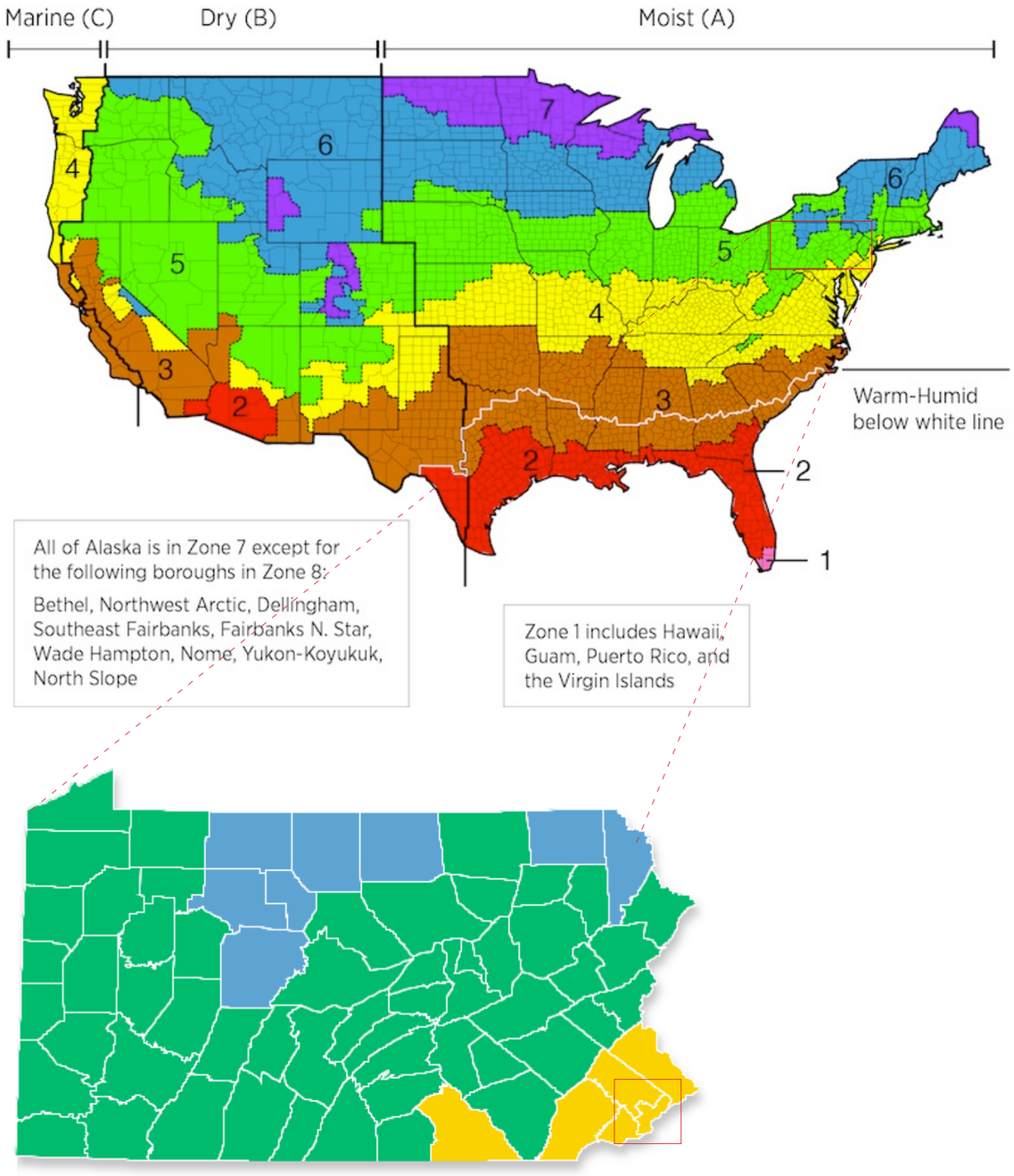
Weather Data Analysis

ARCH 753 Building Performance Simulation
Di Fan

Climate Zone

Weather Data: Philadelphia International Ap, PA,USA, TMY3
Latitude: 39.87
Longitude: -75.23
CDD: 1235
HDD: 4759
Climate Zone: 4A
Characteristic: Mixed-Humid

From the Climate Classification, the heating degree days of philly is very high, almost 4 times than cooling degree days. Thus, the design strategy would focus on the heating efficiency and thermal insulation.

