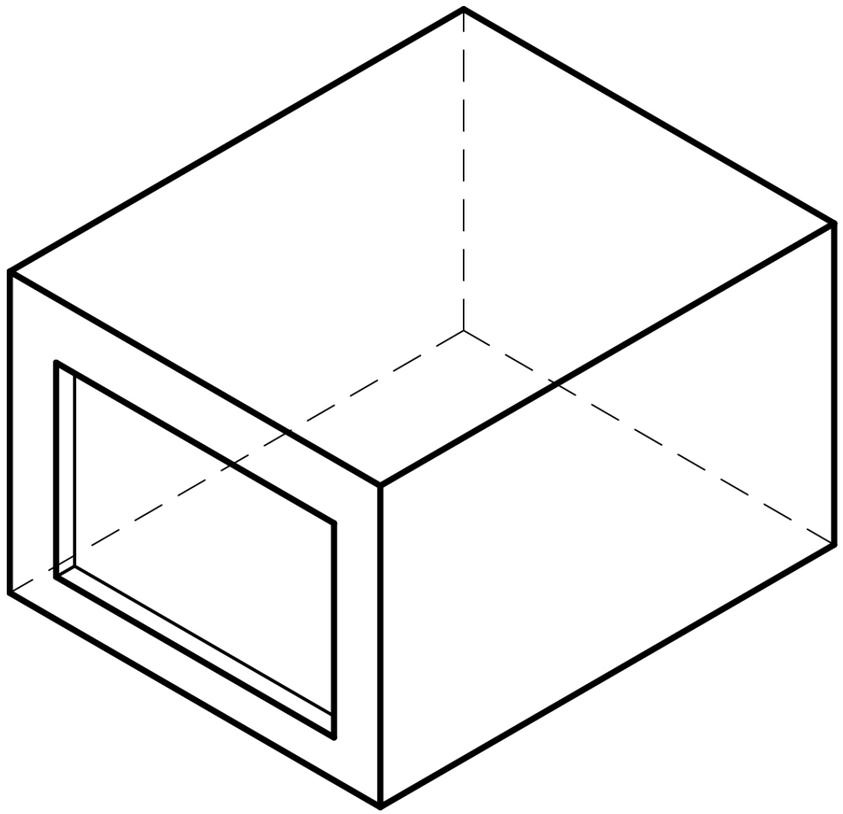
Building Performance Analysis Report

Dream Room

0. About the Room

3701 Chestnut Street
Philadelphia, Pennsylvania, US

The dream room in my mind is not that large, but it should have a large window and could receive enough sunlight. And it is a space that could satisfy all my needs and interests, like the piano by the window and a louge chair for reading at the corner. And next, I will try to improve the comfort of this room step by step.

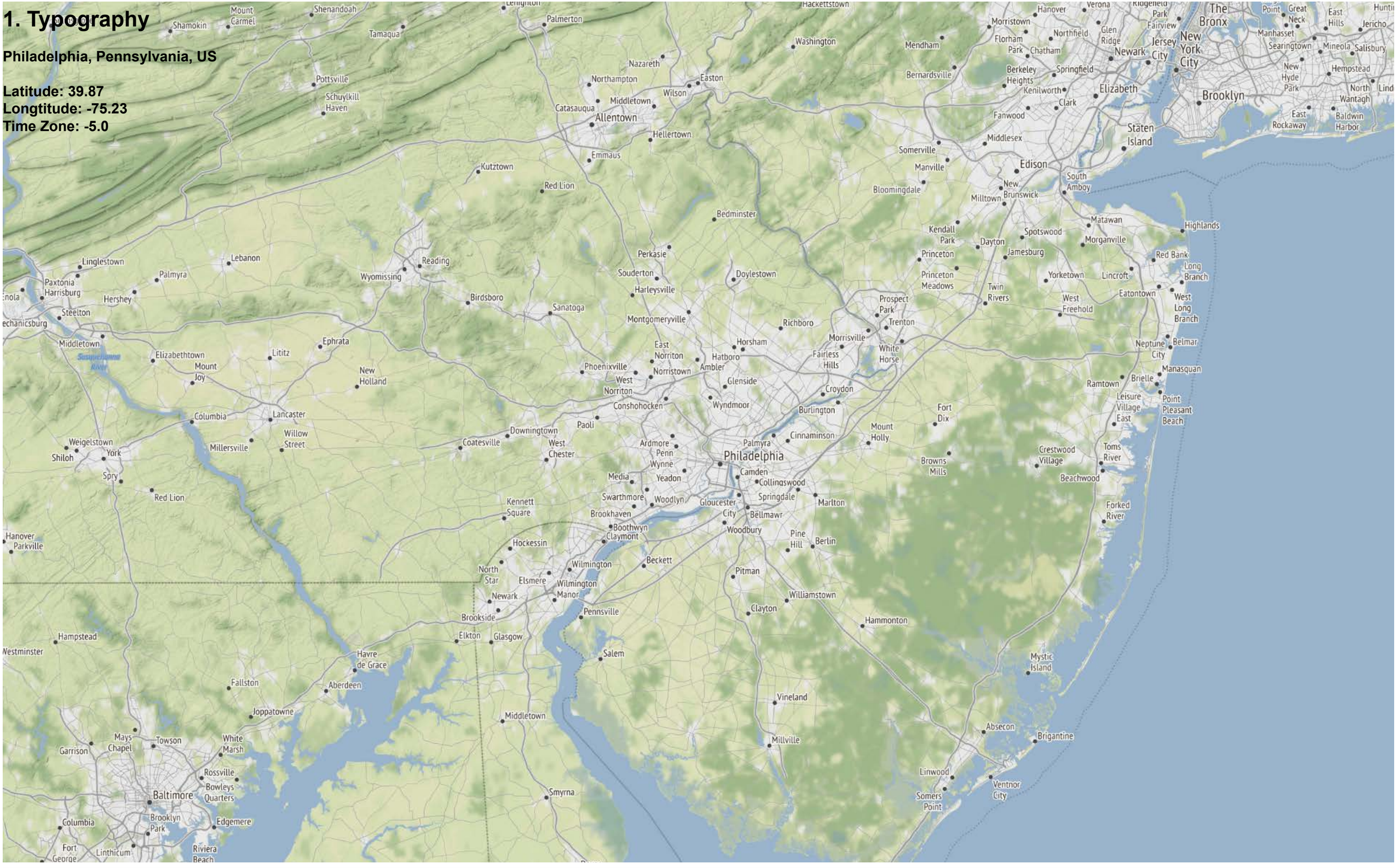


Schedule

1. Typography

Philadelphia, Pennsylvania, US

Latitude: 39.87
Longtitude: -75.23
Time Zone: -5.0



1. Typography

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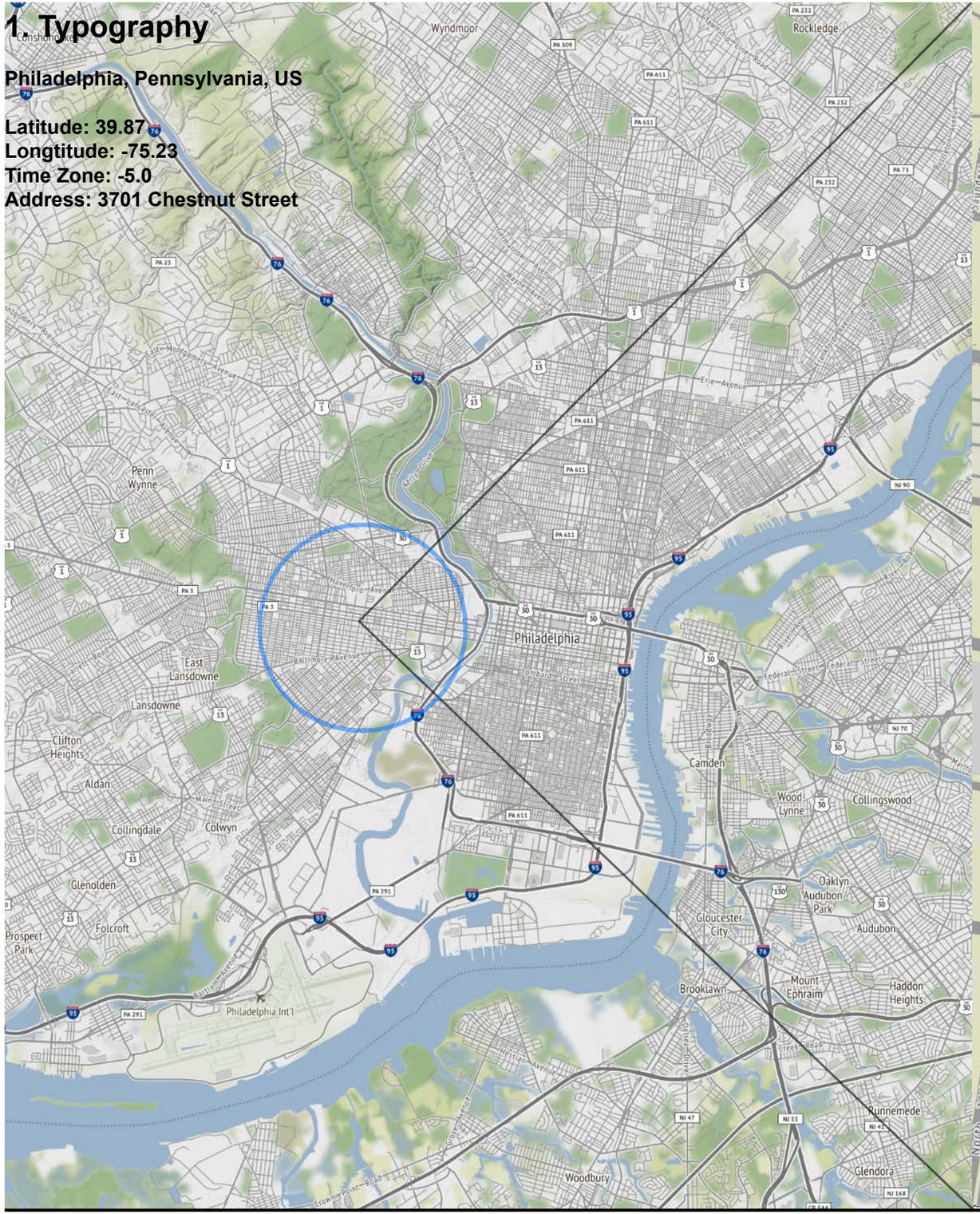
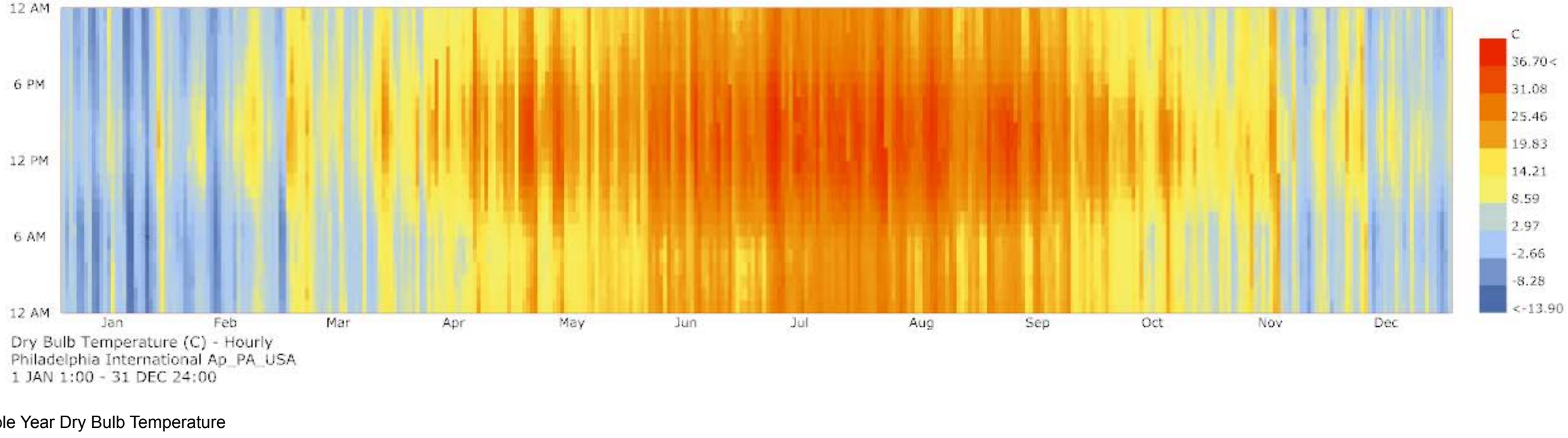
Address: 3701 Chestnut Street



