

**Preliminary Sustainability Analysis  
Al Azhar University - Intermediate college**

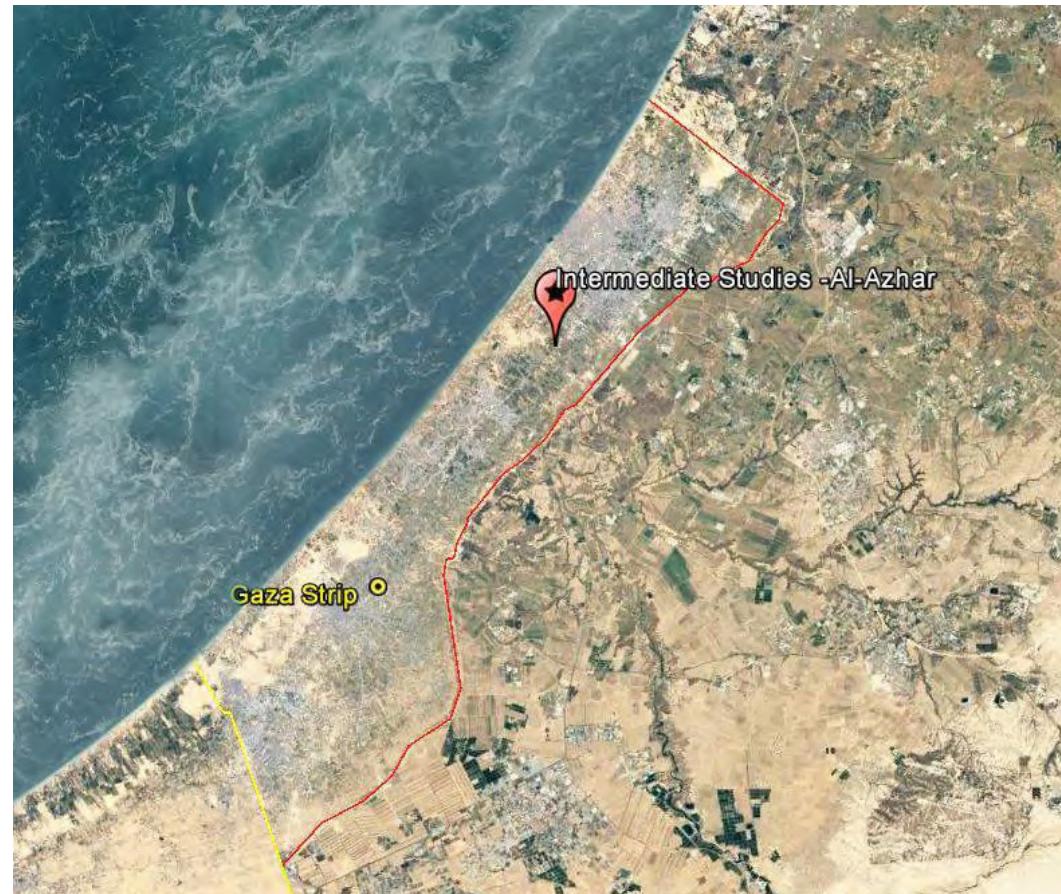
Last updated on : 30th June 2018

# Introduction

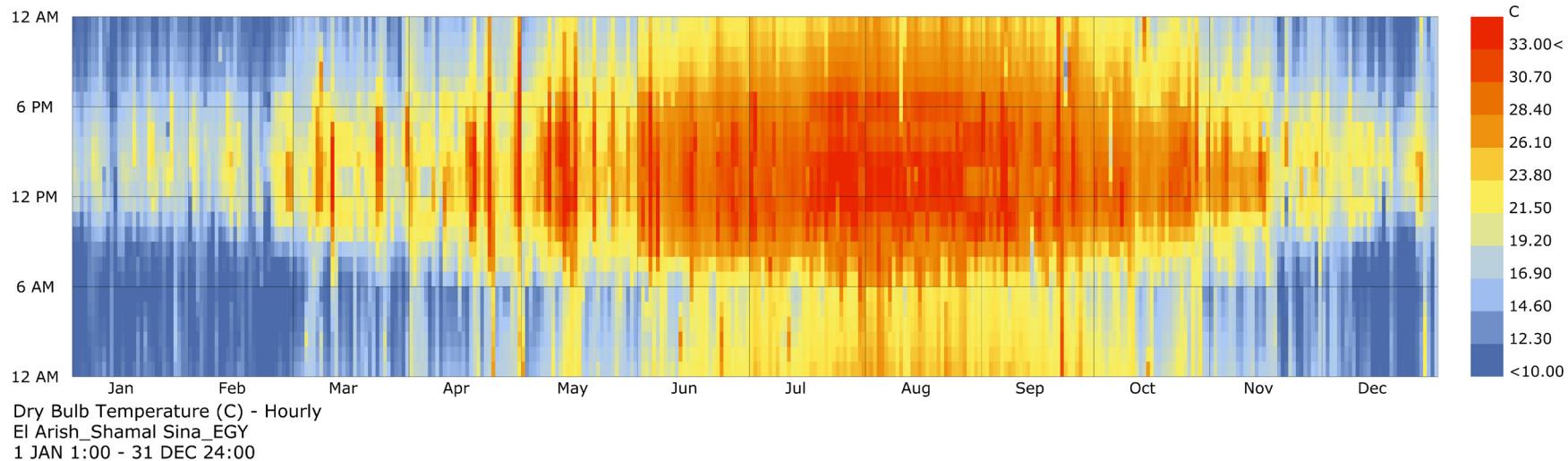
The best opportunities to make an impact on the design and integrate energy saving performance strategies happen during the early stage design. Therefore, this document reports on the climatic performance of the conceptual design and suggests analysis backed performance enhancement strategies.

Historical weather data provide ample clues about the performance strategies to be adopted in early stage design. Therefore, the report starts by review and analysis of local weather. In the absence of historical weather data for a location in Gaza, Typical Meteorological Year (TMY) formatted weather data for a nearby station of **El Arish**, Egypt was chosen. The site is located at approximately 3.5 km from the Mediterranean Sea. And therefore, the climatic conditions at site is expected to be influenced by the Mediterranean Sea. As per weather data, the location falls under the Hot-Humid type under the ASHRAE Zone categories. The other international Koppen climate classification system categorizes this weather as a temperate climate without a dry season and a hot summer.

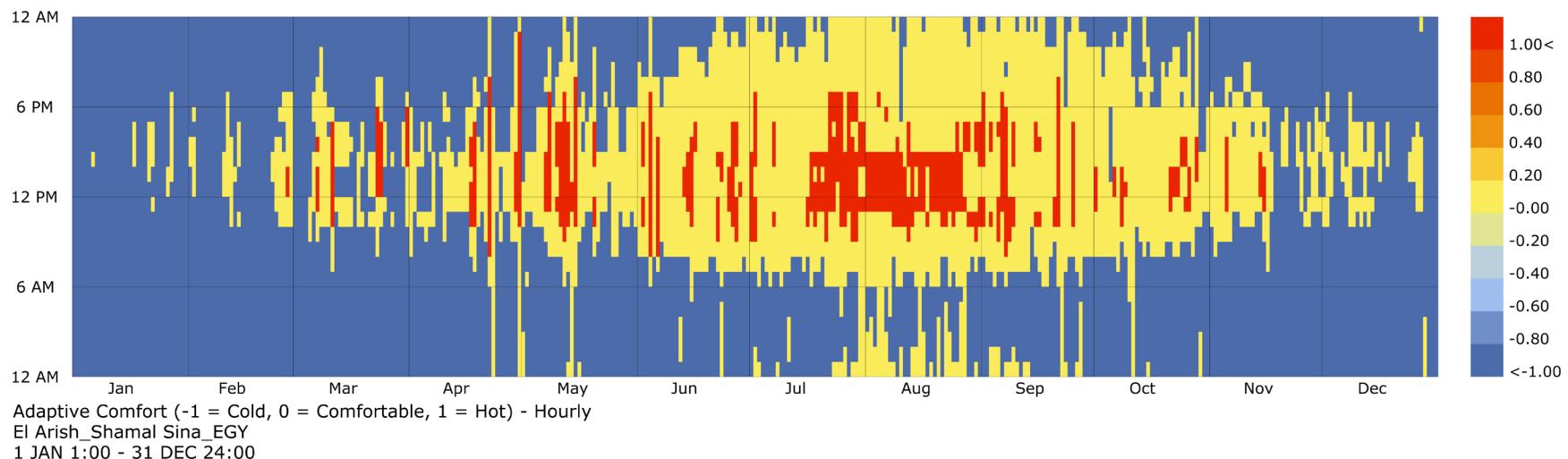
This document starts by reviewing the weather data and then goes into preliminary analysis of climatic variables such as, outdoor shading, incident solar radiation, wind profile at site, annual glare potential, and day-



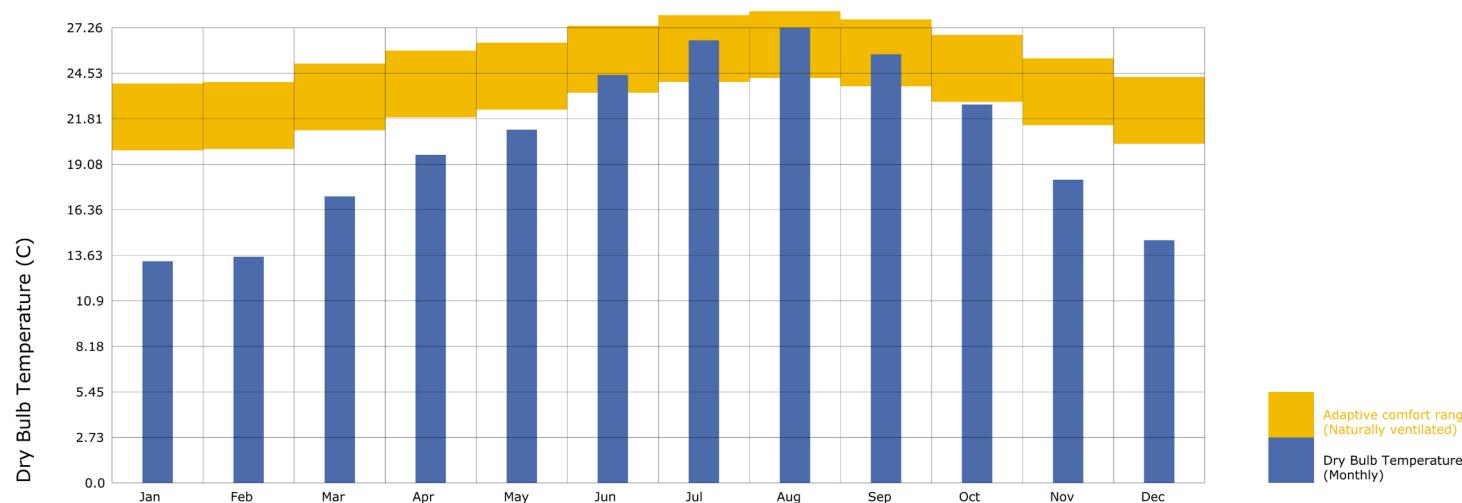
# Weather Data Review



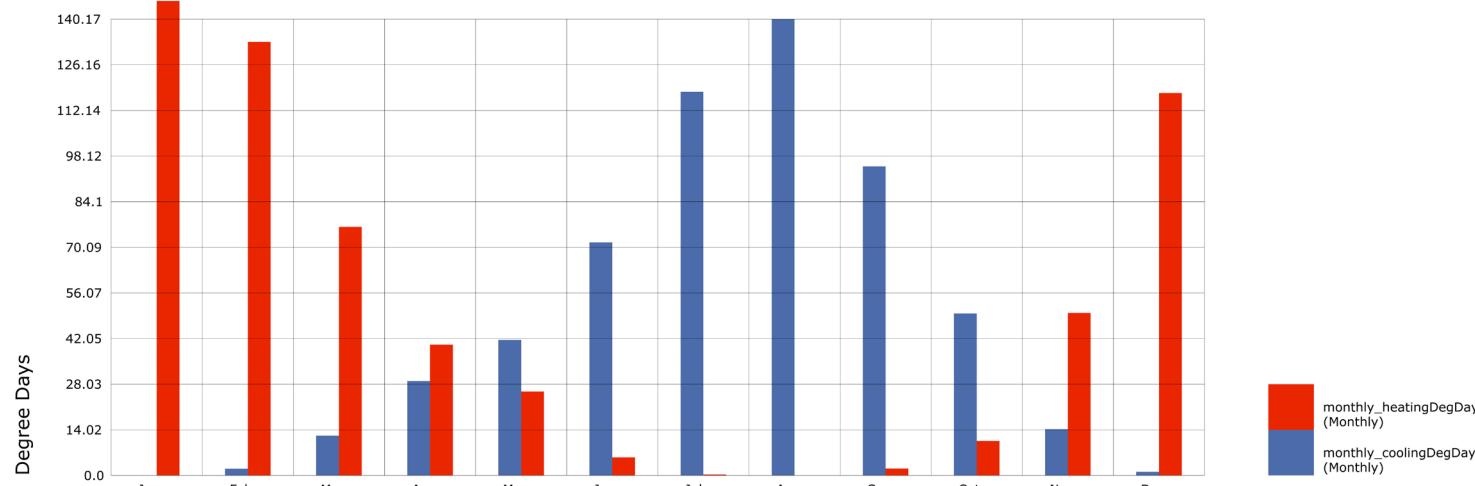
The chart above shows the outdoor dry bulb temperature for all the hours of the year. By running these temperature values through the adaptive comfort model reveals the temperature the occupant may feel. The **adaptive comfort model** was created as a response to the shortcomings of the famous PMV comfort model for the air conditioned buildings. The adaptive comfort model was built on the work hundreds of field studies in which people in naturally ventilated buildings were asked how comfortable they felt. In these studies, it was observed that the occupants of naturally ventilated buildings tended to adapt themselves to the monthly mean temperature as long as the building temperature value remained close to that monthly mean temperature. This situation held true as long as the monthly mean temperature remained above 10C and below 33.5C. The adaptive comfort model is first mentioned in **ASHRAE 55**.



# Weather Data Review



In the chart on the left, monthly mean temperatures are mapped against the adaptive comfort range. For at least four months in the year, the average monthly outdoor air temperature remains within the comfort range. Natural ventilation shall be fully utilized during these months.



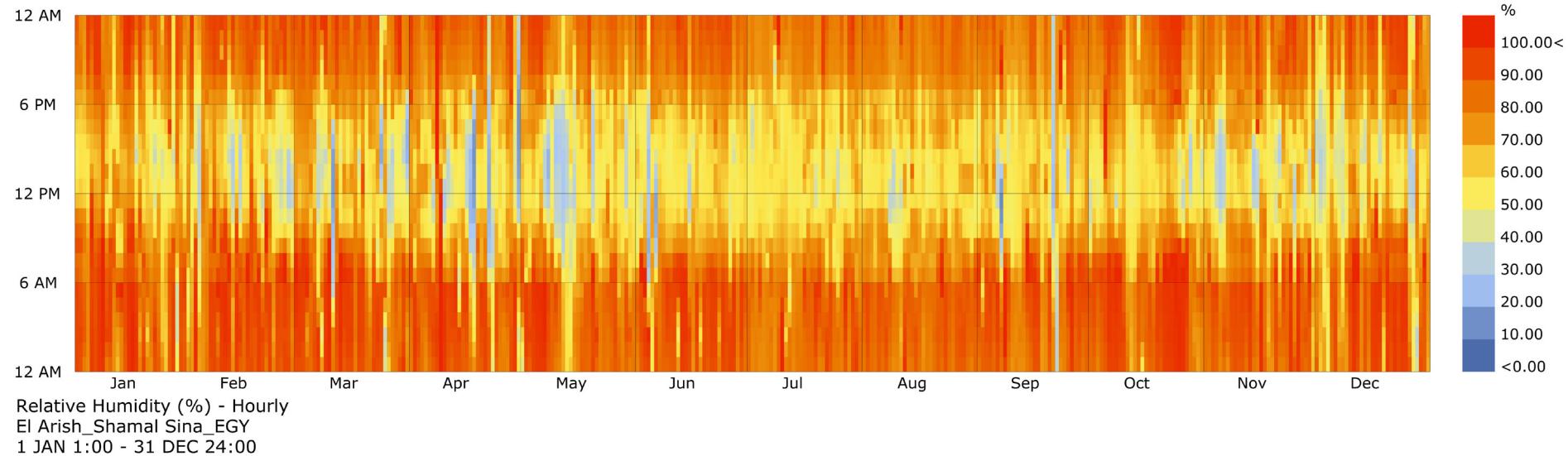
The chart below shows cooling degree days and heating degree days for base temperatures of 23.3C for cooling and 18.3C for heating. Traditionally, degree days are defined as the difference between the base temperature and the average ambient air temperature multiplied by the days that this difference exists.

It is evident from these two charts that solar radiation on the envelope will be desired in the winter months and will

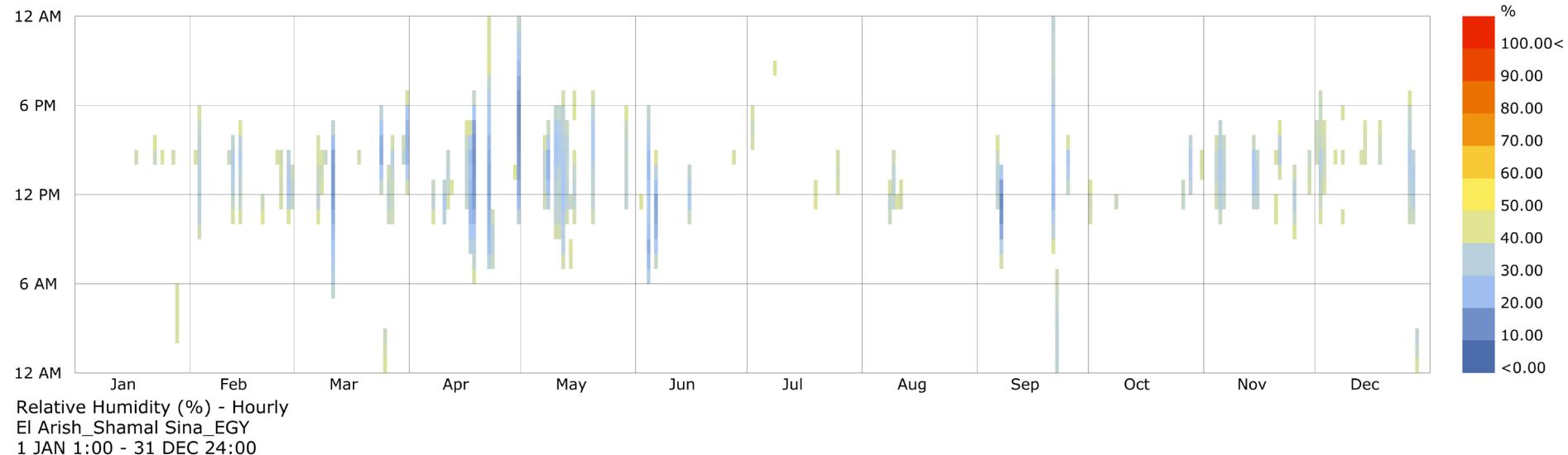
This chart on the left shows cooling degree days and heating degree days for base temperatures of 23.3C for cooling and 18.3C for heating. Traditionally, degree days are defined as the difference between the base temperature and the average ambient air temperature multiplied by the days that this difference exists.