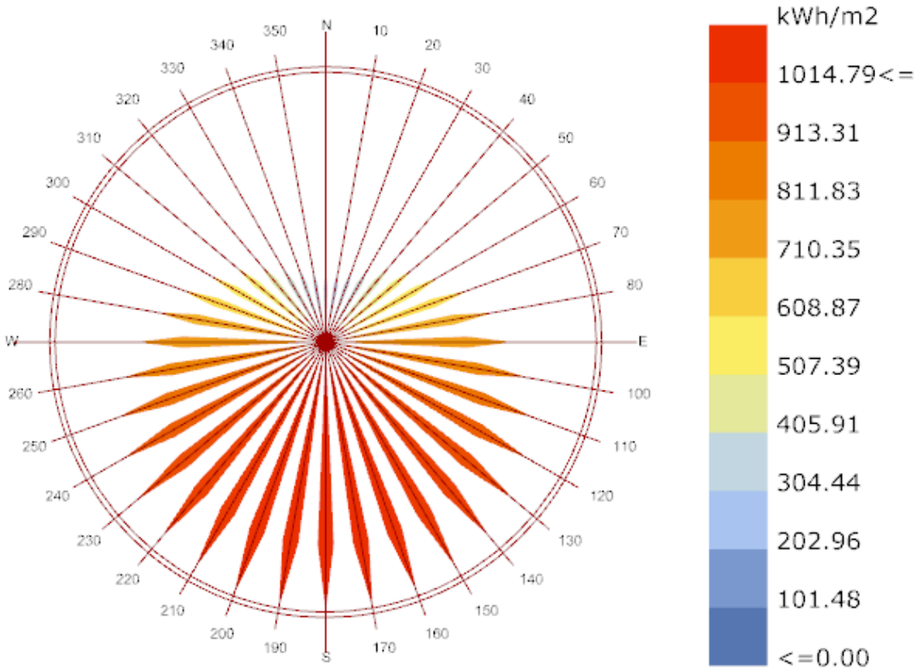


Residential Prescriptive Requirements For Zone 4 (2009 IECC)

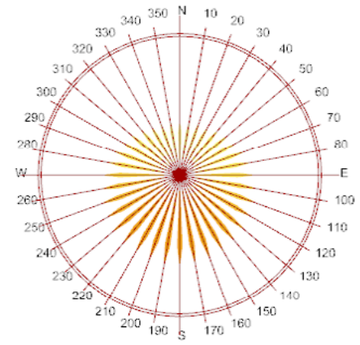
Climate Zone 4 (Except Marine)	
Ceiling R-value	38
Wood Frame Wall R-value	13
Mass Wall R-value [i]	5/10
Floor R-value	19
Basement Wall R-value [c]	10/13
Slab R-value [d], Depth	10, 2 ft
Crawlspace Wall R-value [c]	10/13
Fenestration U-Factor [b]	0.35
Skylight U-Factor [b]	0.60
Glazed fenestration SHGC [b, e]	NR

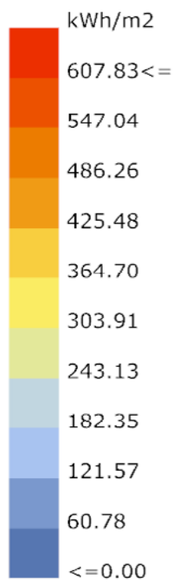
Https://energycode.pnl.gov/EnergyCodeReqs/?state=Pennsylvania

Solar Radiation

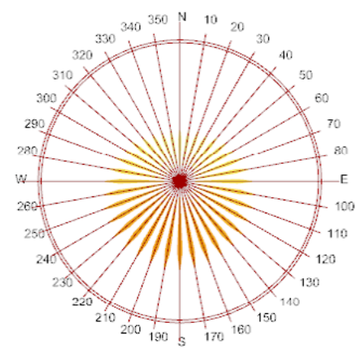


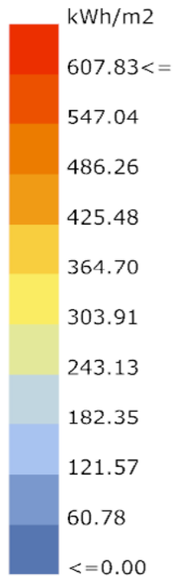
Total Radiation (KWh/m²)
Philadelphia_International_AP_PA_USA
1 JAN 1:00- 31 DEC 24:00





