# CLIMATE ANALYSIS

PHILADELPHIA

# THERMAL AND VISUAL COMFORT MAXIMIZATION

DREAM ROOM

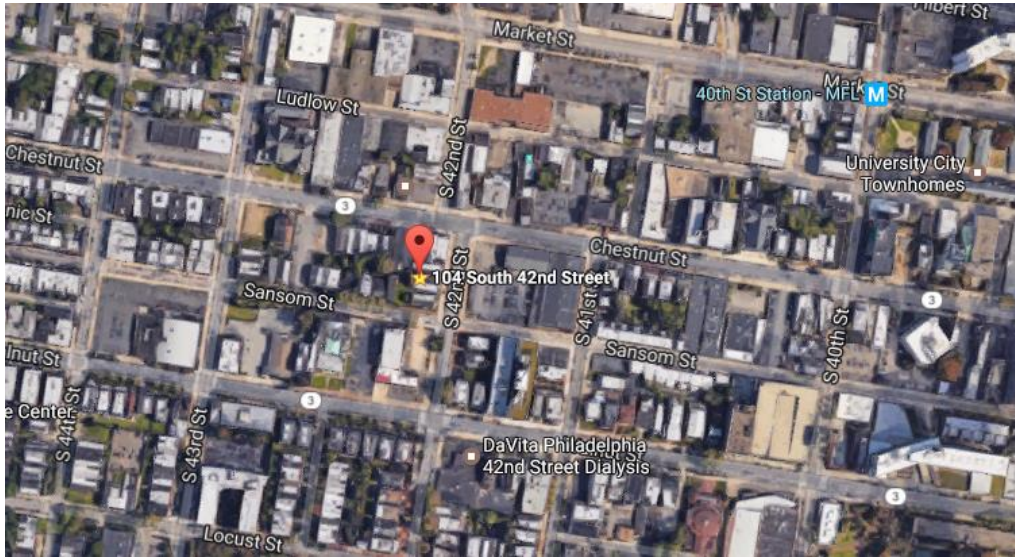
NEEHARIKA SIRAM | BUILDING PERFORMANCE SIMULATION

104 S 42nd Street

East facing apartment
Direction of windows: East facing and provides a view of the 42nd South Street

Problems faced:
Too much of sunlight during the morning hours and the glare also makes it difficult to work at study table
Low thermal comfort

Solutions:
Proper shading or overhang
Use of interior blinds or curtains
Use of energy efficient window panels like insulated panels, high reflectivity films/films that can cut off the summer heat and mesh window screens which can diffuse the solar radiation
Walls with high R-value increase the thermal comfort

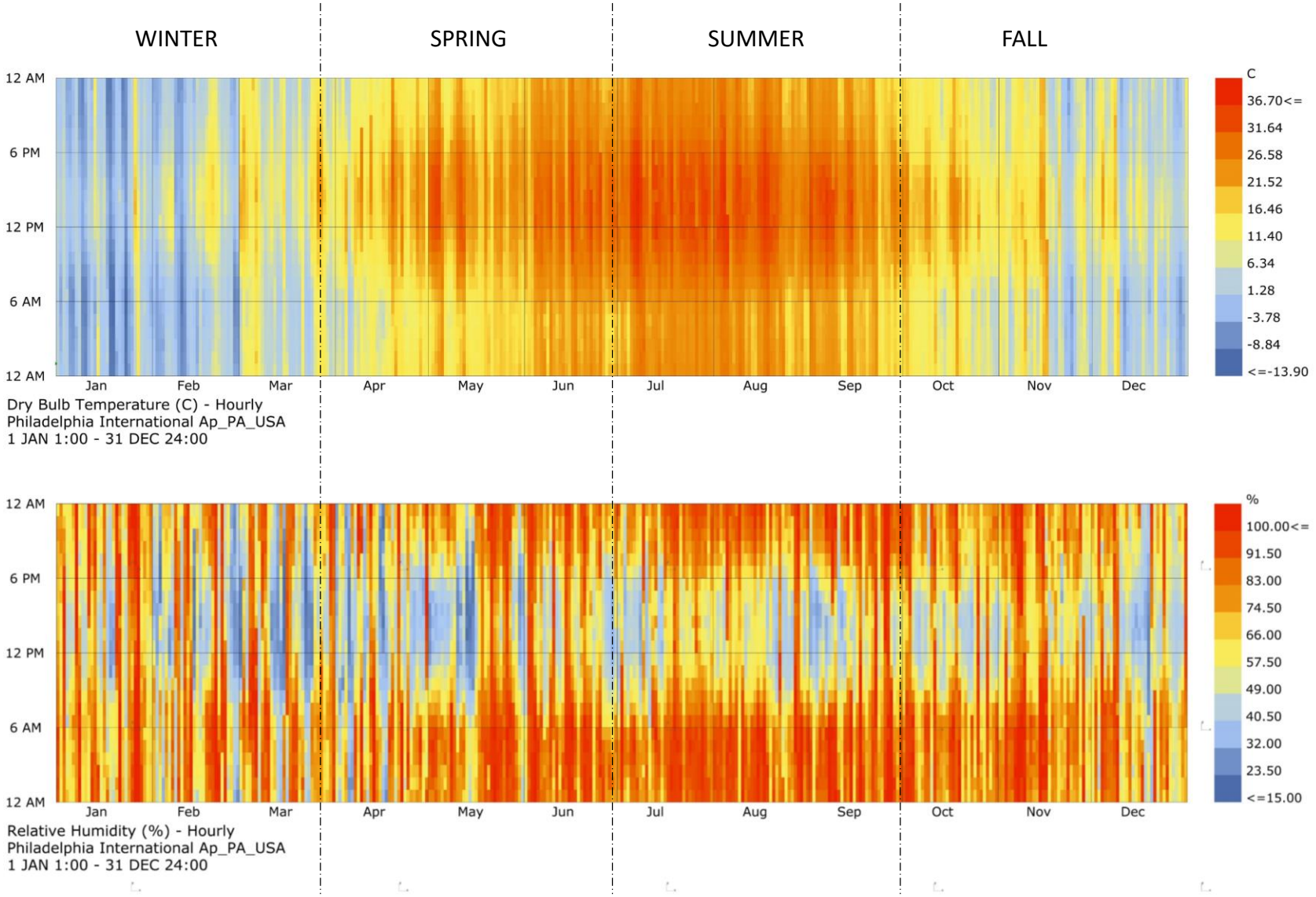


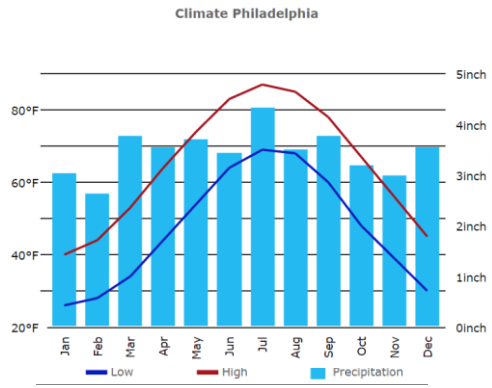

N

Philadelphia Climate Zone:4 | Zone 4 Standards Required:

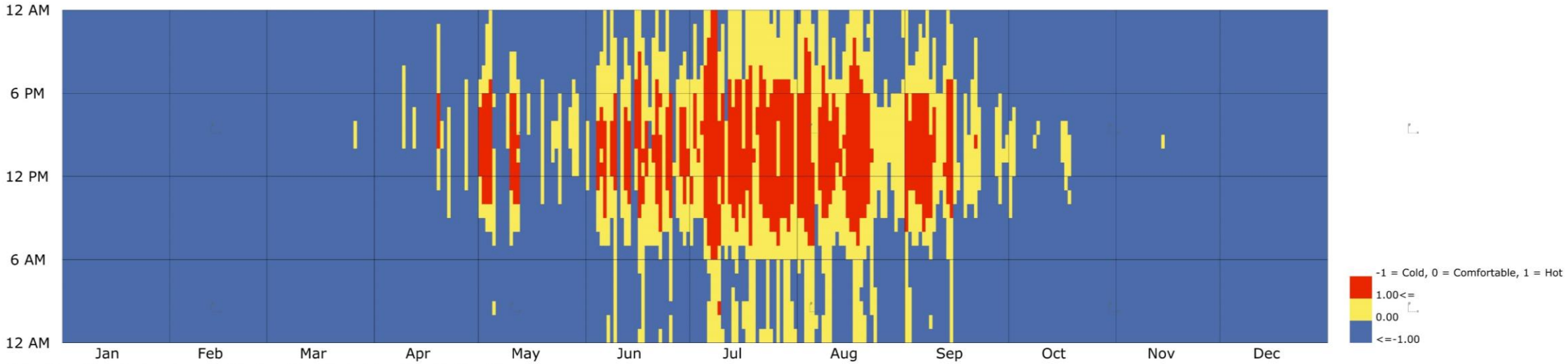
| | |
|---|---|
| Ceiling R-value | **38** |
| Wood Frame Wall R-value | **13** |
| Mass Wall R-value [i] | **5/10** |
| Floor R-value | **19** |
| Basement Wall R-value [c] | **10/13** |
| Slab R-value [d], Depth | **10, 2 ft** |
| Crawlspace Wall R-value [c] | **10/13** |
| Fenestration U-Factor [b] | **0.35** |
| Skylight U-Factor [b] | **0.60** |
| Glazed fenestration SHGC [b, e] | **NR** |

