



WHAT'S NEW IN CLIMATESTUDIO

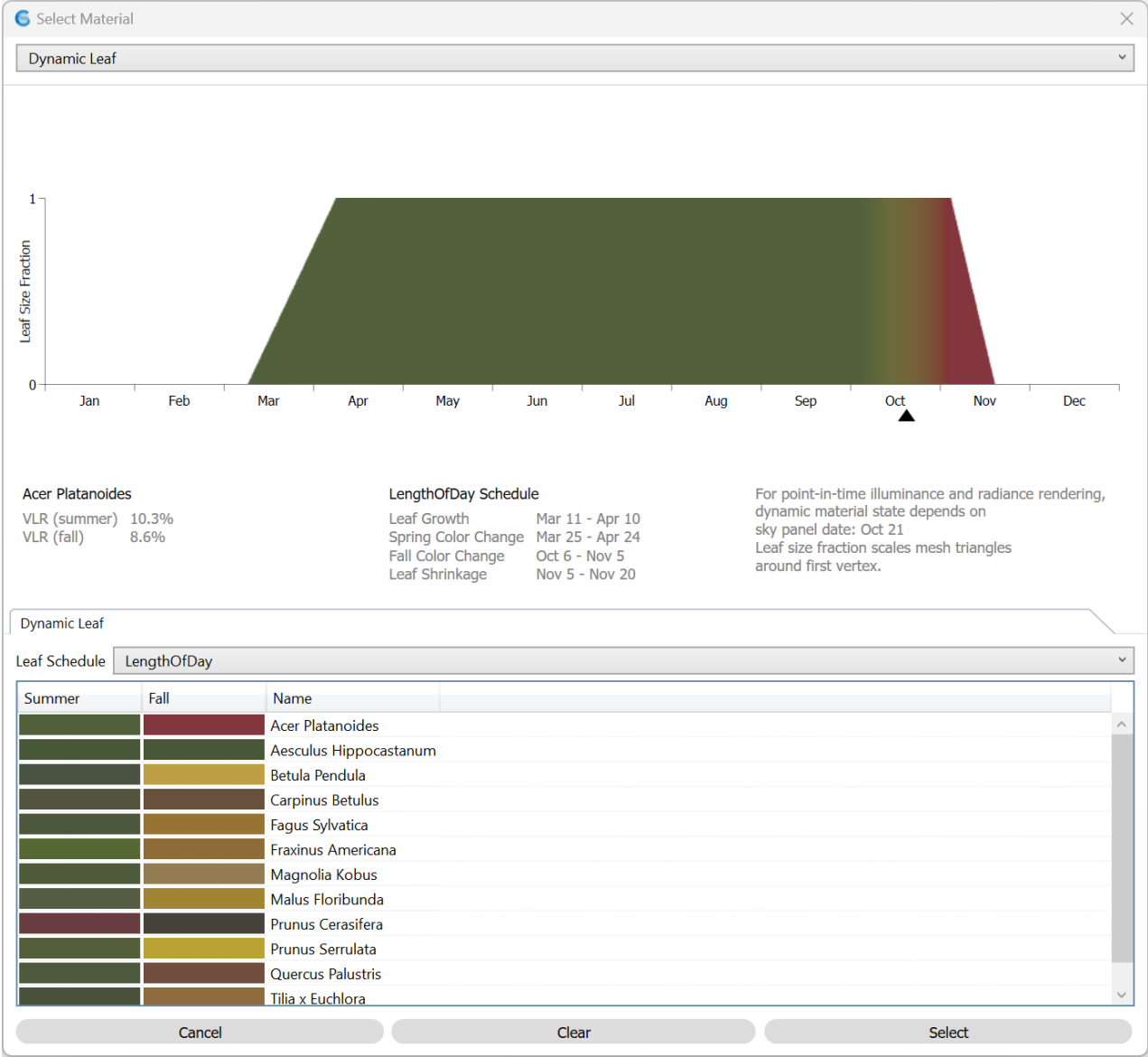
Solemma team: Violeta Lialios-Bouwman, Demi Chang, Timur Dogan, Alstan Jakubiec, Jeff Niemasz, Brandon Pachuca, Christoph Reinhart, Jon Sargent

Slides: Jon Sargent

Narrator: Alstan Jakubiec



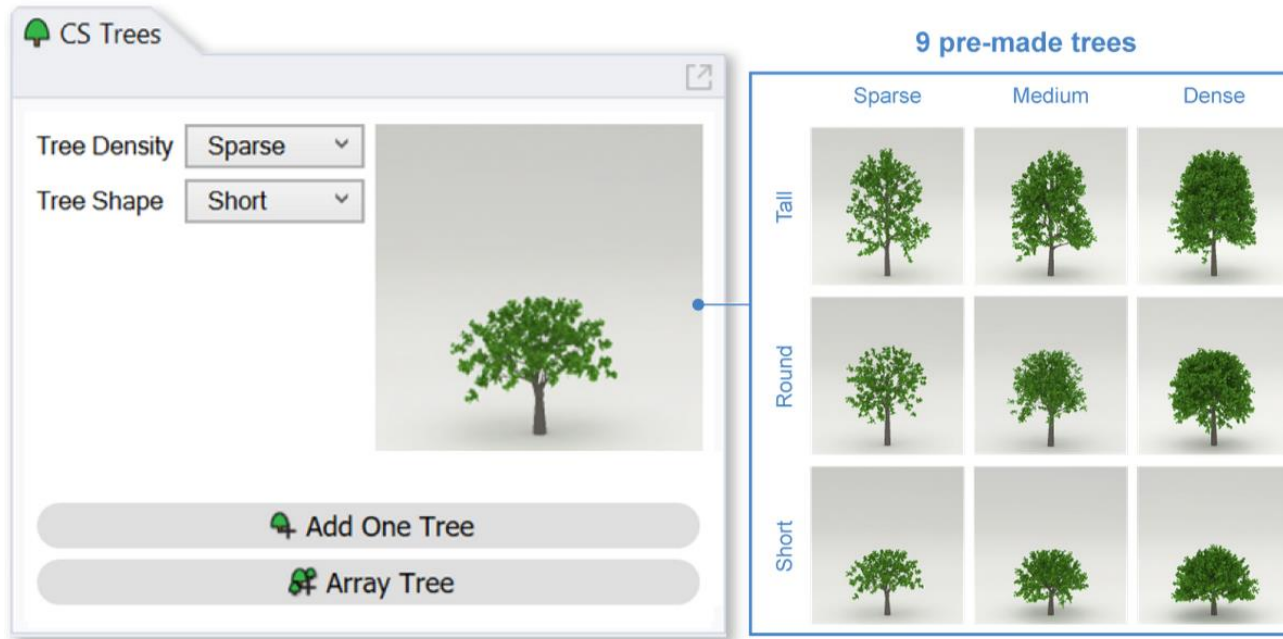
(one) ray trace



Dynamic Leaf

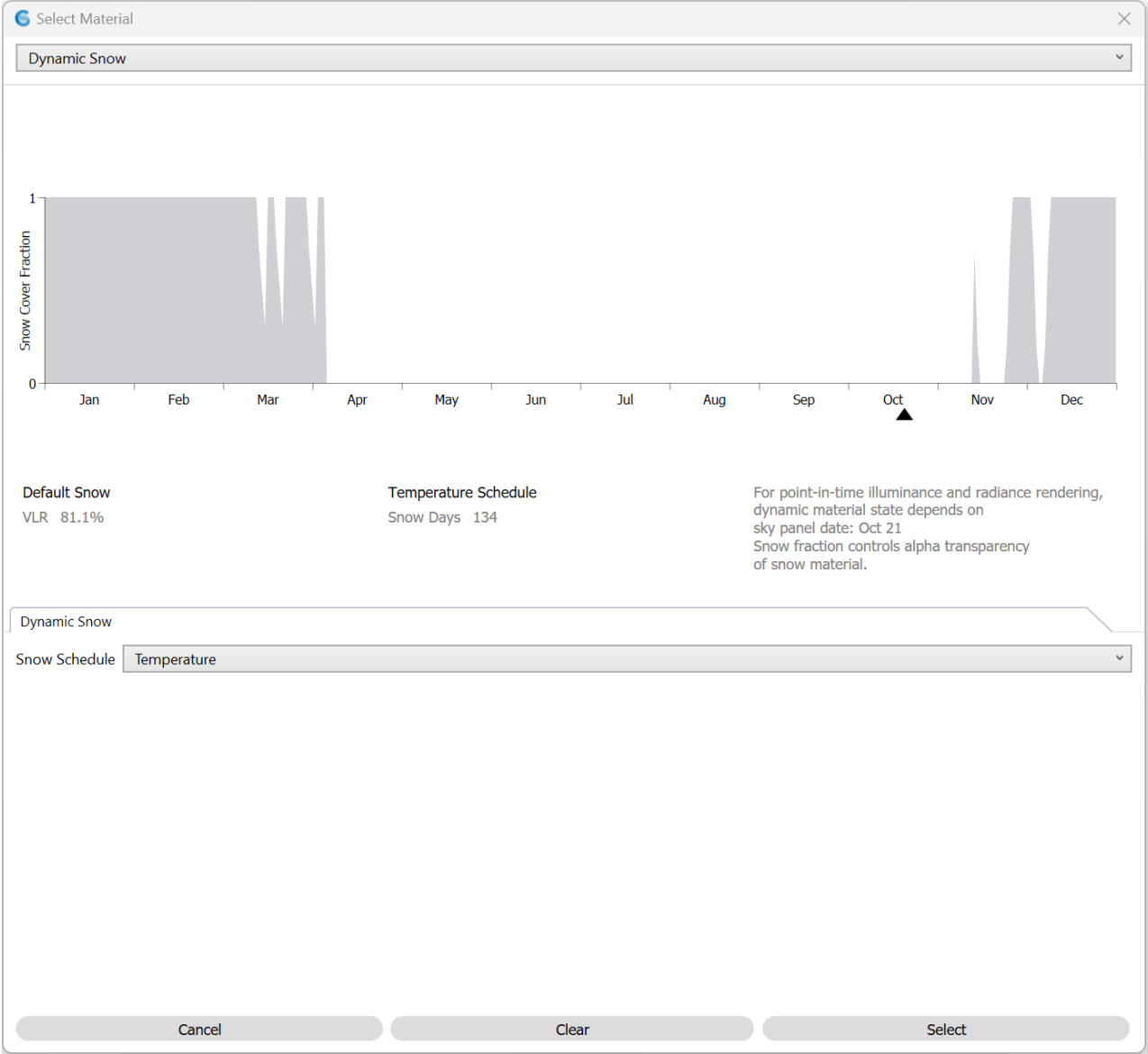
- Species-specific summer/fall color measurements¹
- Size / color schedule based on length of day
- Transition colors by interpolation

¹ “Simulating the Impact of Deciduous Trees on Energy, Daylight, and Visual Comfort,” Pan and Jakubiec (2022)



Dynamic Leaf

- Species-specific summer/fall color measurements¹
- Size / color schedule based on length of day
- Transition colors by interpolation
- Small lib of tree assets (.rtm) or build your own

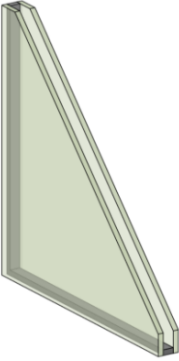


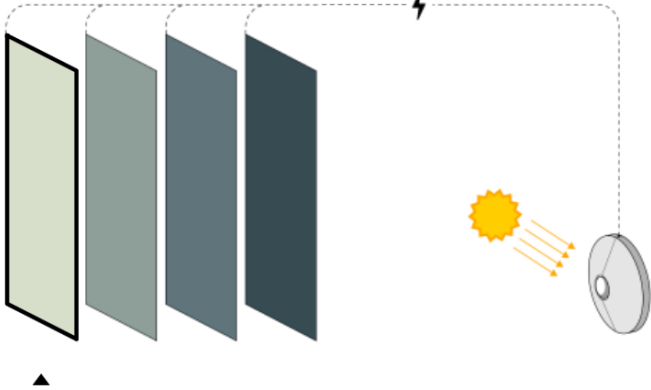
Dynamic Snow

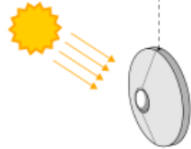
- Fixed white color (81% VLR)
- Transparency schedule based on temperature
- Precipitation not considered

Select Material

Exterior Glass (Electrochromic)







SageGlass Classic

VLT 0.9% - 59.7%

VLR 10% - 16% / 9% - 15%

UVal 1.57

SHGC 0.00 - 0.41

Tint 0

VLT 60%

VLR 16% front / 15% back

Automated Glare Control

Tint for point in time 0

Threshold 3800 lux DNI

Affected Area > 2%

Dynamic Glass System

Tint Control

	Name	Layers	#Tints	VLT	VLR.front	VLR.back	UVal [W/(m²·K)]	SHGC
☆	SageGlass Classic	Double	4	0.9% - 59.7%	10.0% - 15.9%	9.3% - 14.7%	1.57	0.00 - 0.41
☆	SageGlass Harmony	Double	6	0.9% - 59.7%	11.2% - 15.9%	9.5% - 14.7%	1.57	0.00 - 0.25
☆	View	Double	4	0.8% - 52.1%	5.4% - 12.2%	15.2% - 17.1%	1.57	0.00 - 0.37

Cancel

Clear

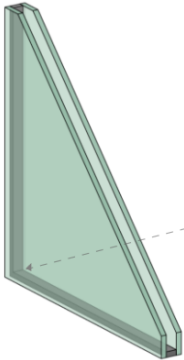
Select

Dynamic Glazing (EC)

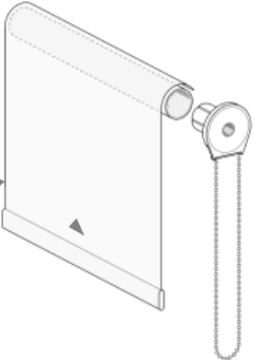
- Manufacturer (IGDB) data
- Auto control based on sun penetration depth (5' default, customizable)


Select Material

Exterior Glass (with Dynamic Shade (optional))



5.08 cm (interior)





Atlantica - Solarban 60 (3)
VLT 46%
VLR 8% / 8%
UVal 1.66
SHGC 0.30

Silverscreen 205EC01
Inset 5.08 cm
Permeability 4%
VLT 5%
VLR 74% / 38%

Manual Glare Control (LM-83)
Position for point in time **DOWN**
Threshold 1000 lux DHI
Affected Area > 2%
User Lag none

Glass Material

Shade Material

Shade Control

Inset from glass 5.08 cm

Name	Manufacturer	Category	Permeability	VLT normal-diffuse	Glare control classification
No Shade					
3000 CA 3% CA01 White/Floral White	Alkenz	FabricShade	4.7%	17.1%	very little effect
3000 HT 3% HT01 White/White	Alkenz	FabricShade	4.0%	13.6%	very little effect
3000 HT 5% HT01 White/White	Alkenz	FabricShade	5.8%	14.8%	very little effect
3000 HT 5% HT01 White/White	Alkenz	FabricShade	4.5%	14.6%	very little effect
3000 HT 5% HT03 White/Light Gray	Alkenz	FabricShade	6.1%	9.4%	very little effect
3000 HT 5% HT09 White/Charcoal	Alkenz	FabricShade	5.8%	1.9%	very little effect
3000 NET 1% N001 White/White	Alkenz	FabricShade	0.2%	12.3%	moderate effect
3000 NET 10% N001 White/White	Alkenz	FabricShade	9.0%	13.0%	very little effect
3000 NET 3% N001 White/White	Alkenz	FabricShade	3.8%	12.0%	very little effect

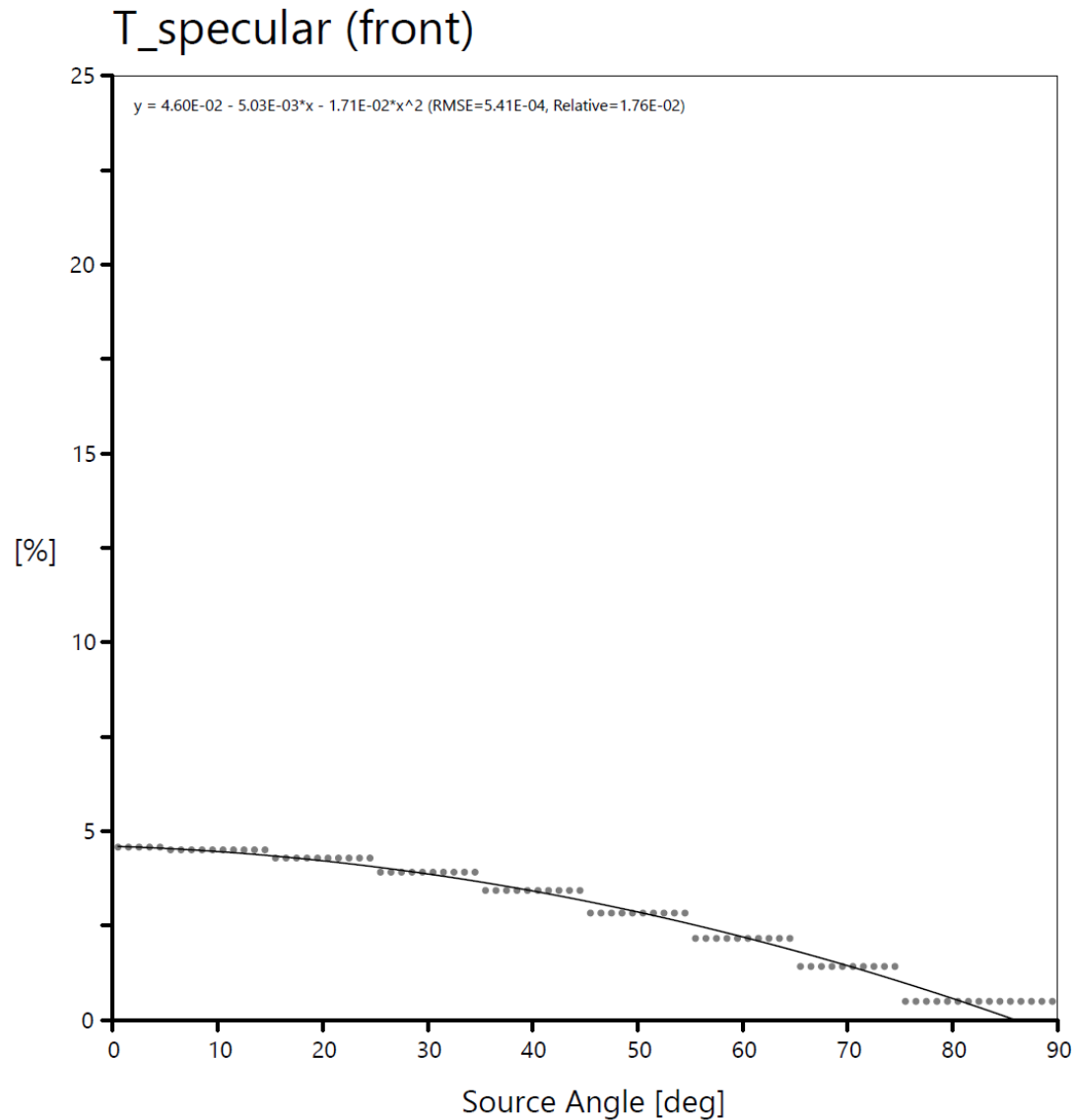
Cancel

Clear

Select

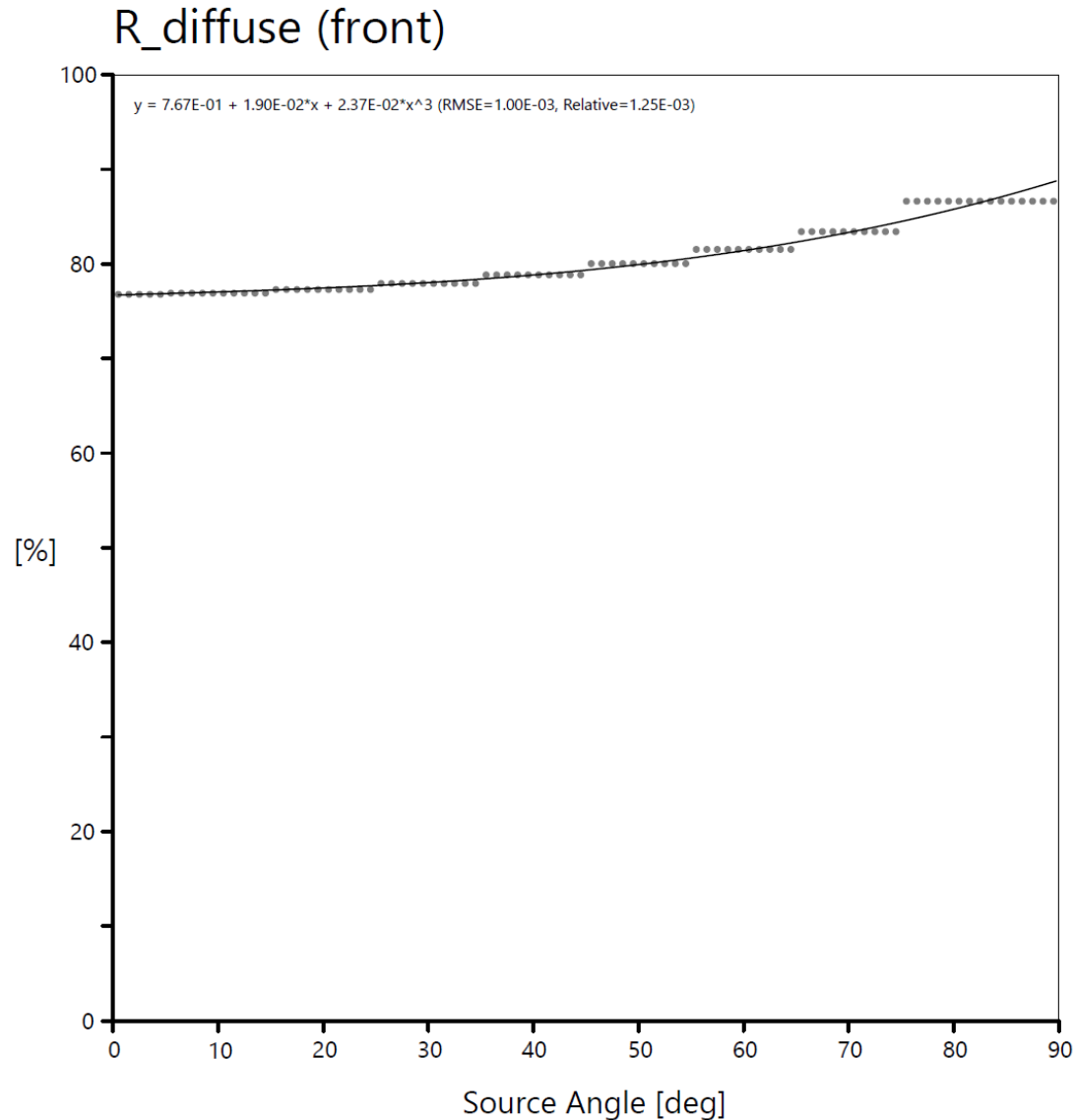
Dynamic Shade

- CGDB fabric shade data
- EN 14501 glare control classification
- LM-83 control, or manual / auto based on sun penetration depth
- Semi-active user option (custom lag time)



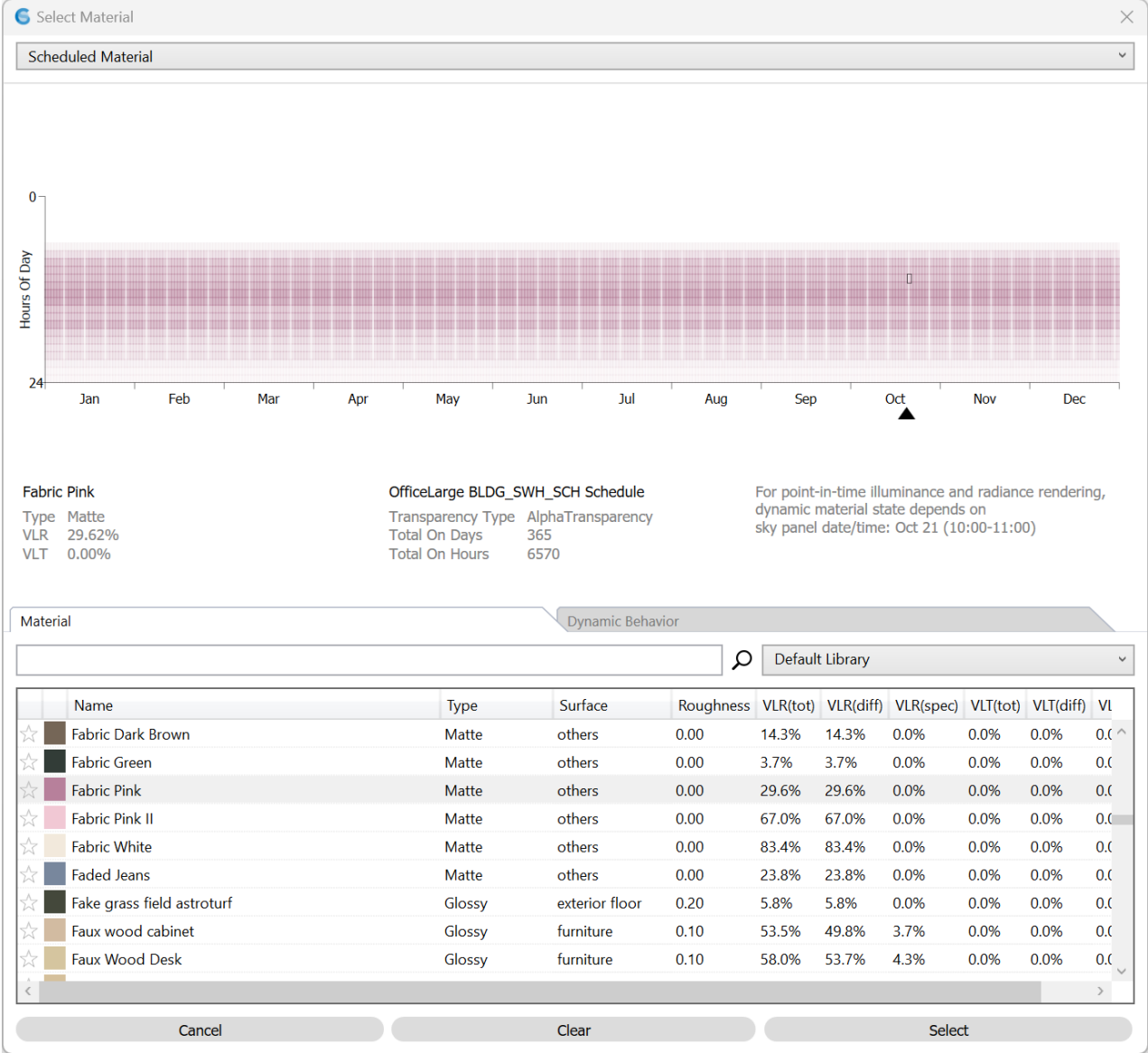
Dynamic Shade

- CGDB fabric shade data
- EN 14501 glare control classification
- LM-83 control, or manual / auto based on sun penetration depth
- Semi-active user option (custom lag time)
- Two material modes:
 - aBSDF
 - BRTDfunc(2)
 - Polynomial fit to CGDB Klems data
 - Evaluates faster than aBSDF



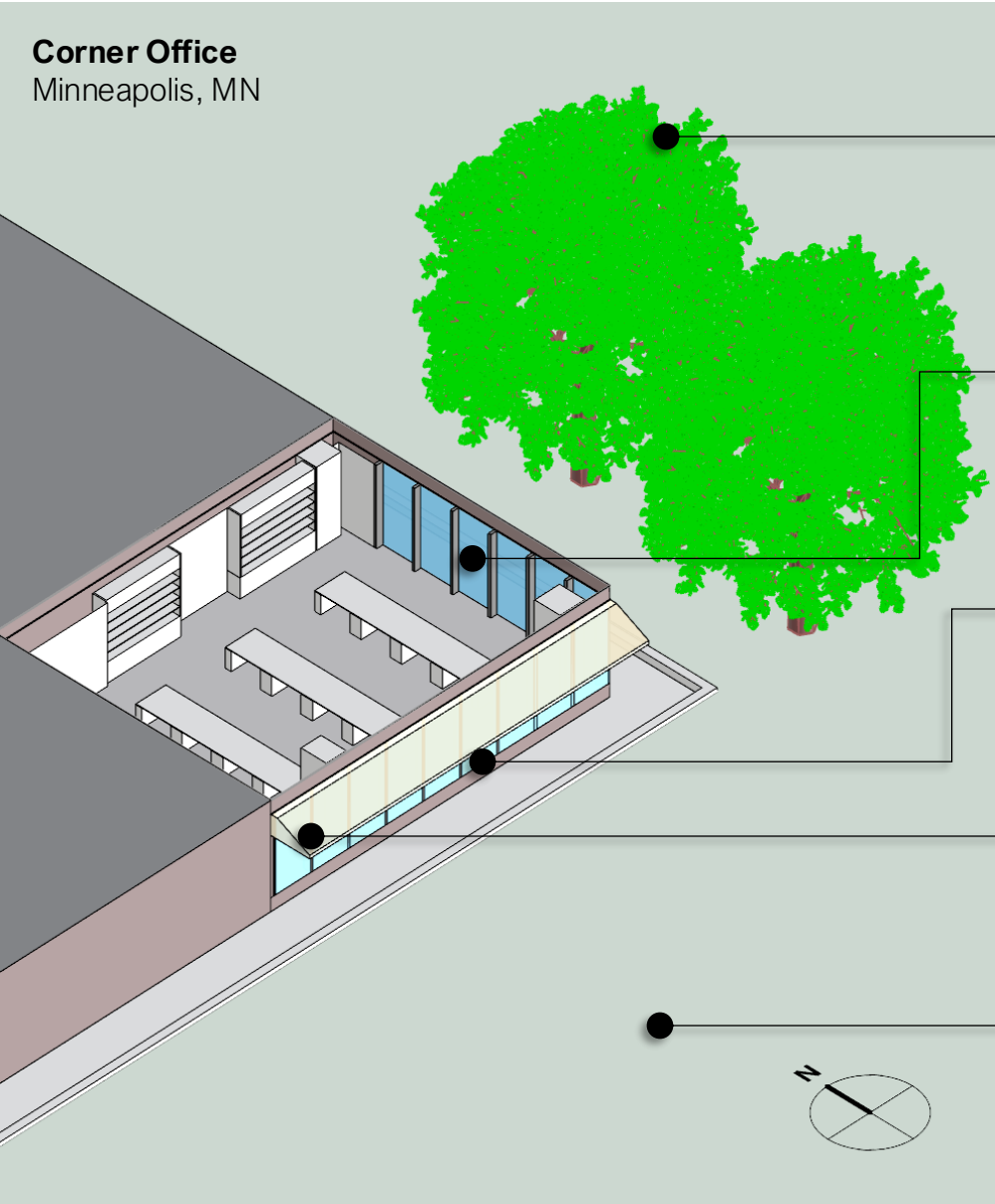
Dynamic Shade

- CGDB fabric shade data
- EN 14501 glare control classification
- LM-83 control, or manual / auto based on sun penetration depth
- Semi-active user option (custom lag time)
- Two material modes:
 - aBSDF
 - BRTDfunc(2)
 - Polynomial fit to CGDB Klems data
 - Evaluates faster than aBSDF
 - Modified BRTDfunc implements incident-angle-dependent T and R in ambient calc
 - Appropriate for fitting BSDFs generated from integrating sphere data (perhaps not much else)



