

BUILDING PERFORMANCE SIMULATION

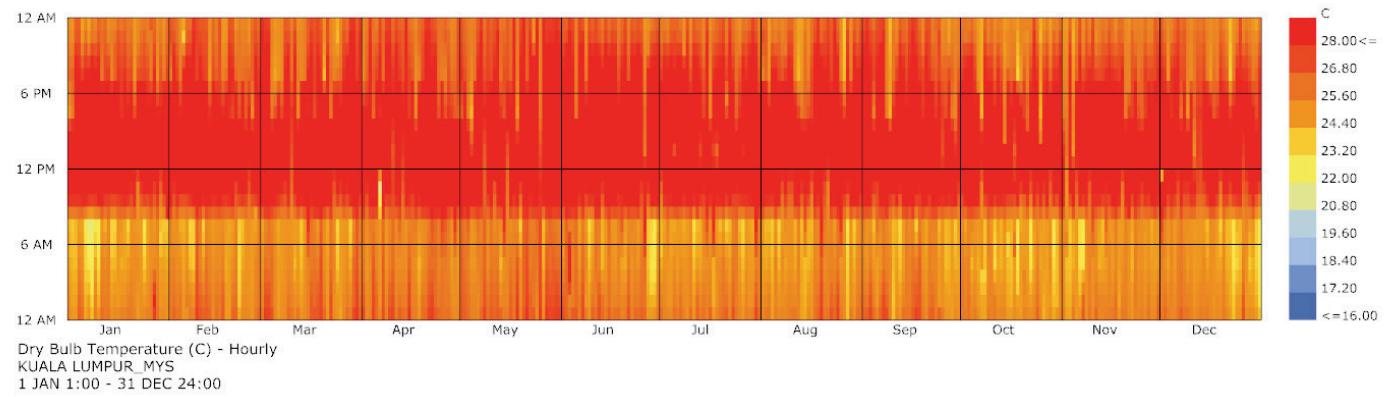
[FINAL]

ARCH 753 | PENNDESIGN | PROFESSOR: MOSTAPHA SADEGHPOUR

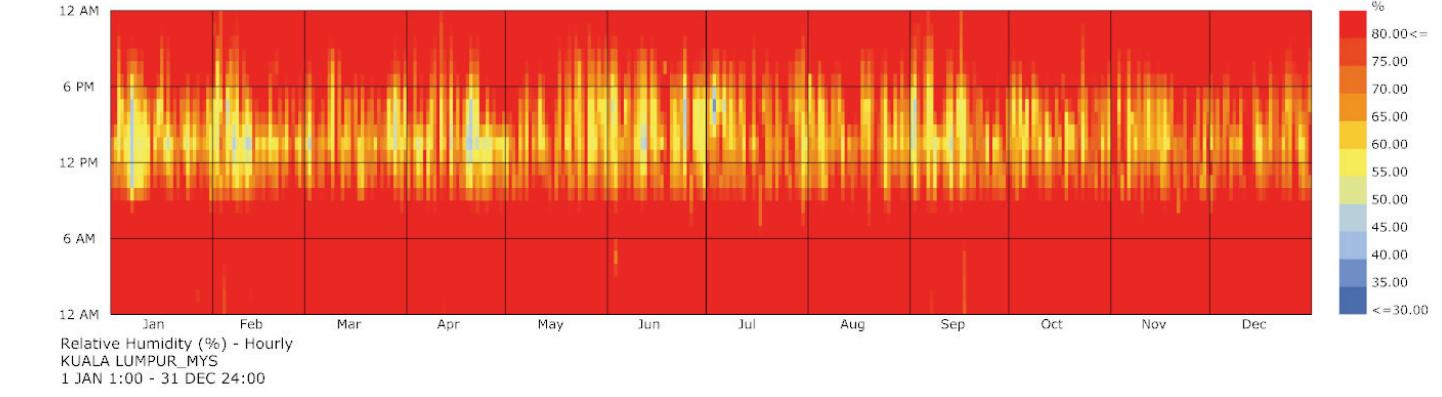
SEUNG - HYEOK BAE

Kuala Lumpur, Malaysia

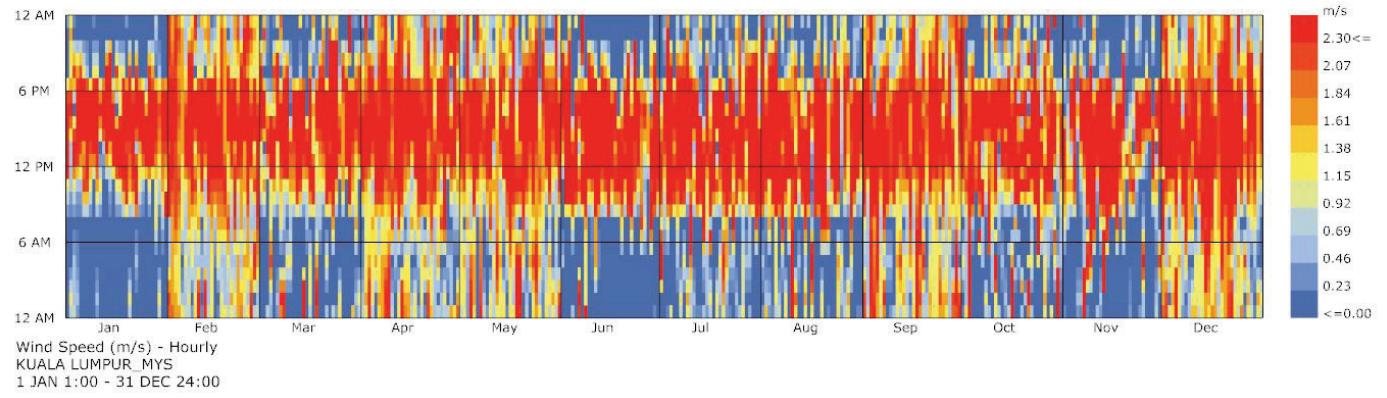
Kuala Lumpur is the capital of Malaysia. According to the research, Kuala Lumpur has mainly 2 seasons - wet or dry. Having said that, it can and does rain heavily at any time of the year. Kuala Lumpur experiences two monsoon periods, from March to April and from October to November. (World Weather Forecasts)



As I assumed annual dry temperature shows that most of the time of a year is above 28°C. Therefore, Kuala Lumpur has hot weather.



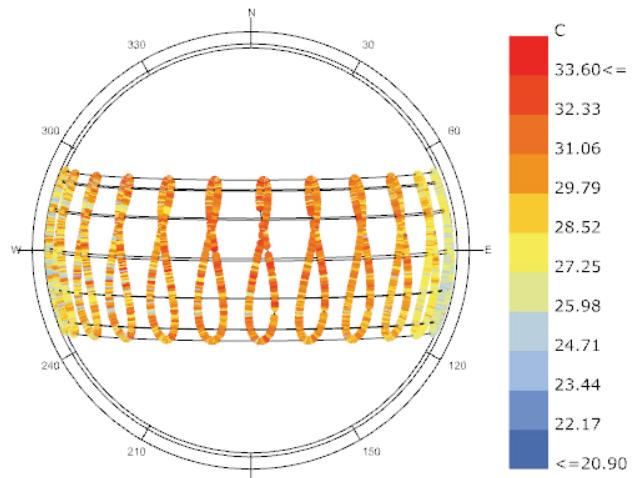
Annual humidity of Kuala Lumpur is usually over 80%. It means this area is very humid. Since Kuala Lumpur experiences two monsoon periods, this high humidity makes sense.



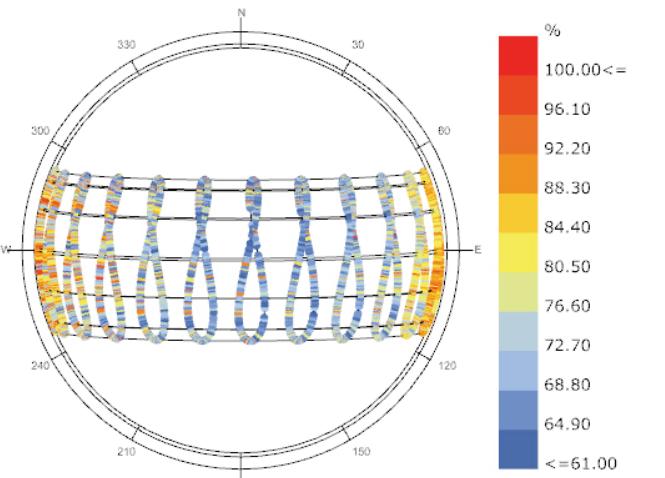
Beaufort number	Description	Wind speed	Wave height	Sea conditions	Land conditions
0	Calm	< 1 mph < 1 km/h < 1 kn < 0.3 m/s	0 ft 0 m	Flat	Calm. Smoke rises vertically.
1	Light air	1-3 mph 1-5.5 km/h 1-2 kn 0.3-1.5 m/s	0-1 ft 0-0.2 m	Ripples without crests	Smoke drift indicates wind direction. Still wind vanes.
2	Light breeze	4-7 mph 5.6-11 km/h 3-6 kn 1.6-3.4 m/s	1-2 ft 0.2-0.5 m	Small wavelets. Crests of glassy appearance, not breaking	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.
3	Gentle breeze	8-12 mph 12-19 km/h 7-10 kn 3.4-5.4 m/s	2-3.5 ft 0.5-1 m	Large wavelets. Crests begin to break. Scattered whitecaps	Leaves and small twigs constantly moving. Light flags extended.
4	Moderate breeze	13-17 mph 20-28 km/h 11-15 kn 5.5-7.9 m/s	3.5-6 ft 1-2 m	Small waves with breaking crests. Fairly frequent white horses	Dust and loose paper raised. Small branches begin to move.
5	Fresh breeze	18-24 mph 29-38 km/h 16-20 kn 8.0-10.7 m/s	6-9 ft 2-3 m	Moderate waves of some length. Many white horses. Small amount of spray.	Branches of a moderate size tree move. Small trees and leafy branches in motion.
6	Strong breeze	25-30 mph 39-49 km/h 21-26 kn 10.8-13.8 m/s	9-13 ft 3-4 m	Long waves begin to form. White foam crests are very frequent. Some airborn spray is present.	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	High wind, Moderate gale, Near gale	31-38 mph 50-61 km/h 27-33 kn 13.9-17.1 m/s	13-19 ft 4-5.5 m	Sea heaps up. Some foam from breaking waves is blown into streaks along wind direction. Moderate amounts of airborn spray.	Whole trees in motion. Effort needed to walk against the wind.

