



University of Pennsylvania

ARCH753: Building Performance Simulation

Assignment II: Climate Analysis

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An aerial photograph of a dense urban landscape in Beijing, China. In the foreground, a multi-lane highway interchange is filled with cars and trucks. Behind the highway, several prominent skyscrapers rise against a hazy sky. The most distinctive building is the CCTV New Building, with its large, angular, and lattice-like structure. Other buildings include a tall, cylindrical tower and several rectangular high-rises. The overall scene depicts a modern, bustling metropolis.

39.9167° N, 116.3833° E

Beijing

A climatic study

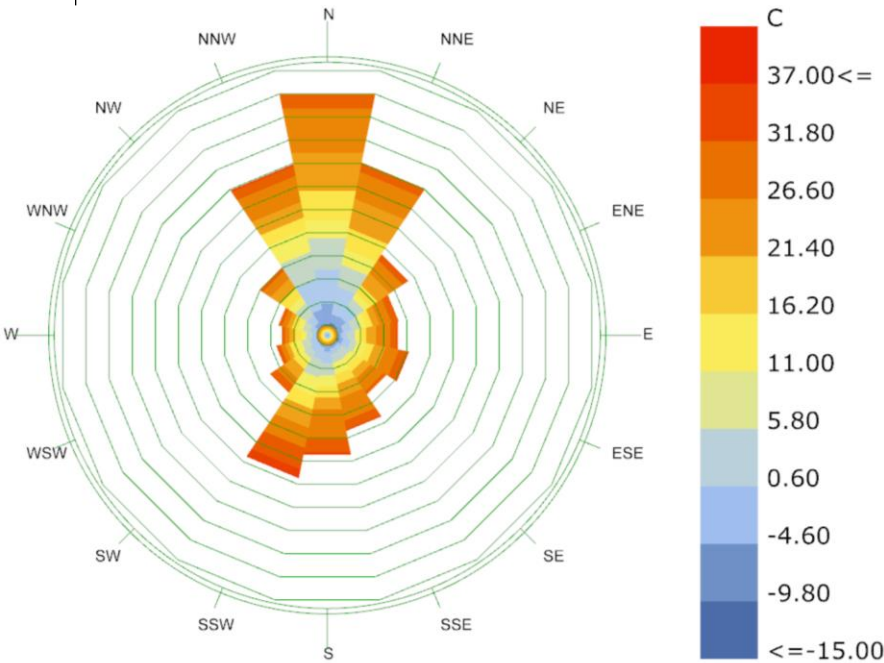


The Climatic analysis for this location aims to find the weather conditions throughout the year while delivering the appropriate design strategies.

