

An aerial photograph of a city skyline, likely Beijing, featuring a prominent highway interchange with multiple lanes of traffic in the foreground. The background is filled with various skyscrapers, including the distinctive CCTV New Building with its large, angular, lattice-like structure. The text is overlaid on the image in a clean, white, sans-serif font.

University of Pennsylvania

ARCH753: Building Performance Simulation

Assignment II: Climate Analysis

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

39.9167° N, 116.3833° E

Beijing

A climatic study

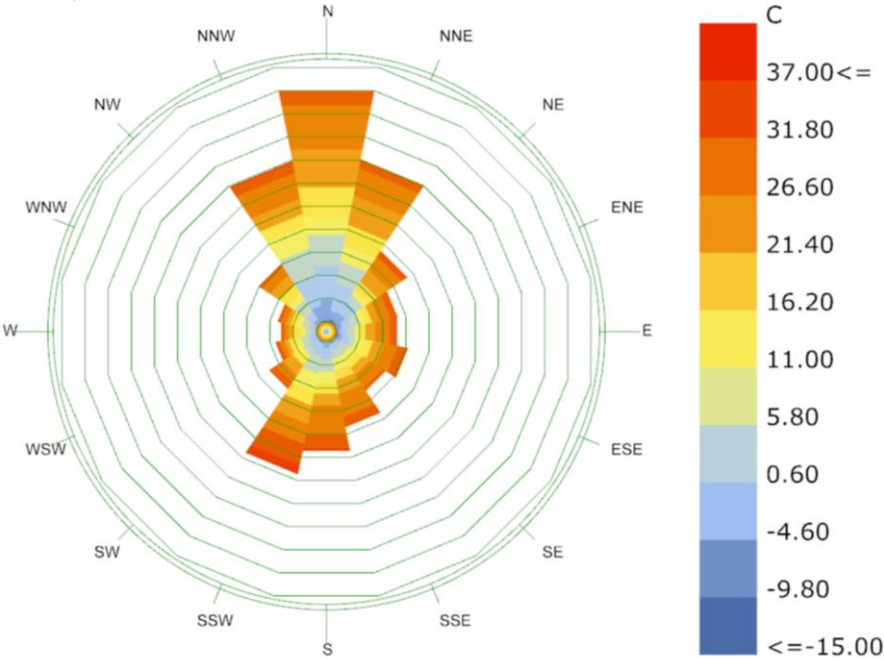


The Climatic analysis for this location aims to find the weather conditions throughout the year while delivering the appropriate design strategies.

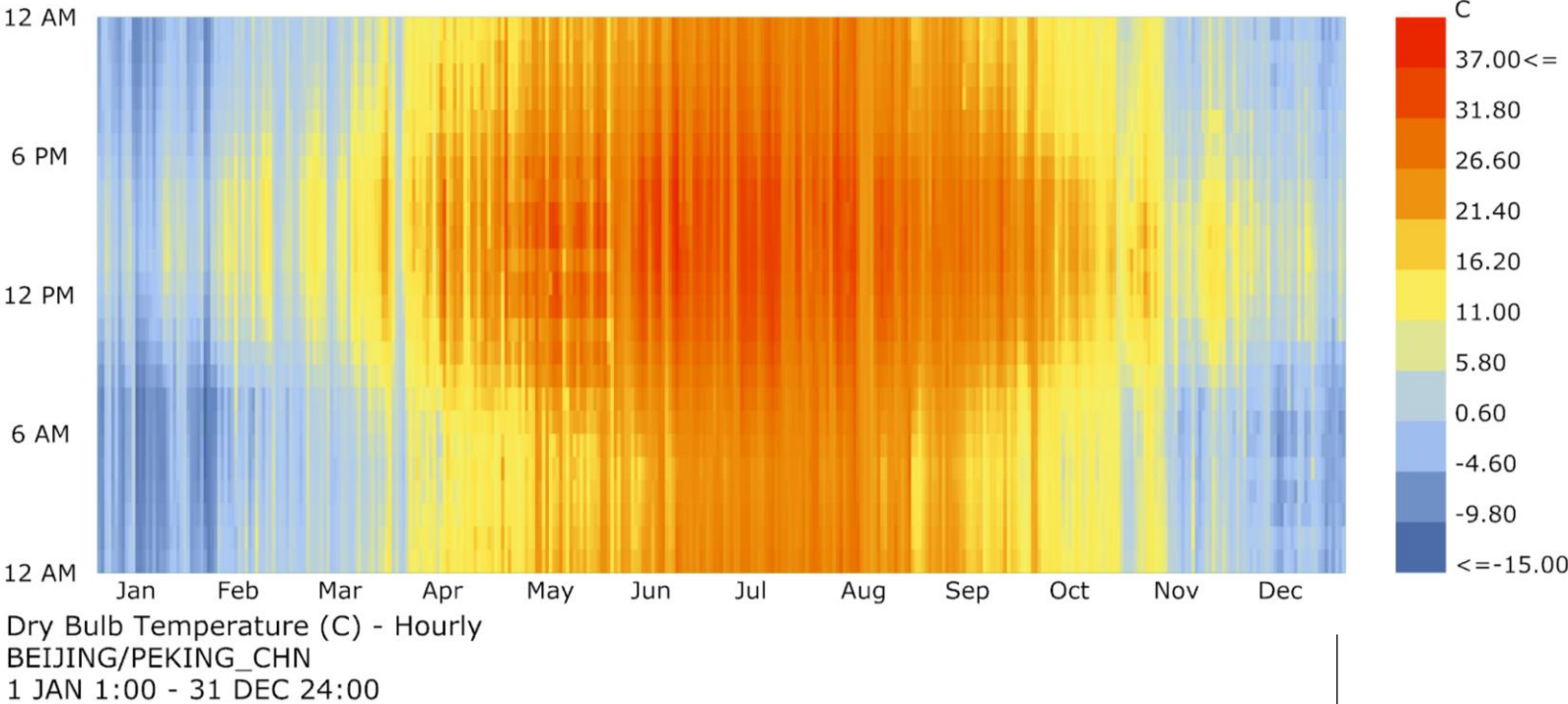
The Study relied on data generated in Grasshopper's LadyBug plugin from DOE weather data, along with the support of Climate Consultant and JALOX Sunpath Diagrams.