It is evident from these two charts that solar radiation on the envelope will be desired in the winter months and will have to be reduced during the summer months.

# Weather Data Review

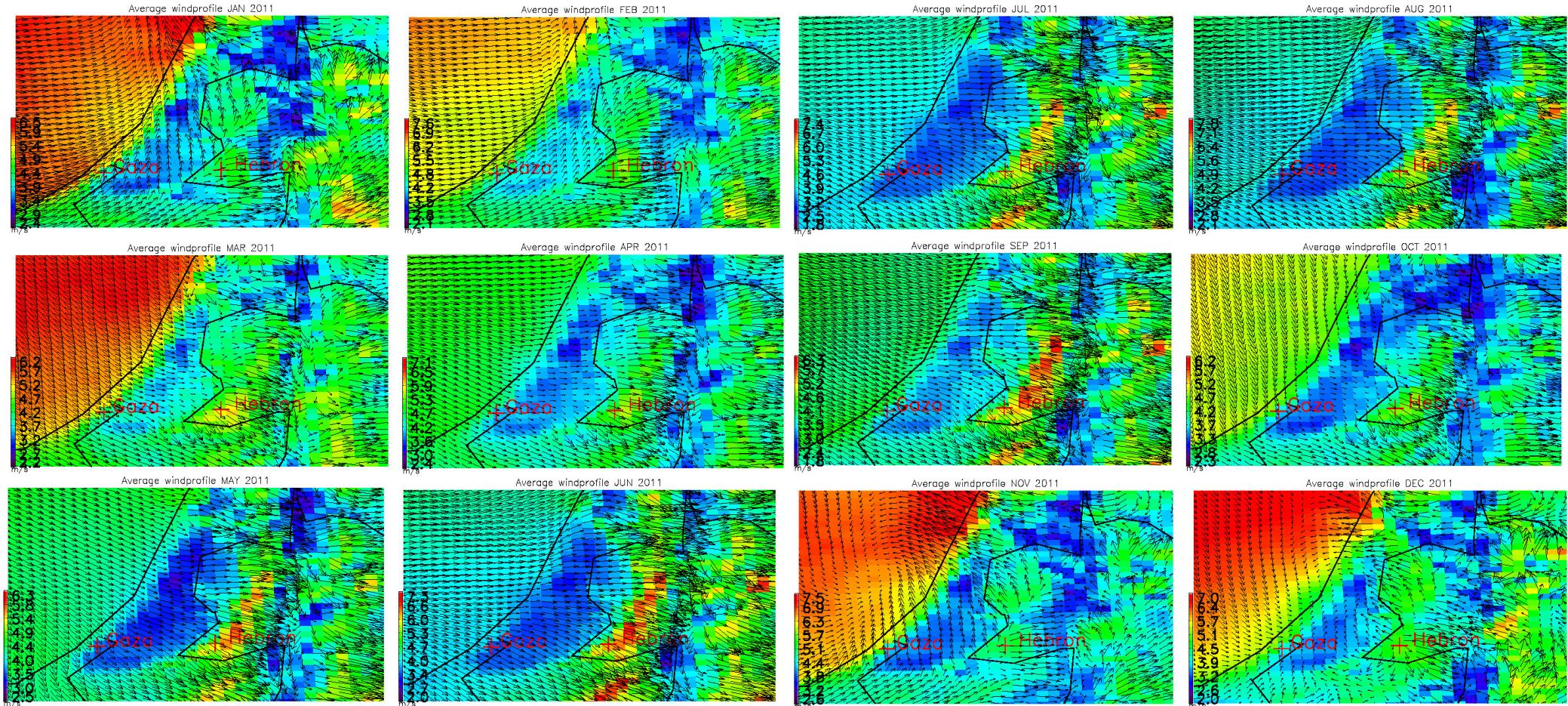


The chart above shows relative humidity for all the hours of the year, and the chart below shows only the hours of the year when the relative humidity is less than 40%. It is evident that the weather remains mostly humid throughout the year.



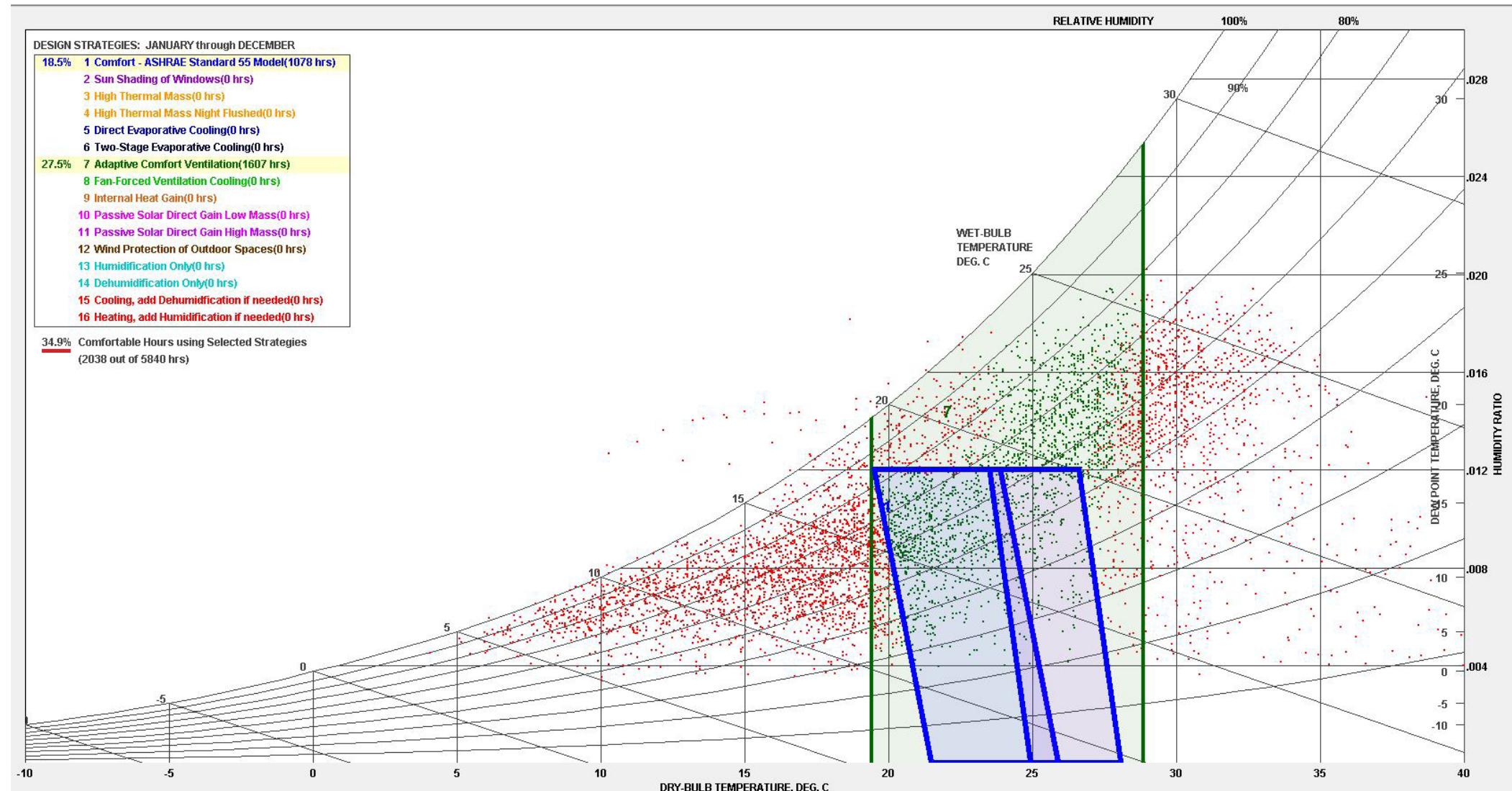
# Weather Data Review

The charts below show the prevailing wind direction experienced in Gaza for all the months of the year. It is evident that for the significant time of the year, the wind comes from the Mediterranean Sea. Openings in the building shall preferable placed perpendicular to these winds in order to take advantage of the natural ventilation whenever outdoor air temperature is within the comfort range.



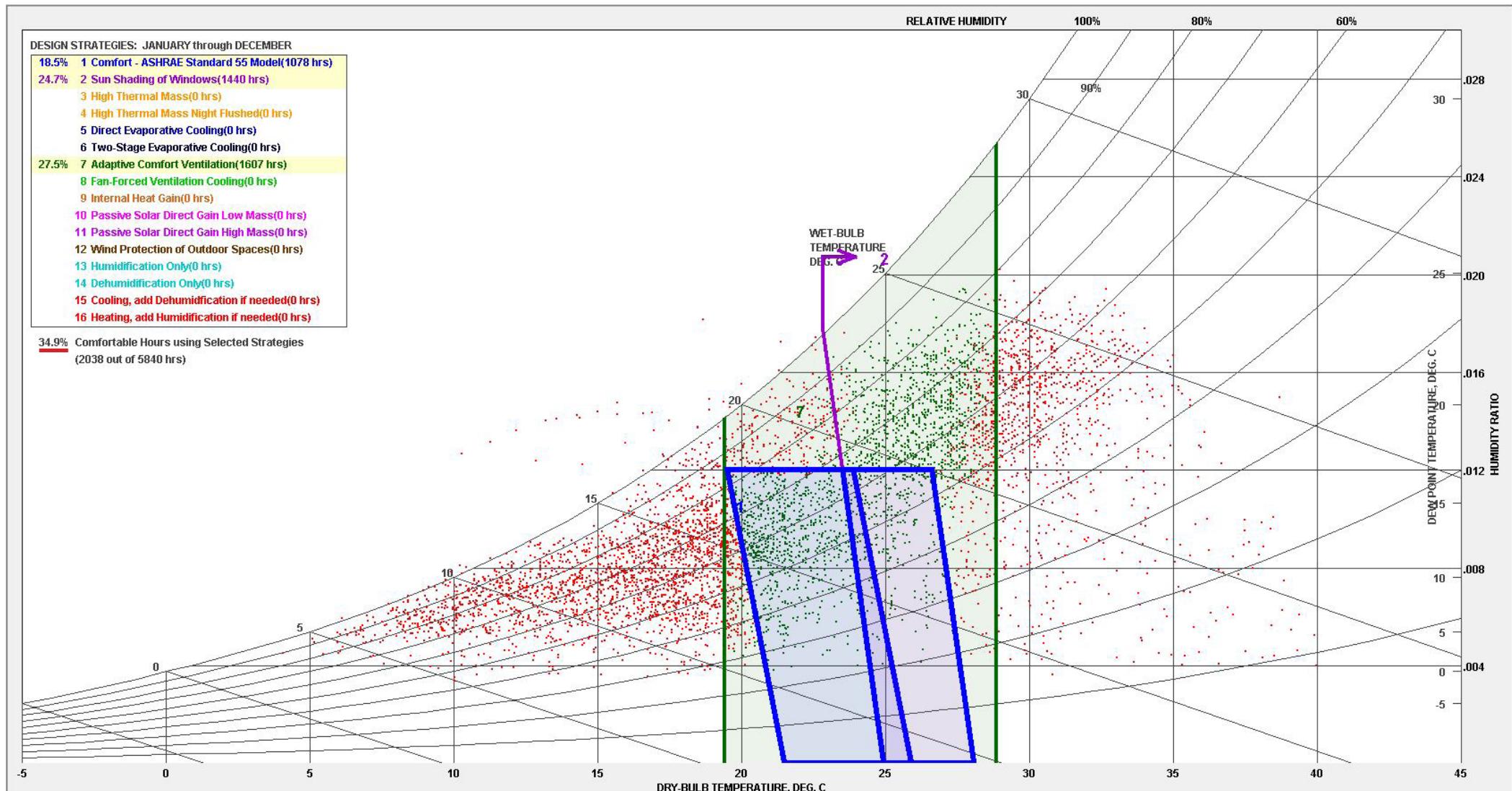
# Weather Data Review

A psychrometric chart shows the hours of the year that fall within the comfort polygon. The comfort polygon on the psychrometric chart is drawn based on Predicted Mean Vote (PMV) model. This chart substantiates the preceding observations. For most of the hours, relative humidity remains more than 50%. **18.5%** of the time, the occupants will feel comfortable with the climate conditions. As per adaptive comfort model, an additional **37.5%** of the time the occupants can feel comfortable with the natural ventilation. On the following pages, effect of different passive strategies on the comfort of the occupants is displayed.



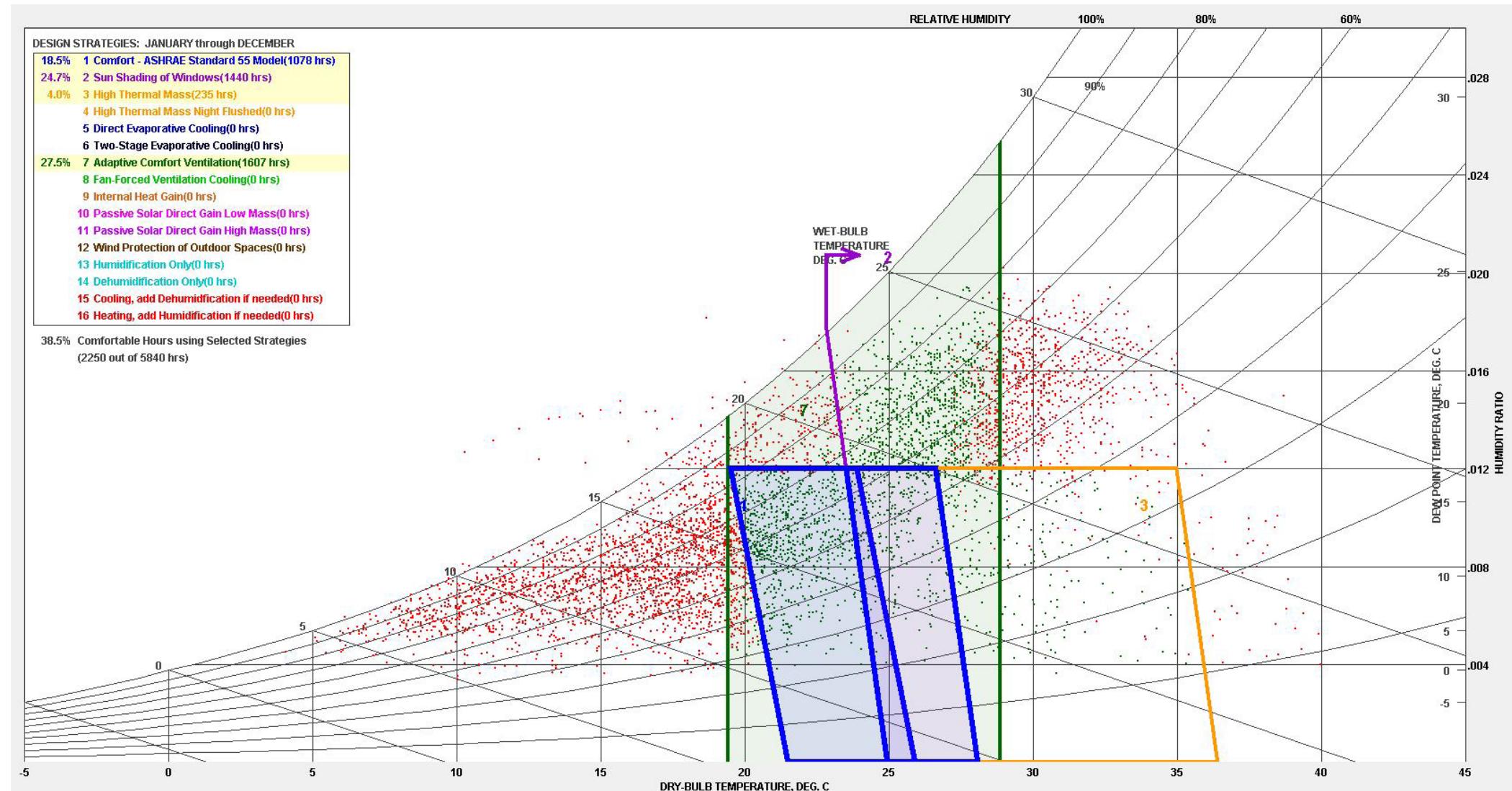
# Weather Data Review

Adding protective shading on the windows will help in achieving comfort for at least **24.7%** of the time during the occupied hours.



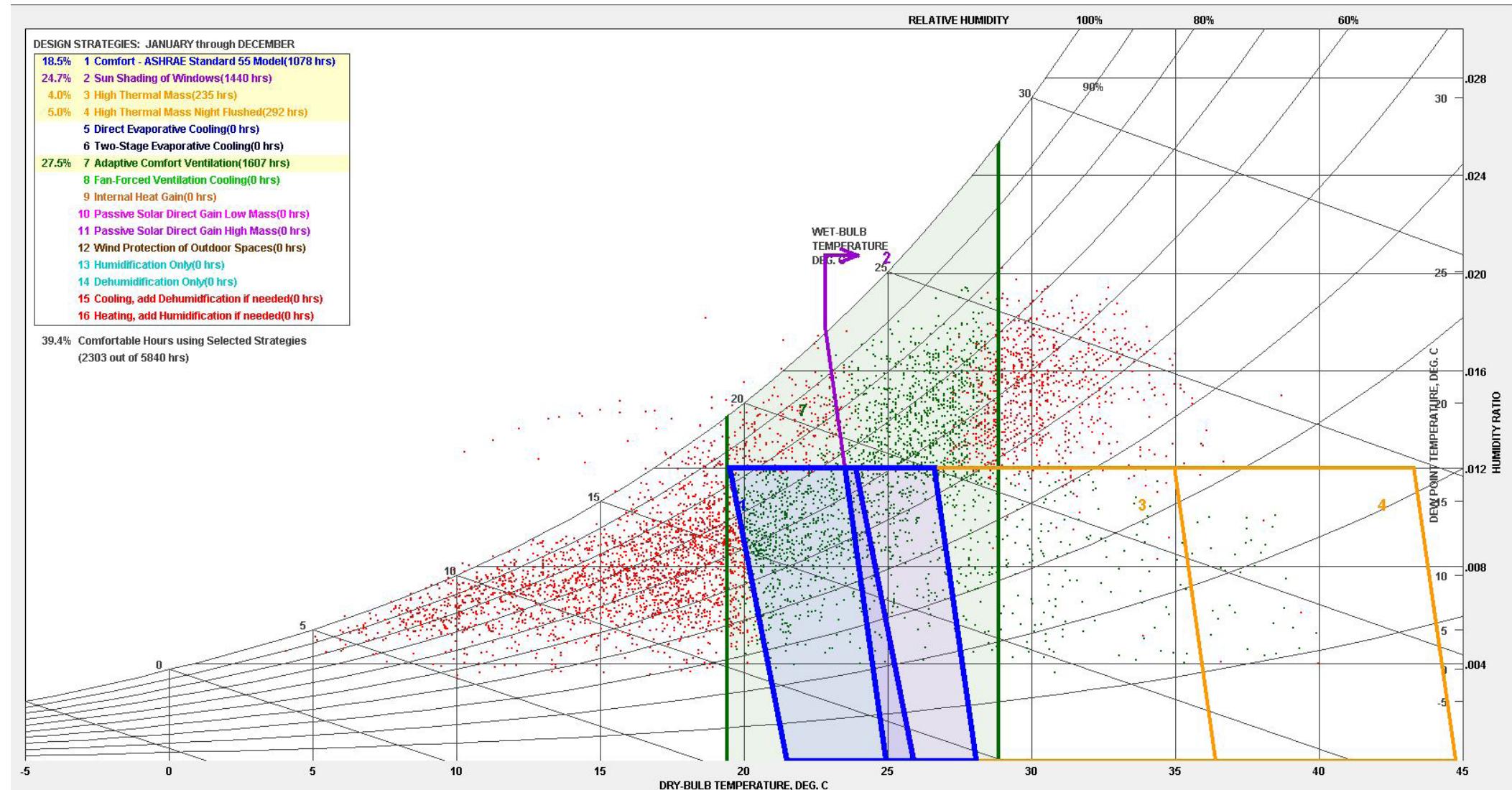
# Weather Data Review

Adding thermal mass to the envelope can help in achieving comfort for at least **4%** of the time.