Annual wind speed is usually higher than 1.38 m/s and many times are also higher 2.30 m/s. Therefore, Kuala Lumpur has about light to gentle breeze.

Sun Path

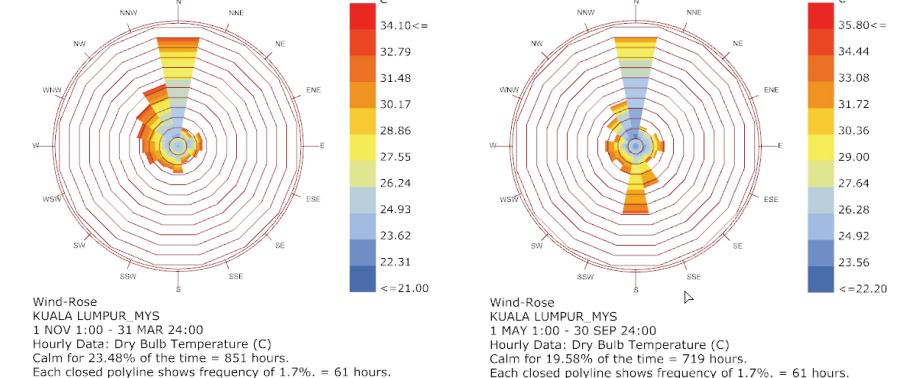
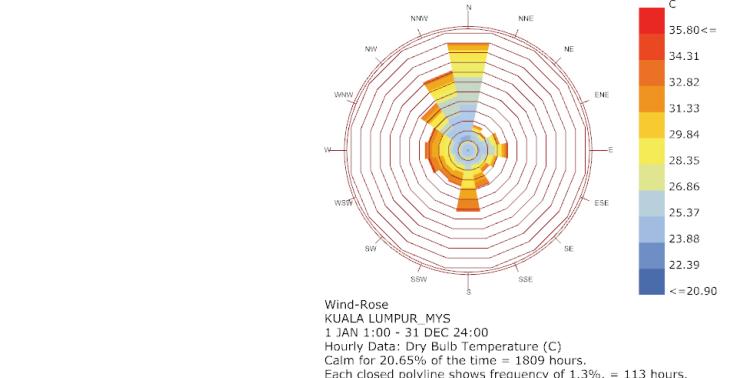
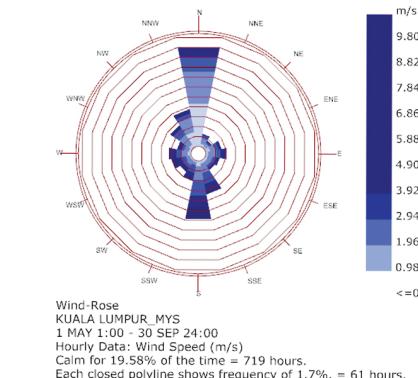
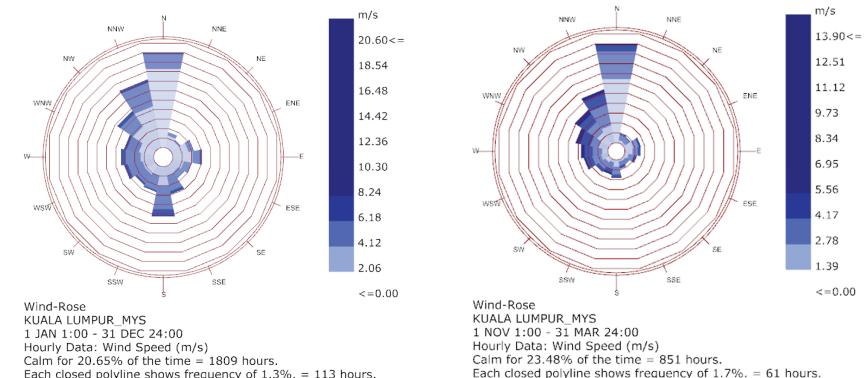


Sun-Path Diagram - Latitude: 3.12
Hourly Data: Relative Humidity (%)
KUALA LUMPUR_MYS
Conditional Selection Applied:
Dry Bulb Temperature>12
and Relative Humidity>60
3646.0 hours of total 4320.0 sun up hours(84.40%).



Sun locates almost vertically since Kuala Lumpur is close to equator.

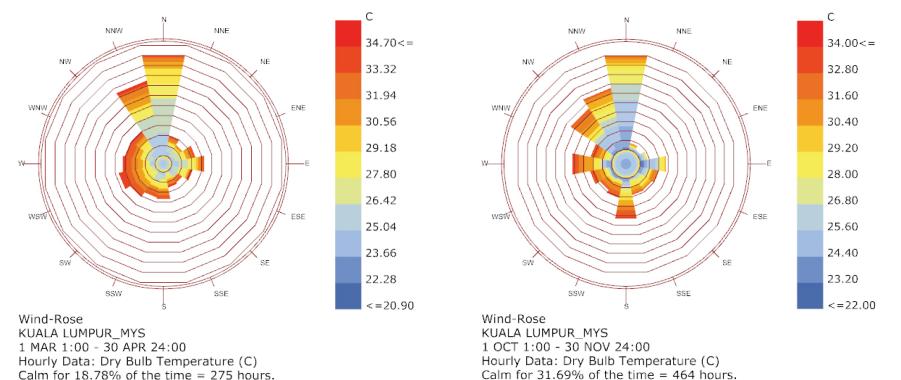
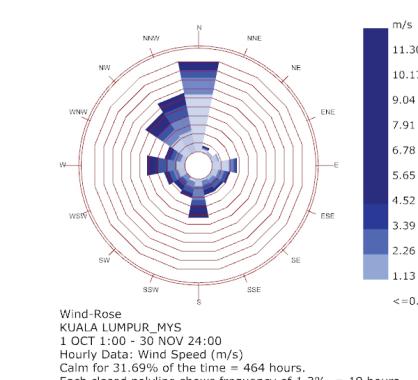
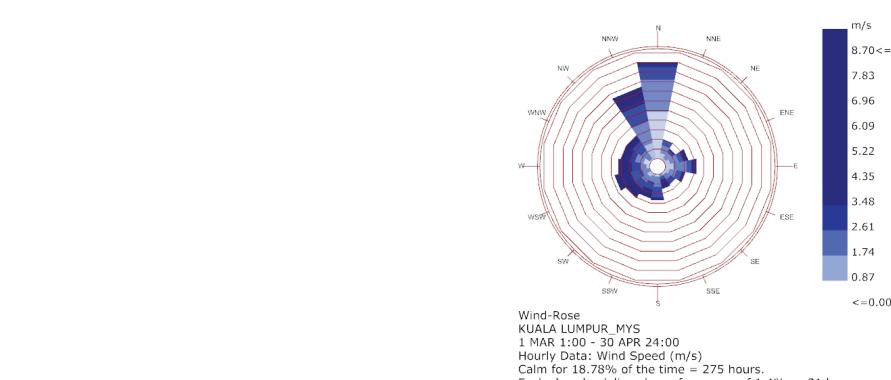
Wind Speed and Direction for Natural Ventilation



Annual

Wet Season

Dry Season



Dry Season

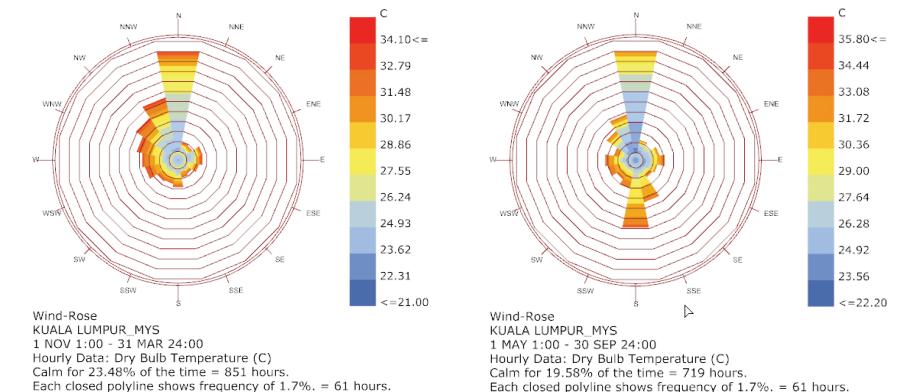
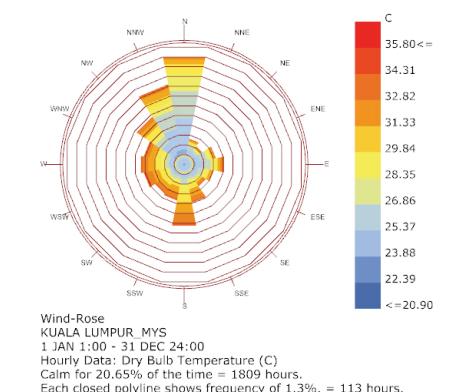
Monsoon Period 1