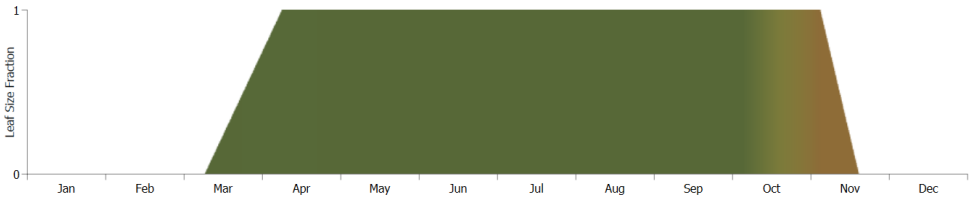
Scheduled Material

- Any material you want
- Any schedule you want
- Partial-state modes:
 - Transparency
 - Mesh-face scaling



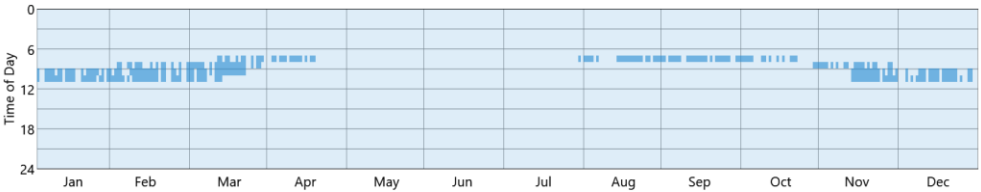
Corner Office
Minneapolis, MN

Fraxinus Americana
Mar 11 – Nov 20



East Shade
LM-83
Time Open: **91%**

■ closed ■ open



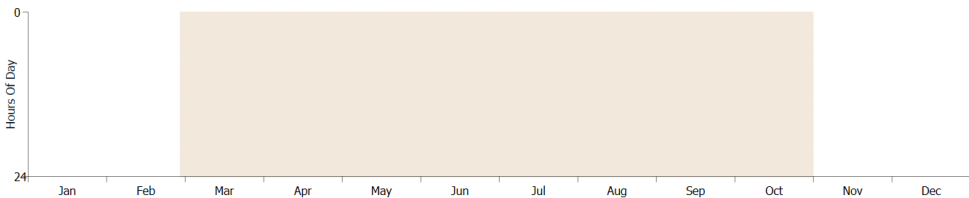
South Shade
LM-83
Time Open: **79%**

■ closed ■ open



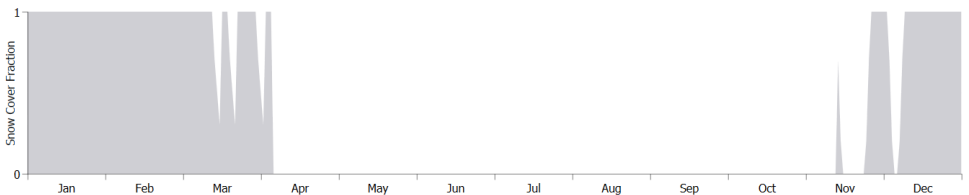
South Awning
Mar - Oct

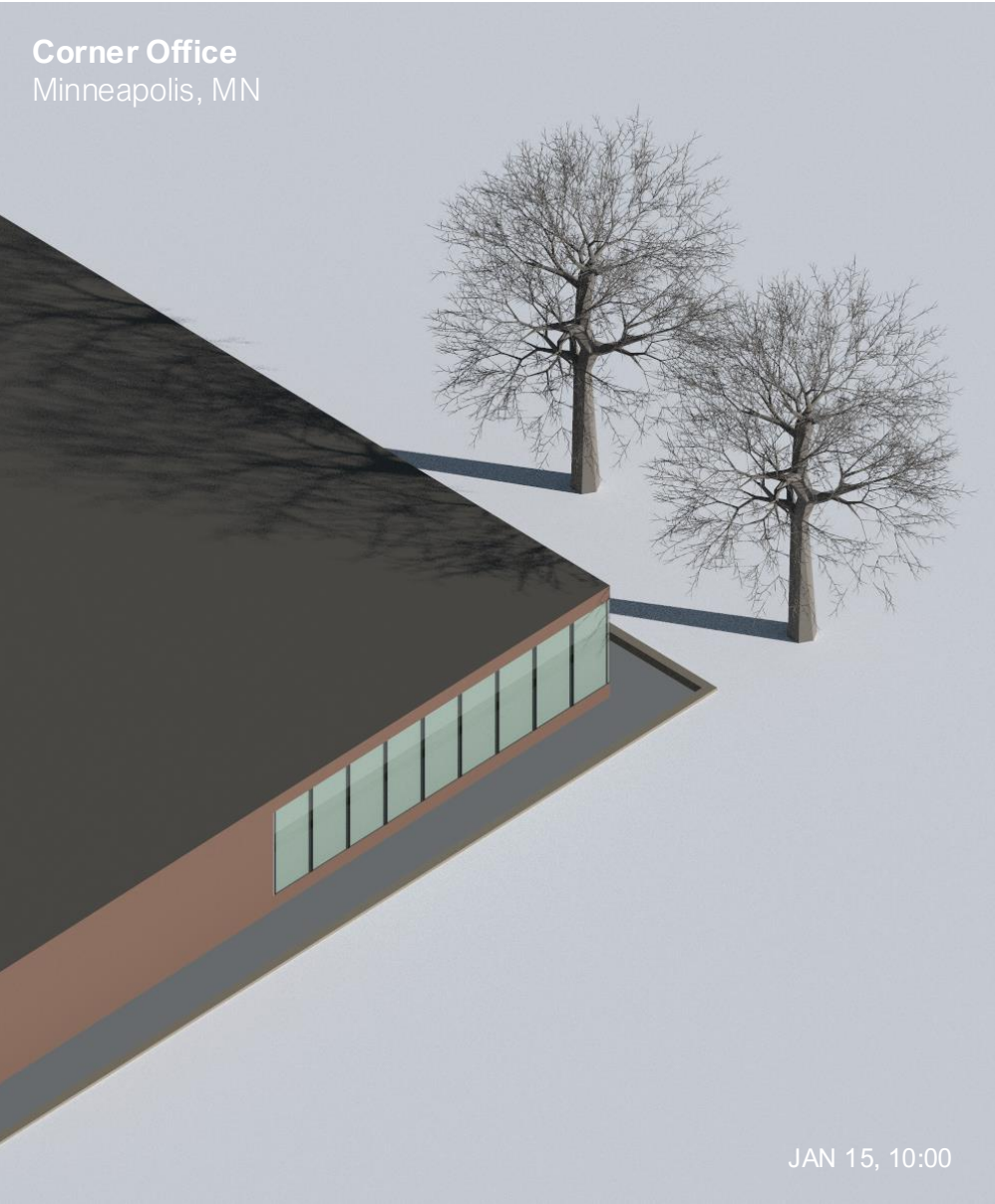
■ material present



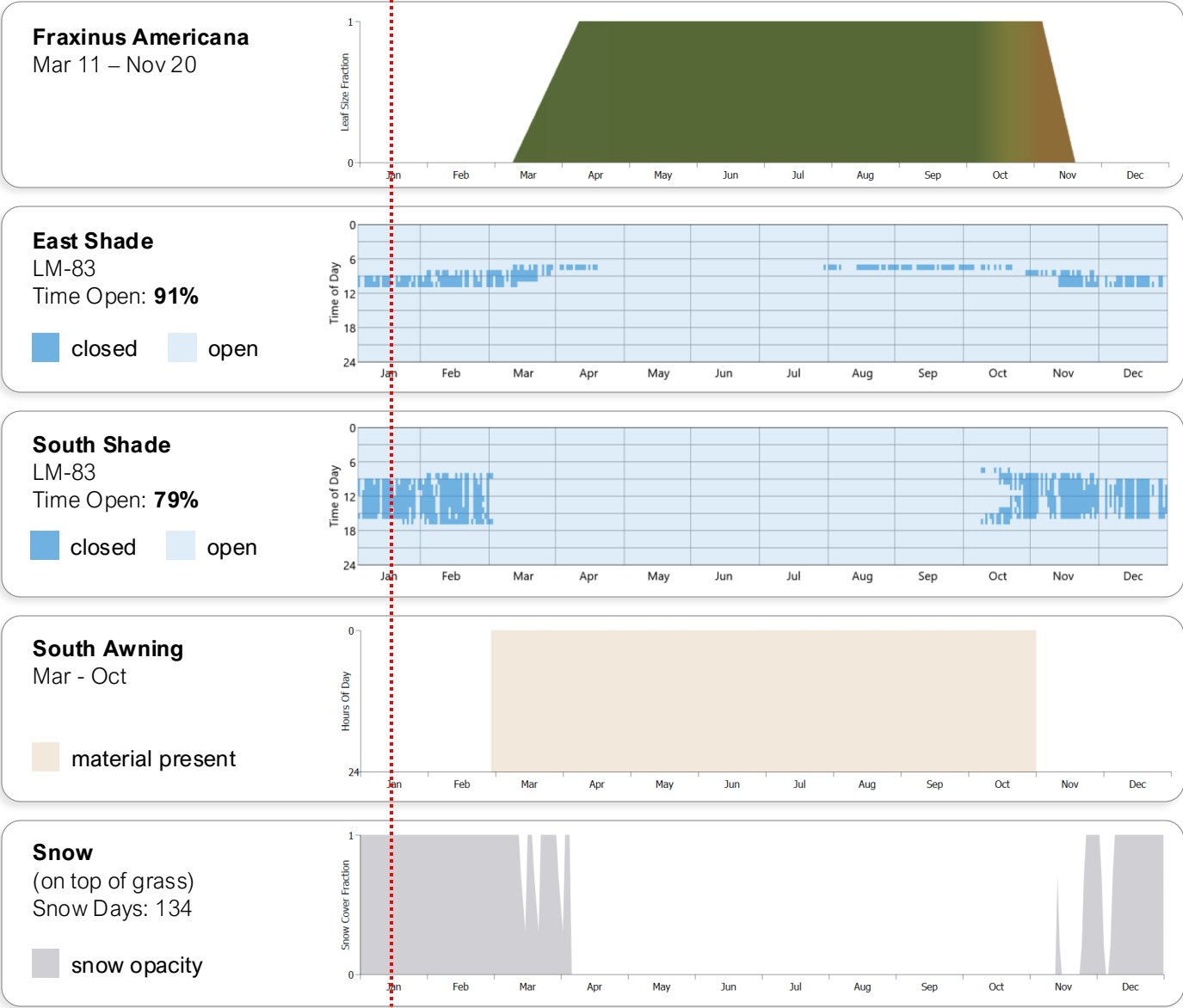
Snow
(on top of grass)
Snow Days: 134