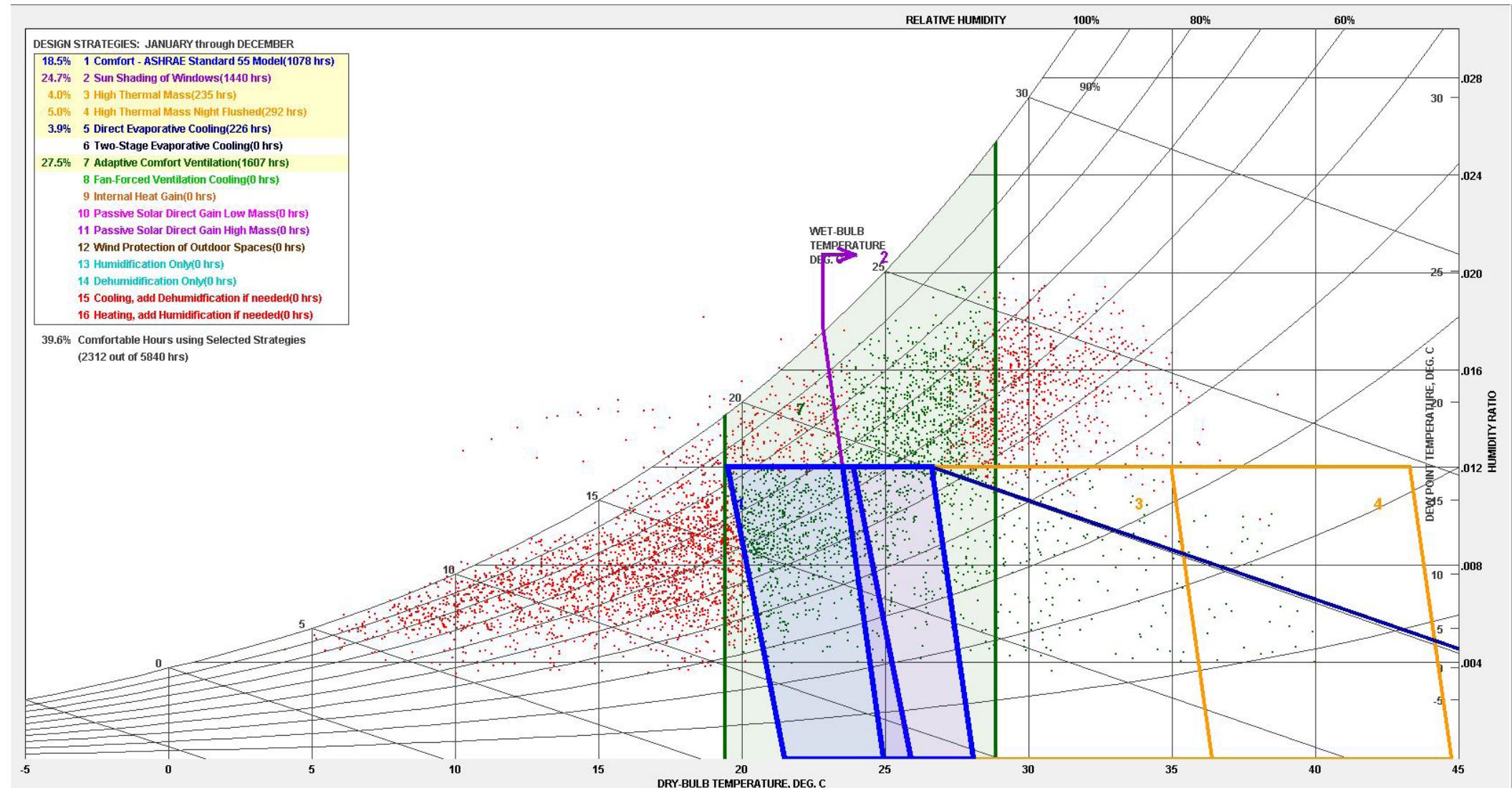
# Weather Data Review

Using night flush can help in achieving comfort for at least **5%** of the time.



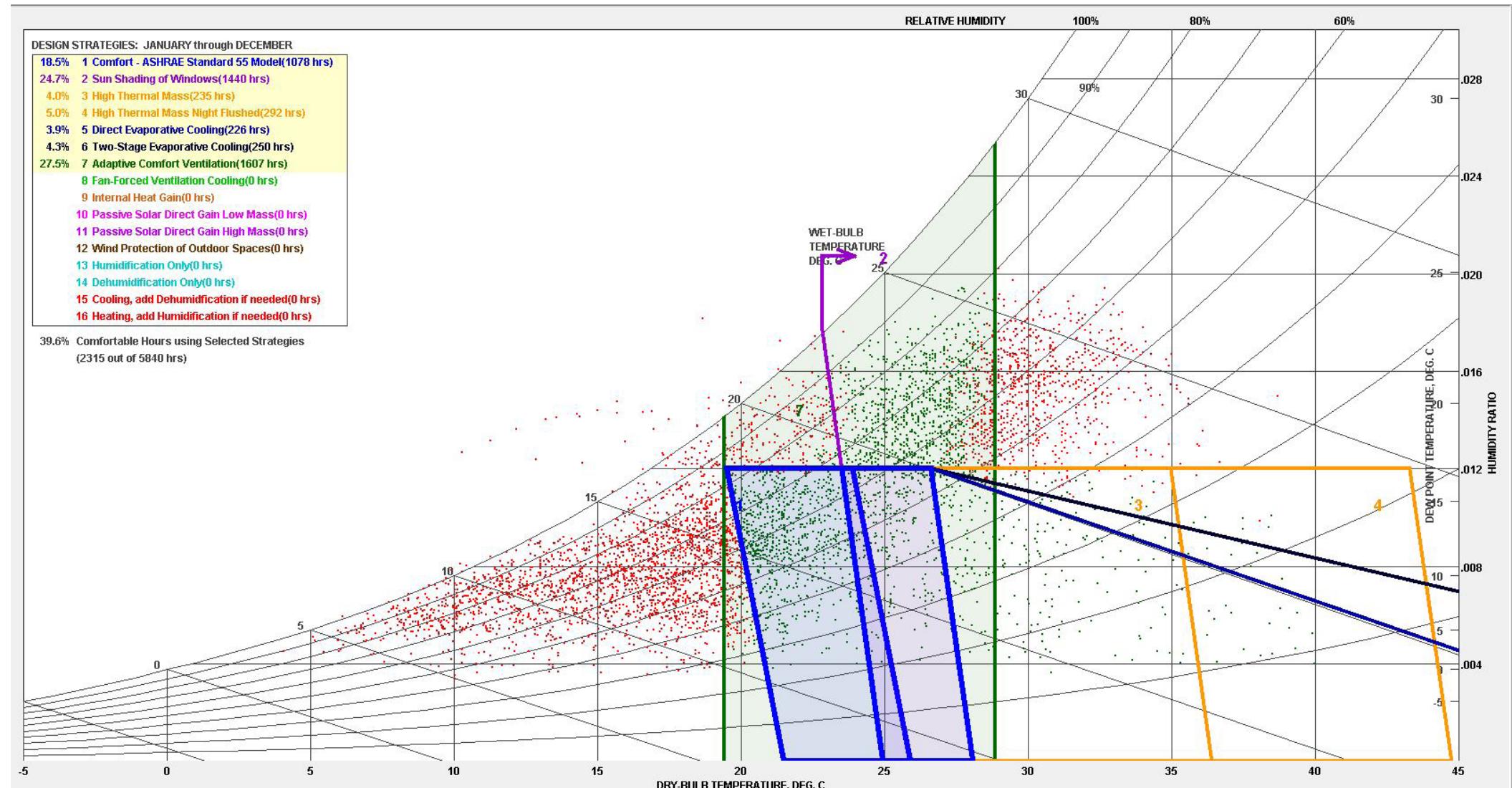
# Weather Data Review

Due to high amount of humidity in the air throughout the year, direct evaporative cooling can help only **3.9%** of the time.



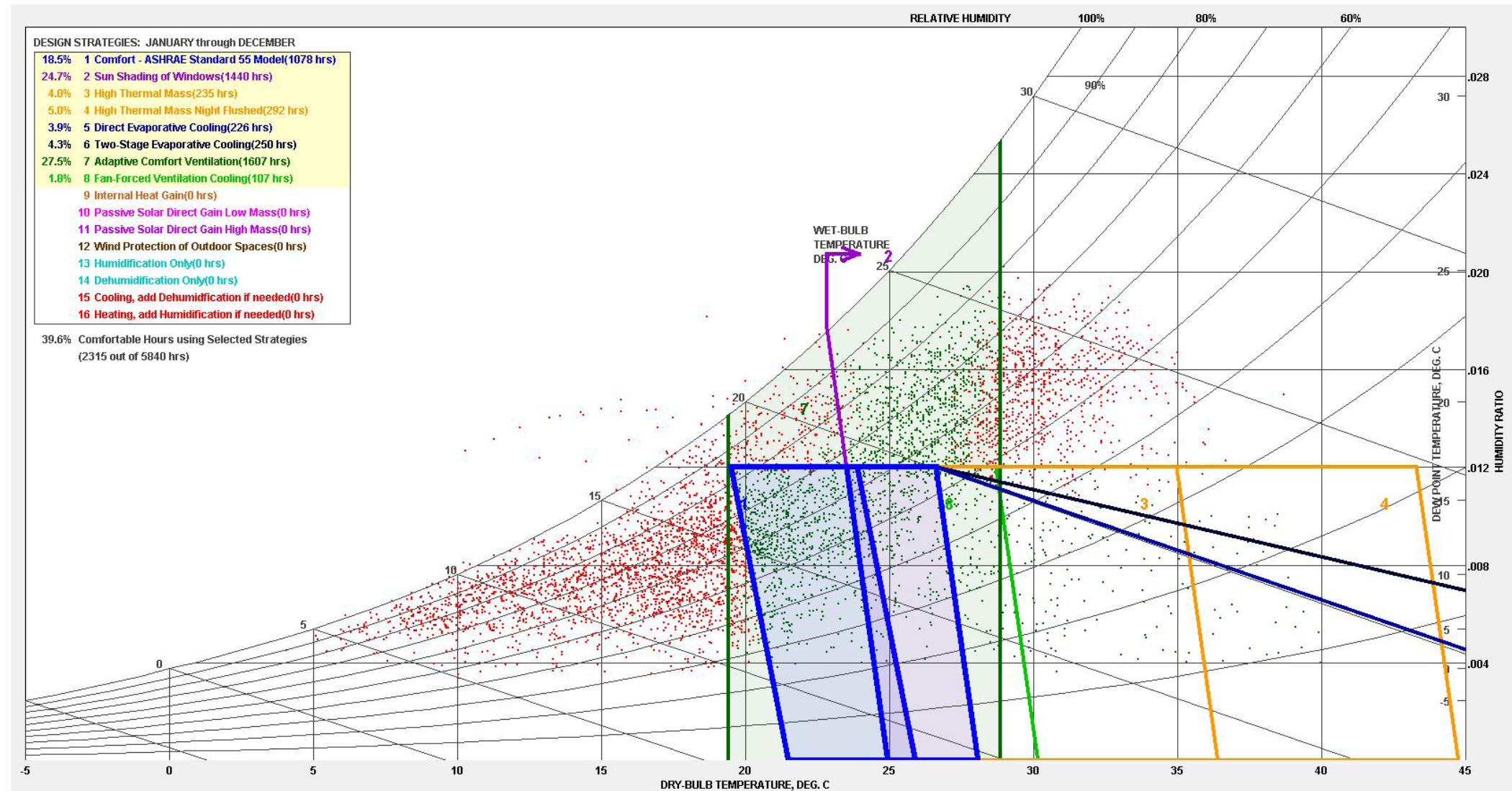
# Weather Data Review

Due to high amount of humidity in the air throughout the year, two stage evaporative cooling can help only **4.3%** of the time.



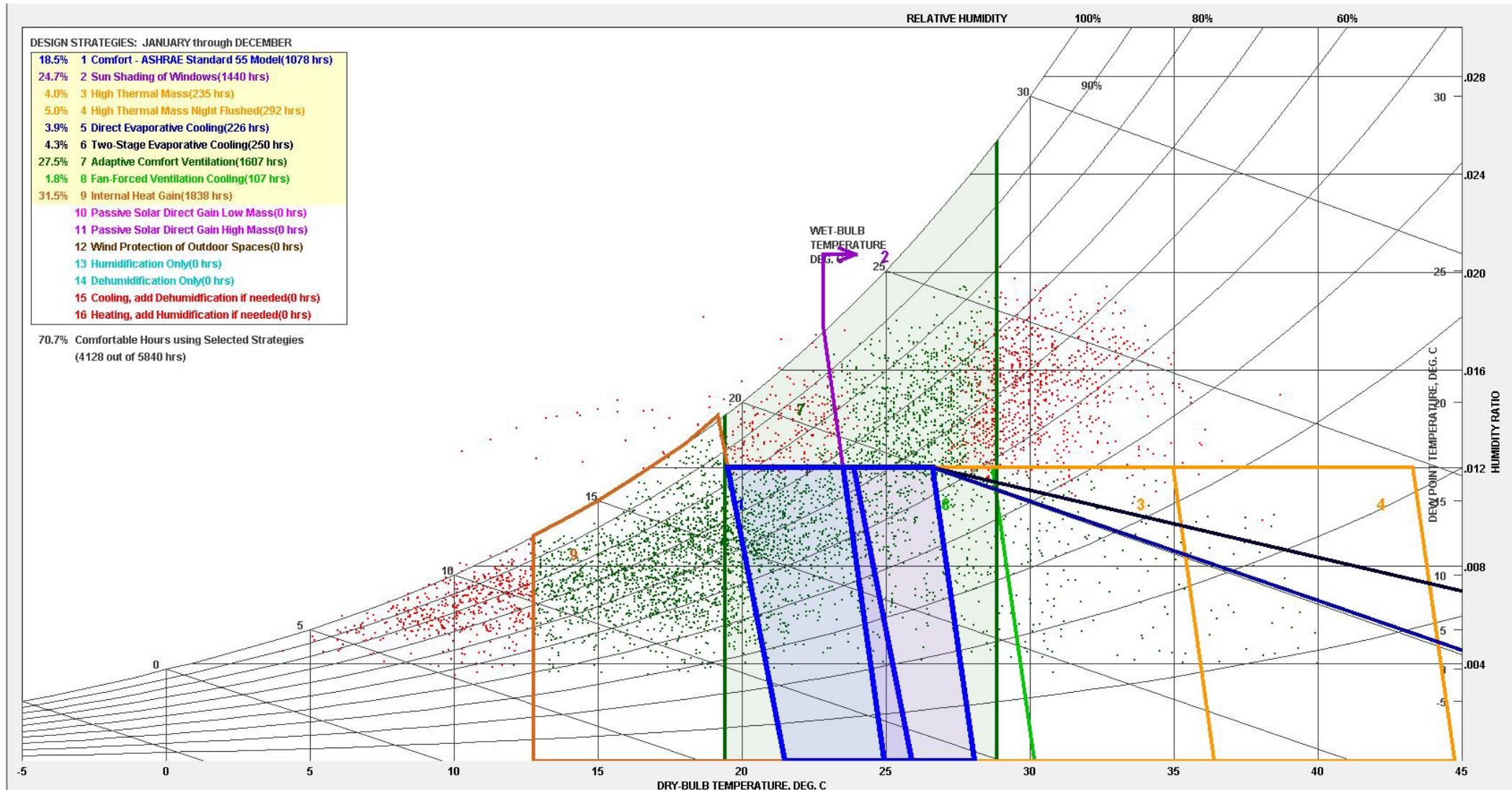
# Weather Data Review

Having running fans can **1.8%** of the time in making occupants comfortable.



# Weather Data Review

Using envelope to trap heat generated by the occupants, equipments, and lights can help **31.5%** of the time in making occupants comfortable.