Monsoon Period 2

Monsoon Period 1

Monsoon Period 2

Wind Rose (Temperature) for Natural Ventilation

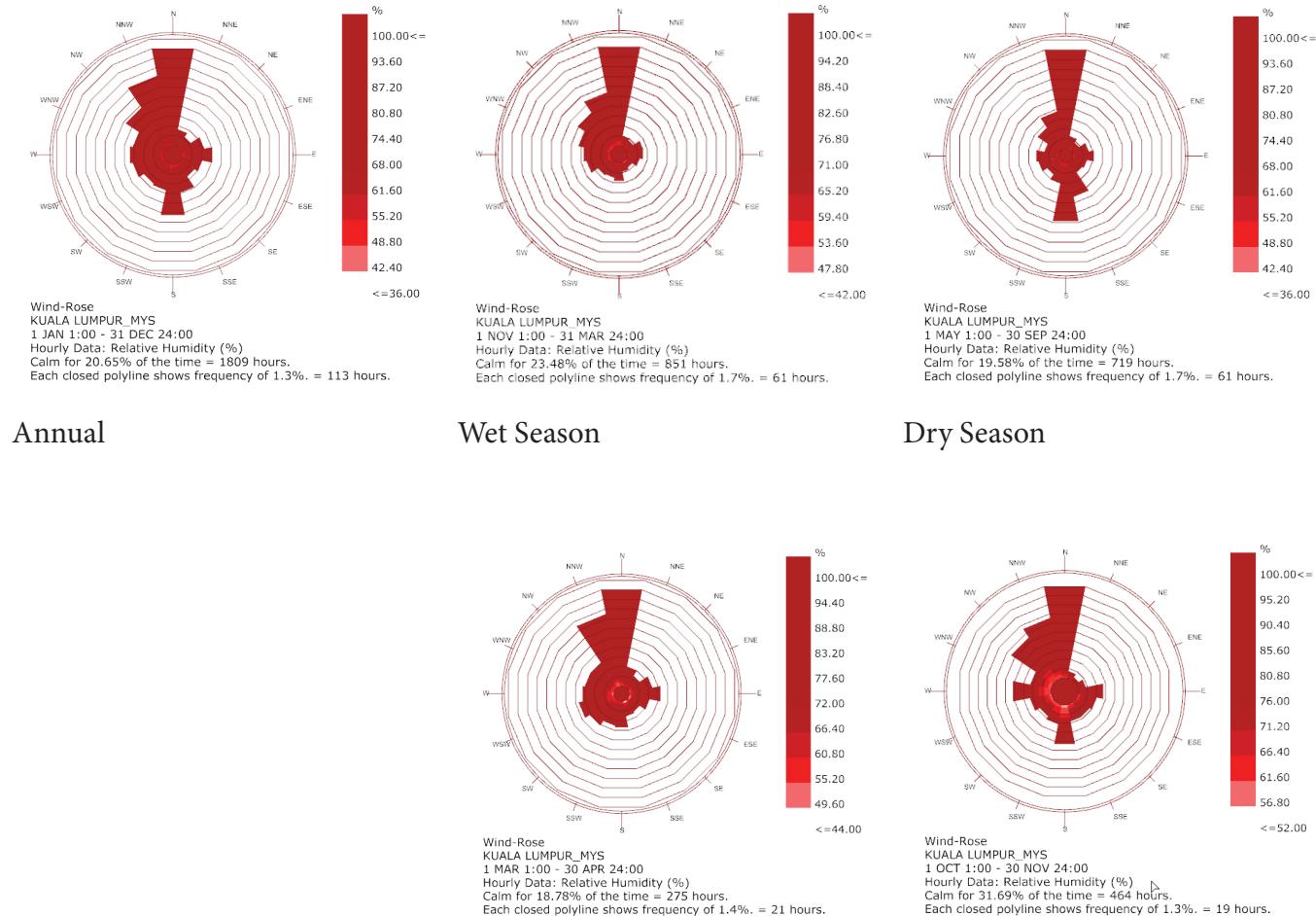


Annual

Wet Season

Dry Season

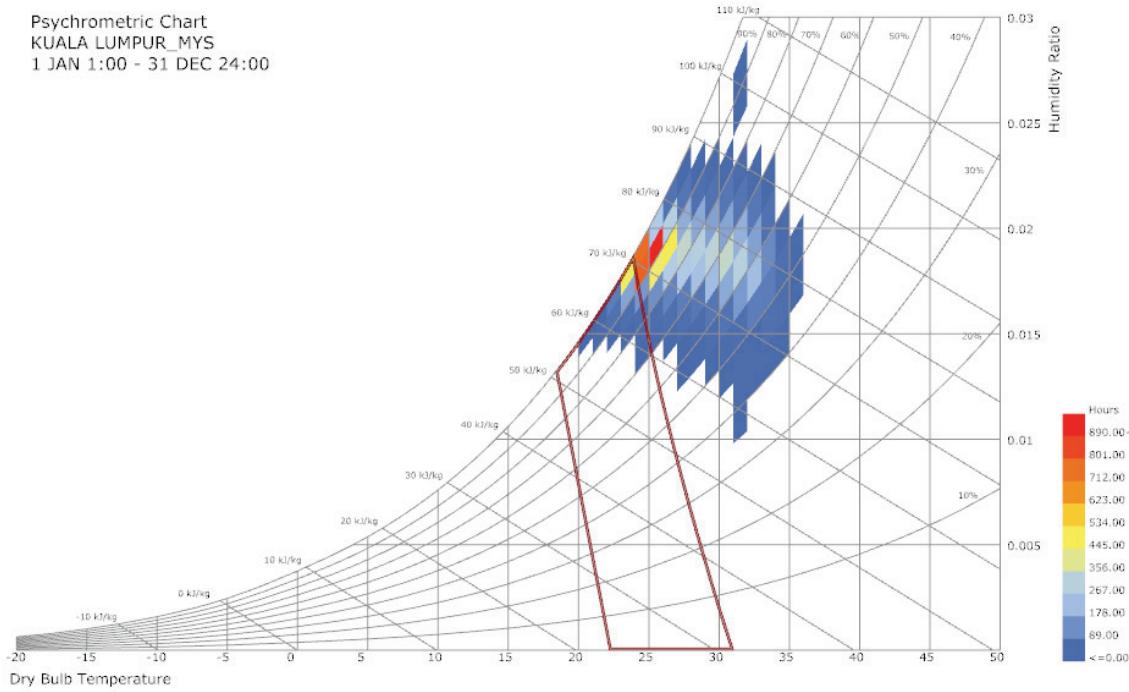
Wind Rose (Relative Humidity) for Natural Ventilation



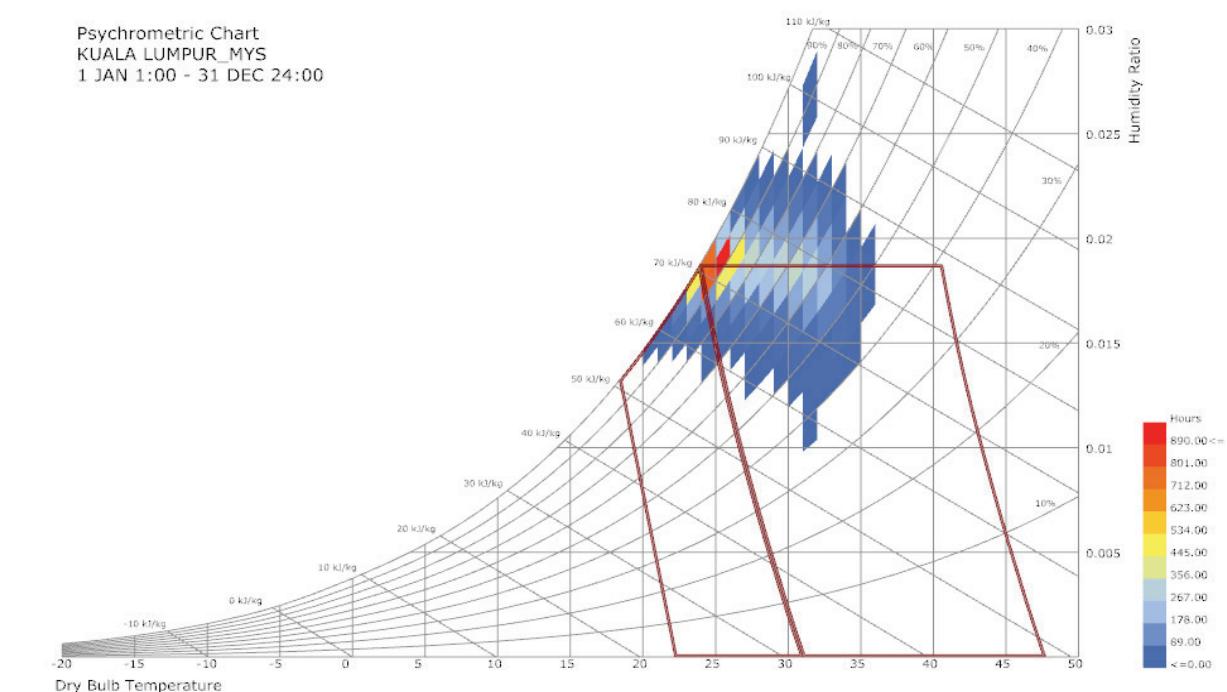
Since we have to provide maximum hours of comfort for an indoor space with no heating and cooling system by redesigning the façade, simulating natural ventilation is very important for redesigning. Kualar Lumpur does not have much wind but the direction is more from North and East.

Asscording to the simualtion and research, I will face a challange to design 100% comfort of the occupancy since Kualar Lumpur does not have much wind.

