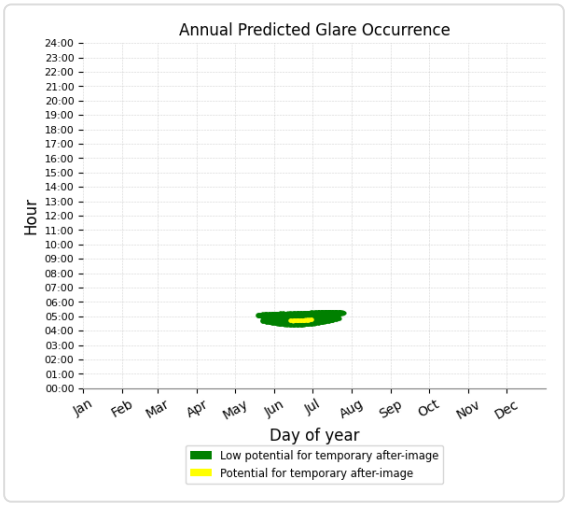
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 1	2,238	37.3	52	0.9	308,166
Route 3	1,935	32.2	0	0.0	60,736
Route 2	0	0.0	0	0.0	0
Route 4	0	0.0	0	0.0	0
Route 5	0	0.0	0	0.0	0
FP 1	0	0.0	0	0.0	0
FP 2	0	0.0	0	0.0	0
OP 9	1,215	20.2	0	0.0	38,403
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0

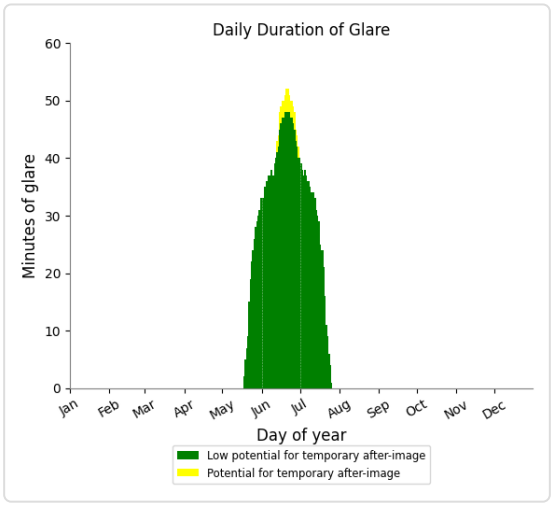


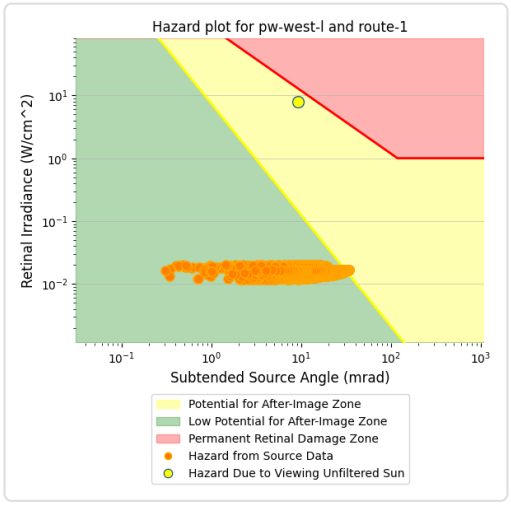
PW west L and Route: Route 1

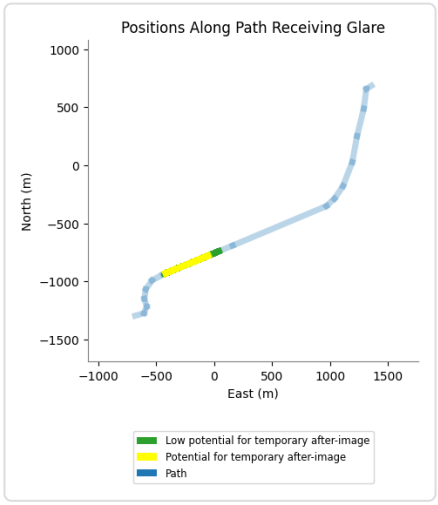
Yellow glare: 52 min.

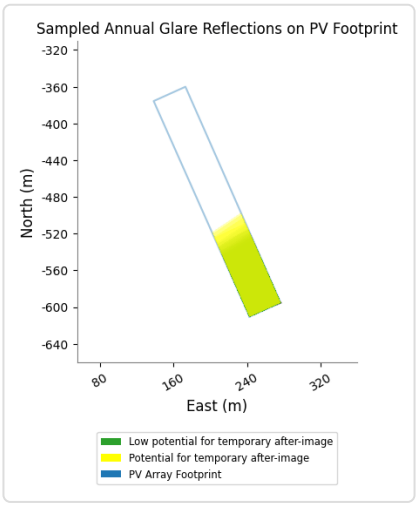
Green glare: 2,238 min.

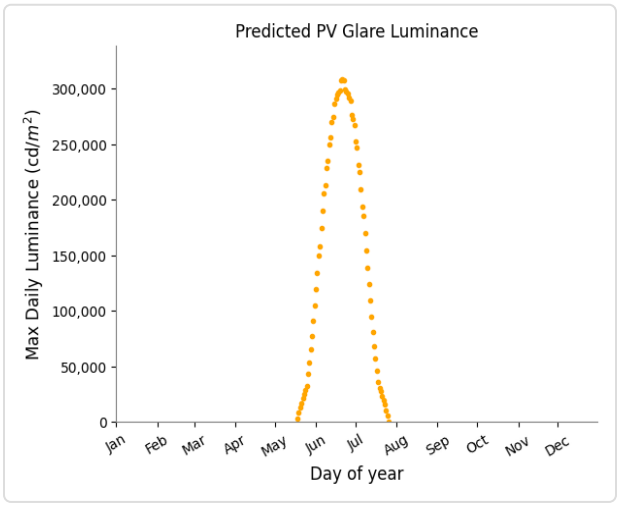








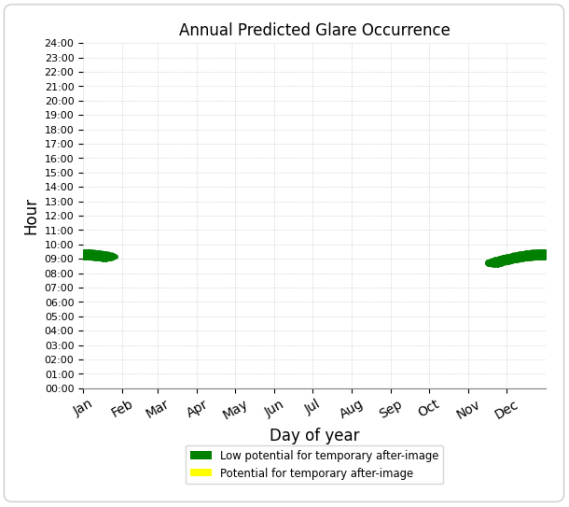


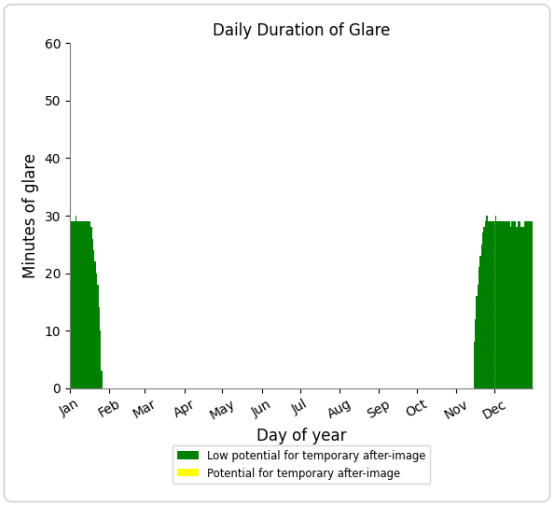


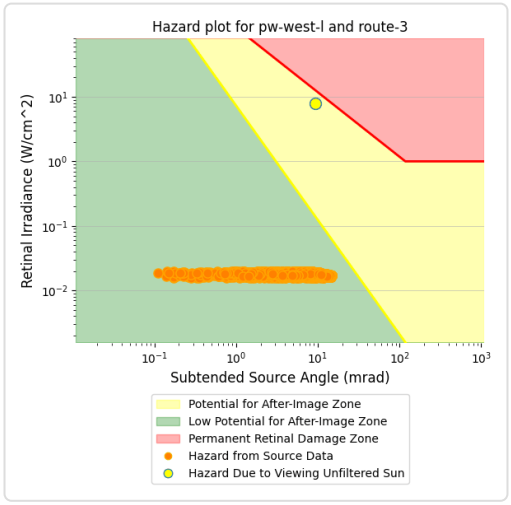
PW west L and Route: Route 3

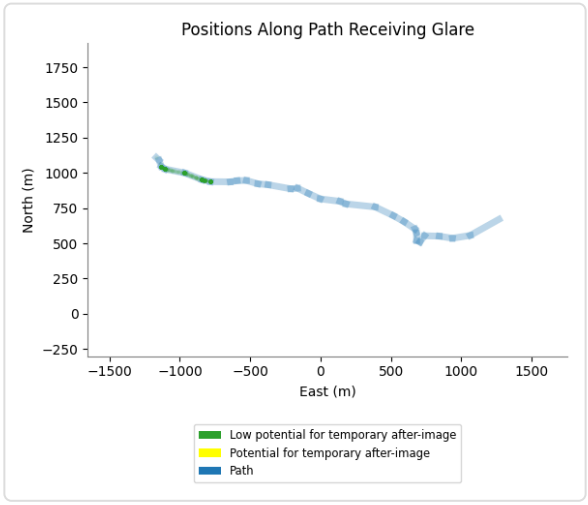
Yellow glare: none

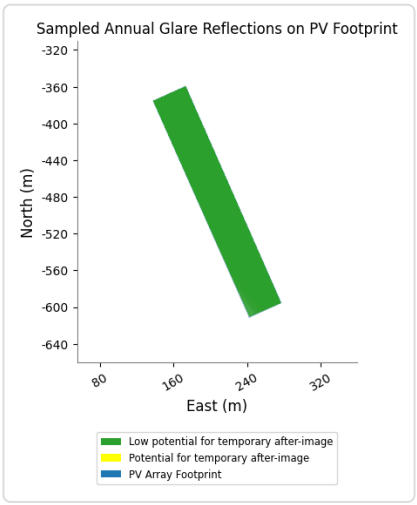
Green glare: 1,935 min.

