

comparing annual glare simulation methods

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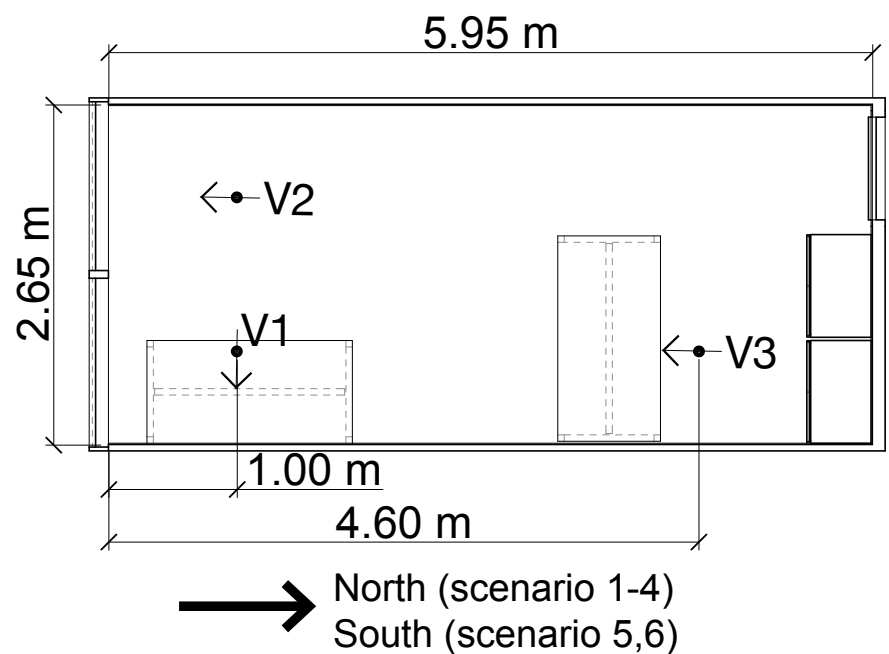
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Methods Producing DGP or DGP analogues

- DGPs (Wienold, 2009)
 - eDGPs (Wienold, 2009)
 - imageless DGP (dcglare) (Jones, 2019)
 - ClimateStudio Annual Glare (www.solemma.com)
 - raytraverse 1compdv (Wasilewski et. al, 2021)
 - AGC (adaptive glare coefficients) (Wienold, pending)
 - glare annual classes evaluation (GLANCE) (Giovannini et al., 2020)
 - a heuristic zonal approach (Santos and Caldas, 2021)
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- magenta colored methods use illuminance values or matrices from 2-phase DDS sensor calcs (Subramaniam, 2017)

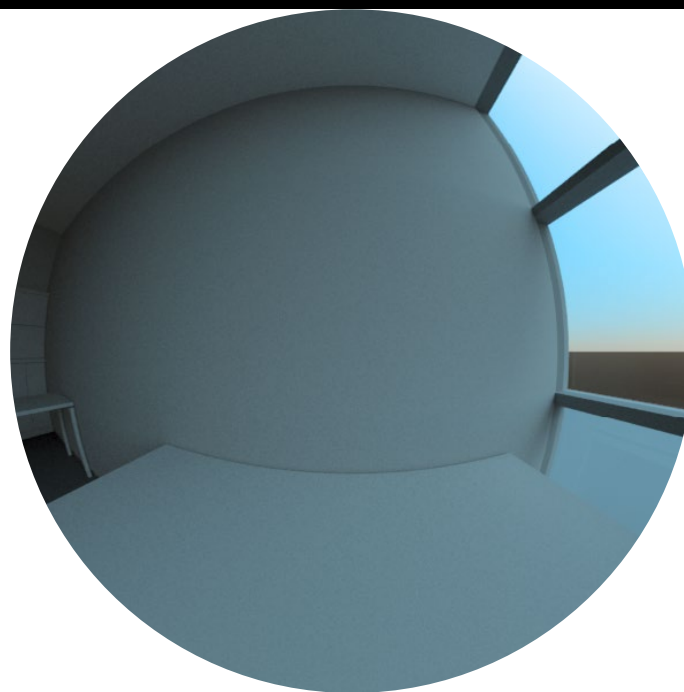
Base Model



a. Floor Plan - Viewpoints are at 1.2 meters above floor.



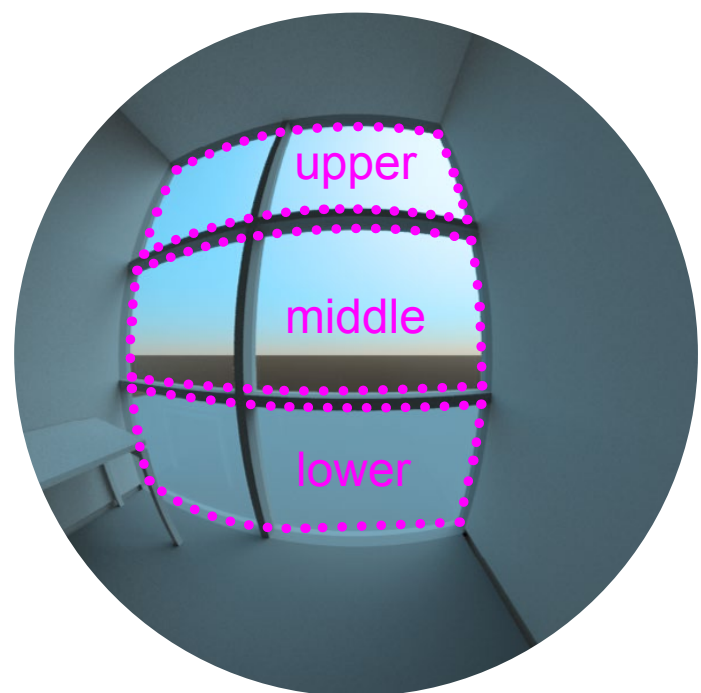
b. Sun Positions - sun-path for Geneva. yellow dots show tested sun-positions with direct normal > 50 W/m²



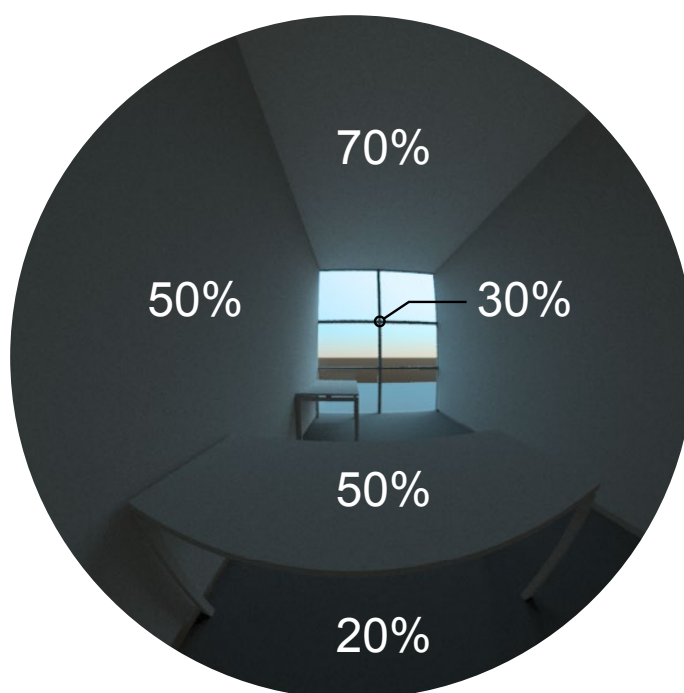
c. View 1 (V1)