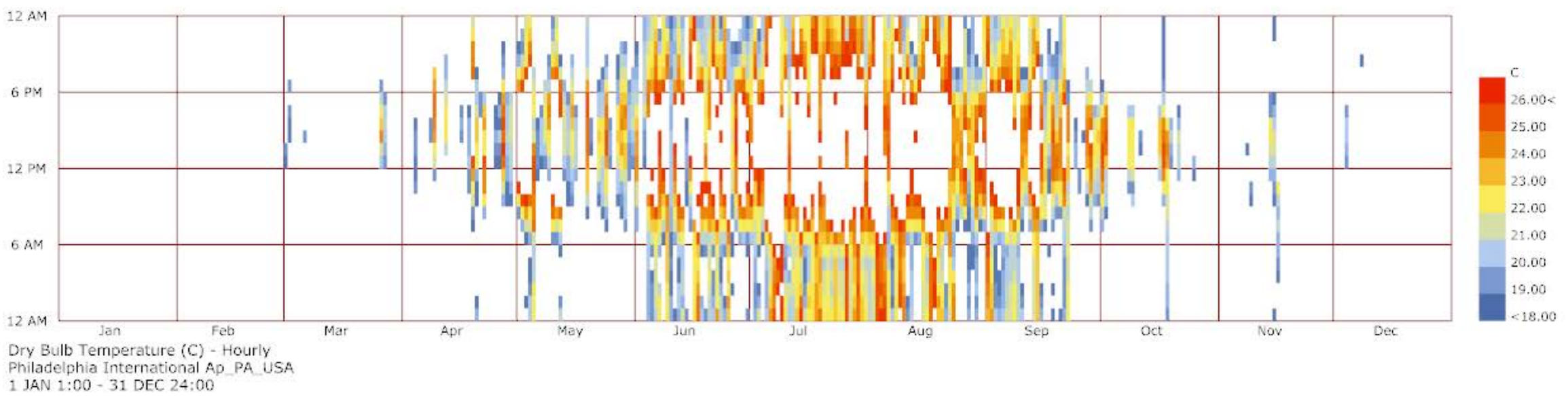
2. Climate Analysis

2.1 Dry Bulb Temperature

The ideal temperature(18C-26C) mainly happens from April to October and only takes up 25% (2157/8760).



Whole Year Dry Bulb Temperature

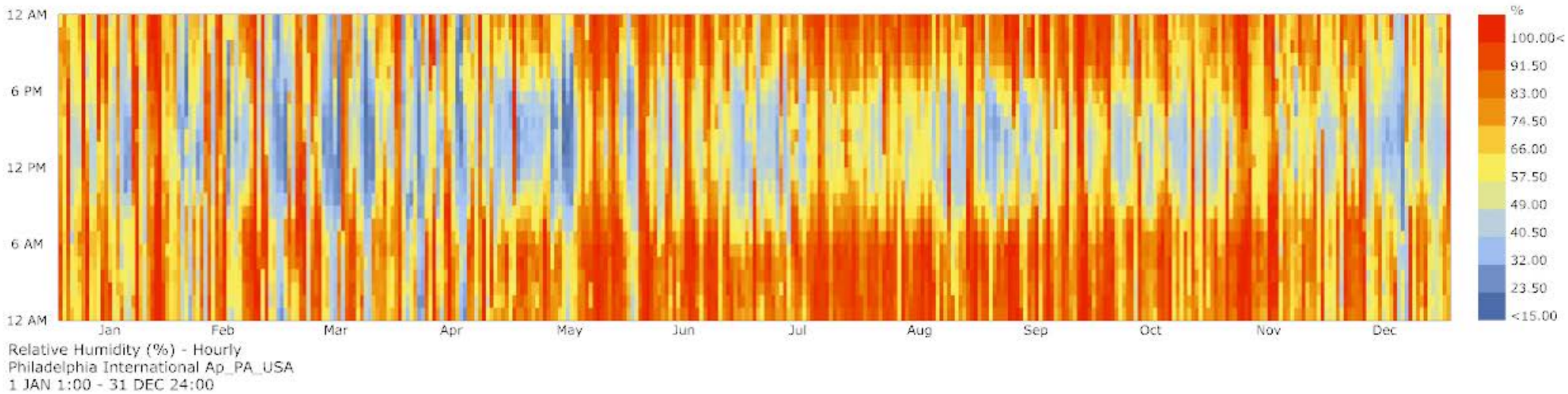


Bulb Temperature 18C to 26C

2. Climate Analysis

2.2 Relative Humidity

During the whole year, the relative humidity is higher in Summer.
During one day, the relative humidity is higher in the morning and at night.



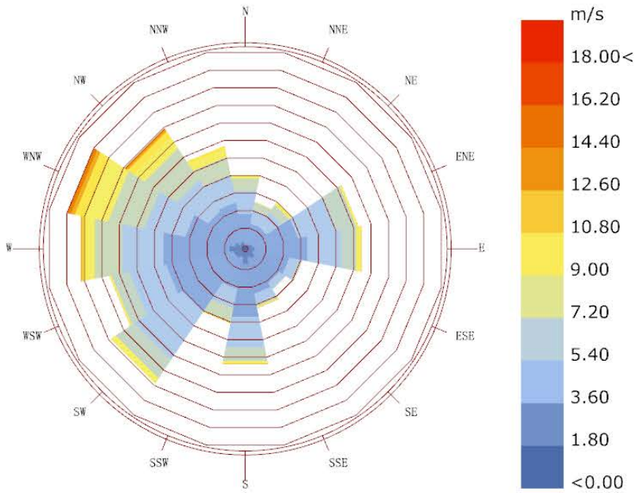
Whole Year Relative Humidity

2. Climate Analysis

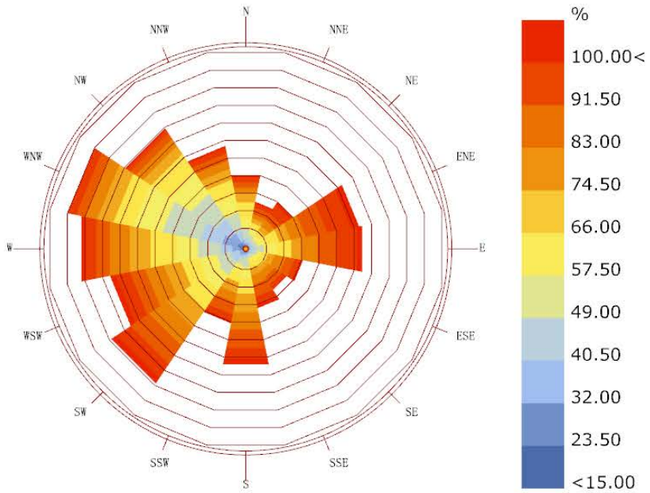
2.3 Wind

From the three wind rose, we could see:

In Summer, the wind from west is more prevailing. The wind is faster and more humid.
In Winter, the wind from northwest is more prevailing. The wind speed is slower than wind from southwest, but more humid.



Wind-Rose
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 2.81% of the time = 246 hours.
Each closed polyline shows frequency of 1.0%. = 90 hours.



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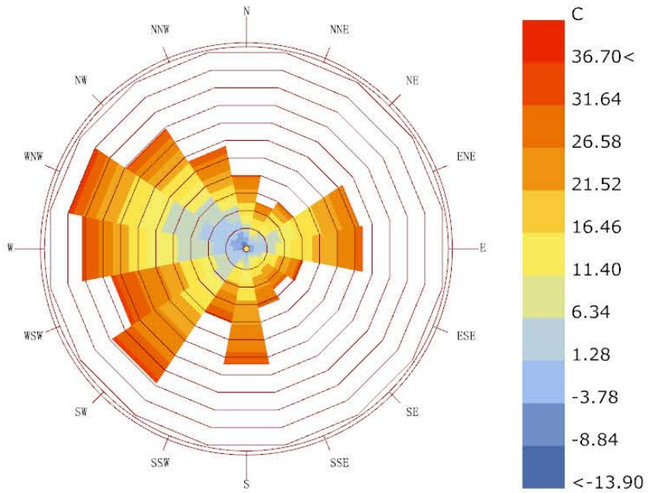
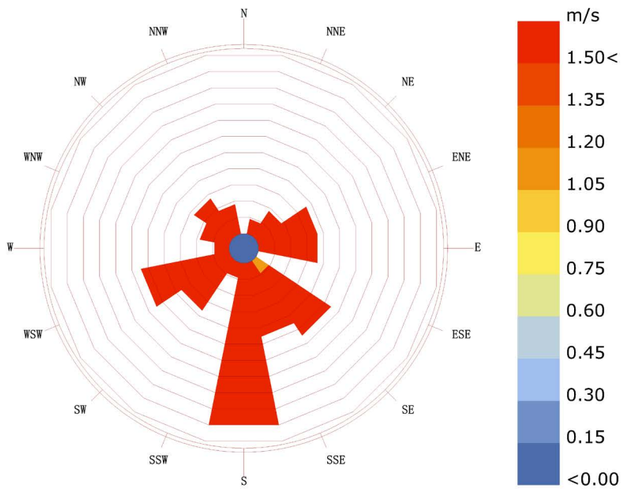


Wind-Rose
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Dry Bulb Temperature (C)
Calm for 2.81% of the time = 246 hours.
Each closed polyline shows frequency of 1.0%. = 90 hours.