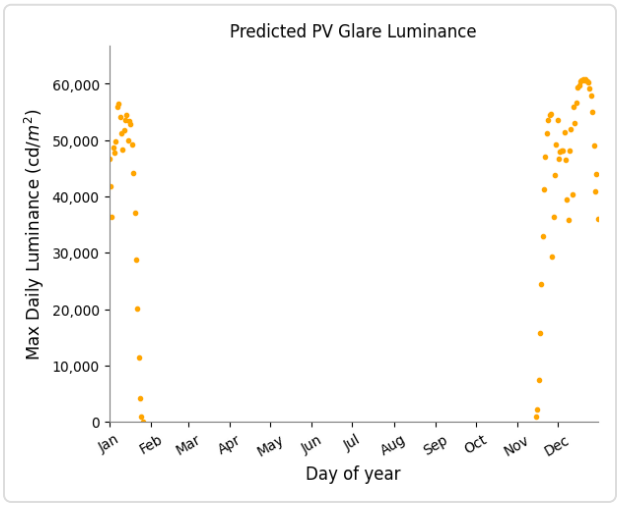












PW west L and Route: Route 2

No glare found

PW west L and Route: Route 4

No glare found

PW west L and Route: Route 5

No glare found

PW west L and FP: FP 1

No glare found

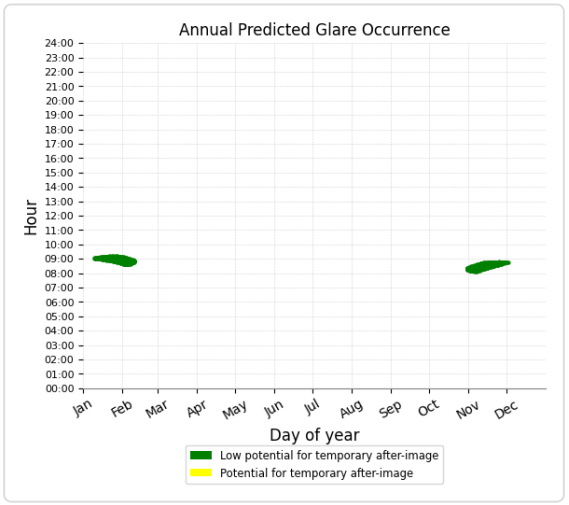
PW west L and FP: FP 2

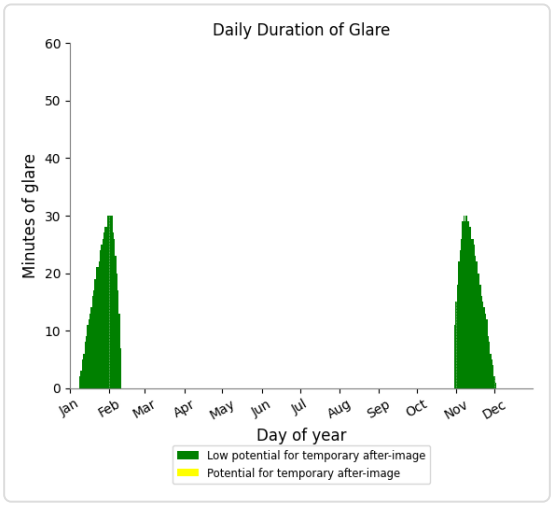
No glare found

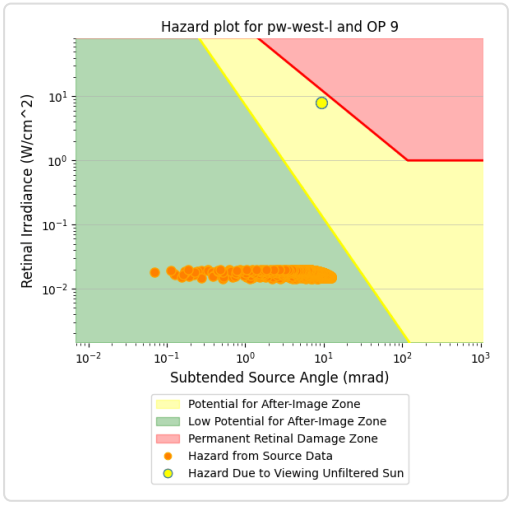
PW west L and OP 9

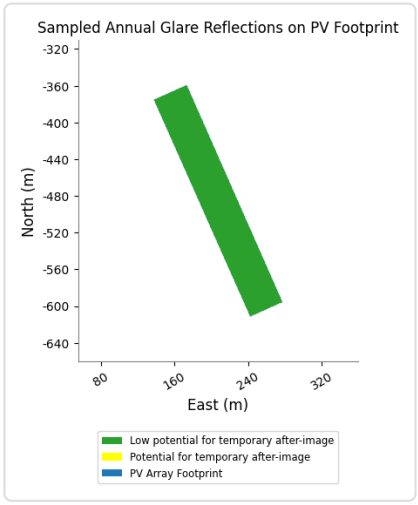
Yellow glare: none

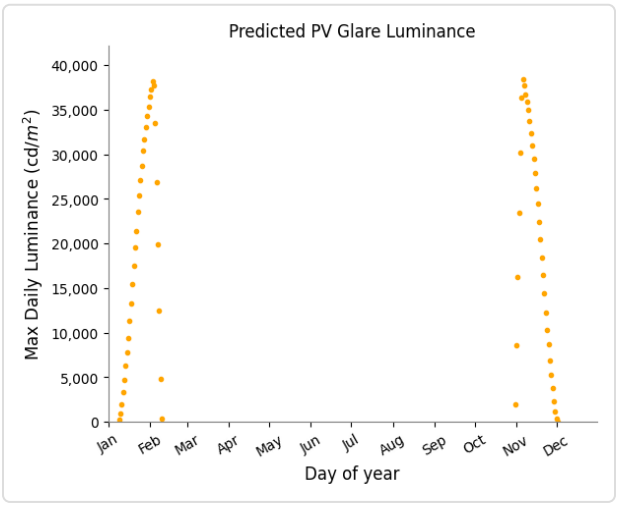
Green glare: 1,215 min.











PW west L and OP 1

No glare found

PW west L and OP 2

No glare found

PW west L and OP 3

No glare found

PW west L and OP 4

No glare found

PW west L and OP 5

No glare found

PW west L and OP 6

No glare found

PW west L and OP 7

No glare found

PW west L and OP 8

No glare found

PW west L and OP 10

No glare found

PW west L and OP 11

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.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
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

FORGESOLAR GLARE ANALYSIS

Project: **IAMP Sunderland rooftop**
Site configuration: **OPs_Feb 2024 OPs12-15**

Created 07 Feb, 2024
Updated 07 Feb, 2024
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 1 MW to 5 MW
Site ID 111465.9902

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PVA east H	1.0	67.0	0	0.0	0	0.0	-	0
PVA east L	4.0	67.0	4,845	80.8	0	0.0	-	60,224
PVA west H	1.0	247.0	0	0.0	0	0.0	-	0
PVA west L	4.0	267.0	0	0.0	0	0.0	-	0
PVB east H	1.0	67.0	0	0.0	0	0.0	-	0
PVB east L	4.0	67.0	4,758	79.3	0	0.0	-	66,987
PVB west H	1.0	267.0	0	0.0	0	0.0	-	0
PVB west L	4.0	267.0	0	0.0	0	0.0	-	0
PVC east H	1.0	67.0	0	0.0	0	0.0	-	0
PVC east L	5.0	67.0	7,262	121.0	0	0.0	-	75,527
PVC west H	1.0	247.0	0	0.0	0	0.0	-	0
PVC west L	5.0	247.0	0	0.0	0	0.0	-	0
PVD east H	1.0	67.0	0	0.0	0	0.0	-	0
PVD east L	5.0	67.0	5,772	96.2	0	0.0	-	91,994
PVD west H	1.0	267.0	0	0.0	0	0.0	-	0
PVD west L	5.0	247.0	0	0.0	0	0.0	-	0
PW east H	1.0	67.0	0	0.0	0	0.0	-	0
PW east L	5.0	67.0	1,883	31.4	0	0.0	-	102,182
PW west H	1.0	247.0	0	0.0	0	0.0	-	0
PW west L	5.0	247.0	0	0.0	0	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
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	14,547	242.4	0	0.0
OP 15	9,973	166.2	0	0.0

Component Data

PV Arrays

Name: PVA east H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.924954	-1.491400	37.83	26.00	63.83
2	54.923707	-1.490407	39.41	26.00	65.41
3	54.923813	-1.489994	39.44	24.56	64.00
4	54.925058	-1.490981	37.65	24.56	62.21

Name: PVA east L
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.923813	-1.489995	39.45	24.56	64.01
2	54.925058	-1.490981	37.65	24.56	62.21
3	54.925162	-1.490589	37.53	23.50	61.03
4	54.923908	-1.489608	39.23	23.50	62.73

Name: PVA west H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 247.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.923602	-1.490829	38.94	24.56	63.50
2	54.924849	-1.491804	38.27	24.56	62.83
3	54.924954	-1.491400	37.83	26.00	63.83
4	54.923707	-1.490409	39.41	26.00	65.41

Name: PVA west L
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 267.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.924754	-1.492197	38.71	23.50	62.21
2	54.923499	-1.491247	39.03	23.50	62.53
3	54.923602	-1.490829	38.94	24.56	63.50
4	54.924848	-1.491804	38.27	24.56	62.83

Name: PVB east H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.924112	-1.488775	38.44	33.00	71.44
2	54.925369	-1.489763	37.66	33.00	70.66
3	54.925480	-1.489343	37.74	31.96	69.70
4	54.924225	-1.488366	38.22	31.96	70.18

Name: PVB east L
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.924225	-1.488367	38.20	31.96	70.16
2	54.925480	-1.489343	37.74	31.96	69.70
3	54.925593	-1.488909	37.31	30.50	67.81
4	54.924338	-1.487928	37.50	30.50	68.00

Name: PVB west H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 267.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.924016	-1.489185	38.96	31.96	70.92
2	54.925269	-1.490179	36.90	31.96	68.86
3	54.925368	-1.489763	37.66	33.00	70.66
4	54.924112	-1.488775	38.44	33.00	71.44

Name: PVB west L
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 267.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.923908	-1.489609	39.23	30.50	69.73
2	54.925162	-1.490590	37.53	30.50	68.03
3	54.925268	-1.490178	36.90	31.96	68.86
4	54.924016	-1.489187	38.96	31.96	70.92

Name: PVC east H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922253	-1.489287	38.46	18.00	56.46
2	54.923706	-1.490408	39.41	18.00	57.41
3	54.923814	-1.489995	39.45	16.51	55.96
4	54.922064	-1.488627	39.06	16.51	55.57
5	54.922029	-1.488756	38.67	17.00	55.67
6	54.922015	-1.488810	38.55	17.00	55.55
7	54.922015	-1.488818	38.52	17.00	55.52
8	54.922014	-1.488830	38.50	17.00	55.50
9	54.922013	-1.488836	38.48	17.00	55.48
10	54.922078	-1.488880	38.45	17.00	55.45
11	54.922309	-1.489073	38.47	17.00	55.47
12	54.922309	-1.489073	38.47	17.00	55.47
13	54.922309	-1.489073	38.47	17.00	55.47
14	54.922309	-1.489073	38.47	17.00	55.47
15	54.922309	-1.489073	38.47	17.00	55.47
16	54.922309	-1.489073	38.47	17.00	55.47

Name: PVC east L
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922064	-1.488628	39.06	16.51	55.57
2	54.923814	-1.489995	39.45	16.51	55.96
3	54.923908	-1.489609	39.23	15.00	54.23
4	54.922156	-1.488220	38.83	15.00	53.83

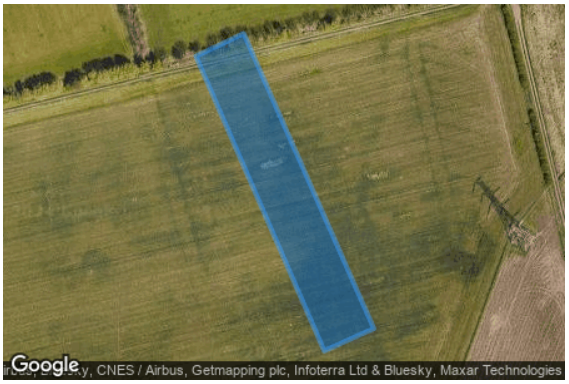
Name: PVC west H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 247.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922141	-1.489720	38.76	16.50	55.26
2	54.923601	-1.490830	38.94	16.50	55.44
3	54.923706	-1.490408	39.41	18.00	57.41
4	54.922253	-1.489289	38.46	18.00	56.46

