University of Pennsylvania

ARCH753: Building Performance Simulation

Assignment II: Climate Analysis

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39.9167° N, 116.3833° E

Beijing

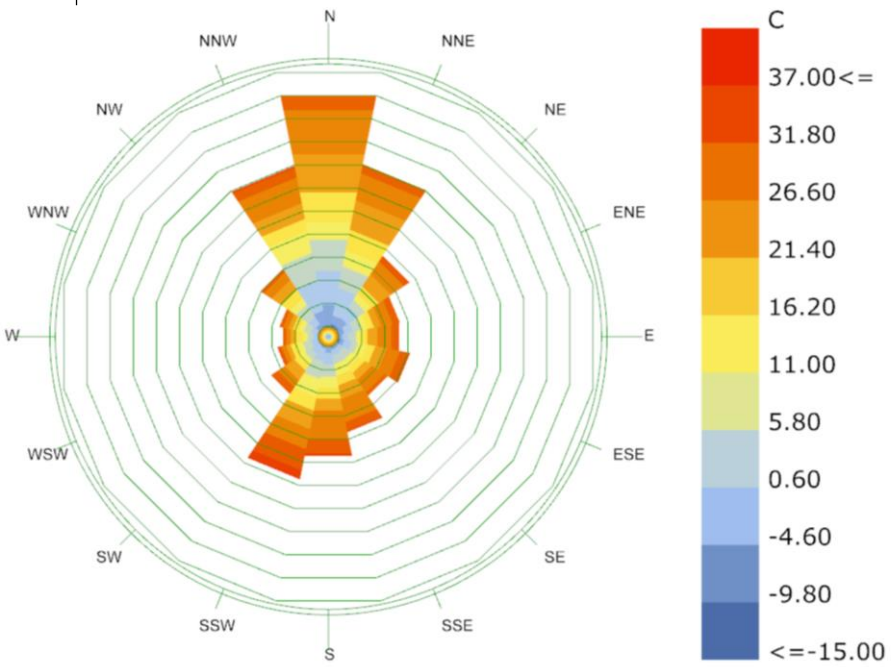
A climatic study

The Climatic analysis for this location aims to find the weather conditions throughout the year while delivering the appropriate design strategies.

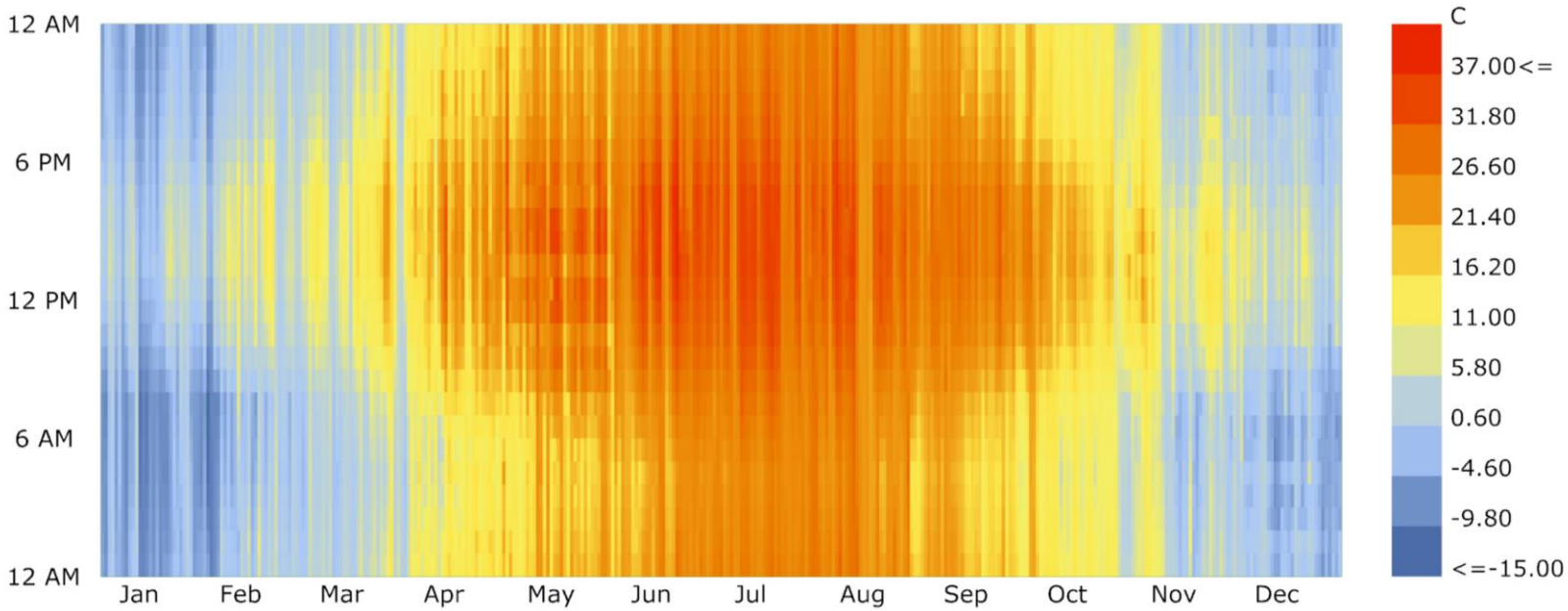
The Study relied on data generated in Grasshopper’s LadyBug plugin from DOE weather data, along with the support of Climate Consultant and JALOXA Sunpath Diagrams.