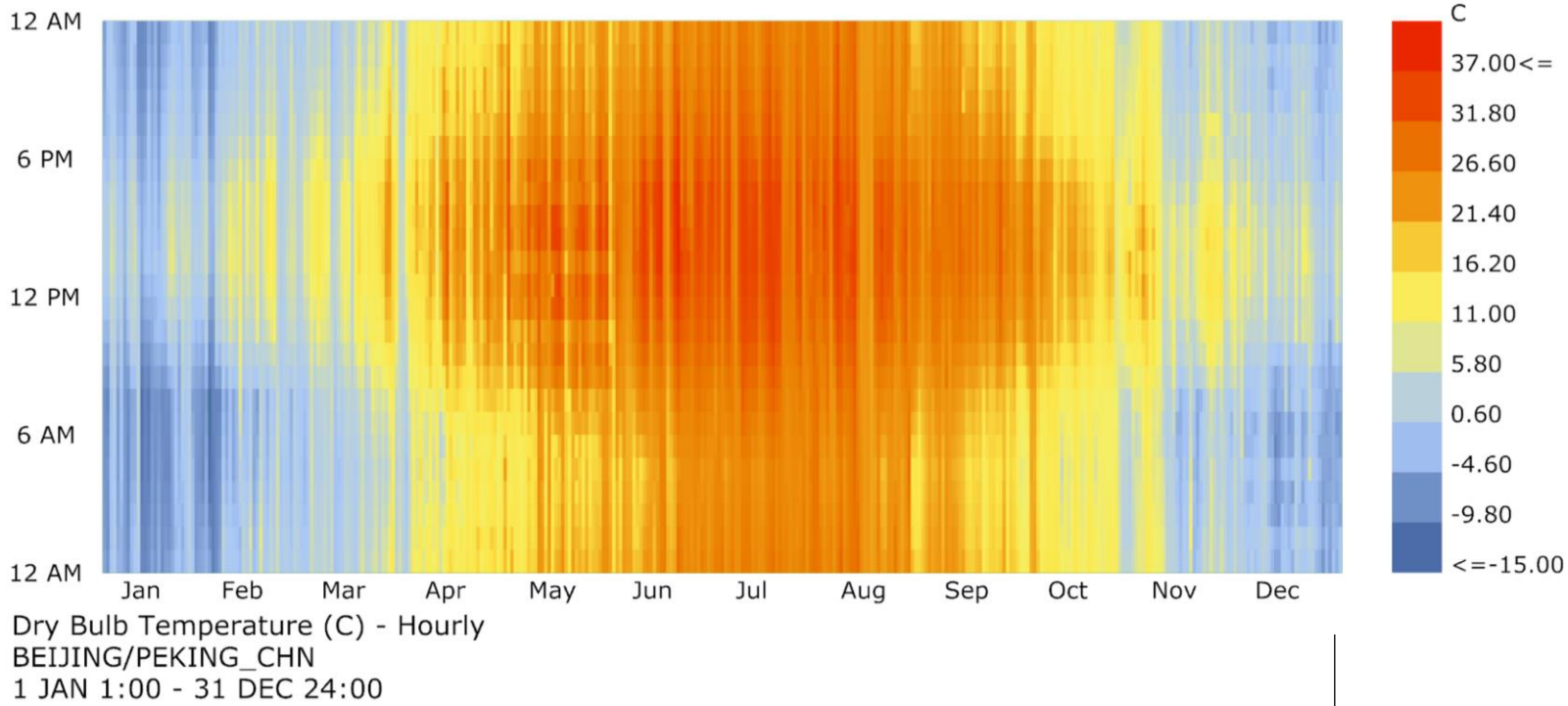
The Study relied on data generated in Grasshopper's LadyBug plugin from DOE weather data, along with the support of Climate Consultant and JALOX Sunpath Diagrams.

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.

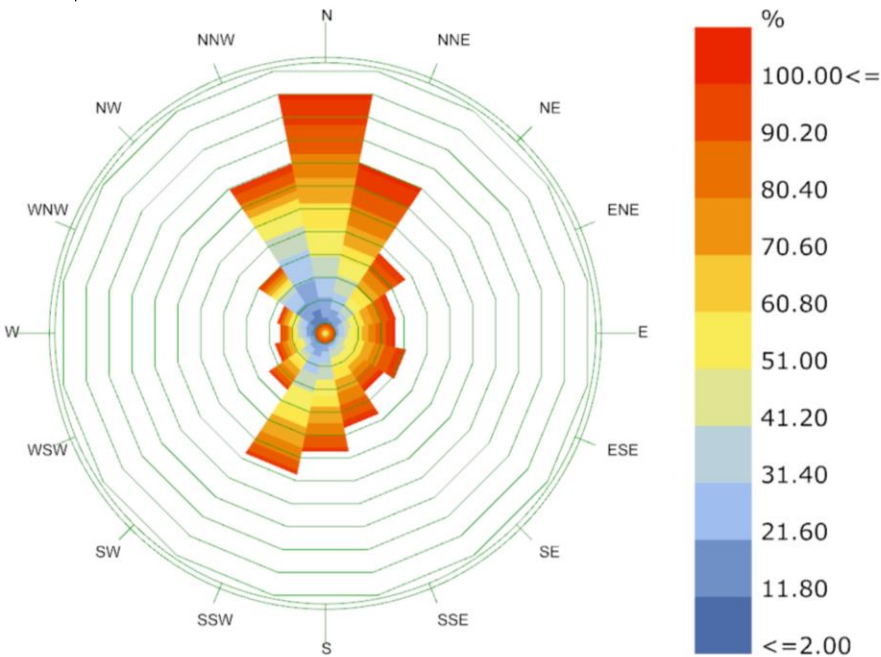


Dry Bulb Temperature (C) - Hourly
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00