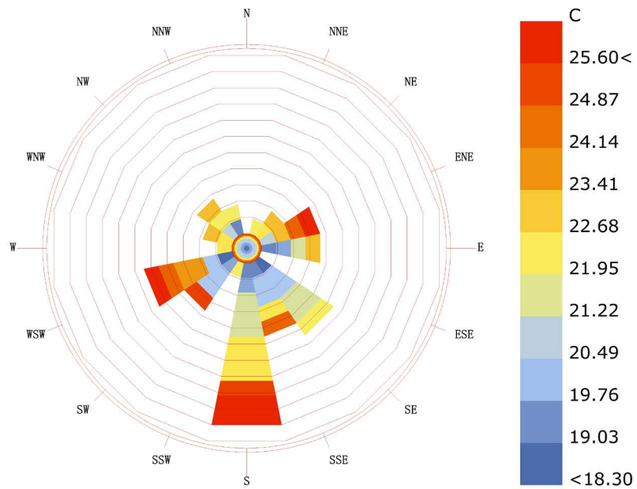
2. Climate Analysis

2.3 Wind

When 18 < dry bulb temperature < 26, wind speed < 2m/s and relative humidity < 80%, the wind we could make use of is mostly from the south.



Wind-Rose
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 0.18% of the time = 16 hours.
Each closed polyline shows frequency of 0.0%. = 1 hours.
... ...
Conditional Selection Applied:
Wind Speed<2
and 18<Dry Bulb Temperature<26
and Relative Humidity<80
68.0 hours of total 8760.0 hours (0.78%).



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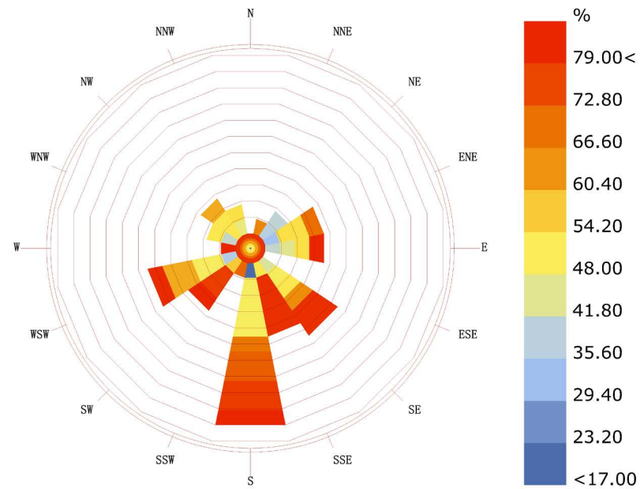

Wind-Rose
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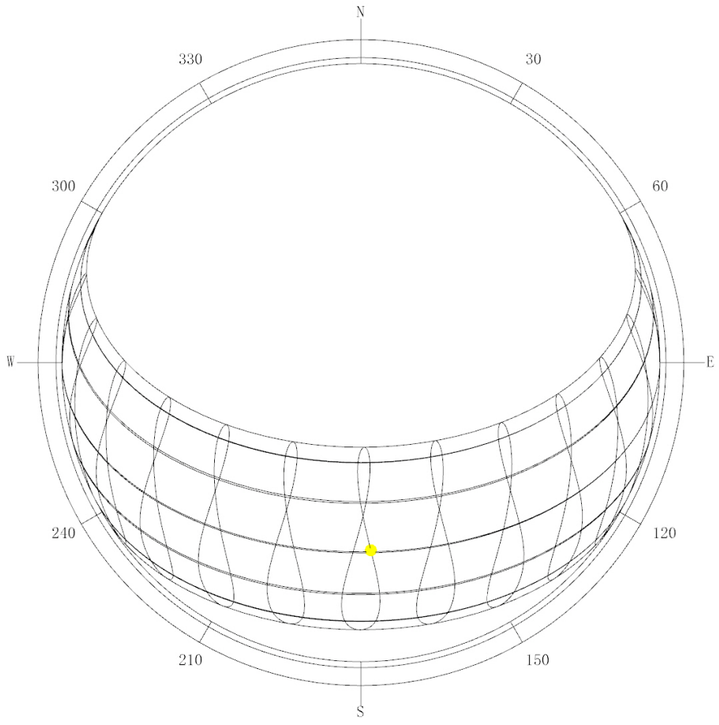
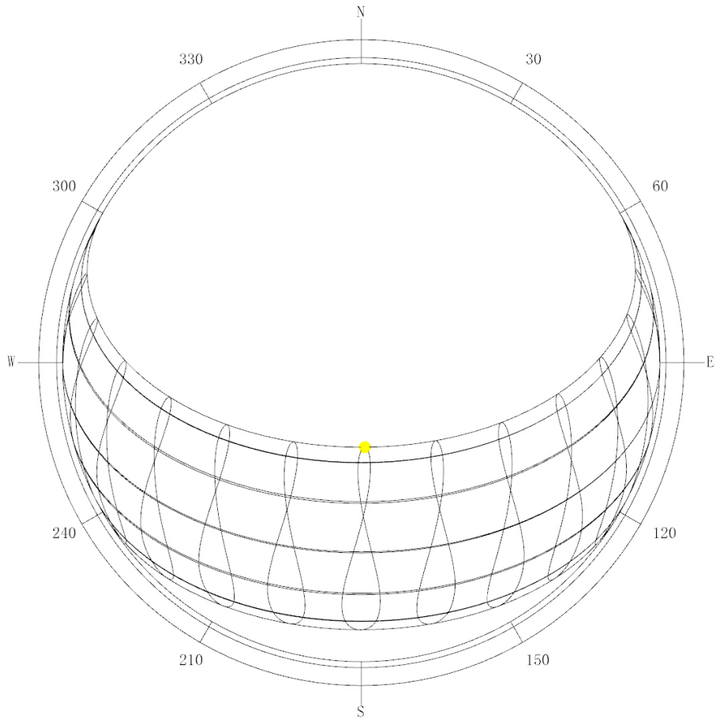
2. Climate Analysis

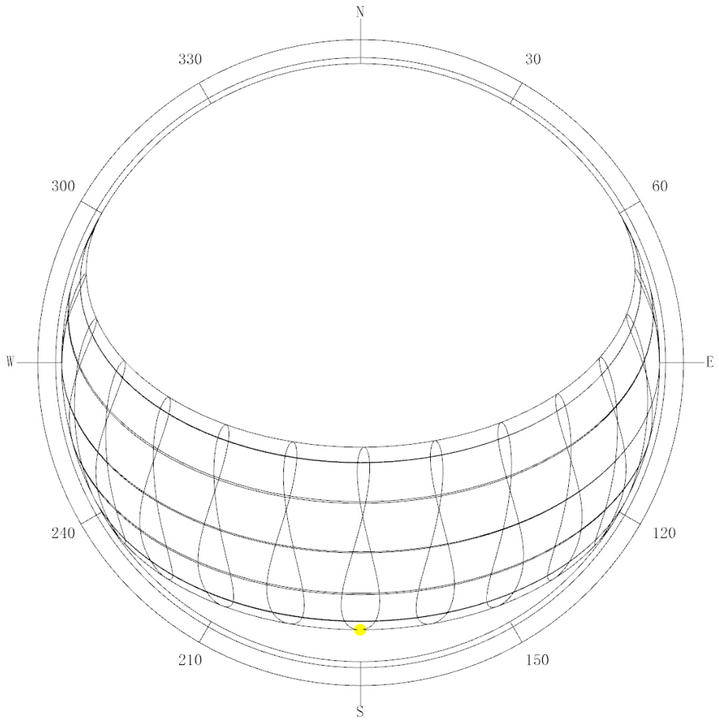
2.4 Sun Path



Date: March 22nd
Sun Altitude: 51.09°



Date: June 22nd
Sun Altitude: 73.54°



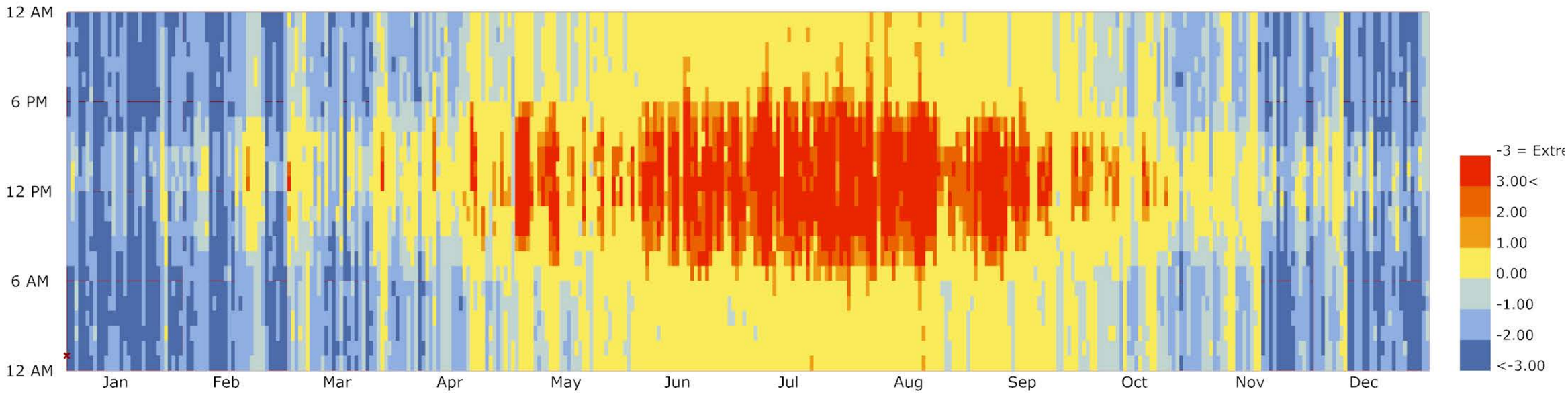
Date: December 22nd
Sun Altitude: 26.70°