Name: PVC west L
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 247.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922040	-1.490146	38.69	15.00	53.69
2	54.923499	-1.491249	39.03	15.00	54.03
3	54.923602	-1.490830	38.94	16.51	55.45
4	54.922140	-1.489719	38.76	16.51	55.27

Name: PVD east H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922664	-1.487674	38.82	18.00	56.82
2	54.924113	-1.488776	38.44	18.00	56.44
3	54.924225	-1.488366	38.20	16.51	54.71
4	54.922774	-1.487248	38.76	16.51	55.27

Name: PVD east L
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922774	-1.487249	38.76	16.51	55.27
2	54.924225	-1.488366	38.20	16.51	54.71
3	54.924338	-1.487927	37.50	15.00	52.50
4	54.922878	-1.486834	38.85	15.00	53.85

Name: PVD west H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 267.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922254	-1.487845	39.08	16.51	55.59
2	54.924017	-1.489186	38.96	16.51	55.47
3	54.924112	-1.488775	38.44	18.00	56.44
4	54.922664	-1.487675	38.82	18.00	56.82
5	54.922616	-1.487867	38.80	17.00	55.80
6	54.922603	-1.487854	38.81	0.00	38.81
7	54.922592	-1.487841	38.82	17.00	55.82
8	54.922580	-1.487829	38.83	17.00	55.83
9	54.922564	-1.487810	38.85	17.00	55.85
10	54.922549	-1.487796	38.87	17.00	55.87
11	54.922391	-1.487696	39.15	17.00	56.15
12	54.922358	-1.487671	39.20	17.00	56.20
13	54.922334	-1.487651	39.23	17.00	56.23
14	54.922320	-1.487639	39.24	17.00	56.24
15	54.922304	-1.487620	39.26	0.00	39.26
16	54.922294	-1.487670	39.22	17.00	56.22

Name: PVD west L
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 247.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.922157	-1.488219	38.83	15.00	53.83
2	54.923908	-1.489608	39.23	15.00	54.23
3	54.924016	-1.489185	38.96	16.51	55.47
4	54.922254	-1.487844	39.08	16.51	55.59

Name: PW east H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.921848	-1.488160	39.16	18.00	57.16
2	54.919747	-1.486548	38.24	18.00	56.24
3	54.919870	-1.486017	38.46	16.00	54.46
4	54.921951	-1.487605	39.65	16.00	55.65

Name: PW east L
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 67.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.921968	-1.487626	39.63	16.00	55.63
2	54.919872	-1.486039	38.47	16.00	54.47
3	54.920030	-1.485470	38.43	14.00	52.43
4	54.922136	-1.487097	39.81	14.00	53.81

Name: PW west H
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 247.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.921719	-1.488703	38.73	16.00	54.73
2	54.919606	-1.487086	38.34	16.00	54.34
3	54.919743	-1.486550	38.24	18.00	56.24
4	54.921847	-1.488161	39.16	18.00	57.16

Name: PW west L
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 247.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	54.919469	-1.487615	41.00	14.00	55.00
2	54.921579	-1.489242	41.03	14.00	55.03
3	54.921719	-1.488703	40.15	16.00	56.15
4	54.919606	-1.487086	41.00	16.00	57.00

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 12	1	54.933214	-1.498090	45.61	1.80
OP 13	2	54.933541	-1.496368	43.53	1.80
OP 14	3	54.928993	-1.481027	36.94	1.80
OP 15	4	54.930867	-1.482352	37.73	1.80

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	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PVA east H	1.0	67.0	0	0.0	0	0.0	-	0
PVA east L	4.0	67.0	4,845	80.8	0	0.0	-	60,224
PVA west H	1.0	247.0	0	0.0	0	0.0	-	0
PVA west L	4.0	267.0	0	0.0	0	0.0	-	0
PVB east H	1.0	67.0	0	0.0	0	0.0	-	0
PVB east L	4.0	67.0	4,758	79.3	0	0.0	-	66,987
PVB west H	1.0	267.0	0	0.0	0	0.0	-	0
PVB west L	4.0	267.0	0	0.0	0	0.0	-	0
PVC east H	1.0	67.0	0	0.0	0	0.0	-	0
PVC east L	5.0	67.0	7,262	121.0	0	0.0	-	75,527
PVC west H	1.0	247.0	0	0.0	0	0.0	-	0
PVC west L	5.0	247.0	0	0.0	0	0.0	-	0
PVD east H	1.0	67.0	0	0.0	0	0.0	-	0
PVD east L	5.0	67.0	5,772	96.2	0	0.0	-	91,994
PVD west H	1.0	267.0	0	0.0	0	0.0	-	0
PVD west L	5.0	247.0	0	0.0	0	0.0	-	0
PW east H	1.0	67.0	0	0.0	0	0.0	-	0
PW east L	5.0	67.0	1,883	31.4	0	0.0	-	102,182
PW west H	1.0	247.0	0	0.0	0	0.0	-	0
PW west L	5.0	247.0	0	0.0	0	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
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	14,547	242.4	0	0.0
OP 15	9,973	166.2	0	0.0

PV: PVA east H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVA east H and OP 12

No glare found

PVA east H and OP 13

No glare found

PVA east H and OP 14

No glare found

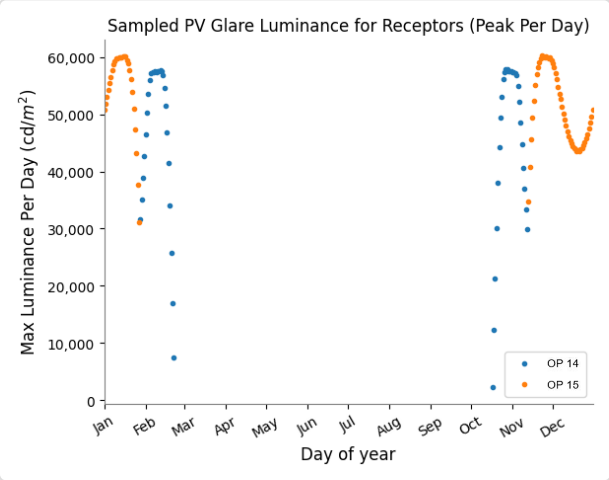
PVA east H and OP 15

No glare found

PV: PVA east L low potential for temporary after-image

Receptor results ordered by category of glare

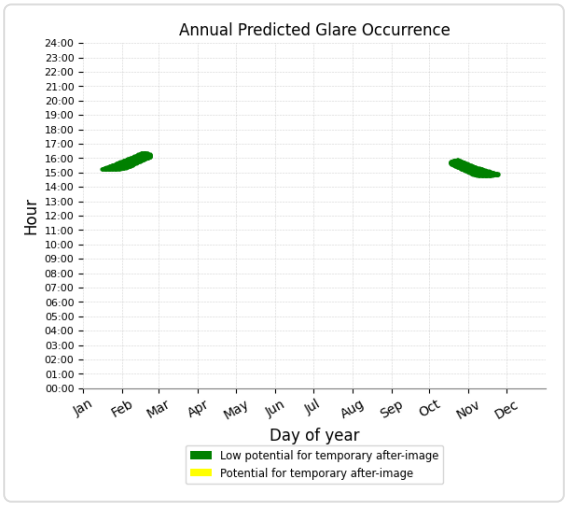
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 14	1,853	30.9	0	0.0	57,865
OP 15	2,992	49.9	0	0.0	60,224
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0

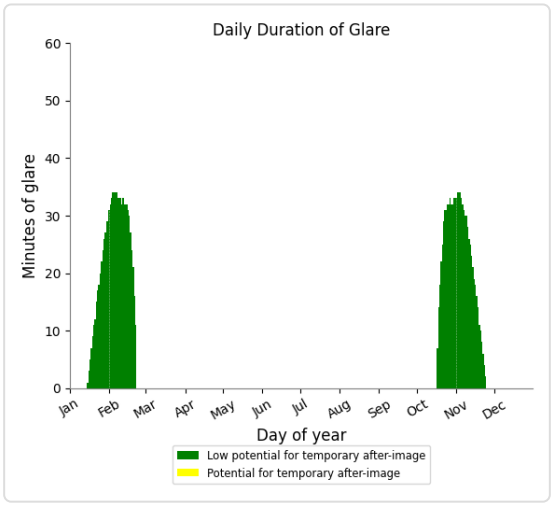


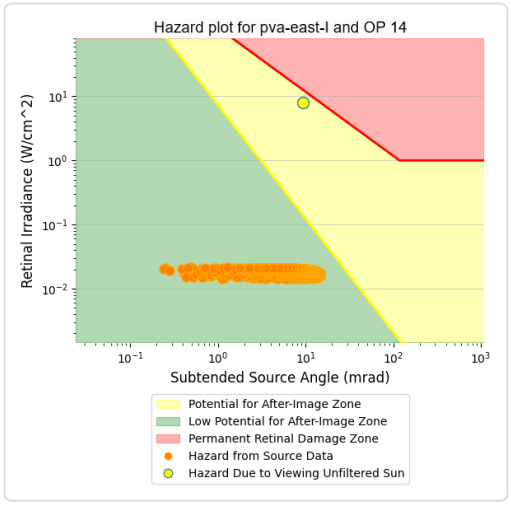
PVA east L and OP 14

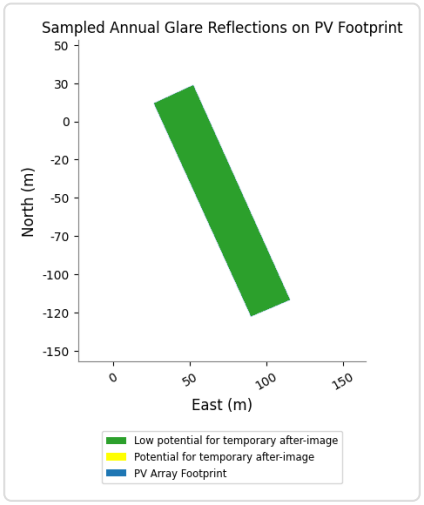
Yellow glare: none

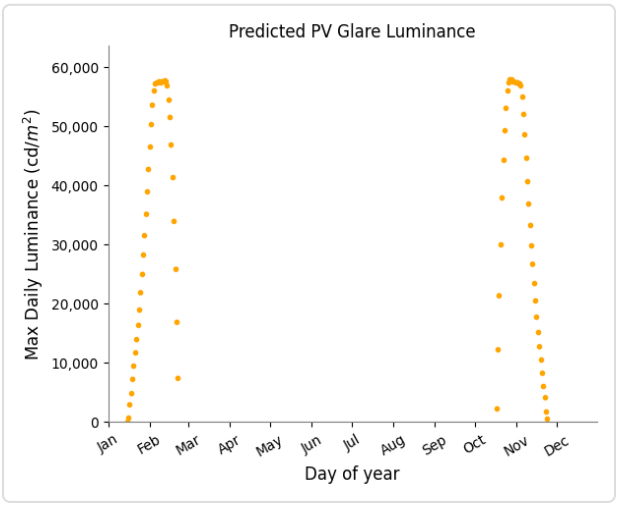
Green glare: 1,853 min.