Dry Bulb Temperature:

The Rose chart below indicates the hourly temperature and direction in relation to the city.



Wind-Rose
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Dry Bulb Temperature (C)
Calm for 9.79% of the time = 858 hours.
Each closed polyline shows frequency of 1.4%. = 123 hours.

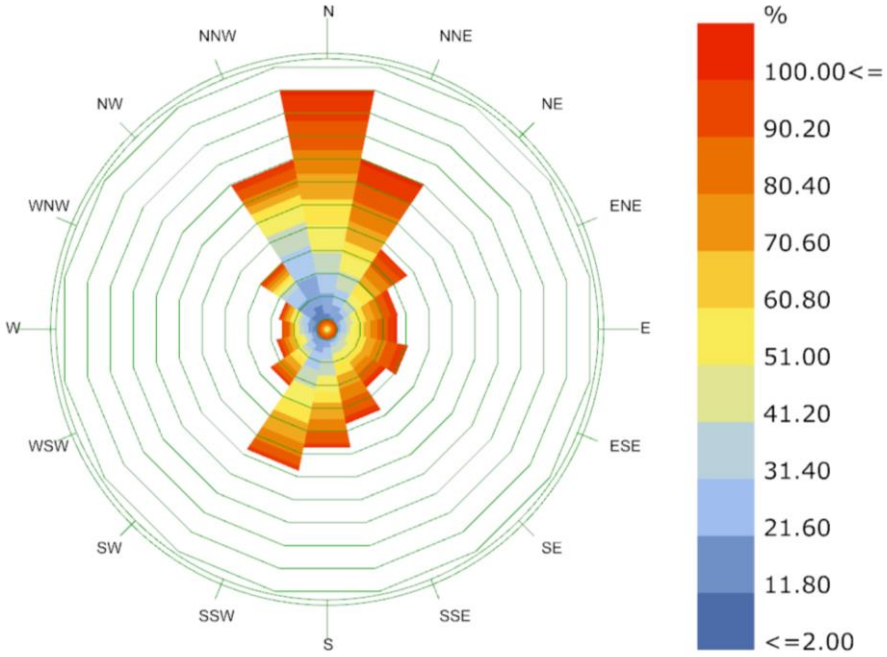


Dry Bulb Temperature (C) - Hourly
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00

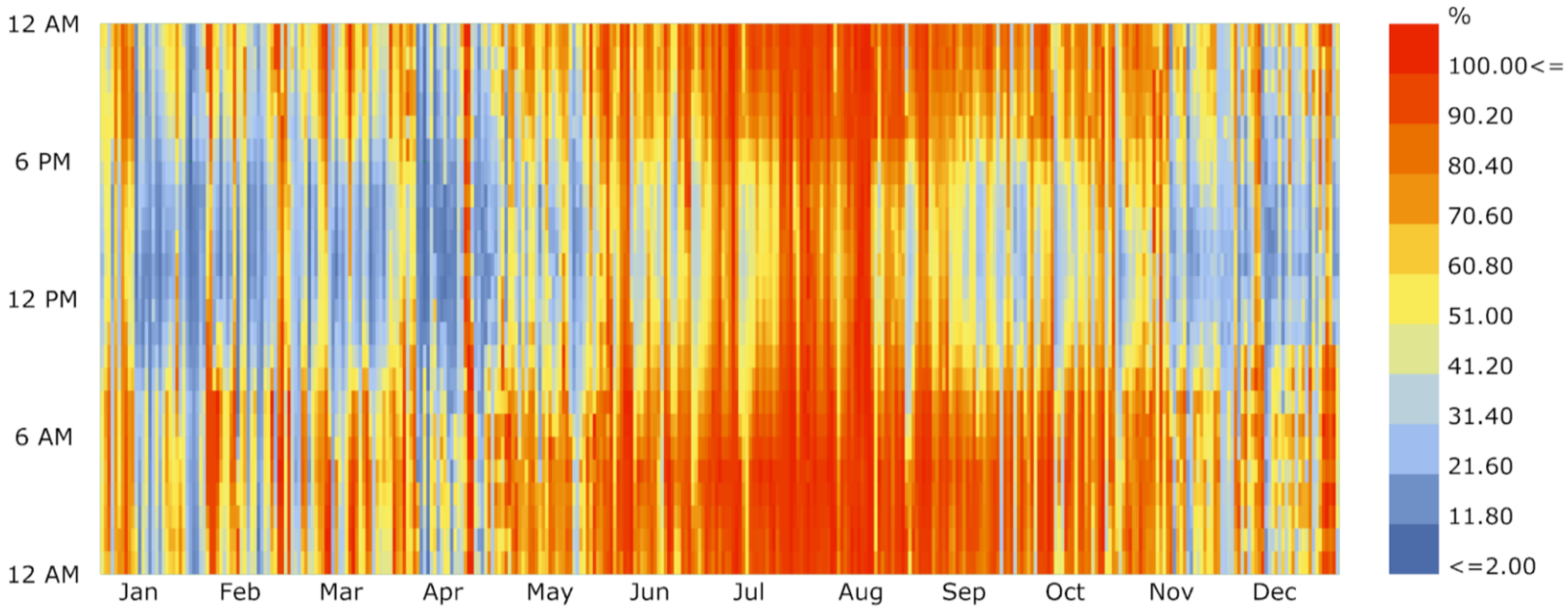
As shown in the chart above, the temperature in Beijing reaches lows bellow -9.8C during winter and highs the reach up to 37C. Most of the temperature throughout the year ranges between 11-26C.