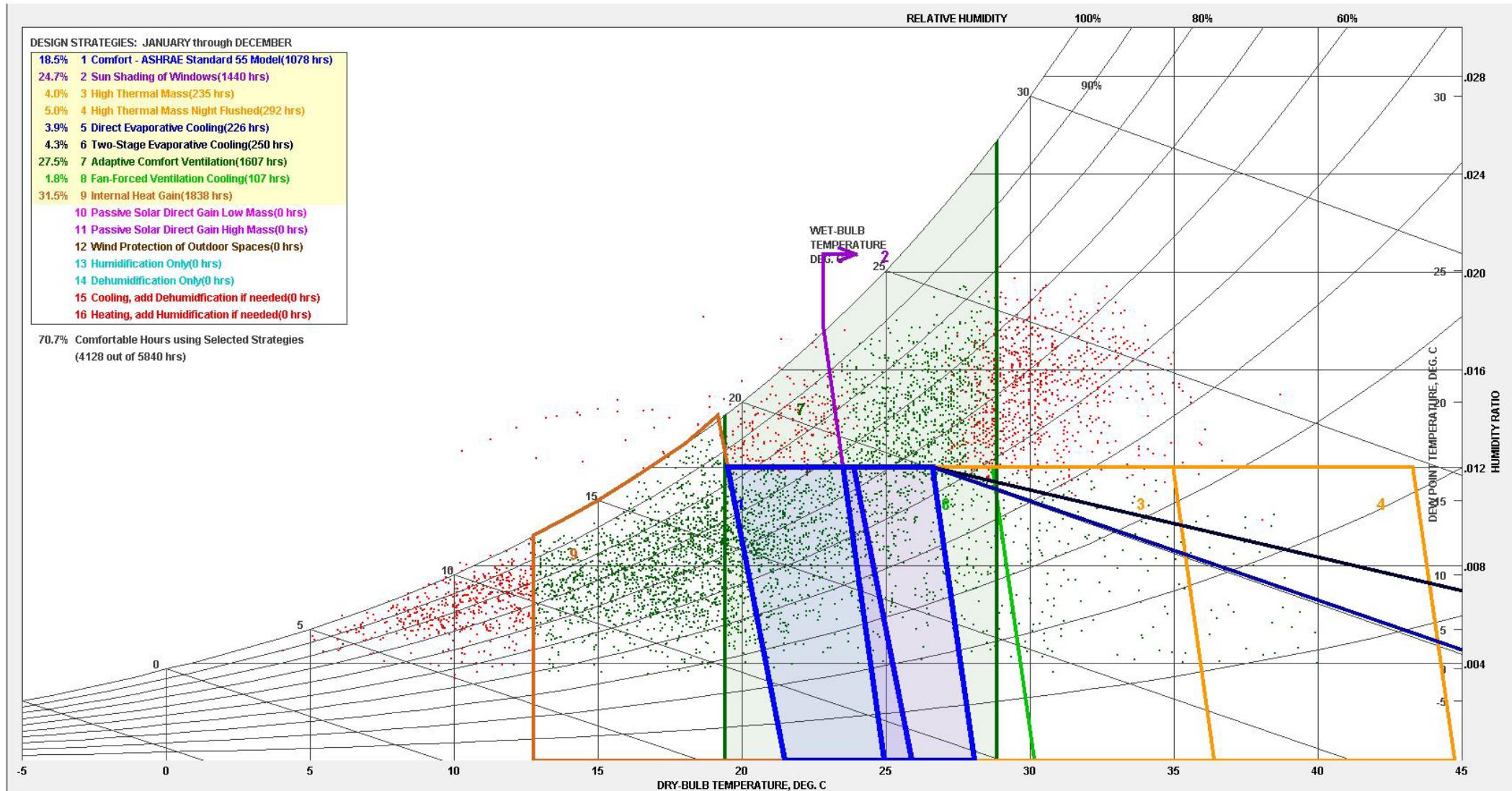
# Weather Data Review

Strategically using envelope to receive solar heat gain can help **16.2%** of the time in making occupants comfortable.

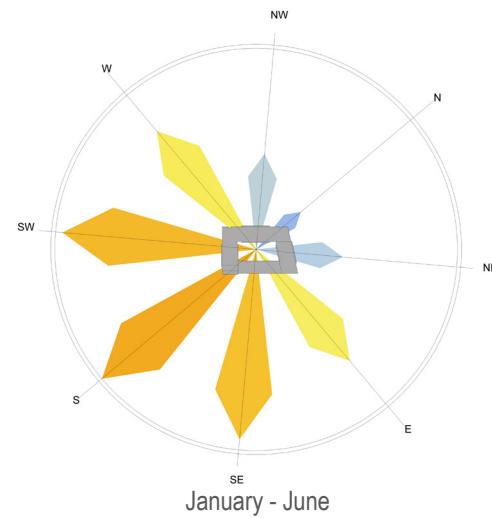
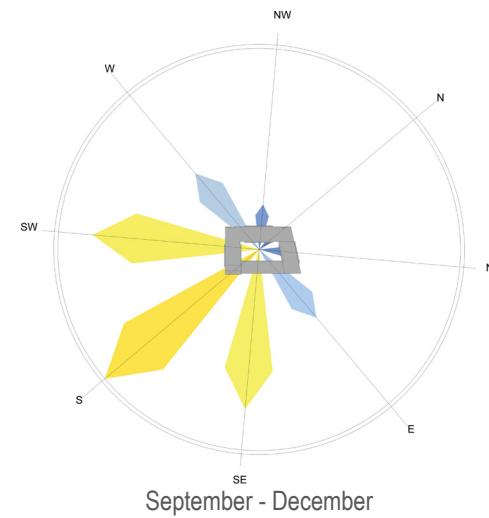
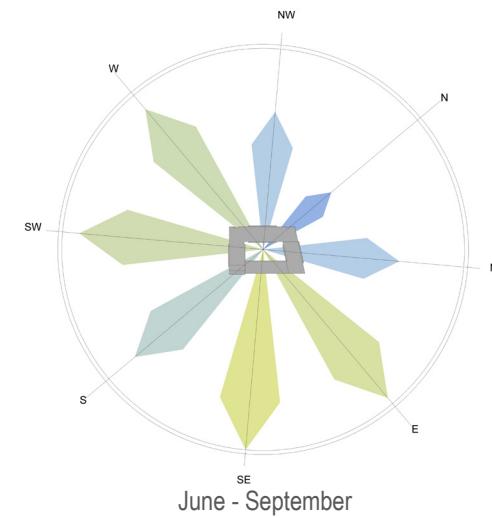
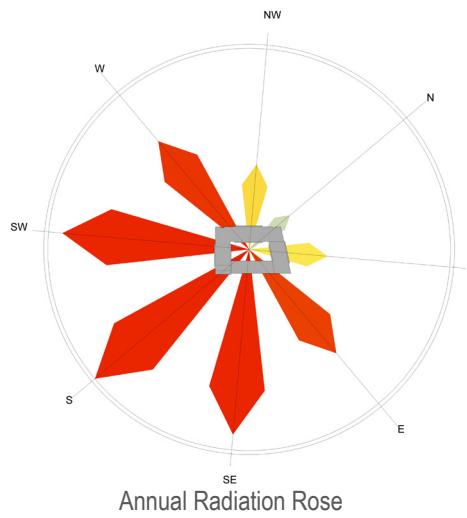
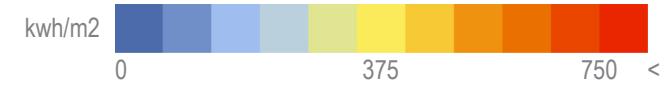


# Weather Data Review

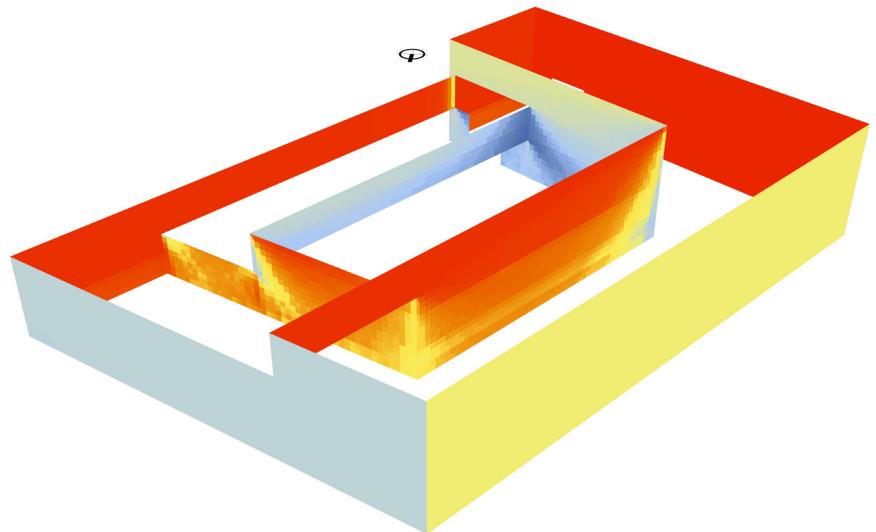
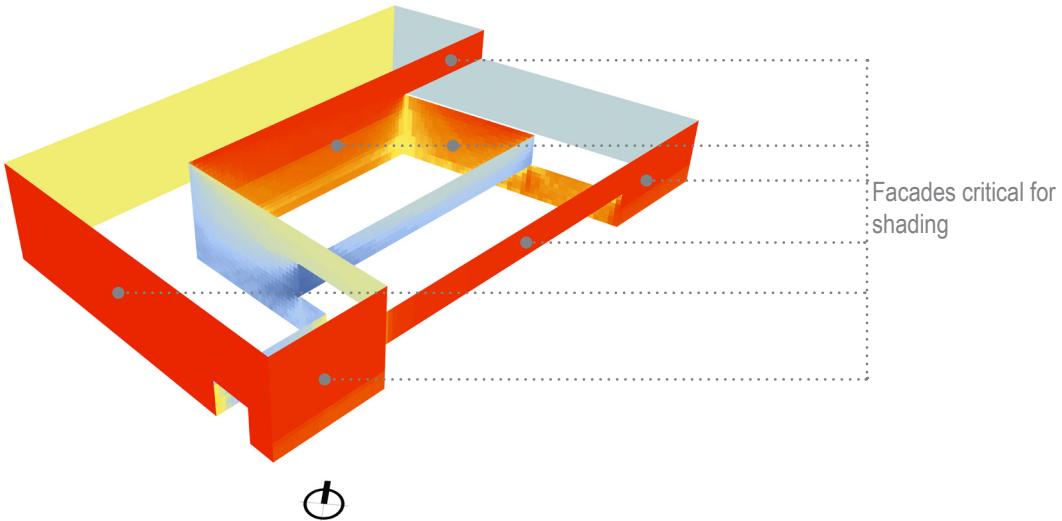
Strategically using envelope to receive solar heat gain can help **16.2%** of the time in making occupants comfortable.



# Preliminary Analysis

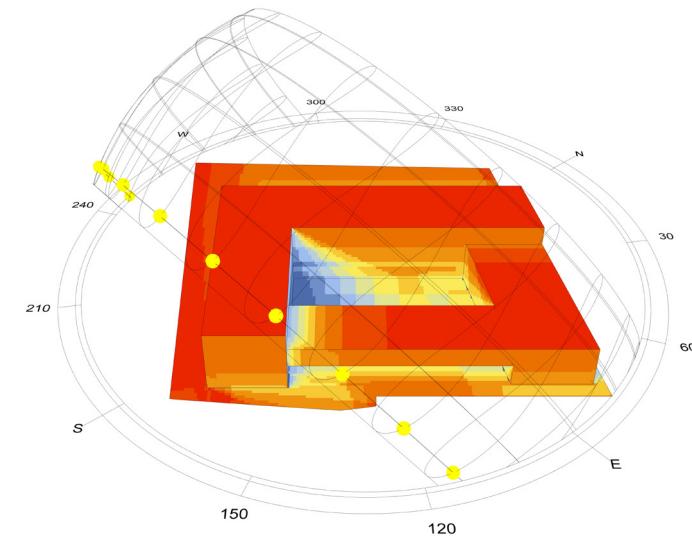
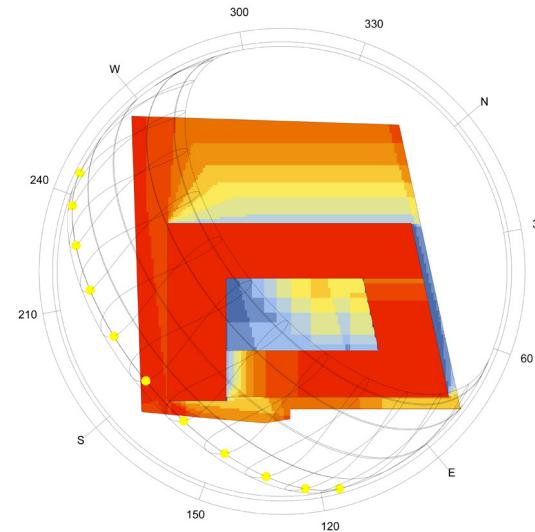
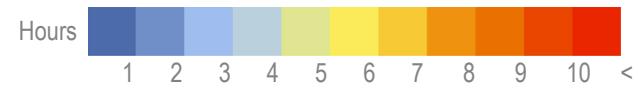


Radiation roses offer shows the amount of **radiation** coming from different directions. It is evident from the roses that during the months of June to September, maximum radiation comes from the east and the west. However, during the months of December to June, maximum radiation comes from the south, south-east and the south-west. The images on the bottom show annual total incident radiation on the façade. The façade strategies will have to be developed to reduce radiation during the summer months and receive radiation in the winter months specifically in the areas in red.

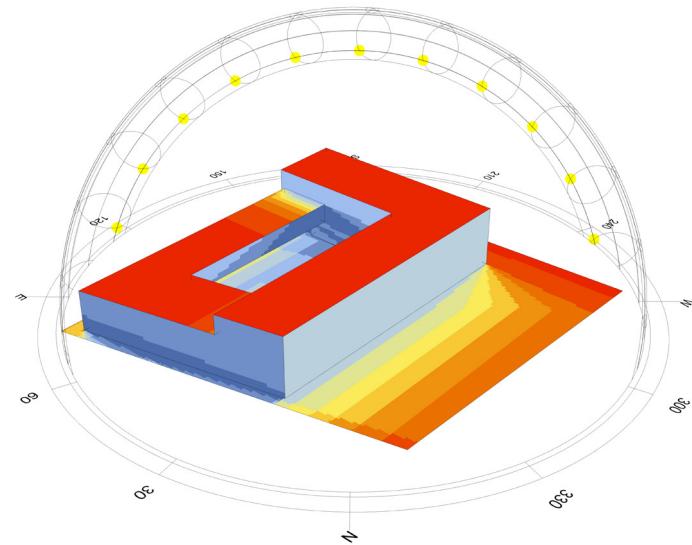
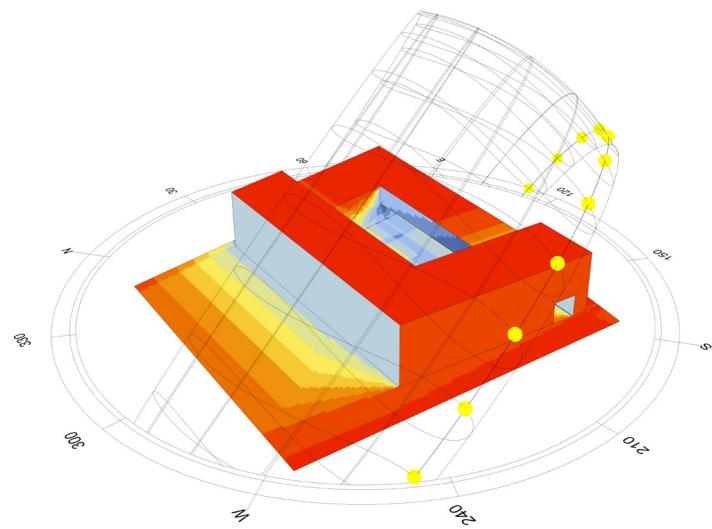


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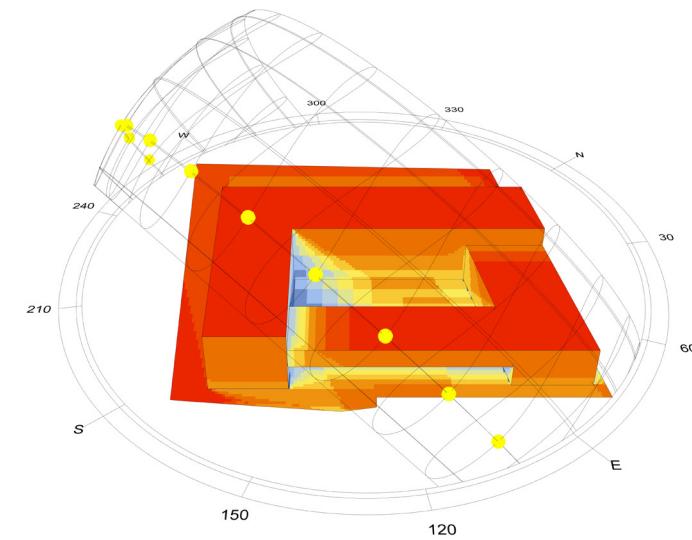
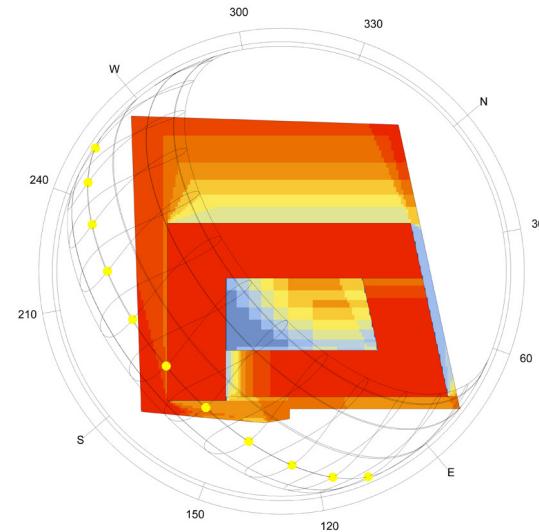
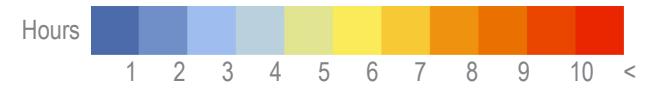
These diagrams show the number of **sunlight hours** a particular point receives throughout the day. The areas in the red receive more than 10 hours of sunlight in the mentioned day.