# CLIMATE PHILADELPHIA



# UNIVERSAL NTHERMAL CLIMATE INDEX
# UTCI



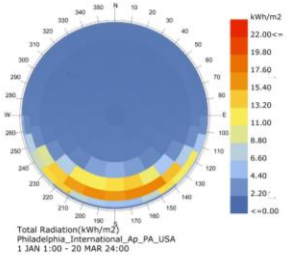

Adaptive Comfort (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

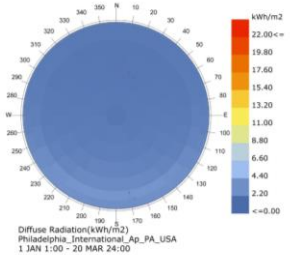
# RADIATION ANALYSIS

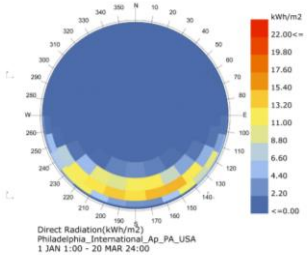
RADIATION ROSE

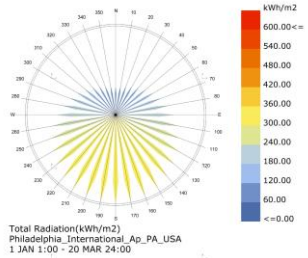
TOTAL RADIATION

WINTER

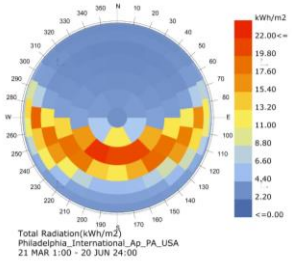


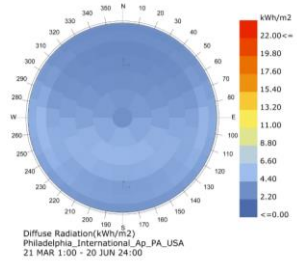



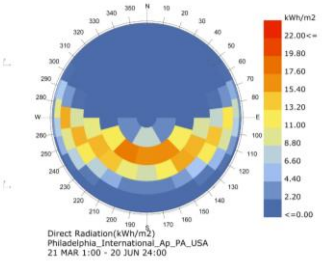



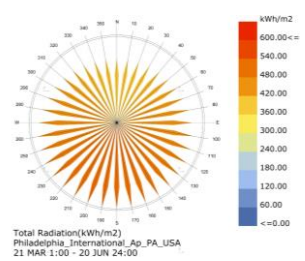




SPRING

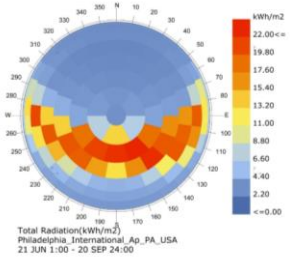


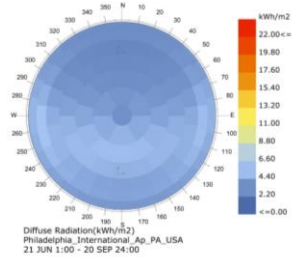



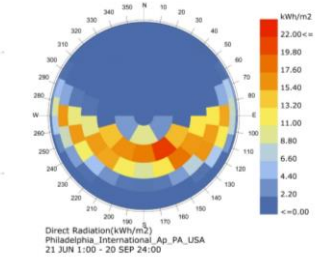



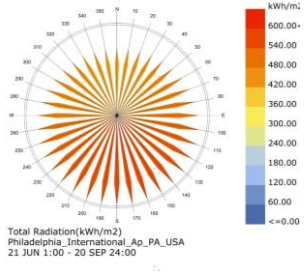




SUMMER

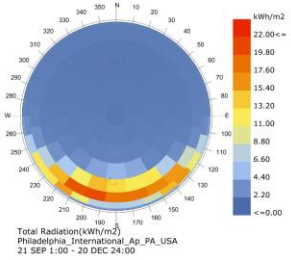


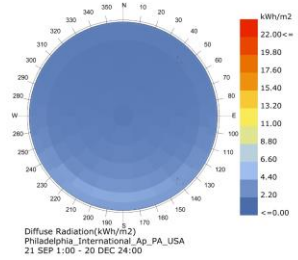



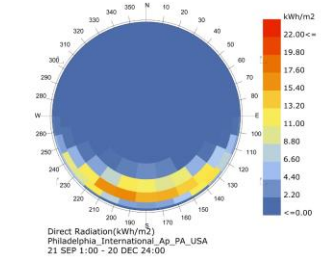



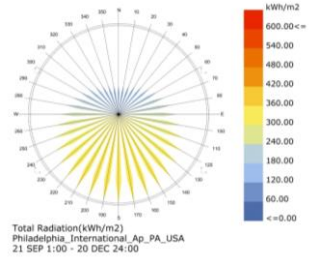




FALL



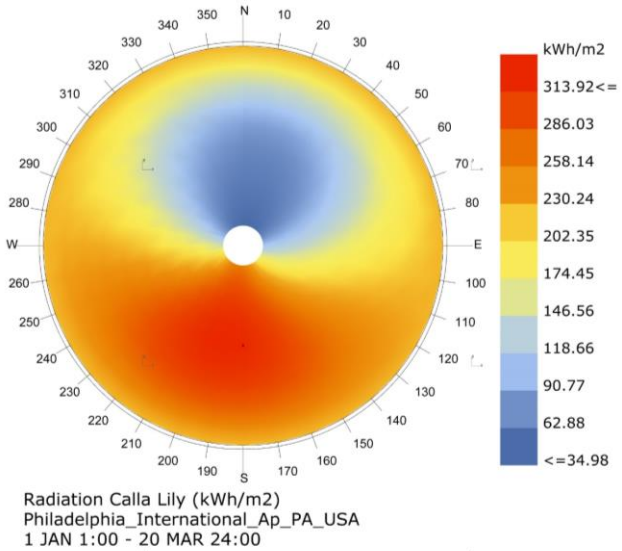



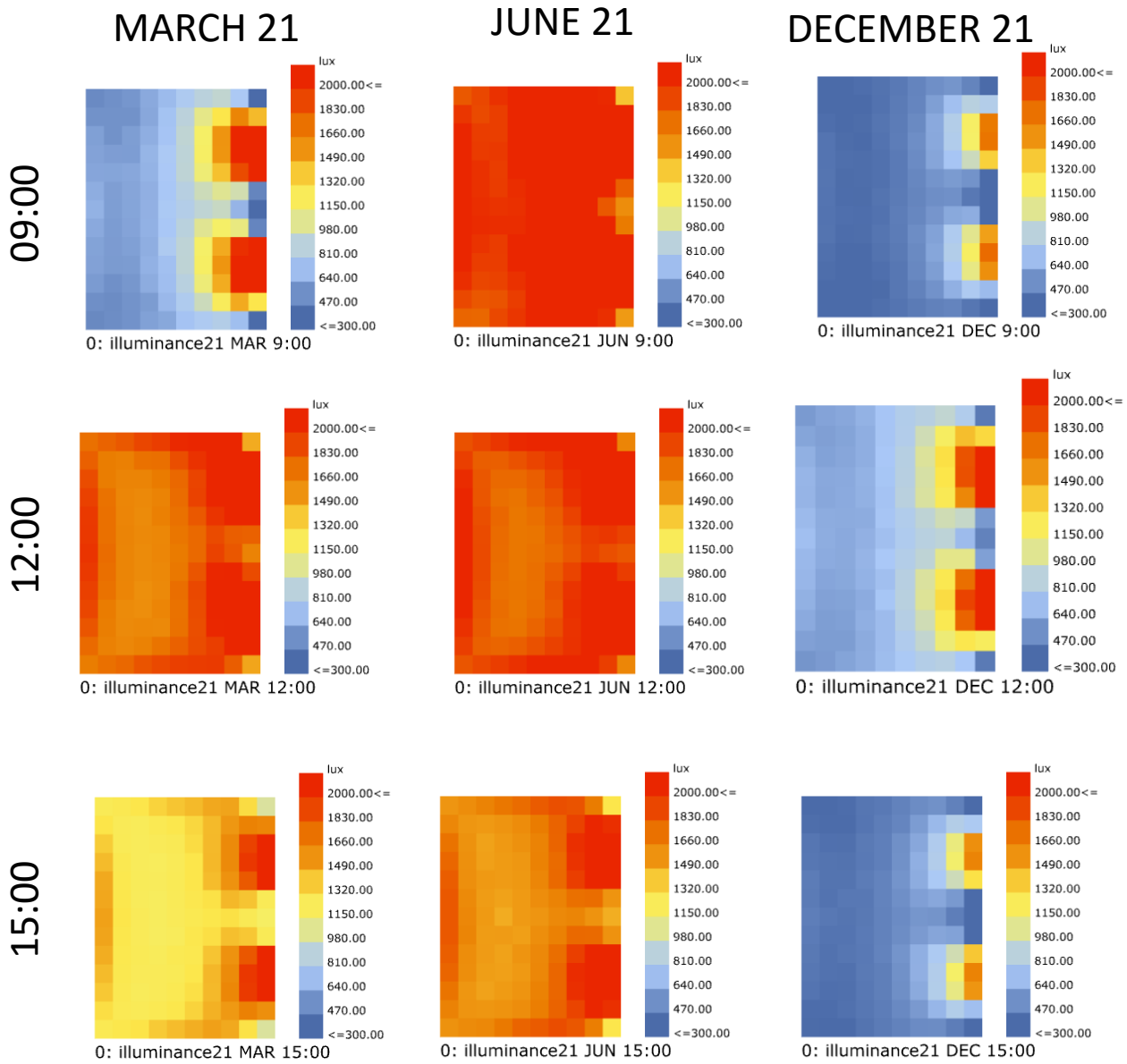




From the Radiation analysis it is evident that the major effect is due to the direct radiation in the summer and the spring months.

Calla Lilly shows that major radiation is from the south-west, so any window oriented towards south-west can get maximum daylight and better heating during winters.

RADIATION CALLA LILLY






# DAYLIGHT ANALYSIS

## BASE CASE
## DAYLIGHT GRID ANALYSIS

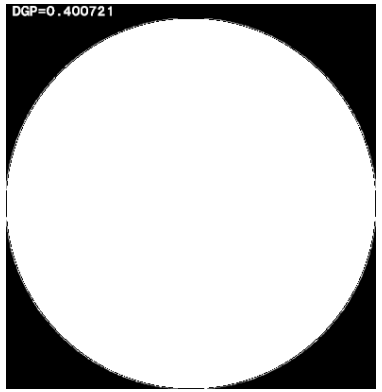
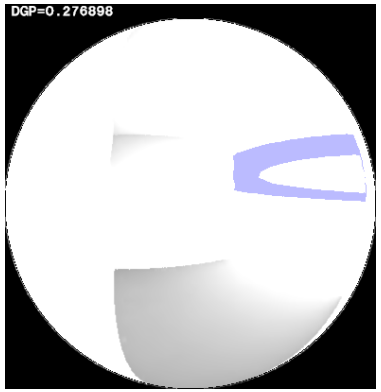
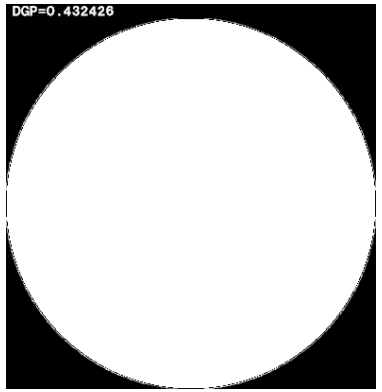
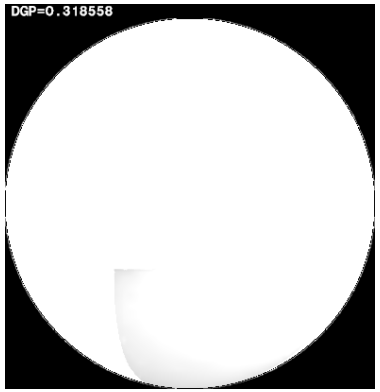
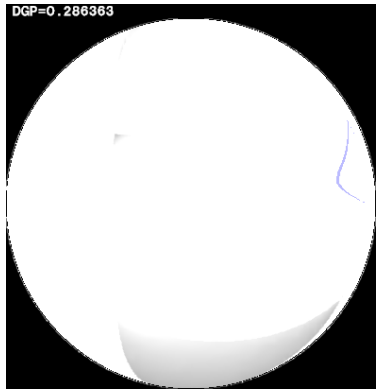
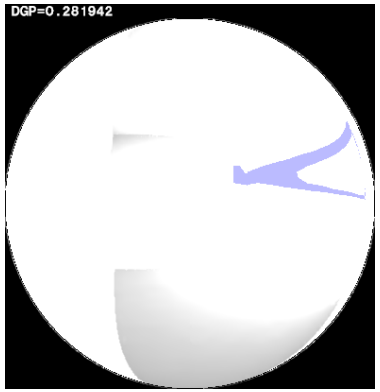
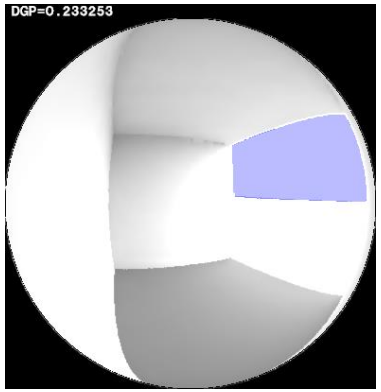
## SDA: 85.61

SDA | Spatial Daylight Autonomy
describes how much of a space receives sufficient daylight. Specifically, it describes the percentage of floor area that receives at least 300 lux for at least 50% of the annual occupied hours.