Scenario	Lower	Middle	Upper
1. GLZ	70% VLT		
2. ECG	60% VLT	1% VLT	
3. SHD	70% VLT	70% VLT w/ 3% openness, 2% VLT, 10% VLR fabric	
4. TRN	30% VLT		30% VLT Trans
5. NGL	70% VLT w/ South Facing Glass Reflector		
6. NMT	70% VLT w/ South Facing Metal Reflector		

d. Glazing Properties by Scenario

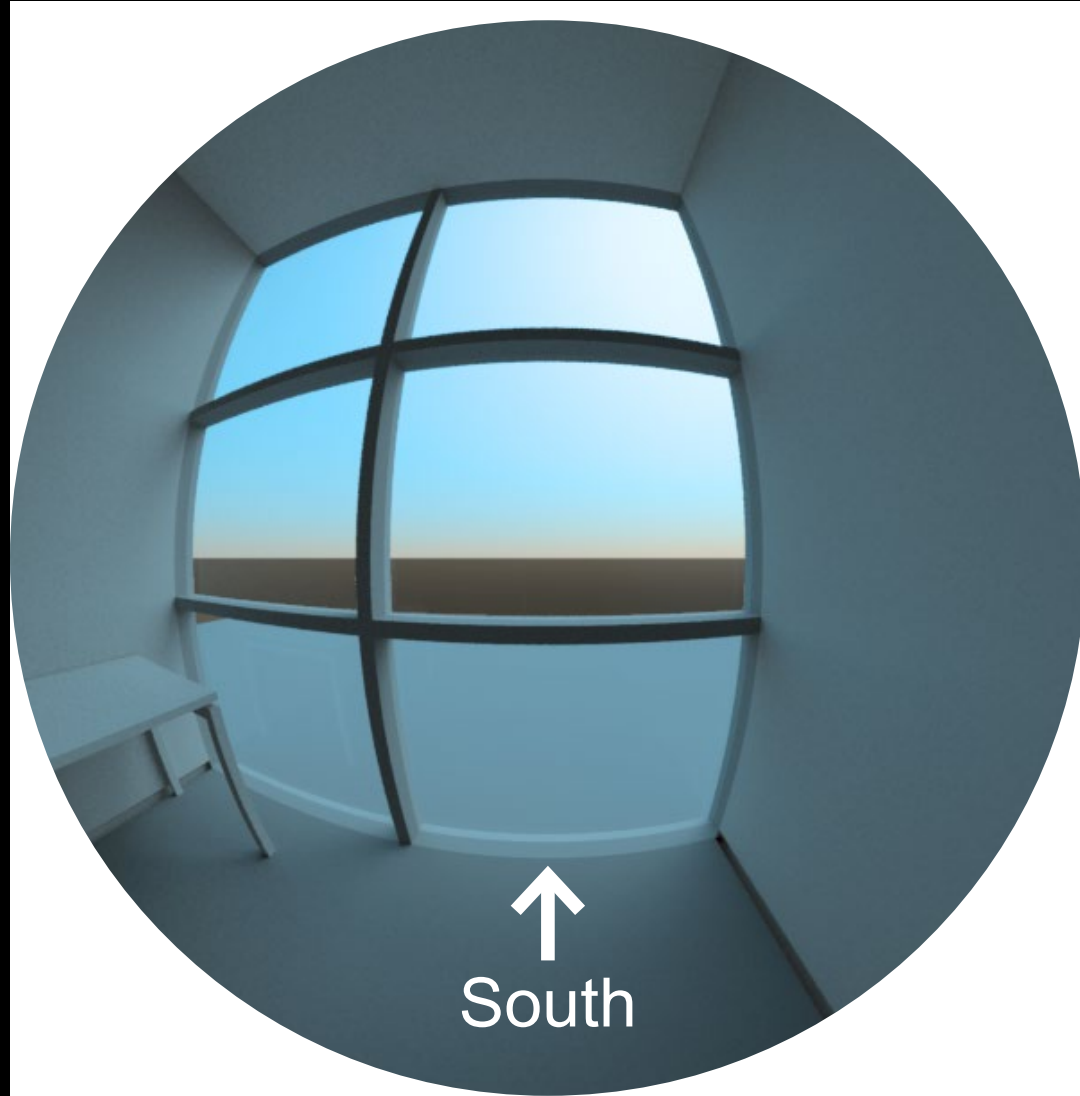