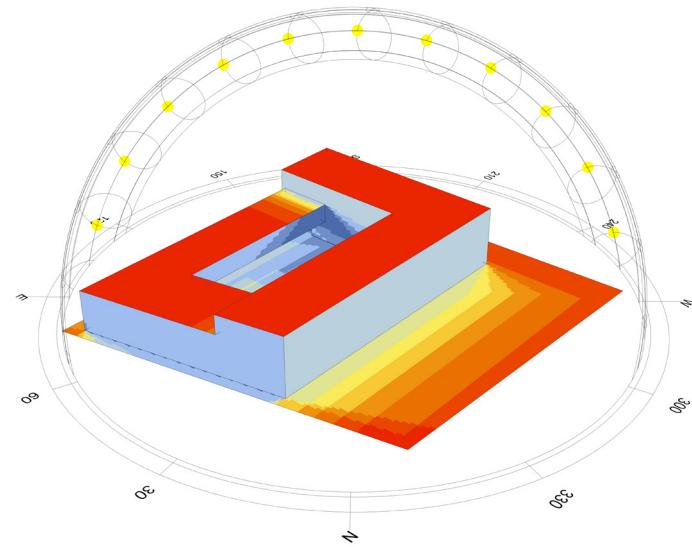
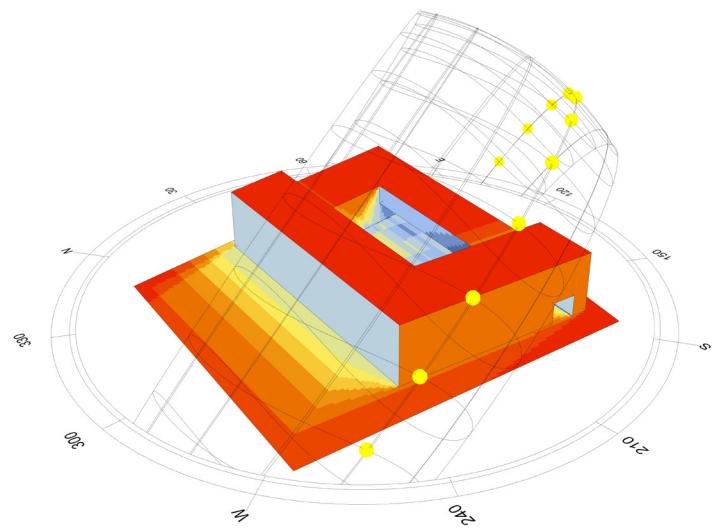
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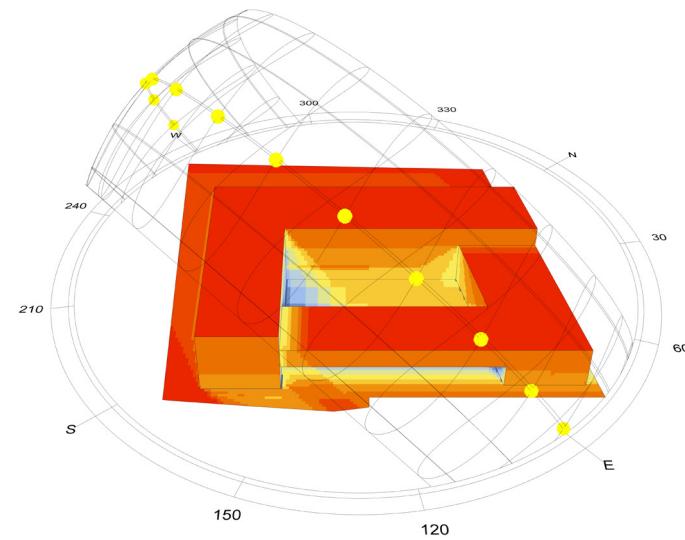
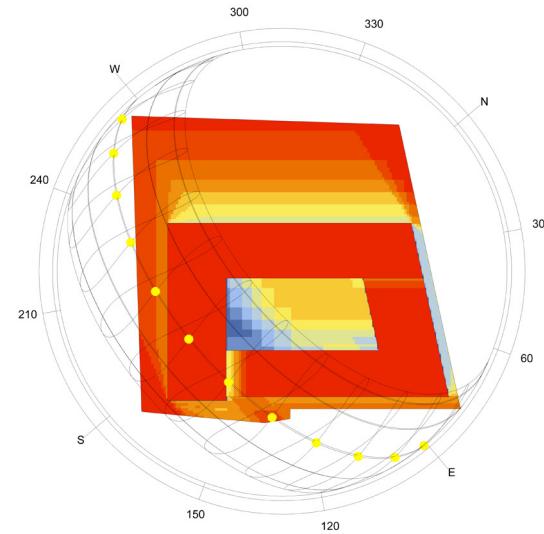
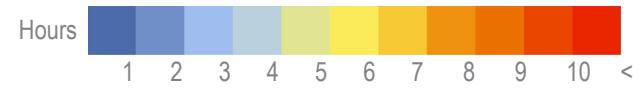
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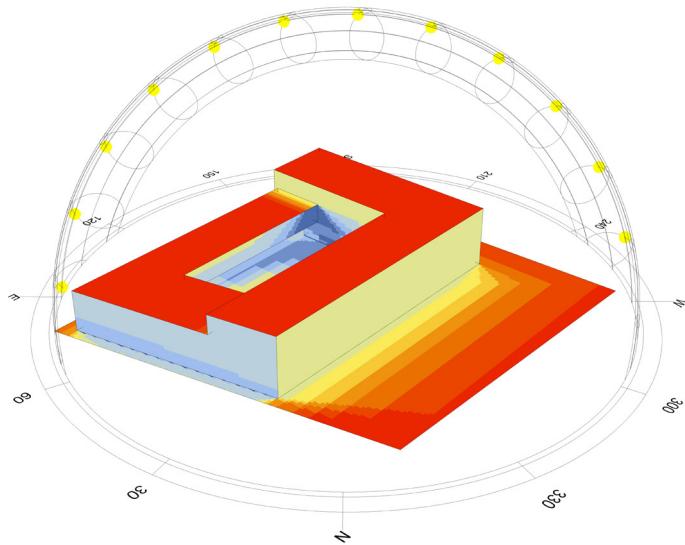
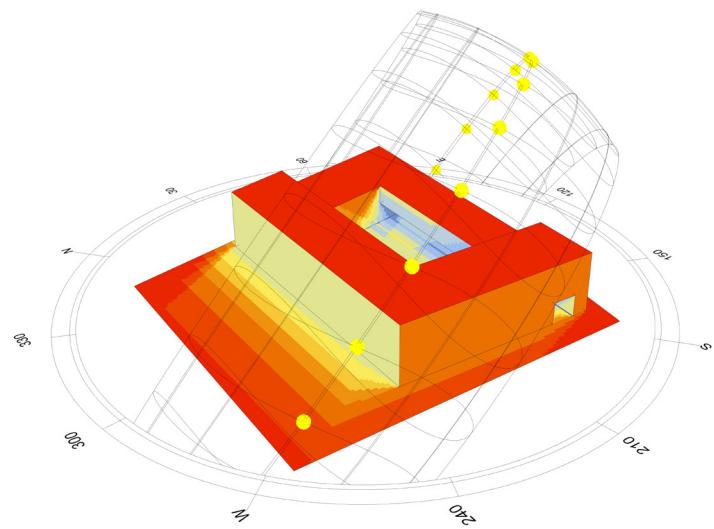
Feb 21st



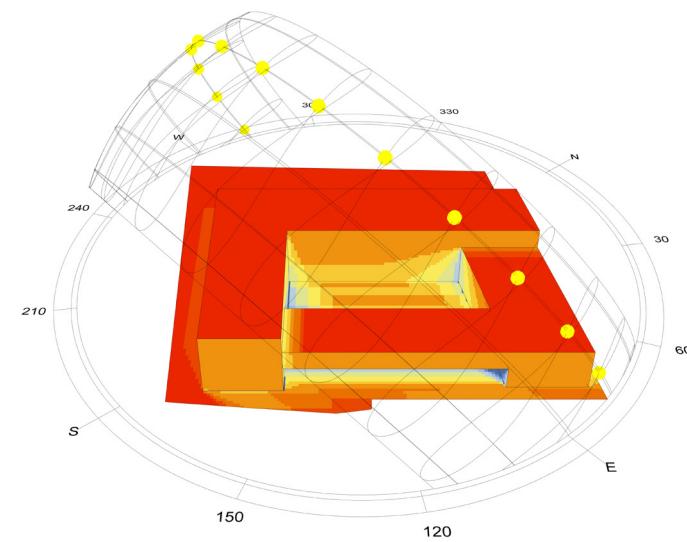
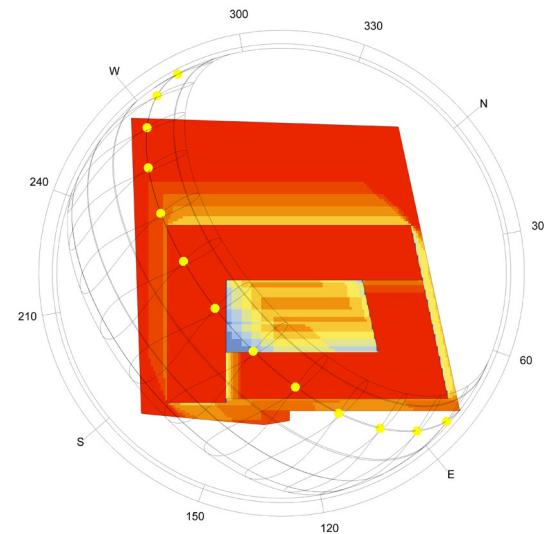
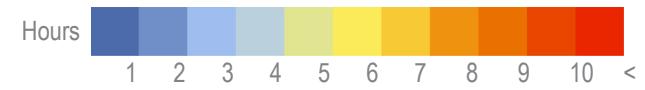
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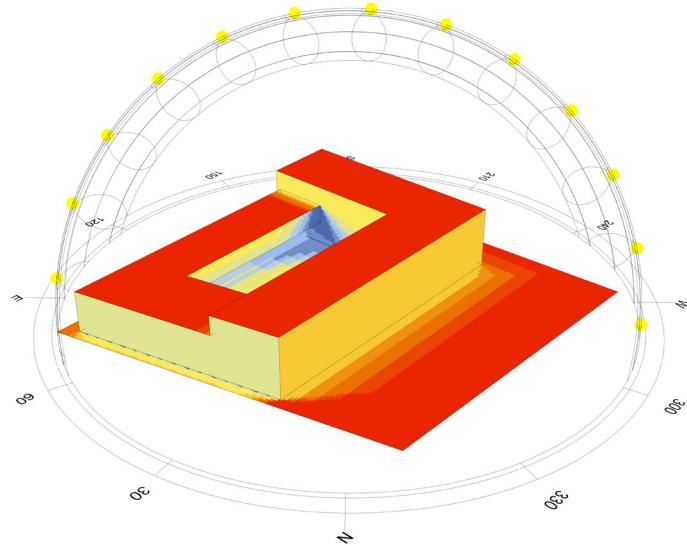
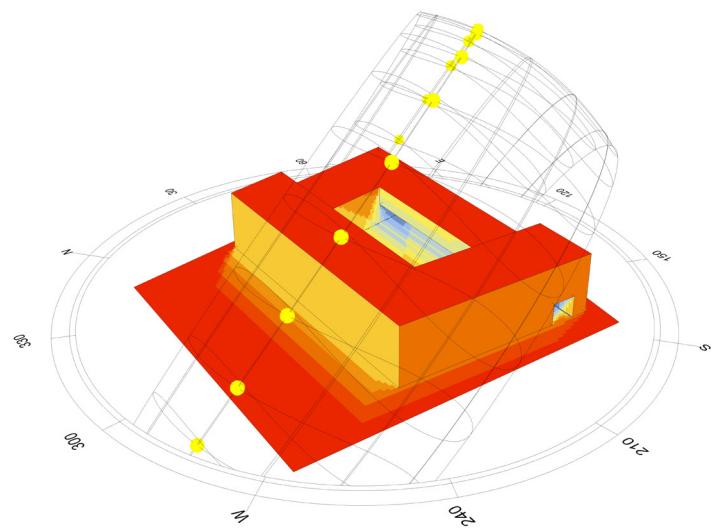
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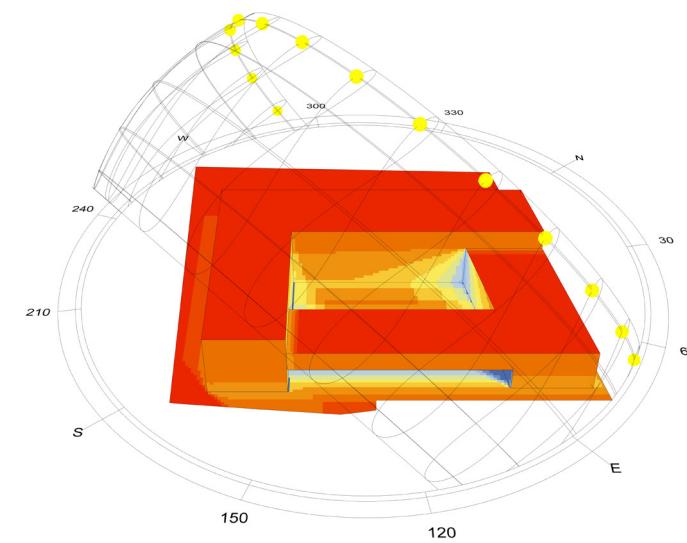
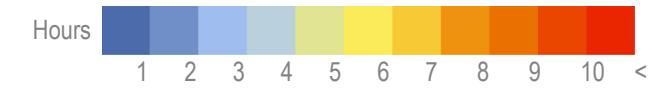
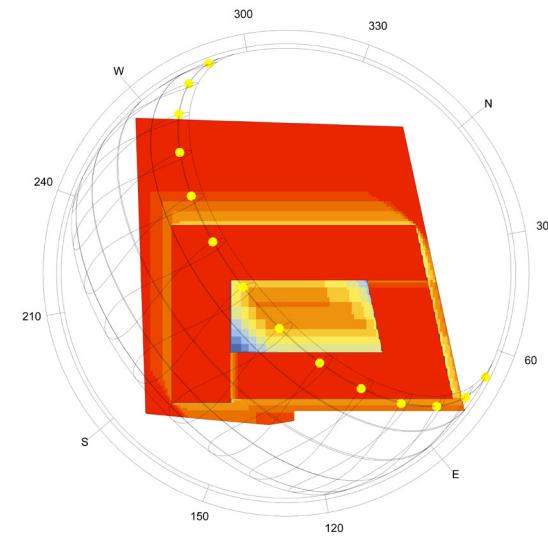
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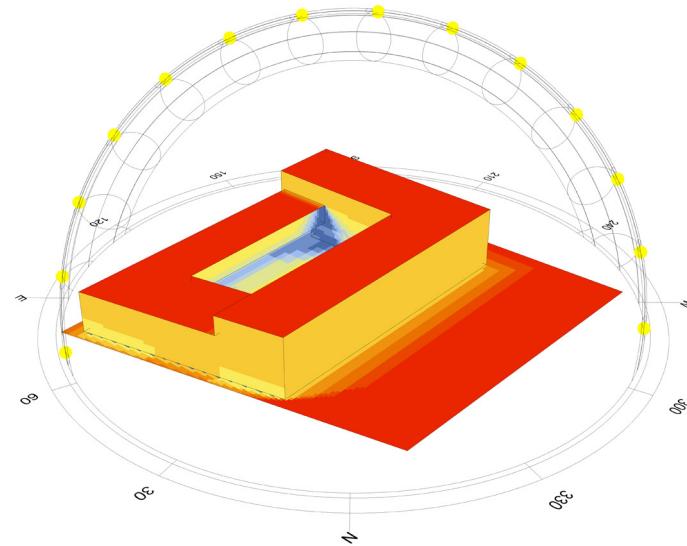
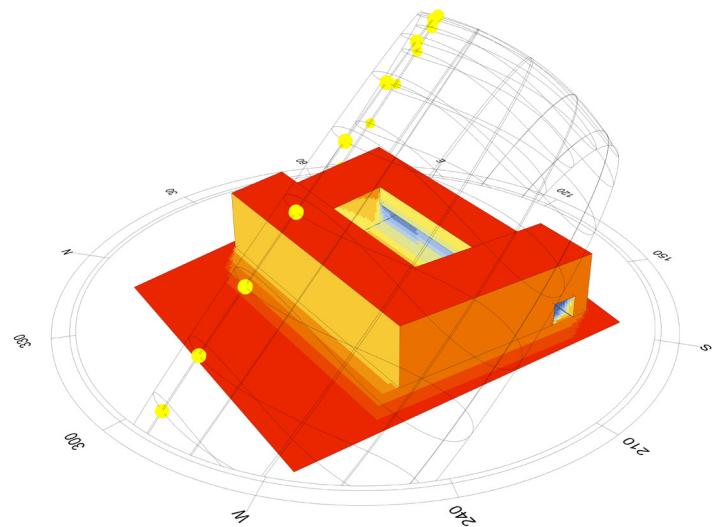
Apr 21st