From the Daylight grid analysis it is evident that there is high intensity of daylight during the spring and the summer months

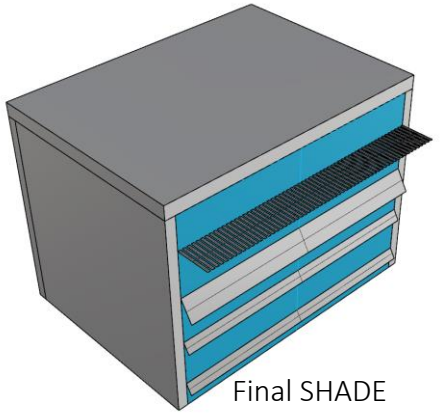
# DAYLIGHT ANALYSIS

BASE CASE
GLARE ANALYSIS

| | MARCH 21 | JUNE 21 | DECEMBER 21 |
|---|---|---|---|
| 09:00 |   |   |   |
| 12:00 |   |   |   |
| 15:00 |   |   |   |

# DAYLIGHT ANALYSIS

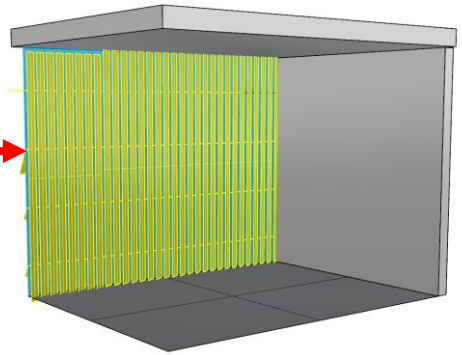
## FULL EAST WINDOW CASE (WWR: 1) DAYLIGHT GRID ANALYSIS



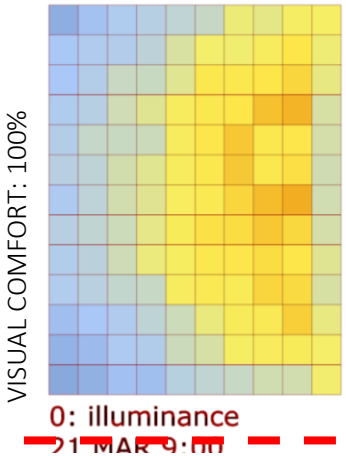
Final SHADE

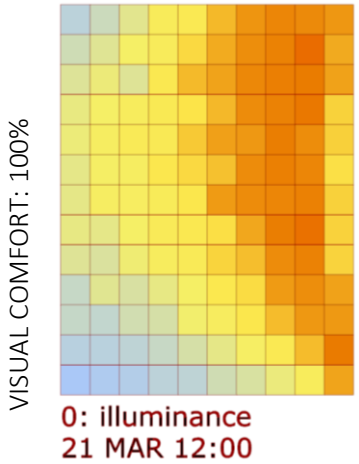
This is a full glass window case, to check how feasible it is to have full glass window.

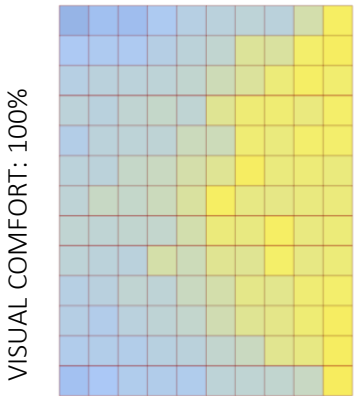
The analysis show that Thermal comfort can be achieved by shade design ad use of vertical blinds during the noon time of summer months.