e. View 2 (V2) labelling window positions used in describing scenarios

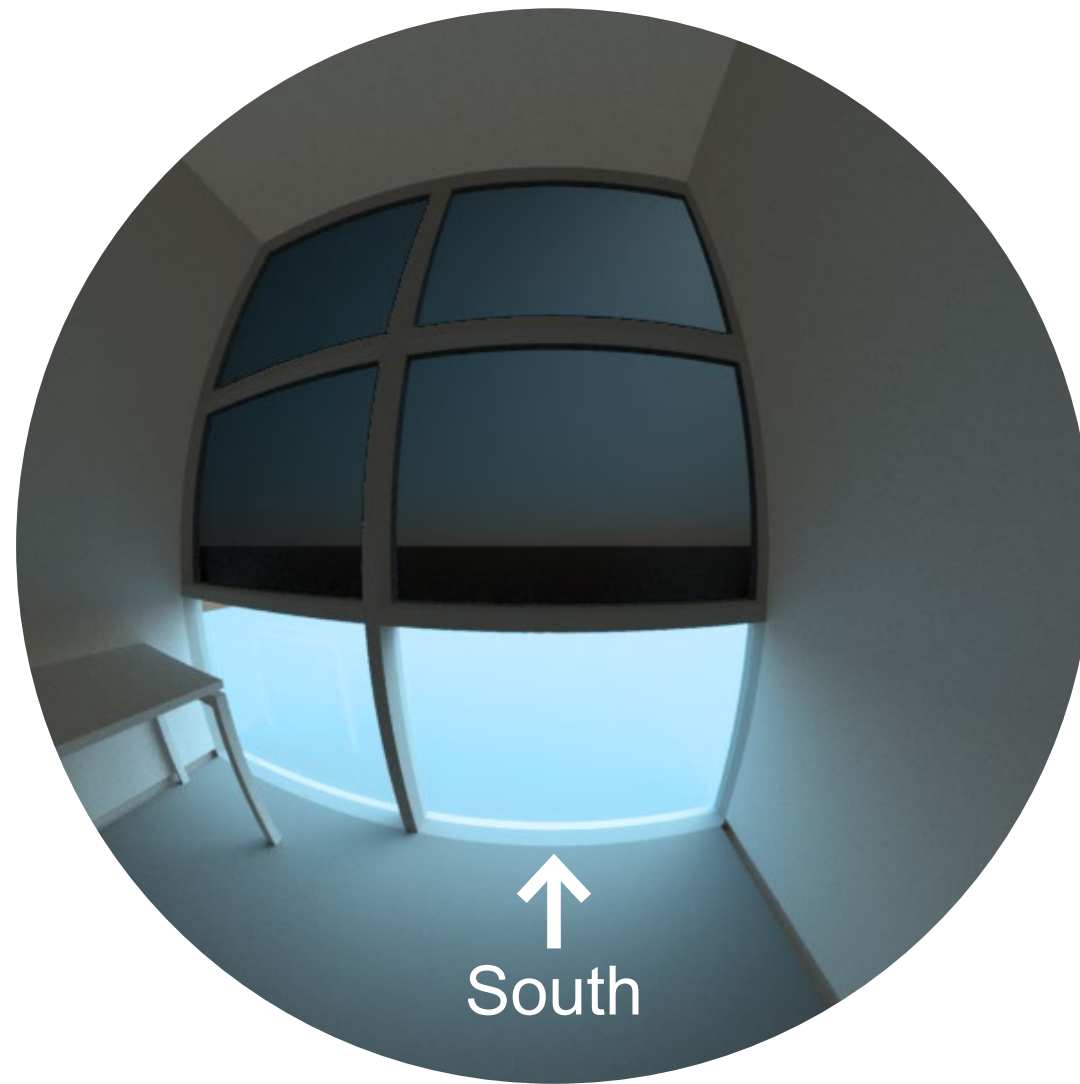


f. View 3 (V3) showing Visible light reflectance (VLR) of interior surfaces

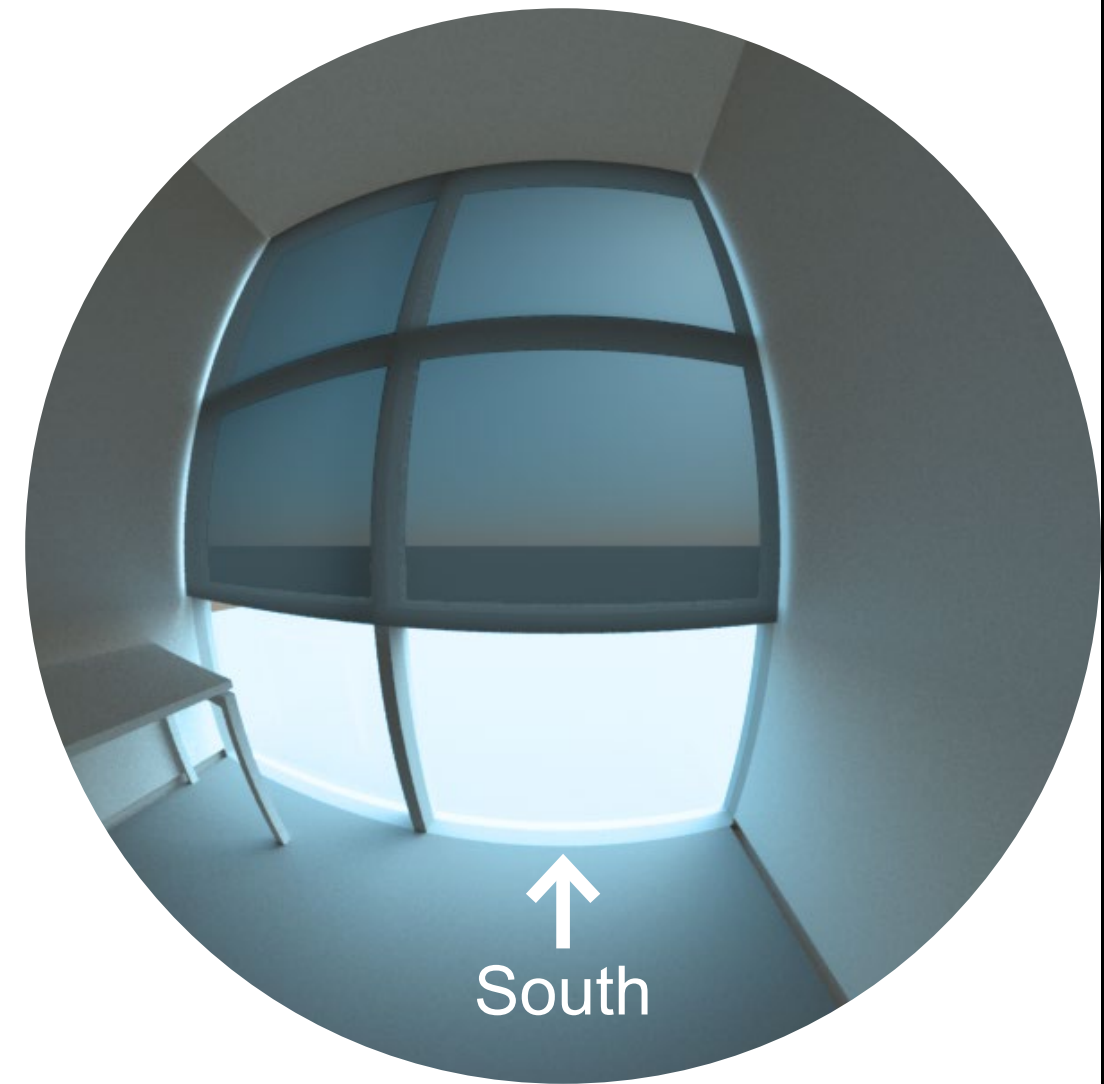
Fenestration and Reflection Scenarios



a. Scenario 1 - Clear Glazing (GLZ)