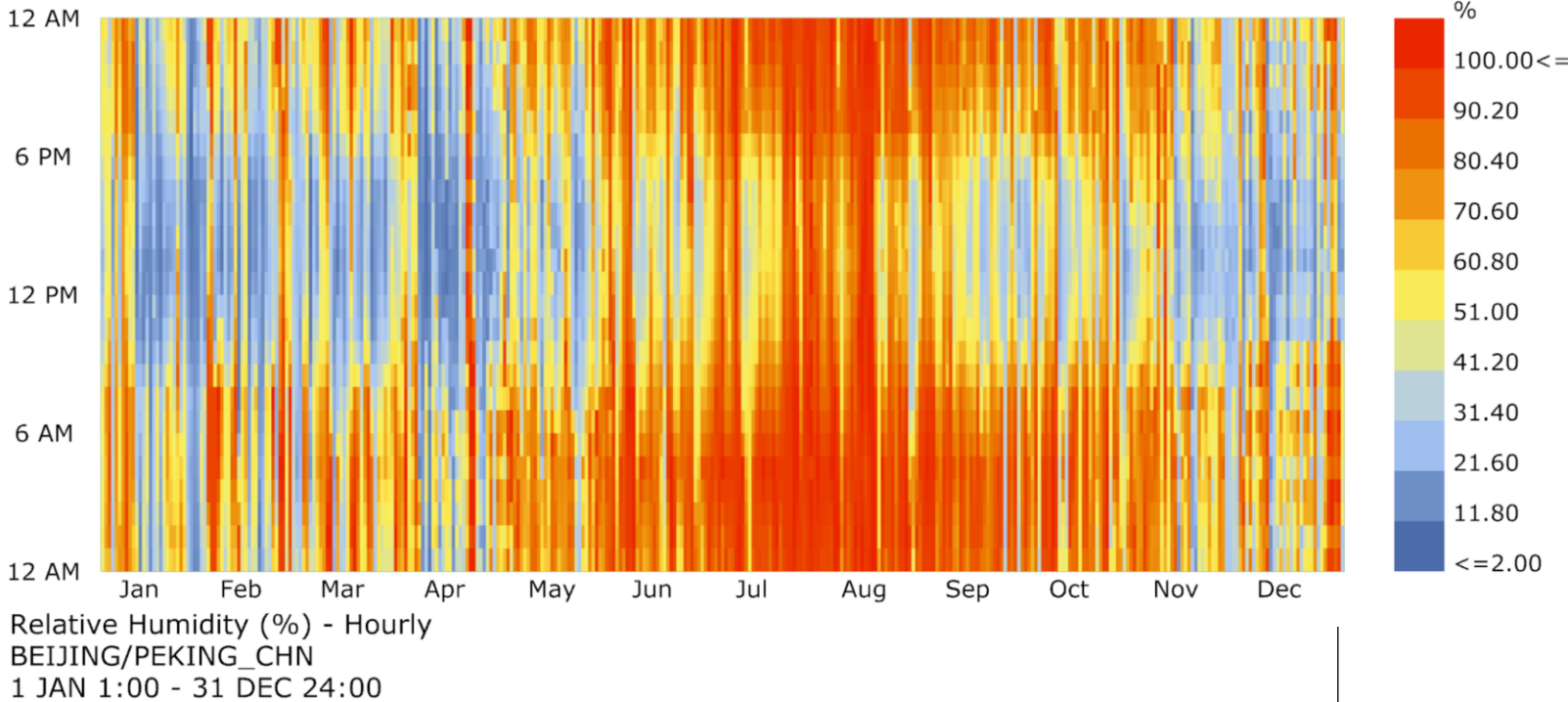
As shown in the chart above, the temperature in Beijing reaches lows bellow -9.8C during winter and highs the reach up to 37C. Most of the temperature throughout the year ranges between 11-26C.

Relative Humidity:

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



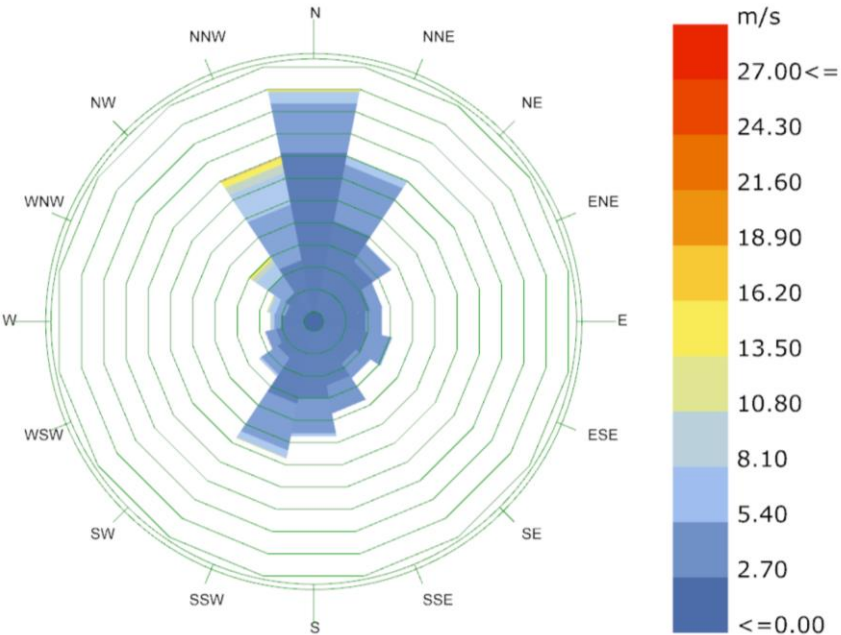
Wind-Rose
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Relative Humidity (%)
Calm for 9.79% of the time = 858 hours.
Each closed polyline shows frequency of 1.4%. = 123 hours.



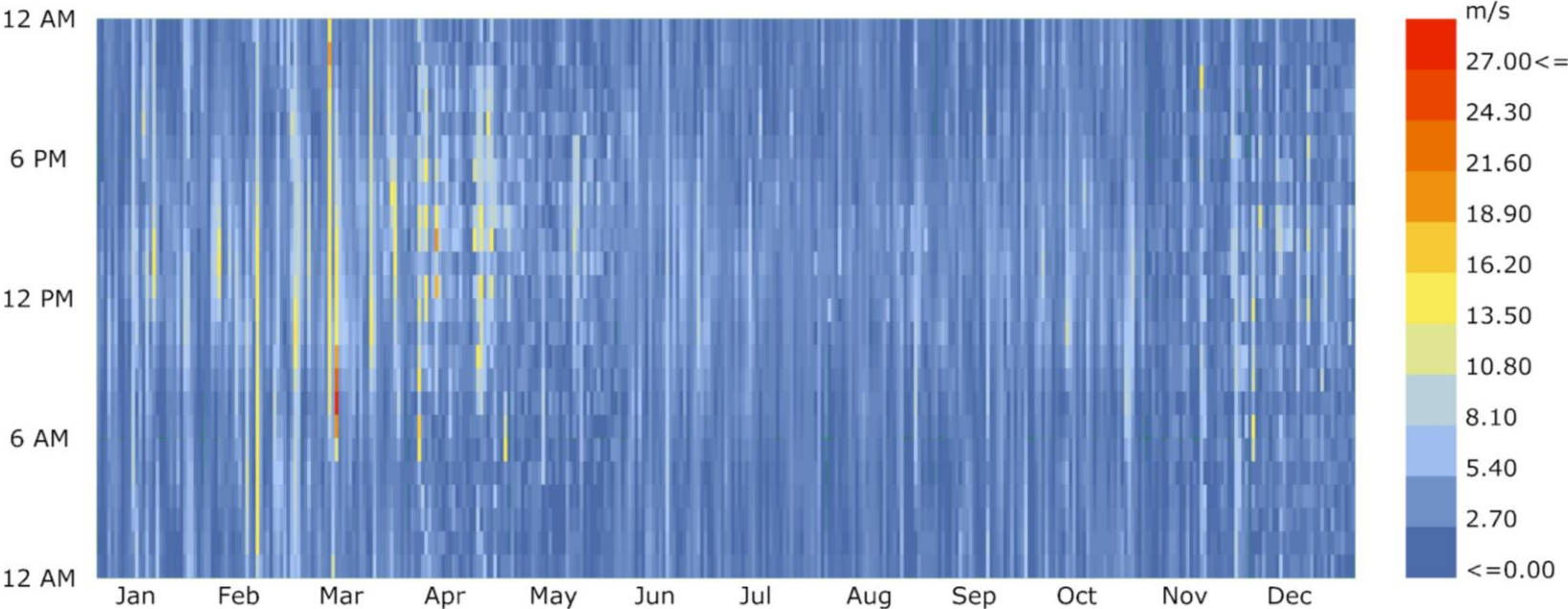
As shown in the chart above, the air humidity reaches an uncomfortable percentage throughout a significant time during the year.