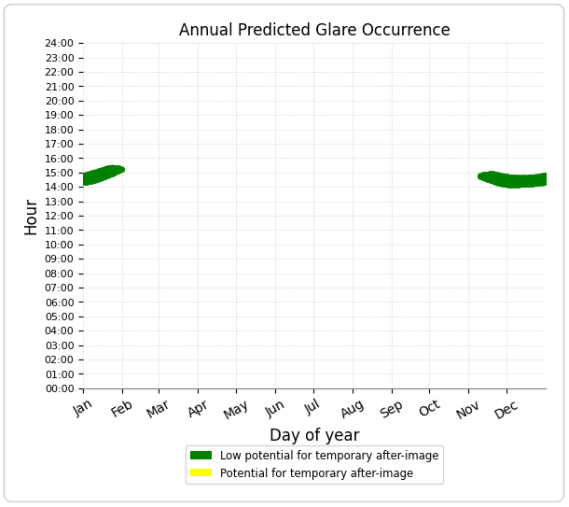


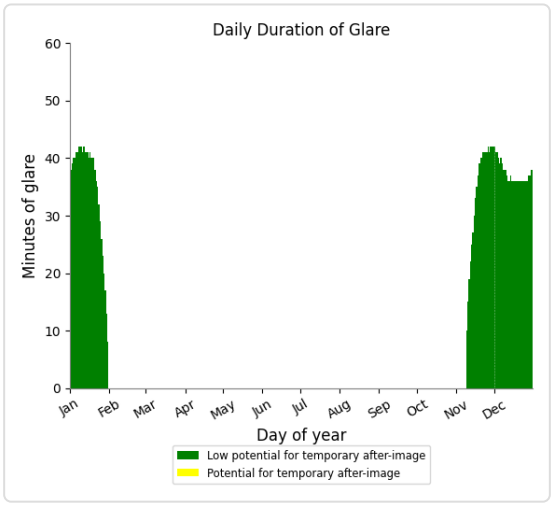


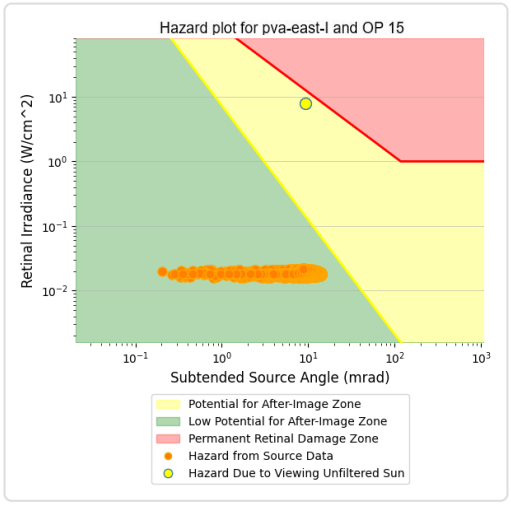
PVA east L and OP 15

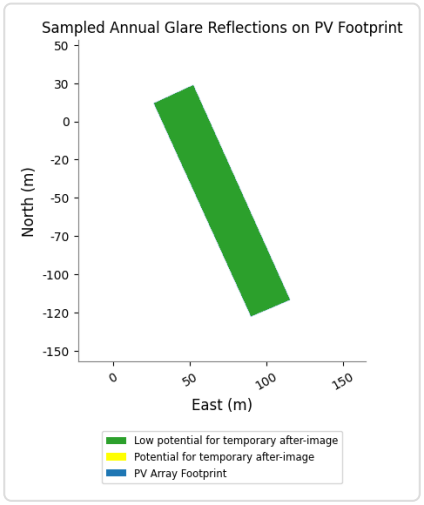
Yellow glare: none

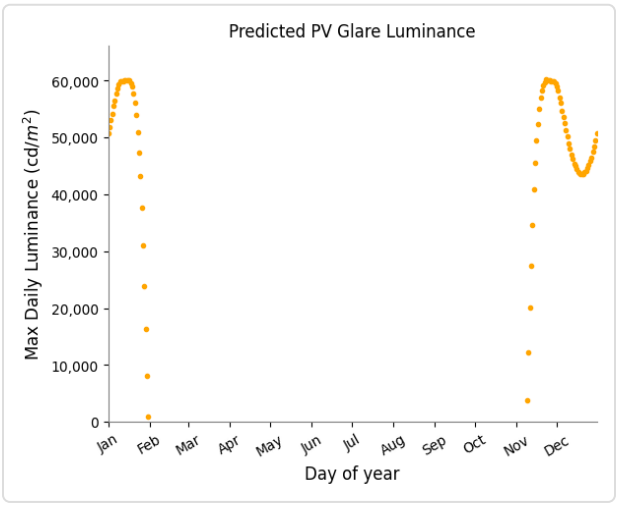
Green glare: 2,992 min.











PVA east L and OP 12

No glare found

PVA east L and OP 13

No glare found

PV: PVA west H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVA west H and OP 12

No glare found

PVA west H and OP 13

No glare found

PVA west H and OP 14

No glare found

PVA west H and OP 15

No glare found

PV: PVA west L no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVA west L and OP 12

No glare found

PVA west L and OP 13

No glare found

PVA west L and OP 14

No glare found

PVA west L and OP 15

No glare found

PV: PVB east H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVB east H and OP 12

No glare found

PVB east H and OP 13

No glare found

PVB east H and OP 14

No glare found

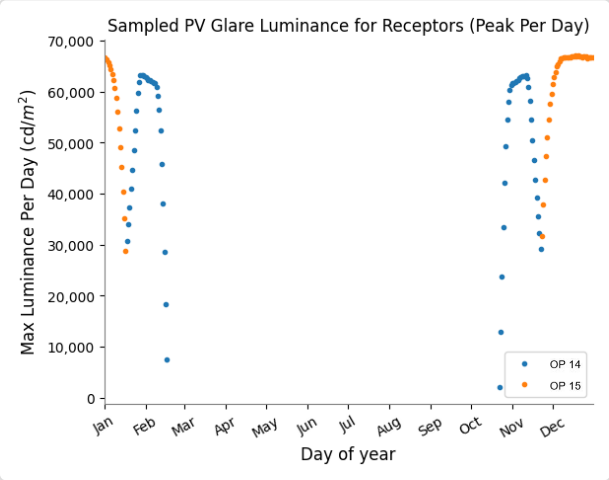
PVB east H and OP 15

No glare found

PV: PVB east L low potential for temporary after-image

Receptor results ordered by category of glare

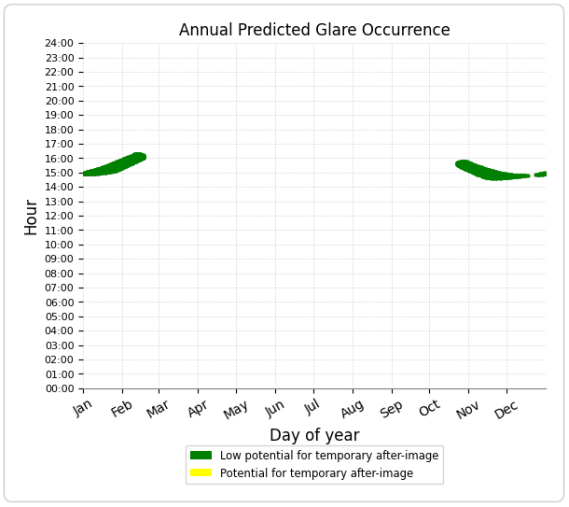
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 14	2,497	41.6	0	0.0	63,258
OP 15	2,261	37.7	0	0.0	66,987
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0

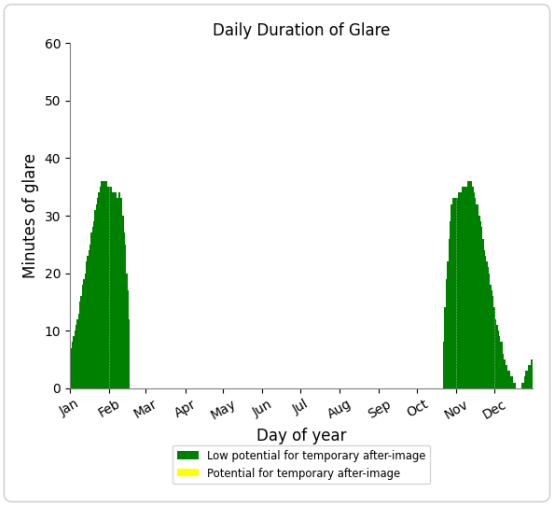


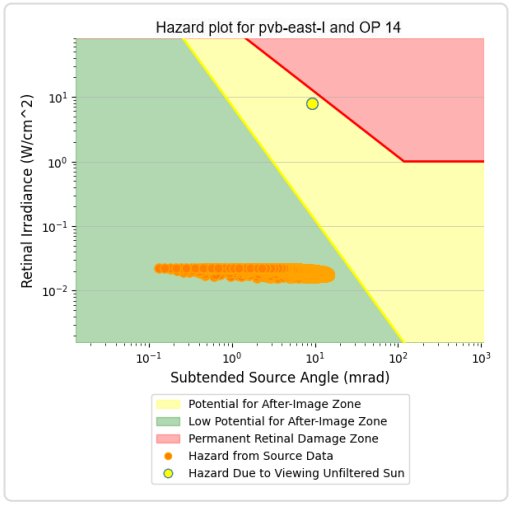
PVB east L and OP 14

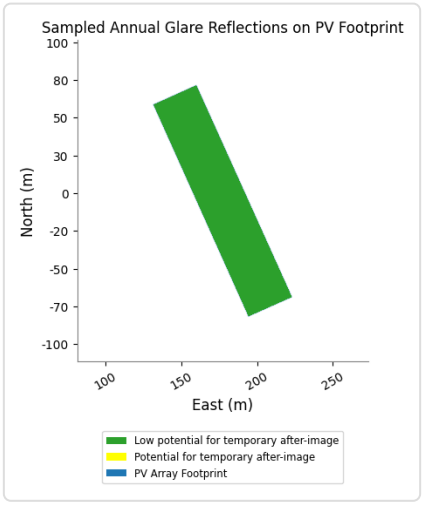
Yellow glare: none

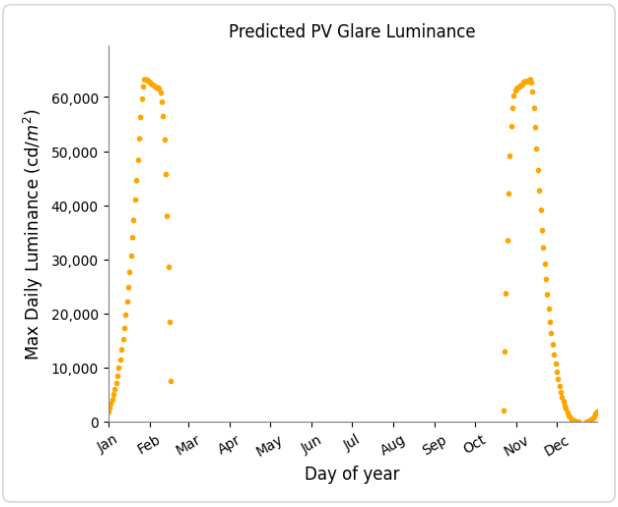
Green glare: 2,497 min.