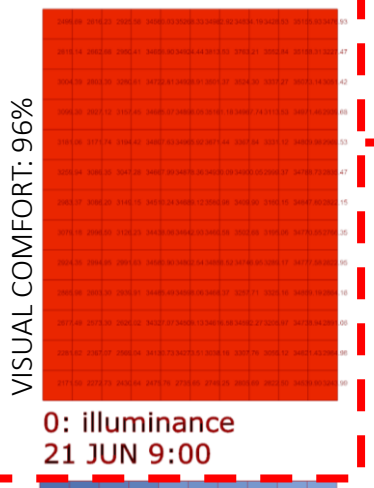


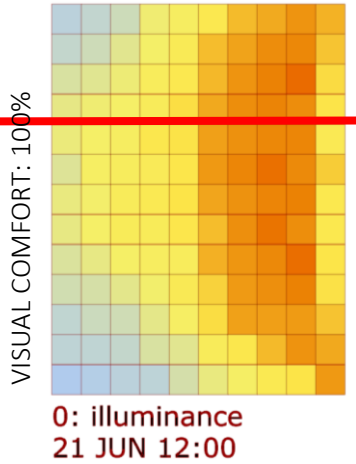
Final SHADE +BLINDS

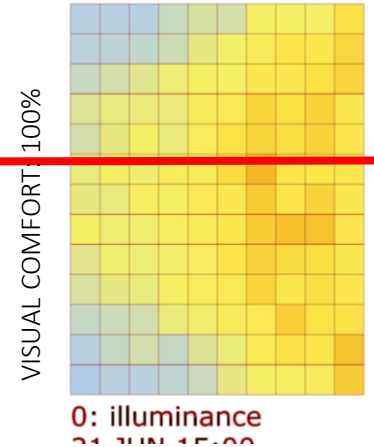


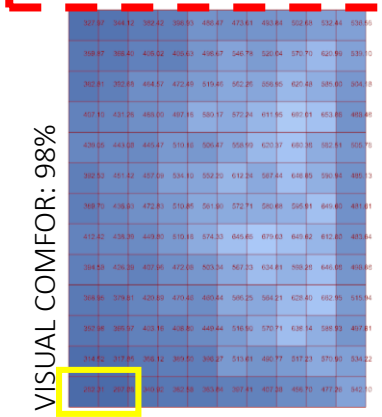



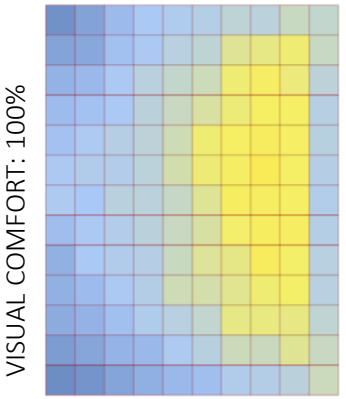



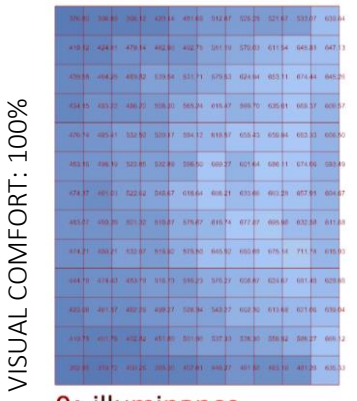



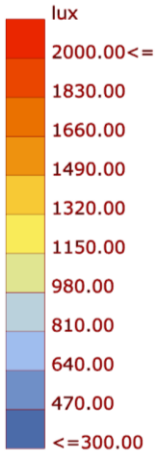



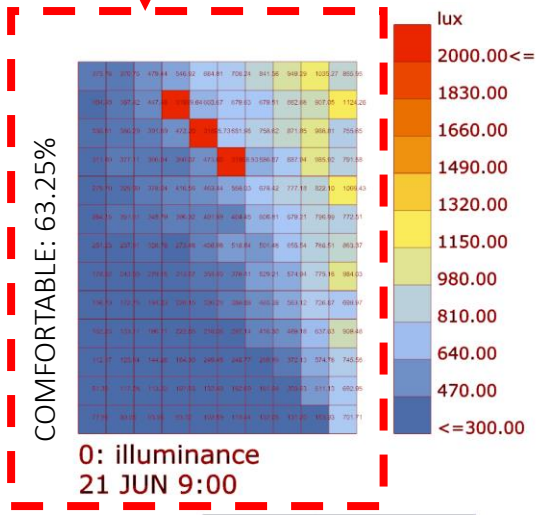



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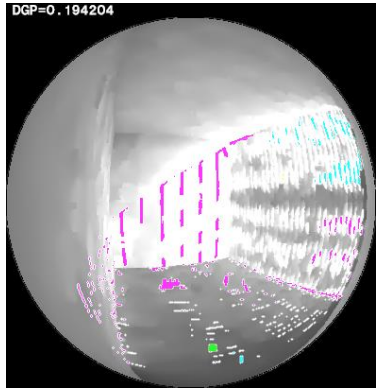
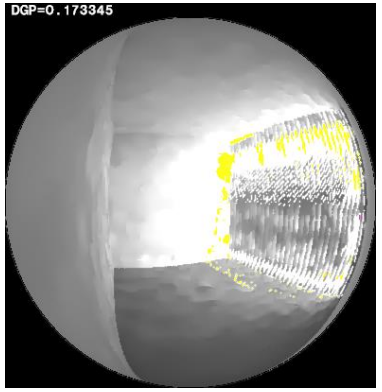
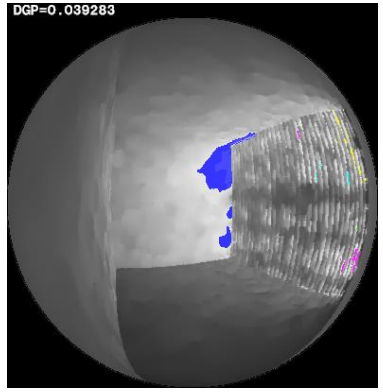
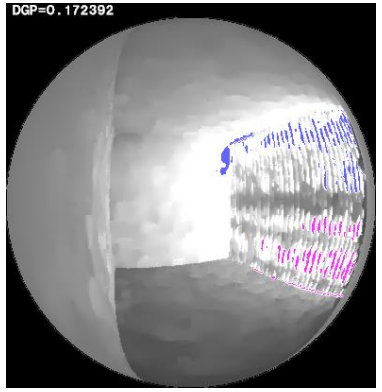
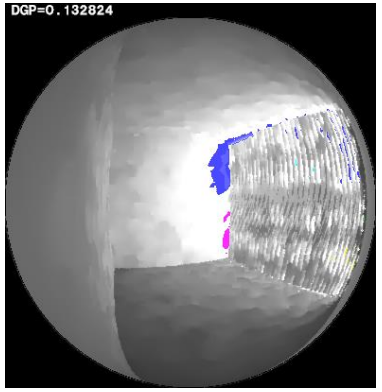
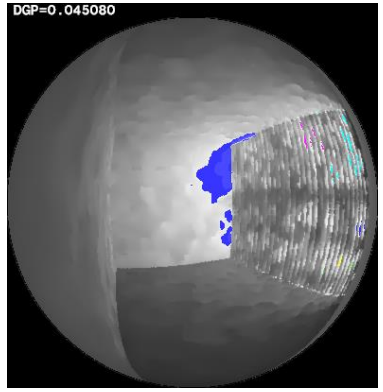
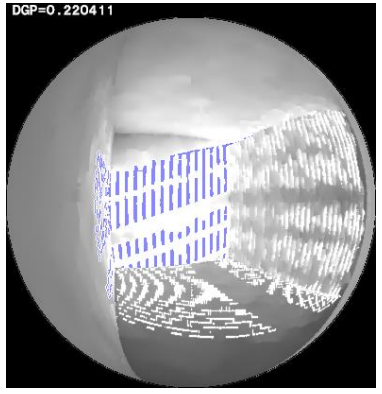
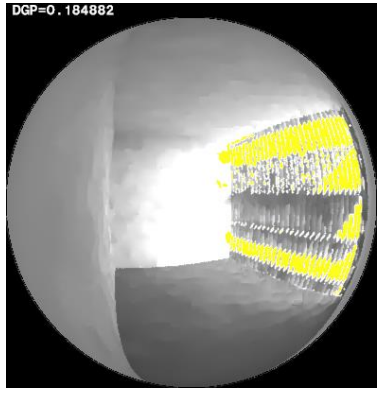
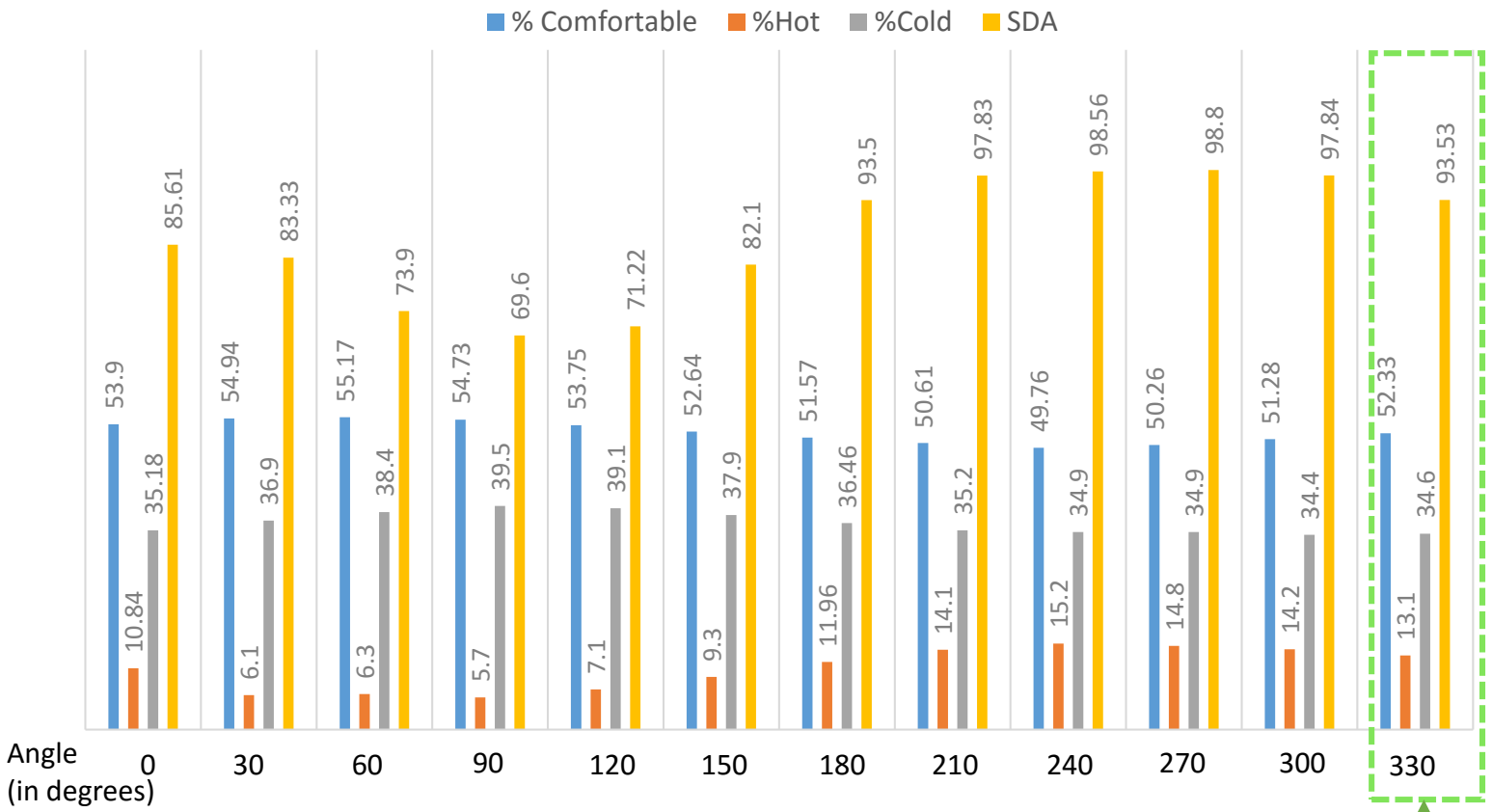
|---|---|---|---|
| 09:00 |   |   |   |
| 12:00 |   |   |   |
| 15:00 |   |   |   |