Relative Humidity:

The Rose chart indicates the air's humidity along with wind direction and speed.



Wind-Rose
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Relative Humidity (%)
Calm for 9.79% of the time = 858 hours.
Each closed polyline shows frequency of 1.4%. = 123 hours.

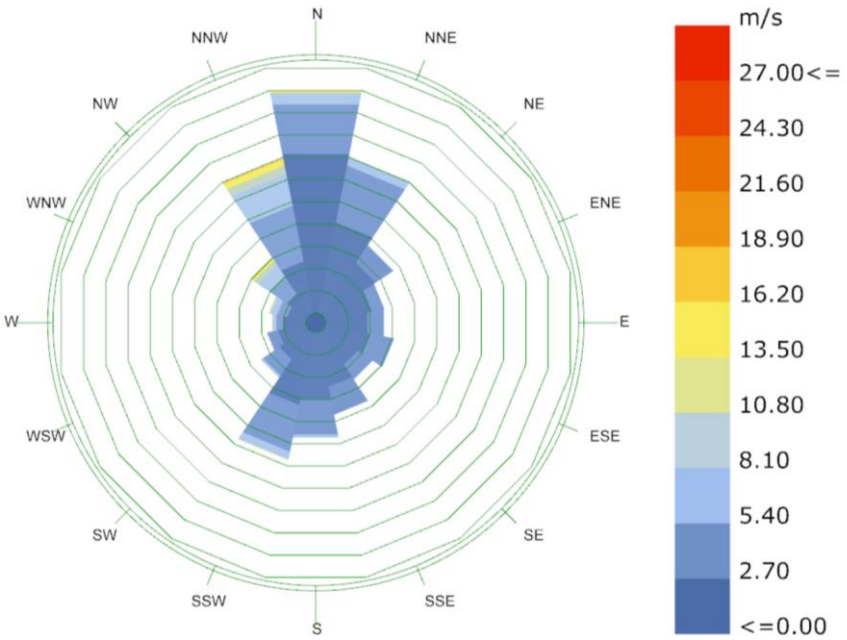


Relative Humidity (%) - Hourly
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00

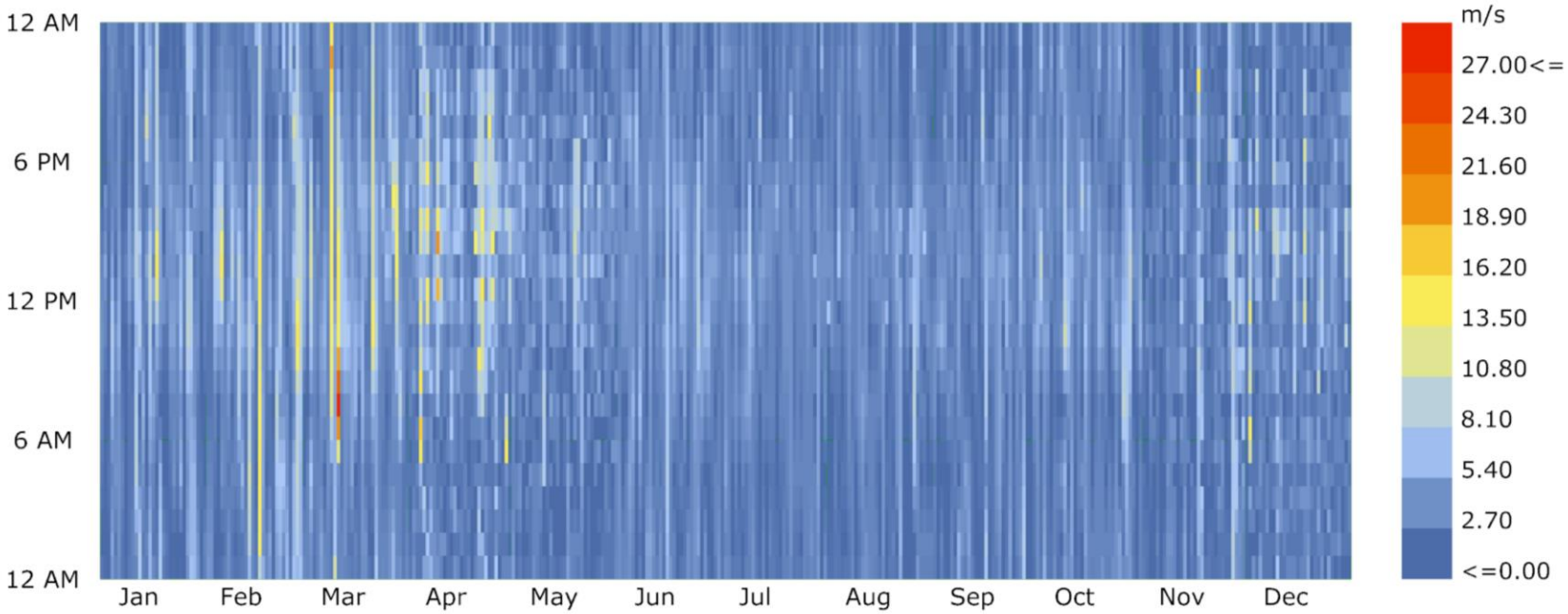
As shown in the chart above, the air humidity reaches an uncomfortable percentage throughout a significant time during the year.