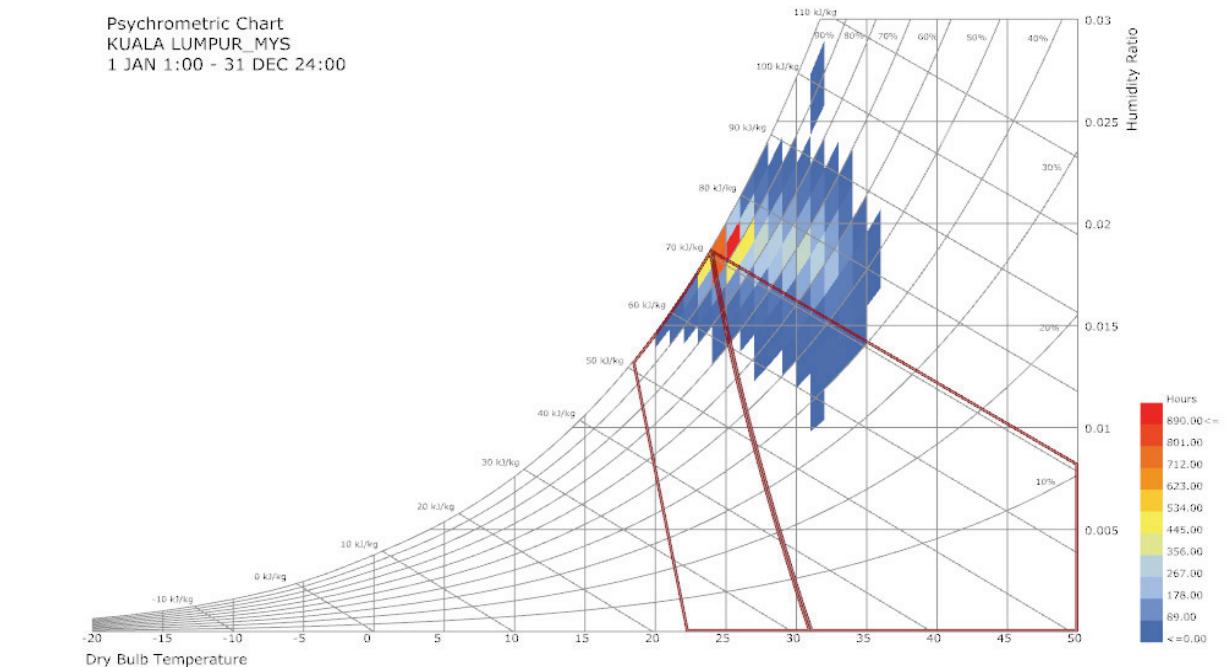
Psychrometric Chart shows comfort zone (Annual)



Psychrometric Chart Annual Thermal Mass

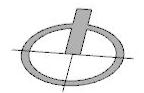
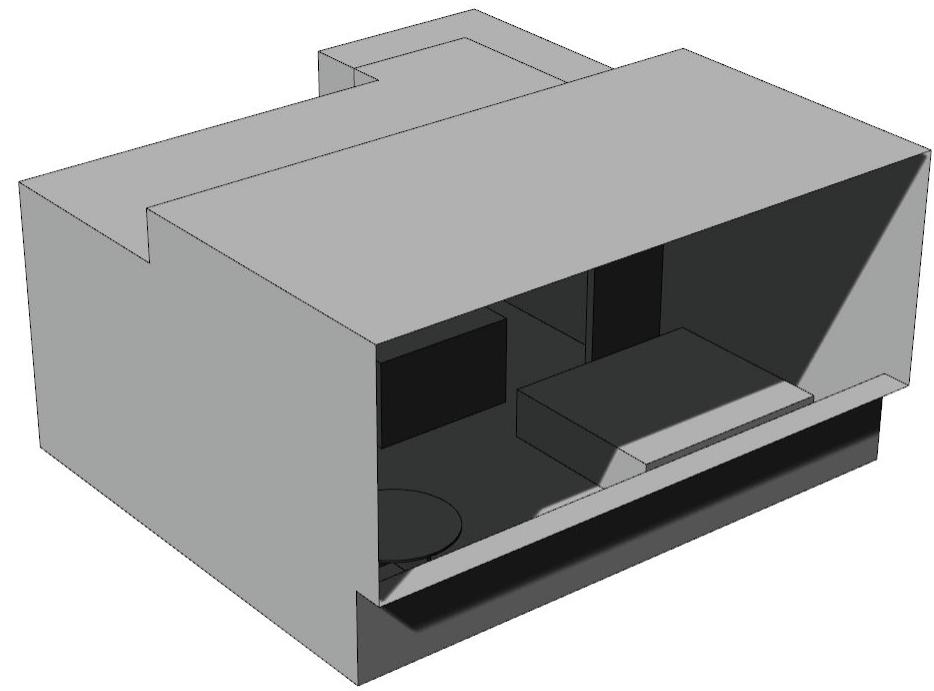


Psychrometric Chart Annual Evaporative Cooling

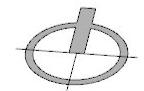
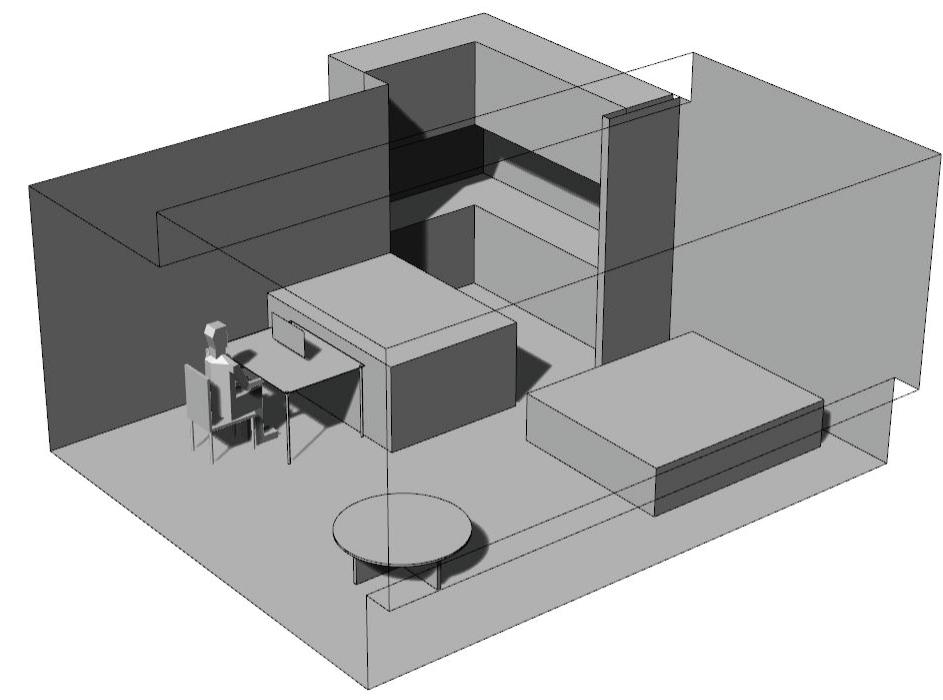


Extra simulation exercises to know more about Kuala Lumpur's climate to figure out solving strategies.