Wind Speed:

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



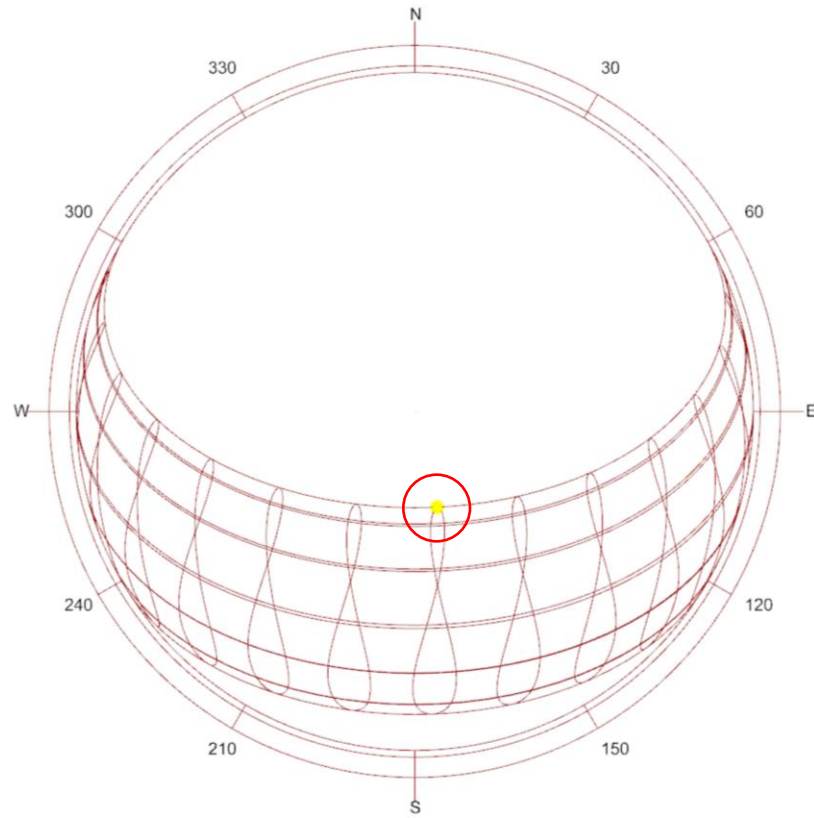
Wind-Rose
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 9.79% of the time = 858 hours.
Each closed polyline shows frequency of 1.4%. = 123 hours.



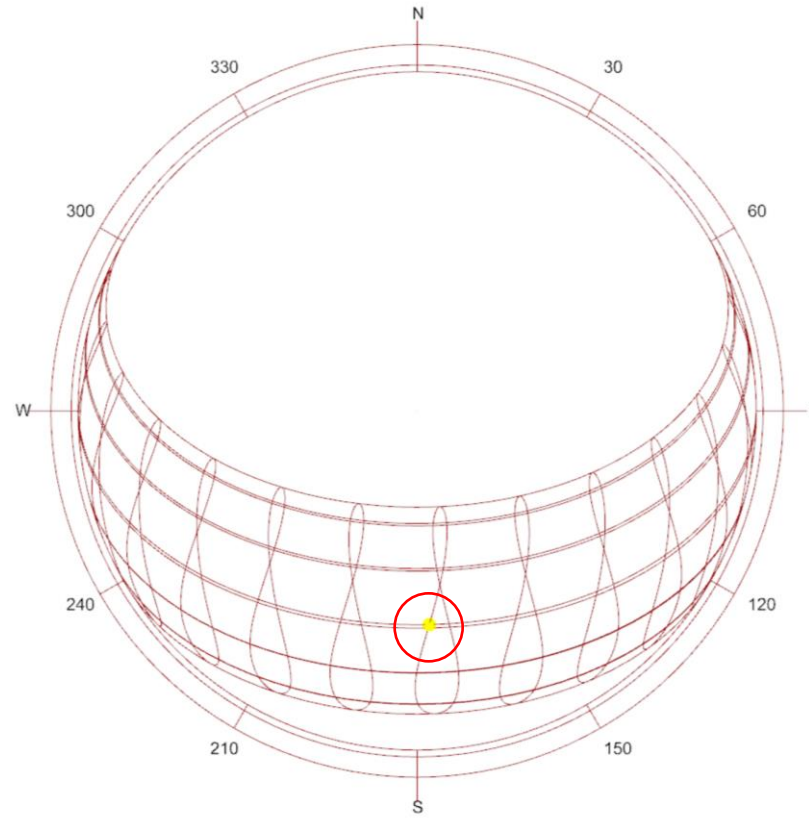
Wind Speed (m/s) - Hourly
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00

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.