Dry Bulb Temperature:

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



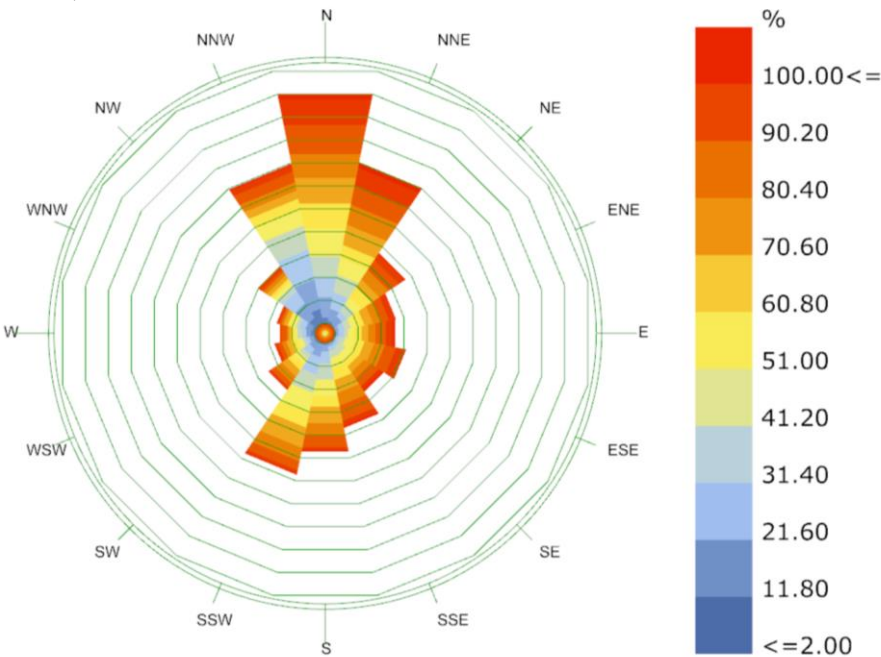
Wind-Rose
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Dry Bulb Temperature (C)
Calm for 9.79% of the time = 858 hours.
Each closed polyline shows frequency of 1.4%. = 123 hours.