Diffuse Radiation(kWh/m2)
Philadelphia_International_Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

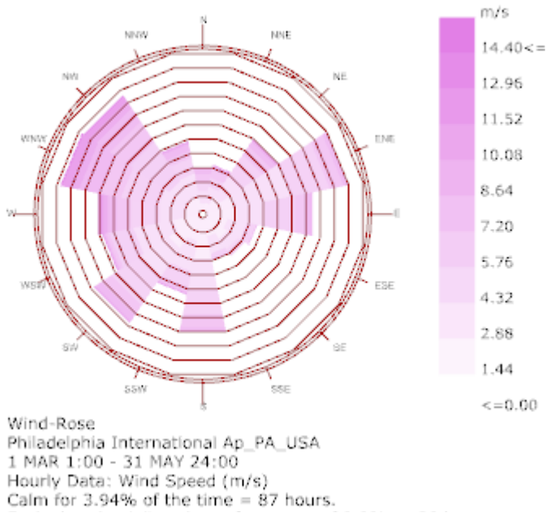




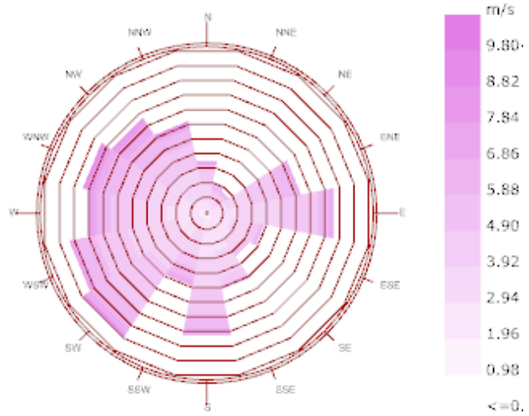
Most Solar Radiation come from the southern direction. There is little solar radiation gain from the northen part.

Diffuse Radiation(kWh/m2)
Philadelphia_International_Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