# DAYLIGHT ANALYSIS

FULL EAST WINDOW CASE
(WWR: 1)
DAYLIGHT GRID ANALYSIS




# ORIENTATION

## Differences

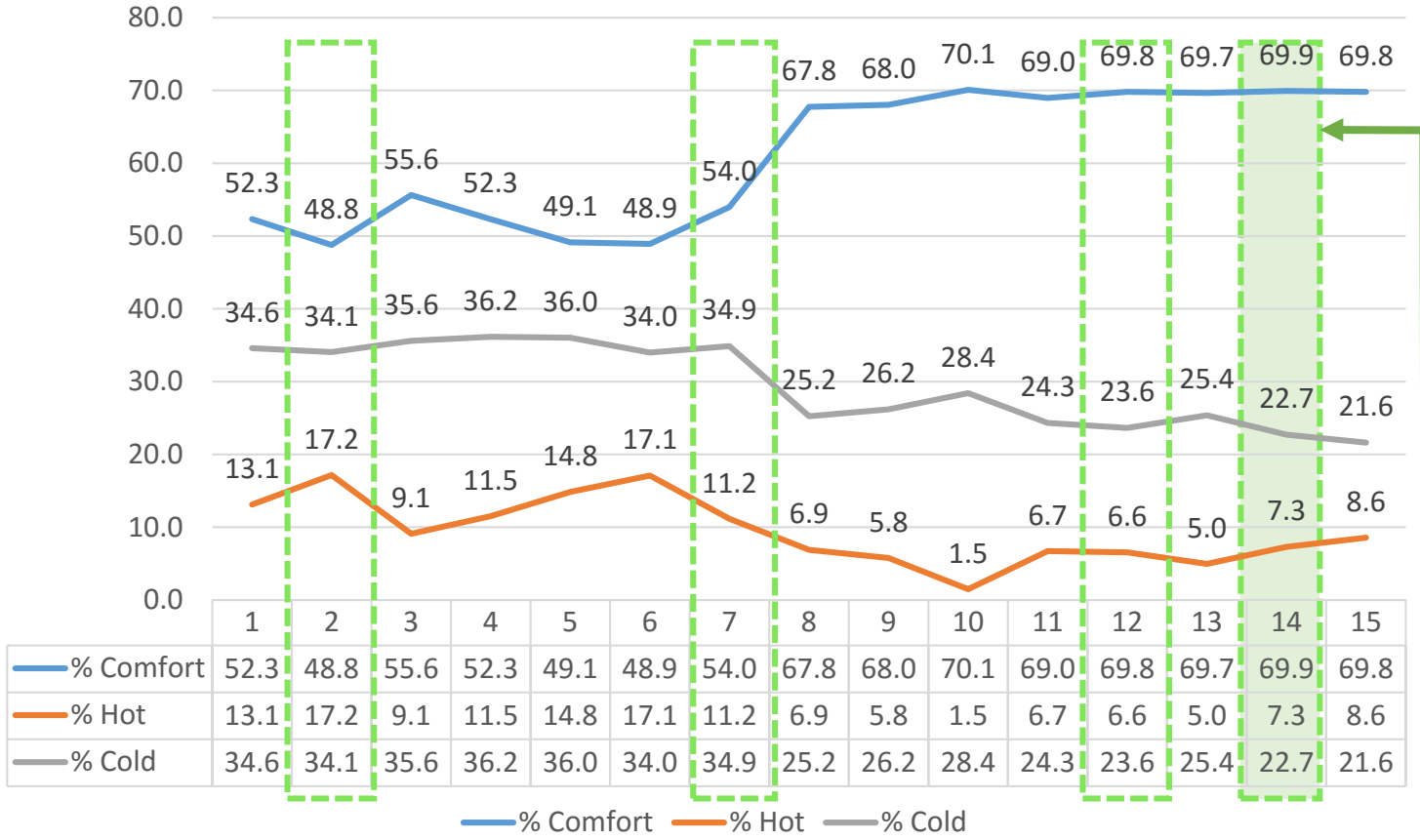
| Base Case | Recommended |
|---|---|
| Orientation: 0degrees | Orientation: 330degrees |
| % Comfortable: 53.9 | % Comfortable: 52.33 |
| SDA: 85.61 | SDA: 93.53 |

Aiming for higher thermal comfort without a proper check on the visual comfort might lead to darker spaces without even achieving the minimum of 50% spatial daylight autonomy.

So it is better to choose such an orientation where both thermal comfort and SDA are near to average

| | THERMAL | | | | VISUAL | |
|---|---|---|---|---|---|---|
| | % Comfortable | %Hot | %Cold | Orientation Angle | SDA | |
| Above Average | 53.9 | 10.84 | 35.18 | 0 | 85.61 | |
| | 54.94 | 6.1 | 36.9 | 30 | 83.33 | |
| | 55.17 | 6.3 | 38.4 | 60 | 73.9 | |
| | 54.73 | 5.7 | 39.5 | 90 | 69.6 | |
| | 53.75 | 7.1 | 39.1 | 120 | 71.22 | |
| | 52.64 | 9.3 | 37.9 | 150 | 82.1 | |
| | 51.57 | 11.96 | 36.46 | 180 | 93.5 | |
| | 50.61 | 14.1 | 35.2 | 210 | 97.83 | |
| | 49.76 | 15.2 | 34.9 | 240 | 98.56 | |
| | 50.26 | 14.8 | 34.9 | 270 | 98.8 | |
| | 51.28 | 14.2 | 34.4 | 300 | 97.84 | |
| | 52.33 | 13.1 | 34.6 | 330 | 93.53 | Above Average |
| | 52.57833333 | | | AVERAGE | 87.15166667 | |

# WWR & MATERIALS




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % Comfort | 52.3 | 48.8 | 55.6 | 52.3 | 49.1 | 48.9 | 54.0 | 67.8 | 68.0 | 70.1 | 69.0 | 69.8 | 69.7 | 69.9 | 69.8 |
| % Hot | 13.1 | 17.2 | 9.1 | 11.5 | 14.8 | 17.1 | 11.2 | 6.9 | 5.8 | 1.5 | 6.7 | 6.6 | 5.0 | 7.3 | 8.6 |
| % Cold | 34.6 | 34.1 | 35.6 | 36.2 | 36.0 | 34.0 | 34.9 | 25.2 | 26.2 | 28.4 | 24.3 | 23.6 | 25.4 | 22.7 | 21.6 |