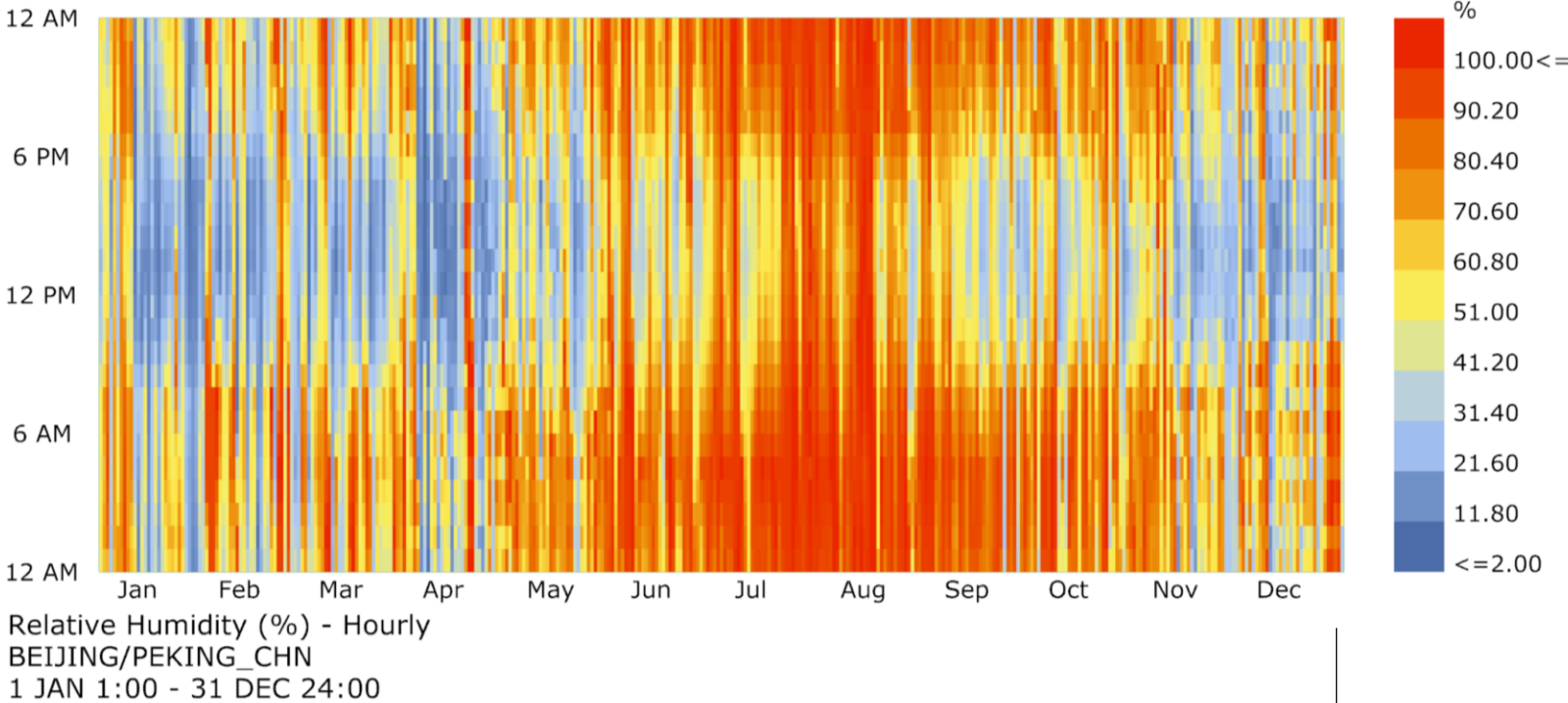
As shown in the chart above, the temperature in Beijing reaches lows bellow -9.8C during winter and highs the reach up to 37C. Most of the temperature throughout the year ranges between 11-26C.

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.