Base Geometry Axon View

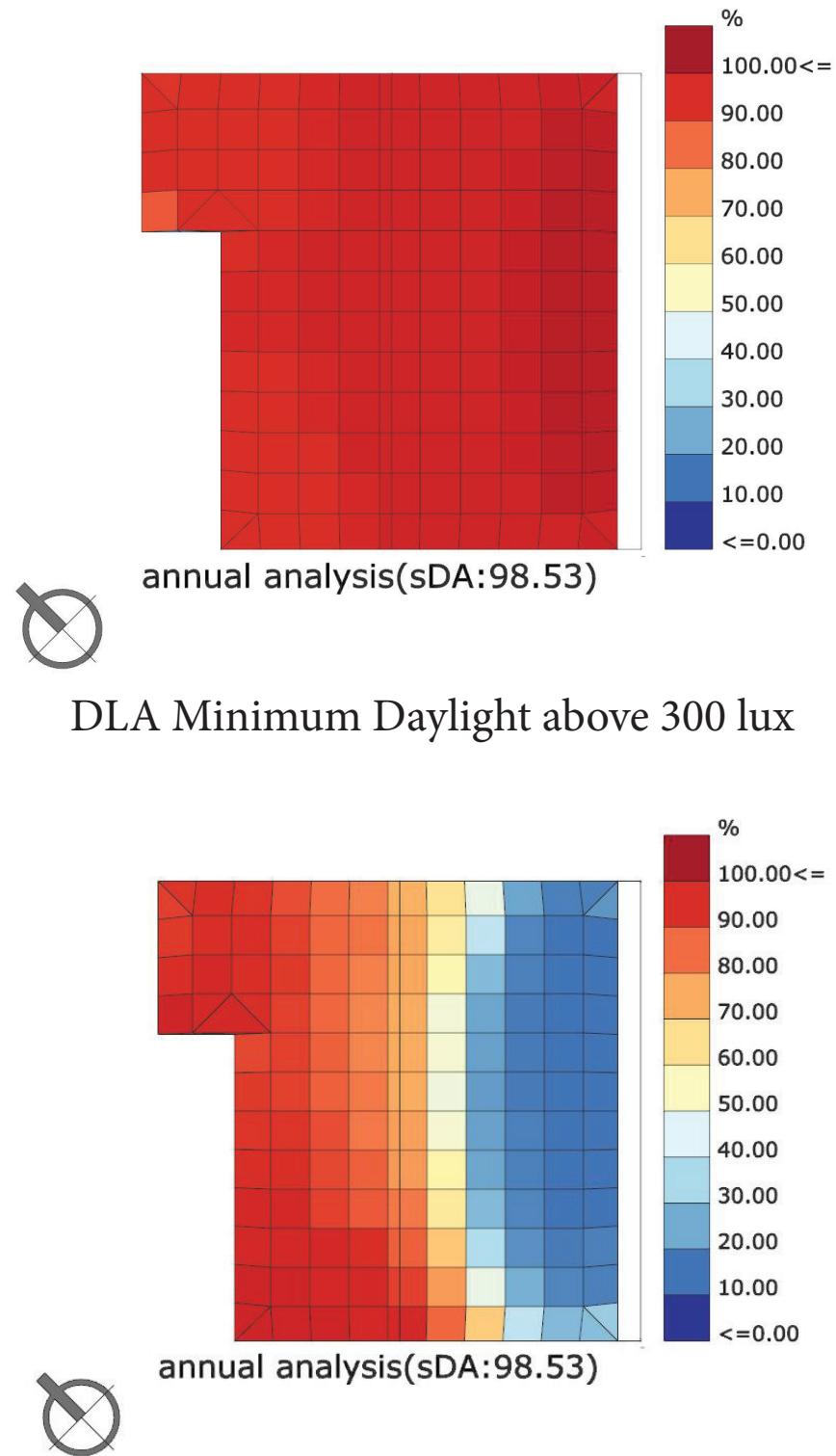


Base Geometry before redesigning Closed View

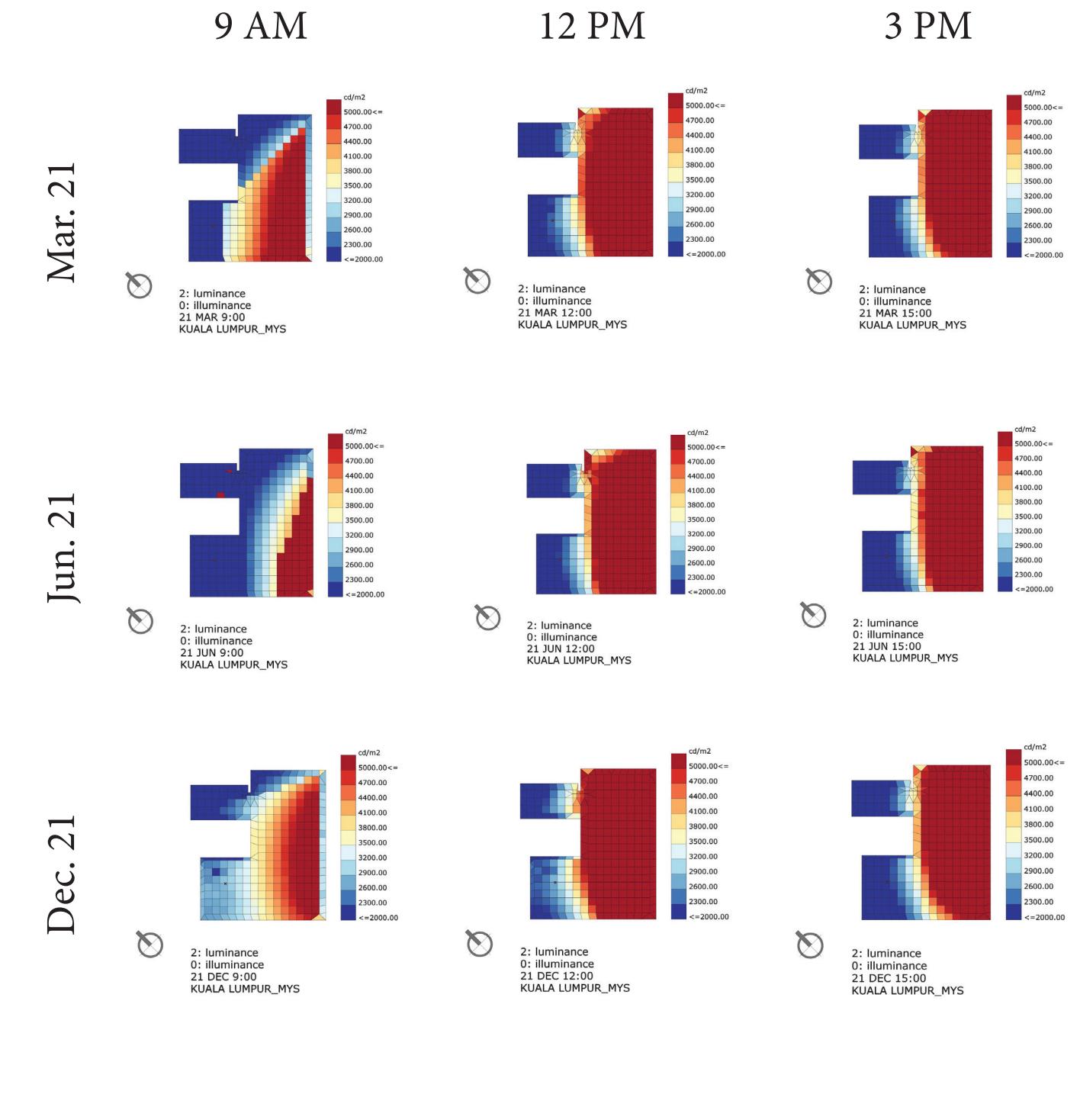


Base Geometry before redesigning Opened View

Annual Daylight Autonomy for the Based Geometry



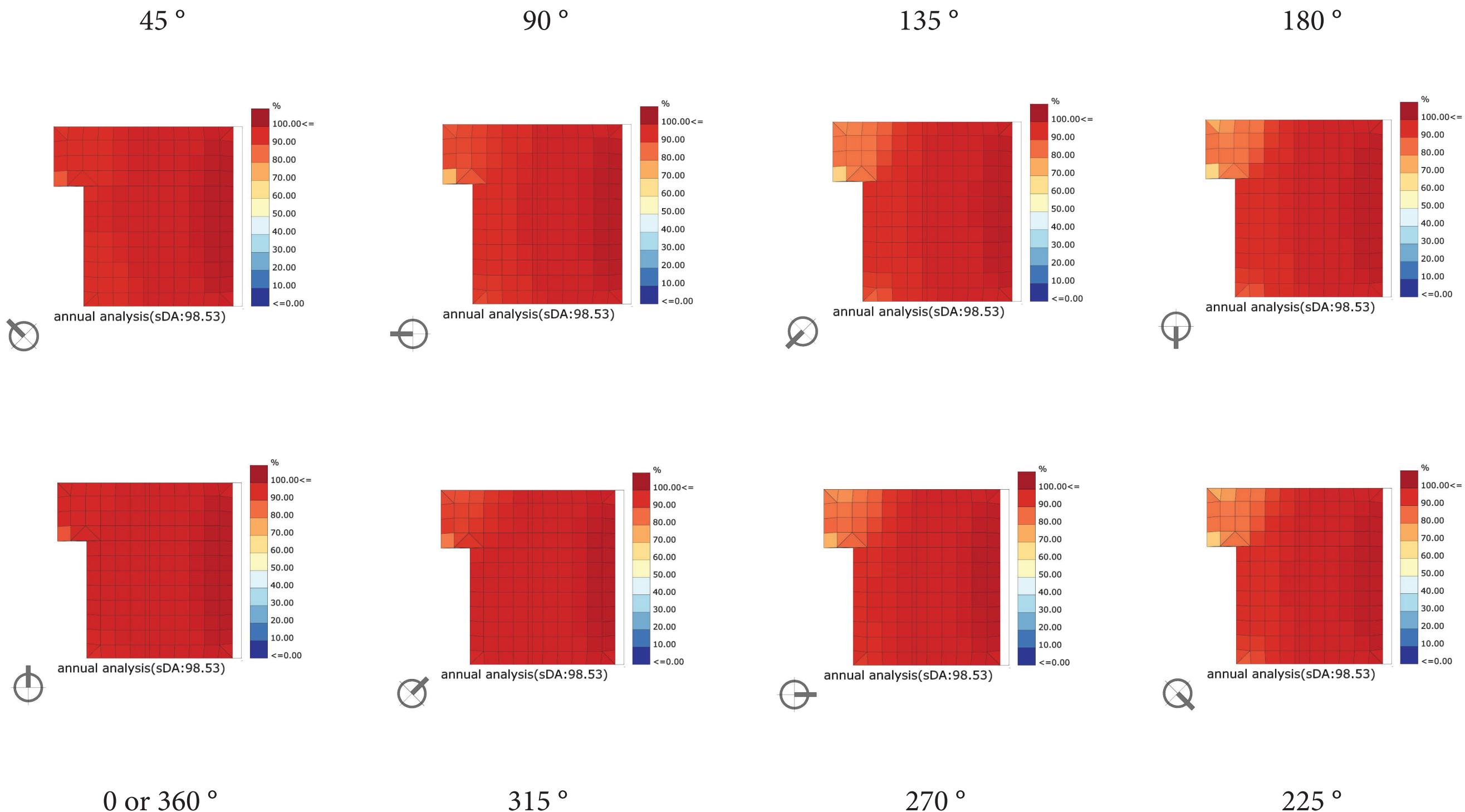
Daylight Analysis in certain periods for the Based Geometry



Useful Daylight between 100 - 2000 Lux

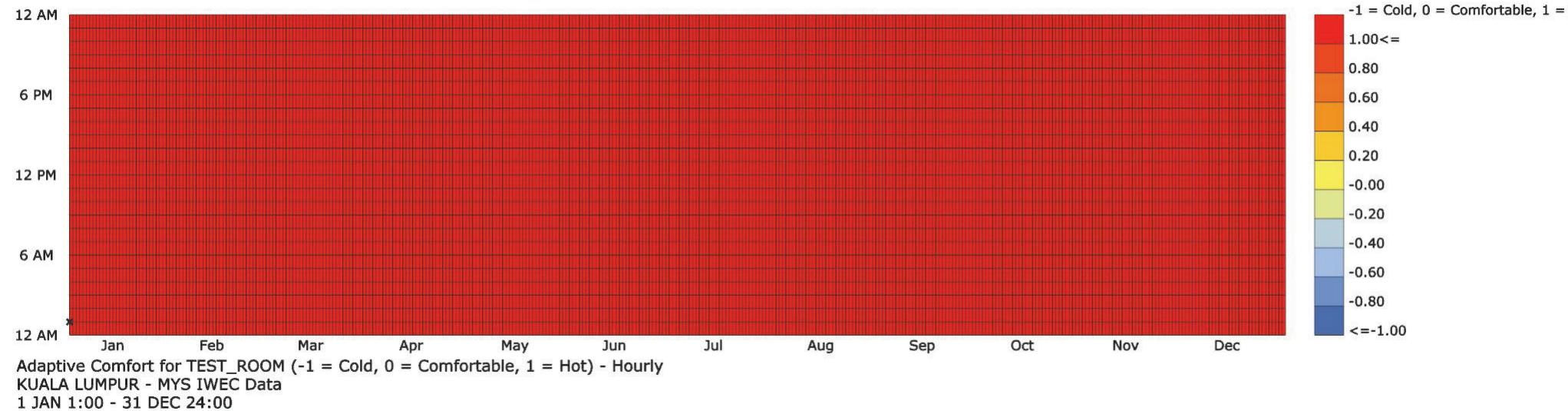
Sun light is more than enough, so dealing with light is one of the most important considerations for redesigning.