2. Climate Analysis

2.5 Outdoor Comfort (UTCI)

In Philadelphia,

the percentage of time with no thermal stress: 37.34%
the percentage of time with slight heat/ cold: 18.50%
the percentage of moderate to extreme heat stress: 12.51%
the percentage of moderate to extreme cold stress: 31.64%



Outdoor Comfort (-3 = Extreme Cold | -2 = Cold | -1 = Cool | 0 = Comfort | 1 = Warm | 2 = Hot | 3 = Extreme Heat) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

2. Climate Analysis

2.6 Conclusion

Dry Bulb Temperature Analysis

Relative Humidity Analysis

Wind Analysis

Sun Path Analysis

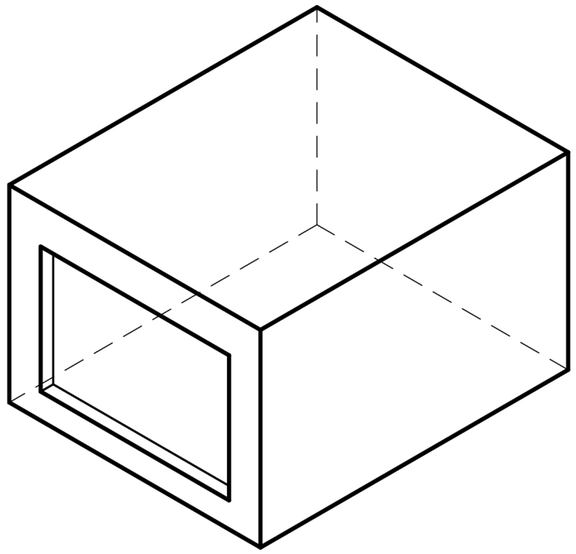
Outdoor Comfort Analysis

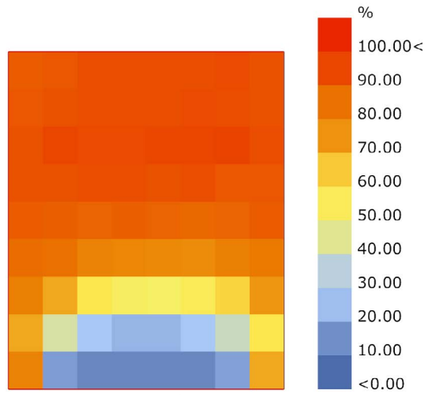
1. The temperature in Philadelphia is somehow extreme and comfortable hours only take up 25% in a whole year. So, during the winter, the room should get more sunshine but in summer, there should be useful shading device.

2. Because of the temperature difference, the wall should be have better insulation to save the energy for heating and airconditioning. Also, I have the requirement of a large window, so the choice of the glass also should be considered.

3.The orientation of the room should facing south, shoutheast or southwest, which could make use of natural ventilation when the temperature and relative humidity is comfortable.

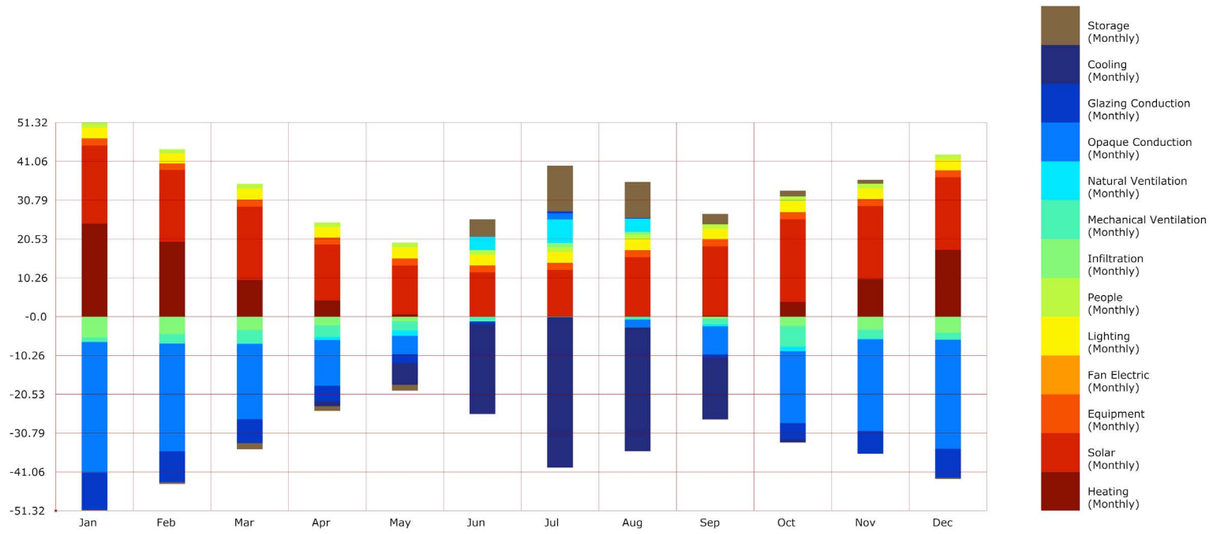
3. Base-case Assessment





UDI:100-2000lux

Percentage of UDI > 80%: **66.7%**



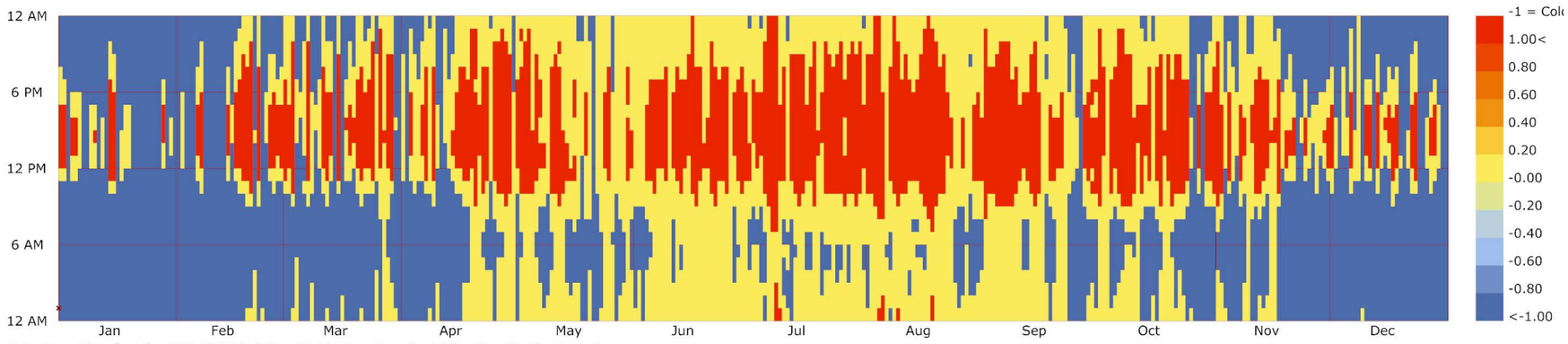
Glazing Face: South
Glazing Ratio: 0.5
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 28C
Occupancy Schedule: My Schedule

Comment

1. Based on looking into the UDI analysis, the light around the window is too much and the daylighting in the room should be more even.

2. From the analysis of adaptive comfort, it is too cold in the winter and it is hot in the noon all year round.

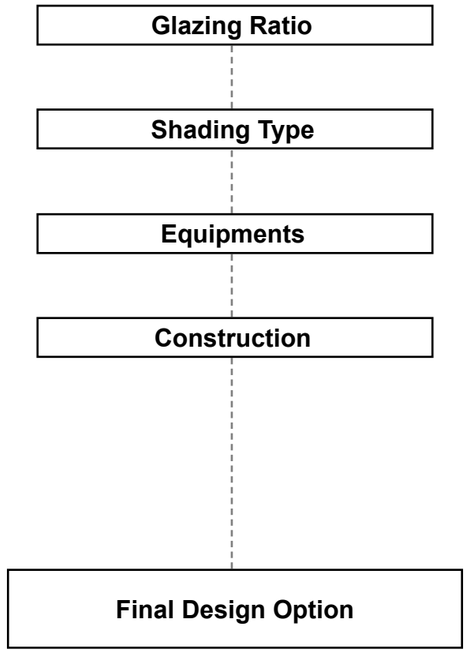
3. From the chart of energy balance analysis, the current room doesn't make use of sunlight and indoor airflow enough. Also, the opaque conduction is too much in the winter.



Adaptive Comfort for MY_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

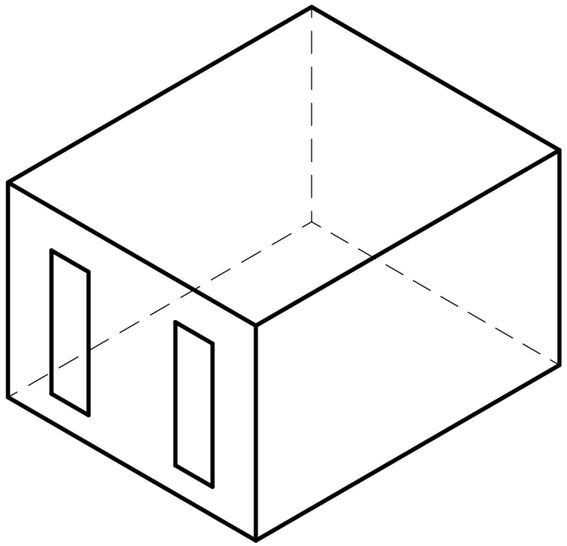
Percentage of time comfortable: **38.5%**
Percentage of time hot: **22.1%**
Percentage of time cold: **39.4%**