Wind Speed:

The Rose chart indicates the wind speed and prevailing direction (North). The speed is relatively within comfort range.



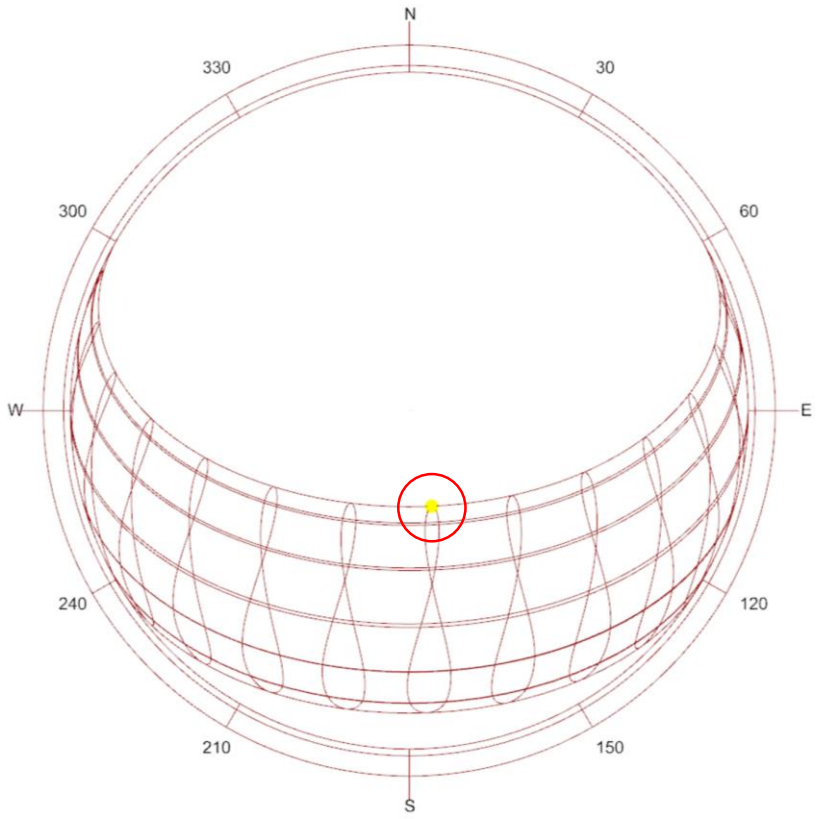
Wind-Rose
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 9.79% of the time = 858 hours.
Each closed polyline shows frequency of 1.4%. = 123 hours.



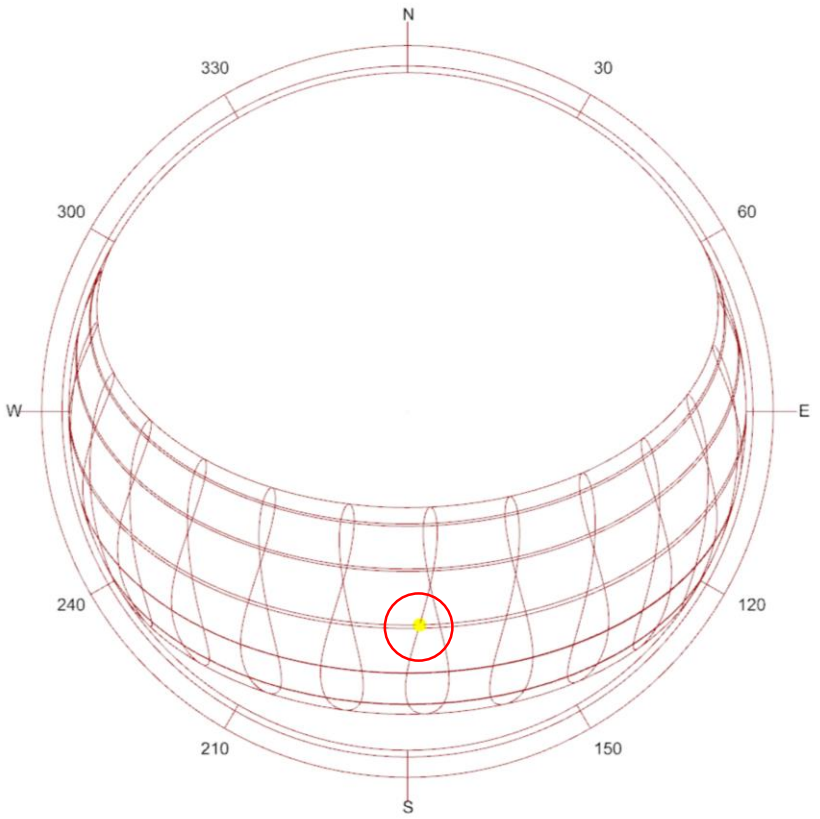
Wind Speed (m/s) - Hourly
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00