Orientation Study of the Base Geometry by Daylight Analysis



There is no typical sun direction to mainly consider because the area is located around the equator.
Therefore, light is always good enough and Sun orientation does not affect the design much.

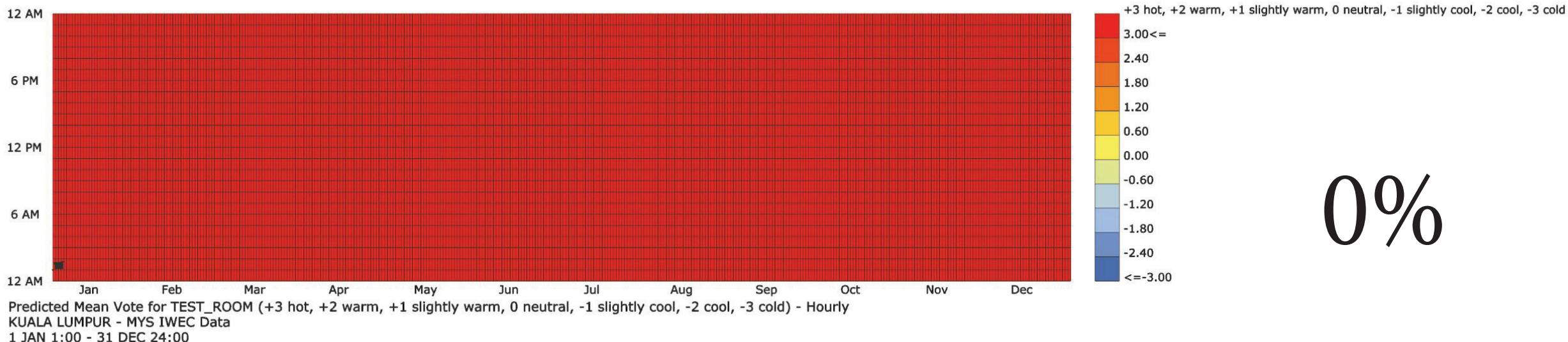
Indoor Adaptive Comfort for the Base Geometry



0%

Percent of Time Comfort of indoor adaptive comfort is 0%. Therefore, this place is very uncomfortable. Also, the most of time of a year is very hot.

Indoor Predicted Mean Vote (PMV) Comfort for the Base



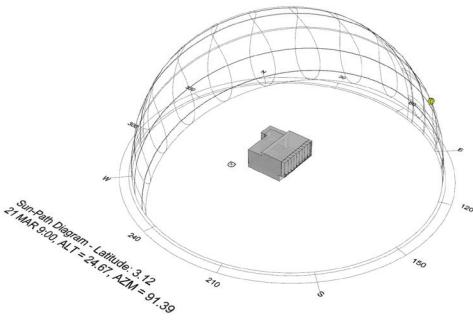
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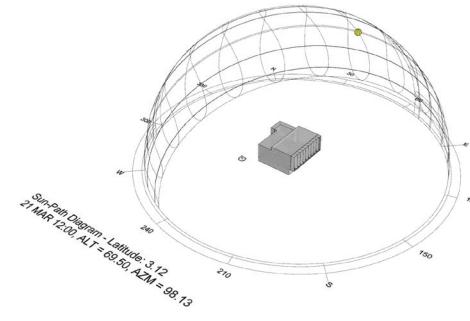
Sunpath Orientation - Redesigned

Mar. 21

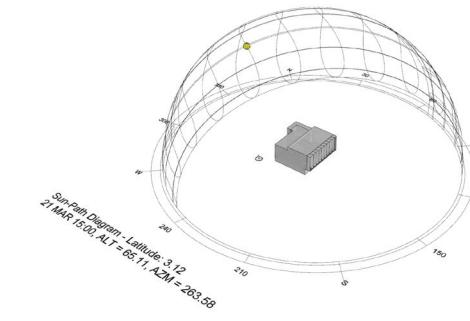
9 AM



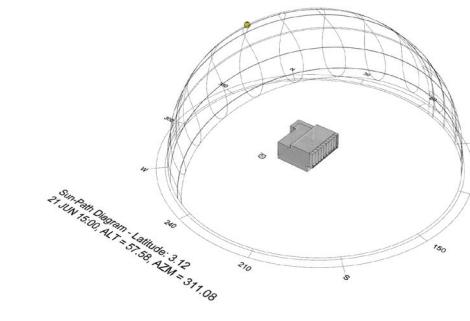
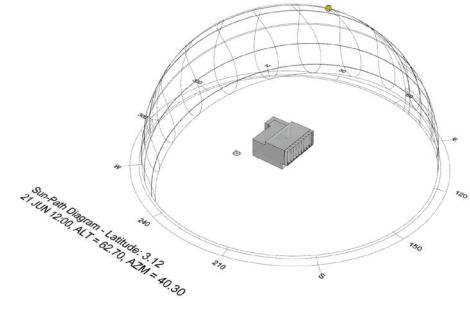
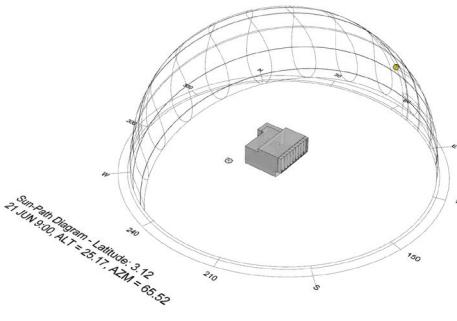
12 PM



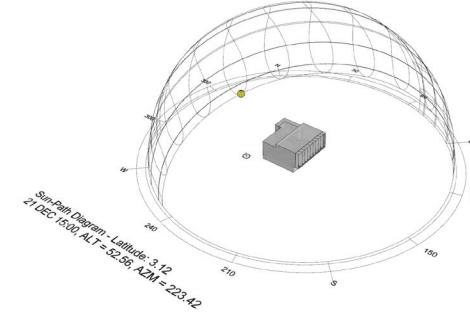
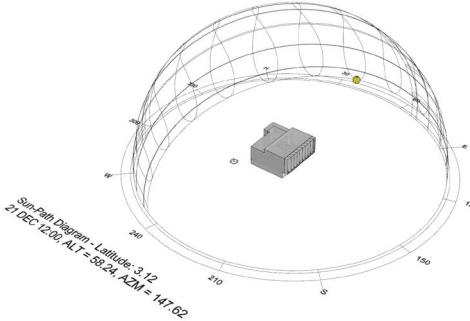
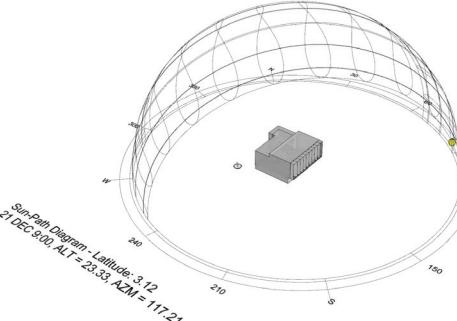
3 PM