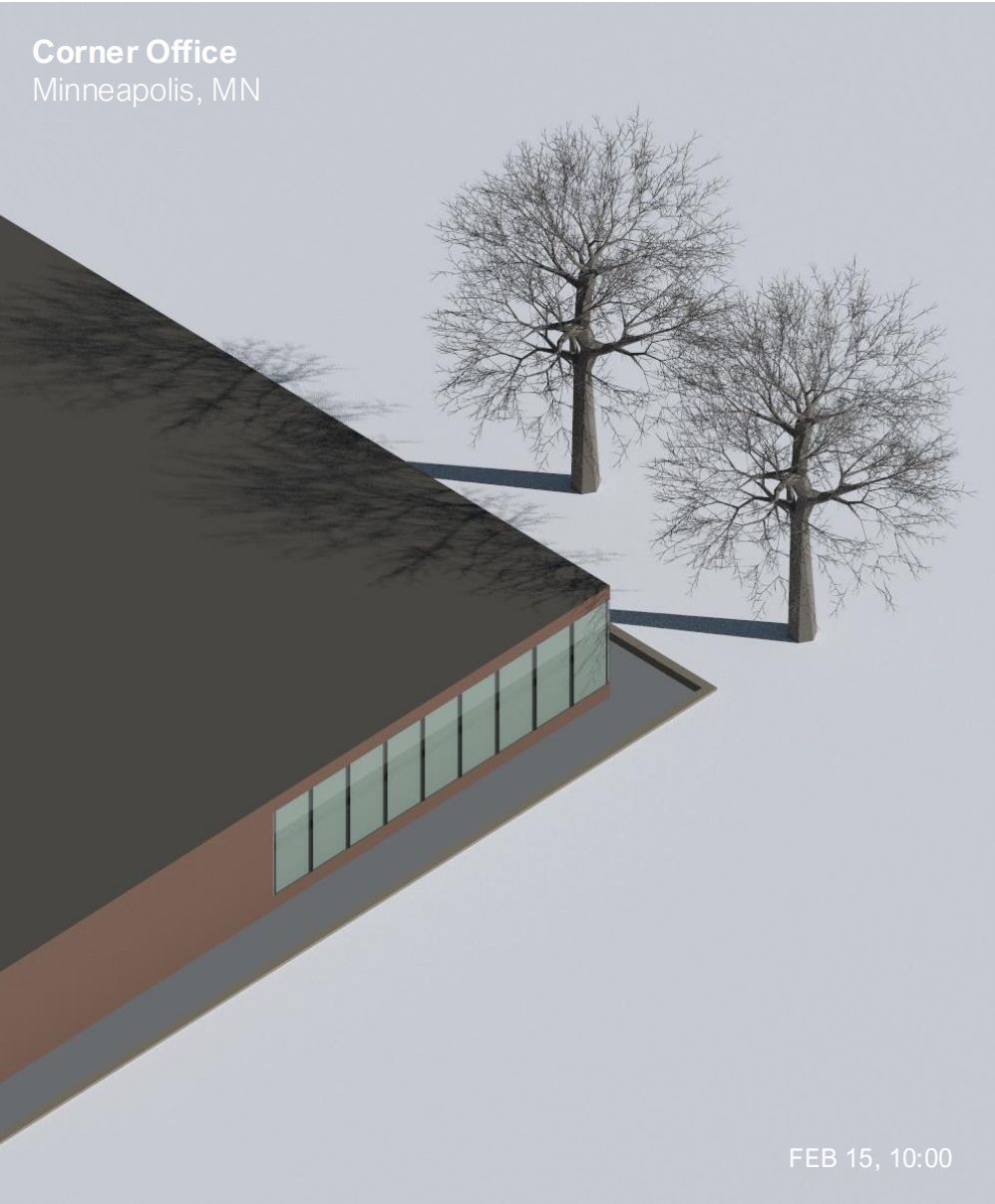
■ snow opacity



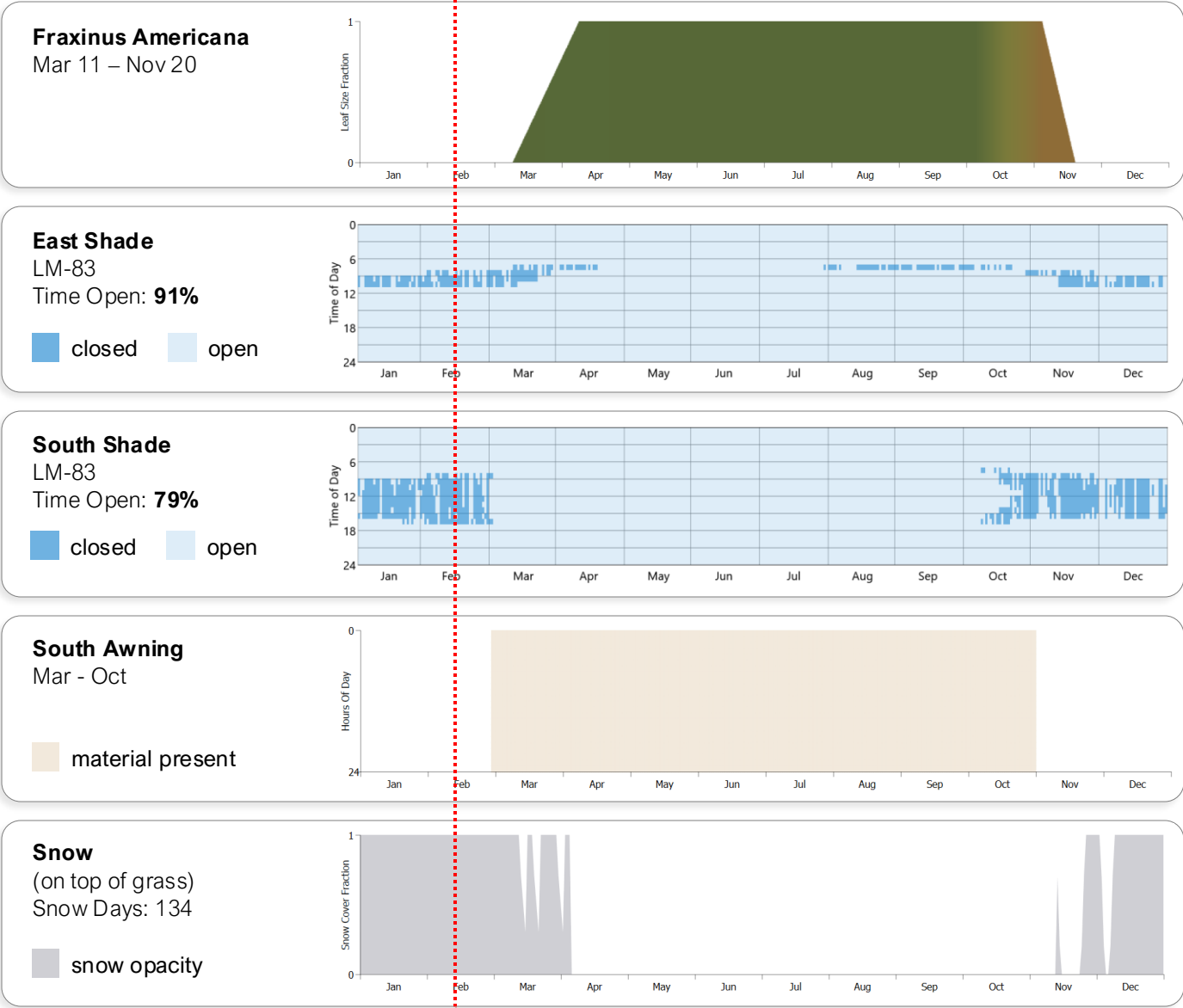


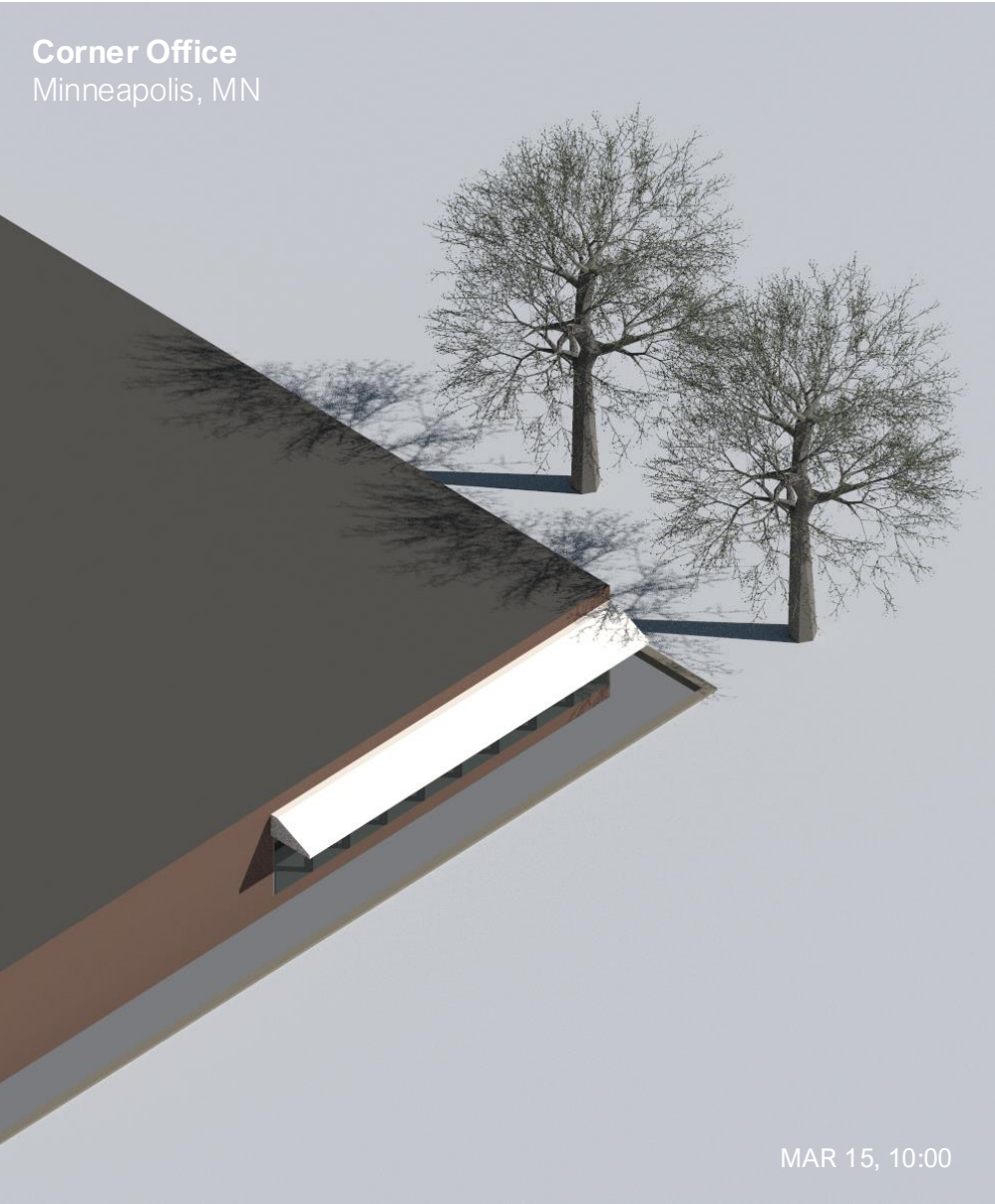
JAN 15





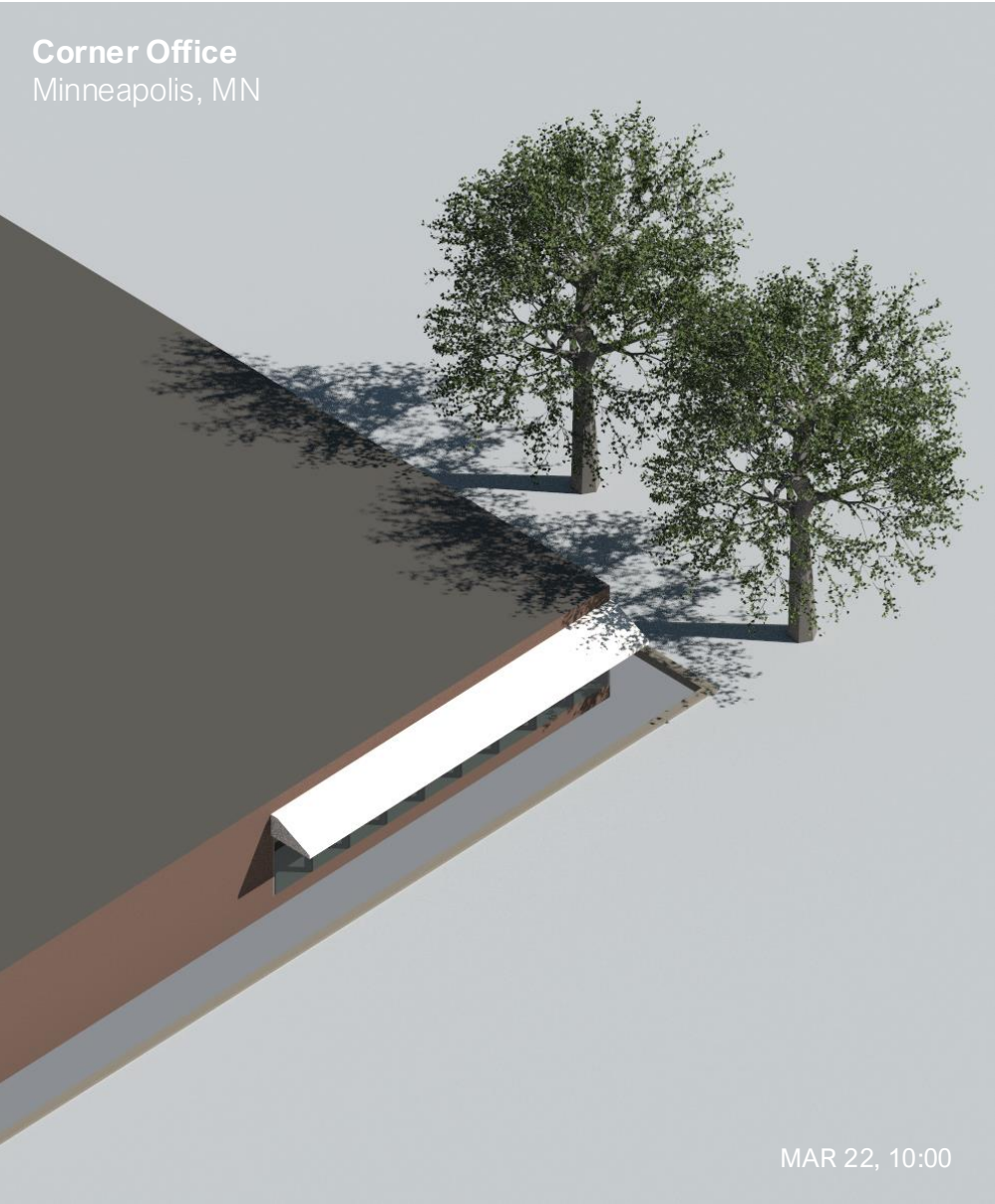
FEB 15



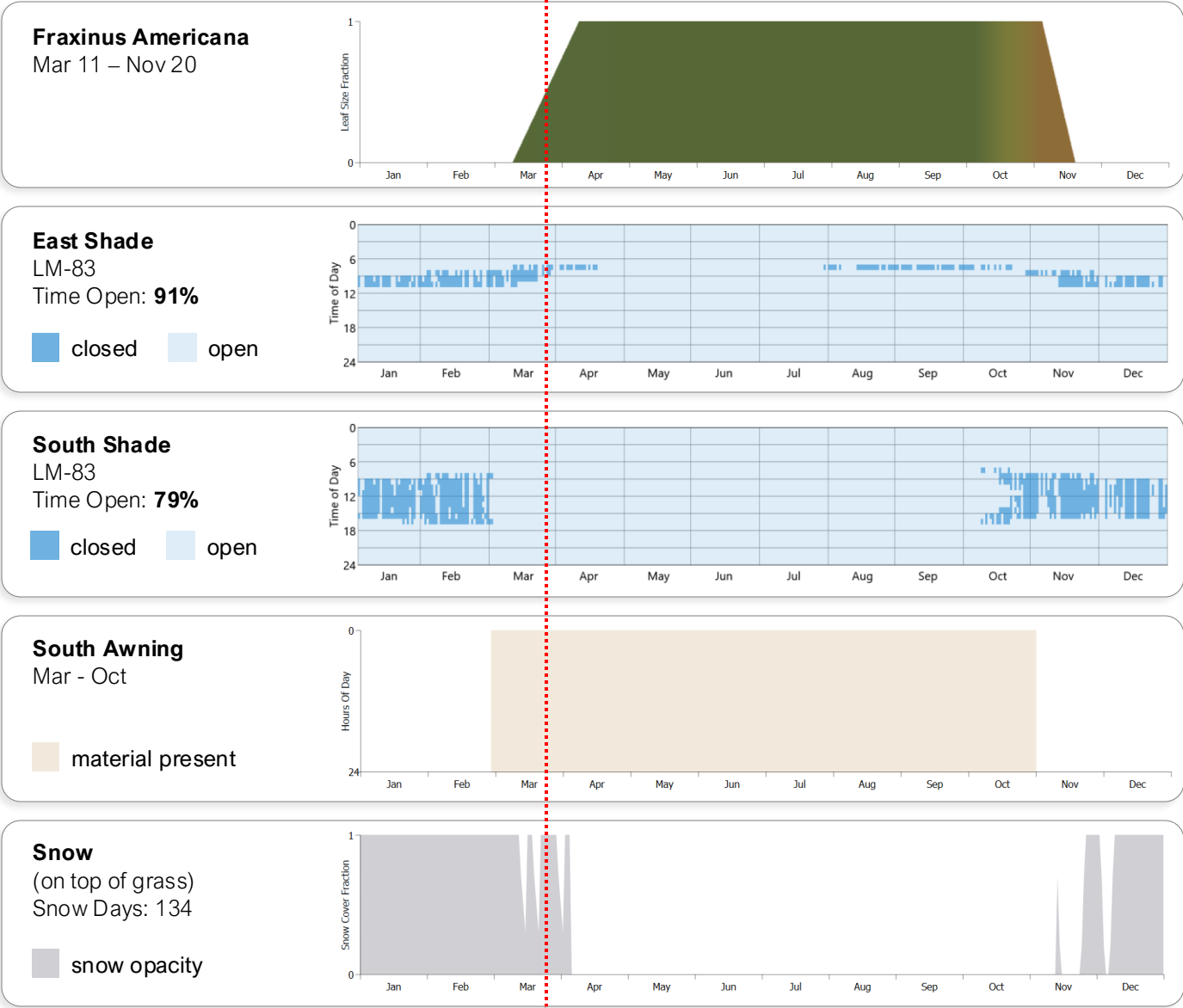


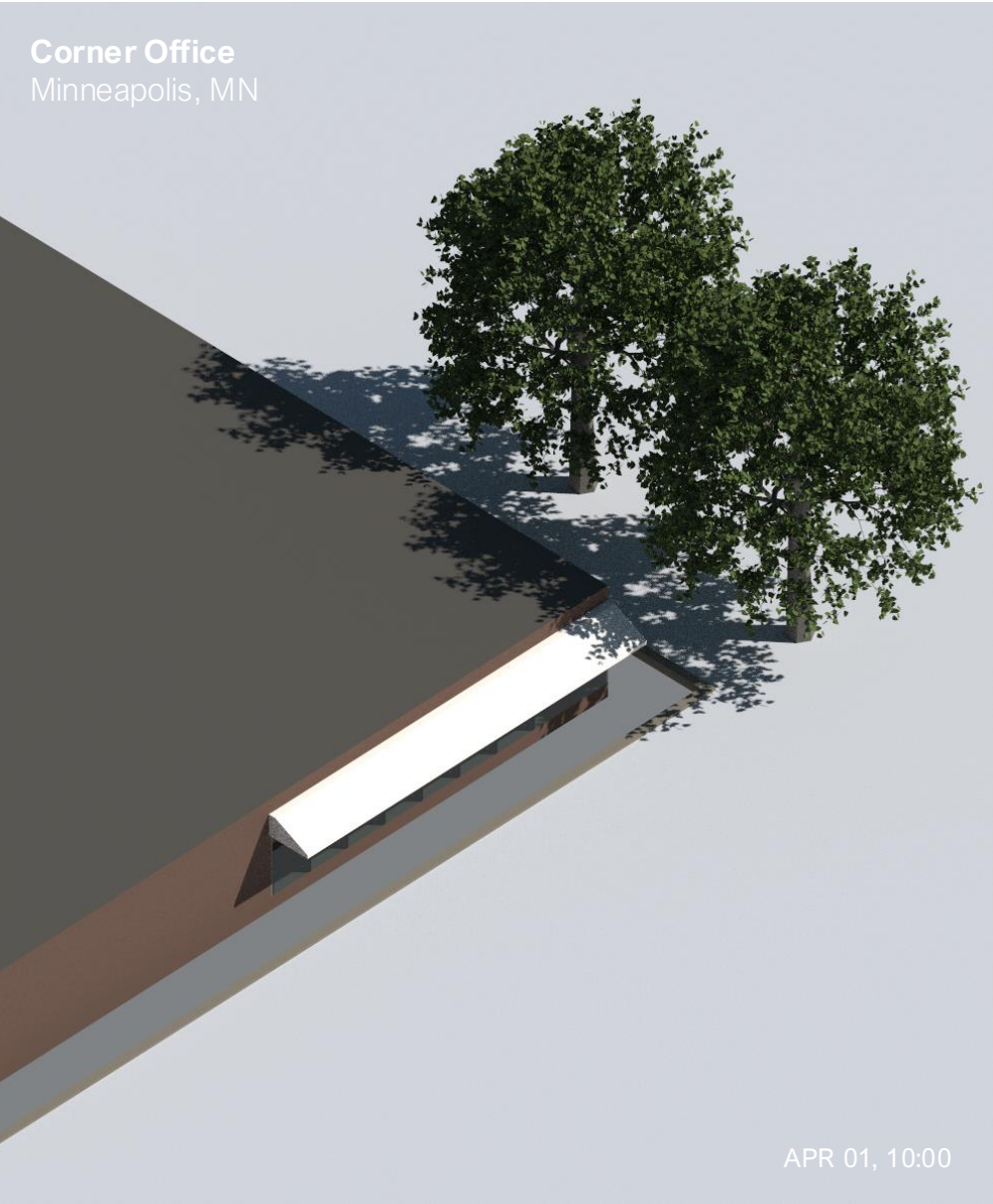
MAR 15



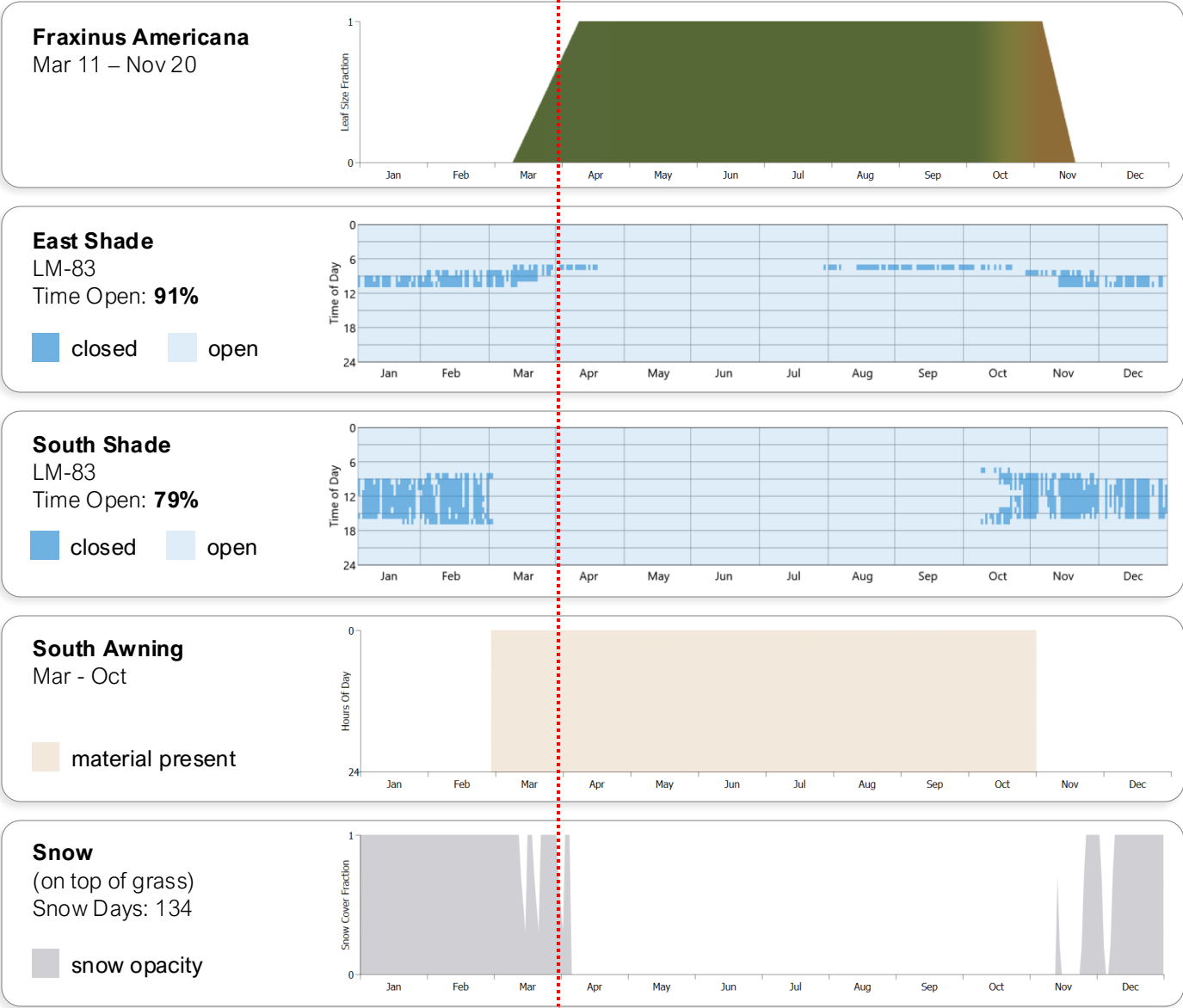


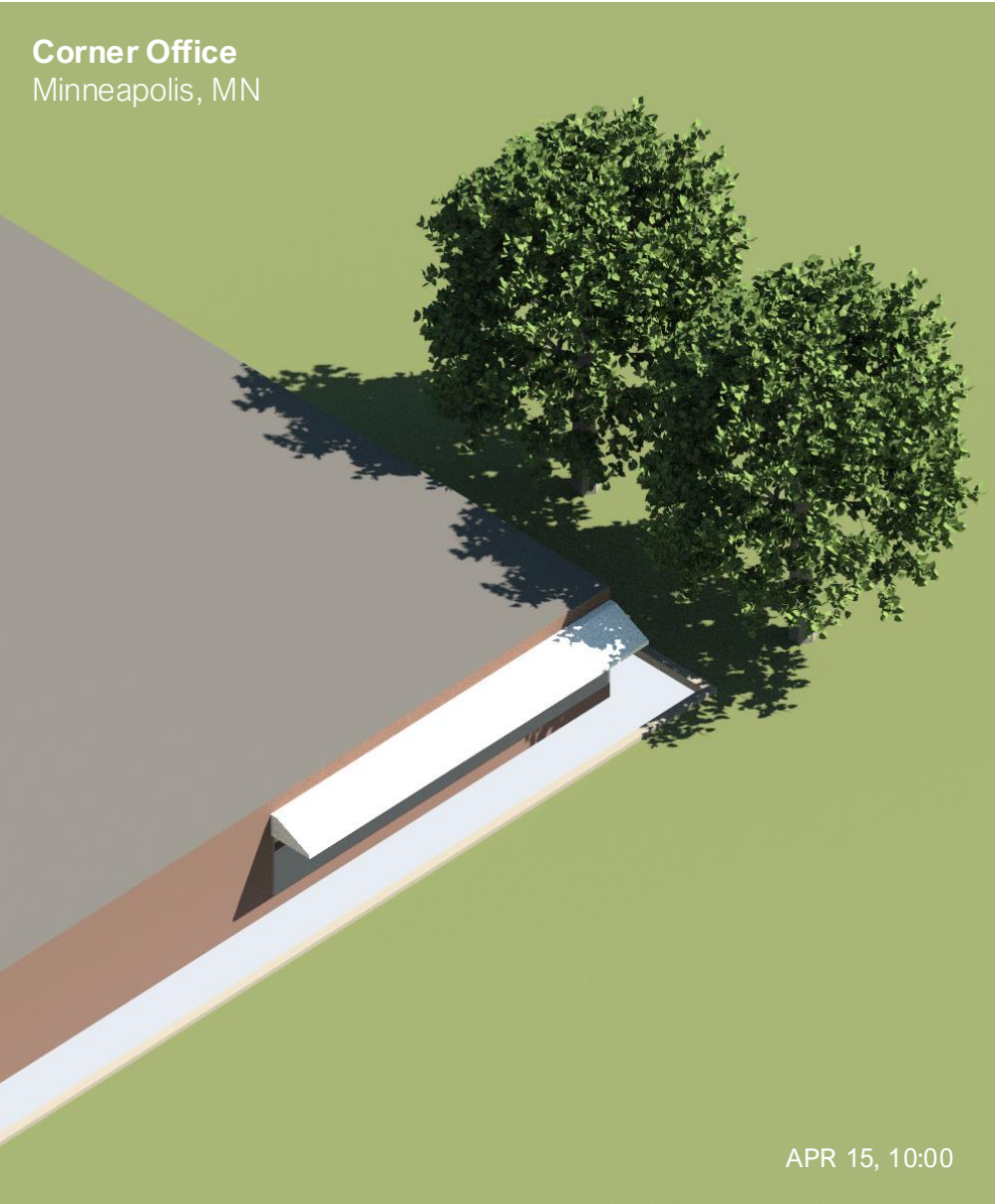
MAR 22



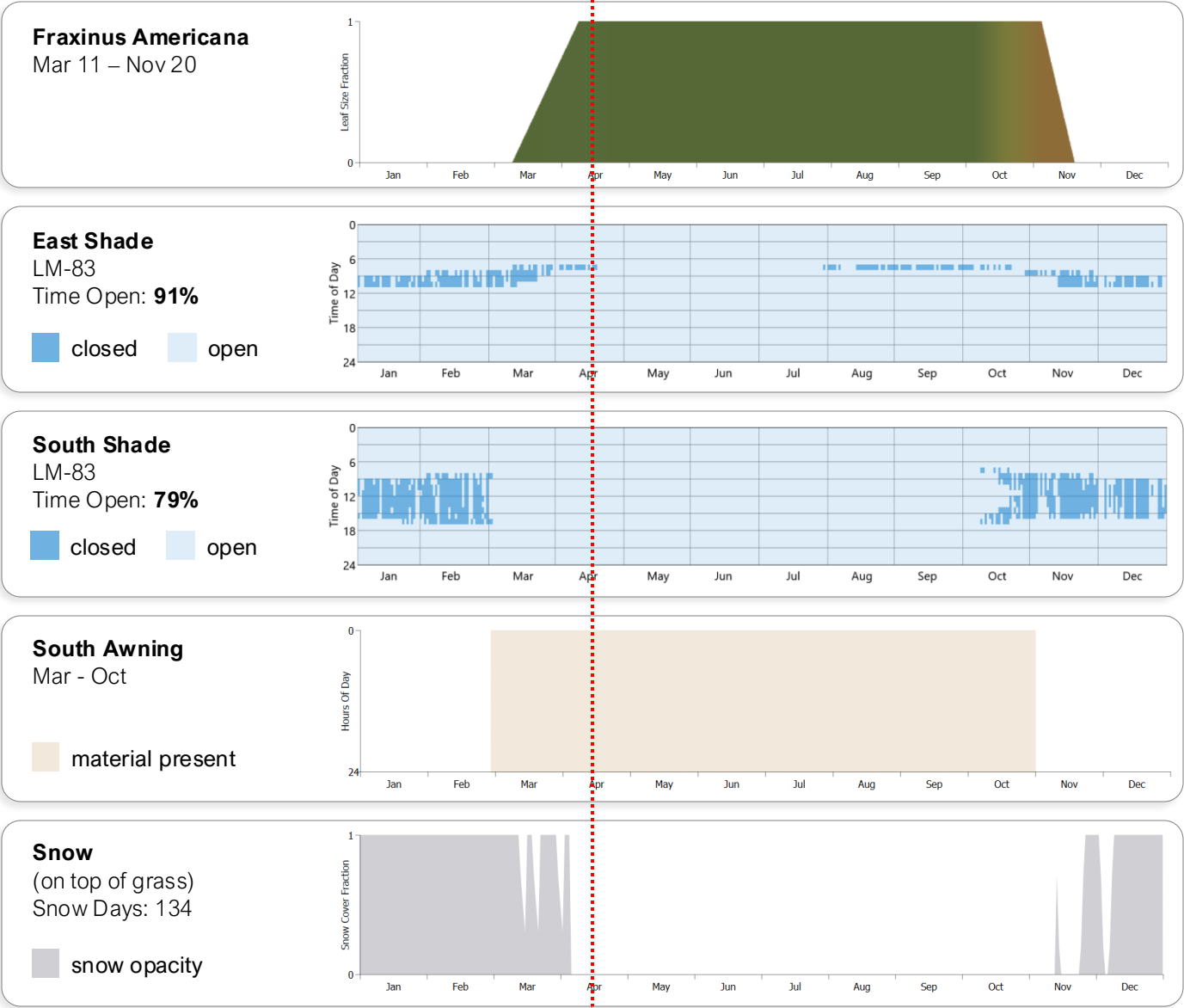


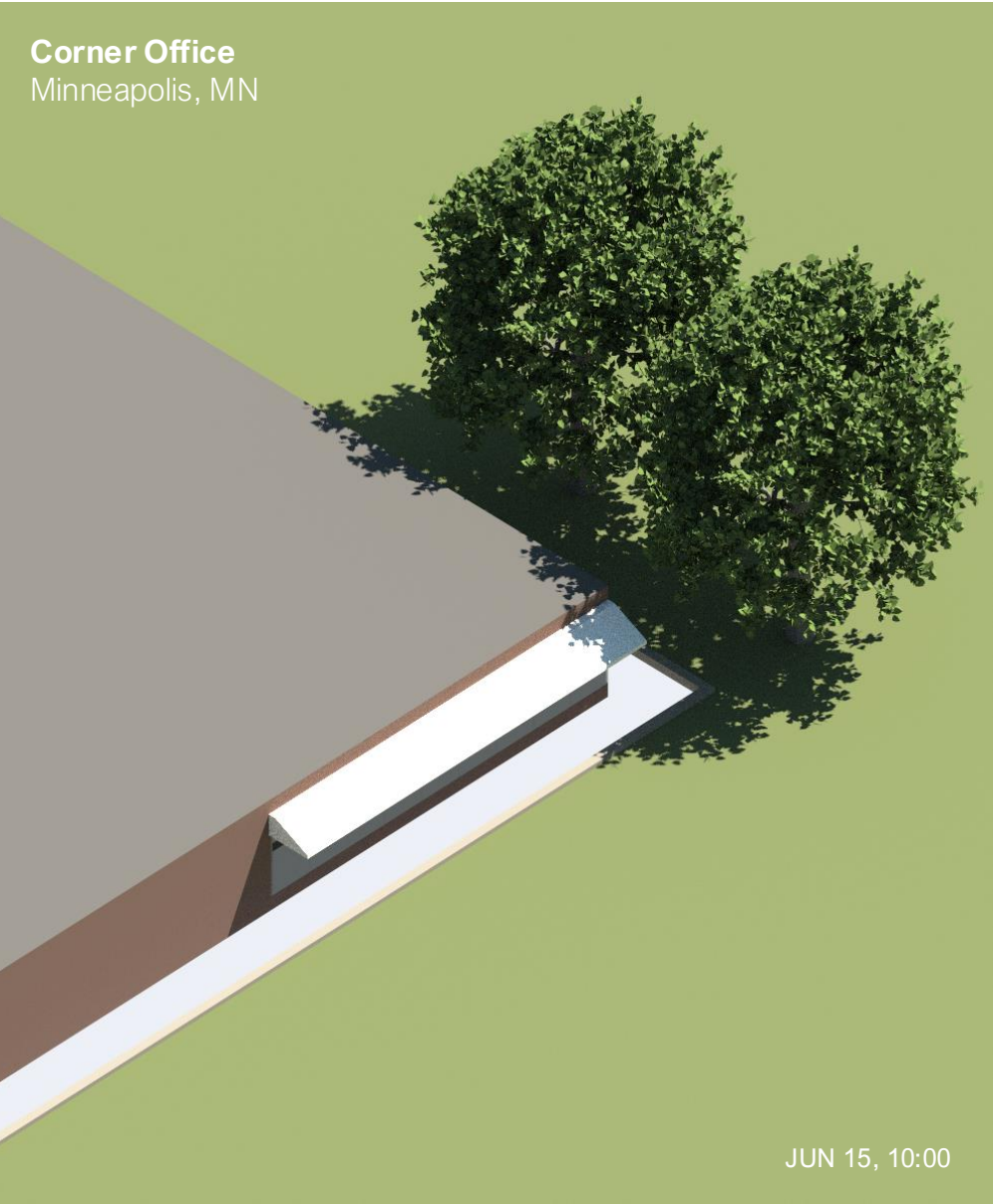
APR 01



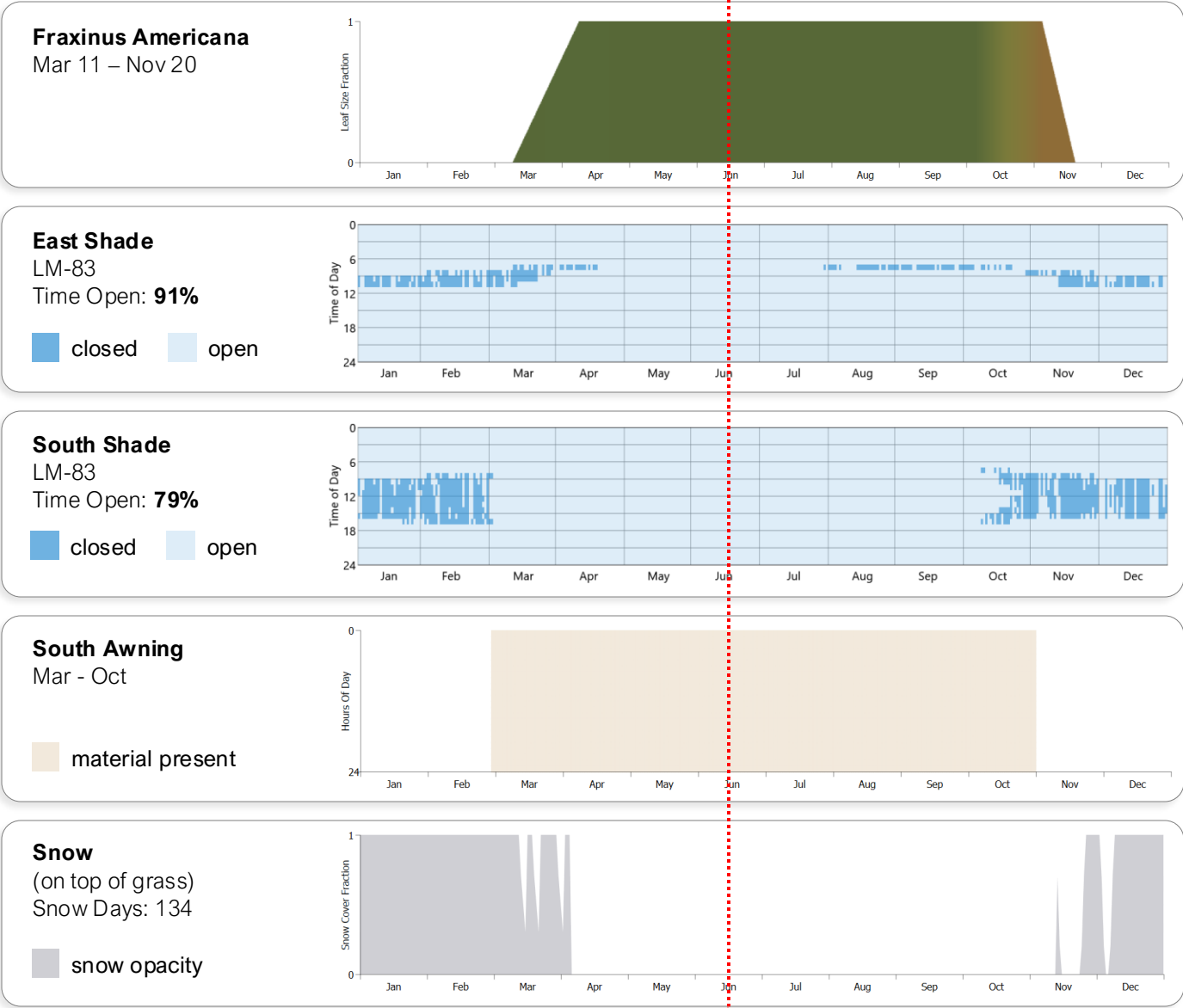


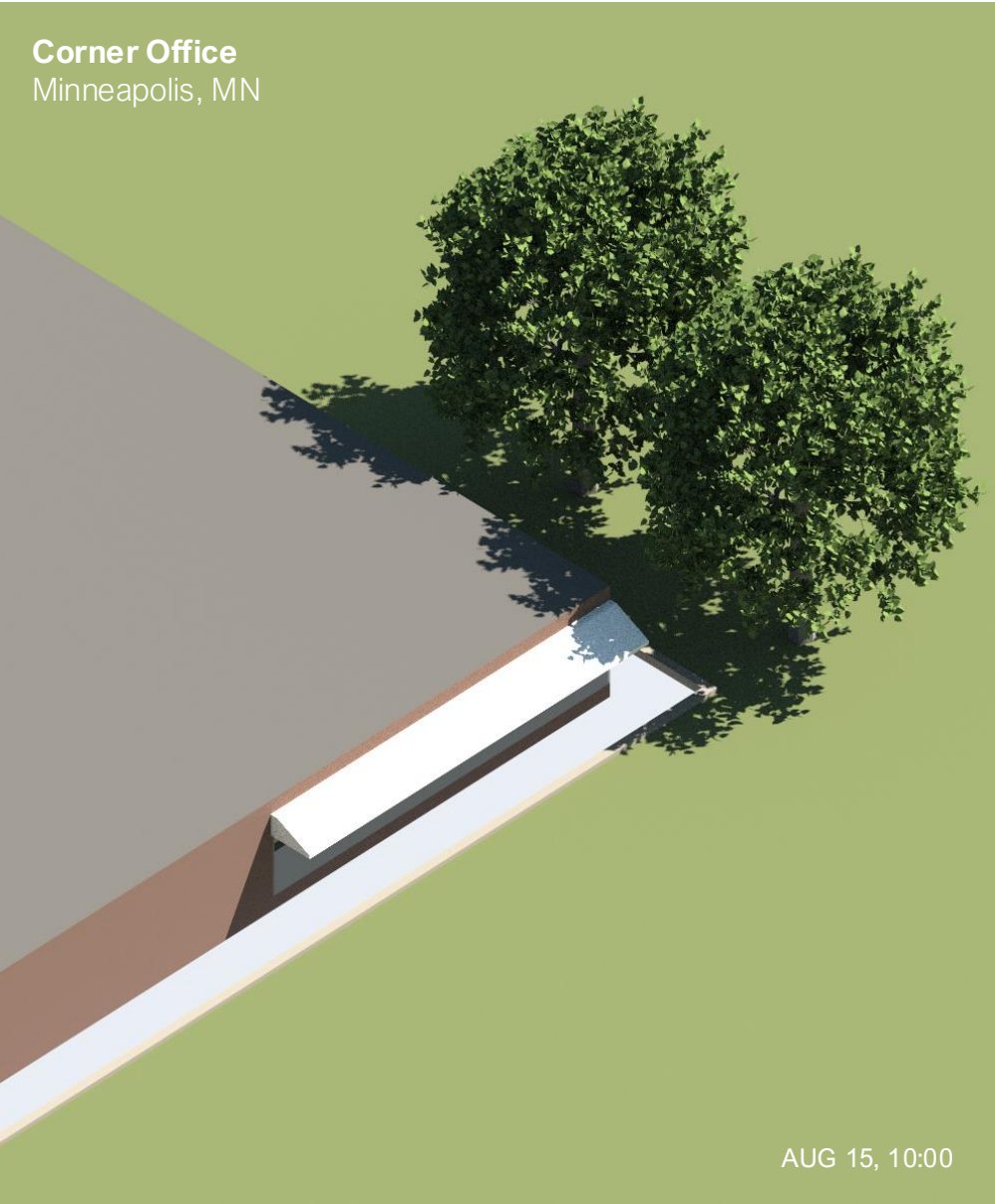
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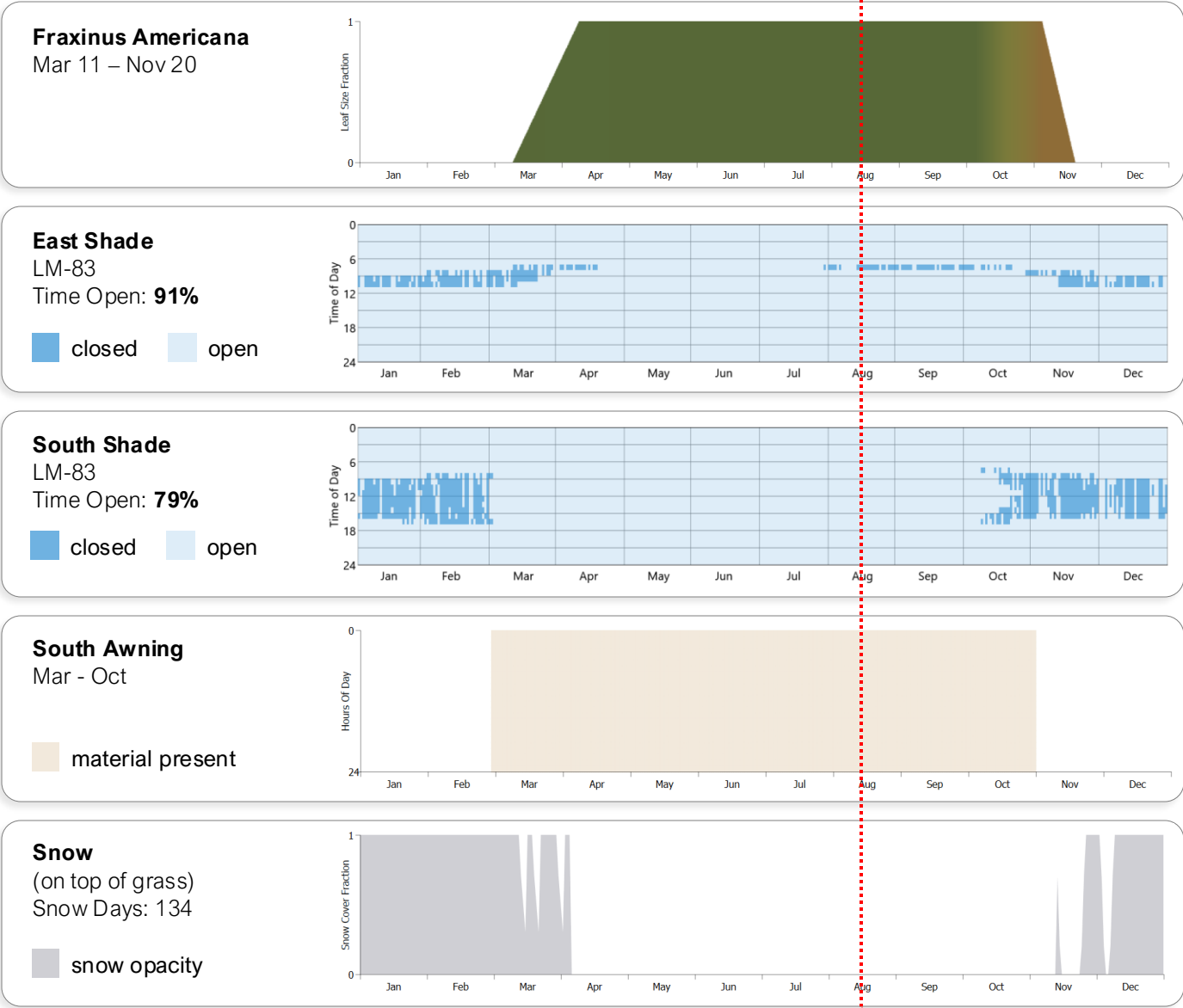