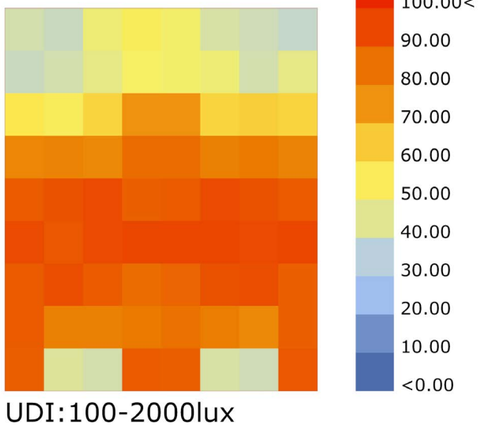
4. Improvement



4. Base-case Assessment

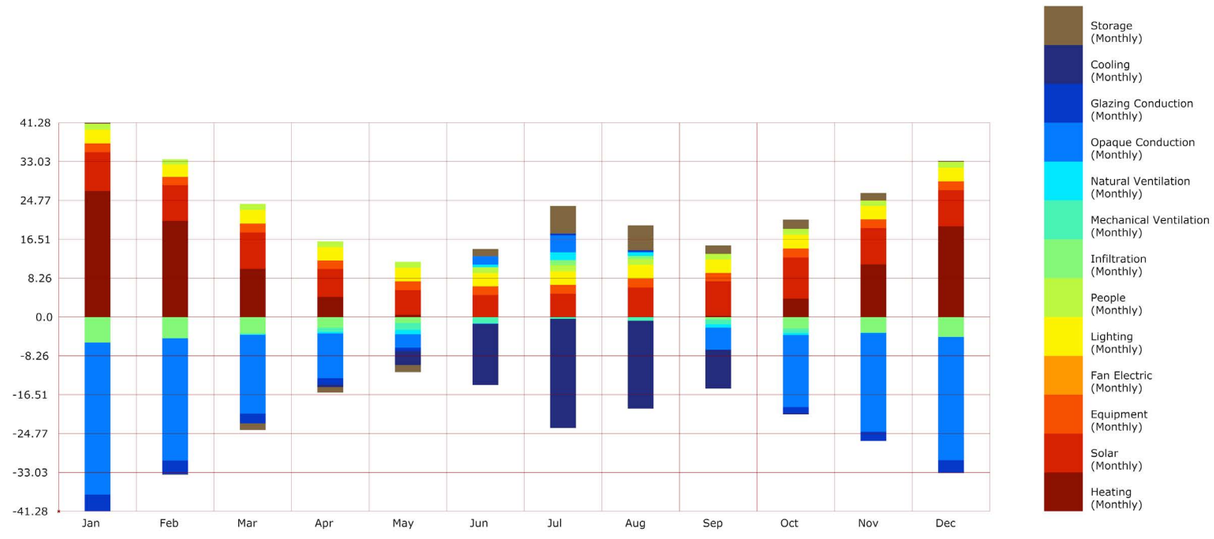
4.1 Ratio of Glazing





UDI:100-2000lux

Percentage of UDI > 80%: **47.2%**



Glazing Face: South
Glazing Ratio: 0.2
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 28C
Occupancy Schedule: My Schedule

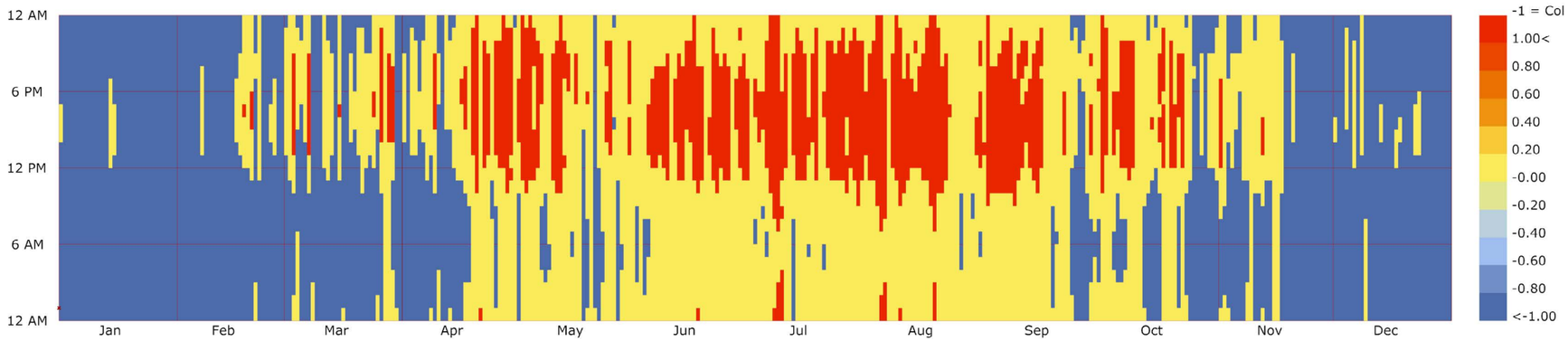
Strategy: Decrease the ratio of glazing

Comment

1. The light is not enough now. So for the next step, the ratio needs to be increased a little bit.
2. Cold time in winter is increased and comdition in summer becomes better.
3. Energy use is decreased but still, the opaque conduction is too high.

Next Step

Increase the ratio of glazing slightly and try different glazing orientation.

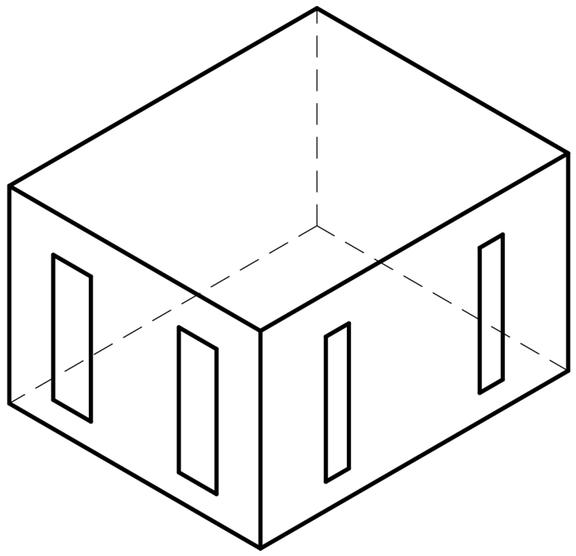


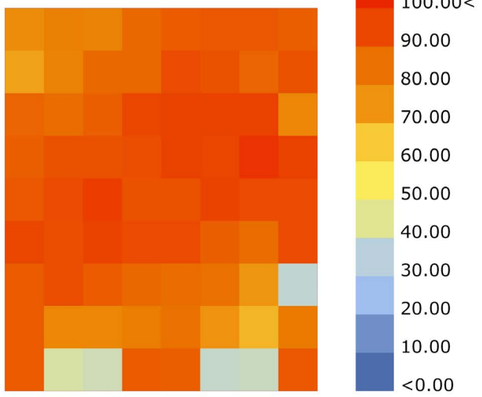
Adaptive Comfort for MY_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

Percentage of time comfortable: **43.0%**
Percentage of time hot: **14.9%**
Percentage of time cold: **42.0%**

4. Base-case Assessment

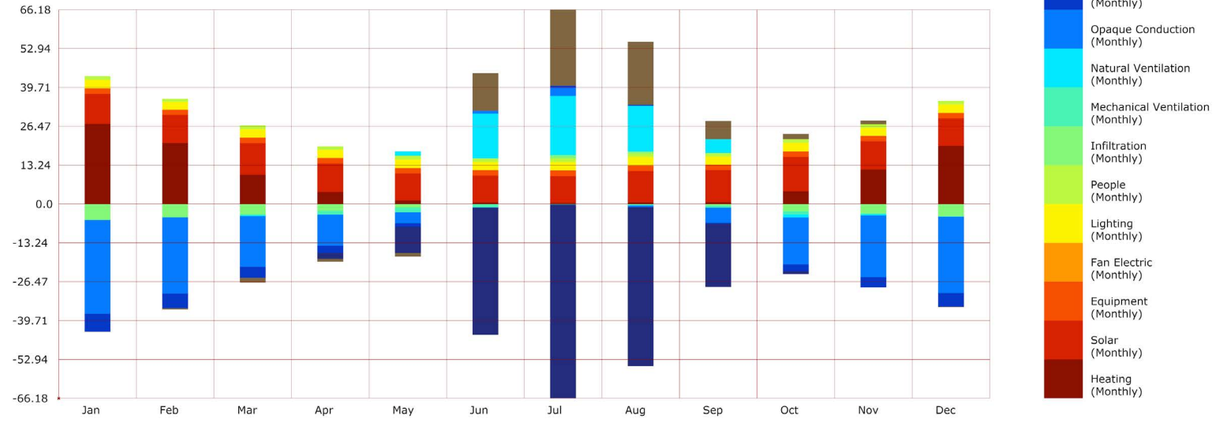
4.1 Ratio of Glazing





UDI:100-2000lux

Percentage of UDI > 80%: **76.4%**



Glazing Ratio: South_0.2, East_0.1
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 28C
Occupancy Schedule: My Schedule

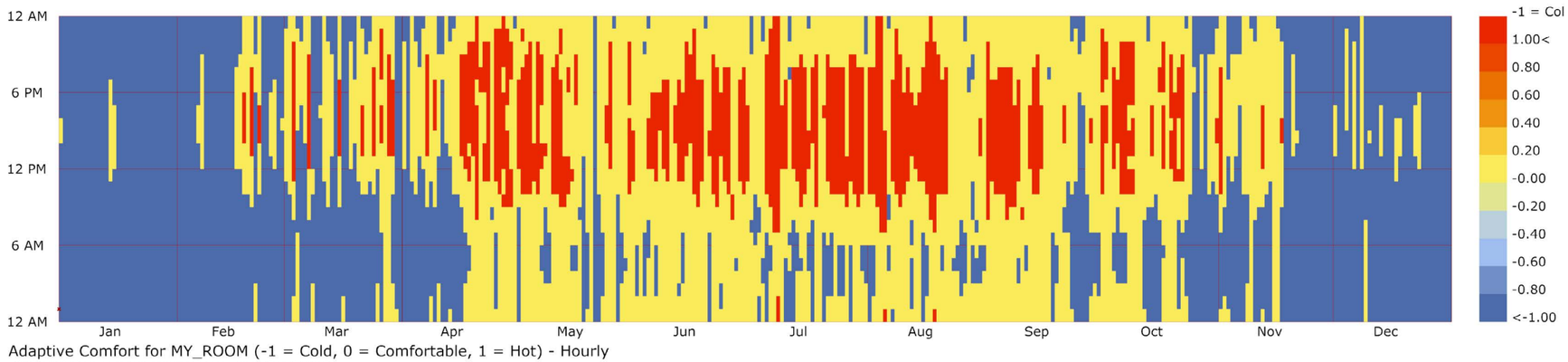
Strategy: Make openings on eastern side.

Comment

1. The daylight becomes much more even but light around the window is still too much.
2. From the analysis of adaptive comfort, the overall comfort percentage is increased and indoor airflow increased, but the cold time becomes more.
3. The energy use in winter decreased because of smaller opening area but it increases a lot in summer.

Next Step

Add shading panels at southern side.