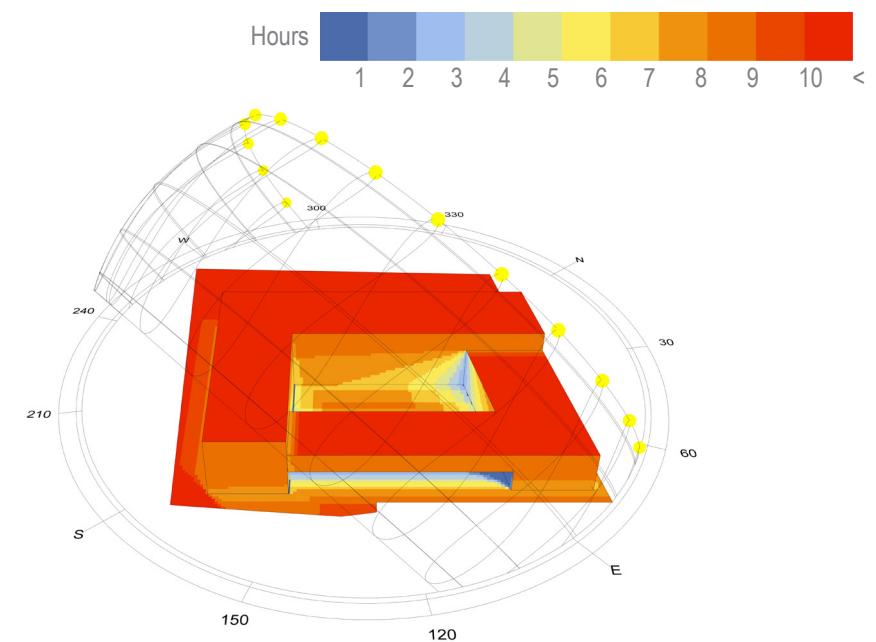
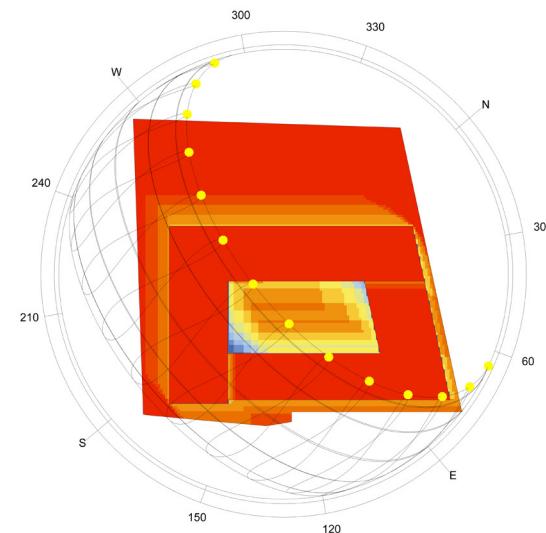
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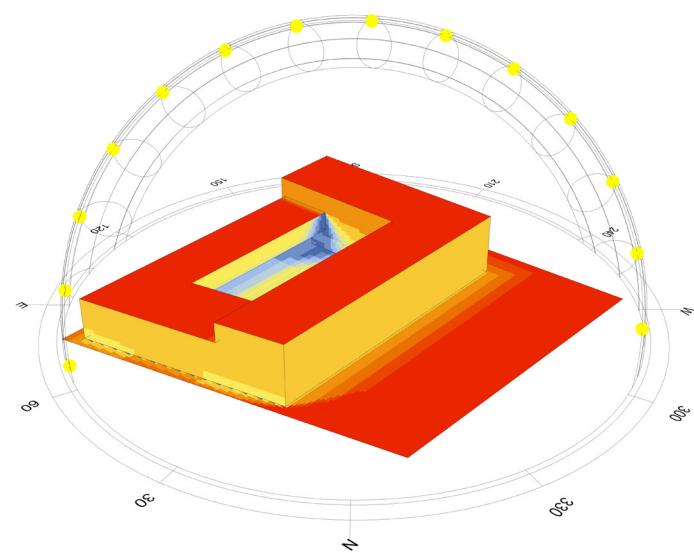
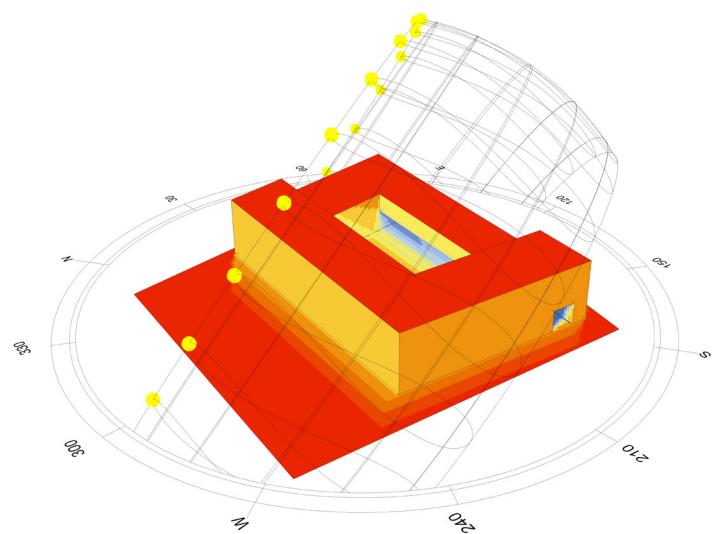
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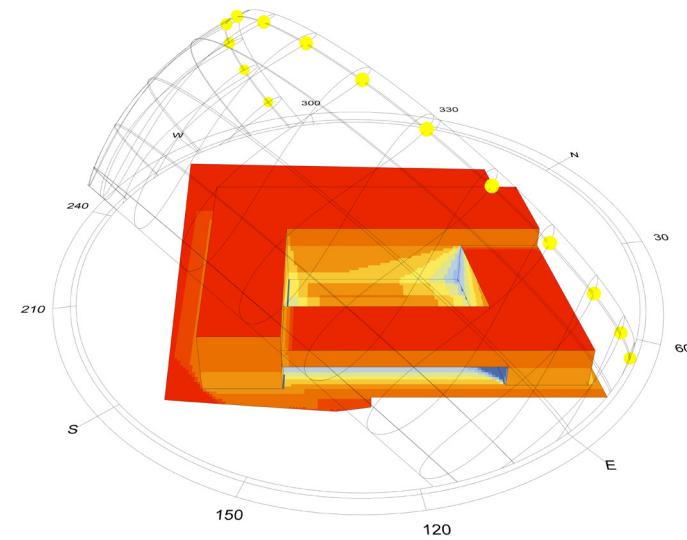
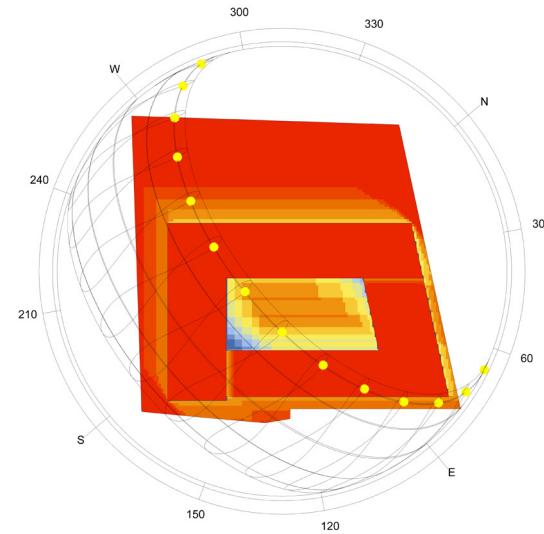
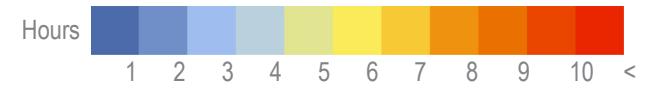
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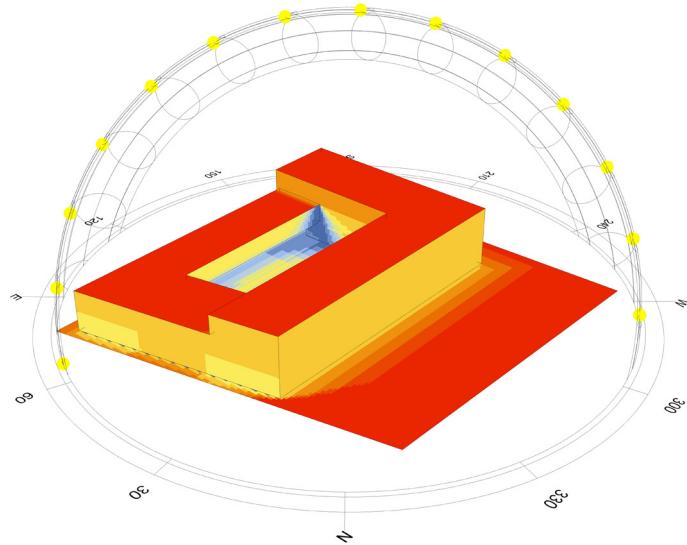
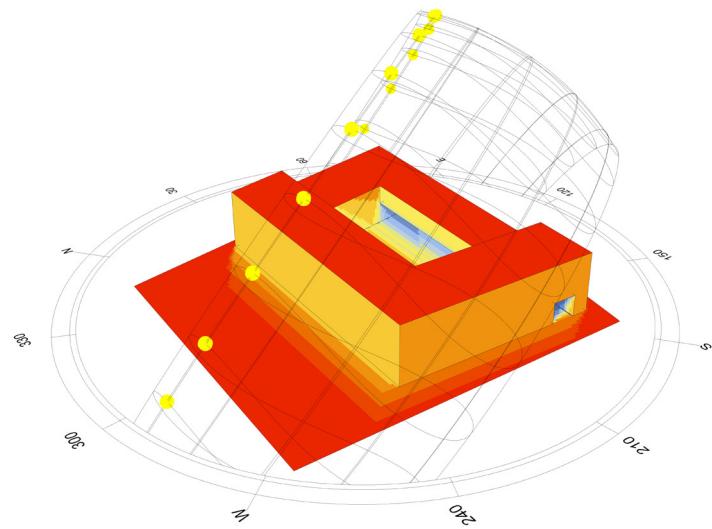
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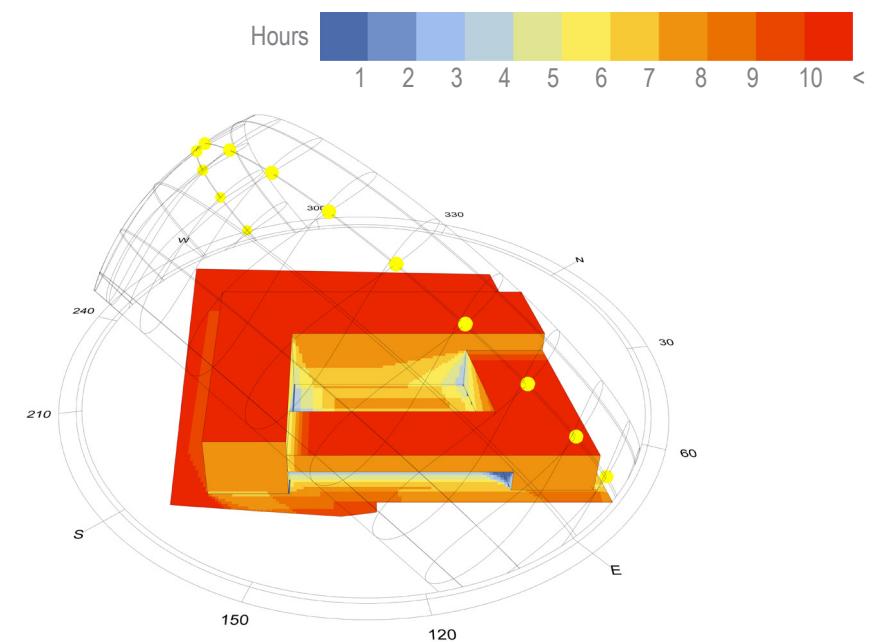
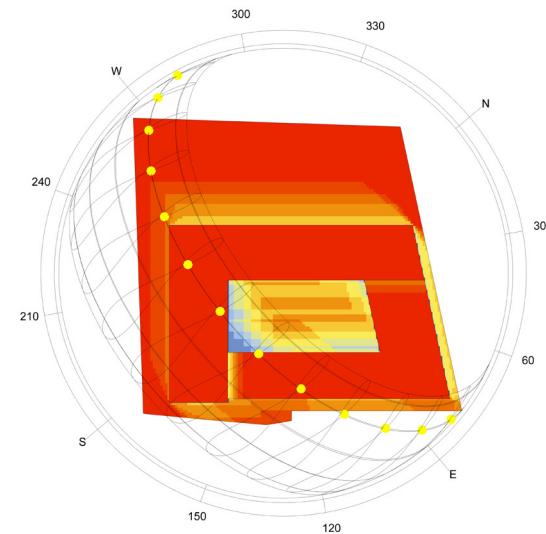
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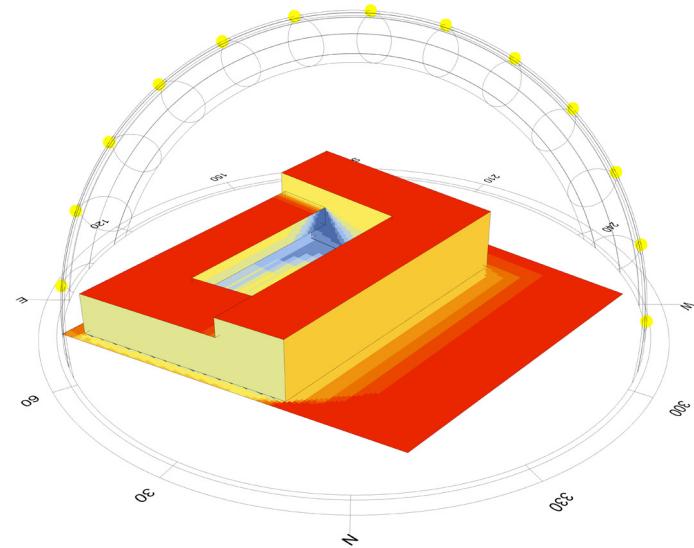
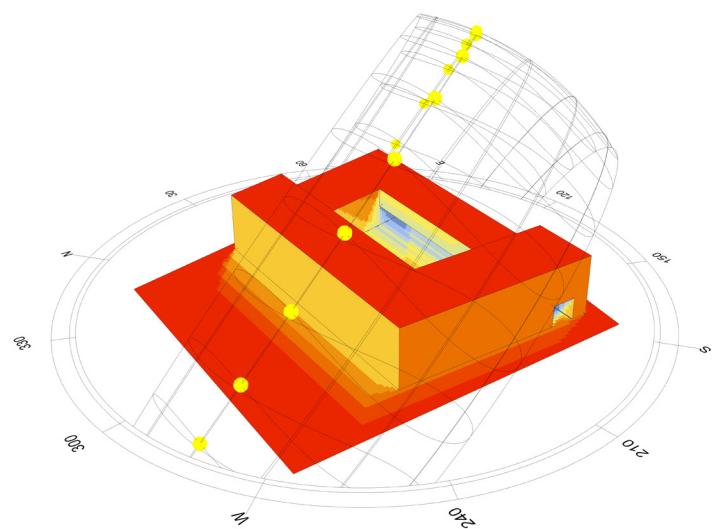
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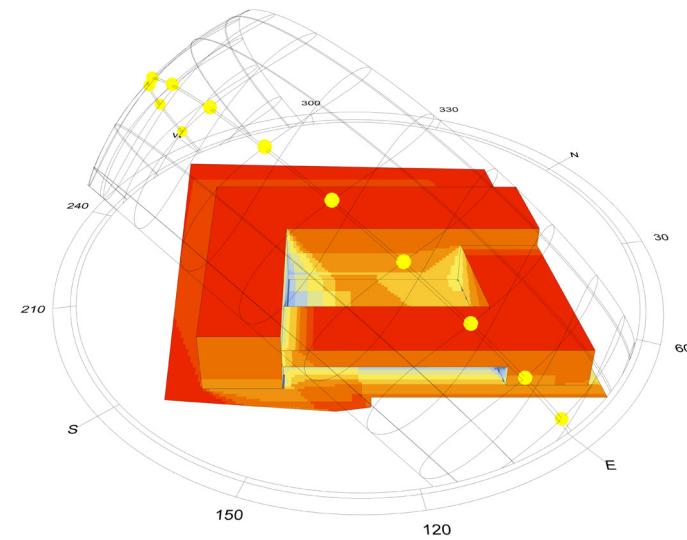
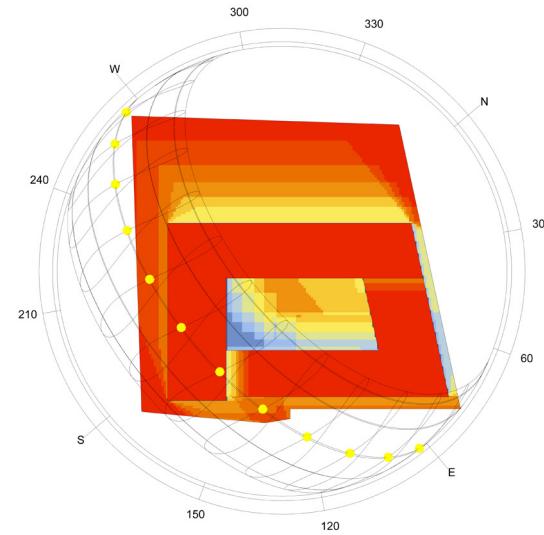
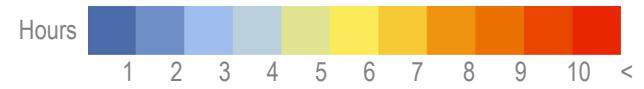
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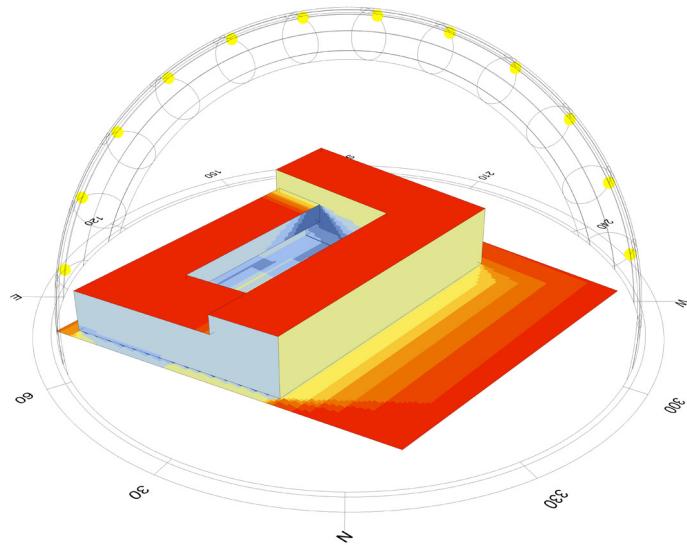
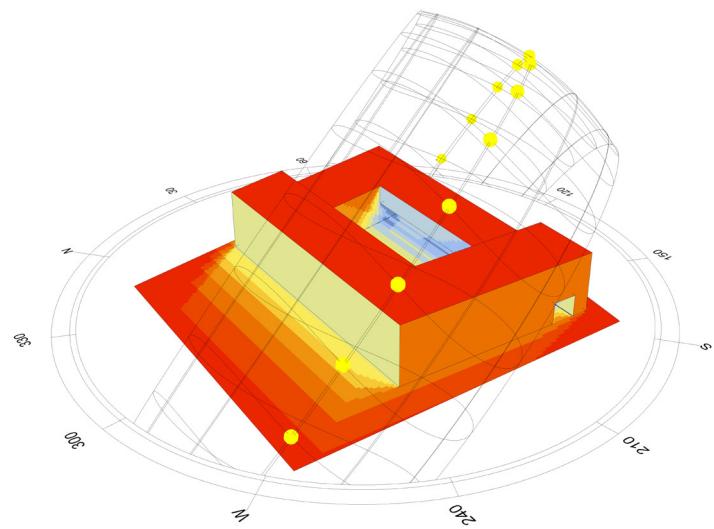
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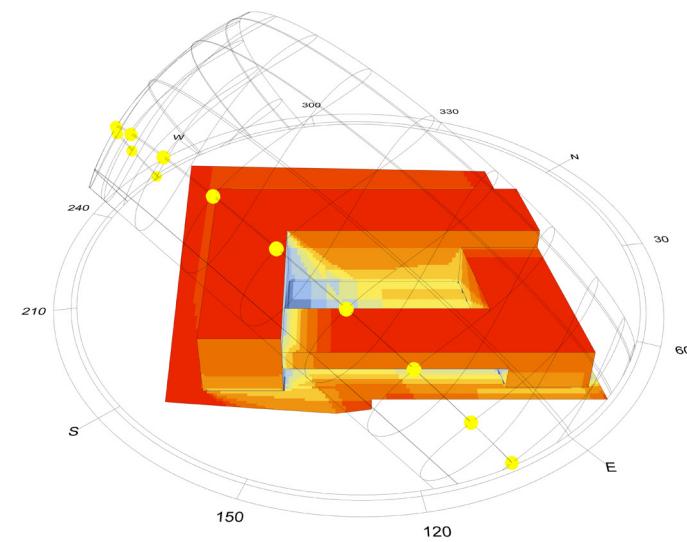
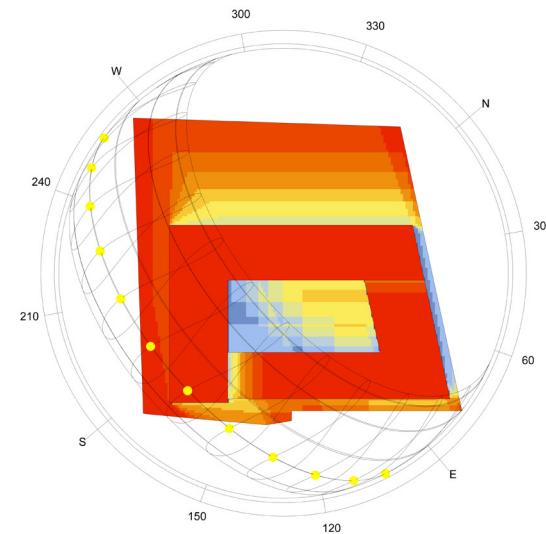
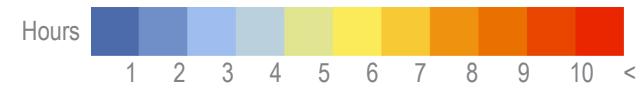
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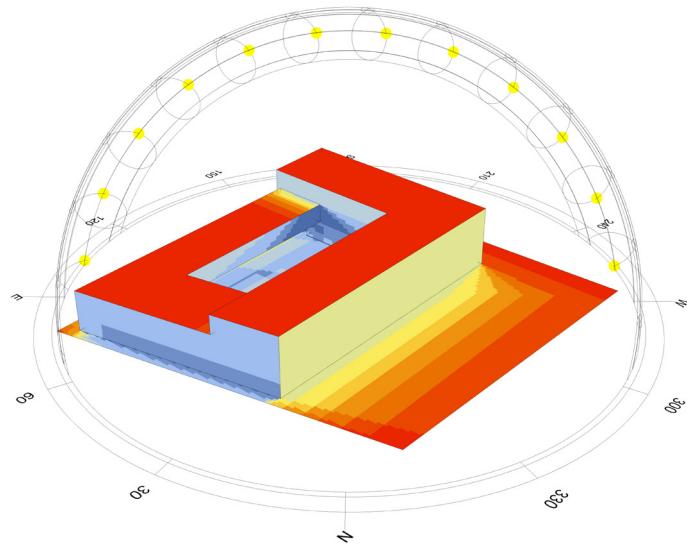
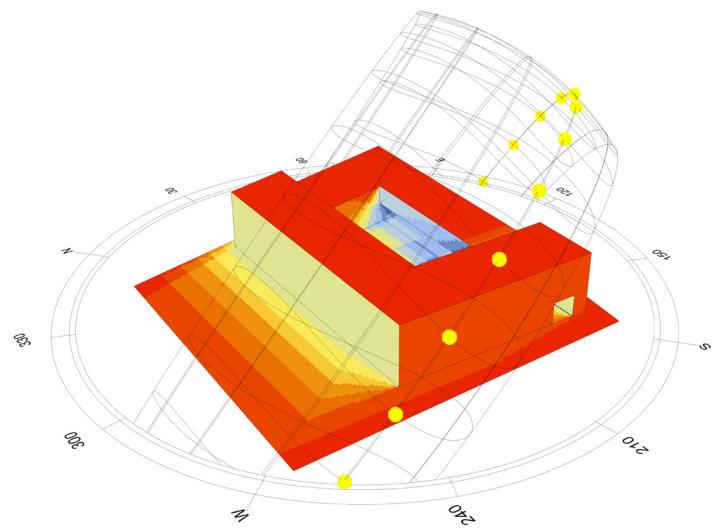
Sep 21st