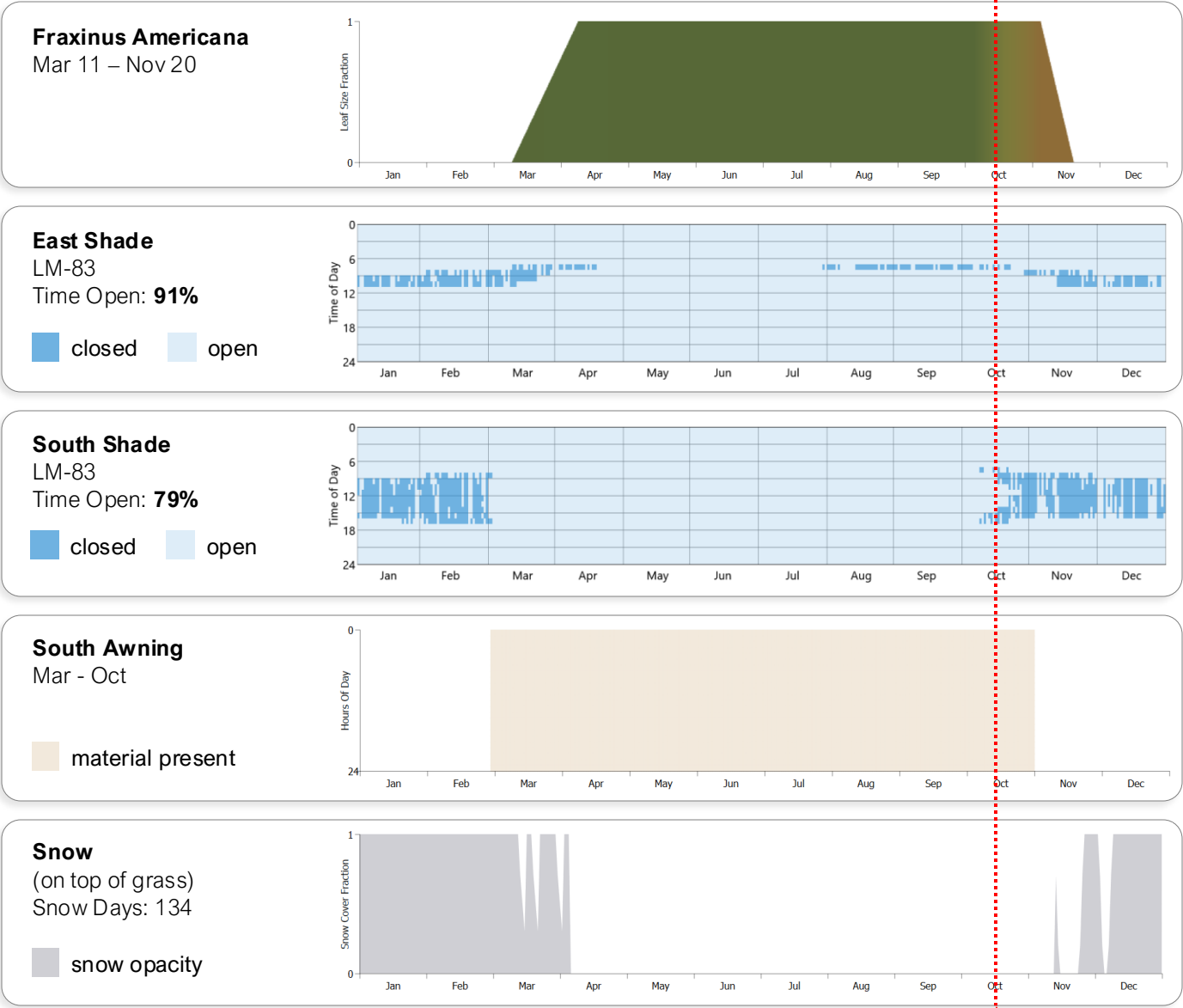
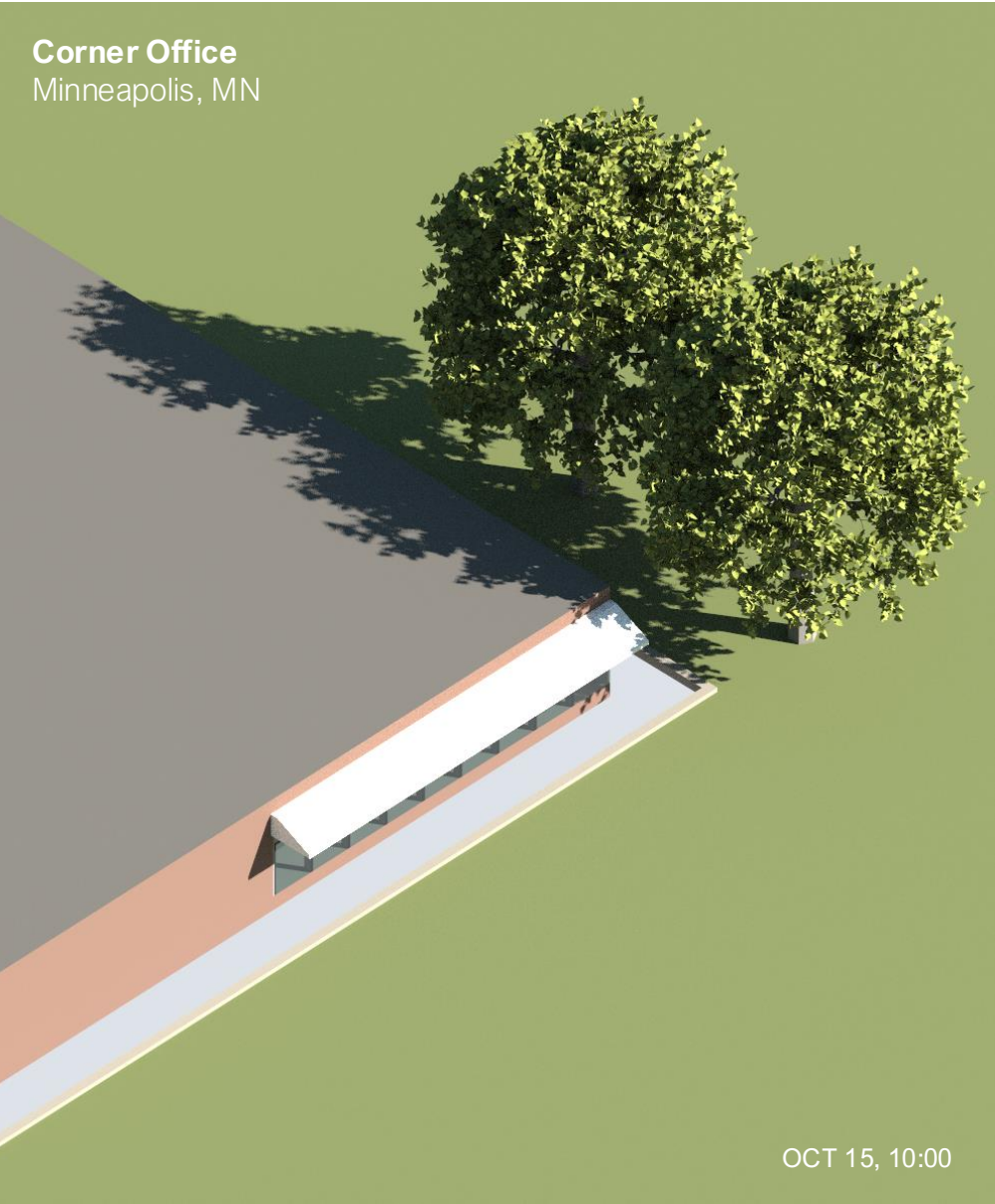
JUN 15

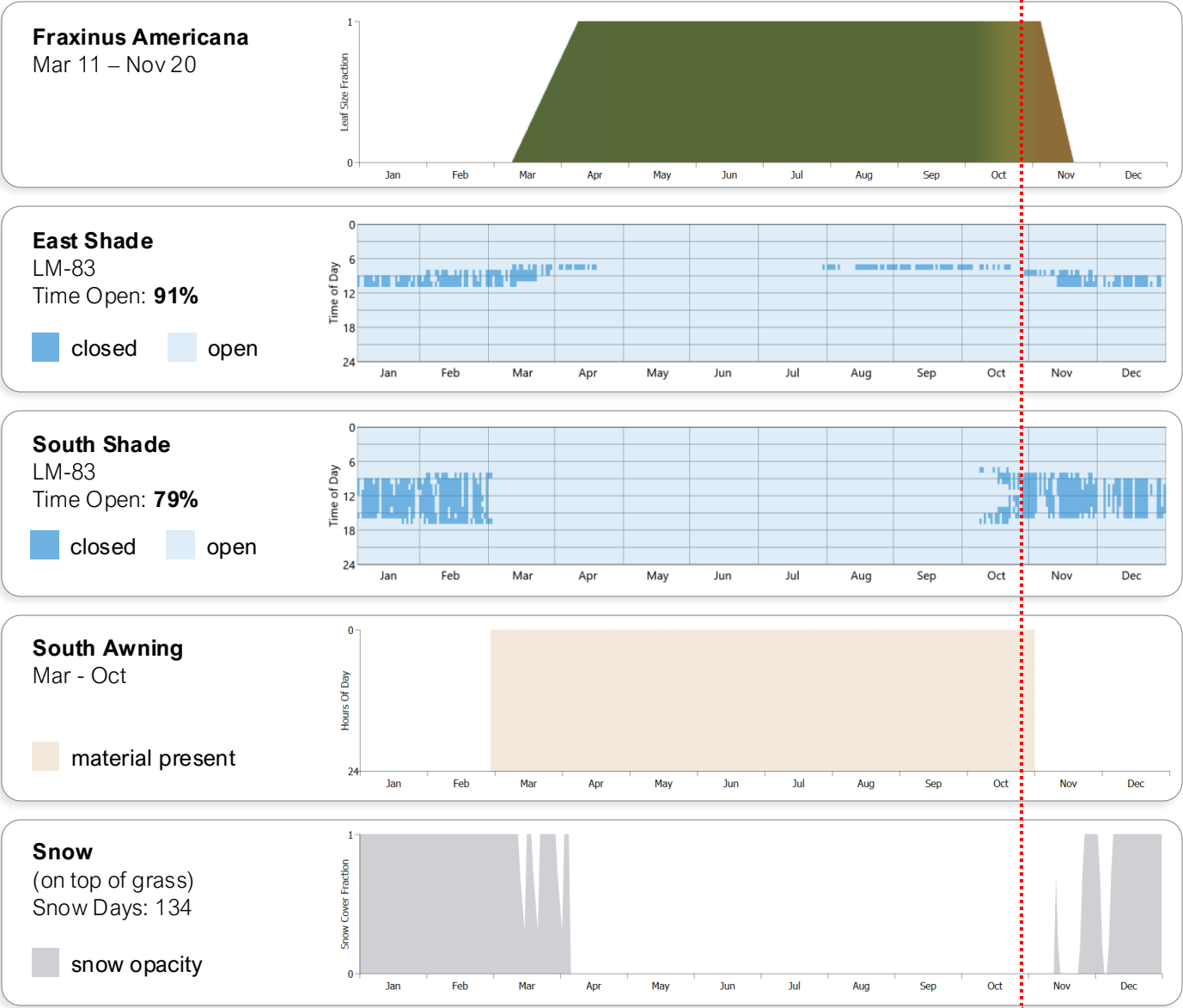
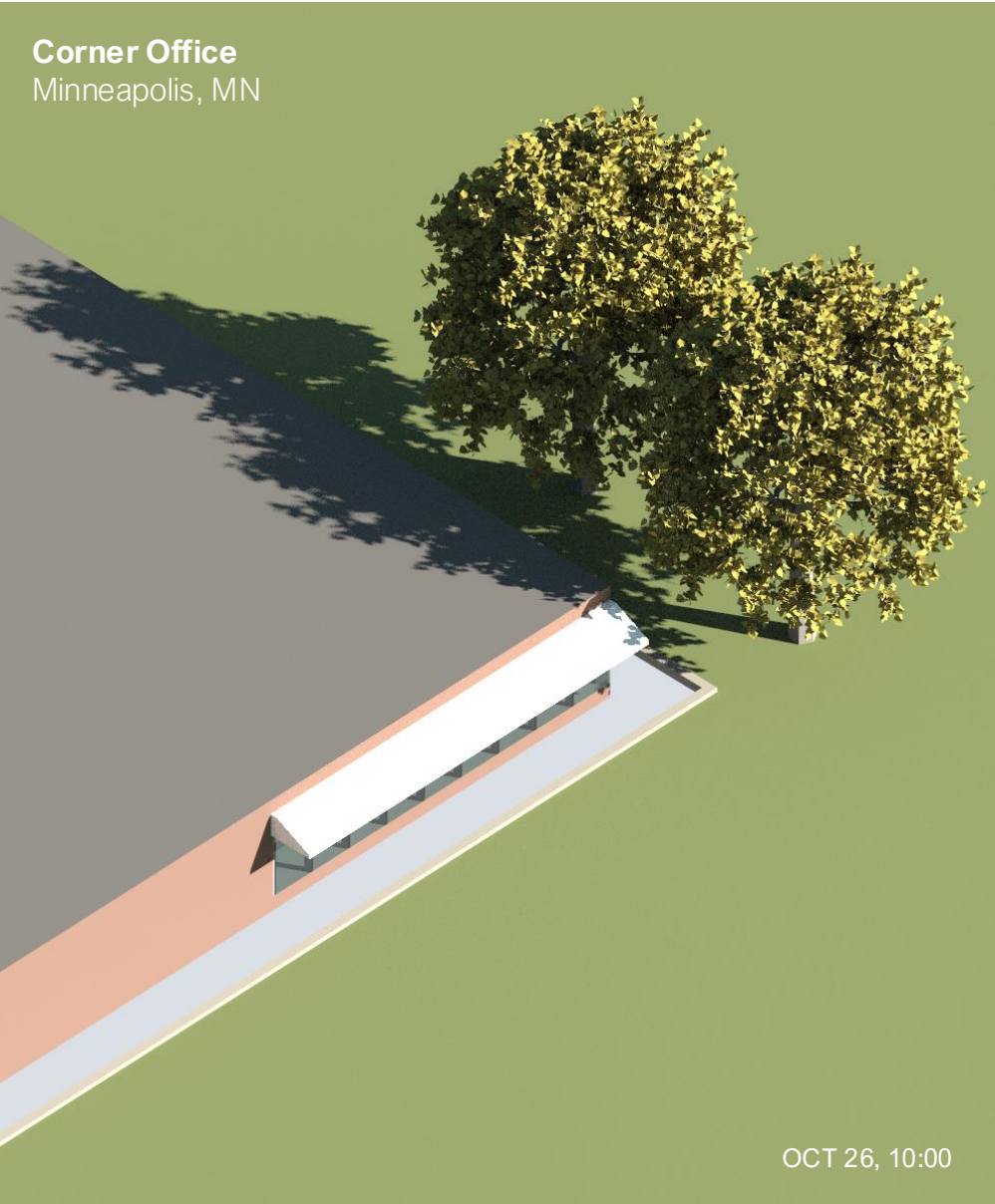


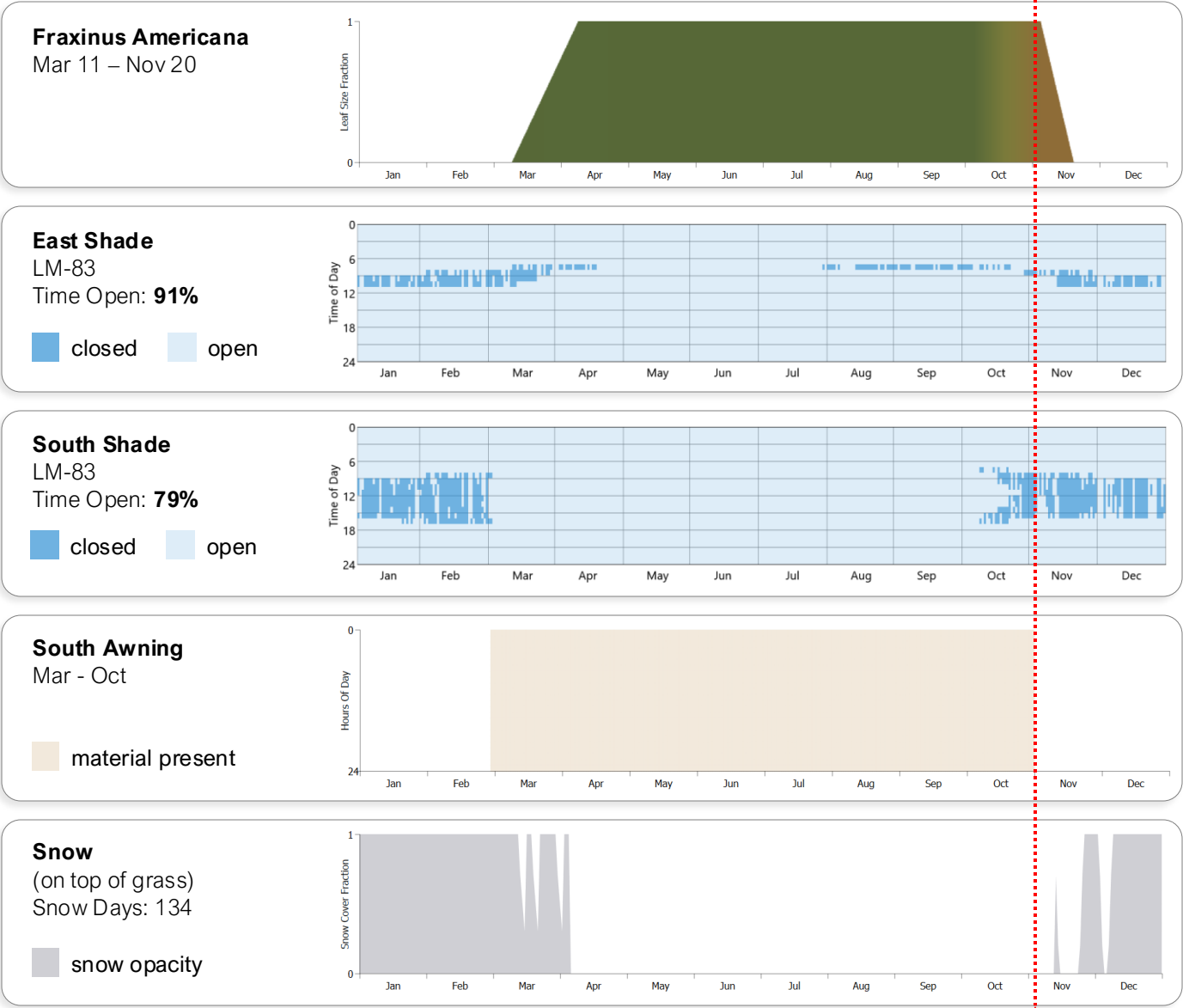


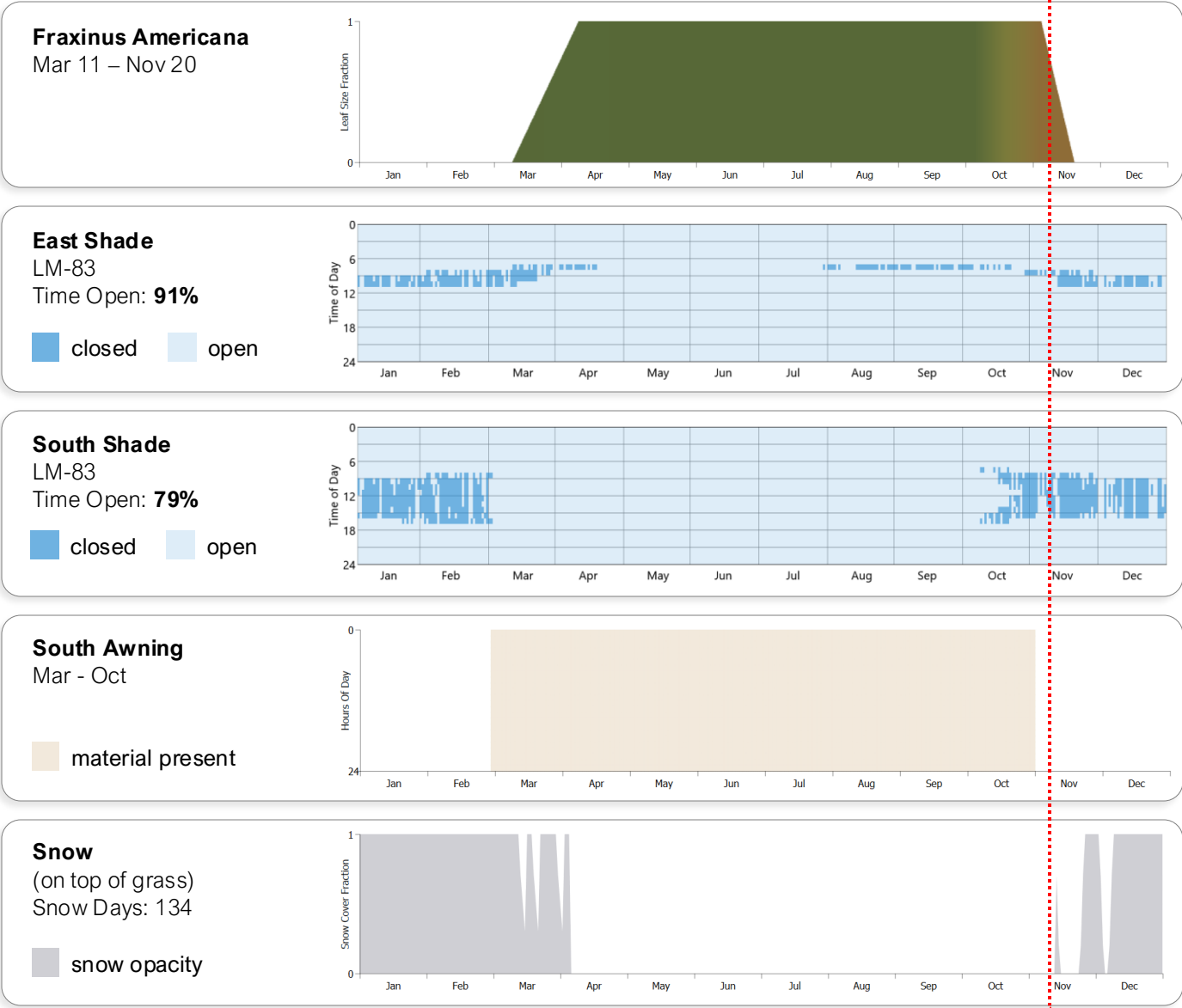
AUG 15

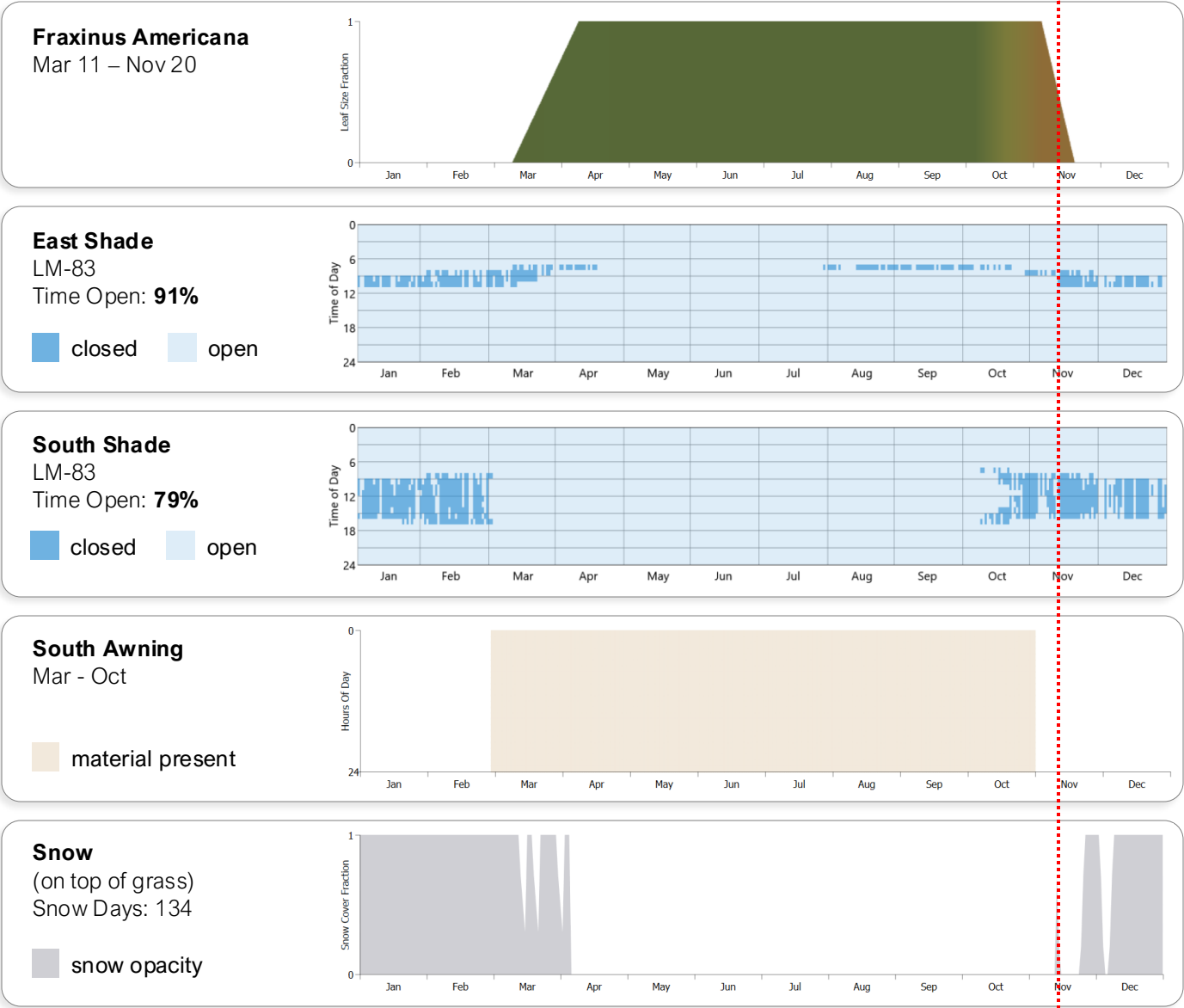
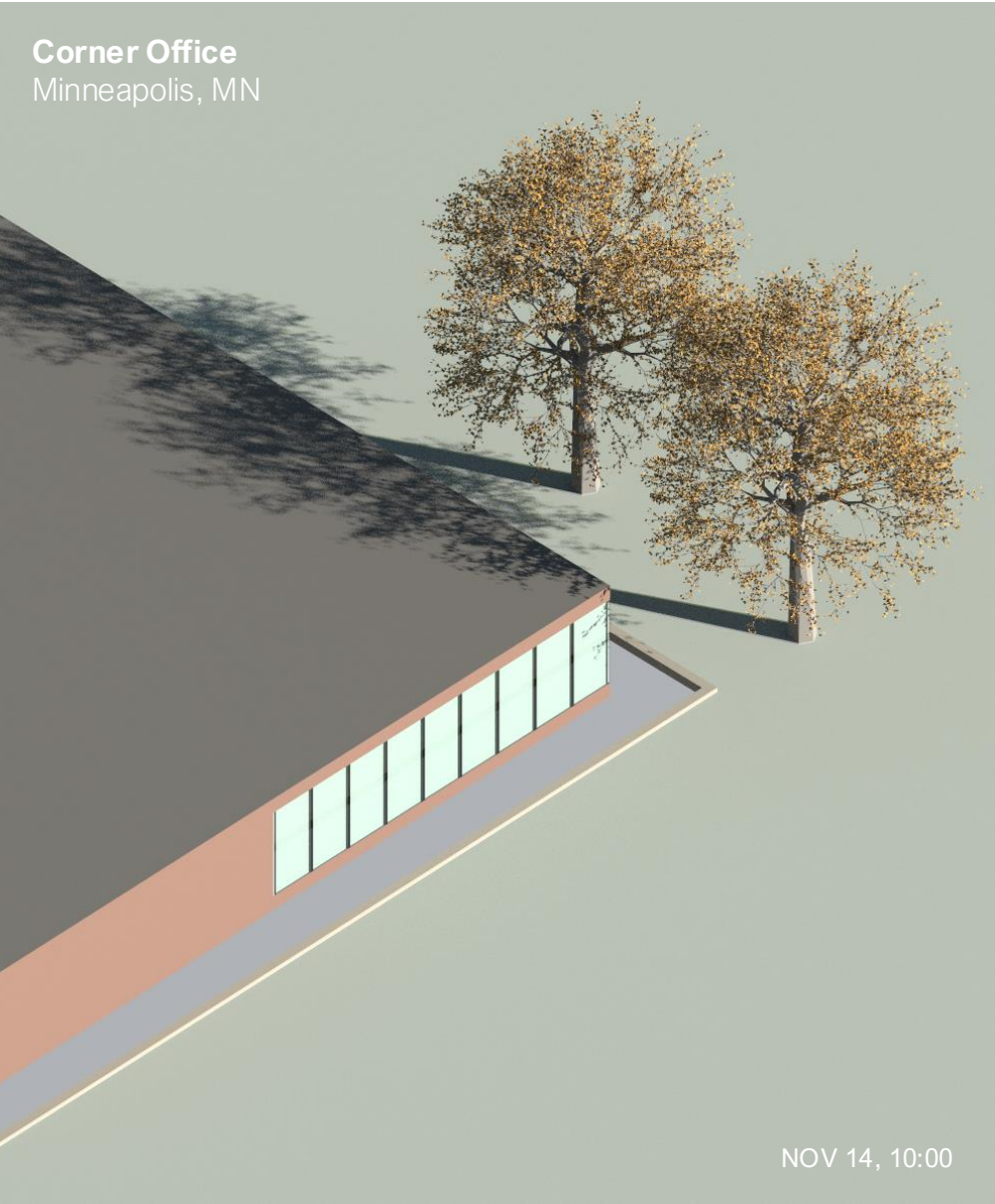