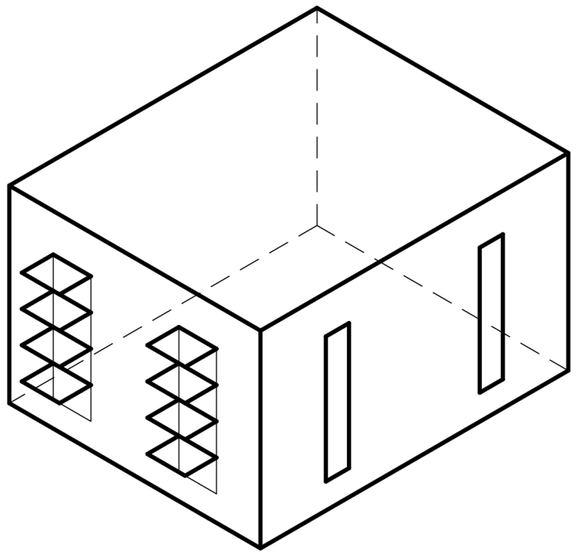


Adaptive Comfort for MY_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

Percentage of time comfortable: **43.7%**
Percentage of time hot: **14.0%**
Percentage of time cold: **42.3%**

4. Base-case Assessment

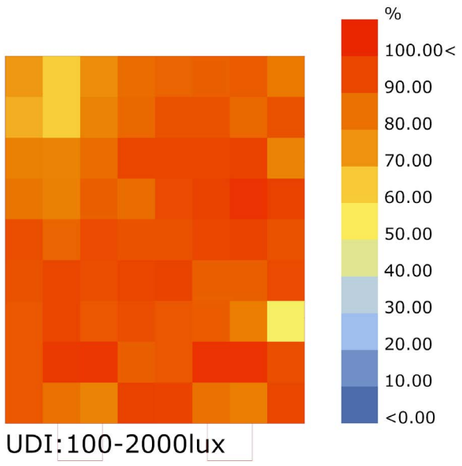
4.2 Shading Device



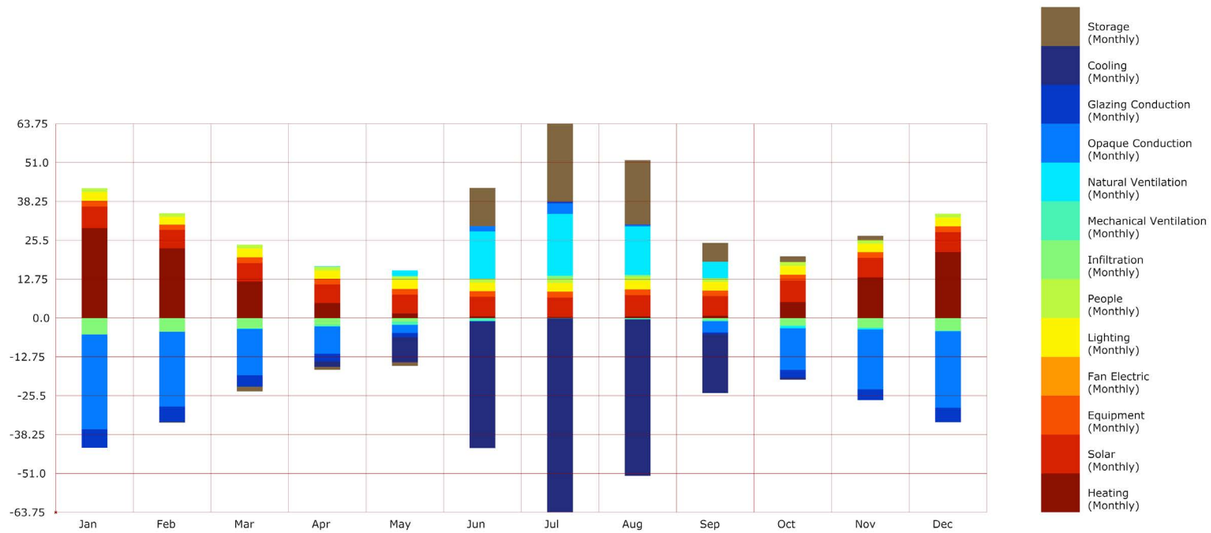
Glazing Ratio: South_0.2, East_0.1
Shading: 0.6m*0.5m*4
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 28C
Occupancy Schedule: My Schedule

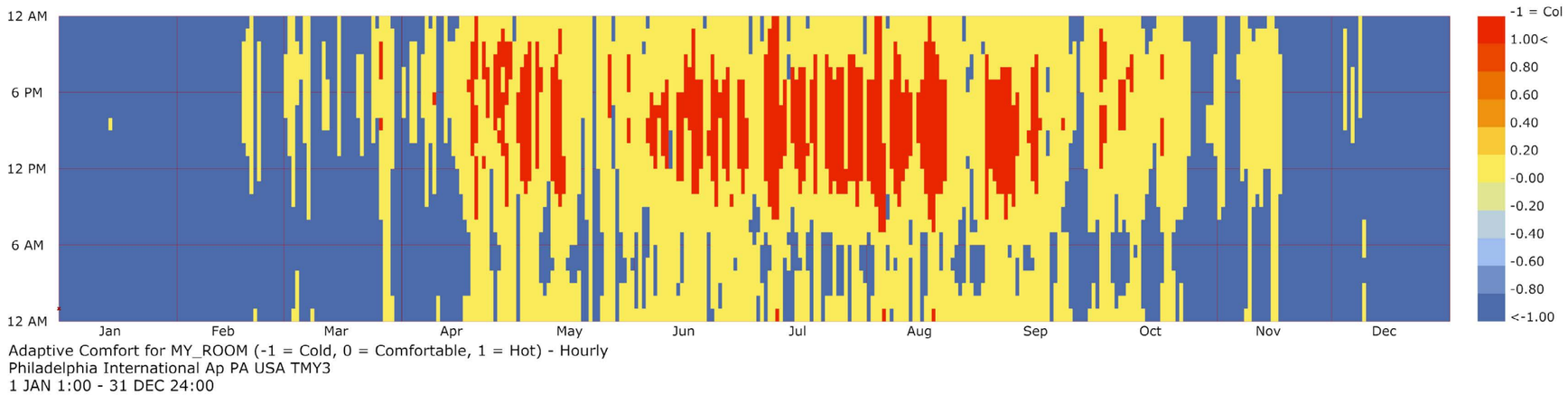
Strategy: Add shading panels on southern side.
Comment
1. Based on looking into the UDI analysis, the day-lighting analysis has reached my expection.
2. From the analysis of adaptive comfort, the situation in summer is better, but in winter, it is too cold.
3. The overall energy use just decreased a little. And the energy use in summer is still too much.

Next Step
Decrease the heat of storage and natural ventilation in summer.



Percentage of UDI > 80%: **79.2%**

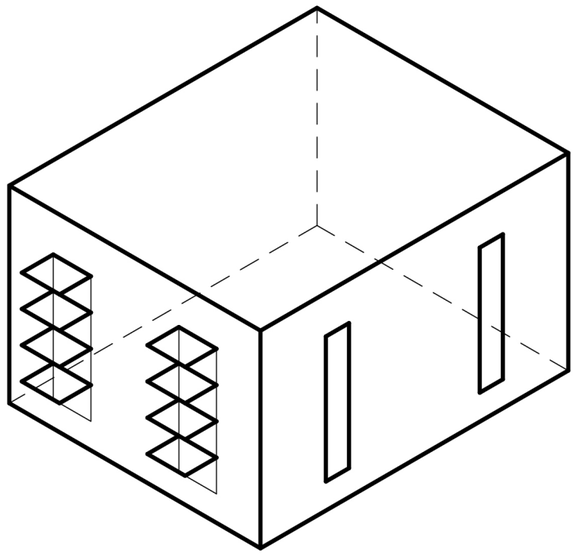




Percentage of time comfortable: **42.1%**
Percentage of time hot: **9.5%**
Percentage of time cold: **48.4%**

4. Base-case Assessment

4.3 Natural Ventilation



Glazing Ratio: South_0.2, East_0.1
Shading: 0.6m*0.5m*4
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 24C
Occupancy Schedule: My Schedule

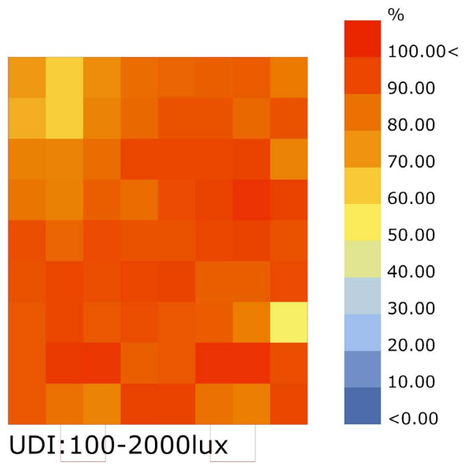
Strategy: Adjust maximum outdoor temperature for matural ventilation.

Comment

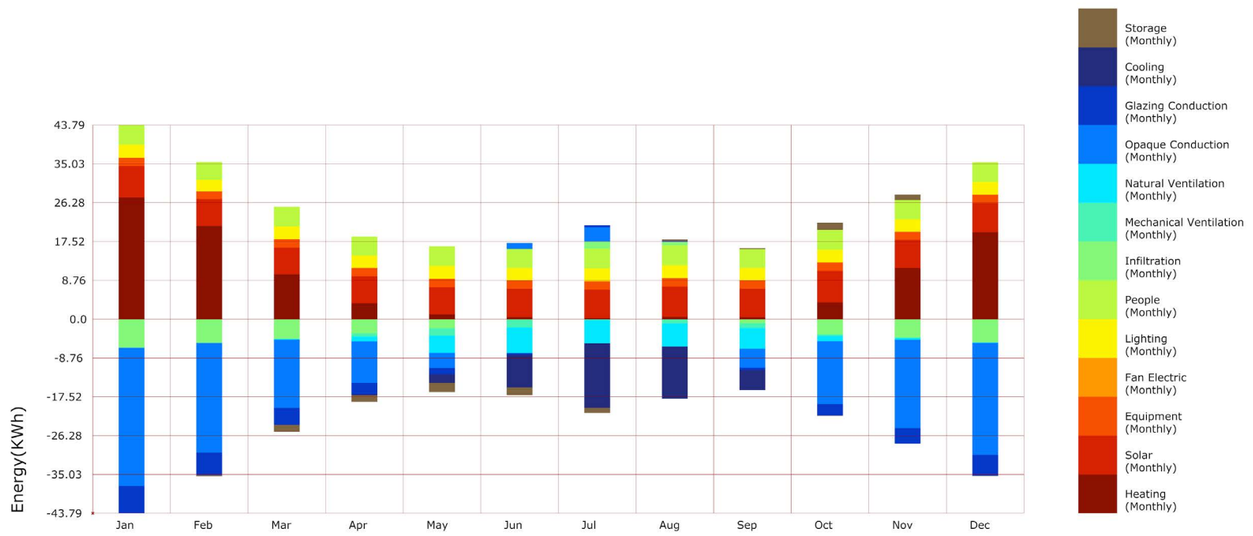
1. Based on looking into the UDI analysis, the day-lighting analysis has reached my expection.
2. From the analysis of adaptive comfort, the situation in summer is better, but in winter, it is too cold.
3. The energy use has improved a lot in summer after decreasing the maximum outdoor temperature for natural ventilation.