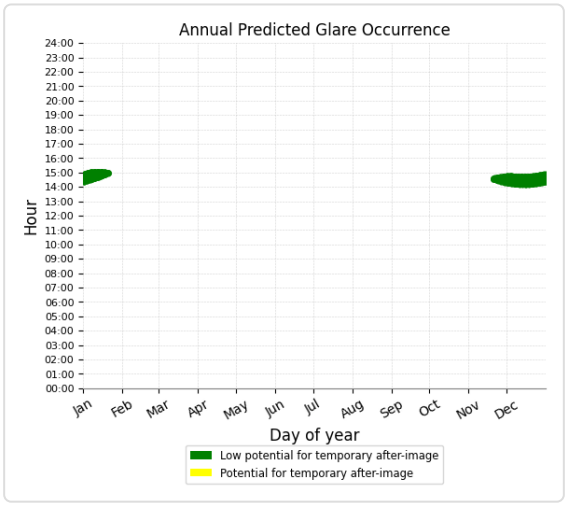


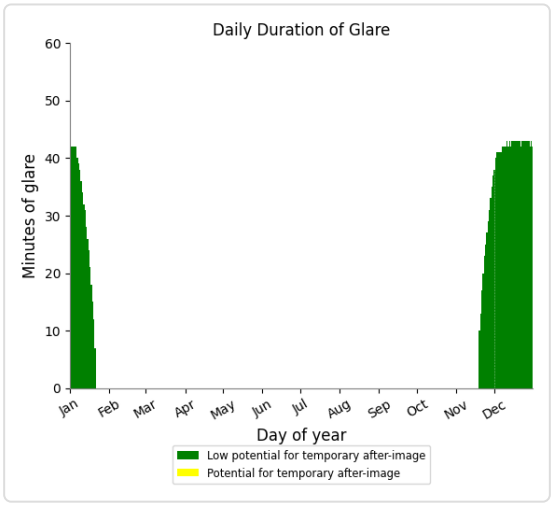


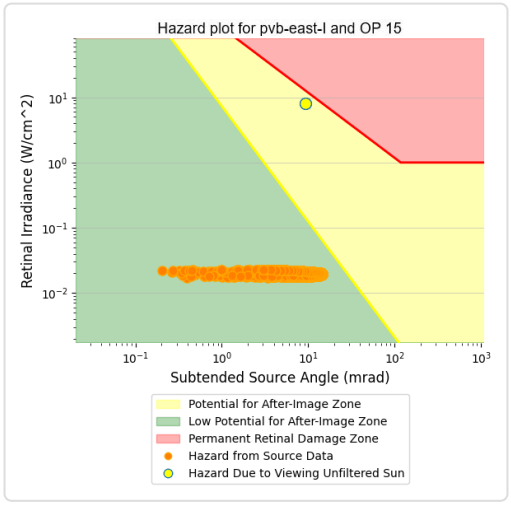
PVB east L and OP 15

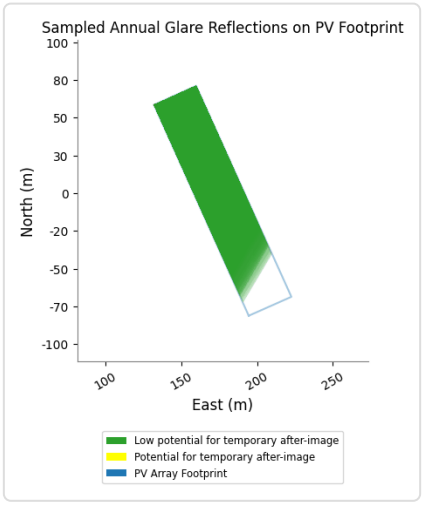
Yellow glare: none

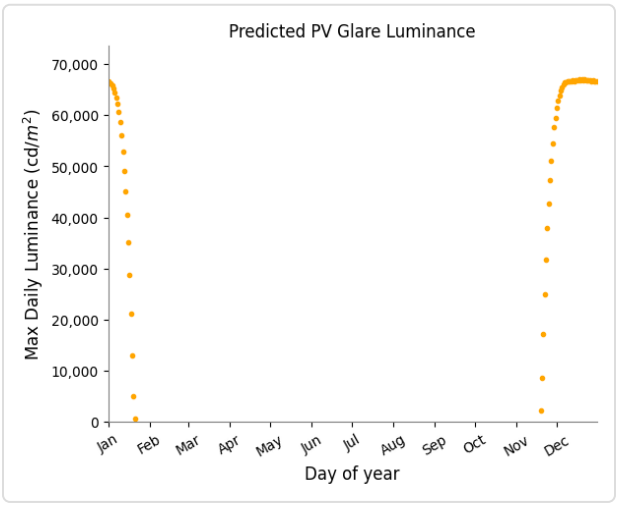
Green glare: 2,261 min.











PVB east L and OP 12

No glare found

PVB east L and OP 13

No glare found

PV: PVB west H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVB west H and OP 12

No glare found

PVB west H and OP 13

No glare found

PVB west H and OP 14

No glare found

PVB west H and OP 15

No glare found

PV: PVB west L no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVB west L and OP 12

No glare found

PVB west L and OP 13

No glare found

PVB west L and OP 14

No glare found

PVB west L and OP 15

No glare found

PV: PVC east H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVC east H and OP 12

No glare found

PVC east H and OP 13

No glare found

PVC east H and OP 14

No glare found

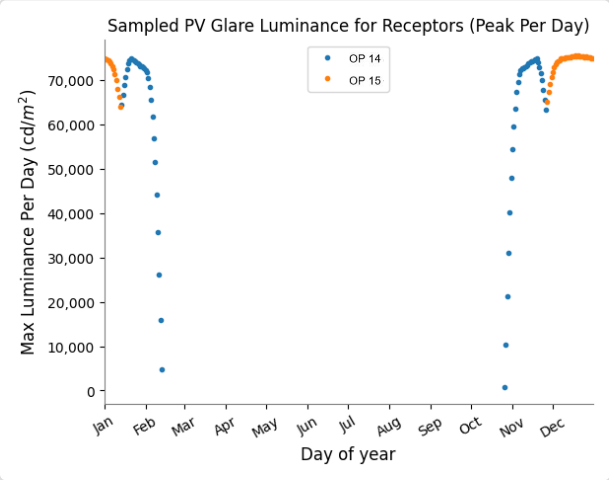
PVC east H and OP 15

No glare found

PV: PVC east L low potential for temporary after-image

Receptor results ordered by category of glare

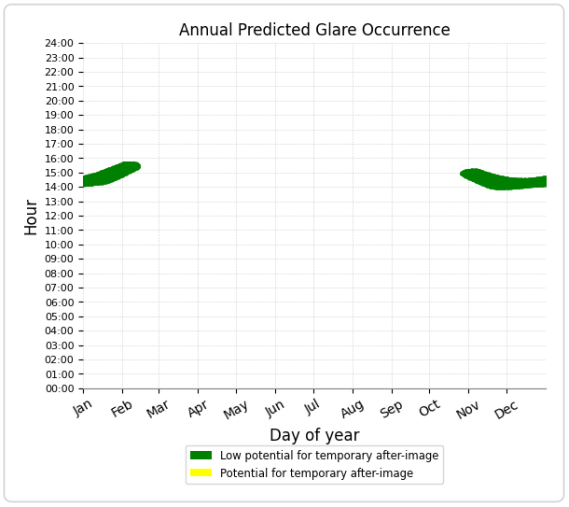
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 14	4,176	69.6	0	0.0	74,968
OP 15	3,086	51.4	0	0.0	75,527
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0

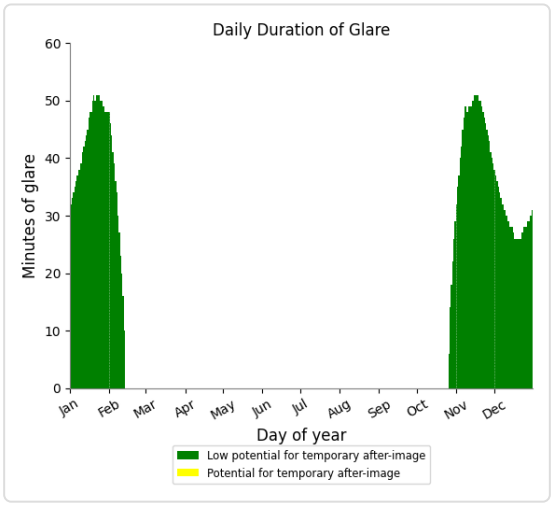


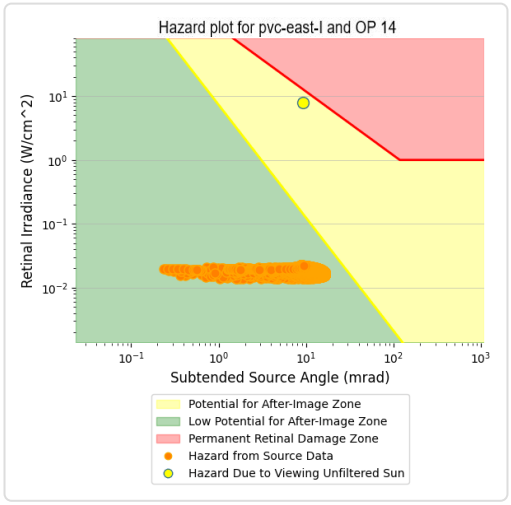
PVC east L and OP 14

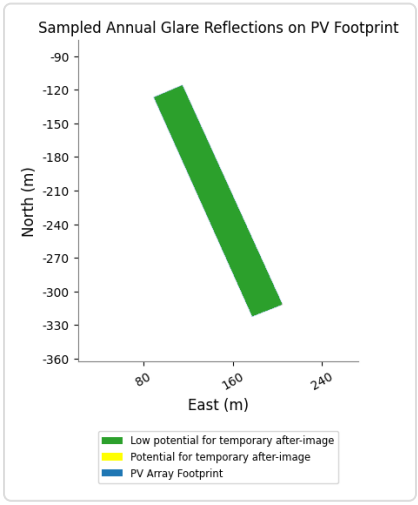
Yellow glare: none

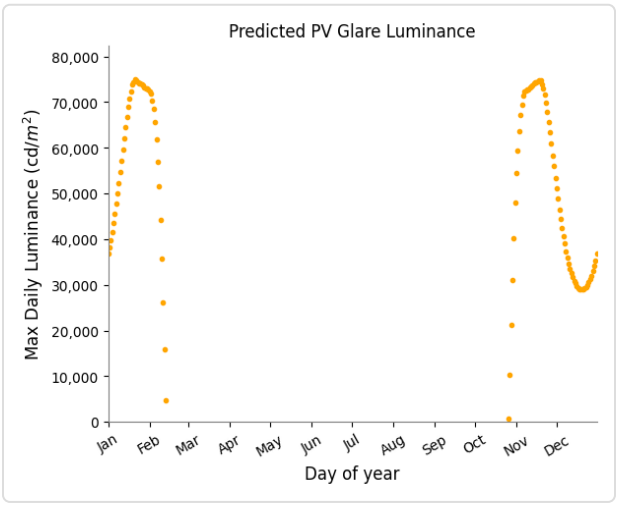
Green glare: 4,176 min.