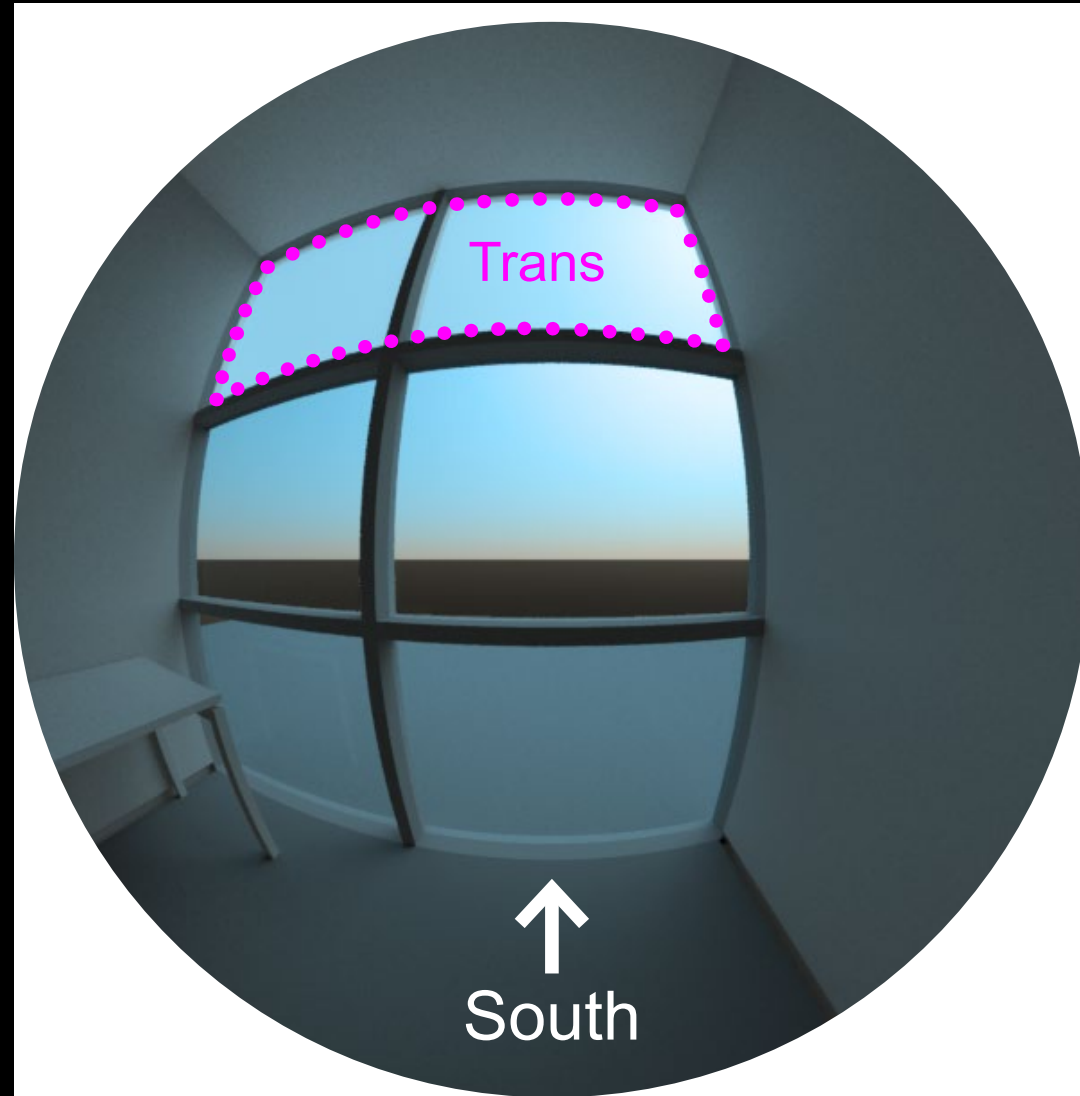


b. Scenario 2 - Low VLT Glazing (ECG)

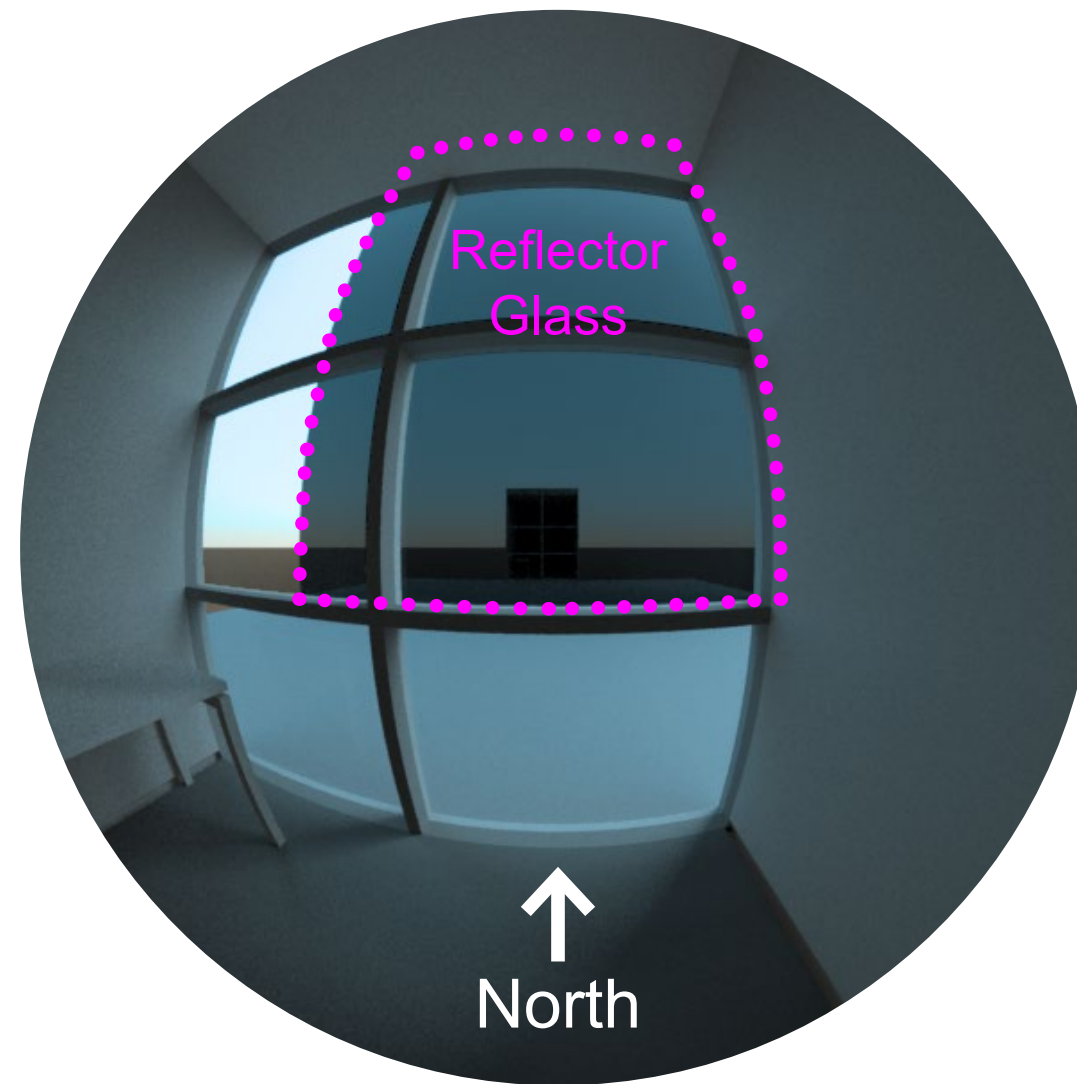


c. Scenario 3 - Fabric Roller-shade (SHD)