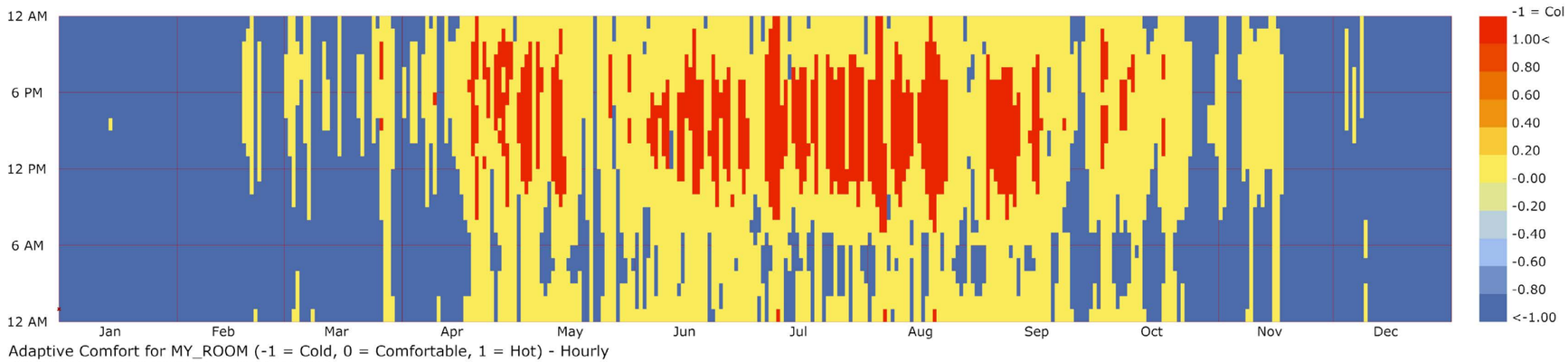
Next Step

Add the factor of equipments.



Percentage of UDI > 80%: **79.2%**



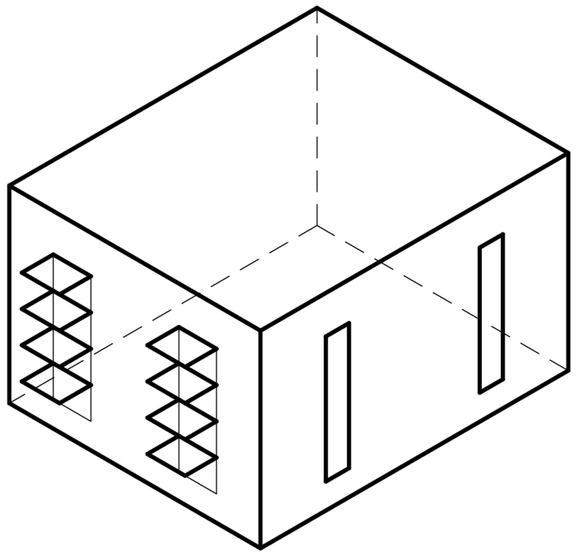


Adaptive Comfort for MY_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

Percentage of time comfortable: **37.9%**
Percentage of time hot: **13.5%**
Percentage of time cold: **48.6%**

4. Base-case Assessment

4.4 Equipments

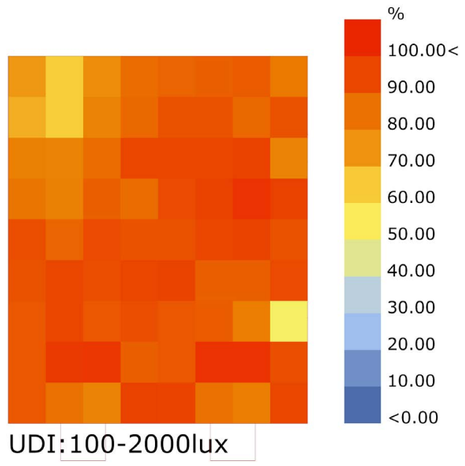


Glazing Ratio: South_0.2, East_0.1
Shading: 0.6m*0.5m*4
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 24C
Equipment Load Per Area: 8W/m^2
Infiltration Rate Per Area: 0.0001m^3/s per m^2
Lighting Density: 8W/m^2
Occupancy Schedule: My Schedule

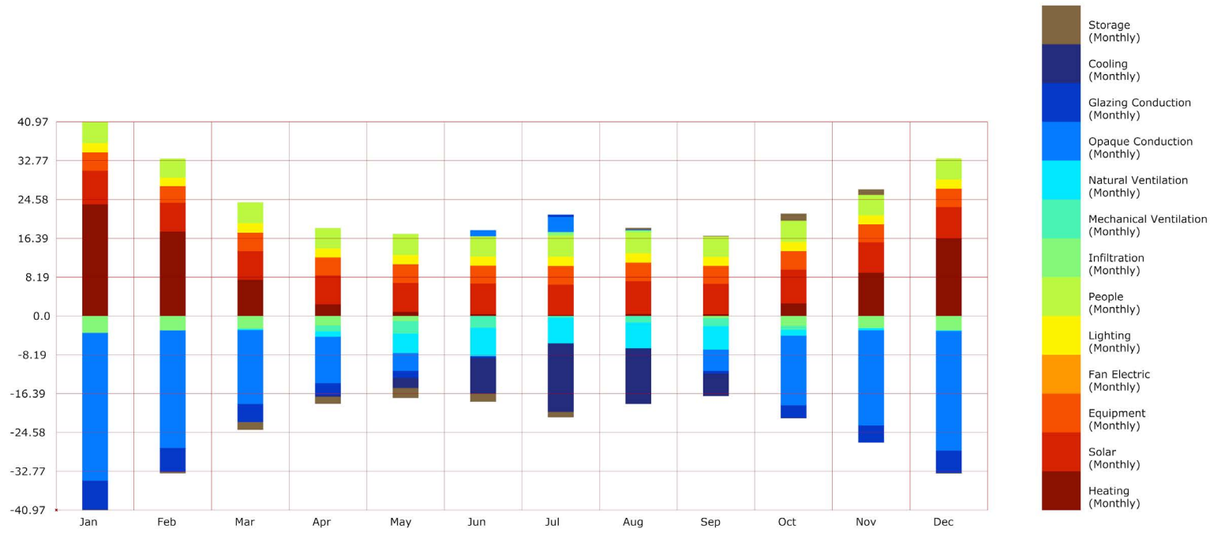
Strategy: Add equipment load, decrease infiltration rate and increase lighting density.

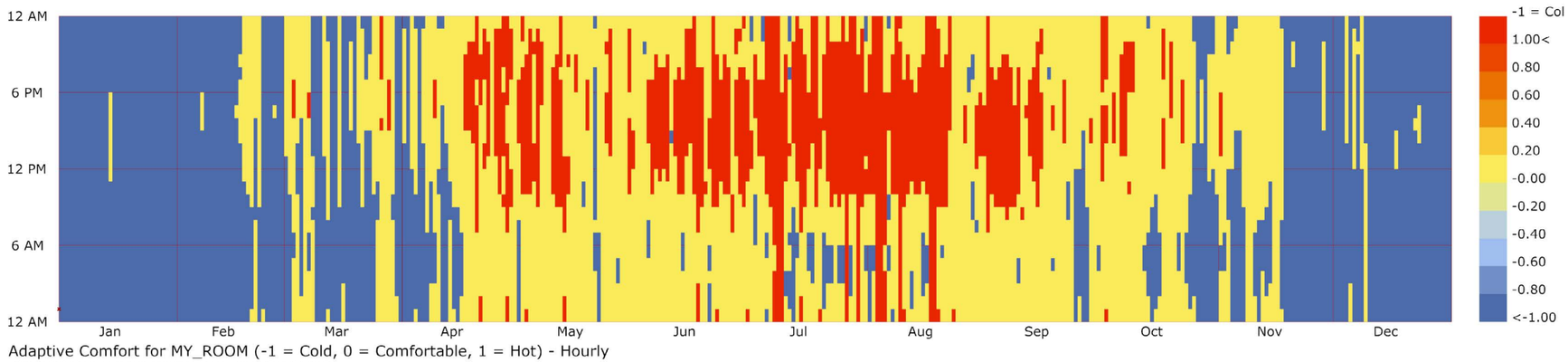
Comment
The comfort in winter and energy balance improves but not much.

Next Step
Improve the thermal performance of construction.



Percentage of UDI > 80%: **79.2%**

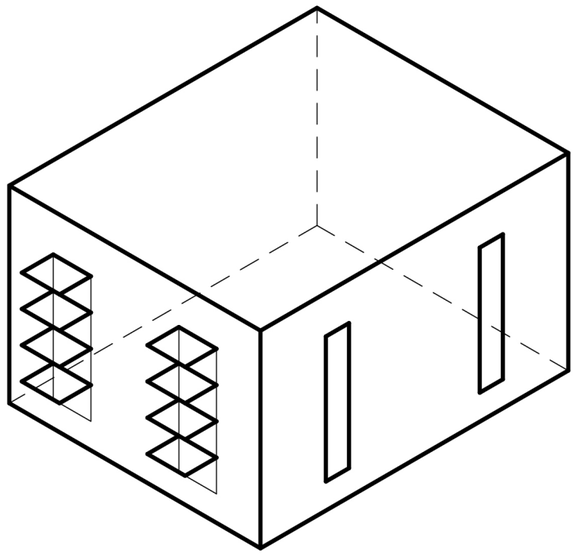




Percentage of time comfortable: **45.2%**
Percentage of time hot: **16.5%**
Percentage of time cold: **38.3%**