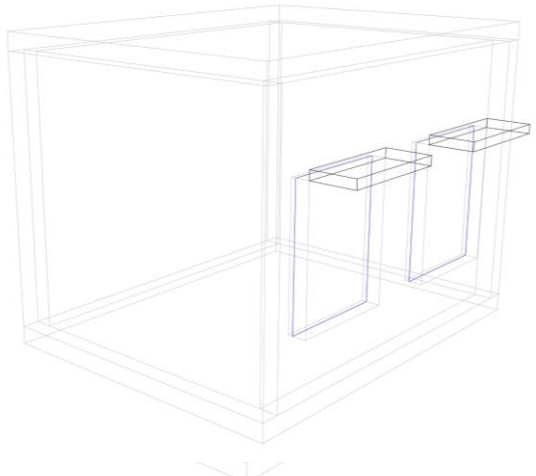
Final Case

| Case | Specifications | % Comfort | % Hot | % Cold |
|---|---|---|---|---|
| Base Case +Orientation | WWR East – 0.3<br>WWR South, North & West - 0.0<br>Wall R Value – 5.5<br>Roof R Value – 9.2<br>No Blinds<br>Sill Height - 0.6m<br>Window Height – 1.5m<br>Number of Windows on East – 2<br>8 inch Thick Concrete Roof<br>Orientation – 330 | | | |
| 1 | Glazing Opening Area = 1 | 52.3 | 13.1 | 34.6 |
| 2 | WWR-east-0.4 | 48.77 | 17.2 | 34.1 |
| 3 | WWR-east-.2 | 55.62 | 9.1 | 35.6 |
| 4 | Case1 + WWR-north-.25 | 52.31 | 11.5 | 36.2 |
| 5 | Case1 + WWR-west-.25 | 49.13 | 14.8 | 36.0 |
| 6 | Case1 + WWR-south-.25 | 48.91 | 17.1 | 34.0 |
| 7 | Case1 + WWR-east-.25 | 53.97 | 11.15 | 34.87 |
| 8 | Case3 + Wall r-8.7 | 67.75 | 6.89 | 25.23 |
| 9 | Case3 + Wall R-34.4 | 68.03 | 5.77 | 26.18 |
| 10 | Case9 + Window R-1.9, SHGC-0.39 | 70.09 | 1.49 | 28.41 |
| 11 | Case8 + Roof R-14.8 | 68.96 | 6.72 | 24.31 |
| 12 | Case8 + Roof R-34.4 | 69.81 | 6.55 | 23.64 |
| 13 | Case12 + rate of air flow (infiltration)-3 | 69.66 | 4.96 | 25.36 |
| 14 | Case12 + rate of air flow (infiltration)-1.5 | 69.93 | 7.3 | 22.72 |
| 15 | Case12 + rate of air flow (infiltration)-1.0 | 69.81 | 8.56 | 21.62 |

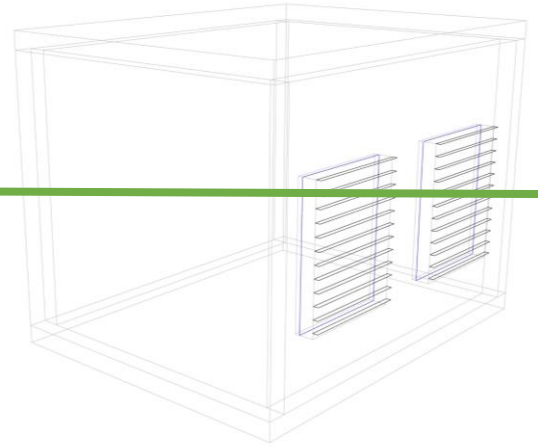
All the cases marked in green are the chosen cases over the other cases.
Reasons:
Any window in the wall (other than east) resulted in decrease of thermal comfort.
Case 8 is chosen over 9, as there is not much evident change even after a high increase in R-value in case 9.

# Shade Design

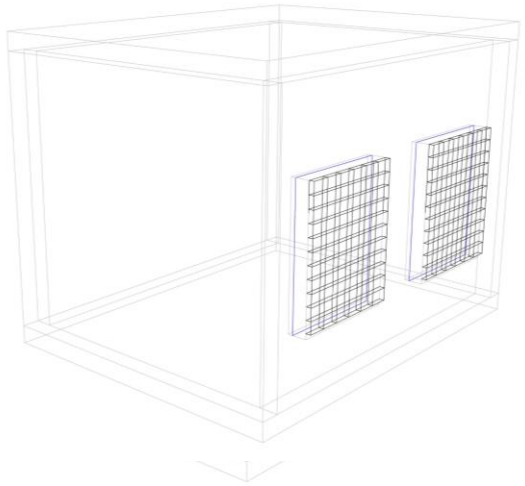
Final Case



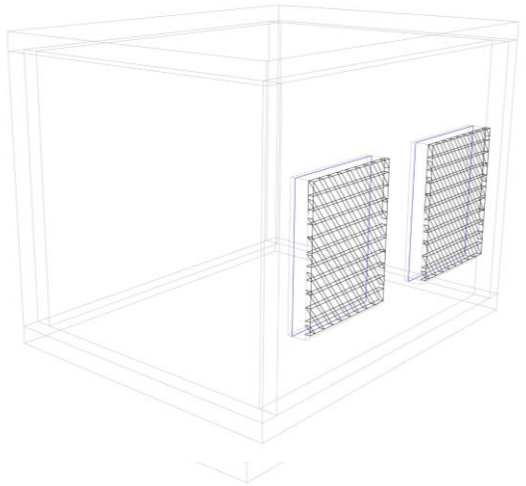
Case 16: Case 15 + Shading
Thermal Comfort: 71.5%
SDA: 98.07



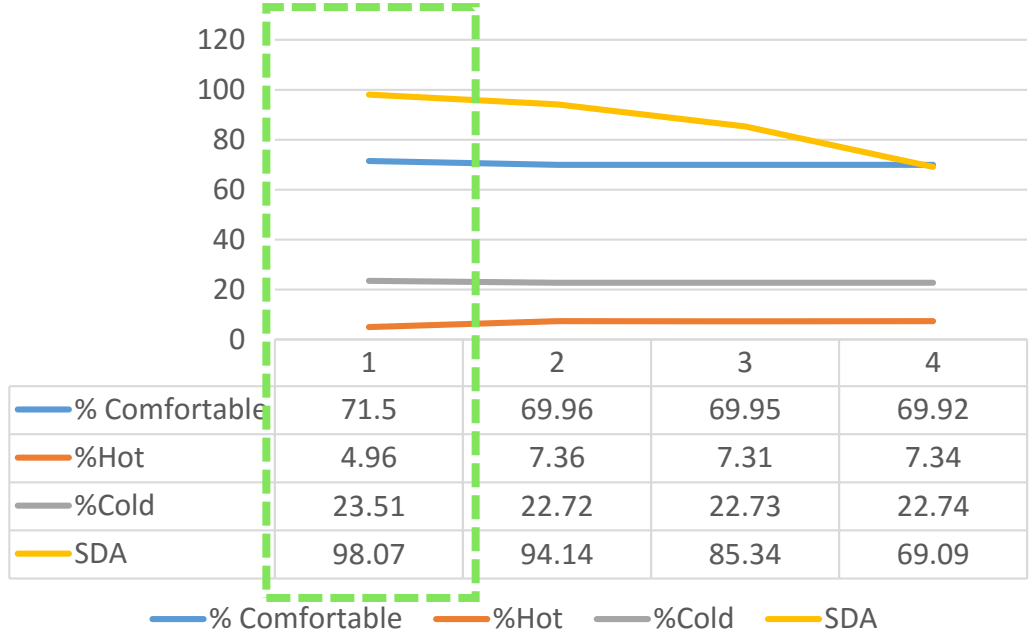
Case 17: Case 15 + Shading
Thermal Comfort: 69.96%
SDA: 94.14