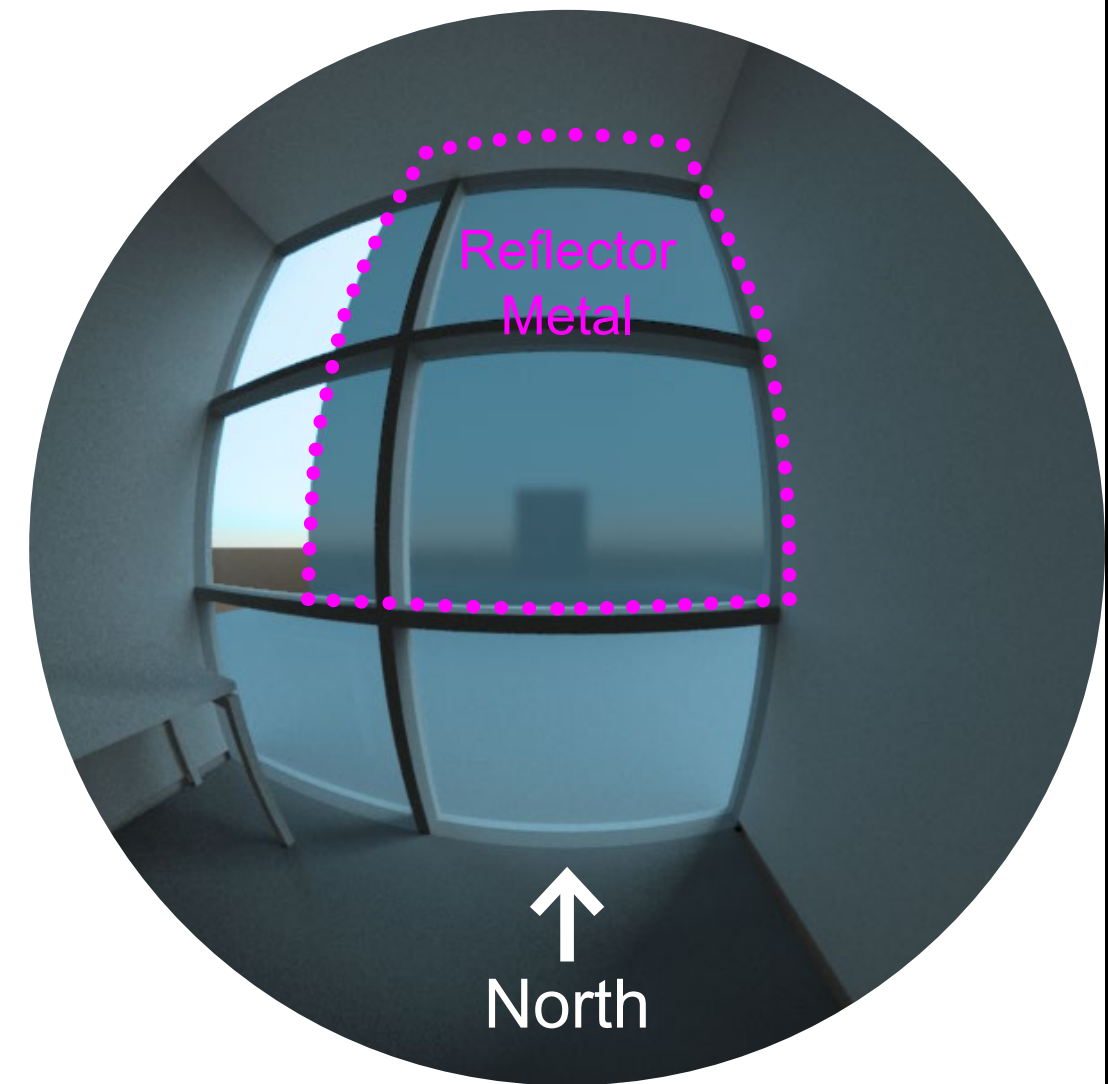
Fenestration and Reflection Scenarios



d. Scenario 4 - Translucent Panel (TRN)



e. Scenario 5 - Reflection From Glazing (NGL)



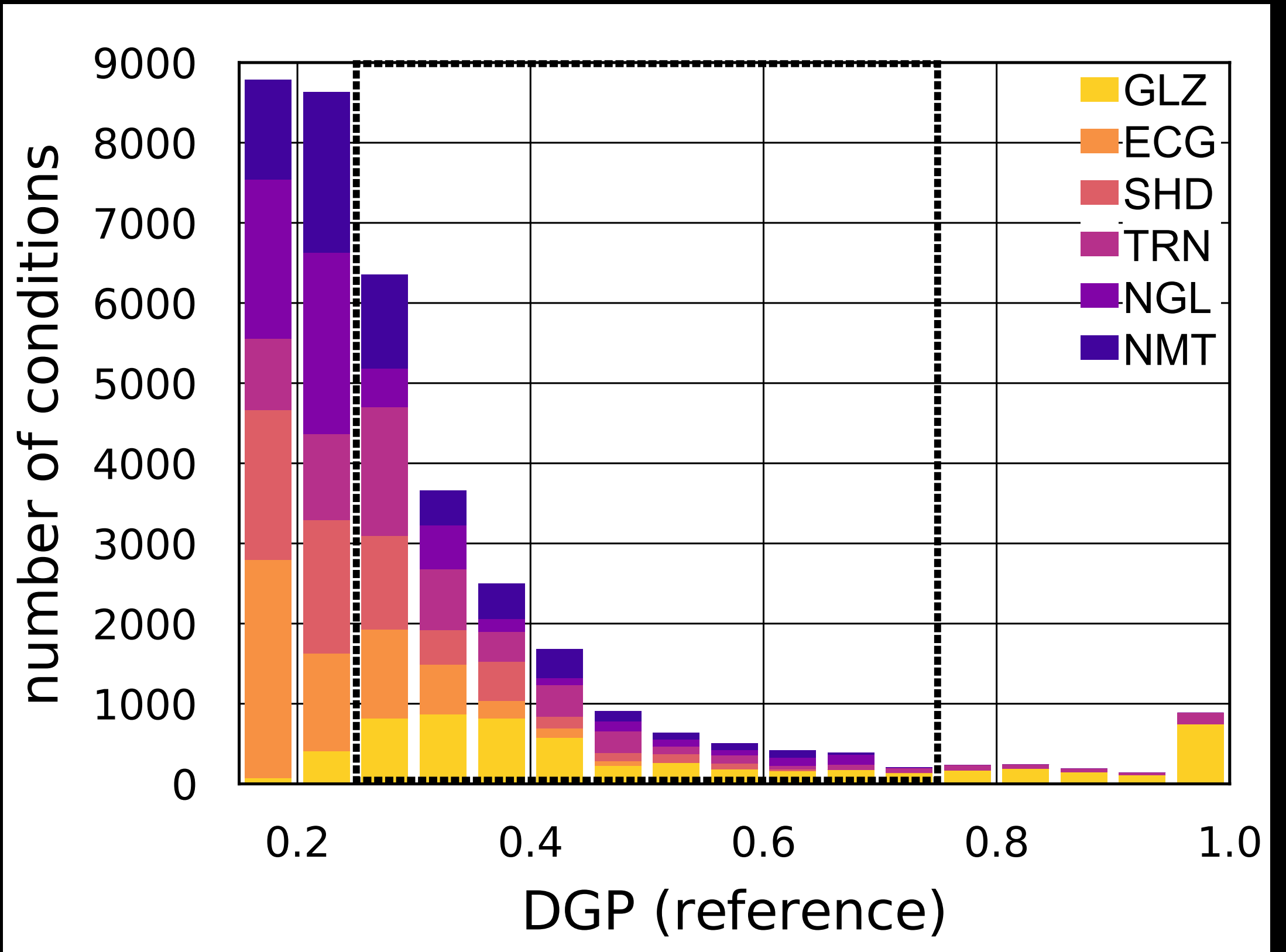
f. Scenario 6 - Reflection from Metal (NMT)