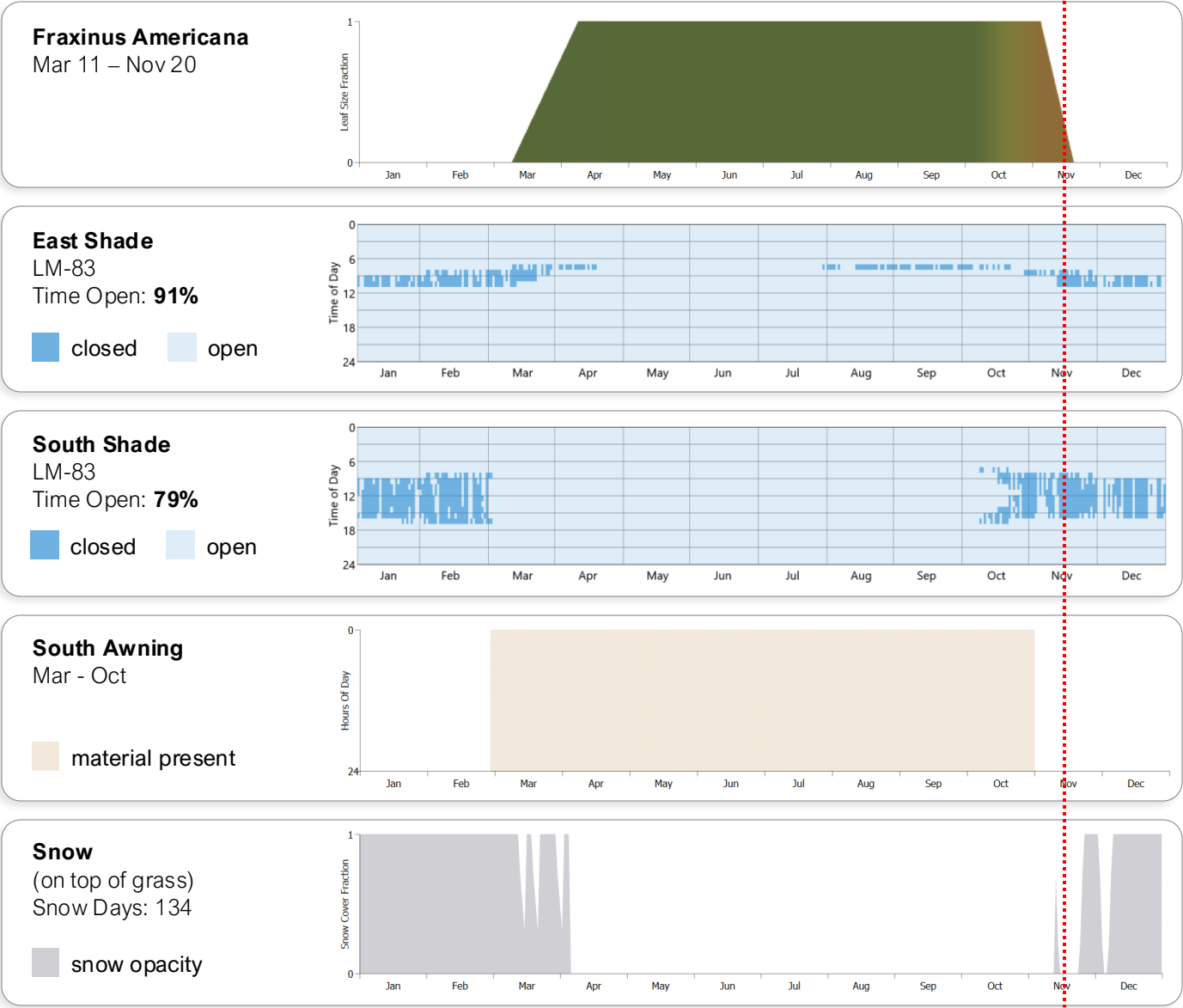
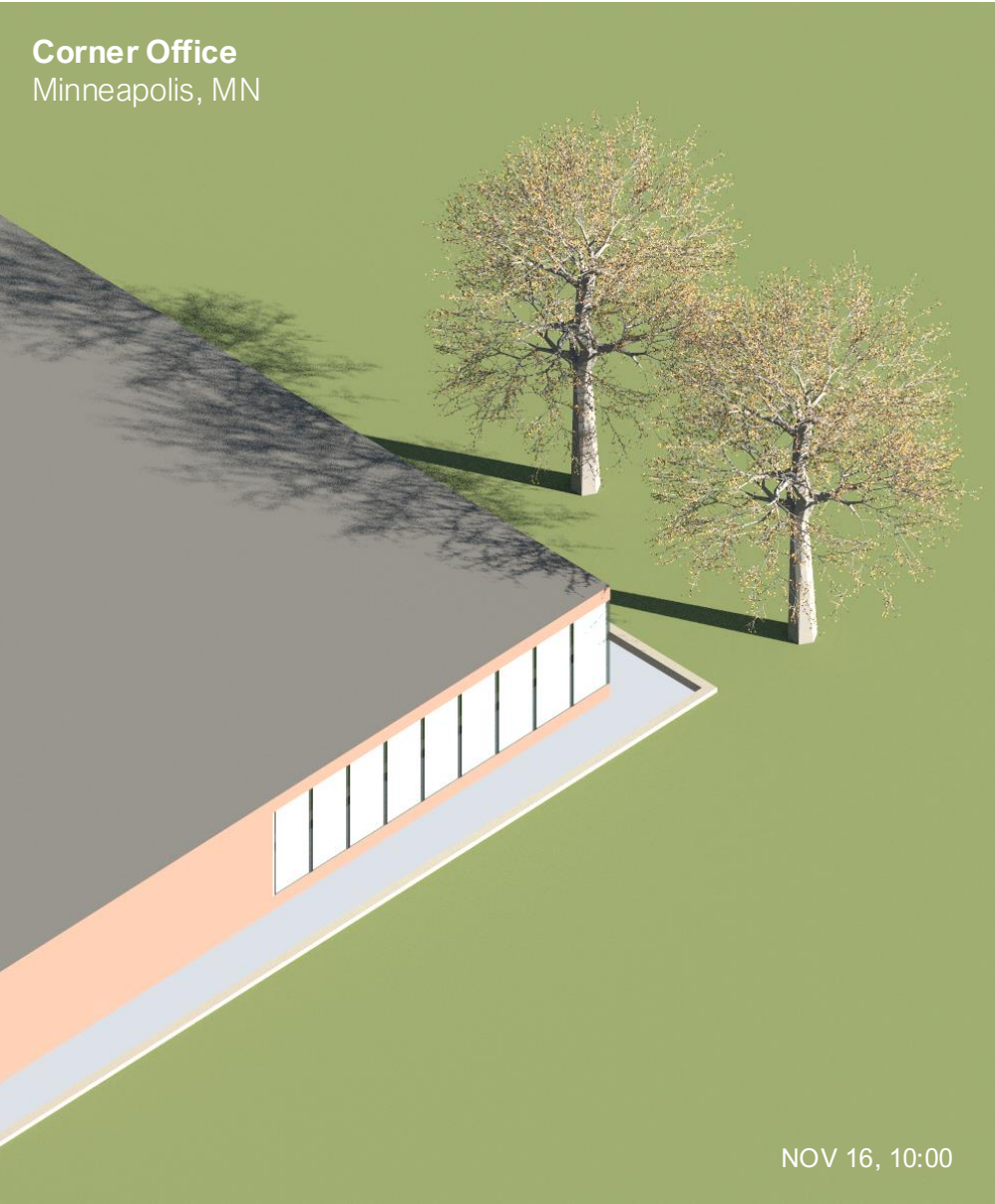


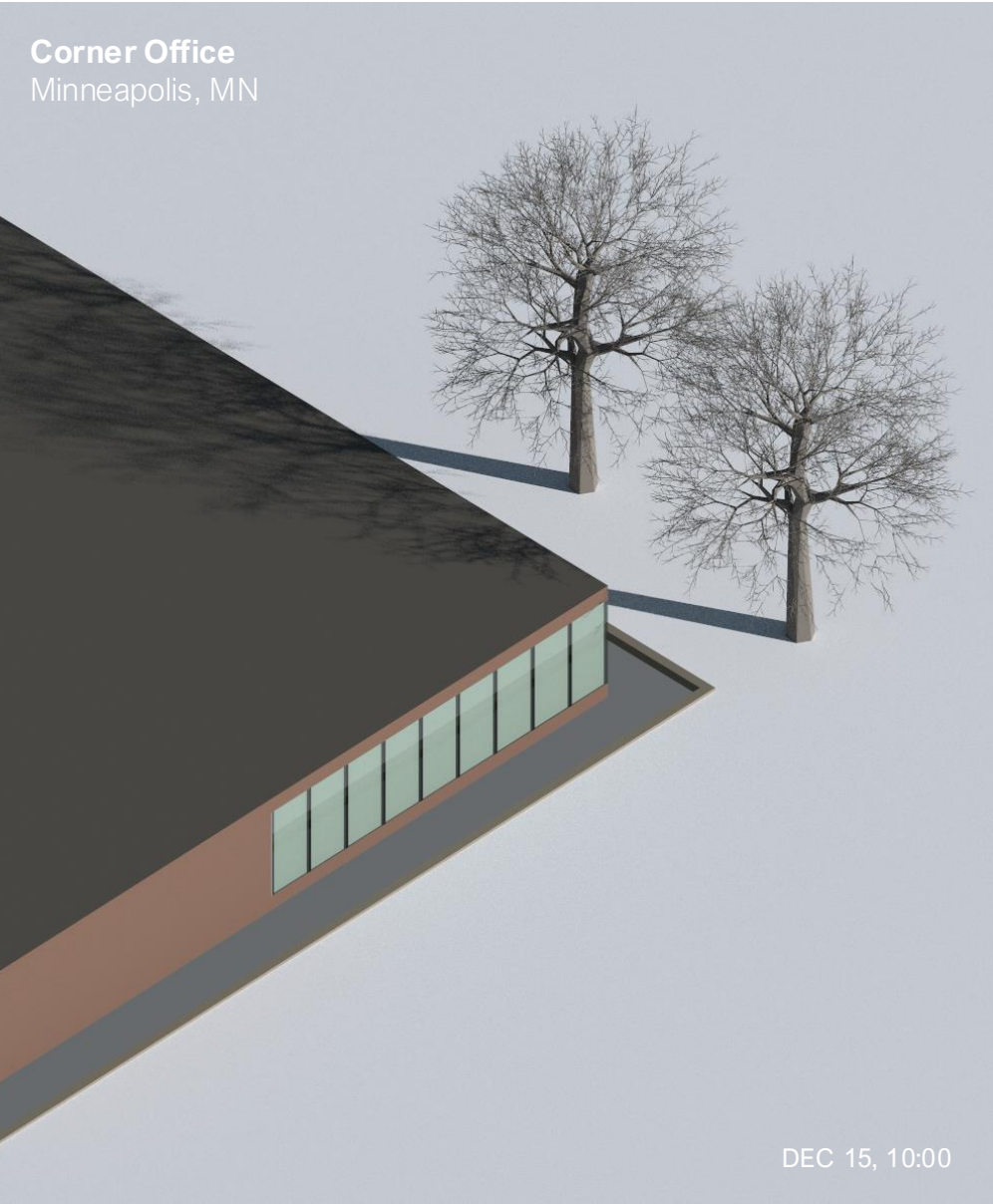


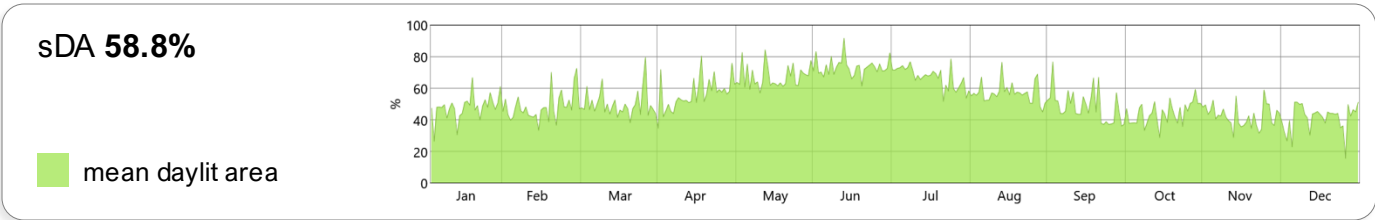
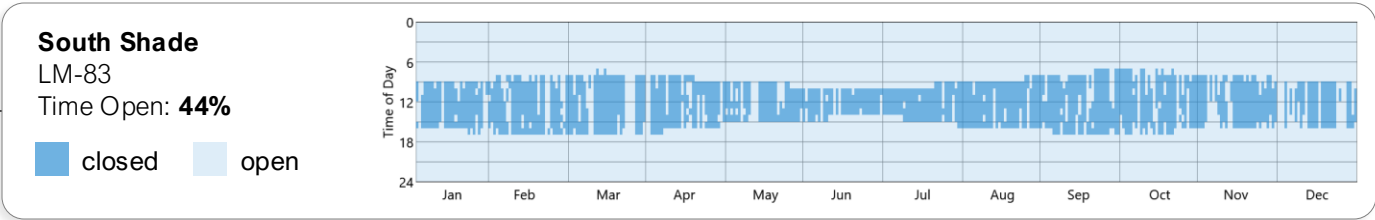
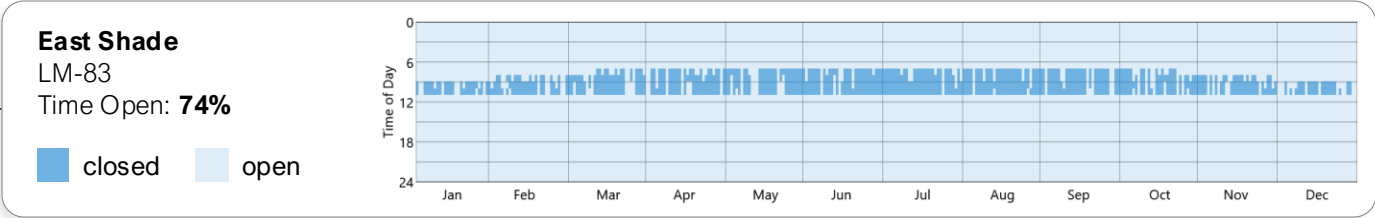
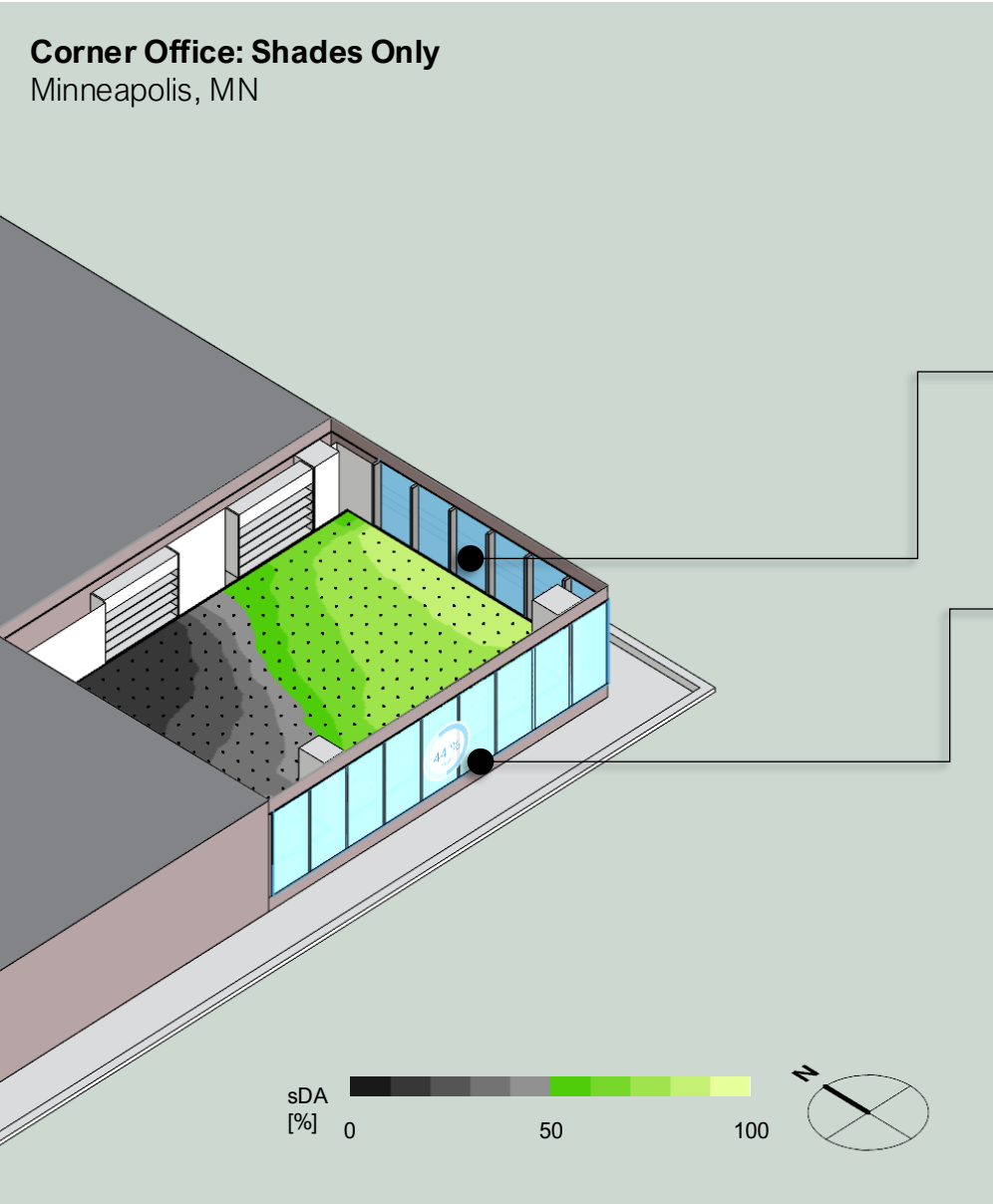


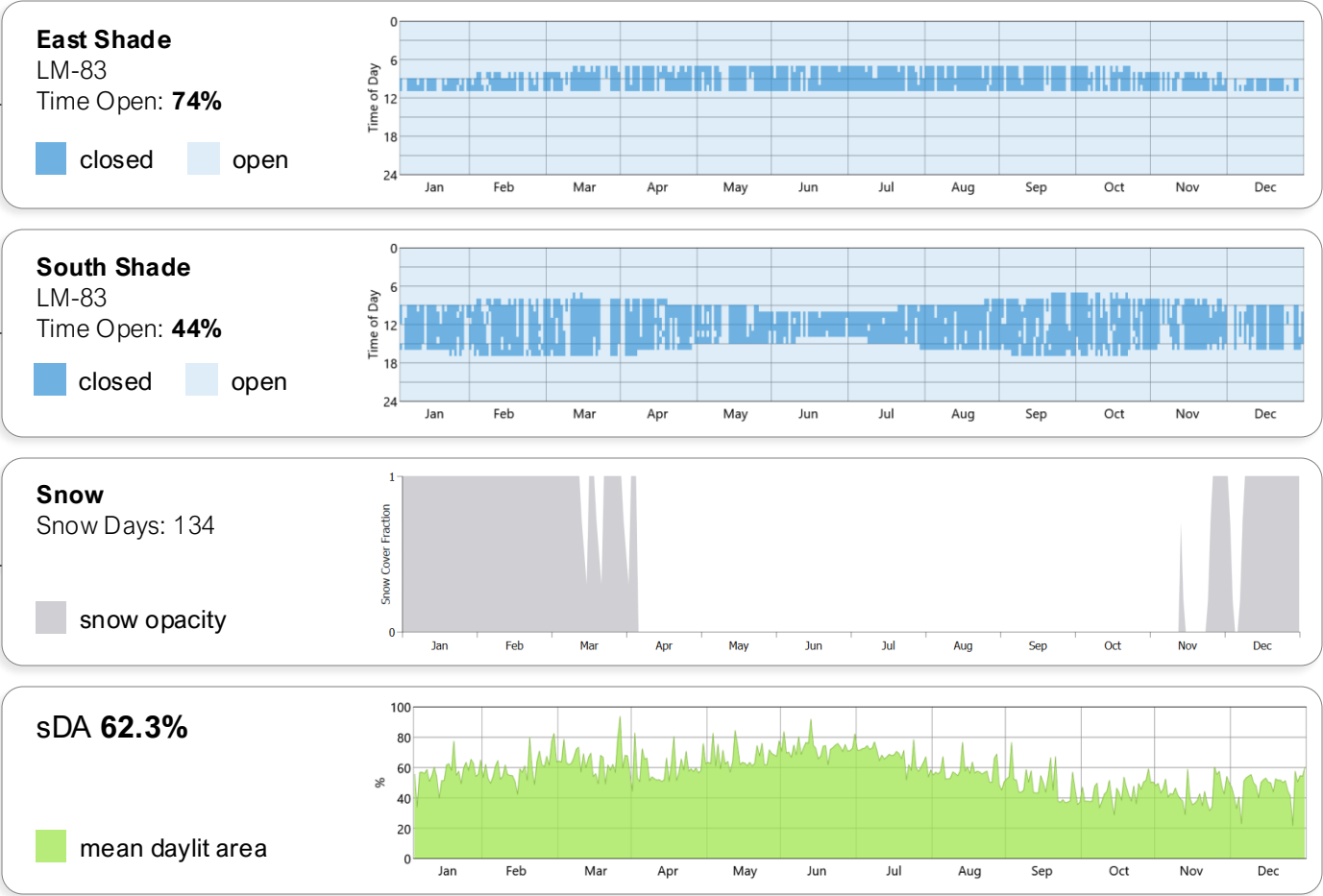
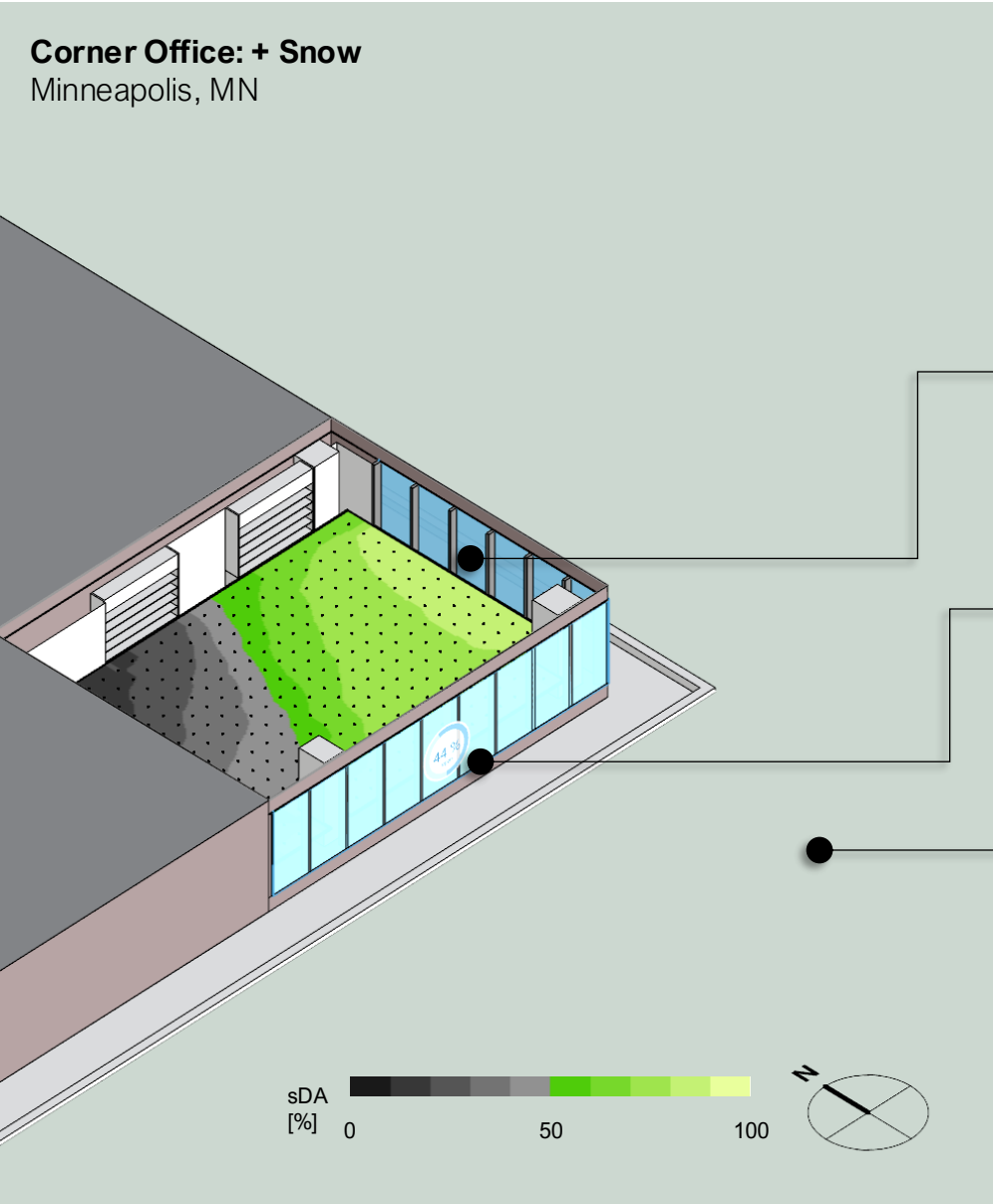