Case 18: Case 15 + Shading
Thermal Comfort: 69.95%
SDA: 85.34



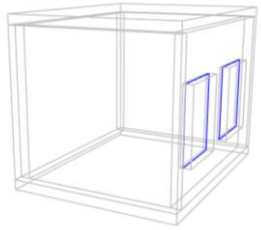
Case 16: Case 15 + Shading
Thermal Comfort: 69.92%
SDA: 69.09

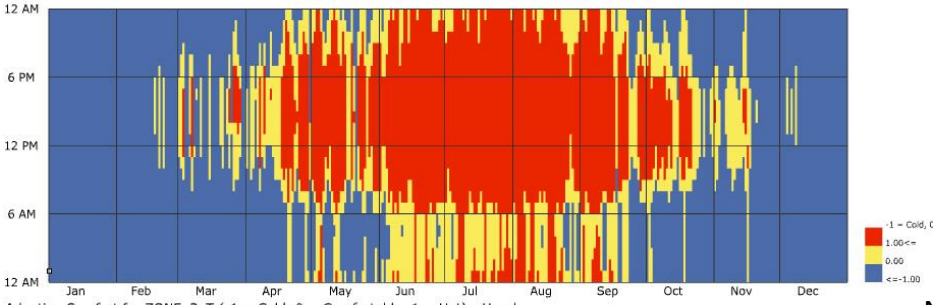


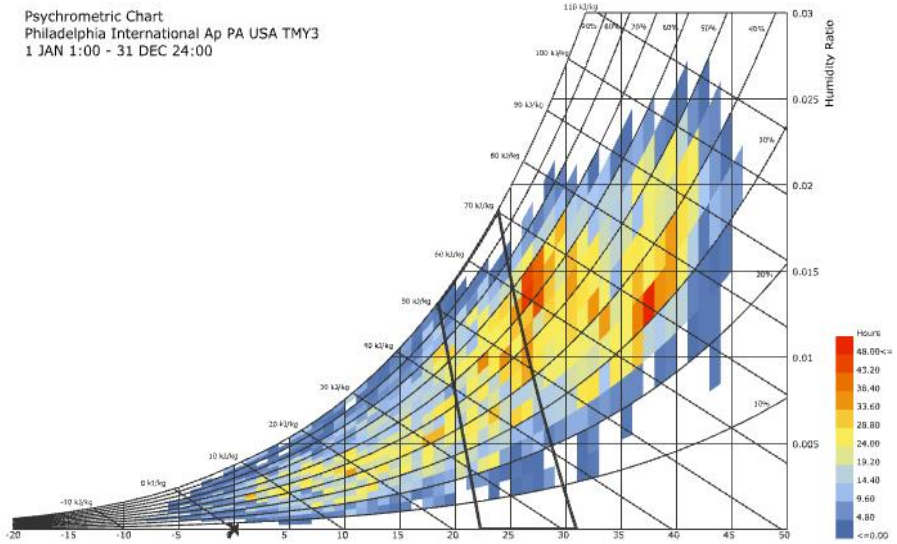

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| % Comfortable | 71.5 | 69.96 | 69.95 | 69.92 |
| %Hot | 4.96 | 7.36 | 7.31 | 7.34 |
| %Cold | 23.51 | 22.72 | 22.73 | 22.74 |
| SDA | 98.07 | 94.14 | 85.34 | 69.09 |

# Energy Simulation | Thermal Comfort & Energy Balance

## Existing Conditions



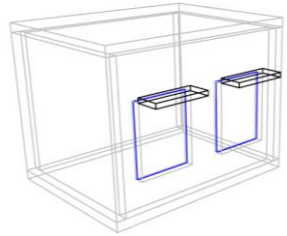


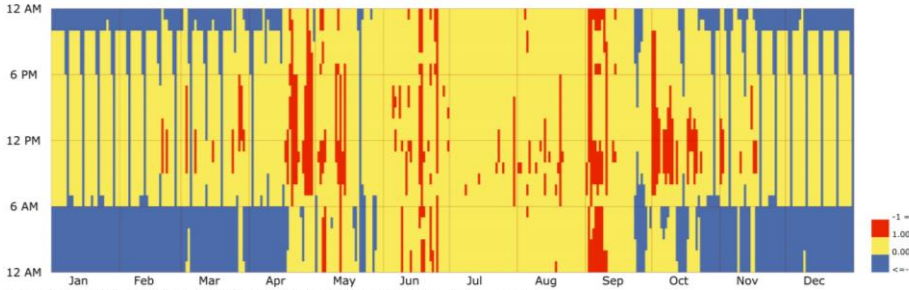



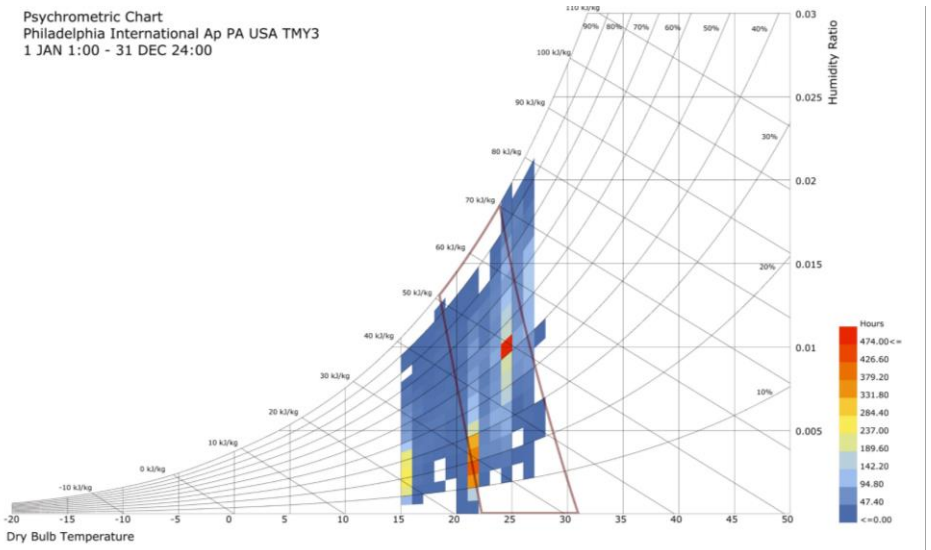

## Differences

| | |
|---|---|
| % Comfortable - 18.00 | % Comfortable - 71.5%% |
| % Hot - 32.56 | Hot - 4.96 |
| % Cold - 49.42 | % Cold - 23.51 |
| SDA - 85.61 | SDA - 98.07 |
| Orientation – 0 | Orientation – 330 degree |
| WWR East – 0.3 | WWR East – 0.2 |
| Wall R Value – 5.5 | Wall R Value – 34.4 |
| Roof R Value – 9.2 | Roof R Value – 34.4 |
| No Blinds | Blinds Specifications |
| | Depth – 0.5m |
| | Number of Blinds - 1 |
| Natural Ventilation – No | Natural Ventilation – Yes |
| | Openable Glazing Are – 1 |
| Air Flow Rate - 2 | Air Flow Rate – 1.5 |

## Improved Conditions






## Common

| | |
|---|---|
| Sill Height - 0.6m<br>Window Height – 1.5m | Not effected by any change |
| Number of Windows on East – 2<br>8 inch Thick Concrete Roof | Any change decreases the comfort percentage |