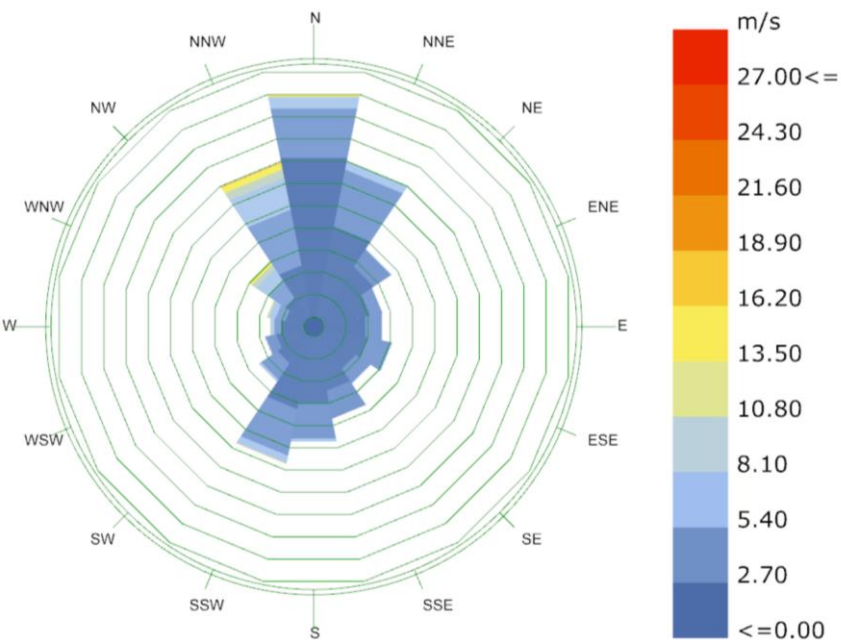


Relative Humidity (%) - Hourly
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00

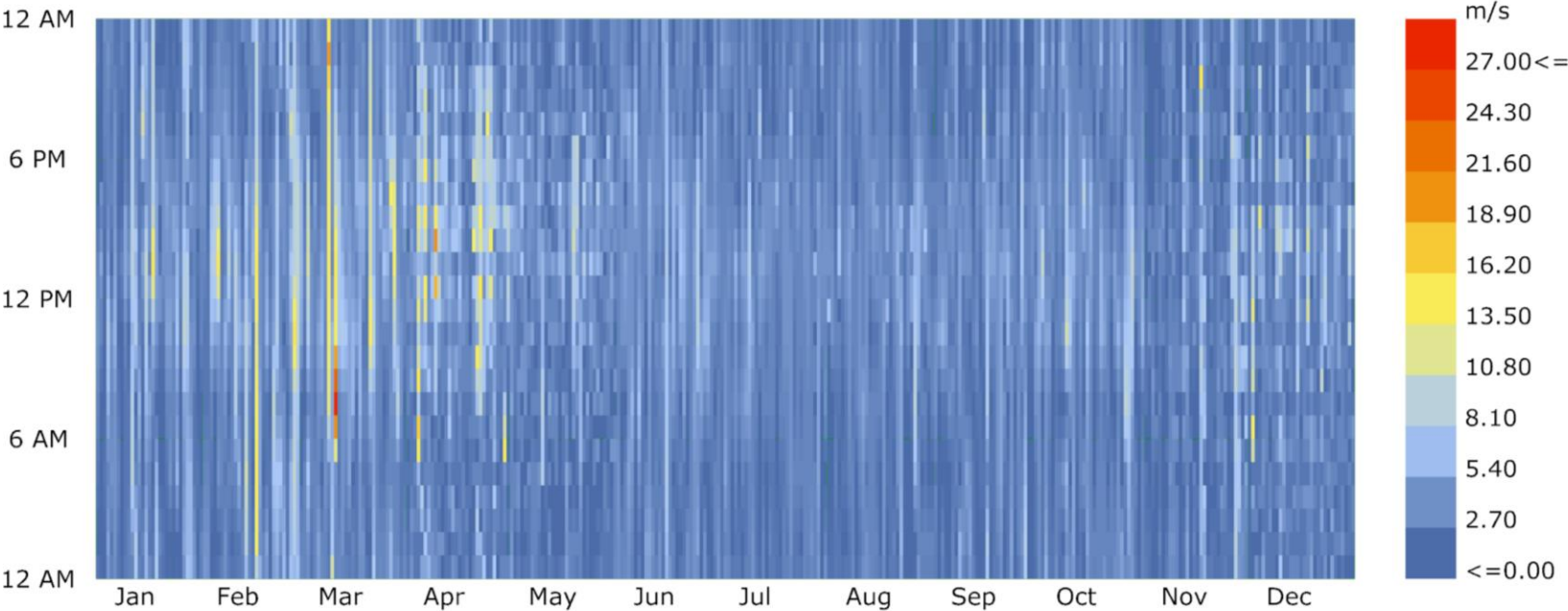
As shown in the chart above, the air humidity reaches an uncomfortable percentage throughout a significant time during the year.