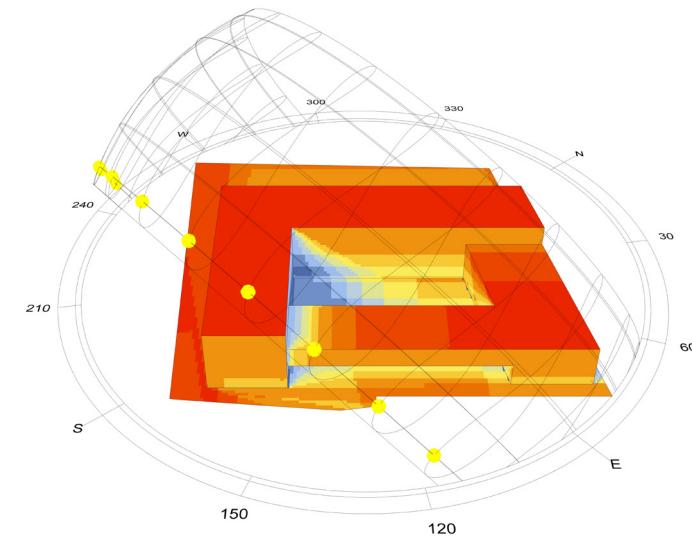
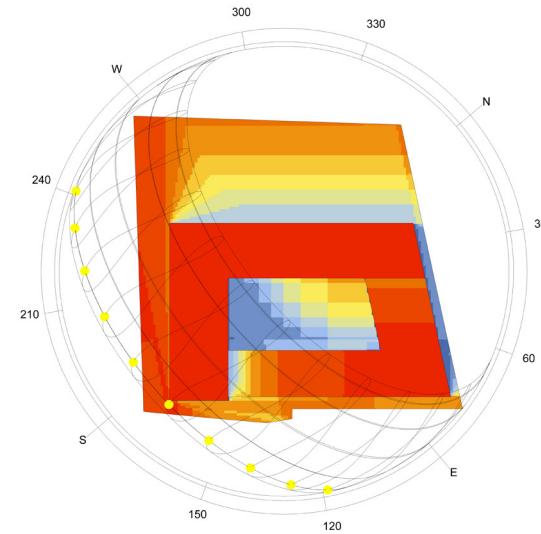
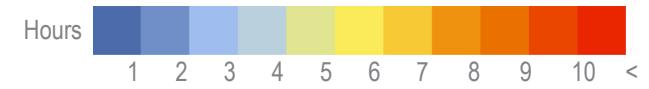
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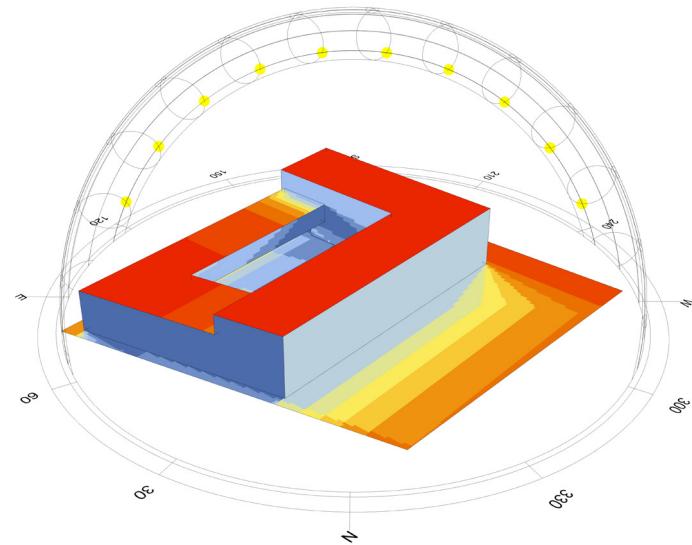
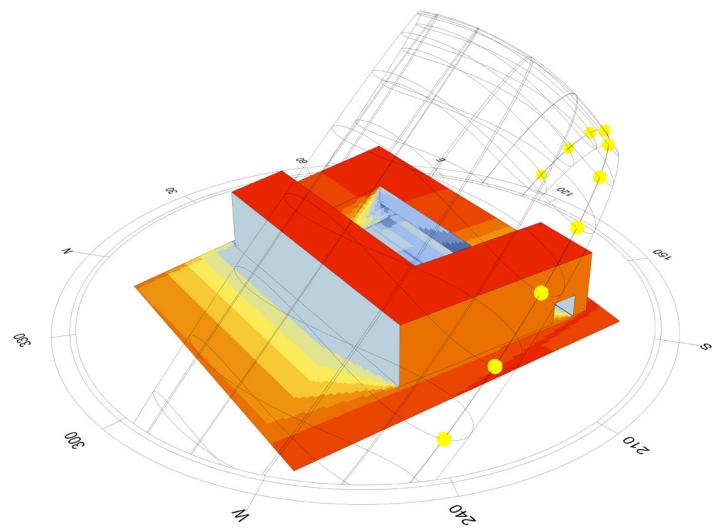
Oct 21st



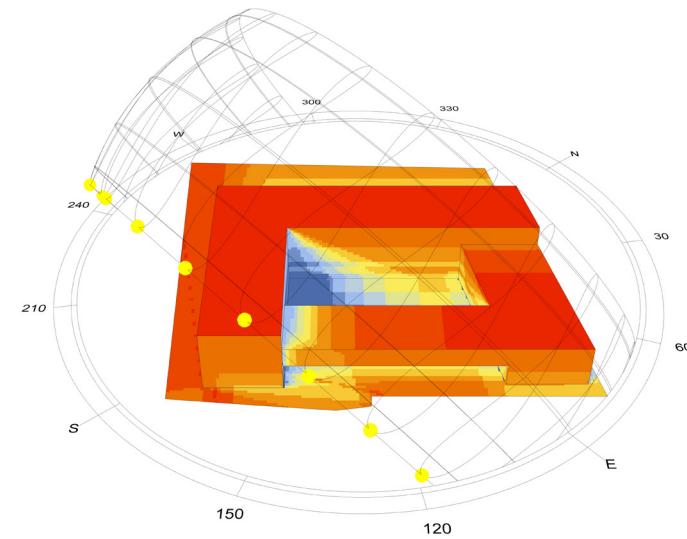
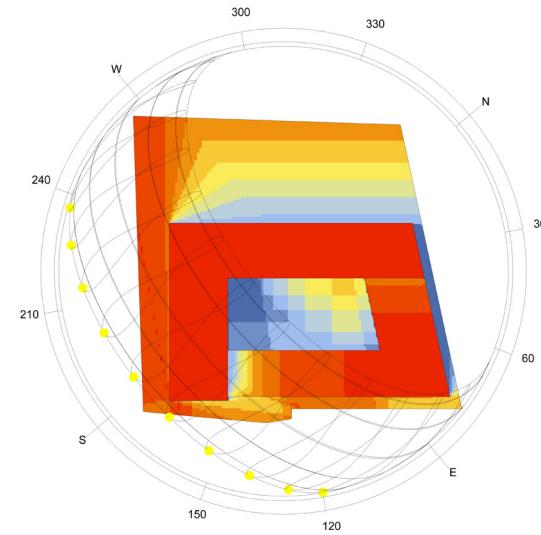
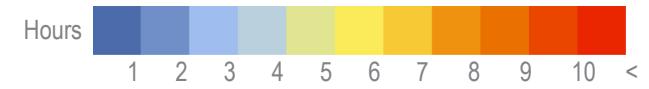
# Preliminary Analysis



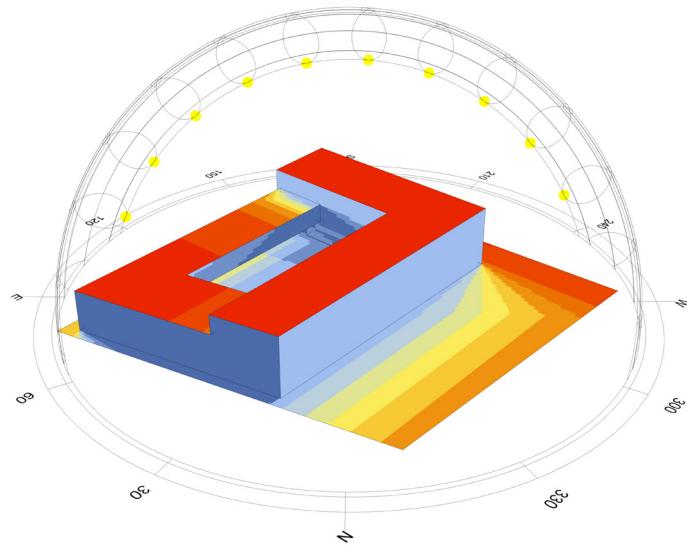
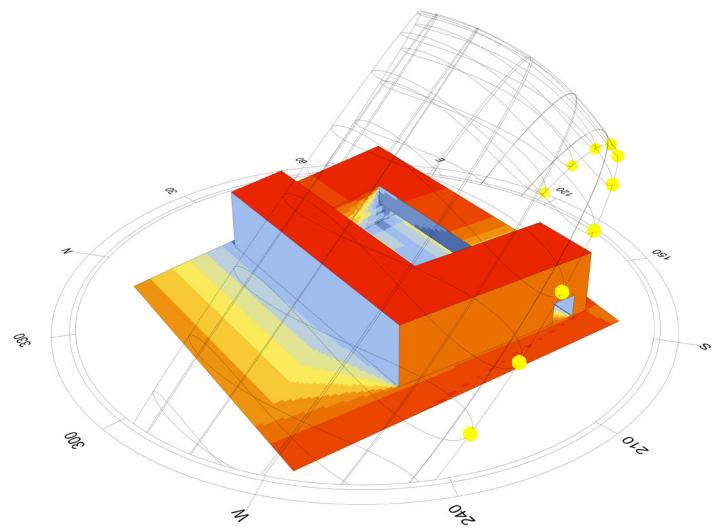
Nov 21st



# Preliminary Analysis

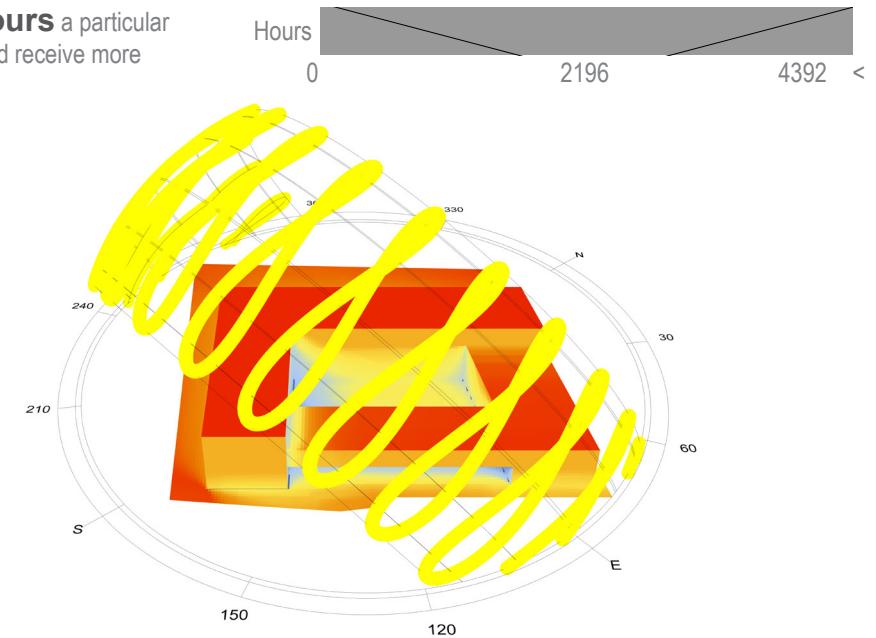
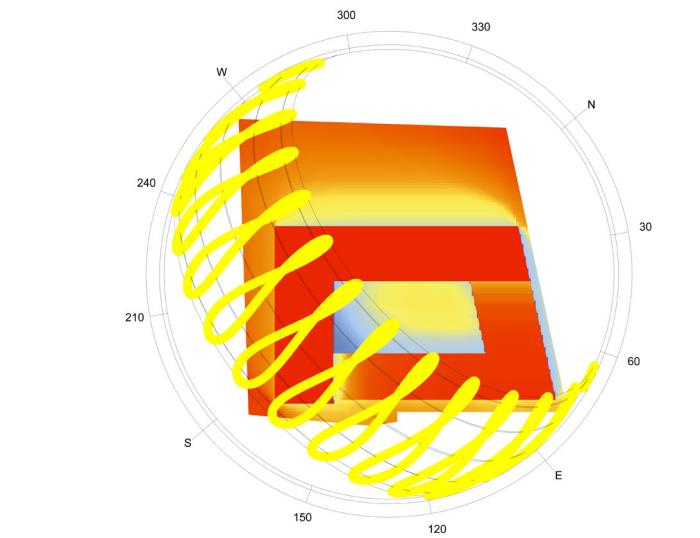


Dec 21st

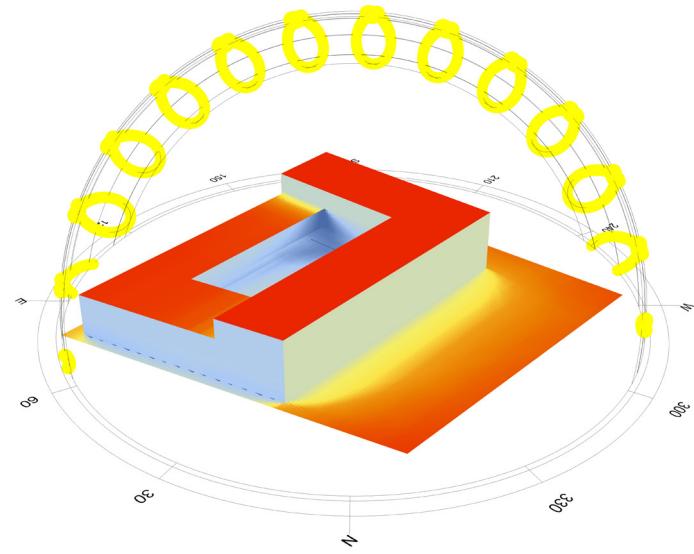
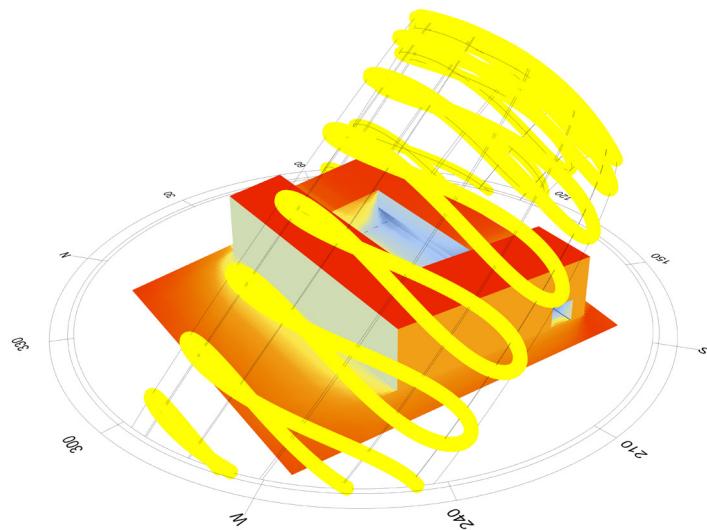


# Preliminary Analysis

These diagrams show the number of **sunlight hours** a particular point receives throughout the year. The areas in the red receive more than 4392 hours of sunlight throughout the year.

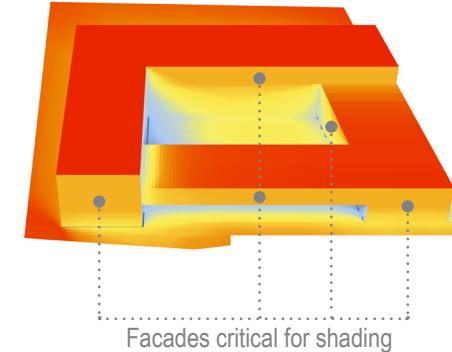
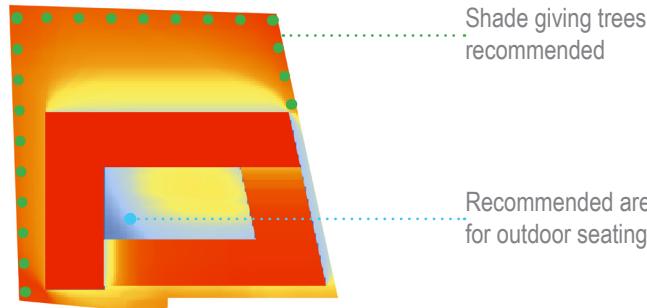
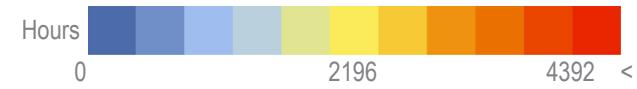


Annual

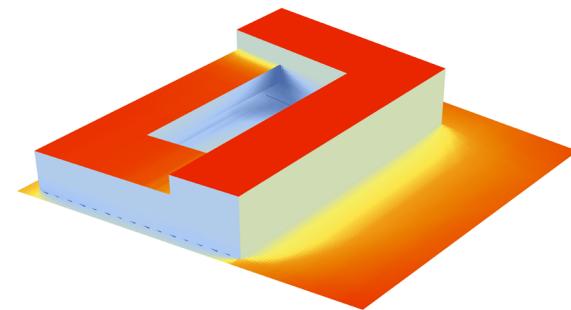
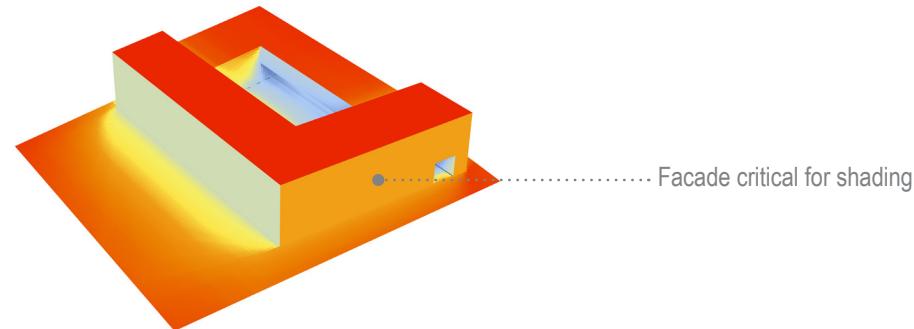


# Preliminary Analysis

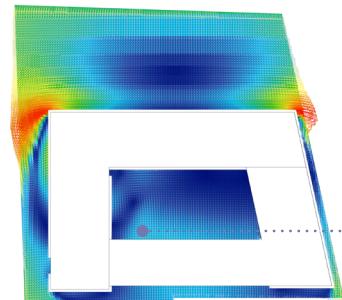
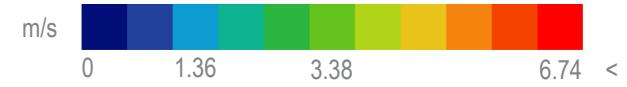
These diagrams clearly point to the areas of the facade and site that will receive shade throughout the year. This analysis shall aid in recommending locations for the outdoor seating areas and the trees.