Jun. 21

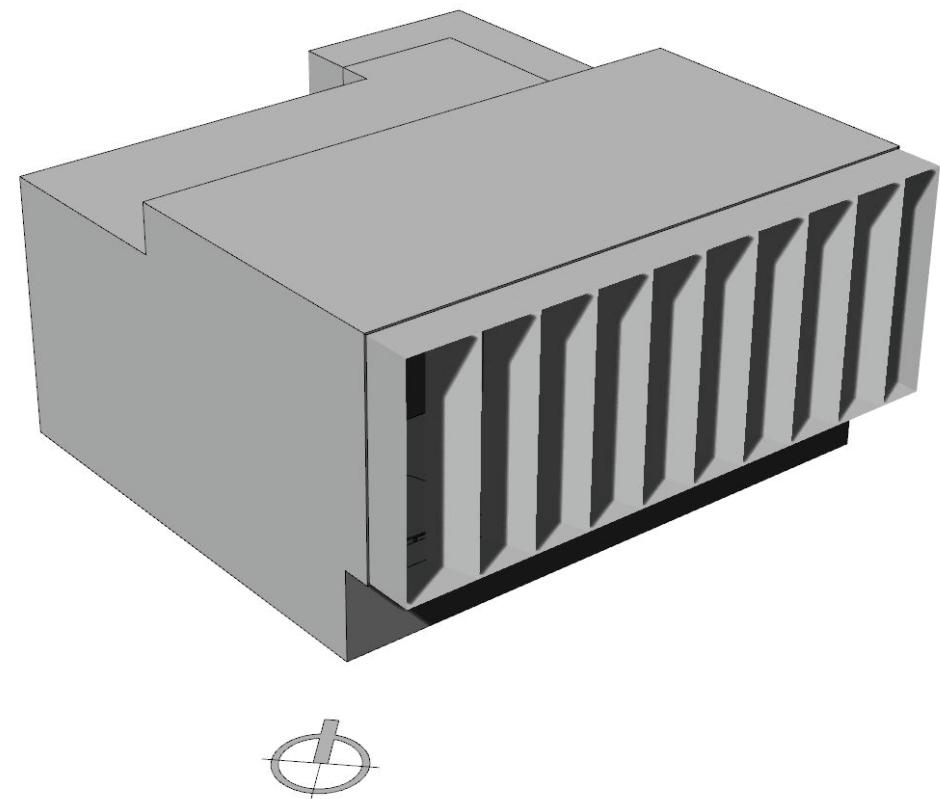


Dec. 21

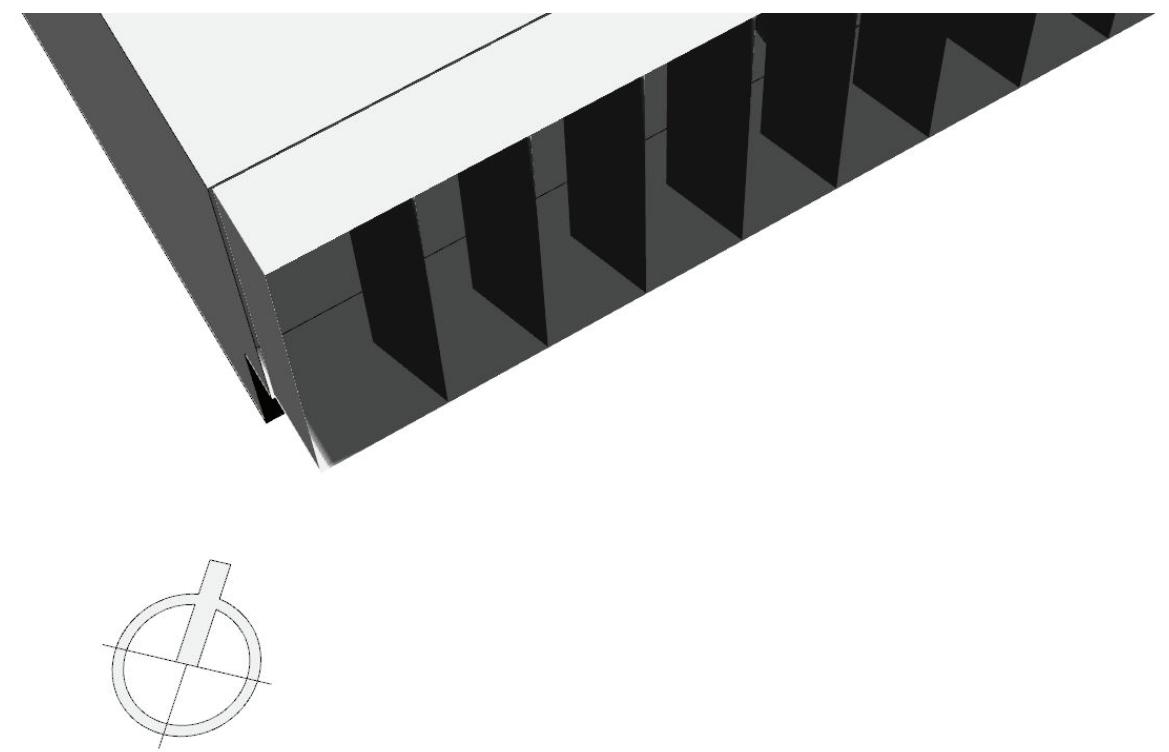


Since Kuala Lumpur is close to equator, sun position is very close to perpendicular from the ground. Moreover, since the building location is tilted 45 degrees and the main opening is located SE, the shading device is installed vertically and a bit tilted to the North to protect direct sunlight from SE direction.

Axon View of Redesigned Shading Device

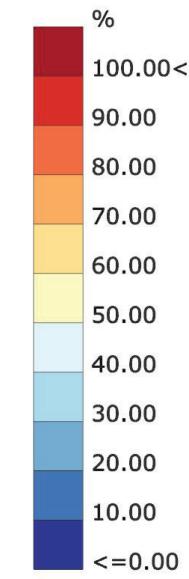
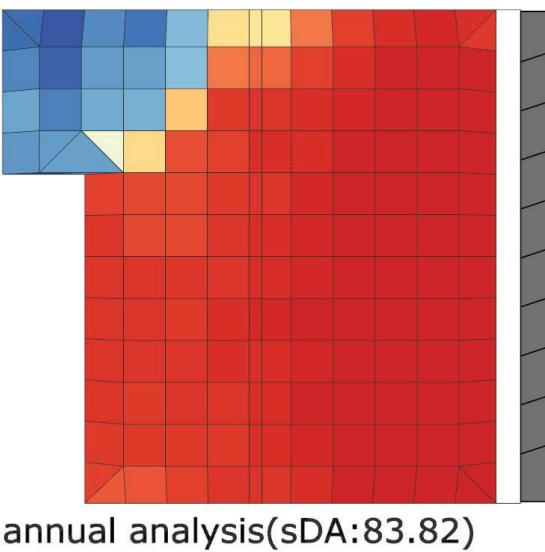


Redesigned Shading Device General View

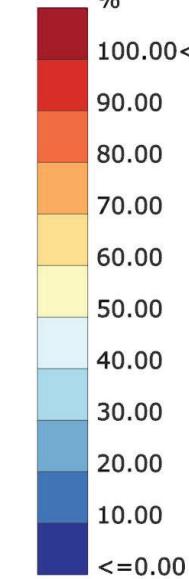
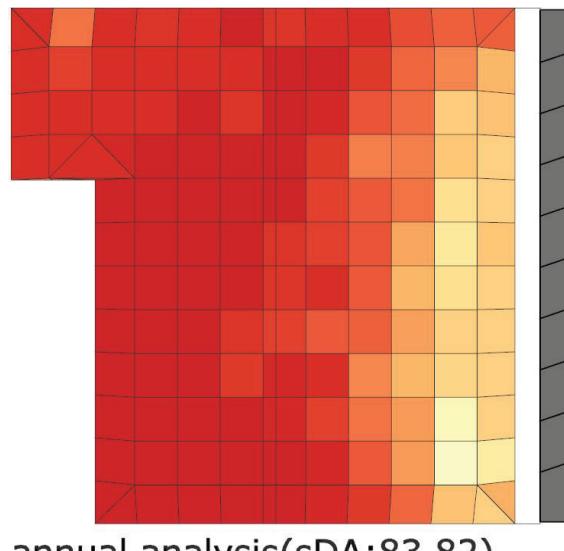


Redesigned Shading Device Close-View
(Angle is a bit tilted to prevent enormous sunlight)