Results

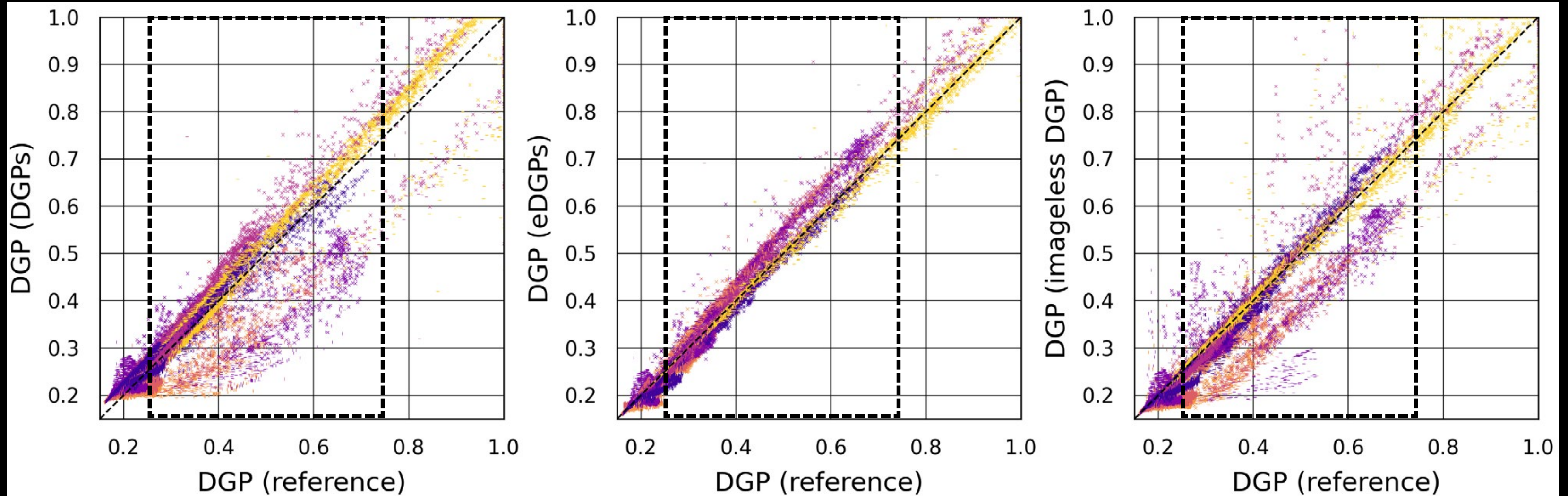
histogram plots distribution of DGP values for evaluated conditions per the reference simulation:

```
rpict -x 3000 -y 3000 -vta -vh 180 -vw 180 -dp 4096 -dt .01 -dc 1 -ds.2 -dr3 -ms 0.025 -ss 16 -st .01 -lr 12 -lw 1e-5 -af afile -av 0 0 0 -aa .075 -ar 600 -ab 6 -ad 1500 -as 750 -ps 3 -pt .04 octree > img.unf
```

```
pfilt -1 -e 1 -m .25 -x /3 -y /3 img.unf > img.hdr
```



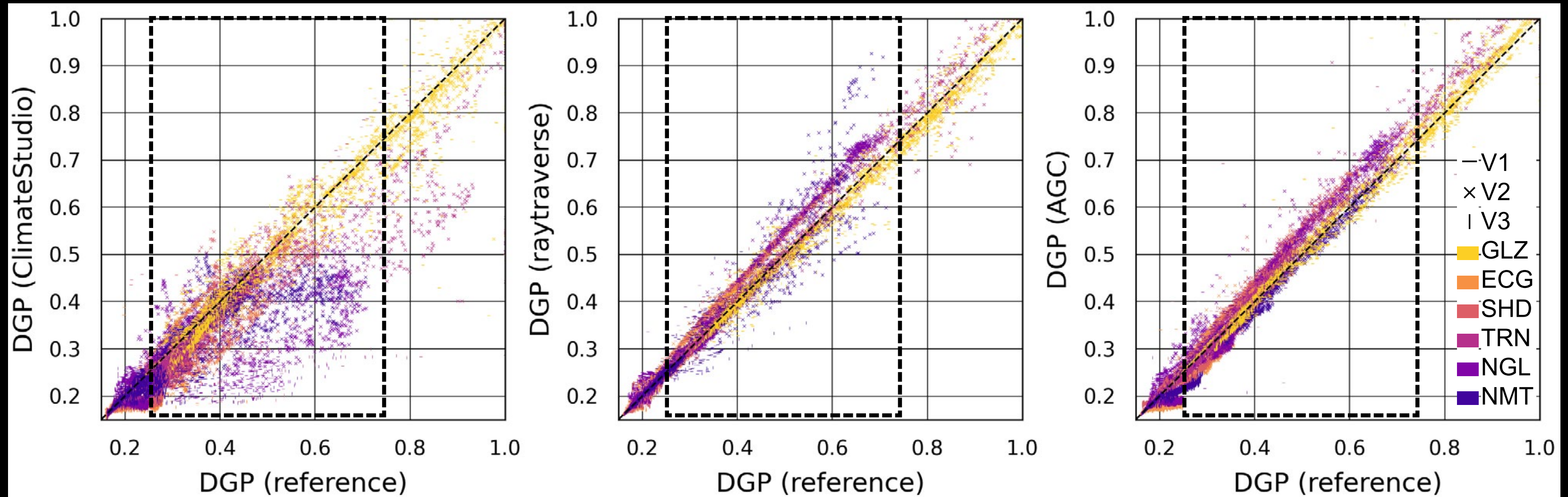
Results



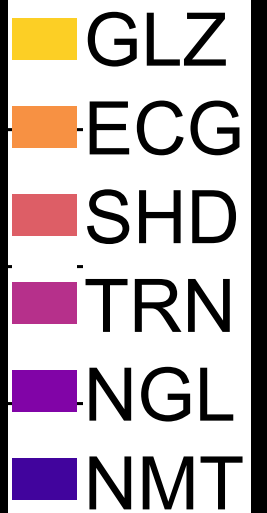
scatter plots show DGP calculated by the reference vs. each timestep tested method