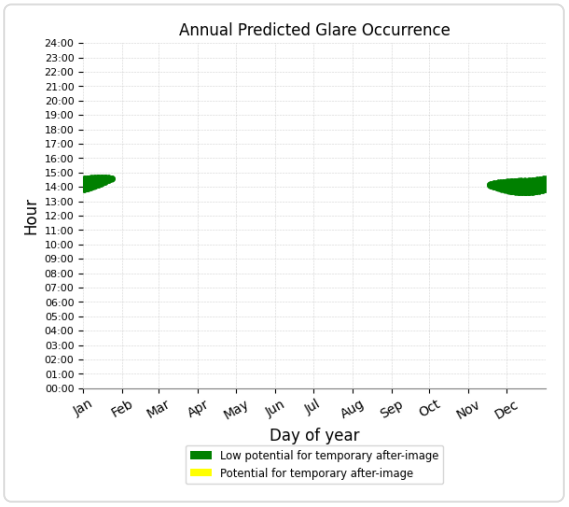


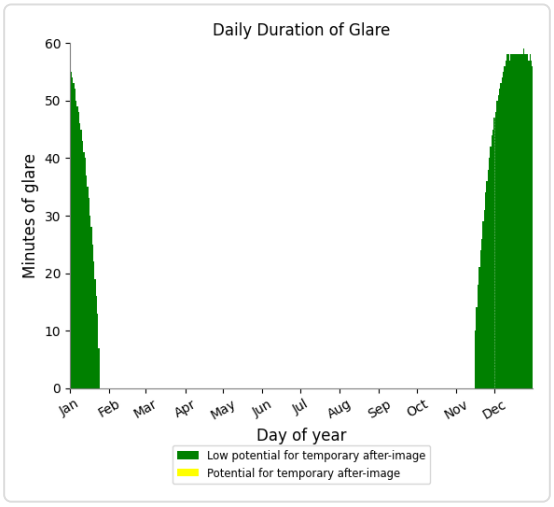


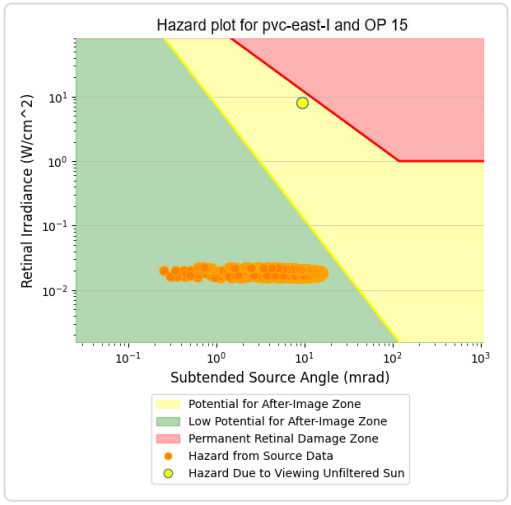
PVC east L and OP 15

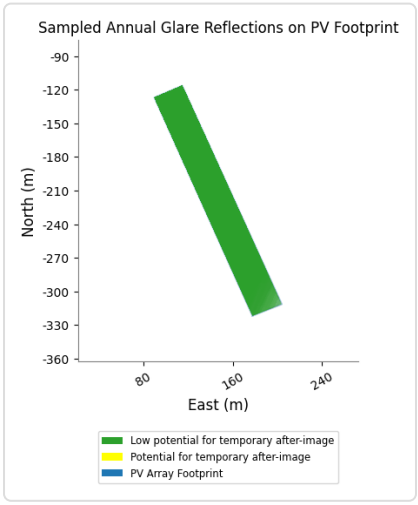
Yellow glare: none

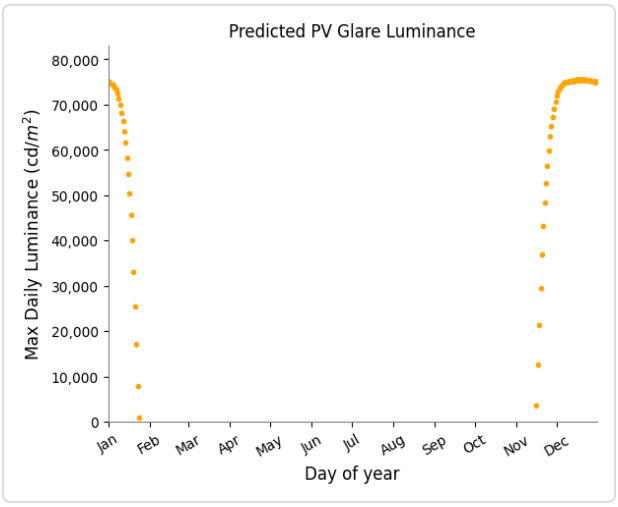
Green glare: 3,086 min.











PVC east L and OP 12

No glare found

PVC east L and OP 13

No glare found

PV: PVC west H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVC west H and OP 12

No glare found

PVC west H and OP 13

No glare found

PVC west H and OP 14

No glare found

PVC west H and OP 15

No glare found

PV: PVC west L no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVC west L and OP 12

No glare found

PVC west L and OP 13

No glare found

PVC west L and OP 14

No glare found

PVC west L and OP 15

No glare found

PV: PVD east H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVD east H and OP 12

No glare found

PVD east H and OP 13

No glare found

PVD east H and OP 14

No glare found

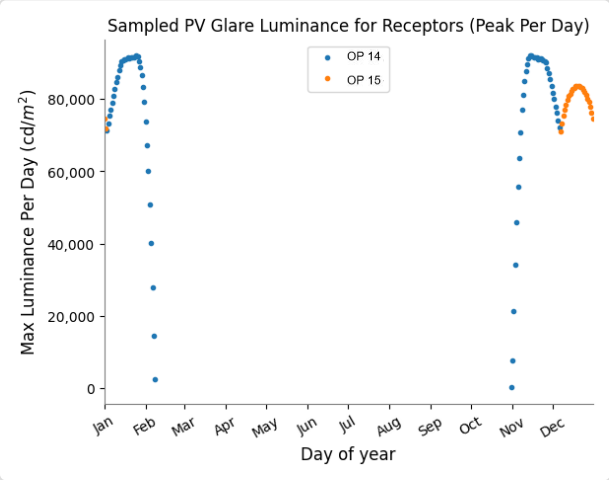
PVD east H and OP 15

No glare found

PV: PVD east L low potential for temporary after-image

Receptor results ordered by category of glare

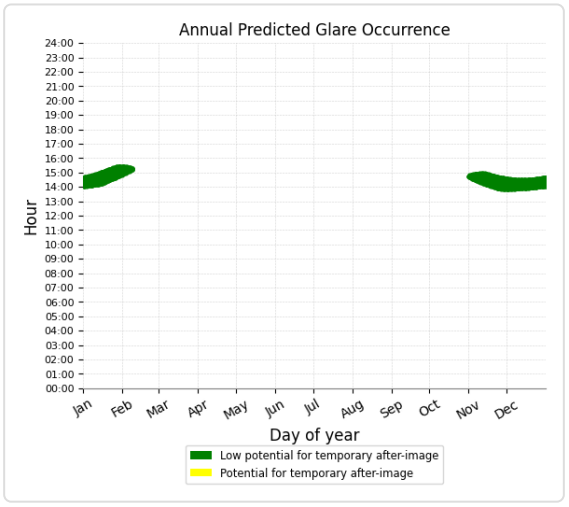
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 14	4,138	69.0	0	0.0	91,994
OP 15	1,634	27.2	0	0.0	83,737
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0

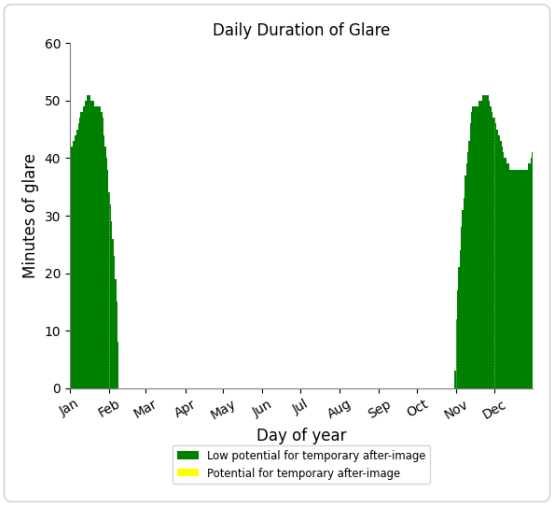


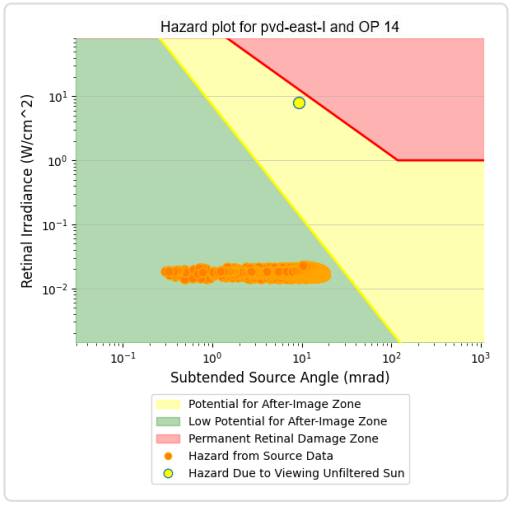
PVD east L and OP 14

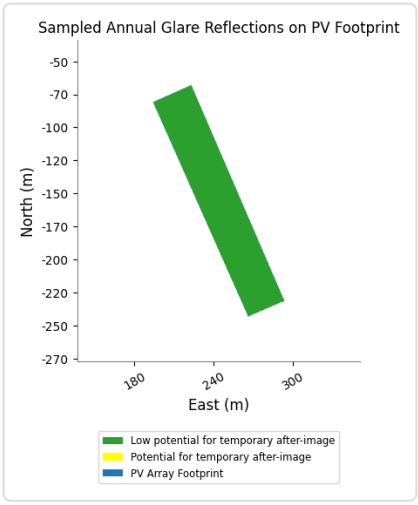
Yellow glare: none

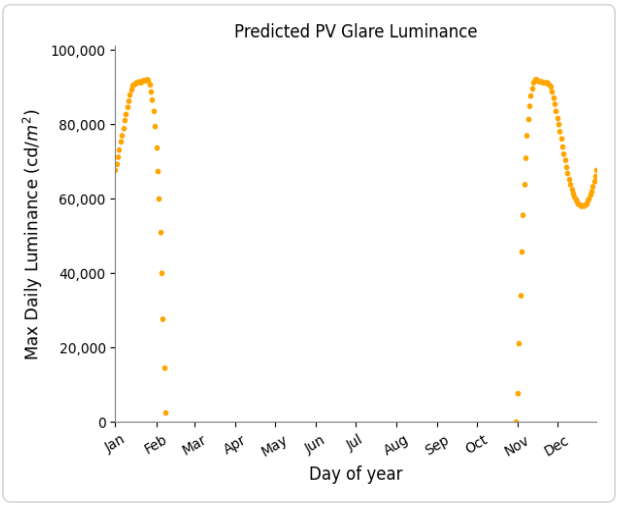
Green glare: 4,138 min.