Annual Daylight Analysis - Redesigned

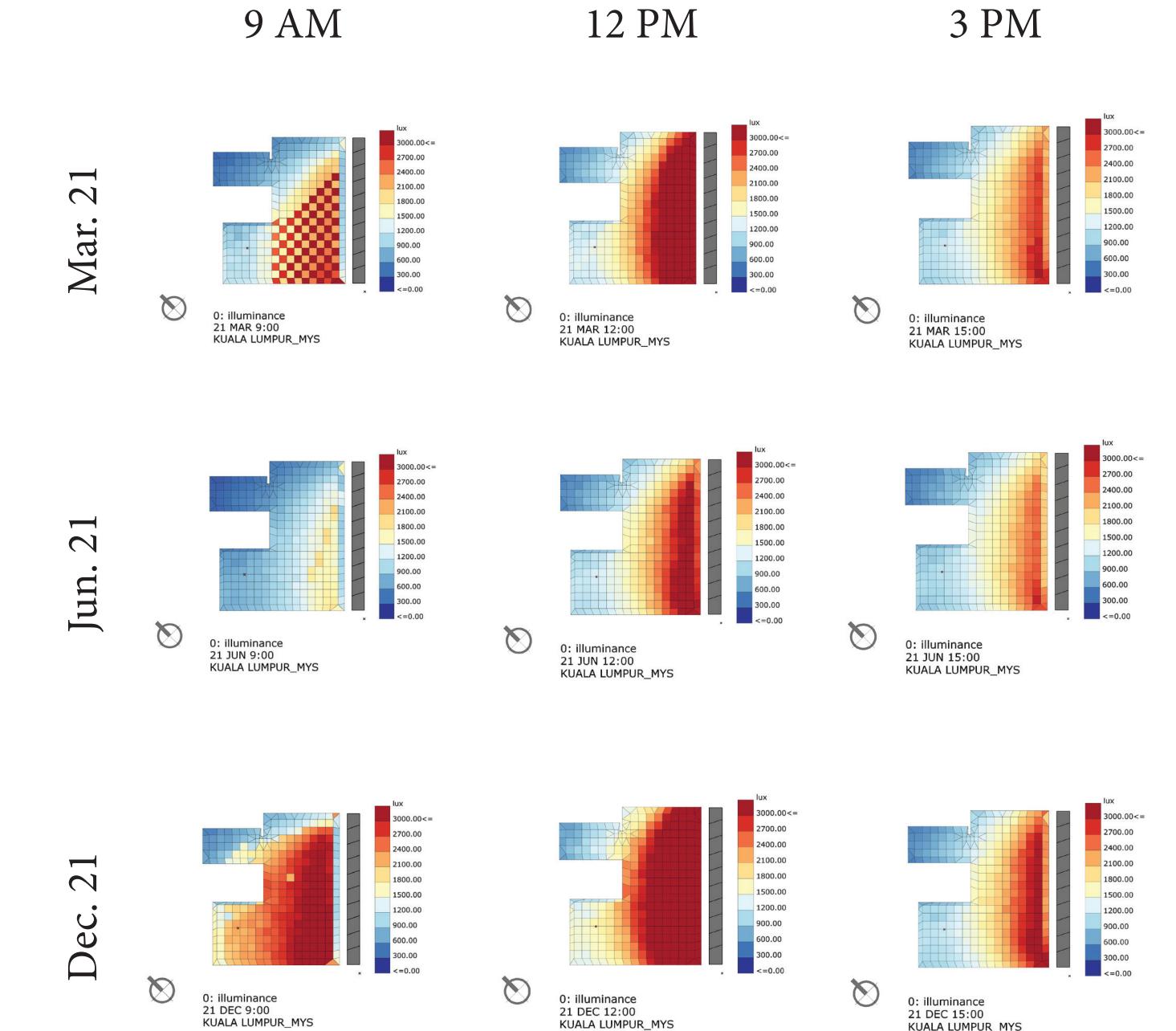


DLA Minimum Daylight above 300 lux



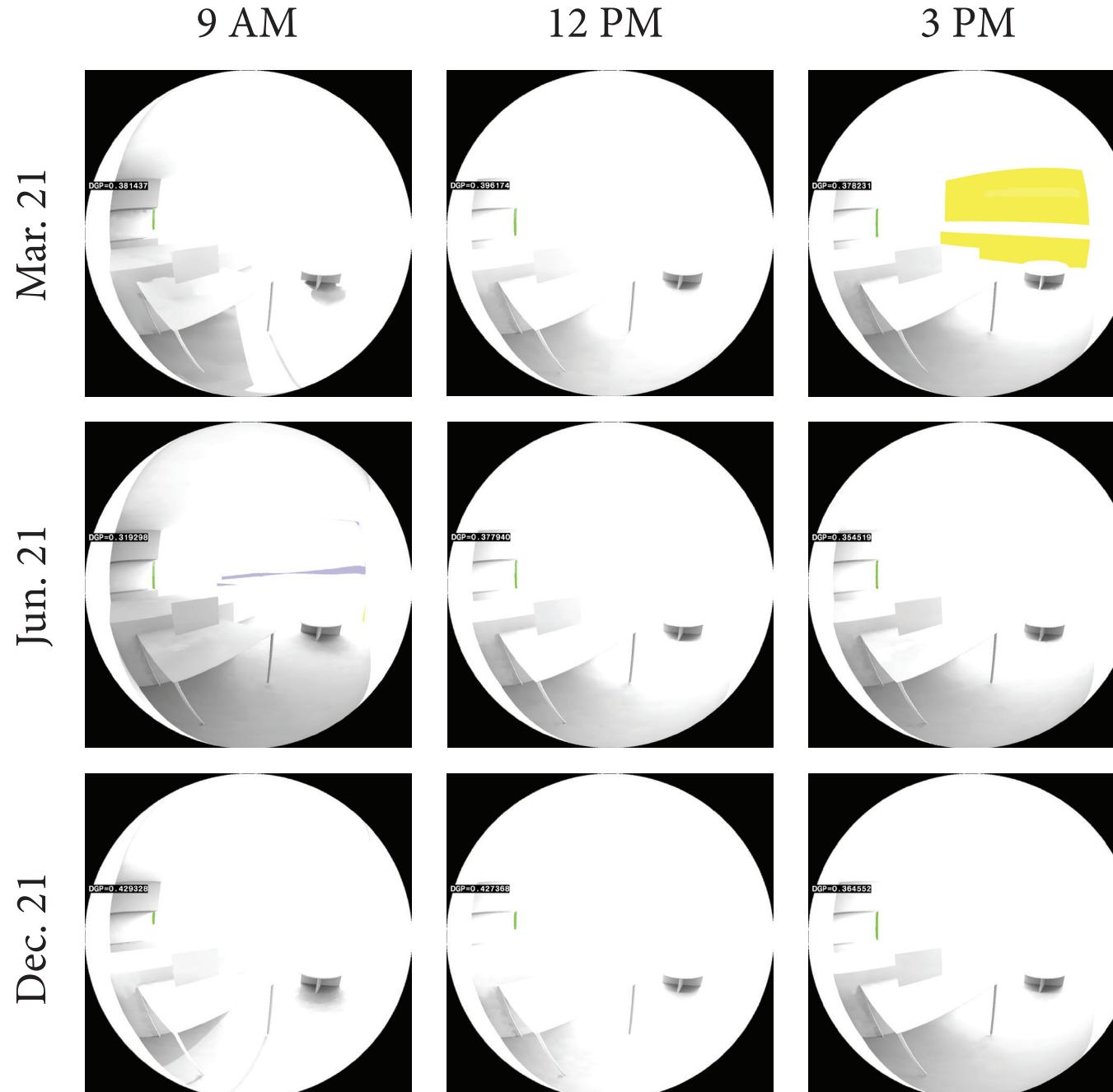
Useful Daylight between 100 - 2000 Lux

Annual Daylight Analysis - Redesigned-

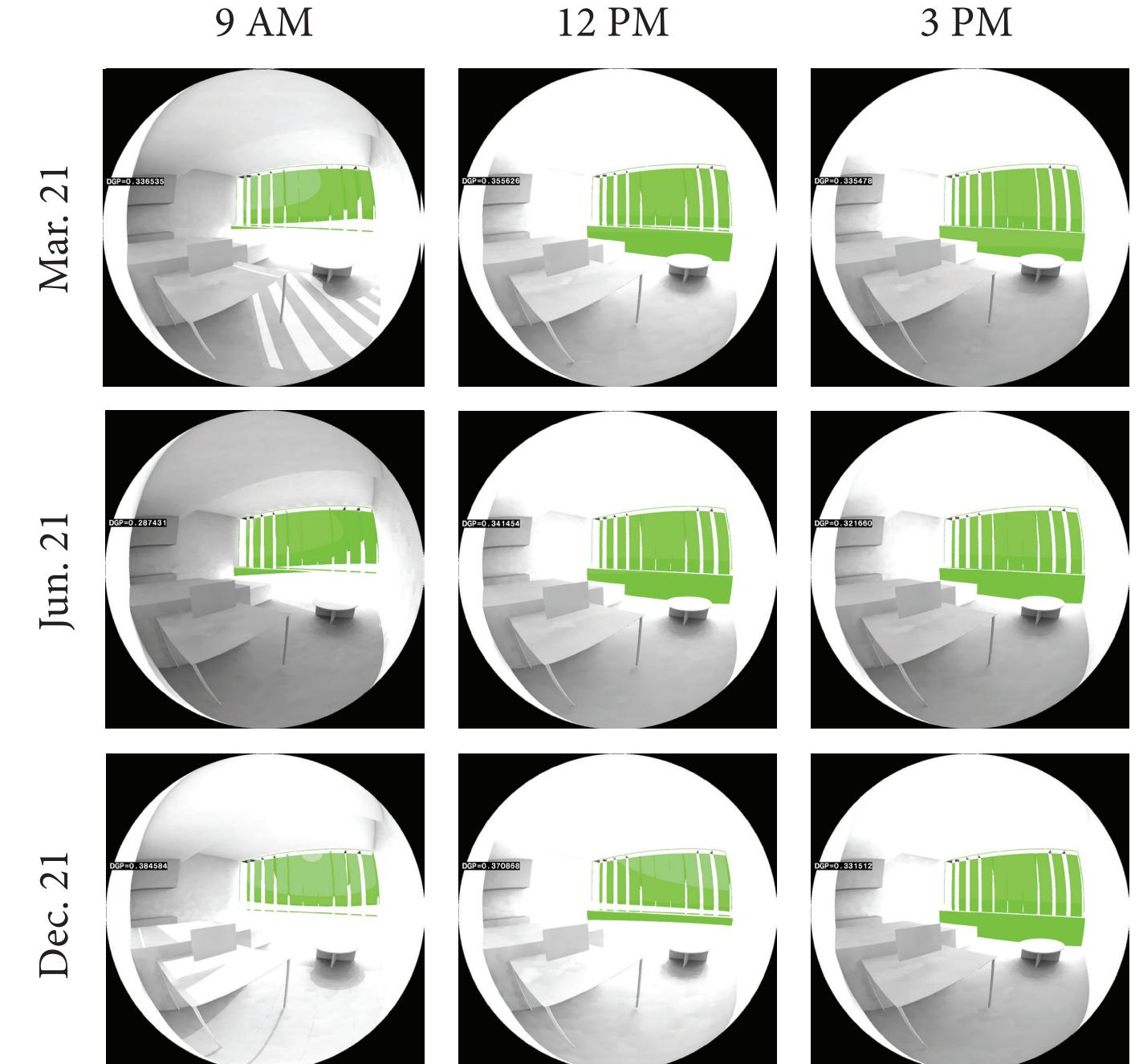


Compare to the previous geometry, before redesigning, new designed shading device helps to control illuminance which is less than 3000 lux, so it is pretty good enough as an indoor place. Also, sDA 83.82 tells this building does not have daylight issue, at least.

Glare Analysis before Redesign



Glare Analysis after Redesigned (Improved)

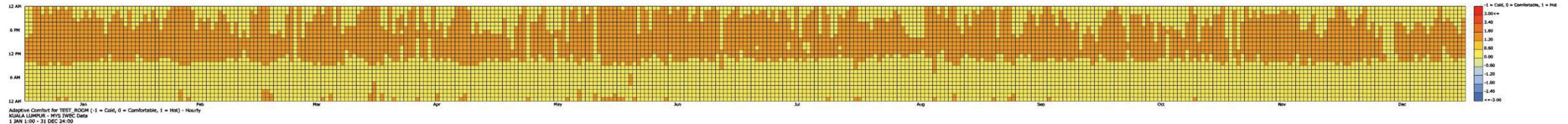


Glare analysis for three different Monthes represented for summer, winter, and in-between seasons

Glare analysis for three different Monthes represented for summer, winter, and in-between seasons

The most of DGPs are within 0.35 in this simulations. Tharefore, glare is good enough.

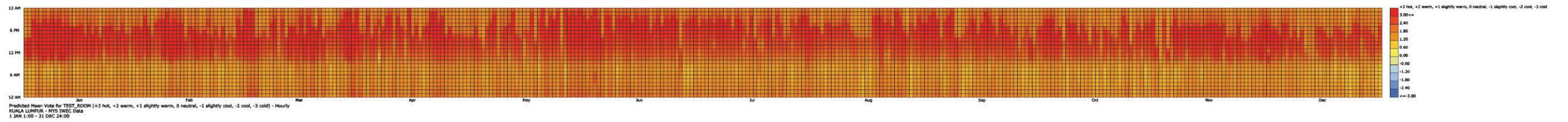
Indoor Adaptive Comfort for the New Shading Device Design + Natural Ventilation



57%

Percent of Time Comfort of indoor adaptive comfort is 56% after adding natural ventilation + new shading device. Therefore, this place is a lot better to feel comfortable now.

Indoor Predicted Mean Vote (PMV) Comfort for the New Shading Device Design + Natural Ventilation



Still 0%

Percent of Time Comfort of PMV is still 0%. The reason is because this place is very humid.

Conclusion

Kuala Lumpur is very typical hot and humid tropical monsoon weather, where has a lot of rain. Since the location is even close to equator, sun light is almost vertical too. These current conditions are very challenging to design effective shading device to satisfy 100% human comfort.

Since sun position is almost vertical, building faces hot during a day. Even location is very humid due to 2 rainy or monsoon seasons, shading device may block natural ventilation or air flow.

Therefore, my strategy was to locate the main opening to south east side and place shading device vertically. I tried not to put many shading devices, so building does not have to worry about natural ventilation or air flow. Due to the shading device and ventilation, indoor lux is less than 3000 and adaptive comfort increases up to 57% without using cooling system.