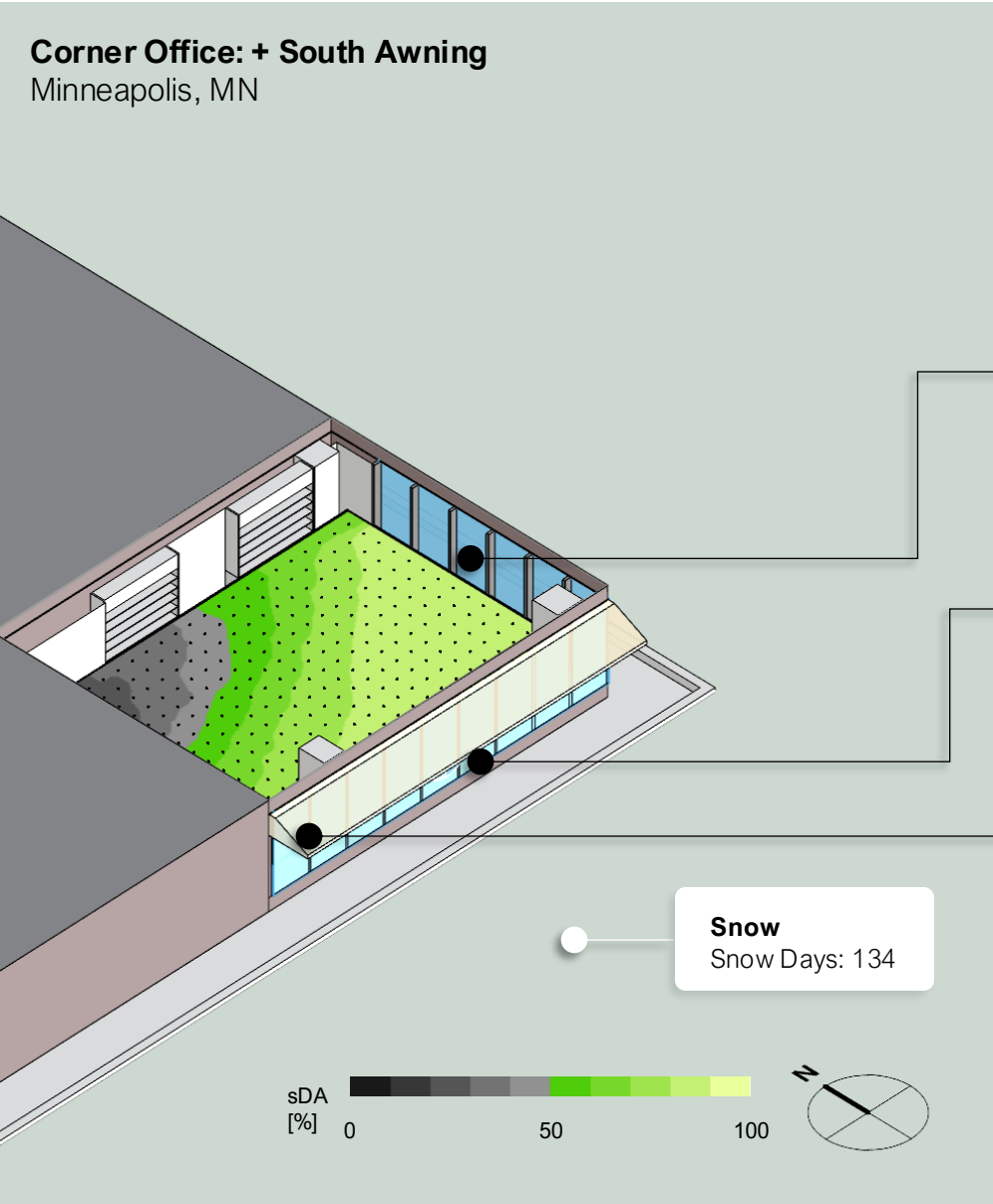


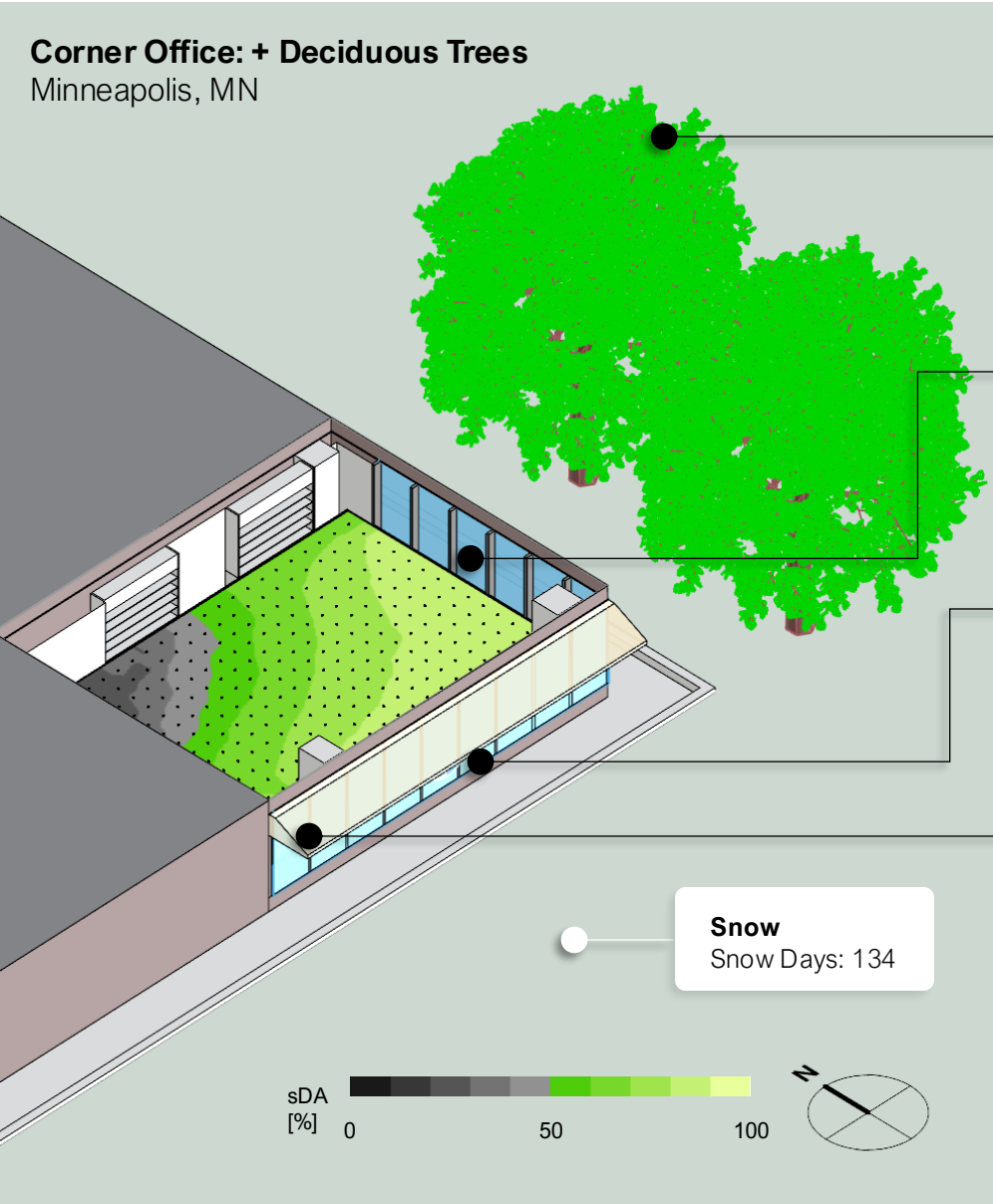


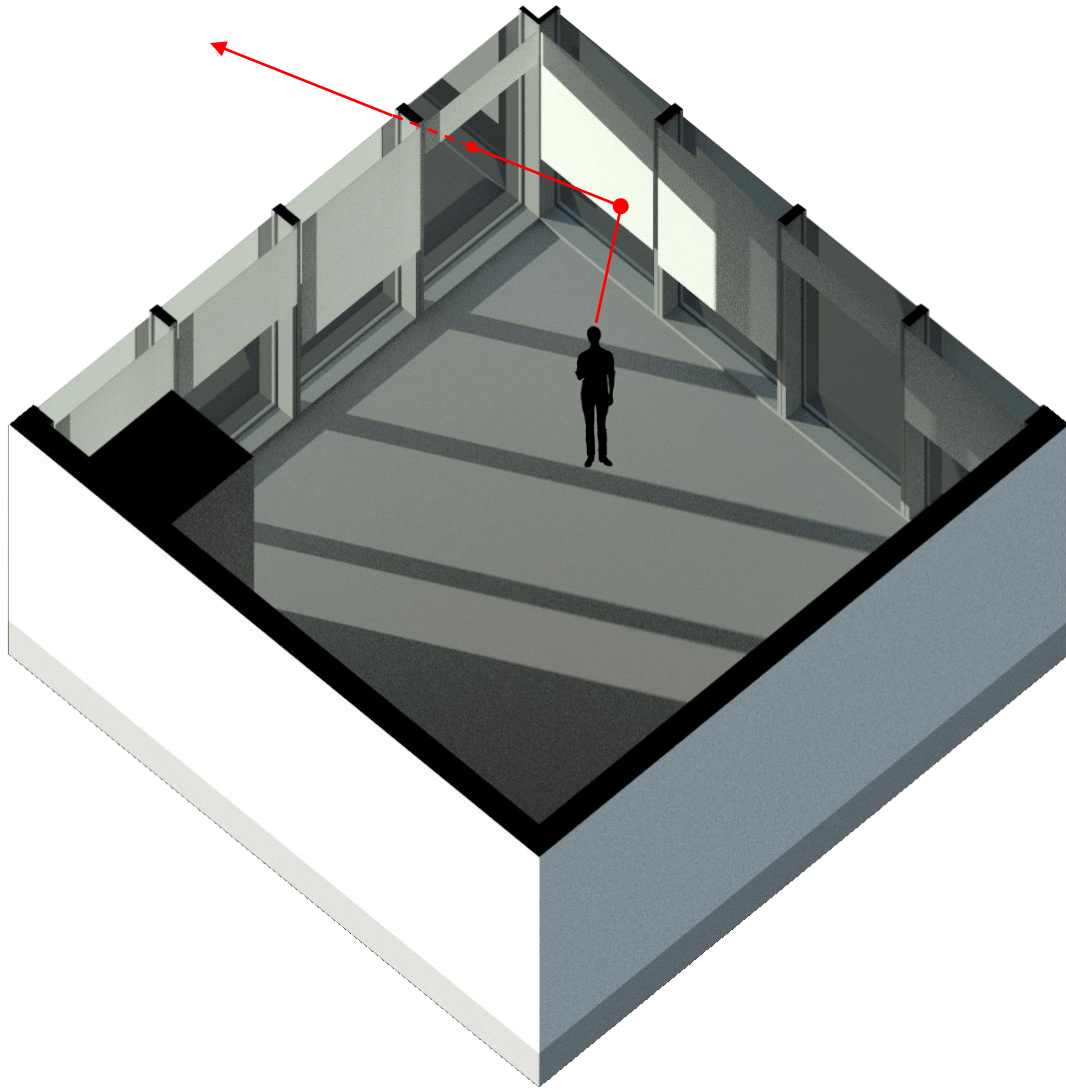








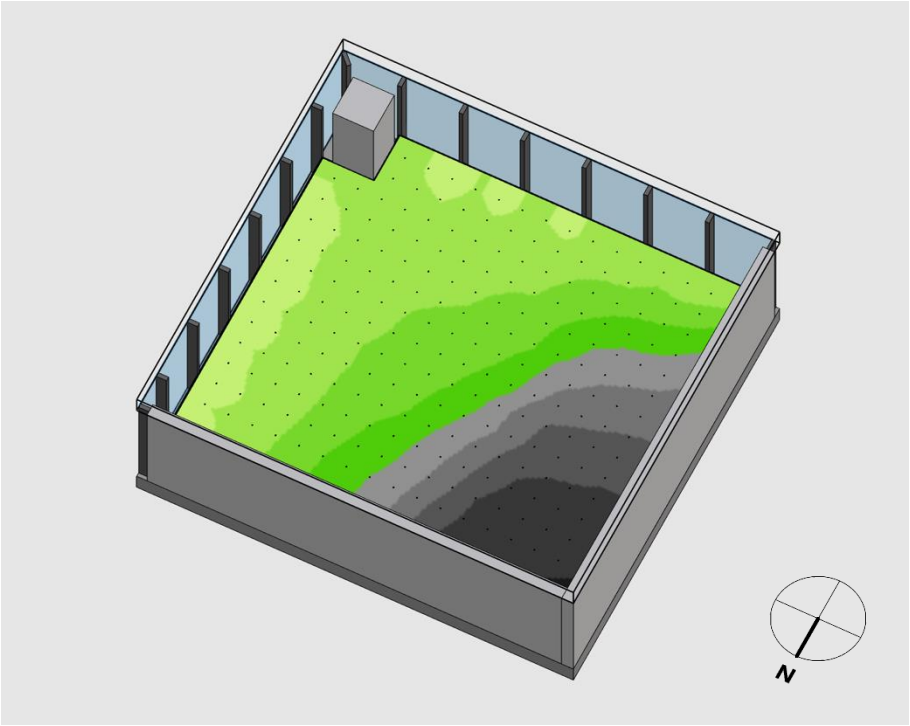
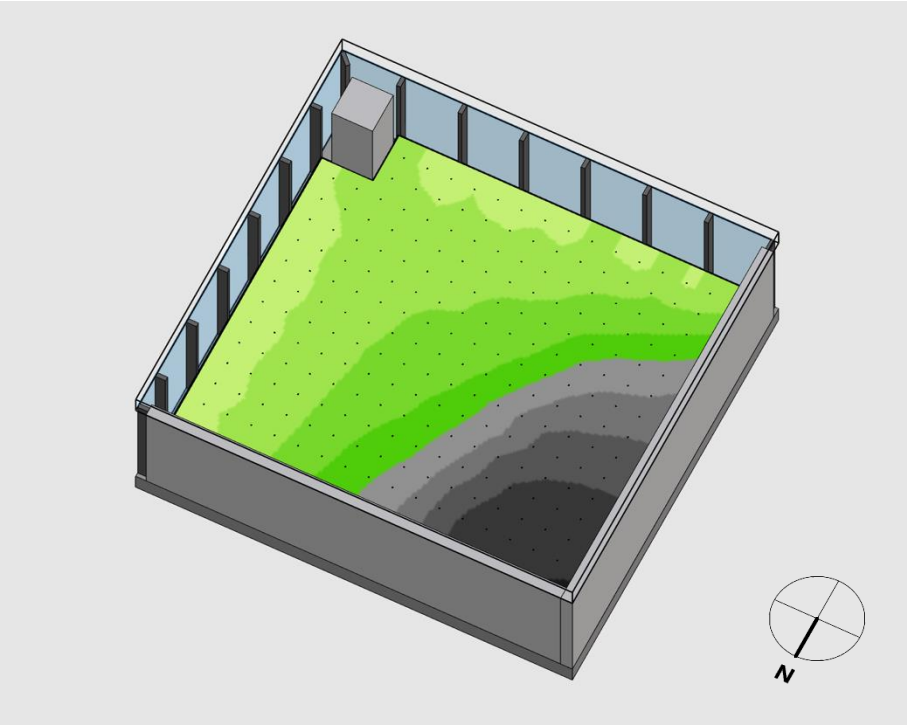
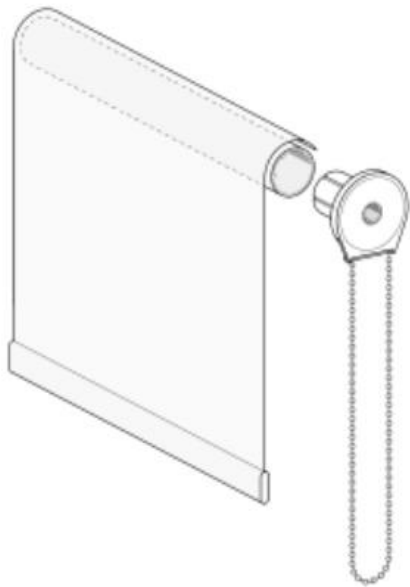




Multiverse finds more reflected light than 3/5-phase methods.

Is this significant?

Low VLR Scenario



Shade
SheerWeave 2410 Performance
V24 CCL/Chestnut
VLR (back) **6%**

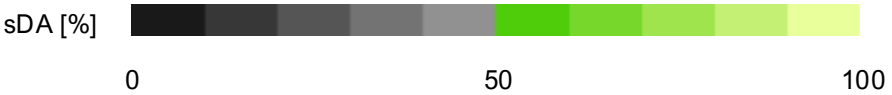
Glazing
Pacifica – Solarban 60 (3)
VLT 30%
VLR (back) **7%**

CFS Reflections On
sDA 67.2%
Mean Lux 552

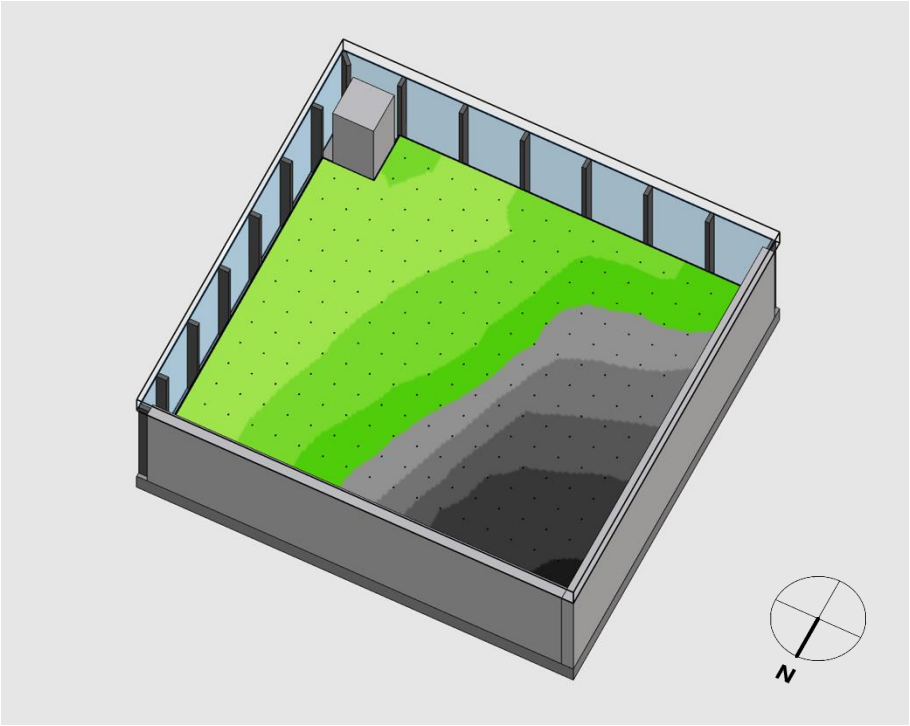
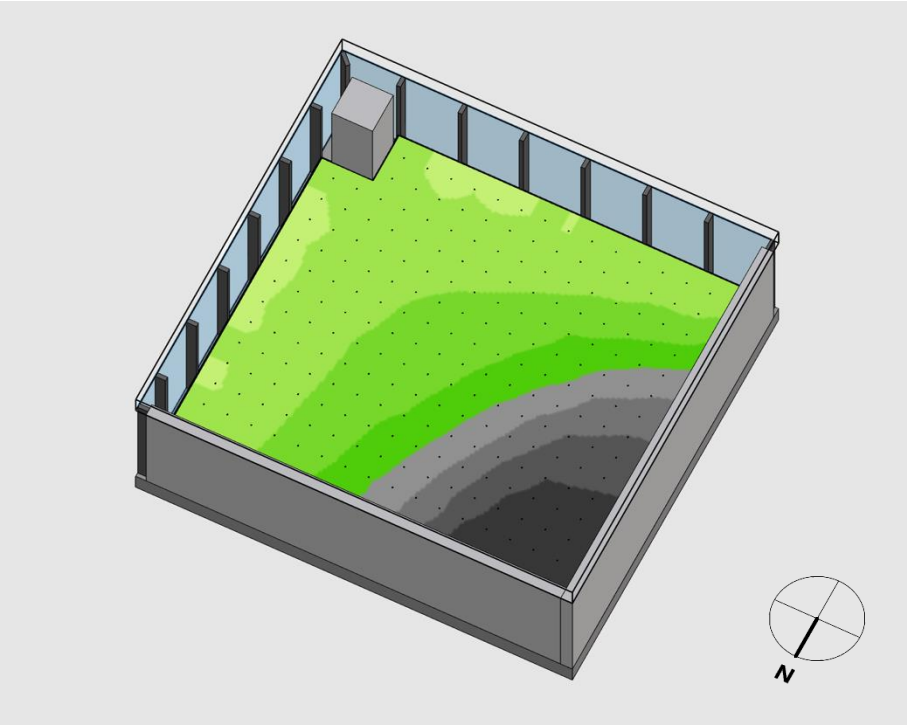
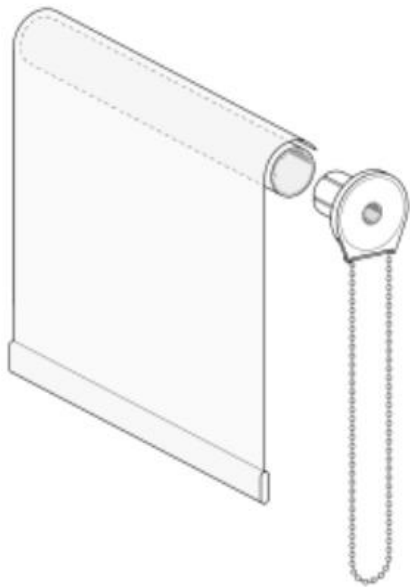
Params
USA_MA_Boston-Logan.Intl.AP.725090_TMYx.2004-2018.epw
65536 samples/sensor, -ab 10 -ad* 1 -lw* 0.001 *per sample
LM-83 shading control

CFS Reflections Off
sDA 64.9%
Mean Lux 541

Rel. Error
-3.2%
-2.0%



High VLR Scenario



Shade
SheerWeave 2410 Performance
P12 Oyster
VLR (back) **78%**

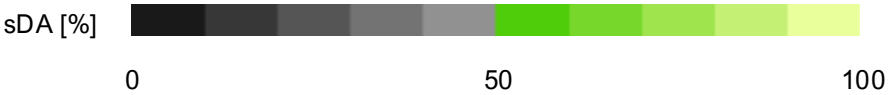
Glazing
Vistacool on Pacifica – Clear
VLT 29%
VLR (back) **31%**

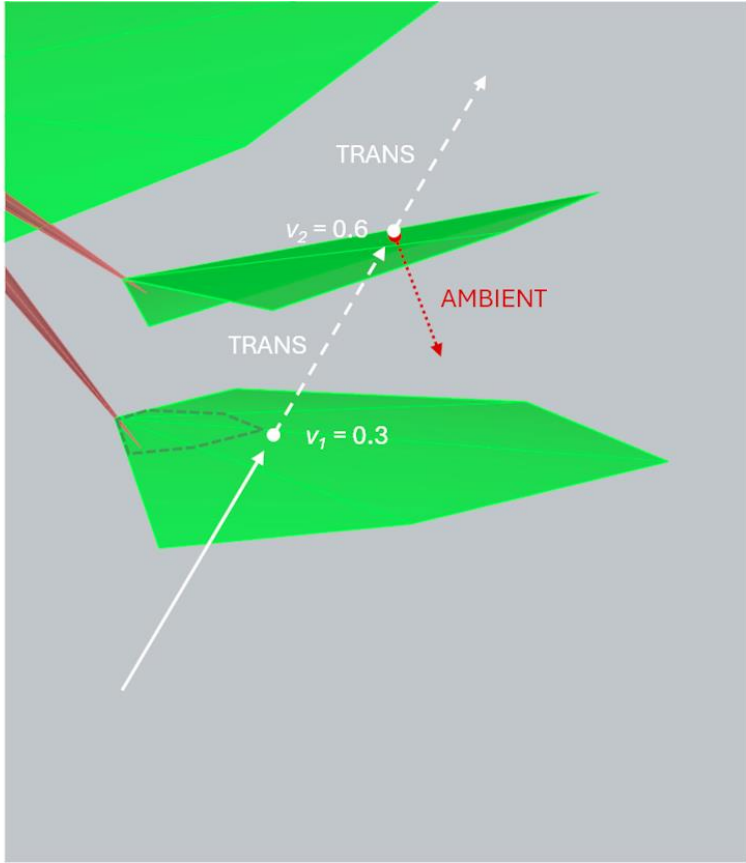
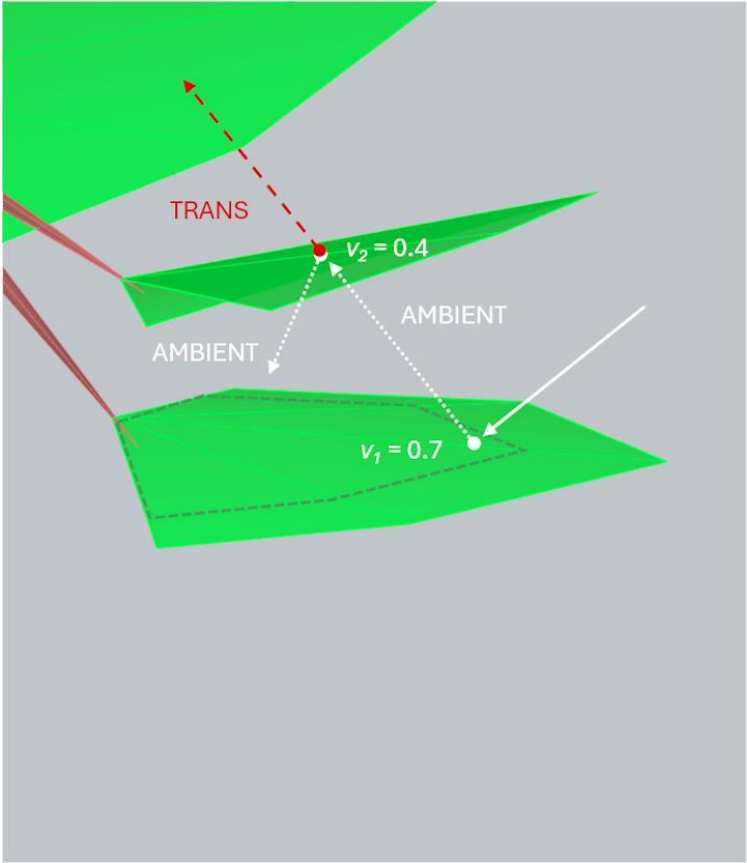
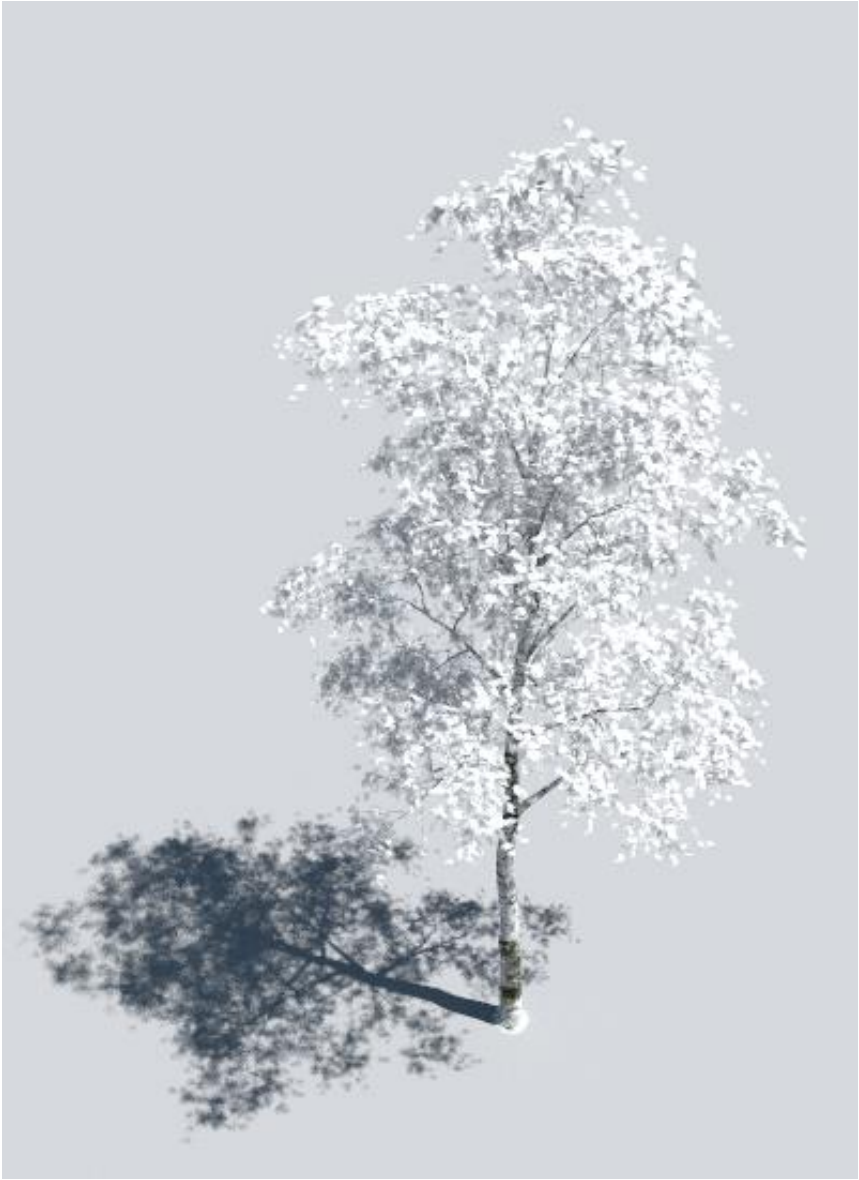
CFS Reflections On
sDA 68.7%
Mean Lux 536

Params
USA_MA_Boston-Logan.Intl.AP.725090_TMYx.2004-2018.epw
65536 samples/sensor, -ab 10 -ad* 1 -lw* 0.001 *per sample
LM-83 shading control

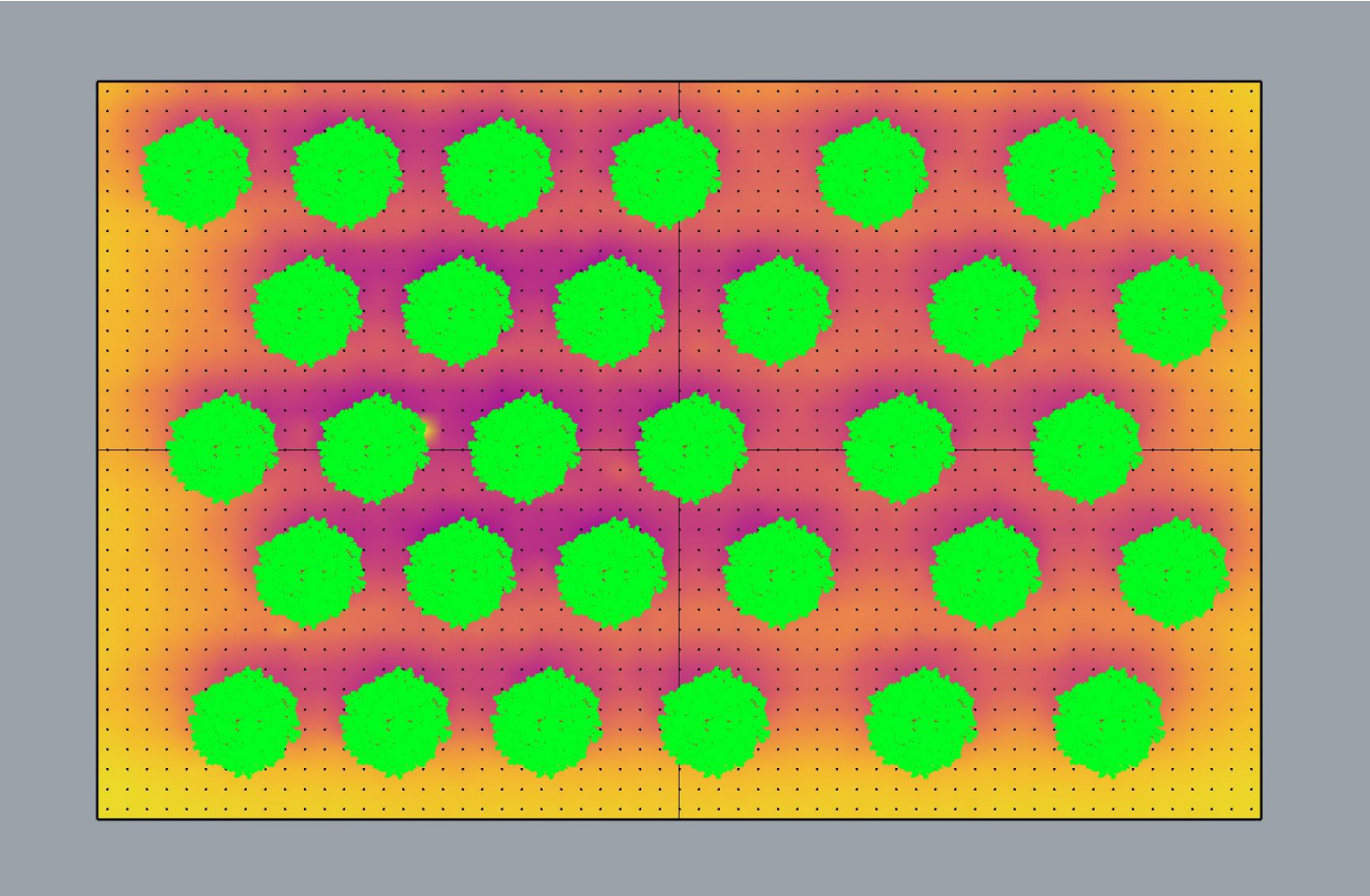
CFS Reflections Off
sDA 58.2%
Mean Lux 489

Rel. Error
-15.5%
-8.8%





Some paths aren't used by any scene state (red rays can't happen if leaves are same size)

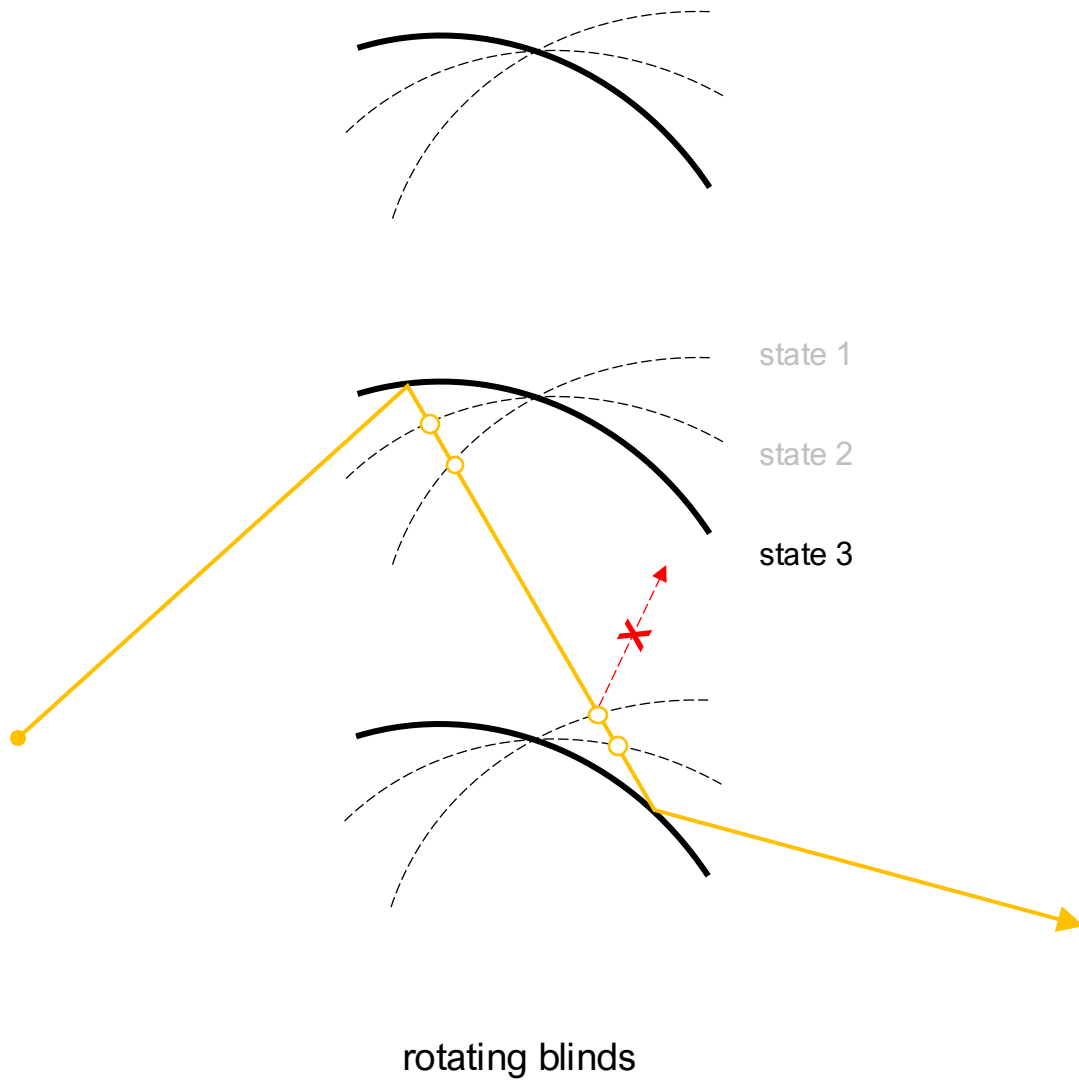


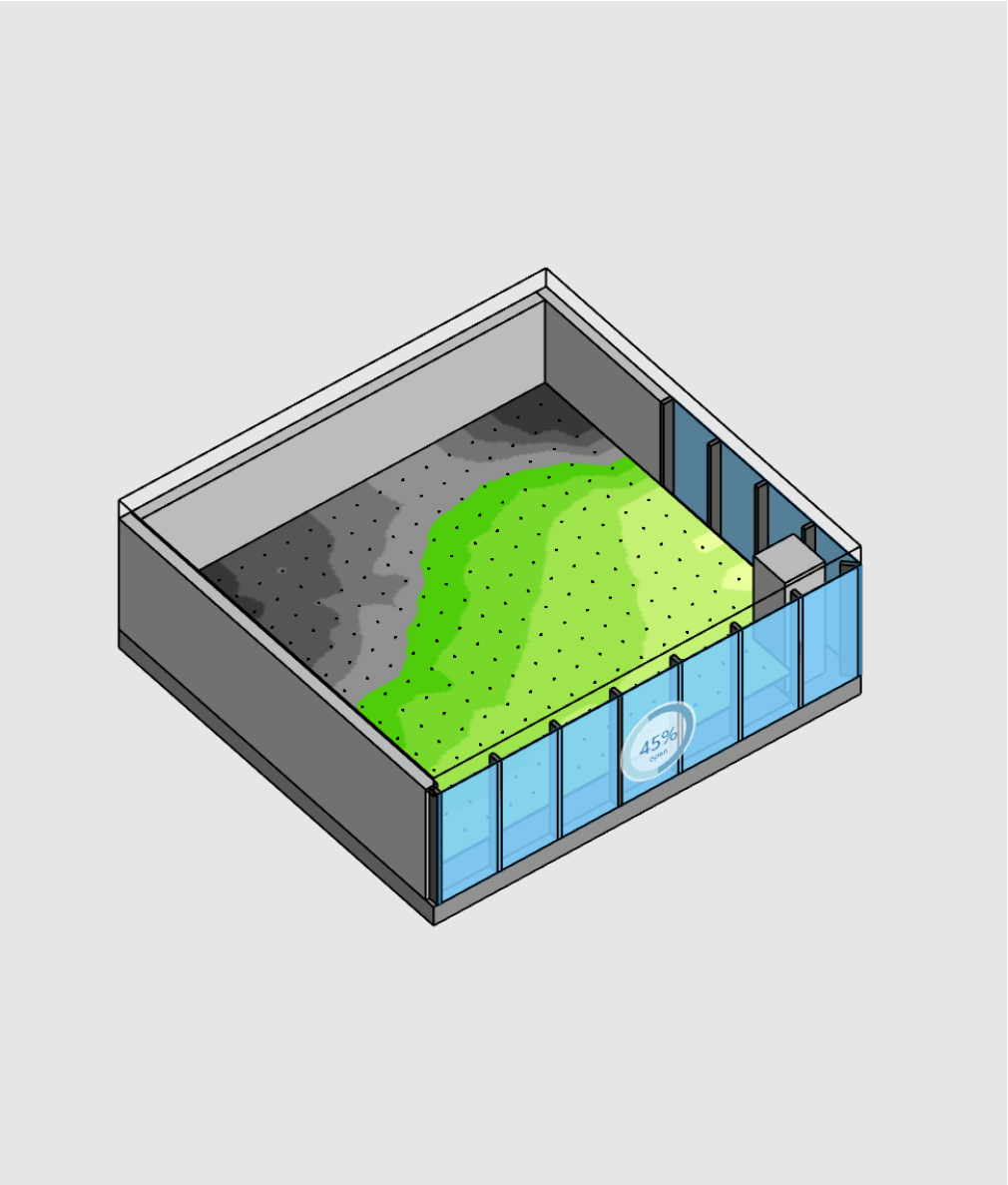
- Custom mixfunc(2) **terminates useless paths**
- 2x speedup for radiation map with dense tall trees

	paths	useless paths	interactions	useless interactions	time [sec]
path termination OFF	13216976	3721244	58882503	35561237	148
path termination ON	9493947	0	23297516	0	71

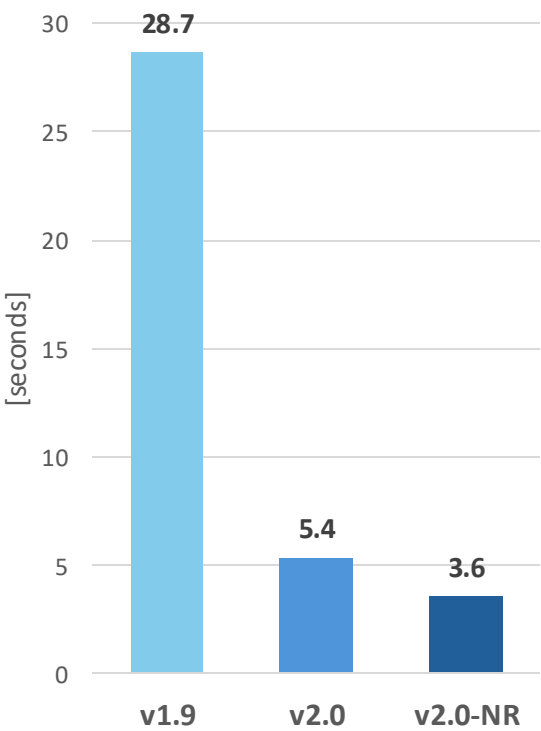
- Custom mixfunc **terminates useless paths**
- 2x speedup for radiation map with dense tall trees
- Potentially useful for rotating blinds, design options

Stay tuned...