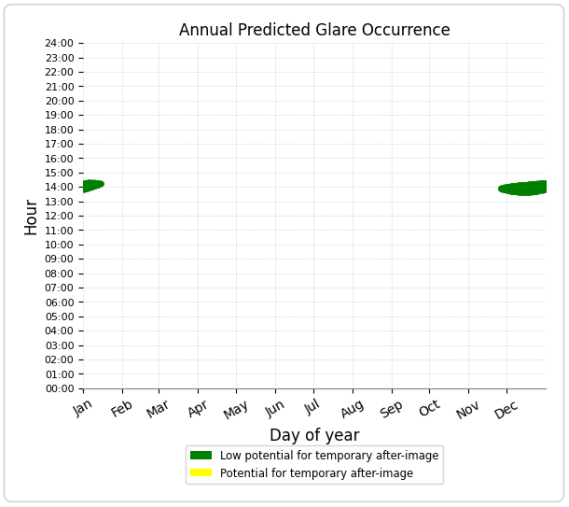


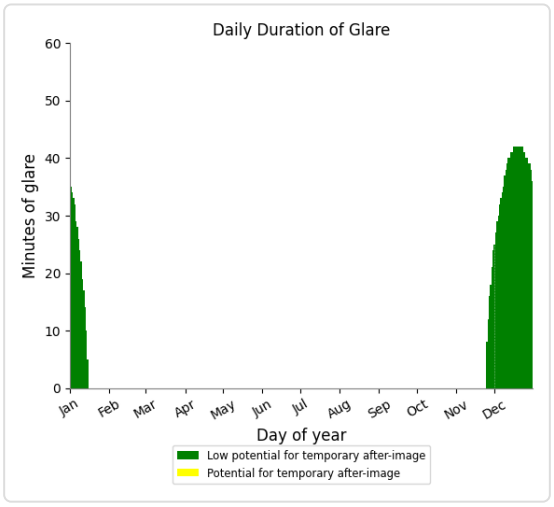


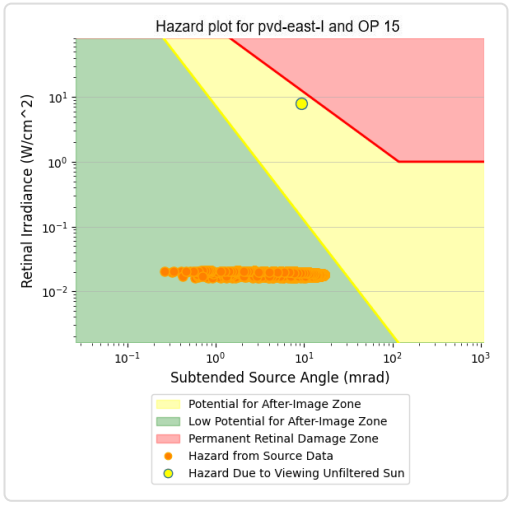
PVD east L and OP 15

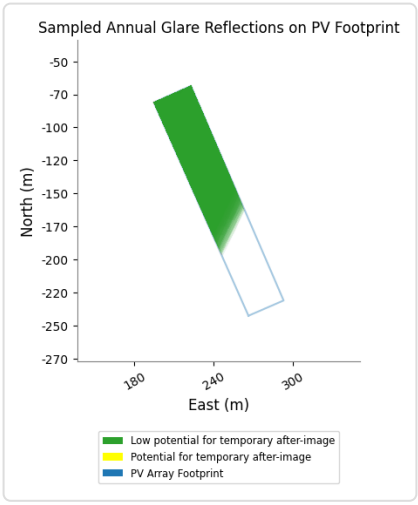
Yellow glare: none

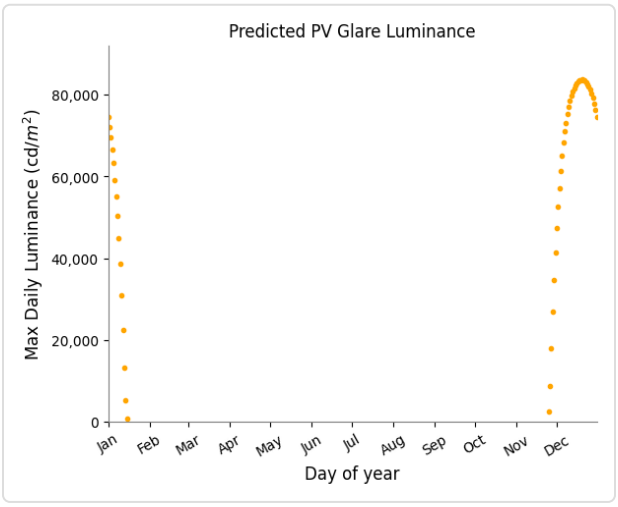
Green glare: 1,634 min.











PVD east L and OP 12

No glare found

PVD east L and OP 13

No glare found

PV: PVD west H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVD west H and OP 12

No glare found

PVD west H and OP 13

No glare found

PVD west H and OP 14

No glare found

PVD west H and OP 15

No glare found

PV: PVD west L no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PVD west L and OP 12

No glare found

PVD west L and OP 13

No glare found

PVD west L and OP 14

No glare found

PVD west L and OP 15

No glare found

PV: PW east H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PW east H and OP 12

No glare found

PW east H and OP 13

No glare found

PW east H and OP 14

No glare found

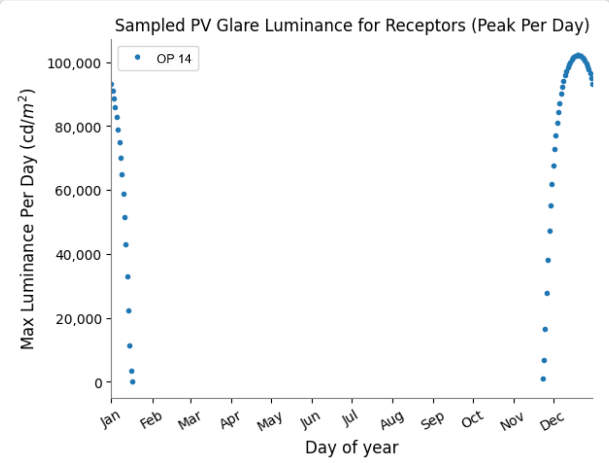
PW east H and OP 15

No glare found

PV: PW east L low potential for temporary after-image

Receptor results ordered by category of glare

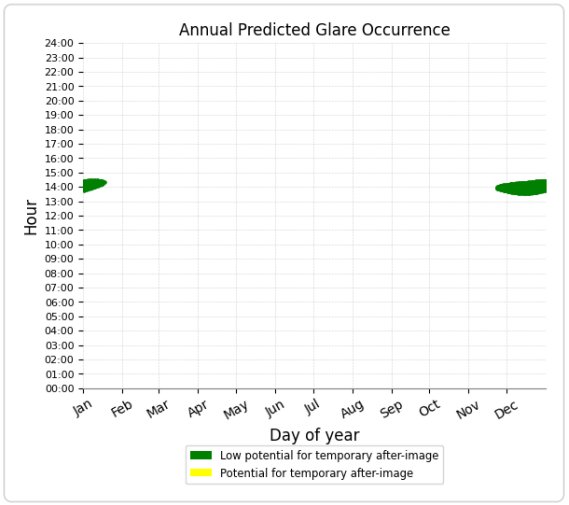
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 14	1,883	31.4	0	0.0	102,182
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

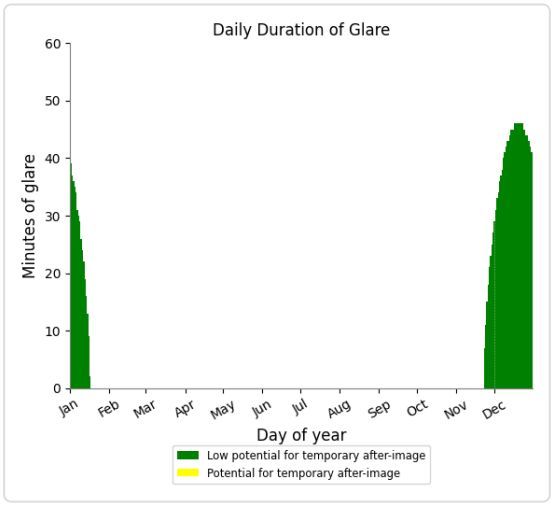


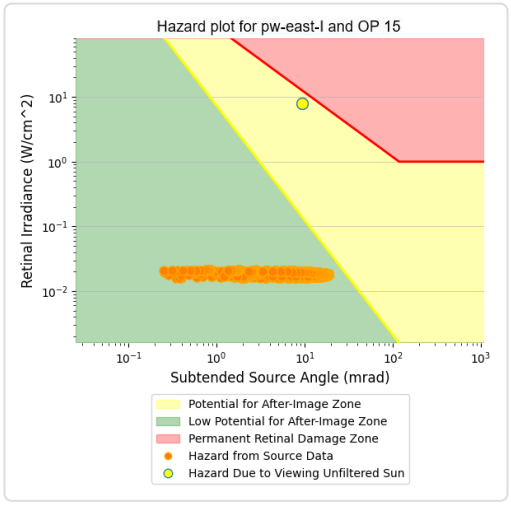
PW east L and OP 14

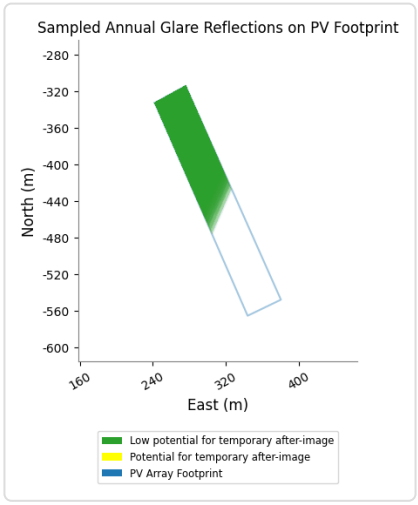
Yellow glare: none

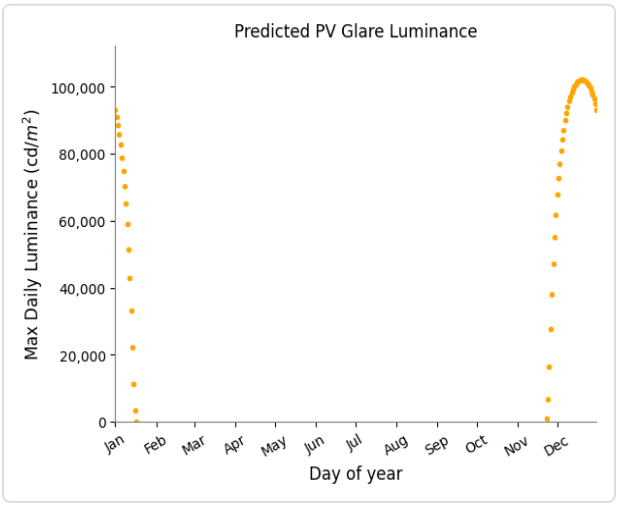
Green glare: 1,883 min.