Results



scatter plots show DGP calculated by the reference vs. each timestep tested method



Time

	time*(base)	time*(high)	Computer
<i>DGP</i> s	9.8	19.0	A
<i>eDGP</i> s ²	6170	-	A, D
<i>imageless DGP</i>	3.8	12.5	A
<i>ClimateStudio</i> ¹	2.3	16.2	B
<i>Raytraverse</i>	15.5	-	A
<i>AGC</i> ²	31.8	-	A, C
<i>*times given are real time in average seconds per point and scene.</i>			

- A. 2018 MacBook Pro with Intel 2.9 GHz Core i9 processor, 16 GB RAM, and a solid-state hard drive. Using 12 processes.
- B. Windows 10 Virtual Machine with Intel Xeon Gold 6248R CPU @ 3.00GHz, 8 GB RAM, Nvidia GRID RTX8000P-2Q GPU
- C. 2022 MacBook Pro M1max. Using 3 processes.
- D. Dell PowerEdge R6515 Server AMD EPYC 7413 with Ubuntu 20.04.3 LTS, using 1 process.
1. ClimateStudio requires simulating a grid of points, so six points were simulated instead of three. Reported times are pro-rated.
2. Illuminance calculations done on computer A.

Accuracy

DGP

RMSE	GLZ	ECG	SHD	TRN	NGL	NMT	AVG
<i>reference</i>	0.01	0.02	0.02	0.01	0.03	0.01	0.02
<i>DGPs</i>	0.03	0.07	0.07	0.05	0.11	0.03	0.06
<i>eDGPs</i>	0.01	0.03	0.03	0.02	0.04	0.02	0.03
<i>imageless DGP</i>	0.04	0.07	0.07	0.05	0.09	0.03	0.06
<i>climatestudio</i>	0.04	0.06	0.06	0.06	0.14	0.07	0.07
<i>raytraverse</i>	0.02	0.02	0.02	0.01	0.04	0.03	0.02
<i>AGC</i>	0.02	0.03	0.03	0.03	0.04	0.02	0.03
MAE							
<i>reference</i>	0.00	0.01	0.01	0.00	0.02	0.01	0.01
<i>DGPs</i>	0.03	0.05	0.05	0.04	0.08	0.02	0.04
<i>eDGPs</i>	0.01	0.02	0.02	0.01	0.03	0.01	0.02
<i>imageless DGP</i>	0.01	0.07	0.06	0.02	0.06	0.02	0.04
<i>climatestudio</i>	0.03	0.06	0.05	0.04	0.09	0.05	0.05
<i>raytraverse</i>	0.01	0.01	0.01	0.01	0.03	0.02	0.01
<i>AGC</i>	0.01	0.03	0.03	0.02	0.03	0.01	0.02
MSD							
<i>reference</i>	0.00	0.01	0.01	0.00	0.01	0.00	0.01
<i>DGPs</i>	0.01	-0.05	-0.04	0.02	-0.05	0.01	-0.02
<i>eDGPs</i>	0.00	0.00	0.00	0.01	0.02	-0.01	0.00
<i>imageless DGP</i>	0.01	-0.07	-0.06	0.00	-0.05	-0.01	-0.03
<i>climatestudio</i>	-0.01	-0.05	-0.04	-0.03	-0.08	-0.04	-0.04
<i>raytraverse</i>	0.00	0.01	0.01	0.00	0.02	0.00	0.01
<i>AGC</i>	0.00	-0.01	0.00	0.01	0.02	-0.01	0.00

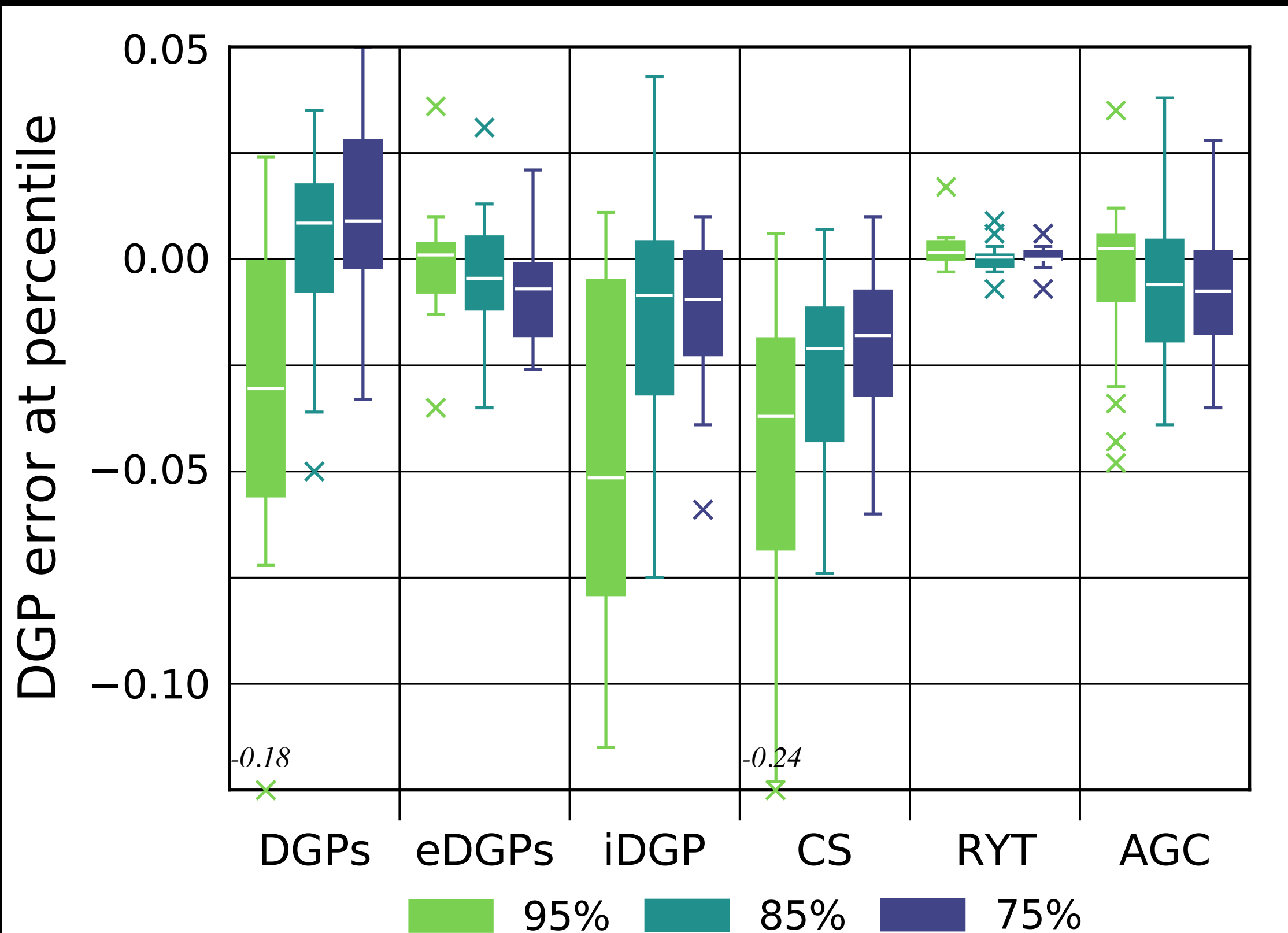
DGPs (Illuminance Error)