As shown in the chart above, the wind speed is fairly low throughout the year with about 60% of the annual wind speed is around 2m/s. which is within the comfort zone.

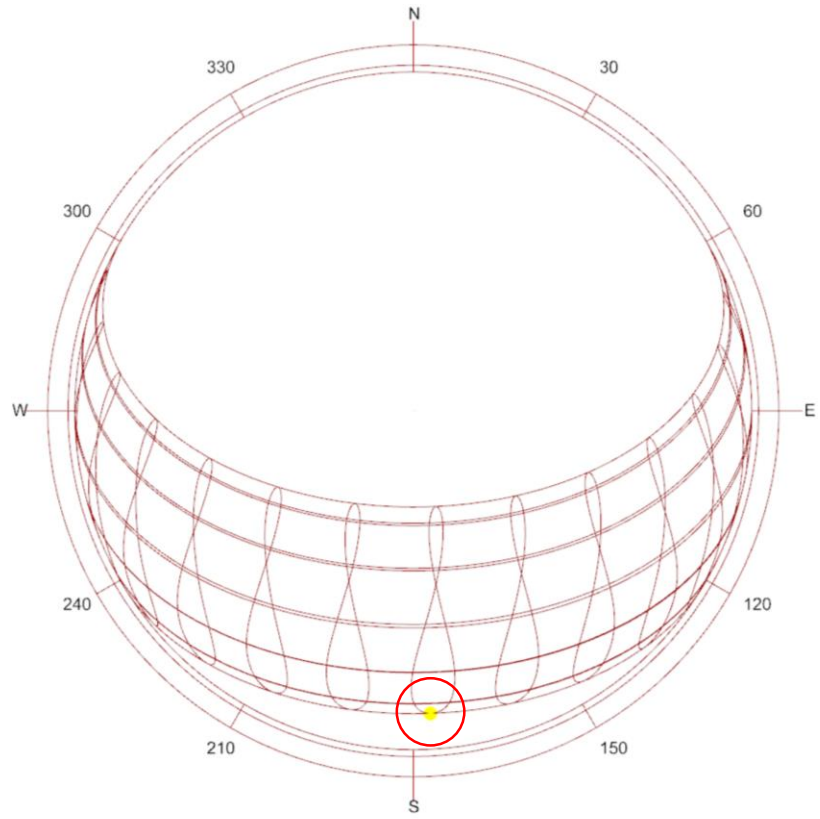
Sun Path:



Sun-Path Diagram - Latitude: 39.93
21 JUN 12:00, ALT = 73.14, AZM = 166.82



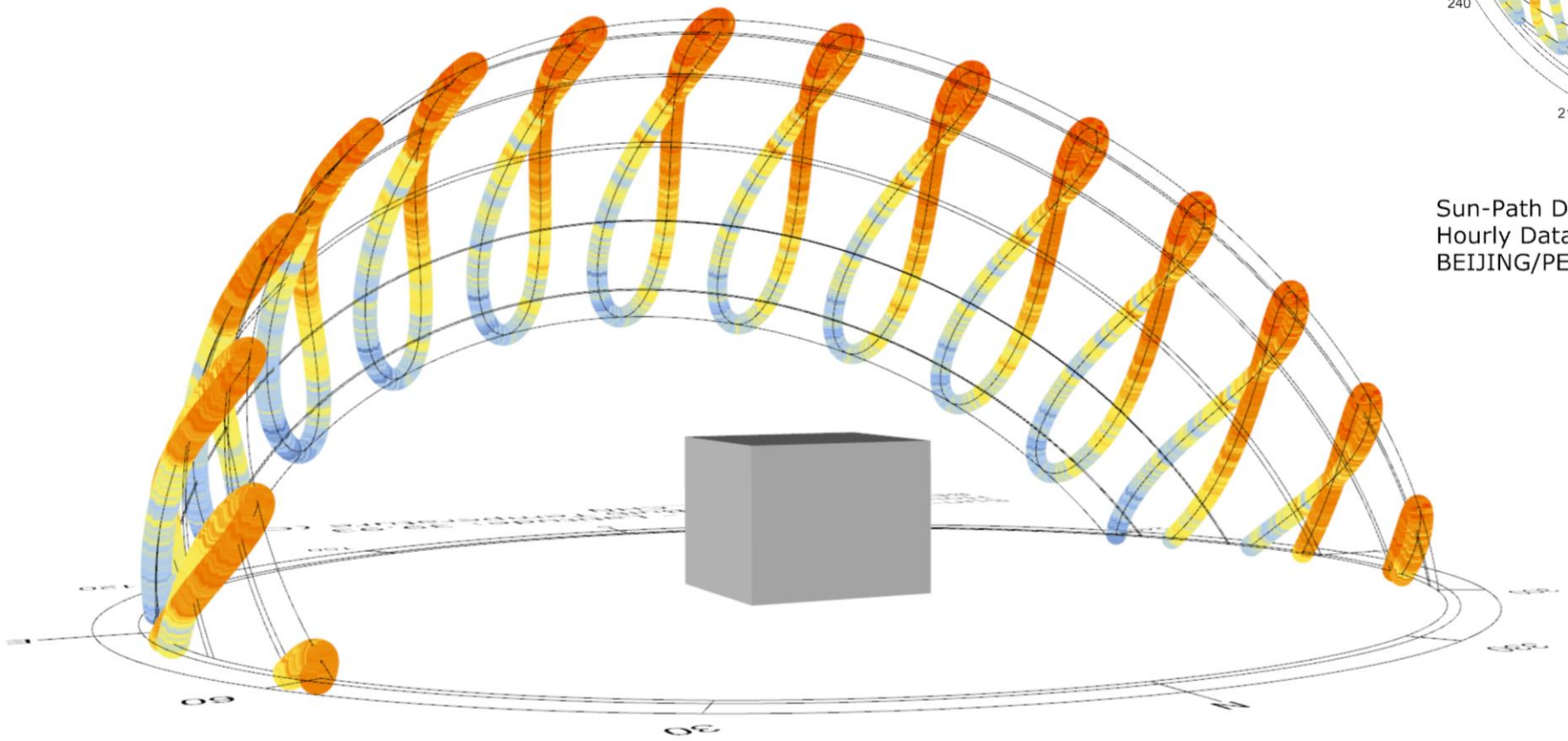
Sun-Path Diagram - Latitude: 39.93
21 SEP 12:00, ALT = 50.87, AZM = 176.75

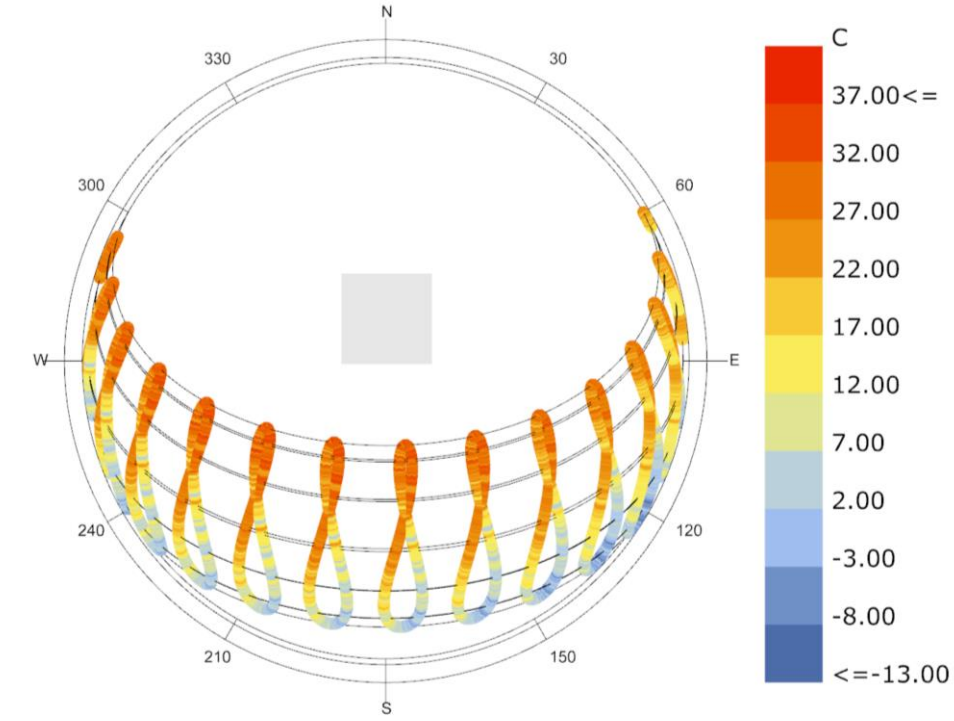


Sun-Path Diagram - Latitude: 39.93
21 DEC 12:00, ALT = 26.57, AZM = 176.75

The sun path diagrams illustrates the position of the sun during crucial times of the year. It is necessary to utilize the sun. Such as, for passive solar heating during the winter, solar panel orientation, etc..

The sun path diagram showcasing the sun’s position along with the dry blub temperature for each hour of the year. The diagram clearly shows the periods of year when shading is needed. For example, during summer horizontal shading on the south is essential while maximizing solar heat gain during winter.