PW east L and OP 12

No glare found

PW east L and OP 13

No glare found

PW east L and OP 15

No glare found

PV: PW west H no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PW west H and OP 12

No glare found

PW west H and OP 13

No glare found

PW west H and OP 14

No glare found

PW west H and OP 15

No glare found

PV: PW west L no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0

PW west L and OP 12

No glare found

PW west L and OP 13

No glare found

PW west L and OP 14

No glare found

PW west L and OP 15

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.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
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

Appendix 3.1.4
Mathematical Calculations used in Geometric Analysis

Solar Position

Firstly the sun position is calculated. The sun position algorithm calculates the sun position in two forms: first as a unit vector extending from the Cartesian origin toward the sun, and second as azimuthal and altitudinal angles. The algorithm relies on the latitude, longitude and time zone offset from UTC in order to determine the position of the sun at every time step throughout the year.

The equations used are:

$$t_{solar} = 4(L_{st} - L_{loc}) + E + t_{standard}$$

Where:

$$L_{st} = tz_{offset} * 15$$

$$E = 229.2(0.000075 + 0.001868 * \cos B - 0.0320077 * \sin B - 0.014615 * \cos 2B - 0.04089 * \sin 2B)$$

L_{st} is the local standard meridian, L_{loc} is the given longitude and E is the equation of time, in minutes.

The solar time can then be used to calculate the Hour angle, ω:

$$\omega = \Delta t_{noon} * 15$$

Where Δt_{noon} is the difference between solar time and solar noon.

Once the declination, δ is known, the solar zenith and azimuthal angle of the sun can be found:

$$\delta = 23.45 * \sin\left(360 * \frac{284 + n}{365}\right)$$

$$\theta_z = \cos^{-1}(\cos\varphi * \cos\delta * \cos\omega + \sin\varphi * \sin\delta)$$

$$\gamma_s = sign(\omega)\left|\cos^{-1}\left(\frac{\cos\theta_z \sin\phi - \sin\delta}{\sin\theta_z \cos\phi}\right)\right|$$

Where:

- n is the day of the year (1 to 365)
- θ_z is the sun zenith angle (subtract from 90 to get the altitude angle, θ_a)
- φ is the given latitude
- γ_s is the sun azimuthal angle

The sun altitude and azimuth can be converted to unit vector components as follows:

$$\overrightarrow{s_i} = \cos\theta_a * \sin\gamma_s$$

$$\overrightarrow{s_j} = \cos\theta_a * \cos\gamma_s$$

$$\overrightarrow{s_k} = \sin\theta_a$$

Reflected Sun Vector

$$x_1' - x_0 = v - 2(v \cdot \hat{n})\,\hat{n}$$

Figure 1 illustrates this vector reflection graphically.

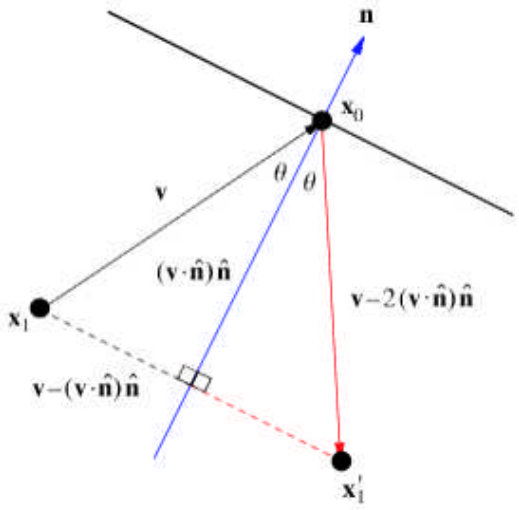


Figure 1 - Vector reflection over normal vector of plane. Source: mathworld.wolfram.com/Reflection.html

Scattering and Subtended Beam Angle

The reflected sun vector calculated above defines the axis of a conical beam which represents an actual beam of sunlight. This sun beam is translated to extend from the observation point (OP) toward the PV array (note this is the whole array not an individual panel). The aperture of this sun beam is equivalent to the subtended beam angle. This is formed of the sum of the sun shape and an additional scattering caused by slope error. This additional scattering takes into account errors in the panel angle across the array and slightly widens the subtended beam angle. The calculation is as follows:

$$\beta = 2 * \left(\frac{\theta_{sun\ angle}}{2} + 2 * 3 * \theta_{slope\ error}\right)$$

Beam Projection onto the PV Array Plane

This calculation takes the sun beam angle defined above and uses the result to calculate a cone from the eye back out to the array in order to define how much of the array is potentially visible and the intensity of any reflections.

The calculation is carried out in several steps. Firstly points lying on the edge of the beam in a conical section orthogonal to the axis (the subtended beam angle) are calculated. This conical section is arbitrarily defined to be 1 meter from the cone apex (the OP).

These 30 points are calculated by randomly generating two coordinates and solving for the third using the following equation:

$$v_{axis} \cdot v_{radius} = 0$$

This equation states that the cone axis is orthogonal to the radius vectors of the conical section upon which the 30 conical points lie. Next, conical edge vectors are defined by subtracting the cone apex (the OP) from the cone points. This collection of vectors extends from the OP toward the PV array plane.

These vectors define the conical sun beam. At their centre, or the axis of the cone, is the reflected sun vector calculated above. These conical vectors are then intersected with the PV array plane. This cone-plane intersection will be an elliptical conical section defined by 30 co-planar points. These intersection points are calculated using line-plane intersection equations:

$$d = \frac{(\boldsymbol{p_0} - \boldsymbol{I_0}) \cdot \vec{\boldsymbol{n}}}{\boldsymbol{I} \cdot \vec{\boldsymbol{n}}}$$

$$(x, y, z) = d\mathbf{I} + \boldsymbol{I_0}$$

Where:

- $\vec{\boldsymbol{n}}$ is the PV array panel normal vector
- **I** is one of the vectors extending from the OP to the PV array plane, which define the conical sun beam.
- $\mathbf{I_0}$ is a point on the vector (the OP)
- $\mathbf{p_0}$ is a point on the PV array plane
- *d* is the distance from the OP to the intersection point, and
- *(x, y, z)* define the intersection point for this vector.

The n intersection points found using the above equations define the elliptical conical section of the sun beam cone as it intersects the PV array plane. Glint is present when any of the OP vertices lie within this co-planar elipse.

In more simple terms we have calculated a cone defining the glint from the array (sections 2 and 3). When an observation point (OP) falls within this cone the subtended angle (the axis)

is used to define a cone from the viewer's eye back to the array. Where this cone intersects then glint will be received by the viewer. The amount of intersection is then used in the intensity calculation and also defines the subtended angle. Both of these are then used to calculate the potential for after-image.

Direct Normal Irradience (DNI), Reflectance and Subtended Beam Angle

The software modifies the peak DNI for a clear day irradiance profile. This lowers the DNI in the morning and evenings around the noon value which is calculated based upon the results of section 1 above. The calculation is as followed:

$$DNI = \cos(1 - t_s)$$

Here t_s represents the normalized time relative to solar noon. Normalization is based on the amount of time between sunrise or sunset and solar noon. Sandia determined the DNI scaling profile by fitting empirical DNI data to the cosine function, as illustrated in Figure 4. Note that DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

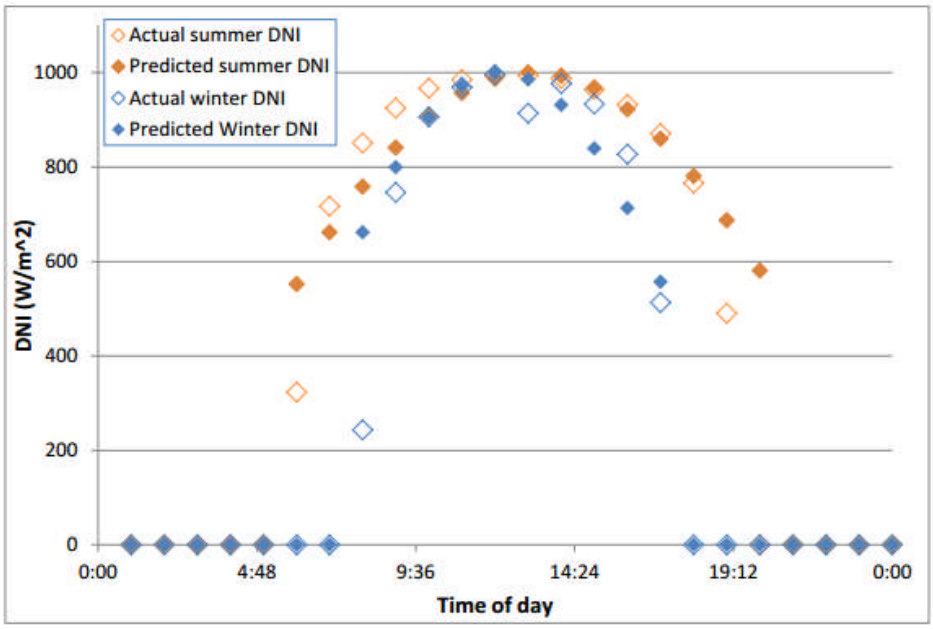


Figure 4 - Fit functions modeling normalized DNI vs. hour. Cosine was chosen to profile empirical data.

The DNI is further modified by Panel reflectivity which can be varied for each time step to account for the position of the sun relative to the array.

Smooth glass and light textured glass with and without Anti-Reflection coating, along with deeply textured glass were analysed to derive accurate functions for computing reflectivity based on sun incidence angle.

Table 1 contains the fit functions for different panel reflectivities.

Table 1 - Reflectance fit functions for PV cover types.

PV Glass Cover Type	Fit Function Defined over $0° \leq \theta \leq 60°$	Fit Function Defined over $60° < \theta < 90°$
Smooth Glass without Anti-Reflection Coating	$y = 1.1977E\text{-}5\ x^2 - 9.5728E\text{-}4\ x + 4.410E\text{-}2$	$y = 6.2952E\text{-}5\ e^{0.1019x}$
Smooth Glass with Anti-Reflection Coating	$y = 1.473E\text{-}5\ x^2 - 9.6416E\text{-}4\ x + 3.2395E\text{-}2$	$y = 4.7464E\text{-}5\ e^{0.1051x}$
Light Textured Glass without Anti-Reflection Coating	$y = 1.5272E\text{-}5\ x^2 - 1.1304E\text{-}3\ x + 4.305E\text{-}2$	$y = 7.3804E\text{-}5\ e^{0.0994x}$
Light Textured Glass with Anti-Reflection Coating	$y = 1.4188E\text{-}5\ x^2 - 1.0326E\text{-}3\ x + 3.9016E\text{-}2$	$y = 7.0179E\text{-}5\ e^{0.0994x}$
Deeply Textured Glass	$y = 6.8750E\text{-}6\ x^2 - 6.5250E\text{-}4\ x + 2.10E\text{-}2$	$y = 4.1793E\text{-}5\ e^{0.0834x}$

The glare analysis must account for the actual visible area of the PV array when viewed from the observation point. For example, less viewable area will be apparent when viewing an array with panel tilt of 0 degrees on a flat surface from the side than when viewing it from above in an aircraft.

To account for this, the analysis replaces the solar beam angle with an array-limiting beam angle if the latter is a smaller value. This represents the physical situation where the sun beam “overflows” the PV array from the viewer’s perspective, and thus less glare is possible.

The calculation is as follows:

$$\theta = \frac{1}{d}\sqrt{\frac{4 * A * \left|\cos\theta_{ref-pva}\right|}{\pi}}$$

where:

- A is area of PV array
- d is distance between observer and array
- $\theta_{ref\text{-}pva}$ is angle between reflected sun vector and PV array normal

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