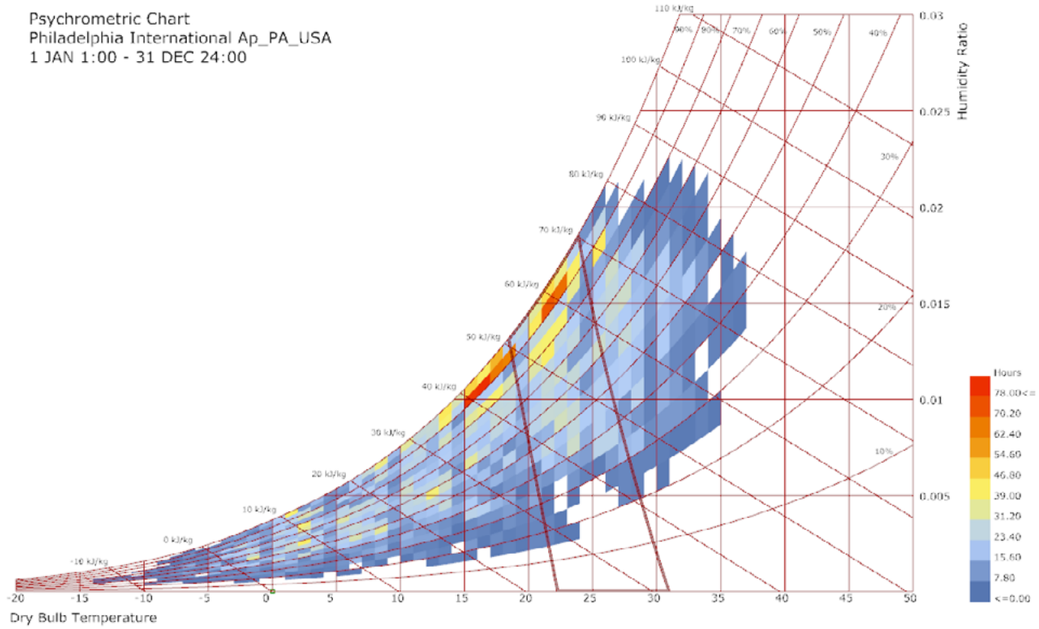
Wind Frequency

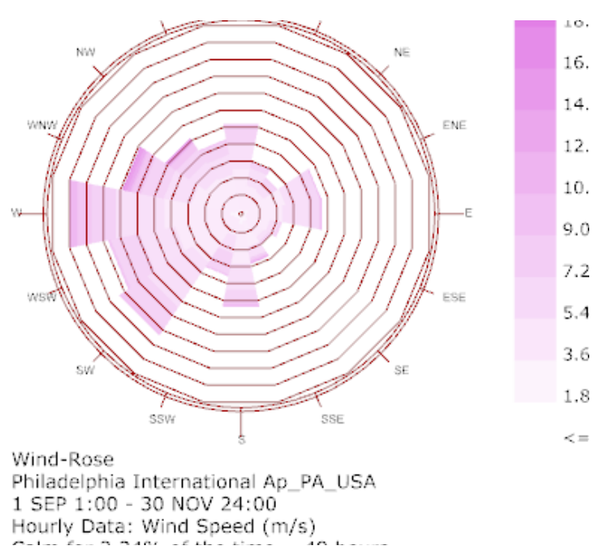


Spring Wind Frequency

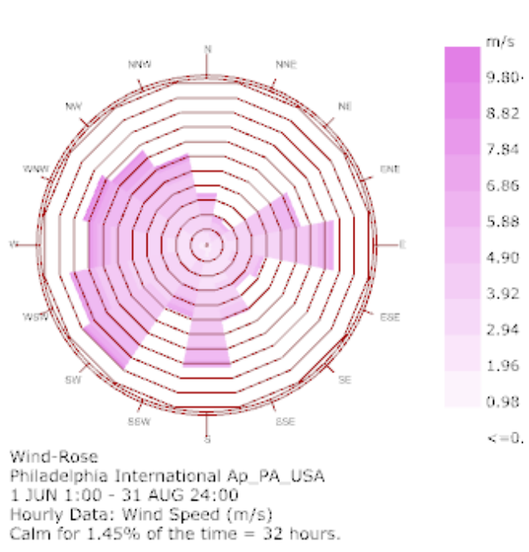


Summer Wind Frequency

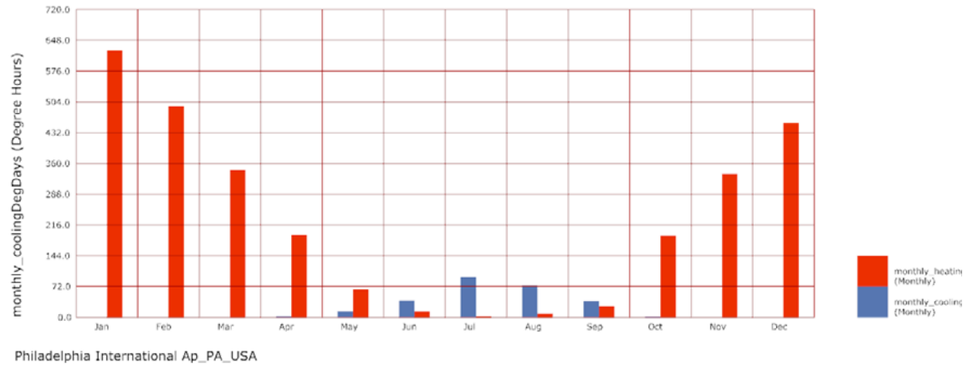




Autumn Wind Frequency



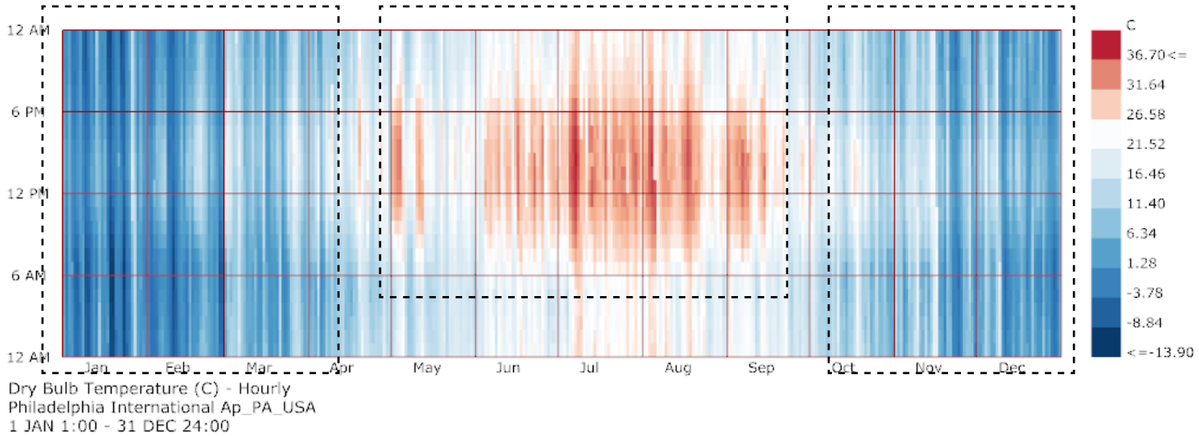
Winter Wind Frequency



From two charts above, we can see that Philadelphia has a lot of cold days from November to April.And also during