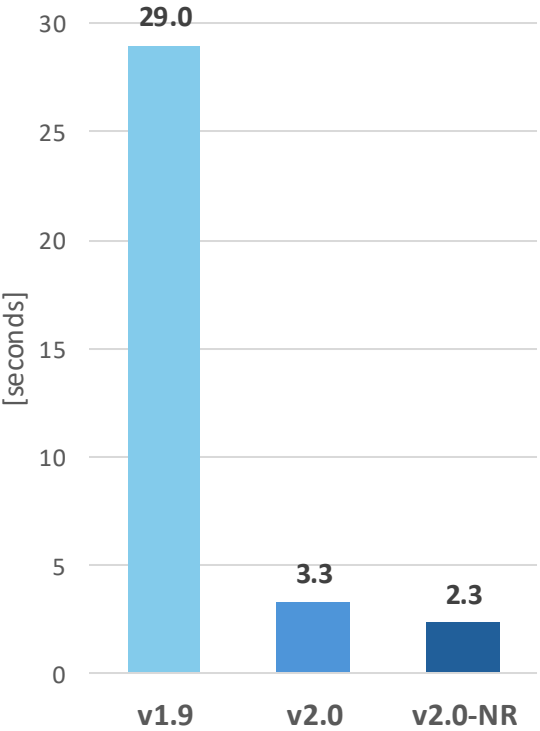




Small Model • CBDM Run Time
Single-room corner office
1,013 ft² | 268 sensors | 2 shading groups

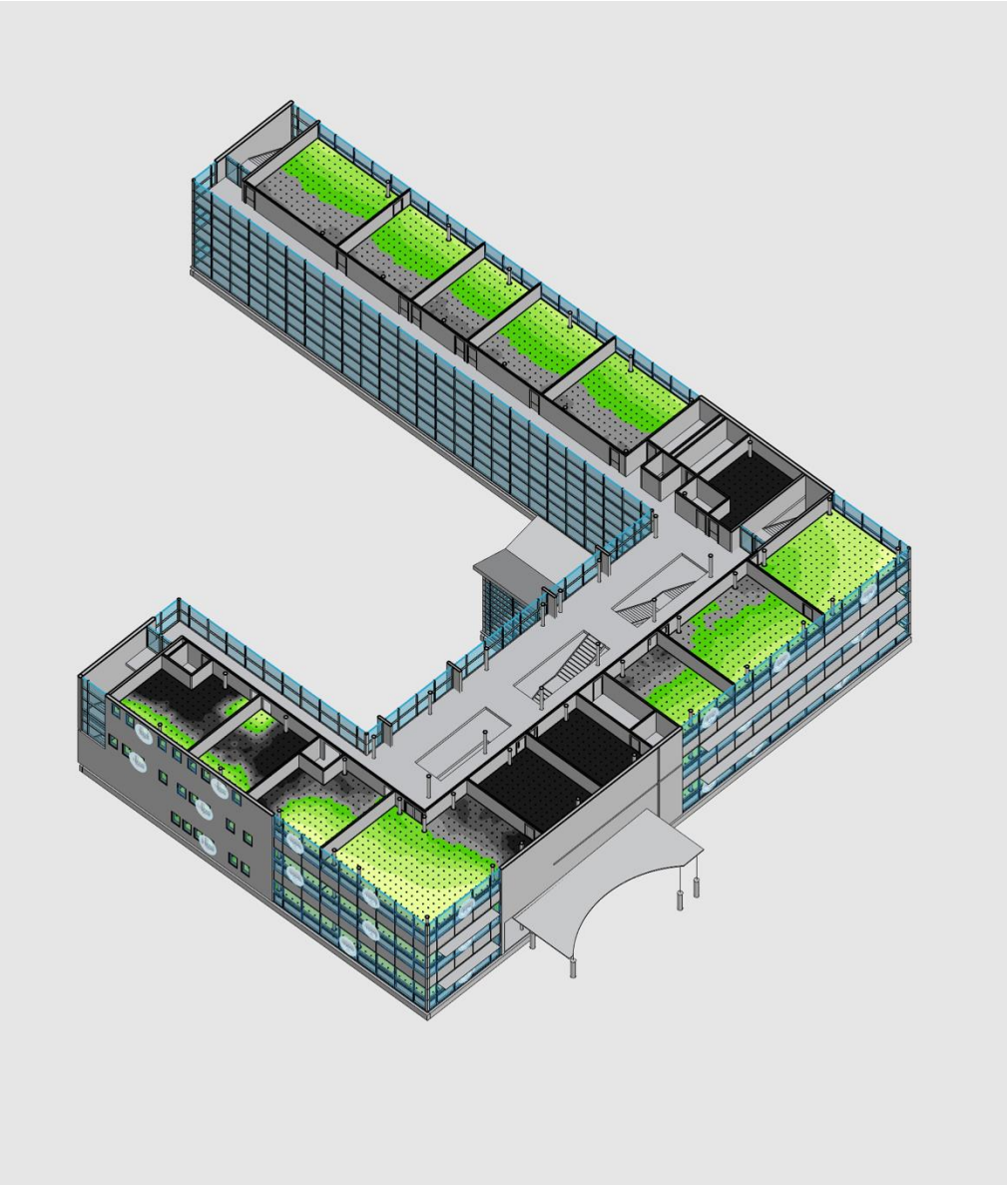


8-Core Laptop
AMD Ryzen 9 7940HS 8-Core CPU (4.00 GHz)
16 GB RAM
NVIDIA GeForce RTX 4060 Laptop GPU



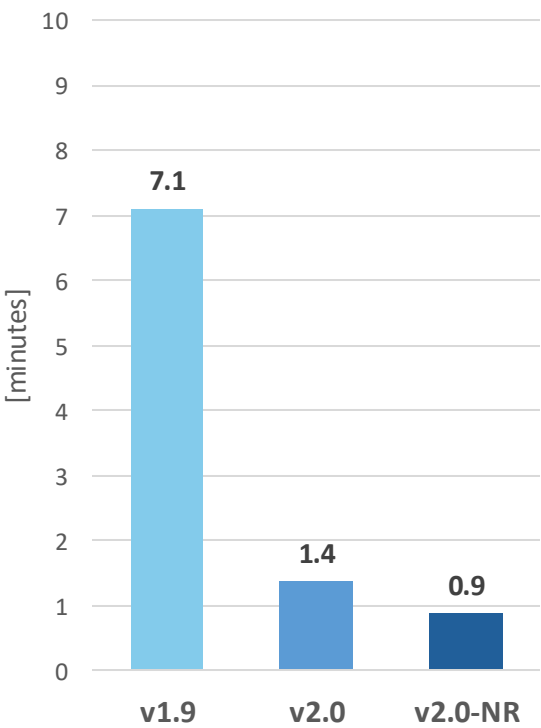
16-Core Desktop
AMD Ryzen Threadripper 2950X 16-Core CPU (3.50 GHz)
64 GB RAM
NVIDIA GeForce RTX 2080Ti GPU

NR: No interior reflections from fenestration
Params: -ab 6, 4096 samples/sensor



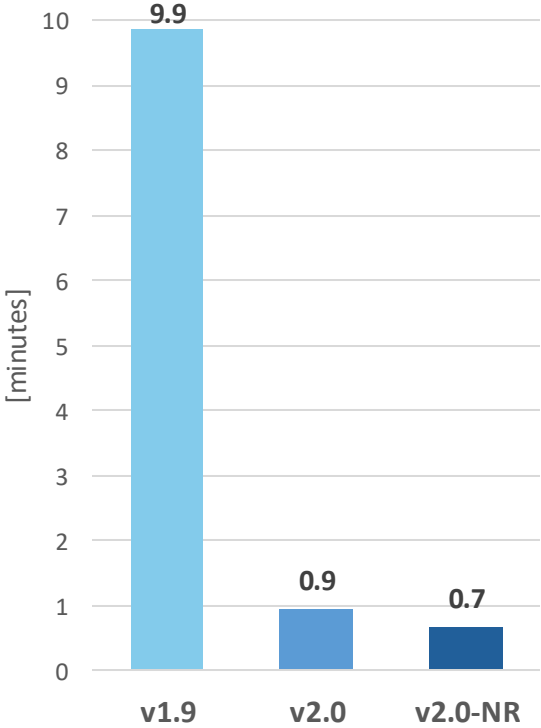
Medium Model • CBDM Run Time

Three-story classroom building
29,020 ft² | 6,912 sensors | 46 shading groups



8-Core Laptop

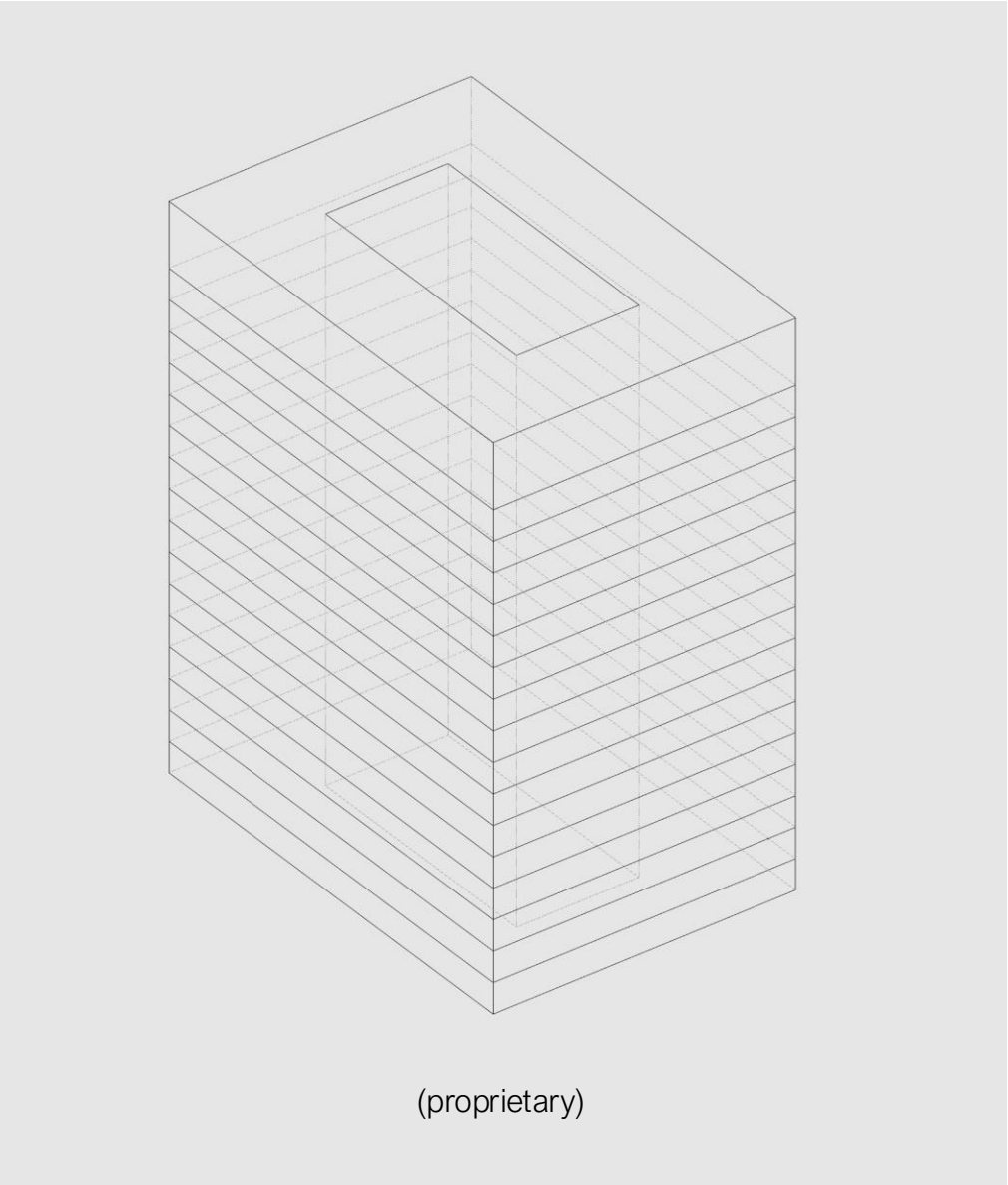
AMD Ryzen 9 7940HS 8-Core CPU (4.00 GHz)
16 GB RAM
NVIDIA GeForce RTX 4060 Laptop GPU



16-Core Desktop

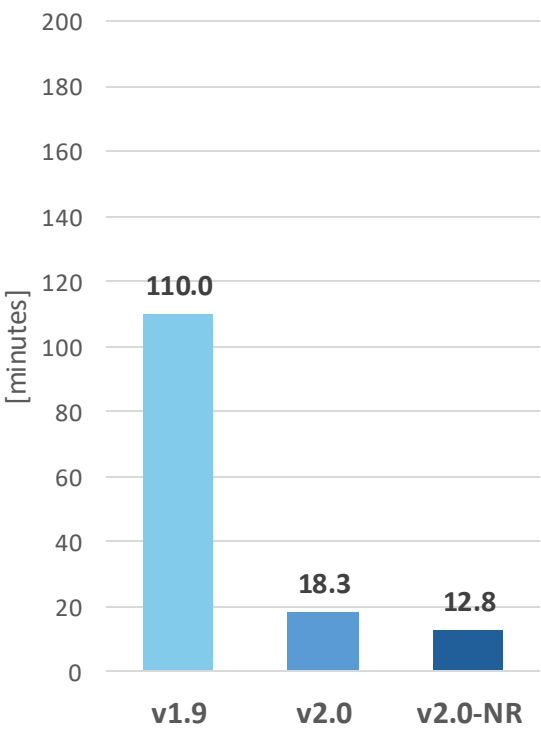
AMD Ryzen Threadripper 2950X 16-Core CPU (3.50 GHz)
64 GB RAM
NVIDIA GeForce RTX 2080Ti GPU

NR: No interior reflections from fenestration
Params: -ab 6, 4096 samples/sensor



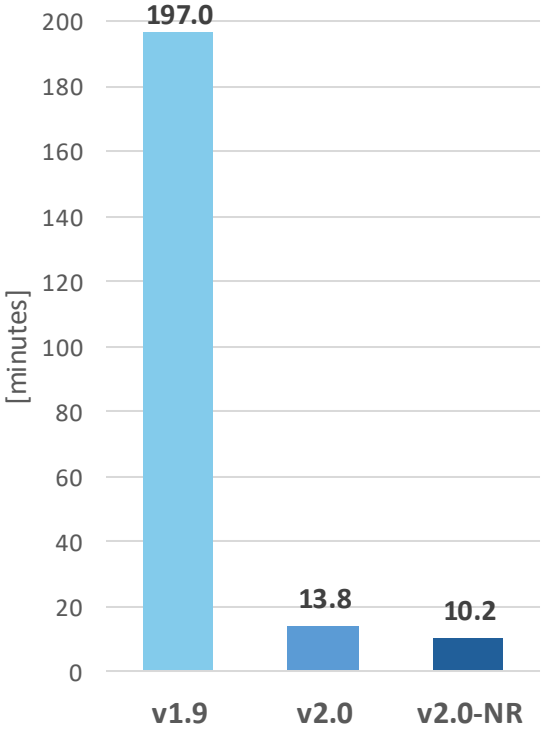
Large Model • CBDM Run Time

Seventeen-story office tower
399,764 ft² | 97,353 sensors | 174 shading groups



8-Core Laptop

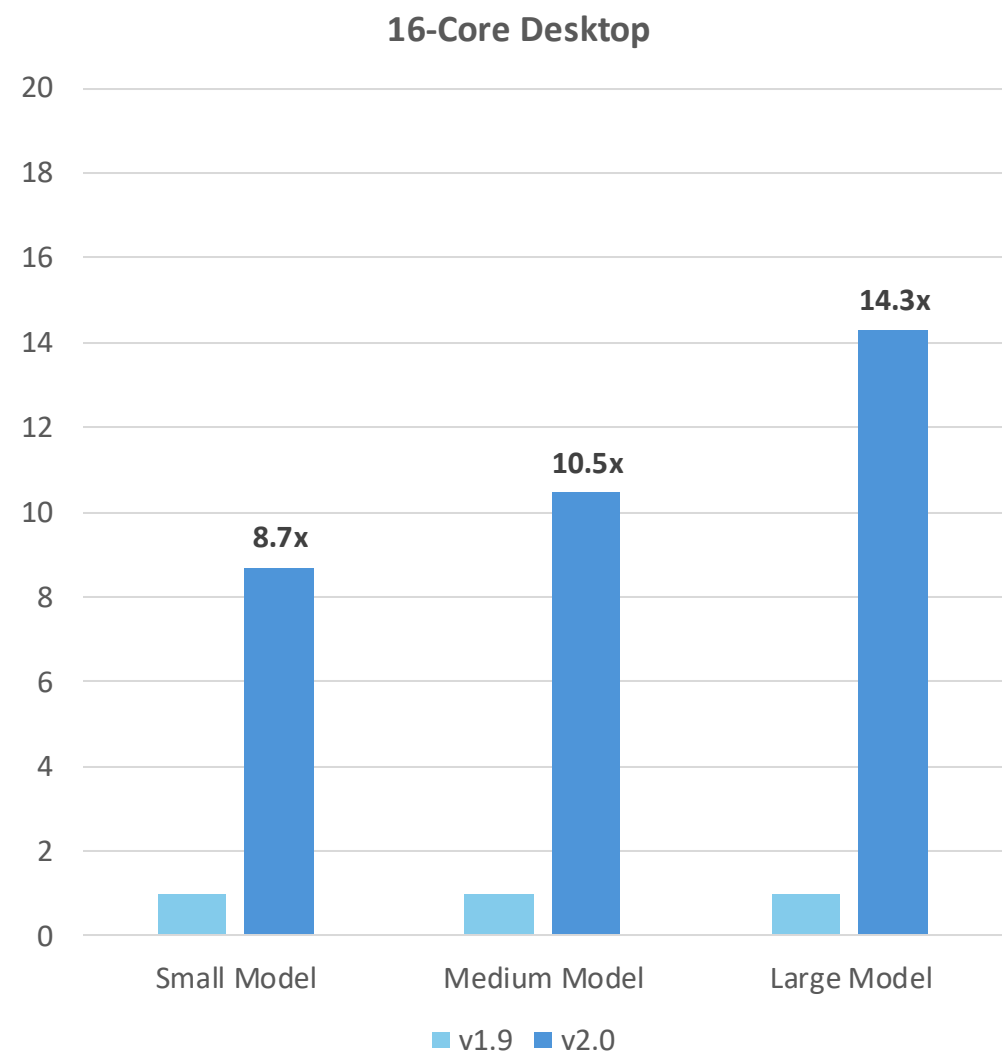
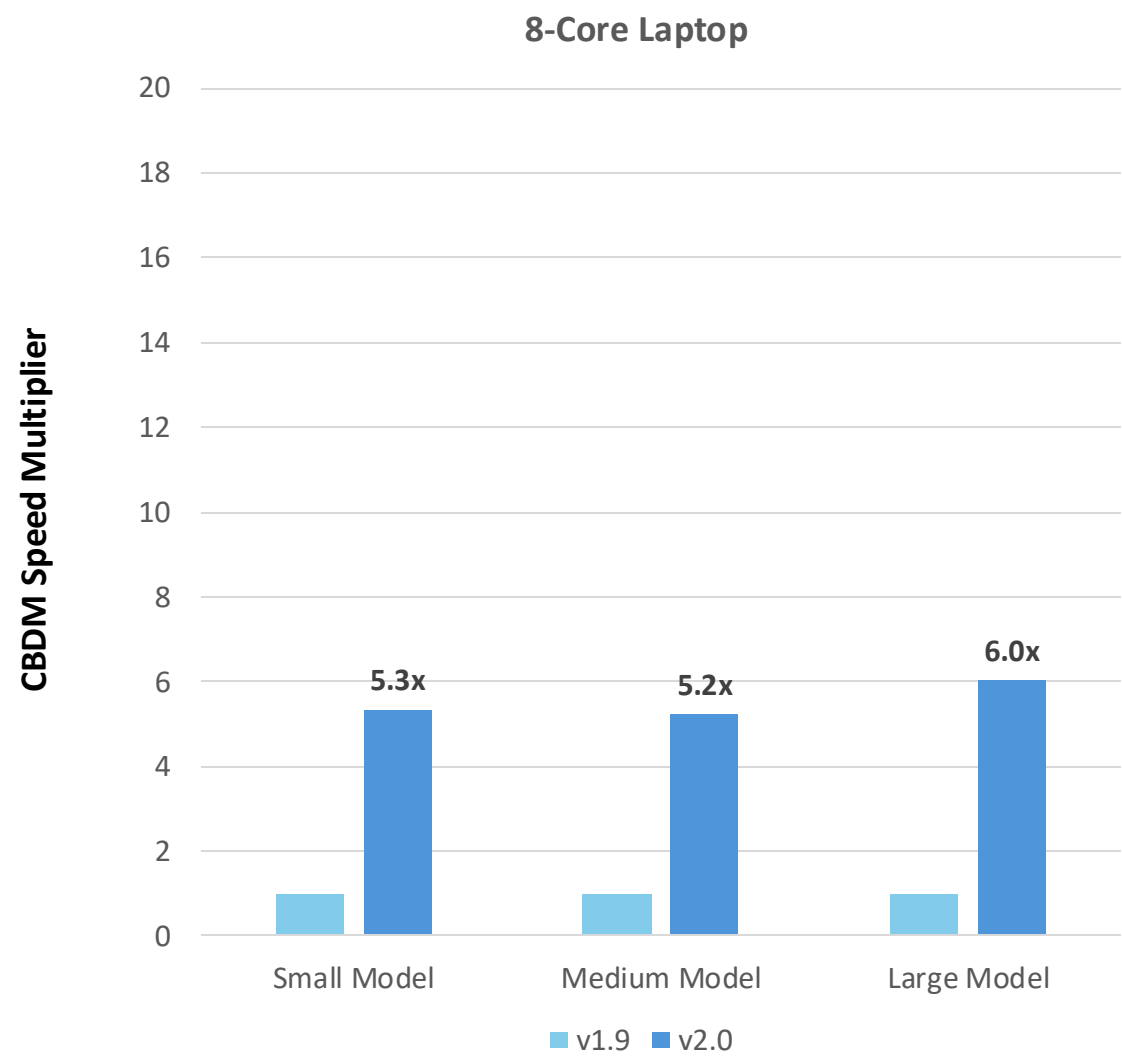
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Edit Luminaire Product

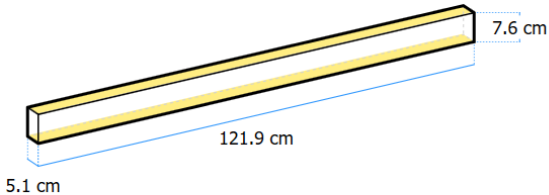
Luminaire Product Name

Linear 4' Direct/Indirect (Aisle/Flood) - 8800 lm - Copy

Photometry

Fixture

Lamp Color



SHAPE

Custom

Box

DIMENSIONS

Length (cm.)

121.9

Height (cm.)

7.6

Width (cm.)

5.1

HOUSING

On / Off

On

Material

Matte White

Shape	Size (cm.)	Lumens	CCT	CRI	M/P	Watts
Box	122 x 5 x 8 cm	8758 lm	4029	81.8	0.67	0

OK

Cancel

- Editable fixture shapes!