4. Base-case Assessment

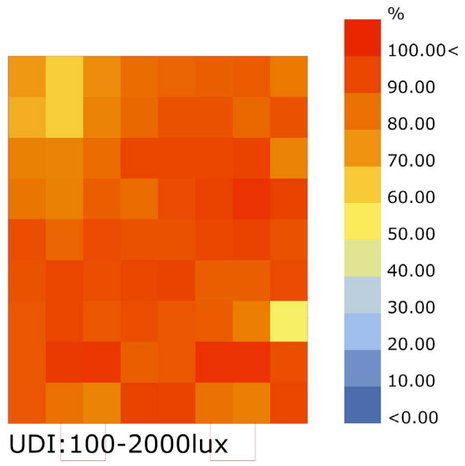
4.5 Construction



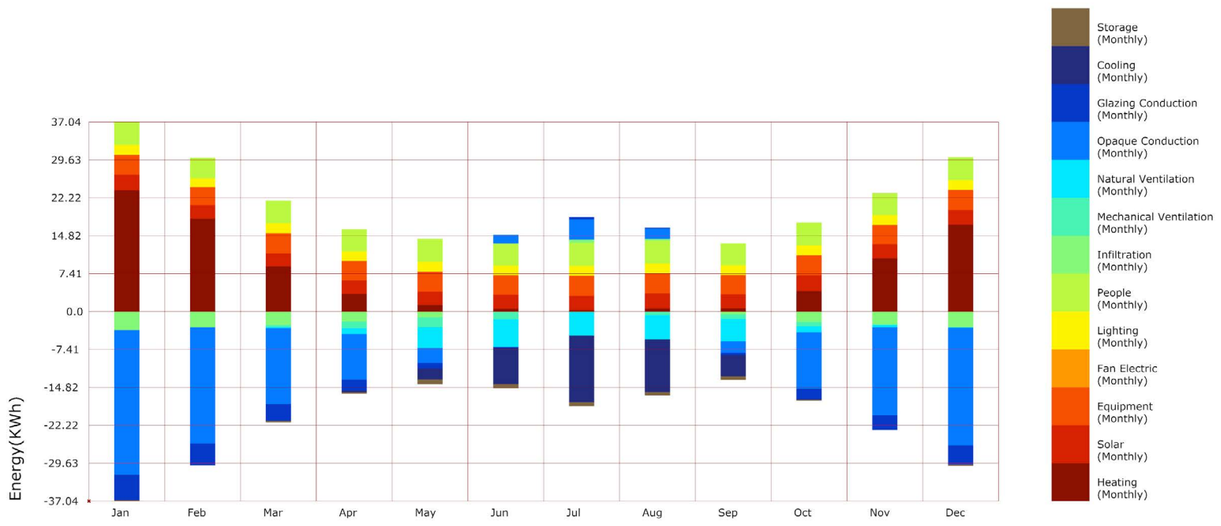
Glazing Ratio: South_0.2, East_0.1
Shading: 0.6m*0.5m*4
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 24C
Equipment Load Per Area: 8W/m^2
Infiltration Rate Per Area: 0.0001m^3/s per m^2
Lighting Density: 8W/m^2
Occupancy Schedule: My Schedule

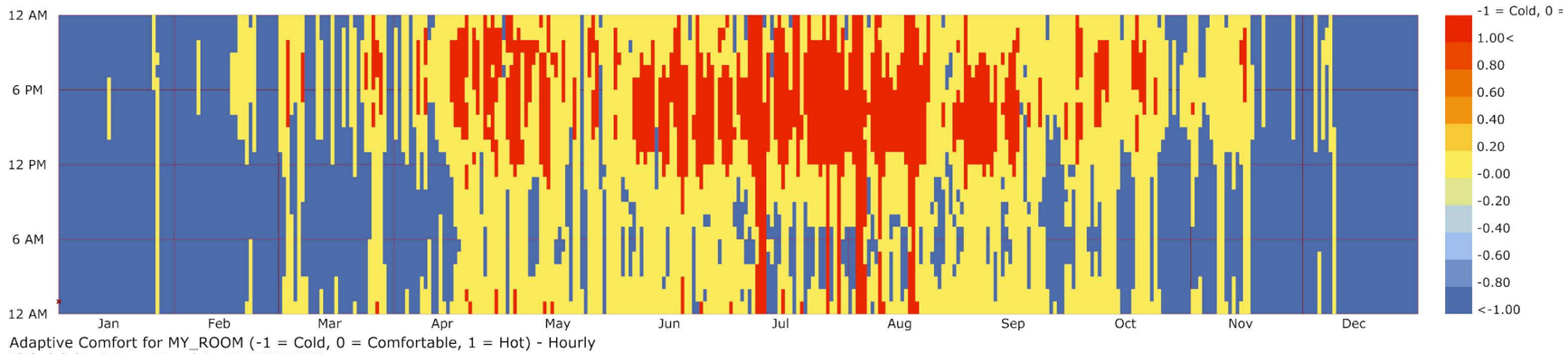
Strategy: Change materials of exterior wall, window, and floor of higher R value.

Comment
After changing materials of higher R value, the comfort has no improvement, but energy balance gets better.



Percentage of UDI > 80%: **79.2%**





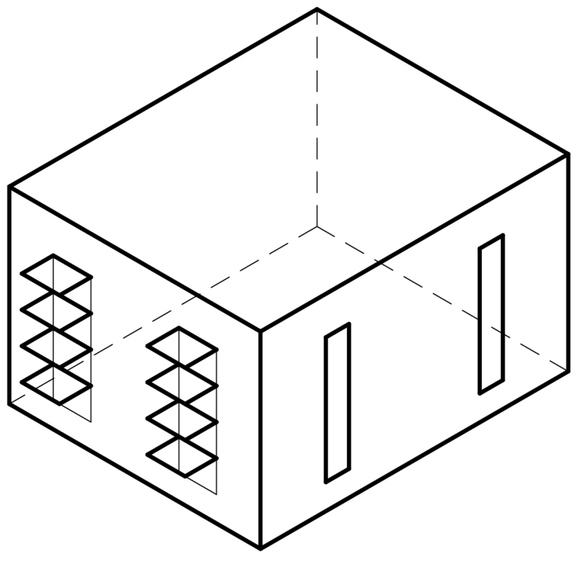
Adaptive Comfort for MY_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

Percentage of time comfortable: **41.2%**
Percentage of time hot: **14.5%**
Percentage of time cold: **44.2%**

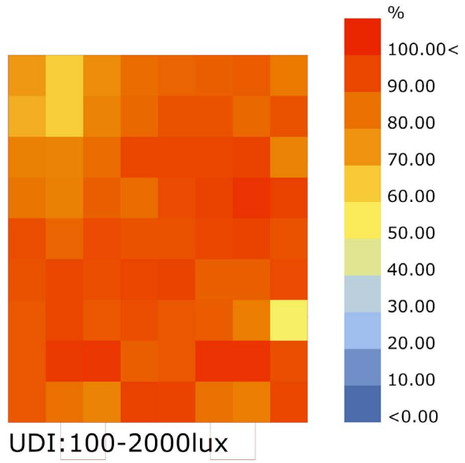
5. Final Design Option

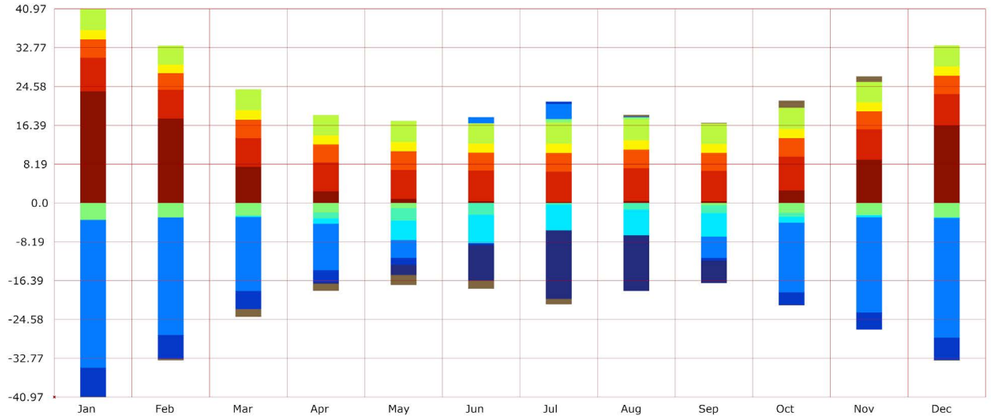
This is my final design option. Firstly, I prefer many windows in my room and get enough natural lighting. In this option, the daylighting is comfortable. Secondly, the comfortable hours in this case is the most. Also, the energy balance is reasonable.

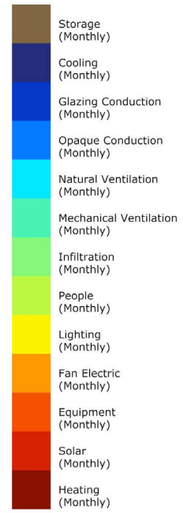
The problem of this option is that a large portion of uncomfortable time in winter. It helps through making the window larger after making materials and effects of equipments in the best condition. But it also means too much light in summer. So I will choose using heating system to make it more comfortable in winter.



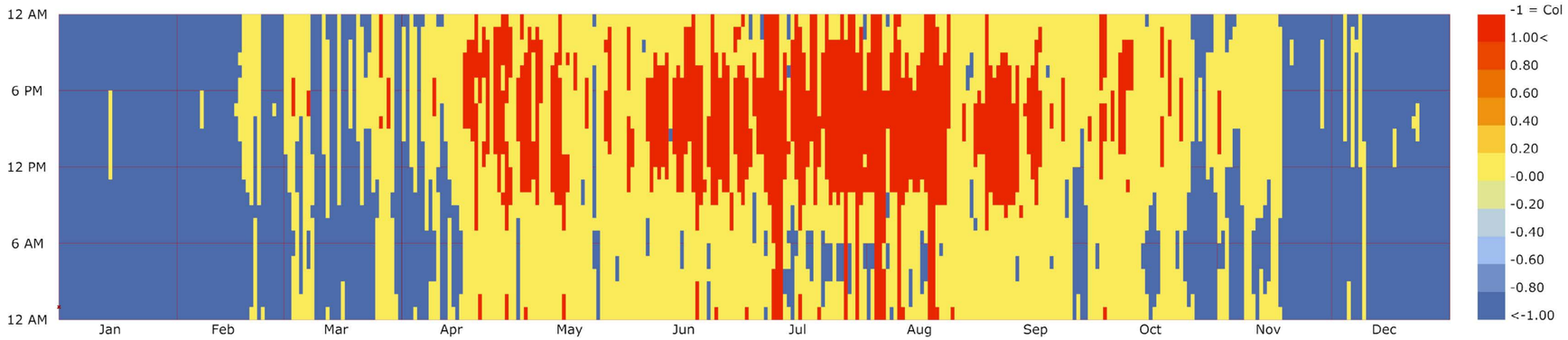
Glazing Ratio: South_0.2, East_0.1
Shading: 0.6m*0.5m*4
Sill Height : 0.4m
Minimum & maximum outdoor temperature for natural ventilation : 20C & 24C
Equipment Load Per Area: 8W/m^2
Infiltration Rate Per Area: 0.0001m^3/s per m^2
Lighting Density: 8W/m^2







Percentage of UDI > 80%: **79.2%**



Adaptive Comfort for MY_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

Percentage of time comfortable: **45.2%**
Percentage of time hot: **16.5%**
Percentage of time cold: **38.3%**