summer, there are hot days especially from July to August. The Heating degree days is higher than Cooling degree days. Thus, how to get the maximam solar energy gain is one of the main concern of increaing annual comfort days of the dream room.

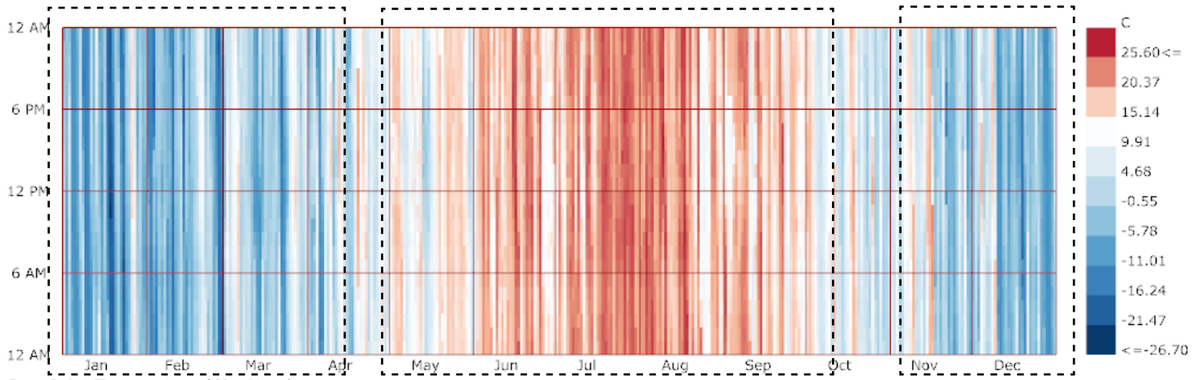
Exterior Factors

Dry Bulb Temperature



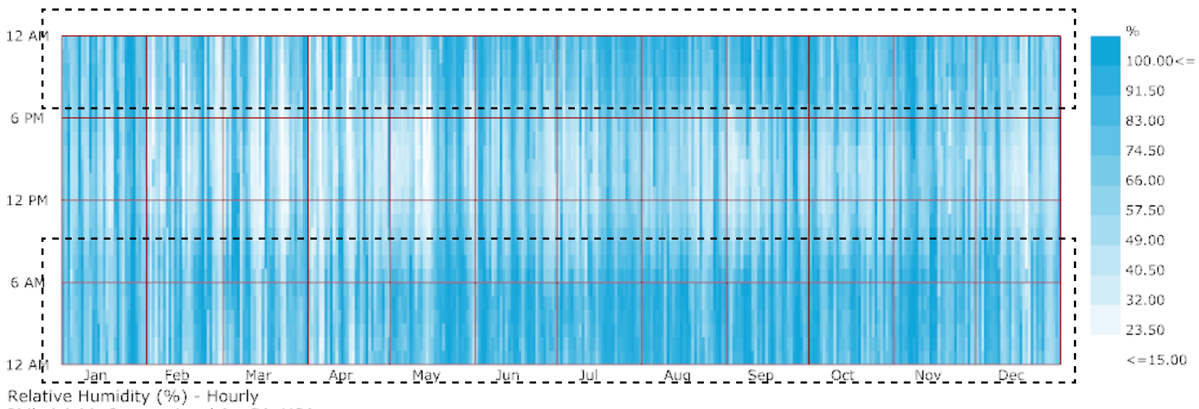
Dry Bulb Temperature (C) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