Edit Luminaire Product

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OK

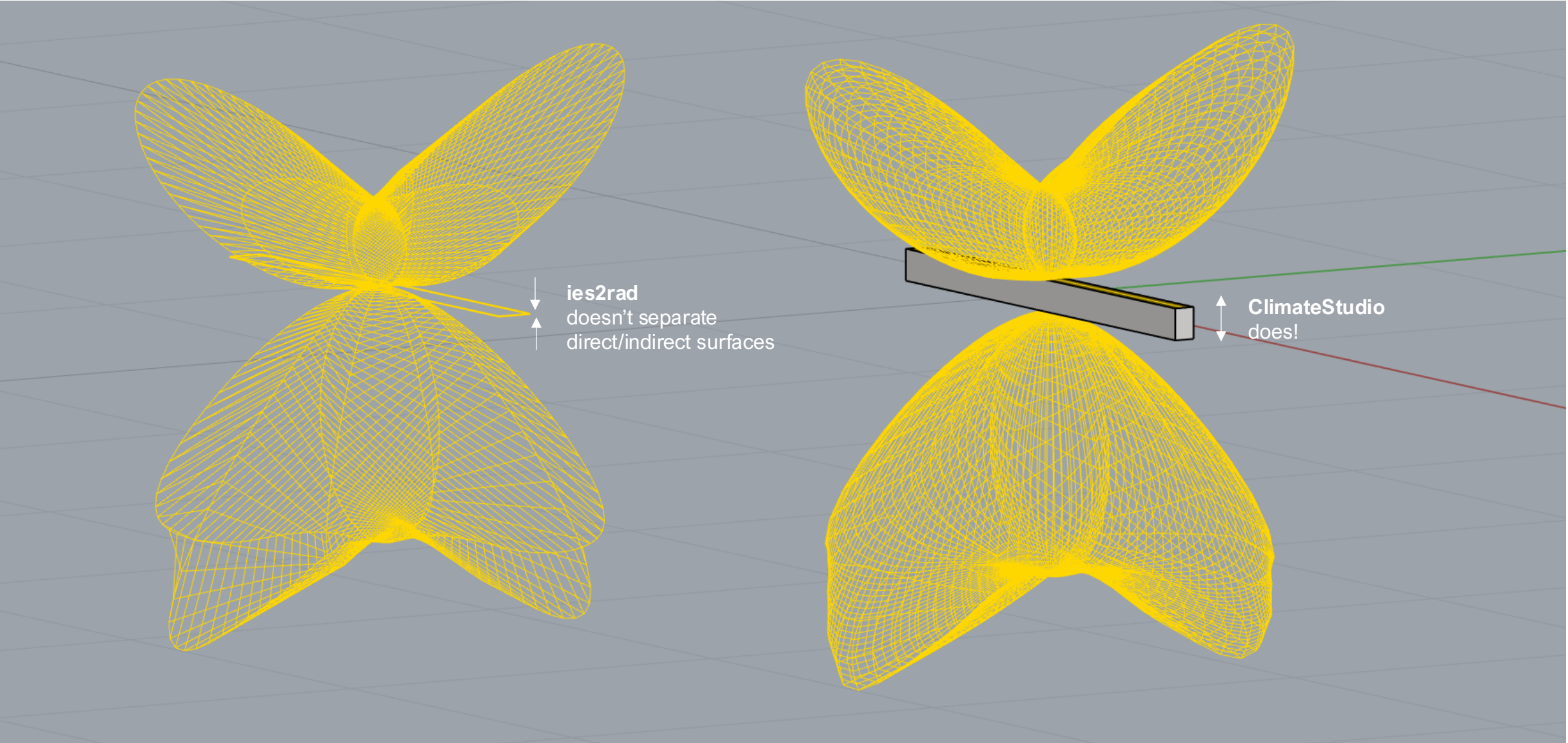
Cancel

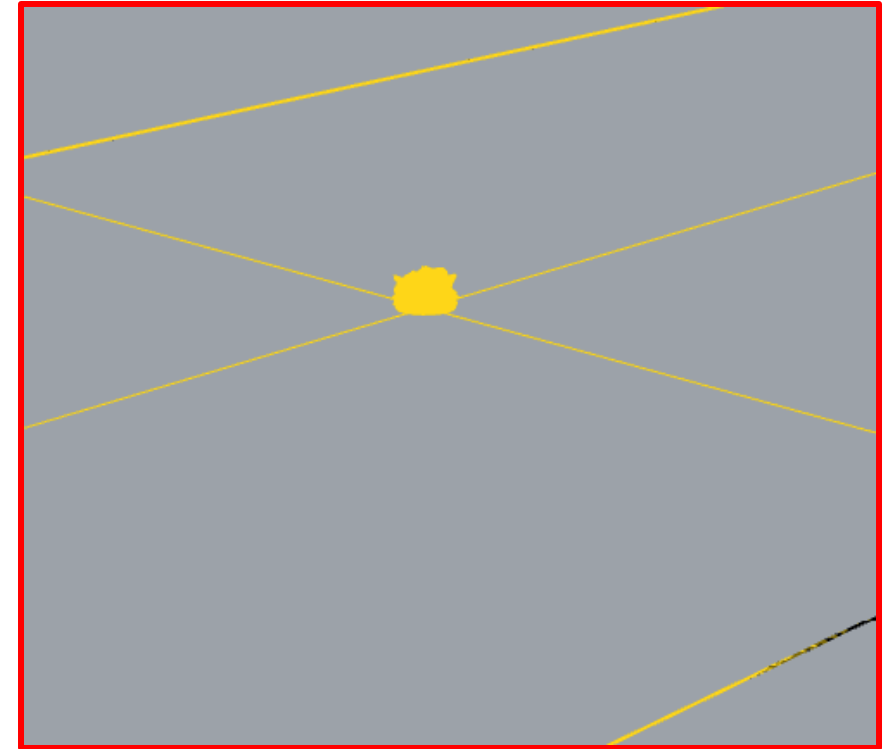
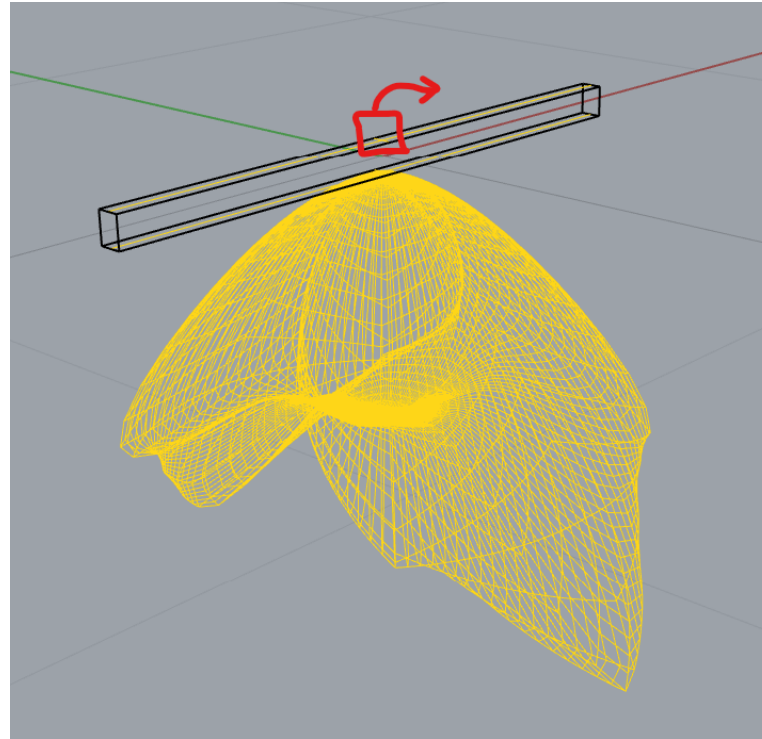
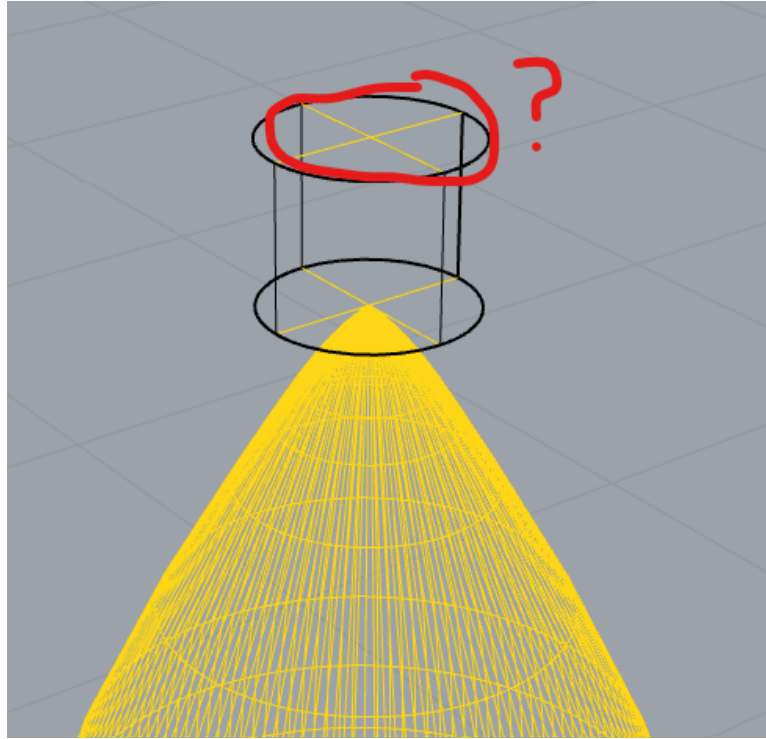
- Editable fixture shapes!
- Auto-generated housing

A 3D perspective rendering of a linear luminaire fixture. The fixture is a long, thin, rectangular object with a white, matte finish. It is positioned in a dark, textured environment, possibly a room corner. The fixture is illuminated from within, casting a warm, yellowish light. The light is visible as a bright, glowing area on the wall and ceiling, and a softer, more diffused glow on the floor. The fixture's housing is clearly visible, showing its profile and the way it integrates with the light source. An arrow from the 'HOUSING' section of the software interface points to this rendering, indicating that the housing is auto-generated based on the fixture's specifications.

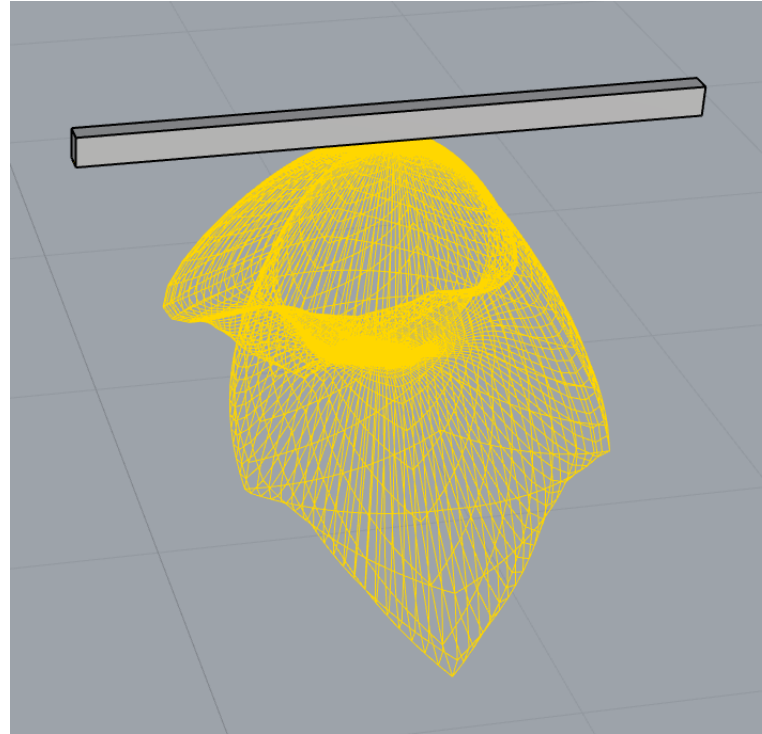
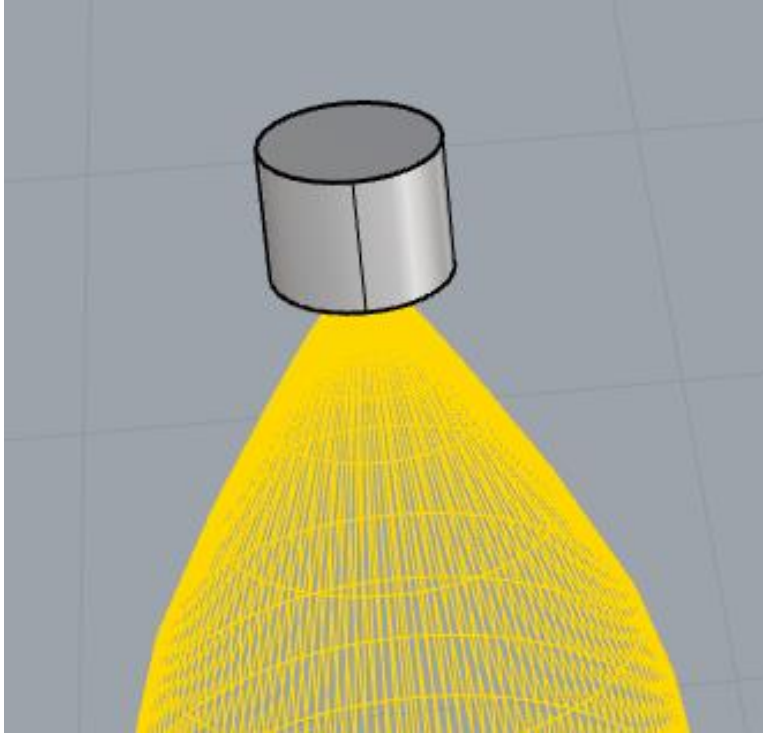
42 | 22nd International Radiance Workshop | 27 AUG 2024

SOLEMMA

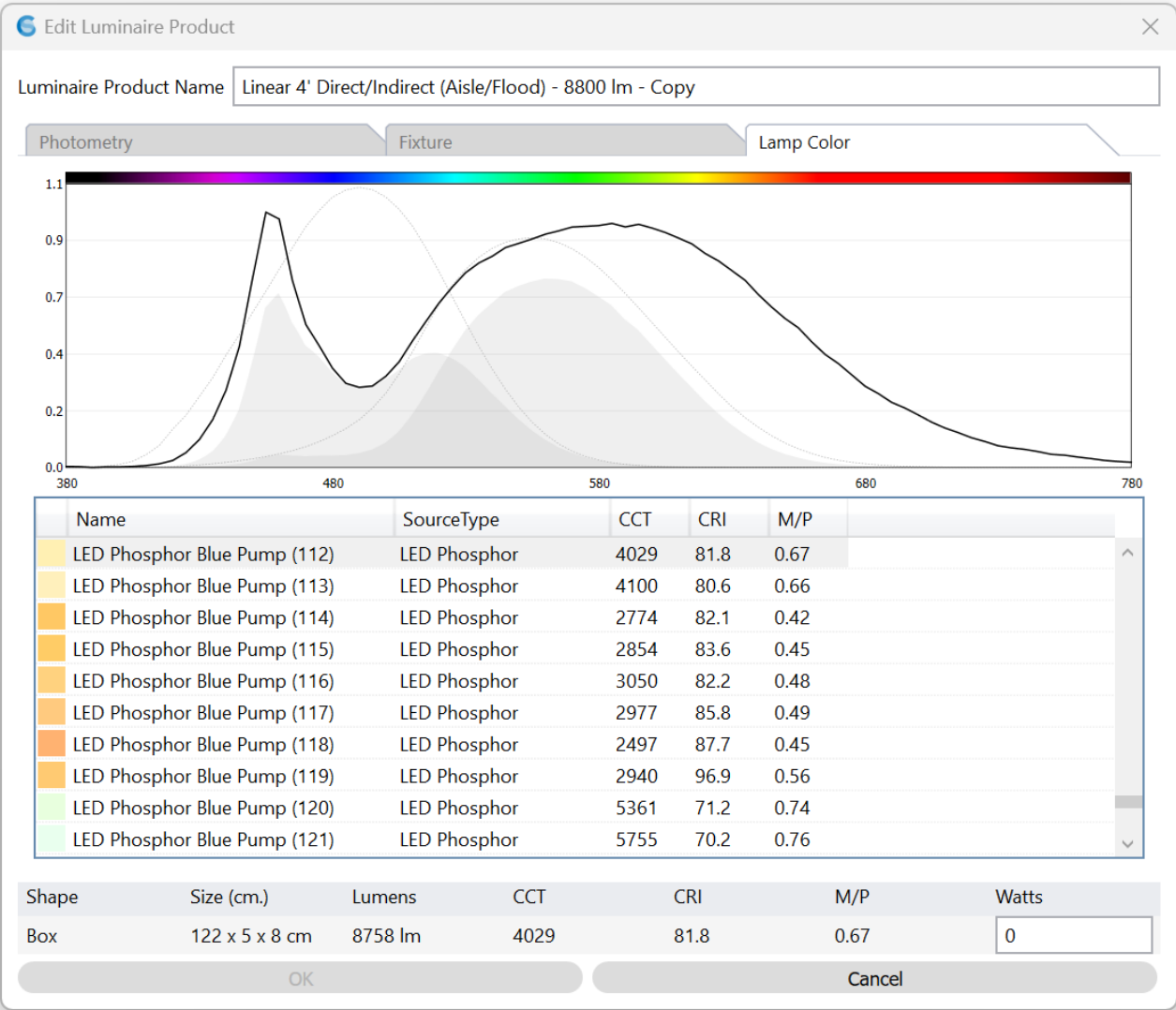




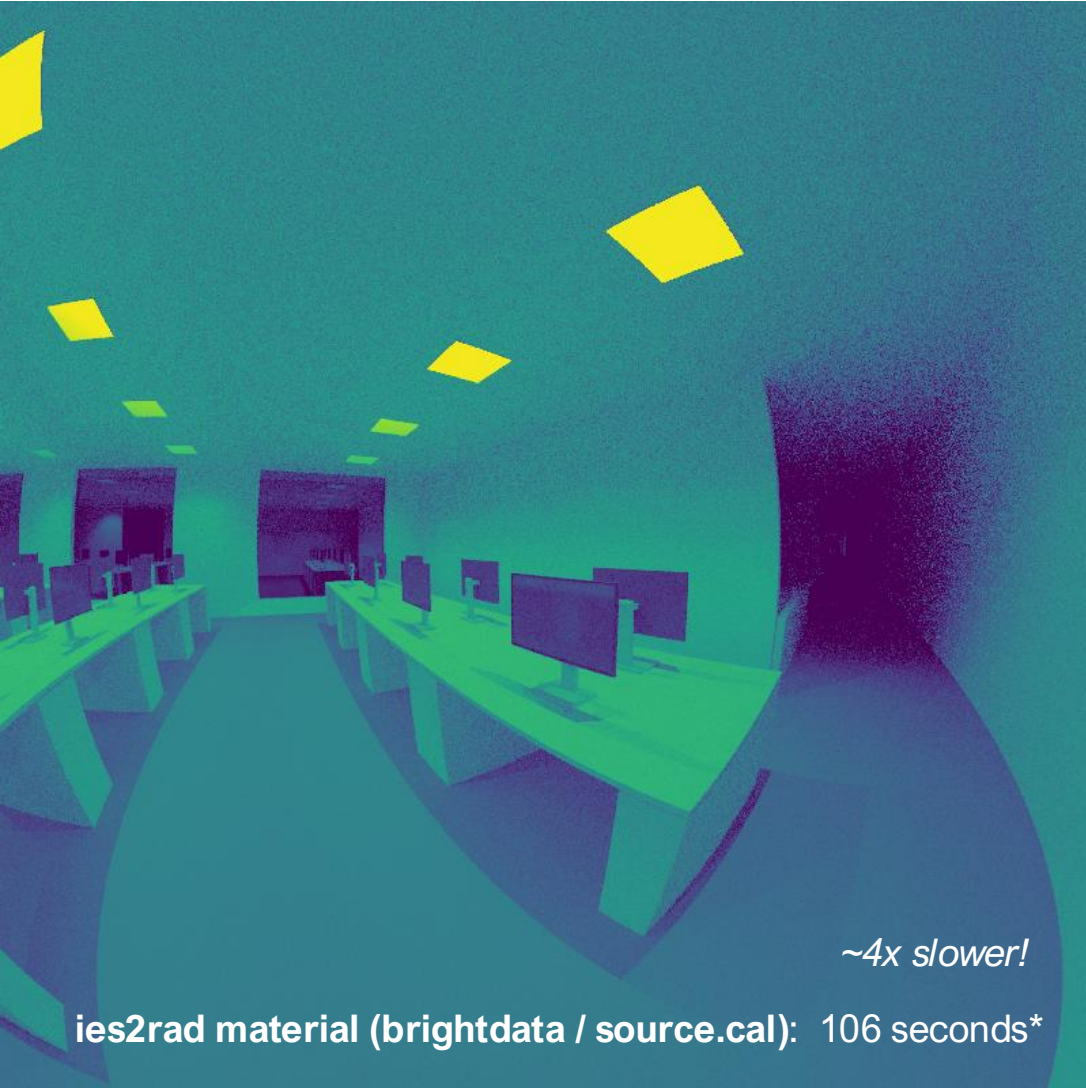
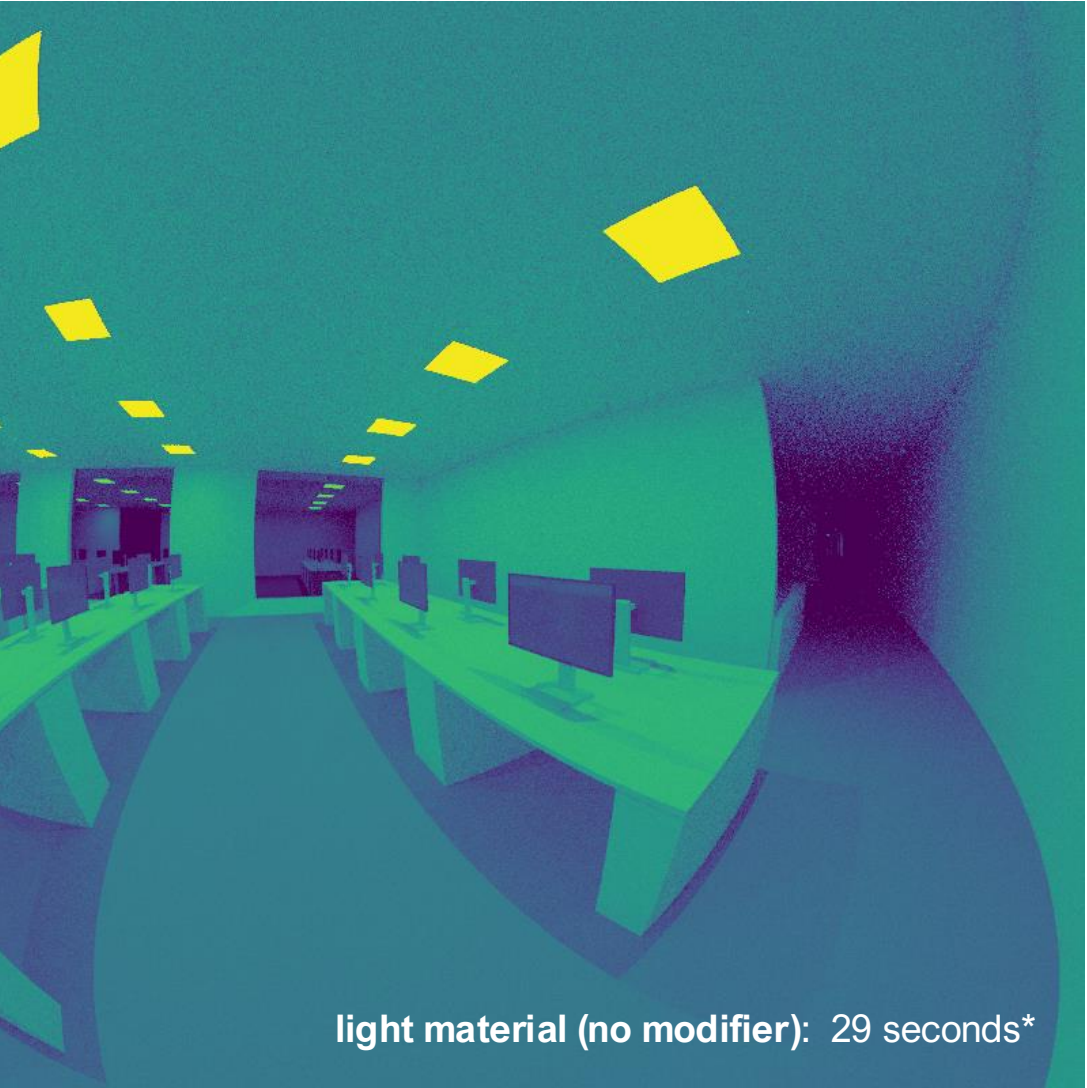
- *ies2rad* sometimes produces luminous faces with insignificant flux



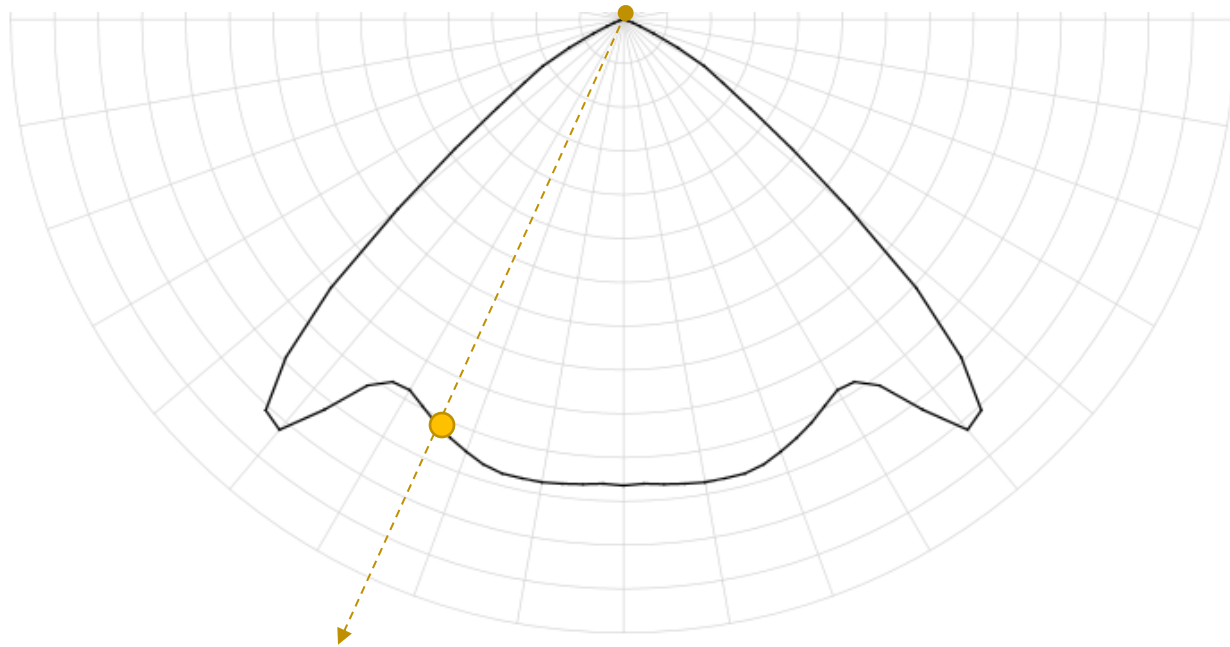
- *ies2rad* sometimes produces luminous faces with insignificant flux
- ClimateStudio now removes them (if $<1\%$ actinic flux through hemisphere)



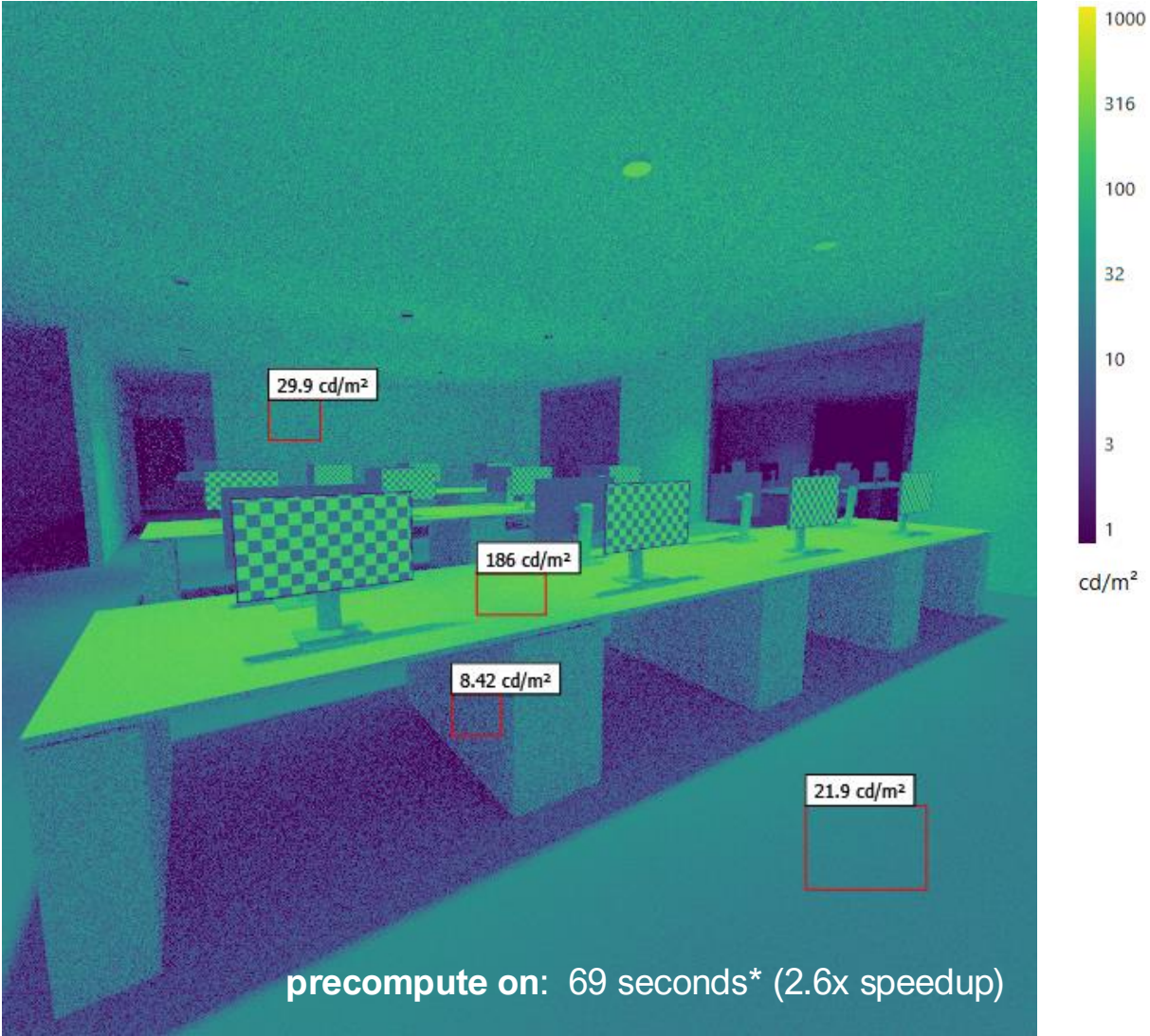
- Measured SPDs provided by Pacific Northwest National Laboratory (**PNNL**)
- Spectrum > RGB for 3-channel simulation
- Hyperspectral output using Radiance 6 coming soon (thank you Greg!)



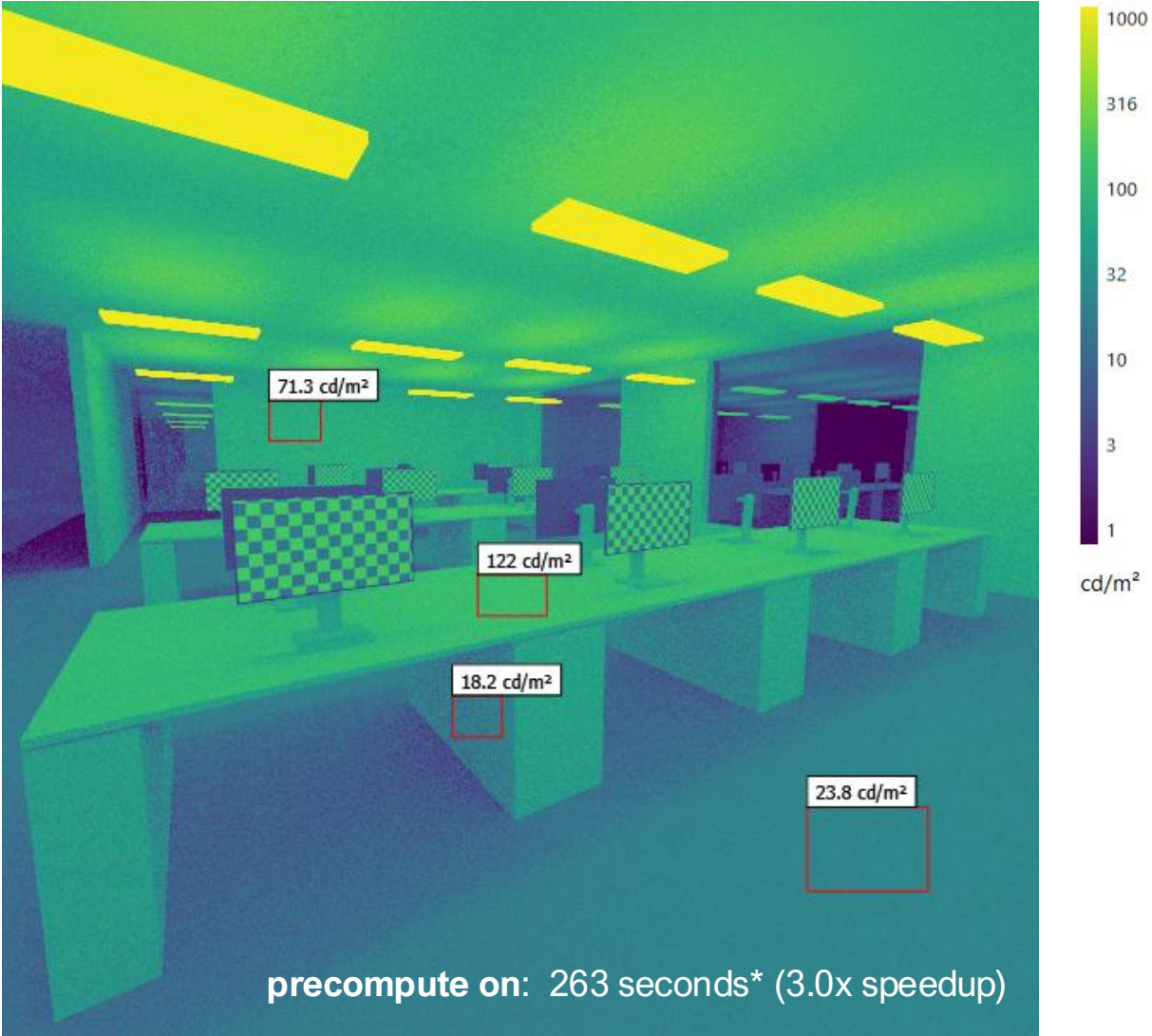
*rtrace -ds 0 -dj 0 (16 lights, 10 spp, 16 CPU cores)



- brightdata / source.cal overhead is significant
- Lookup can be accelerated by precomputing $L(\theta, \varphi)$ for each luminaire on a high-resolution grid (0.5°)
- Speedup depends on scene and IES-file(s), typically 2-4x



*16 down lights, 16 spp, 6 CPU cores



*16 box lights, 16 spp, 6 CPU cores