Wind Speed:

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



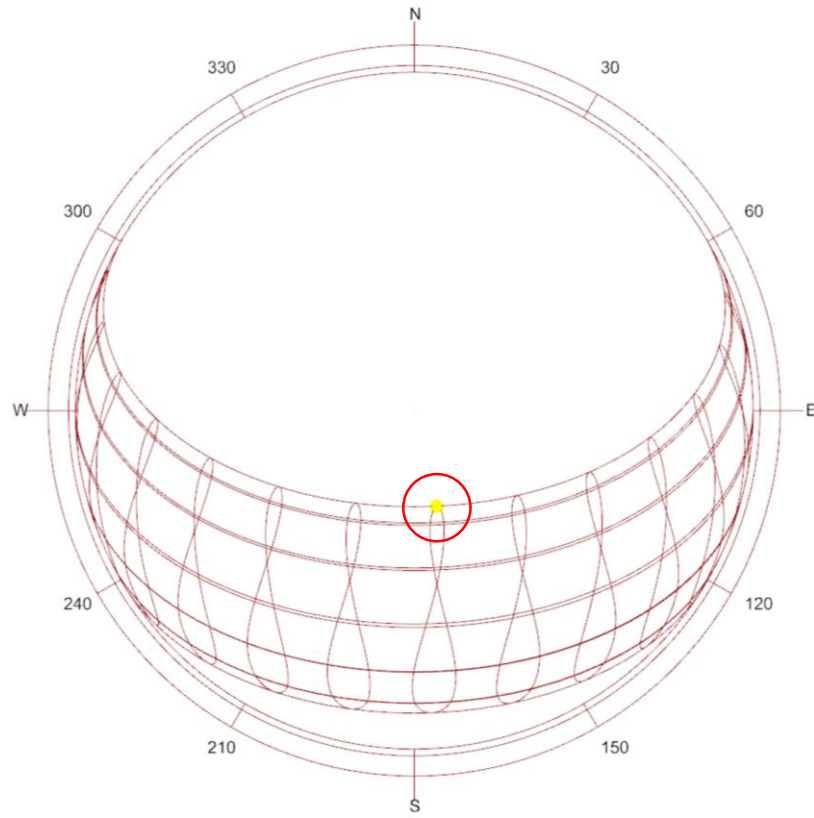
Wind-Rose
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 9.79% of the time = 858 hours.
Each closed polyline shows frequency of 1.4%. = 123 hours.



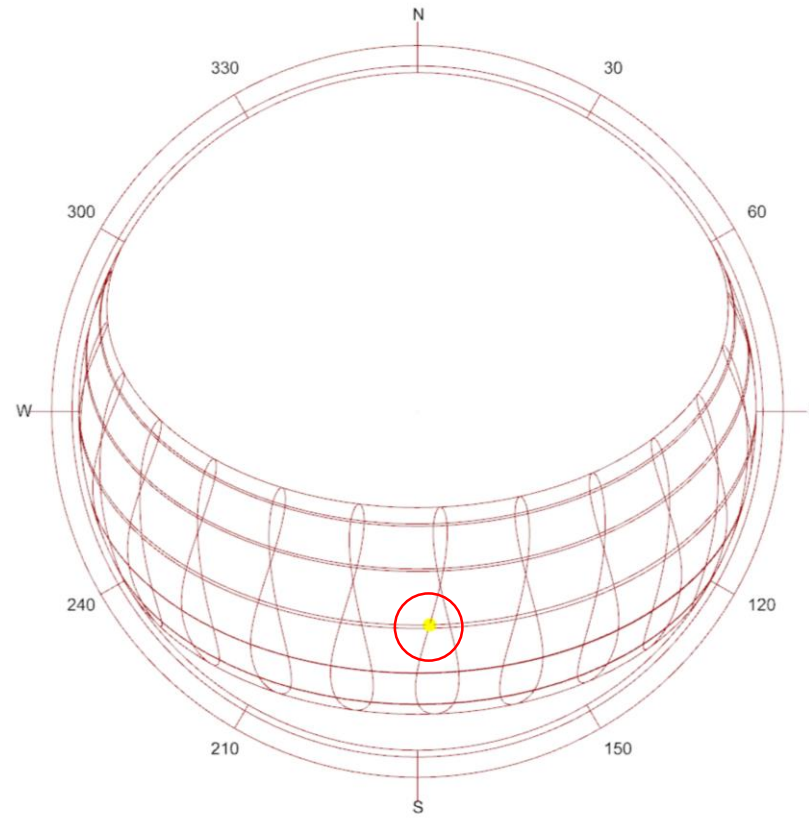
Wind Speed (m/s) - Hourly
BEIJING/PEKING_CHN
1 JAN 1:00 - 31 DEC 24:00

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.