Dew Bulb Temperature



Dew Point Temperature (C) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

Relative Humidity

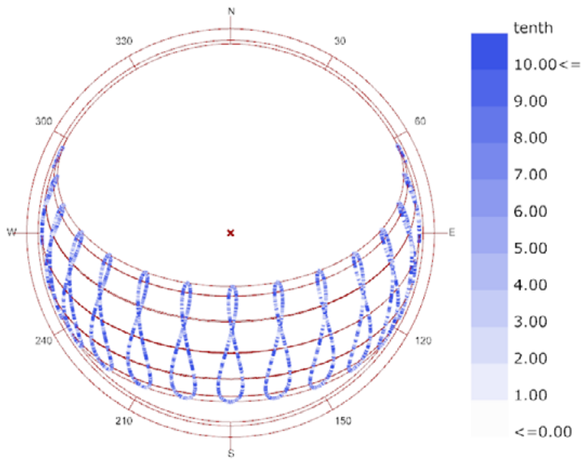


Relative Humidity (%) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

From the TMY3 data, we could know that the temperature in Philadelphia has a extreme difference between winter and summer time. From June to September, the temperature is mainly between 26 - 36 celsius degree. However, during winter time, the temperature is mainly bewteen - 13 to 6 celsius degree. According to the chart of relative humidty, the humidity is relatively high during nighttime than in daytime through the whole year. The high ratio of relative humidity increase the heat stress during summer time, especially at nighttime, and decrease part of the cold stress in winter time. Besides, the buidling type of this project is residential apartment, and the main occupied hour is from 6pm to 8am, in which the outside temperature is not as high as daytime. Thus, introduce evaporative strategy by increasing the ventilation of the room during summer time, especially during night can help get more comfort hours in the dream room.