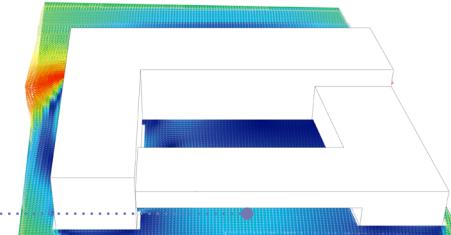
Annual



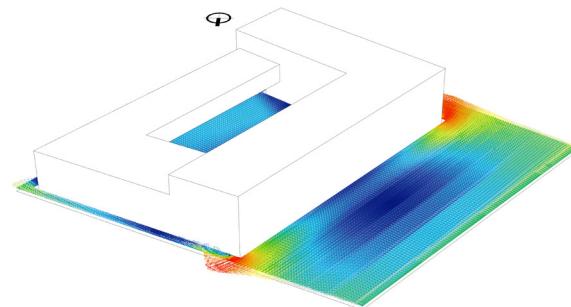
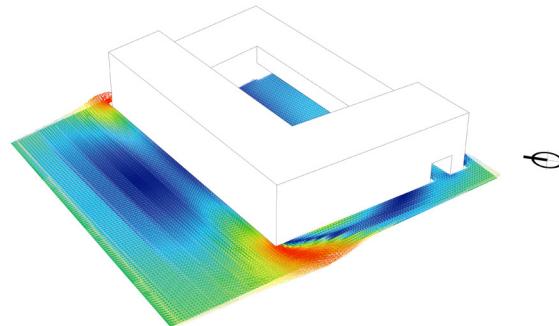
# Preliminary Analysis



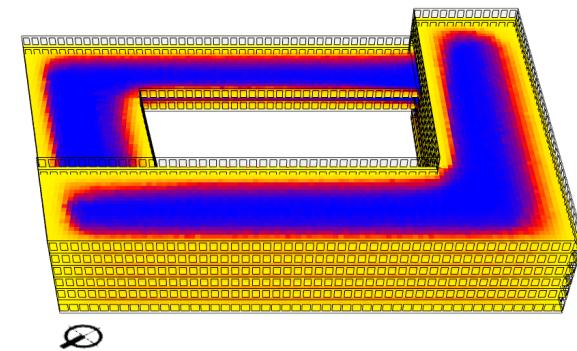
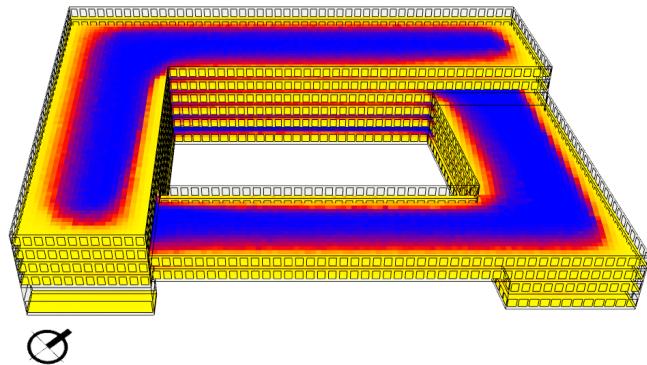
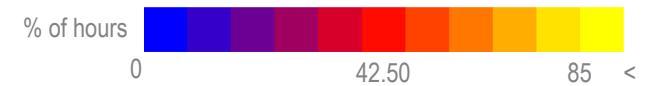
Recommended area  
for outdoor seating



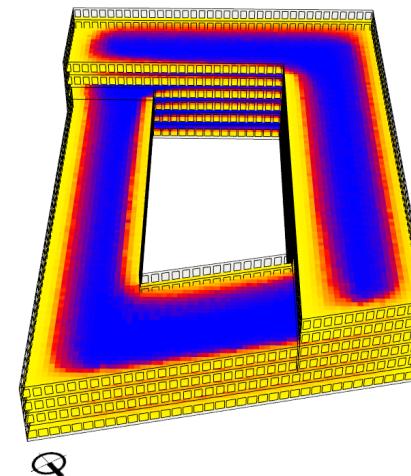
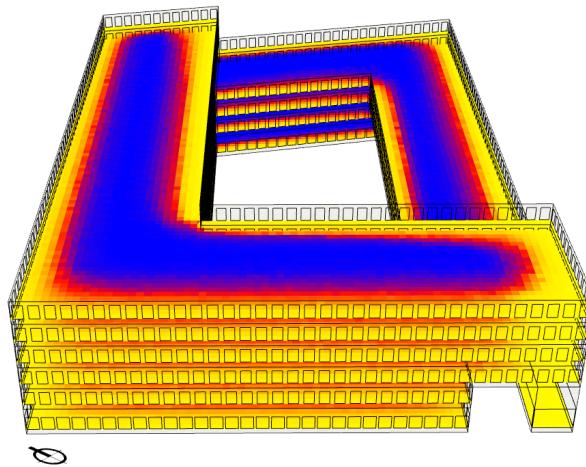
These diagrams show **wind velocity** at 0.9 meter height. Adequate wind velocity experienced at the skin gives cooling sensation. This phenomenon is called physiological cooling. The movement of the air past the skin surface typically accelerates heat dissipation by increasing convective heat loss and accelerating evaporation. Although loosing heat through evaporation will be difficult in the climate with high humidity, receiving wind at the skin can help in loosing heat via convection.



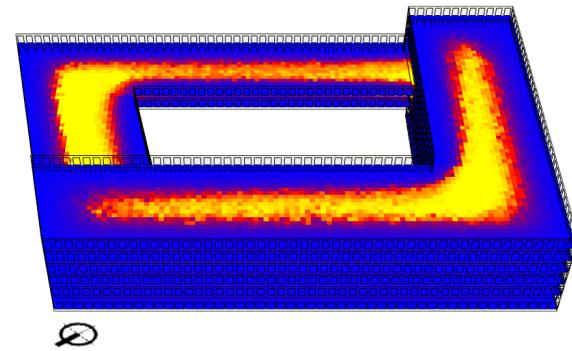
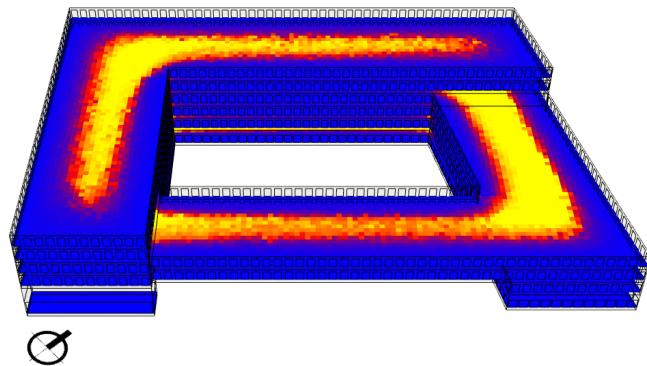
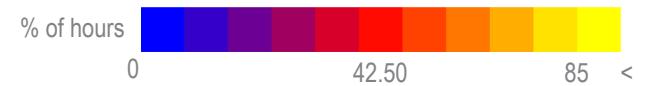
# Preliminary Analysis



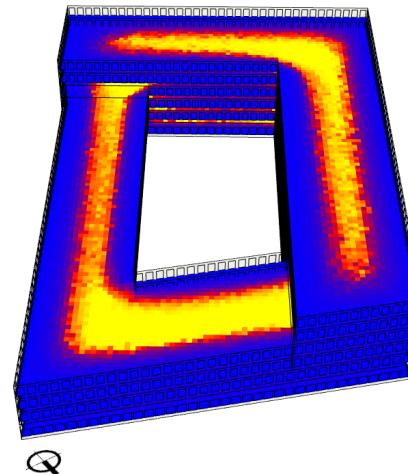
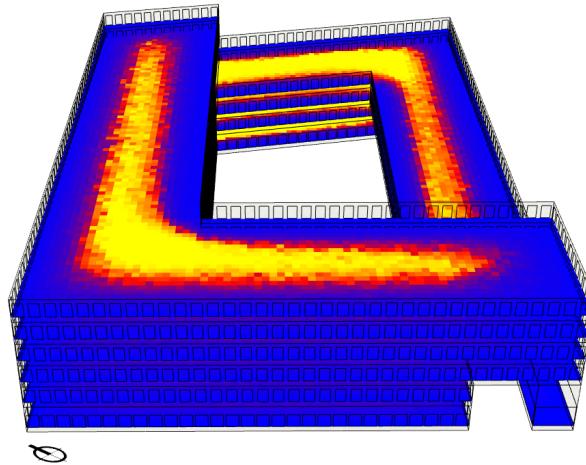
These diagrams show **daylight autonomy** at 0.75 meters height from the floor level. The test points are spaced at a distance of 1 meters from each other. On all the facades, 40% window to wall ratio is considered for this analysis. Daylight autonomy is specified as a percentage of annual occupied hours when the space attains specified level of illuminance by daylight. In this study, 300 lux is chosen as the illuminance threshold. The area in the yellow receives **at least 300 lux** for at least 85% of the occupied hours throughout the year. These diagrams show that the depth of area that can attain at least 300 lux by daylight



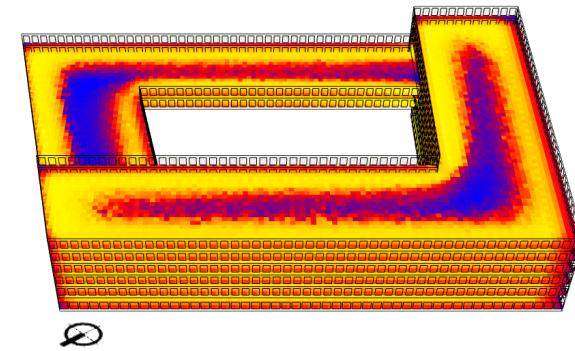
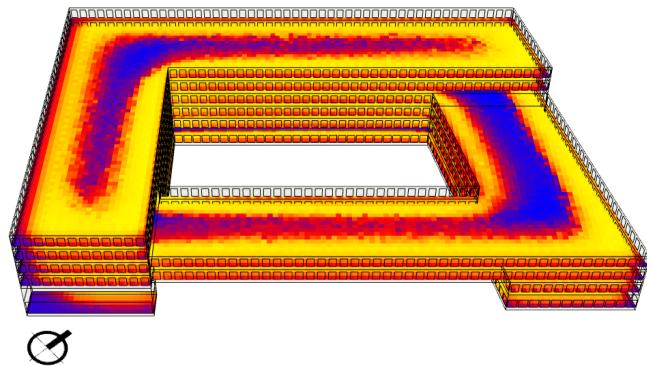
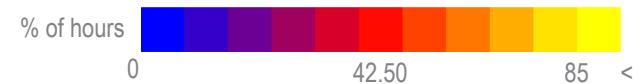
# Preliminary Analysis



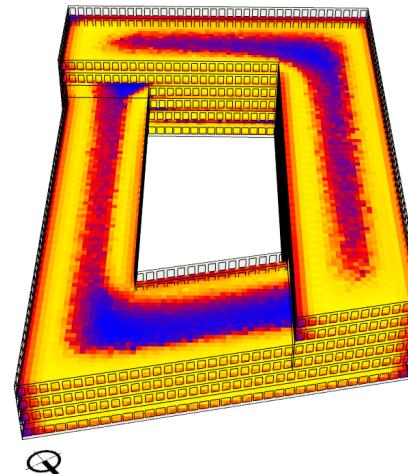
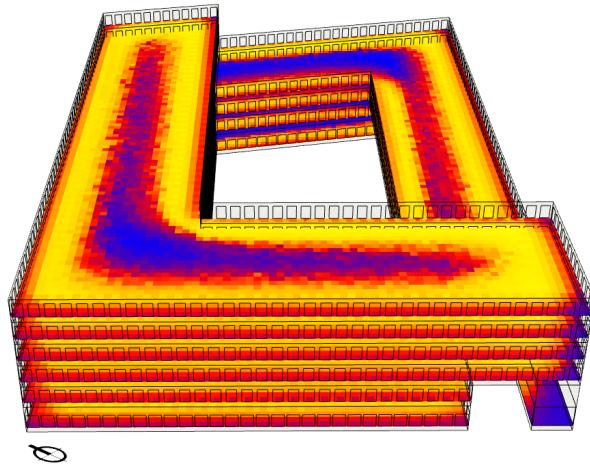
These diagrams show the area of the floor when illuminance of **less than 100 lux** is achieved a certain percentage of occupied hours. Use of artificial lighting during the day-time shall be anticipated in these areas. These areas are well suited for conference room or laboratories that require artificial lighting anyway. Making use of these central areas for special uses such as conference or laboratory will also help from thermal perspective. For these areas are automatically insulated from climatic effects experienced at the periphery of the building.



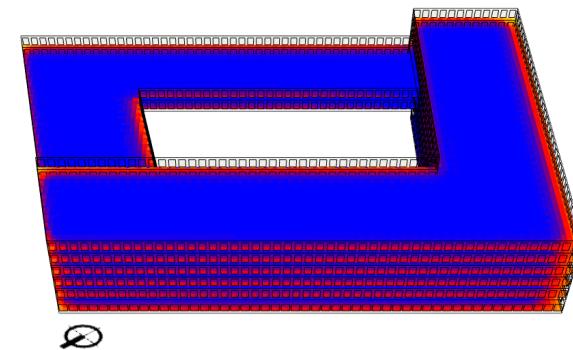
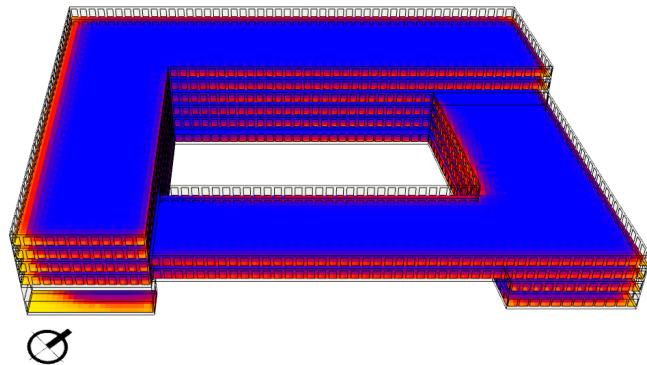
# Preliminary Analysis



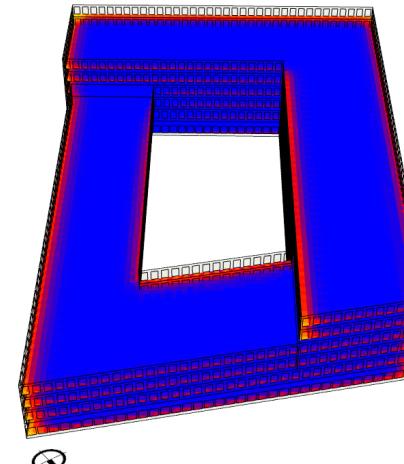
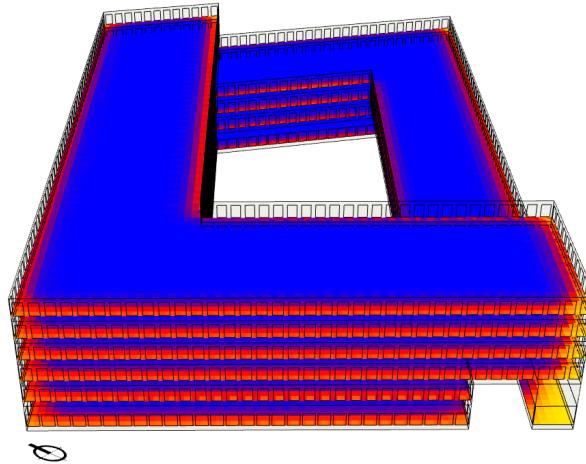
These diagrams show the area of the floor when illuminance of **more than 100 lux and less than 2000 lux** is achieved throughout a certain percentage of occupied hours. This quantity is otherwise known as **useful daylight illuminance**. These are the areas that receive adequate amount of illuminance at the work plane to carry out tasks such as reading and writing, and using computers. The



# Preliminary Analysis



Finally, these are the areas that receive **more than 2000 lux** for a certain percentage of occupied hours throughout the year. It is most likely that some type of glare will be experienced in these areas. These diagrams again point to the peripheral areas of the building where a special care has to be taken in developing façade that addressed the issue of visual discomfort (glare).

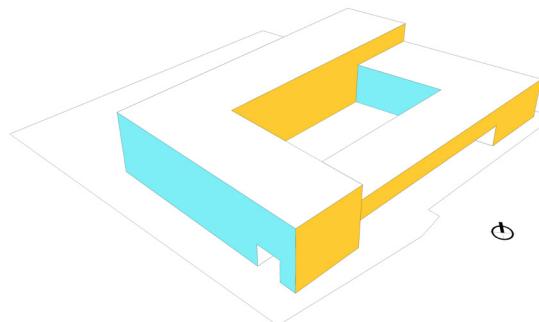


# Conclusion

It is in the early stages that maximum impact on the design can be made to integrate performance enhancement strategies. As pointed out in the preliminary analysis in this report, there are certain orientation of the building that are to be paid special attention in order to reduce the incident radiation during the summer months and welcome radiation during the winter months. The façade shall also be able to address the matter of visual discomfort due to excessive light levels experienced in the peripheral areas of the building and should help in taking daylight deep in to the building.



- These facades need to receive winter sun while addressing the issue of visual discomfort (glare). A combination of vertical louvers and internal light shelf is recommended. The vertical louvers can block low direct sun which can cause glare and the light shelf can help in bringing daylight deep into the space.



- These facades need to block off the summer sun and welcome the winter sun. The sun in the east is typically low in the altitude and therefore vertical louvers are recommended to block off the sun and receive the radiation in the winter months.