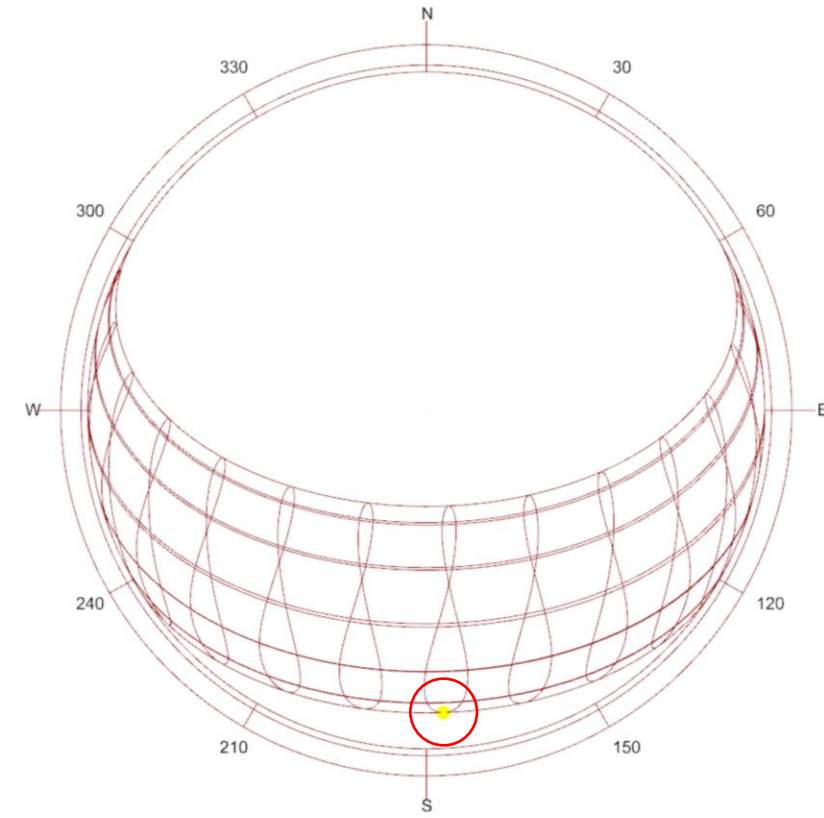
Sun Path:



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 hours of comfort...

If the temperature comfort range is $18-22\text{ C}^{\circ}$

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.

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.

CCWorldWeatherGen [Compatibility Mode] - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ACROBAT

Clipboard Font Alignment Number Styles Cells Editing

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A B C D E F G H I J K L M N O P Q R S T U V W

EPW weather file selection

(1) Please specify the EPW file you want to transform

Select EPW File for Morphing

Current EPW baseline weather file for morphing:

BEIJING/PEKING, CHN	Latitude:	39.93 N
	Longitude:	116.28 E
	Elevation:	55 m

HadCM3 scenario timeframe selection

(2) Please select a HadCM3 A2 scenario ensembe timeframe

☐ 2020's
 ☒ 2050's
 ☐ 2080's
 Load Scenario

Closest four HadCM3 96x73 grid points to BEIJING/PEKING, CHN	A	Latitude: 40.00 N	Longitude: 116.25 E
	B	42.50 N	116.25 E
	C	40.00 N	120.00 E
A2 scenario for the 2050's	D	37.50 N	116.25 E

EPW weather file morphing

(3) Click button to start morphing procedure

Start Morphing Procedure

Current morphed EPW weather file:

No morphed weather file

EPW/TMY2 weather file generation

(4) Click the appropriate button for EPW / TMY2 file generation

Generate Climate Change EPW Weather File

Generate Climate Change TMY2 Weather File

To create a TMY2 file of the original EPW file click the button below:

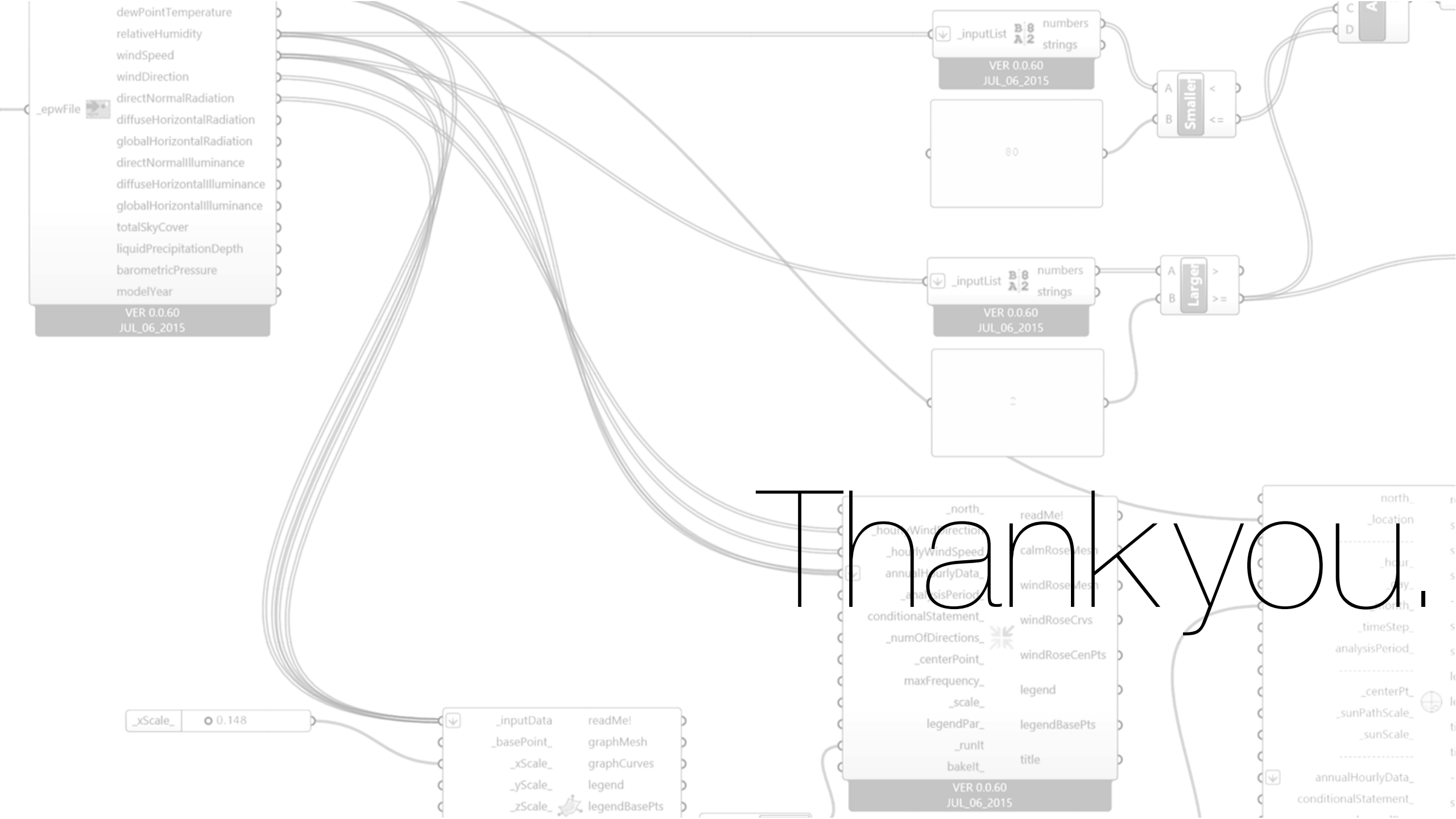
Generate Present-Day TMY2 Weather File form EPW data

Copyright notes and disclaimer of warranties

This tool is provided free of charge and WITHOUT the required baseline weather files and/or climate change scenario data!

Copyright and licensing notes

The original weather files used for generating climate change adapted weather data may be copyrighted material. Therefore, generated weather files can only be used by persons or entities who possess the corresponding licensed weather files. The user of this tool takes the sole responsibility of complying



Thank you.