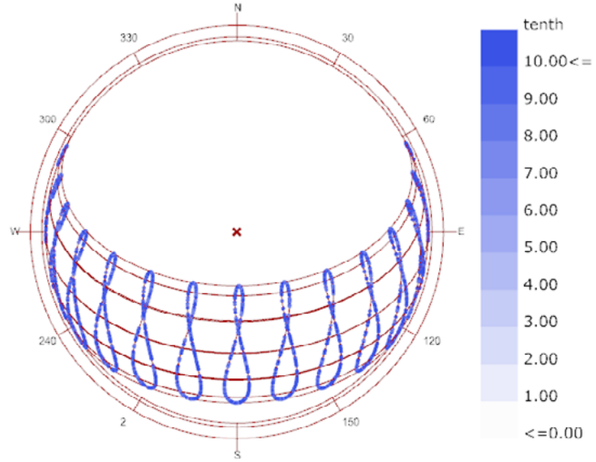
Sun Path

Annual Sun Positions



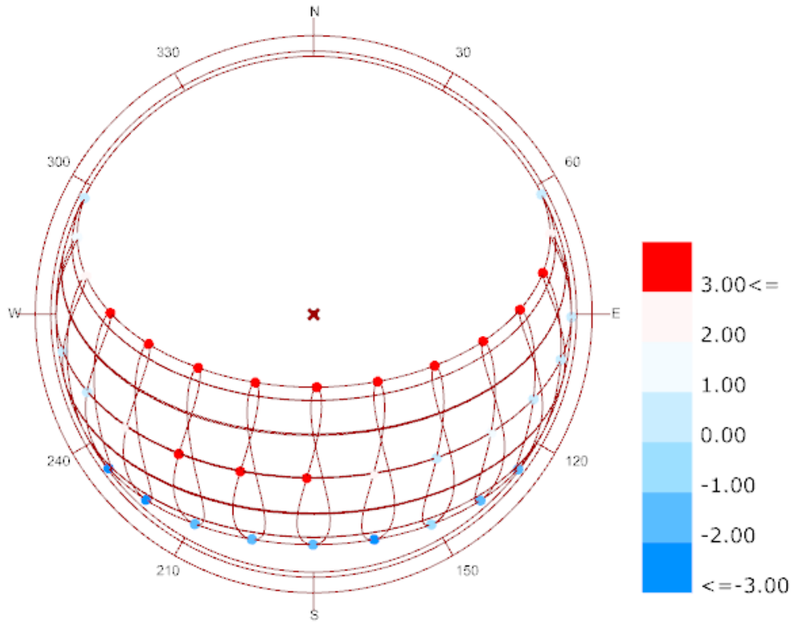
Sun-Path Diagram - Latitude: 39.87
Hourly Data: Total Cloud Cover (tenth)
Philadelphia International Ap_PA_USA

Sun Positions (Sky Cover >6)



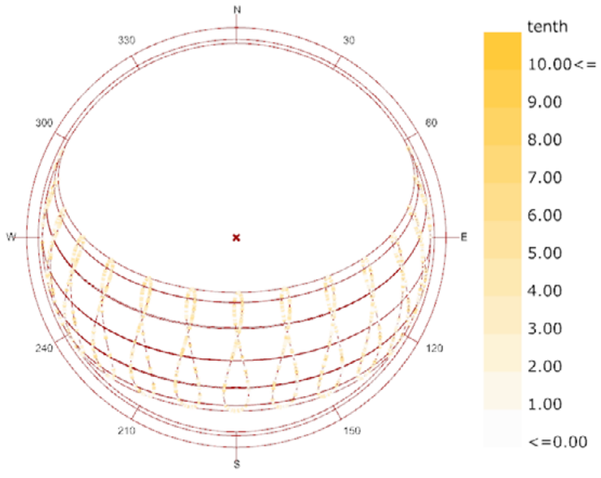
Sun-Path Diagram - Latitude: 39.87
Hourly Data: Total Cloud Cover (tenth)
Philadelphia International Ap_PA_USA
... ...
Conditional Selection Applied:
Total Cloud Cover>6
2324.0 hours of total 4398.0 sun up hours(52.84%).

Annual Comfort on Sun Path



Sun-Path Diagram- Latitude : 39.87
Hourly Data: Ourdoor Comfort (-3 = Extreme Cold |-2 = Cold |-1 = Cool | 0 = Comfort | 1 = Warm | 2 = Hot | 3 = Extreme Hot)
Philadelphia International Ap_PA_USA

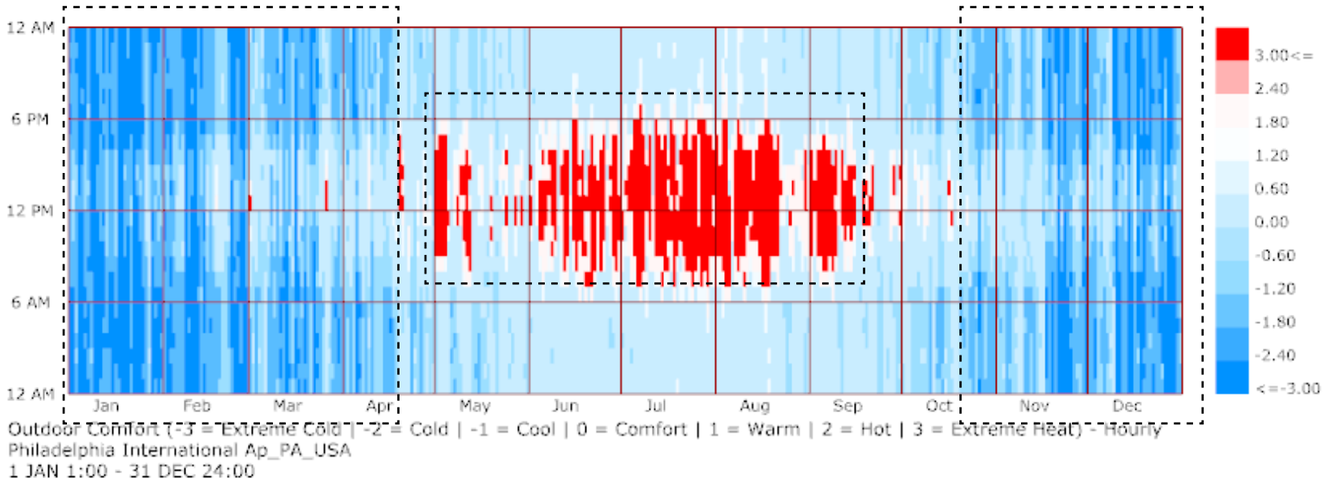
Sun Positions (Sky Cover <6)