Sun-Path Diagram - Latitude: 39.93
Hourly Data: Dry Bulb Temperature (C)
BEIJING/PEKING_CHN

The hours of comfort...

If the temperature comfort range is 18-22 C°

And the relative humidity is below 80%

And wind speed is around 2 m/s

Only 503 out of 8765 hours a year would be comfortable.

Which accounts for only 5.7% of the year

That being said, passive design strategies have must be considered for the other 94.3% of the time...

Solution#1

Applying Super insulation in exterior walls and eliminating thermal bridges.

Solution#2

To take advantage of passive solar heat gain during winter, large openings must be implemented on the south façade. [1]

Solution#3

Applying double or triple pane (Low-E) windows to the east, west, and north façade. [1]

Solution#4

Minimizing openinigs to the north to reduce exposure to the north winds.

[1] Climate Consultant 6.0

The useful information from the client and the Design Team...

Client:

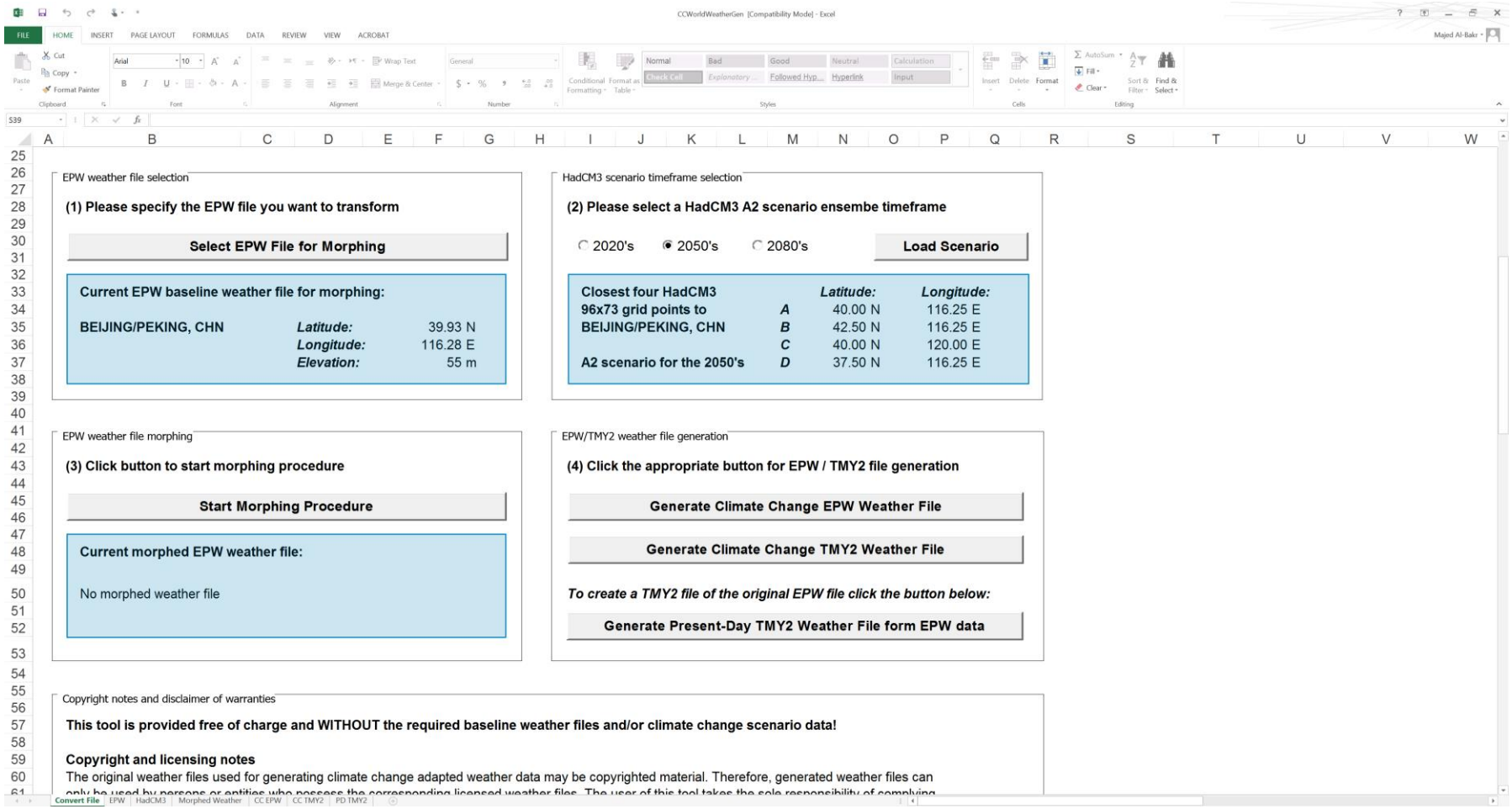
- Project Budget
- Main Activities
- Required spaces

Design Team:

- Site Analysis
- Project Program
- Preliminary Zoning Diagram

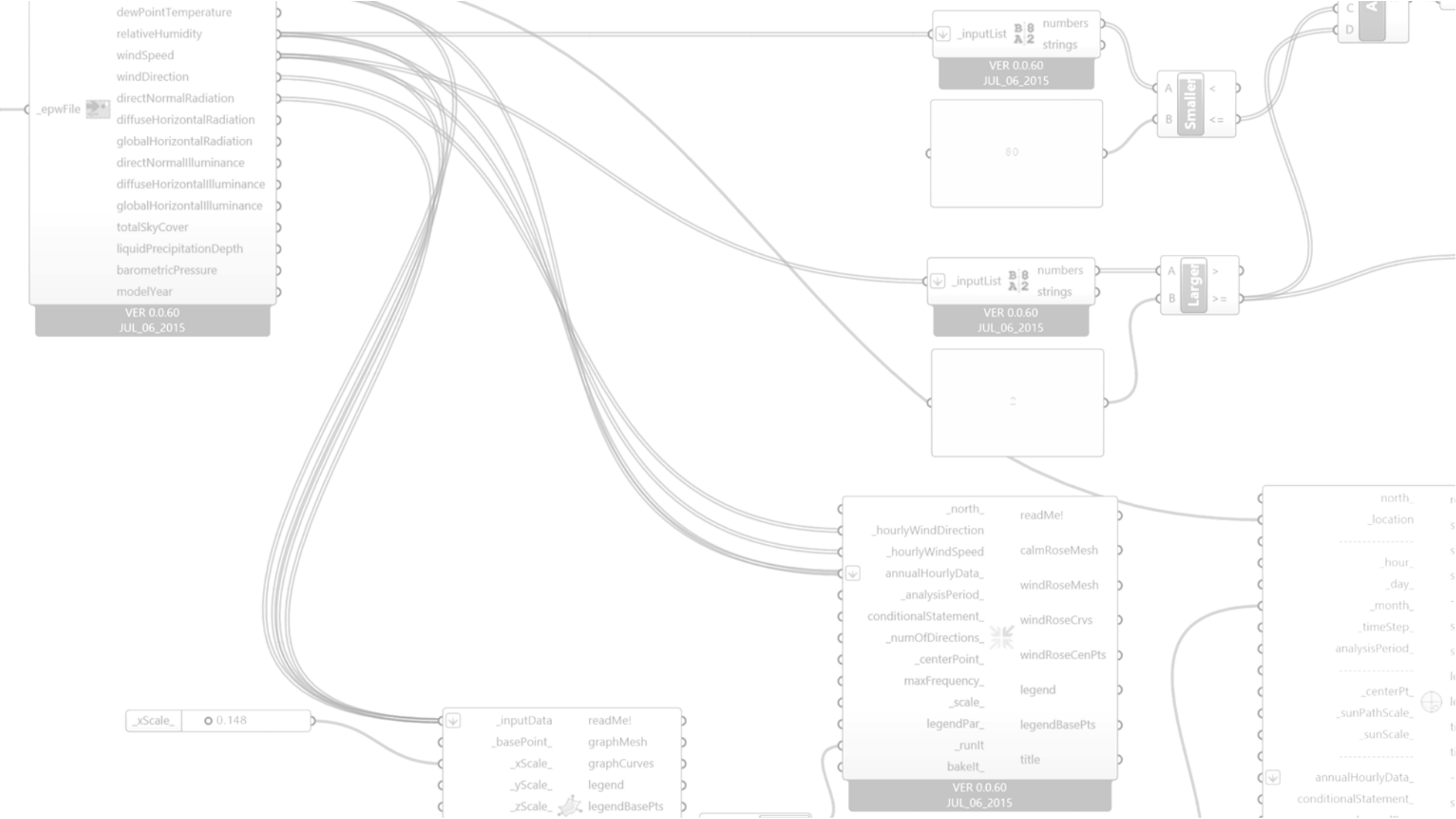
How does climate change affect design recommendations?

There is no doubt that the global weather patterns are changing. That might be a factor that designers worry considering that most buildings are designed to be used for many decades. Luckily, there are tools, such as the “CCWorldWeatherGen” which adapts current EPW data to future climate situations.



Updates to file (As of Sep 27):

- Hourly sun path diagram with dry bulb temperature (Slide 8).


dewPointTemperature
relativeHumidity
windSpeed
windDirection
_epwFile
directNormalRadiation
diffuseHorizontalRadiation
globalHorizontalRadiation
directNormalIlluminance
diffuseHorizontalIlluminance
globalHorizontalIlluminance
totalSkyCover
liquidPrecipitationDepth
barometricPressure
modelYear
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xScale
yScale
zScale
readMe!
graphMesh
graphCurves
legend
legendBasePts
north
_hourlyWindDirection
_hourlyWindSpeed
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conditionalStatement_
numOfDirections
centerPoint
maxFrequency_
scale
legendPar_
_runIt
bakeIt_
readMe!
calmRoseMesh
windRoseMesh
windRoseCrvs
windRoseCenPts
legend
legendBasePts
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month
timeStep
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