RMSE	GLZ	ECG	SHD	TRN	NGL	NMT	AVG
<i>2-phase DDS</i>	0.01	0.01	0.01	0.02	0.02	0.01	0.01
<i>2-phase</i>	0.03	0.01	0.01	0.03	0.02	0.01	0.02
<i>ClimateStudio</i>	0.04	0.02	0.02	0.04	0.04	0.05	0.03
<i>raytraverse</i>	0.02	0.00	0.00	0.01	0.01	0.03	0.01
MAE							
2-phase DDS	0.01	0.00	0.01	0.01	0.01	0.01	0.01
2-phase	0.01	0.00	0.01	0.01	0.01	0.01	0.01
<i>ClimateStudio</i>	0.03	0.01	0.01	0.02	0.02	0.03	0.02
<i>raytraverse</i>	0.01	0.00	0.00	0.01	0.01	0.01	0.01
MSD							
<i>2-phase DDS</i>	0.00	0.00	0.01	0.01	0.01	0.00	0.01
2-phase	0.01	0.00	0.00	0.01	0.01	0.00	0.00
<i>ClimateStudio</i>	0.02	0.00	0.00	-0.01	0.01	-0.01	0.00
<i>raytraverse</i>	0.00	0.00	0.00	0.00	0.01	0.00	0.00

Error in Illuminance Calculation scaled as DGPs. AGC, DGPs, eDGPs use 2-phase DDS. Image-less DGP uses 2-phase matrices.

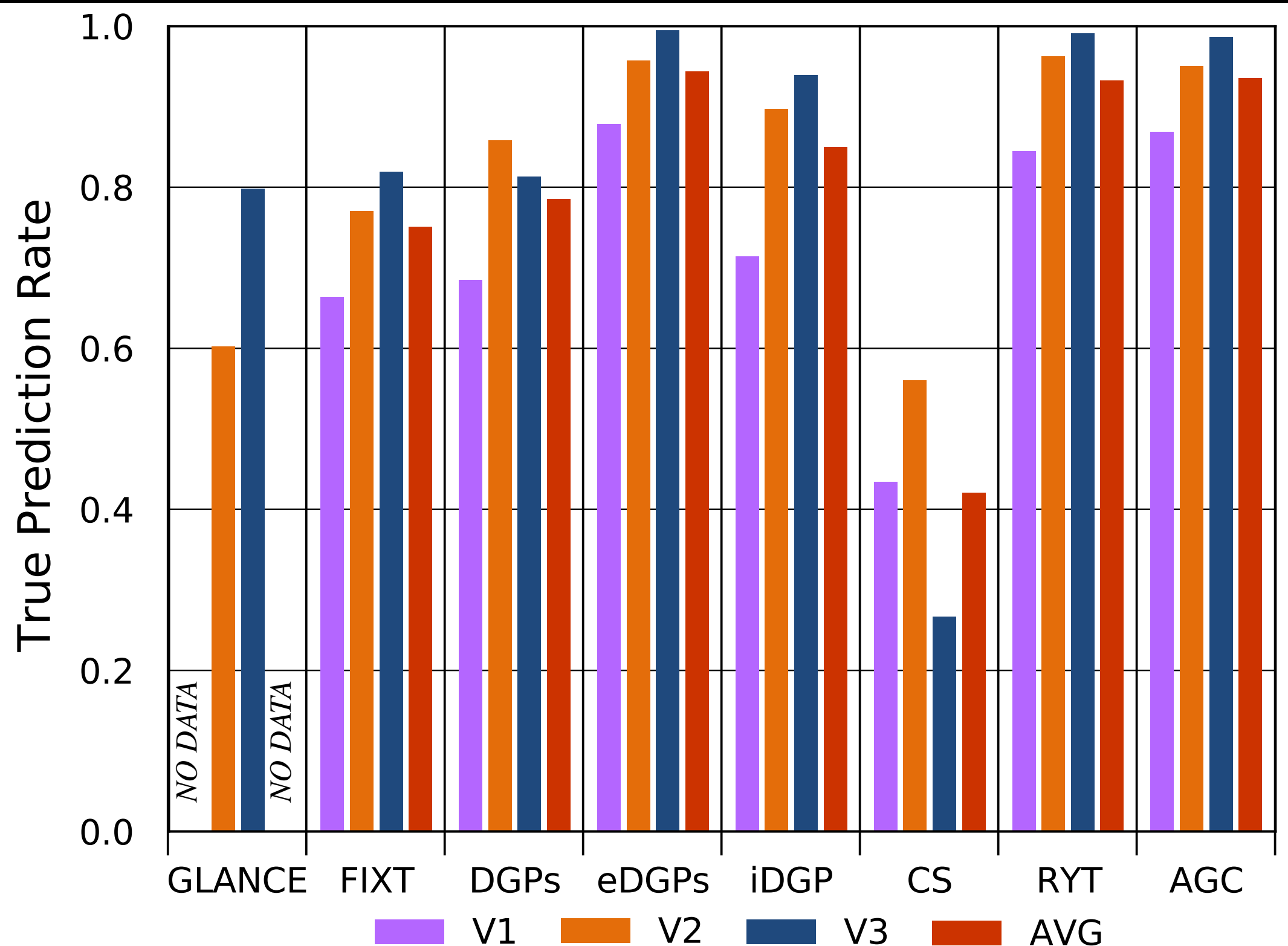
Accuracy

Distribution of error in annual percentiles for 18 view/scene combinations. Method abbreviations: imageless DGP (iDGP), ClimateStudio (CS), raytraverse (RYT)



Accuracy

Comparing GLANCE and Heuristic Zonal approaches requires a different quantification of error. This bar chart shows the true prediction rates for each method used as a binary classifier with a threshold of 0.35 at each view (all 6 options) as well as the average of all views (AVG)



Acknowledgments

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Light fields in climate-based daylight modeling for spatio-temporal glare assessment

<http://p3.snf.ch/project-179067>