Sun-Path Diagram - Latitude: 39.87
Hourly Data: Total Cloud Cover (tenth)
Philadelphia International Ap_PA_USA
... ...
Conditional Selection Applied:
Total Cloud Cover<6
1858.0 hours of total 4398.0 sun up hours(42.25%).

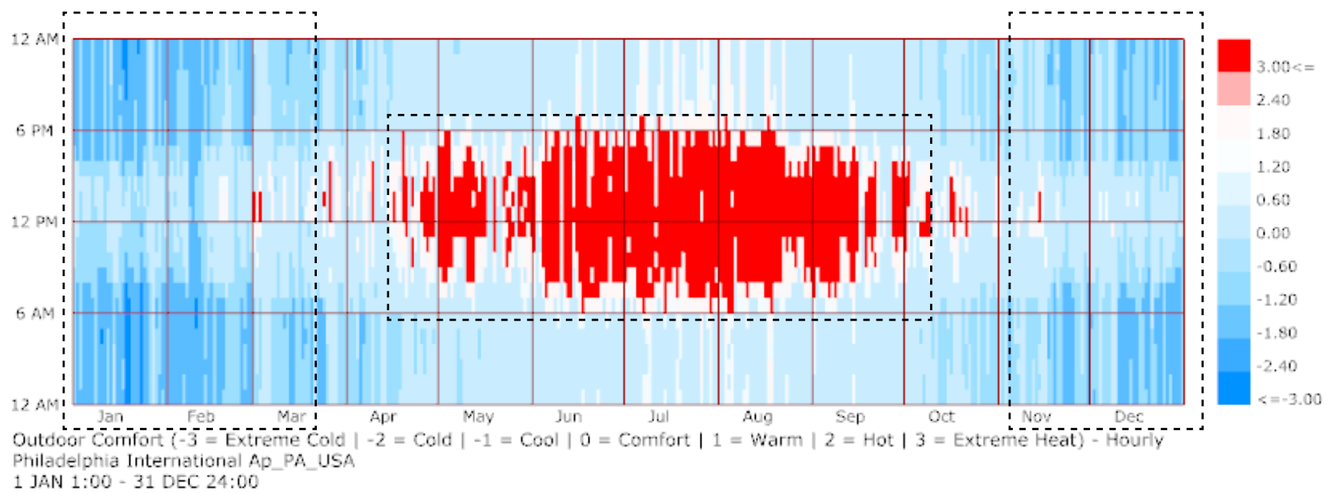
UTCI

UTCI Range (Temperature, RH%, Wind Speed, MRT)



Percent of Time Comfortable: **37.34**
Percent of Heat Stress: 12.51
Percent of Cold Stress: 31.64

UTCI Range (Temperature, RH%, MRT)



Percent of Time Comfortable: **45.38**
Percent of Heat Stress: 20.19
Percent of Cold Stress: 11.42

UTCI, is Universial Thermal Climate Index, meaning the temperature of what the weather “feels like” and it takes into account radiant temperature(usually including solar radiation),relative humidity, wind speed and uses them in a human energy balance model to give a temperature value that is indicative of the heat stress or cold stress felt by the human body.”

From the UTCI mapping on the left, the main issue is there is stong cold stress during winter time and also a high portion of heat stress during the daytime in summer. The annul comfortable time increases from 37.34 to 45.38 when not considering local wind condition. Therefore, prevent passive ventilation during winter and introduce it during summer time may help increase more interior comfort time.