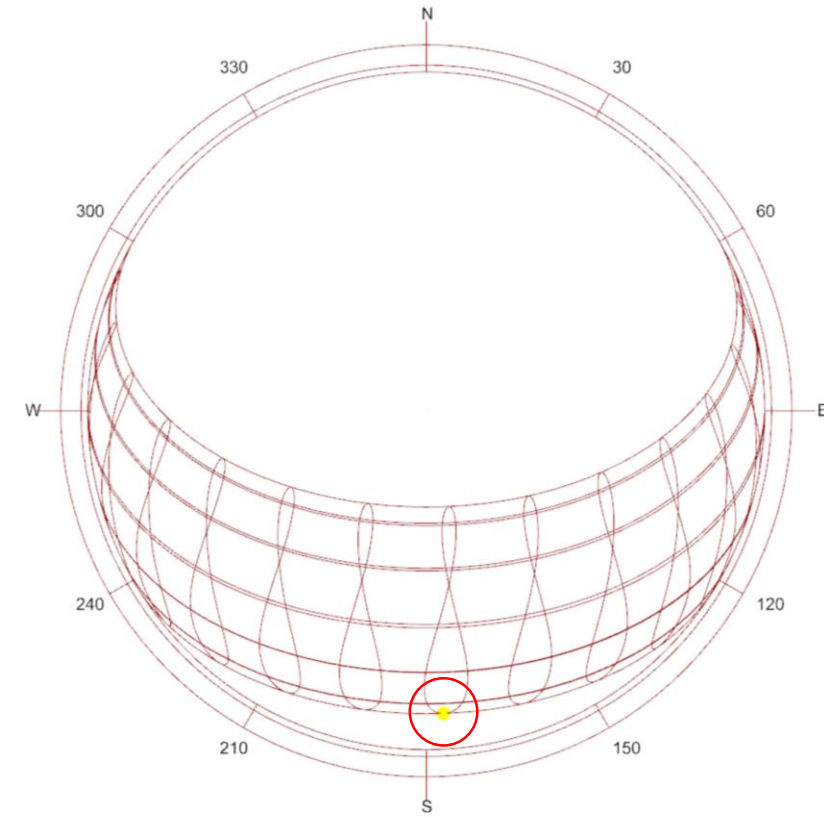
Sun Path:



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



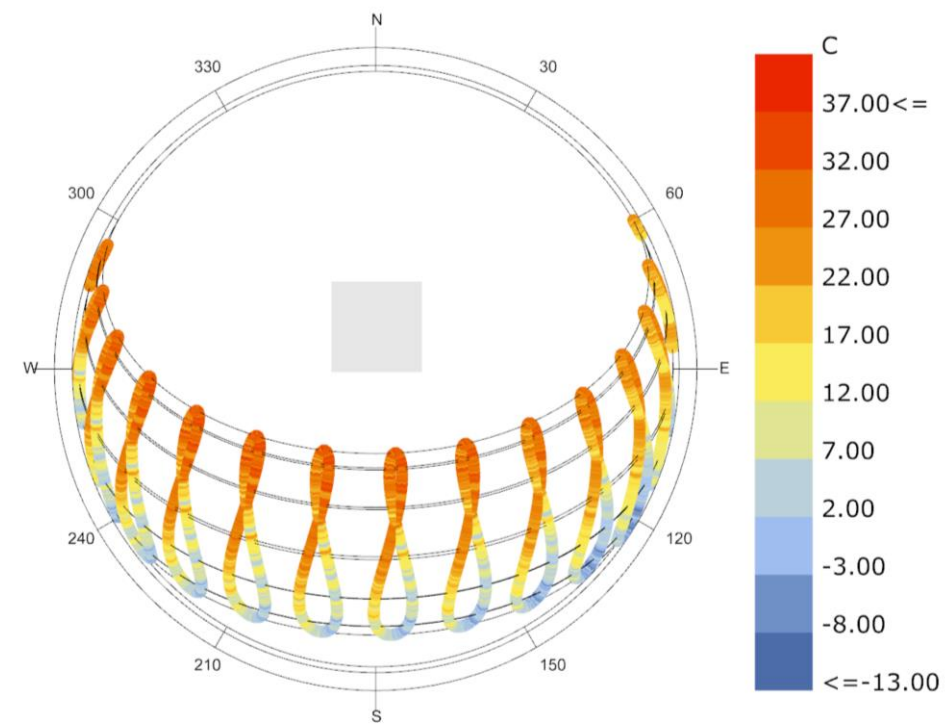
Sun-Path Diagram - Latitude: 39.93
21 SEP 12:00, ALT = 50.87, AZM = 176.75



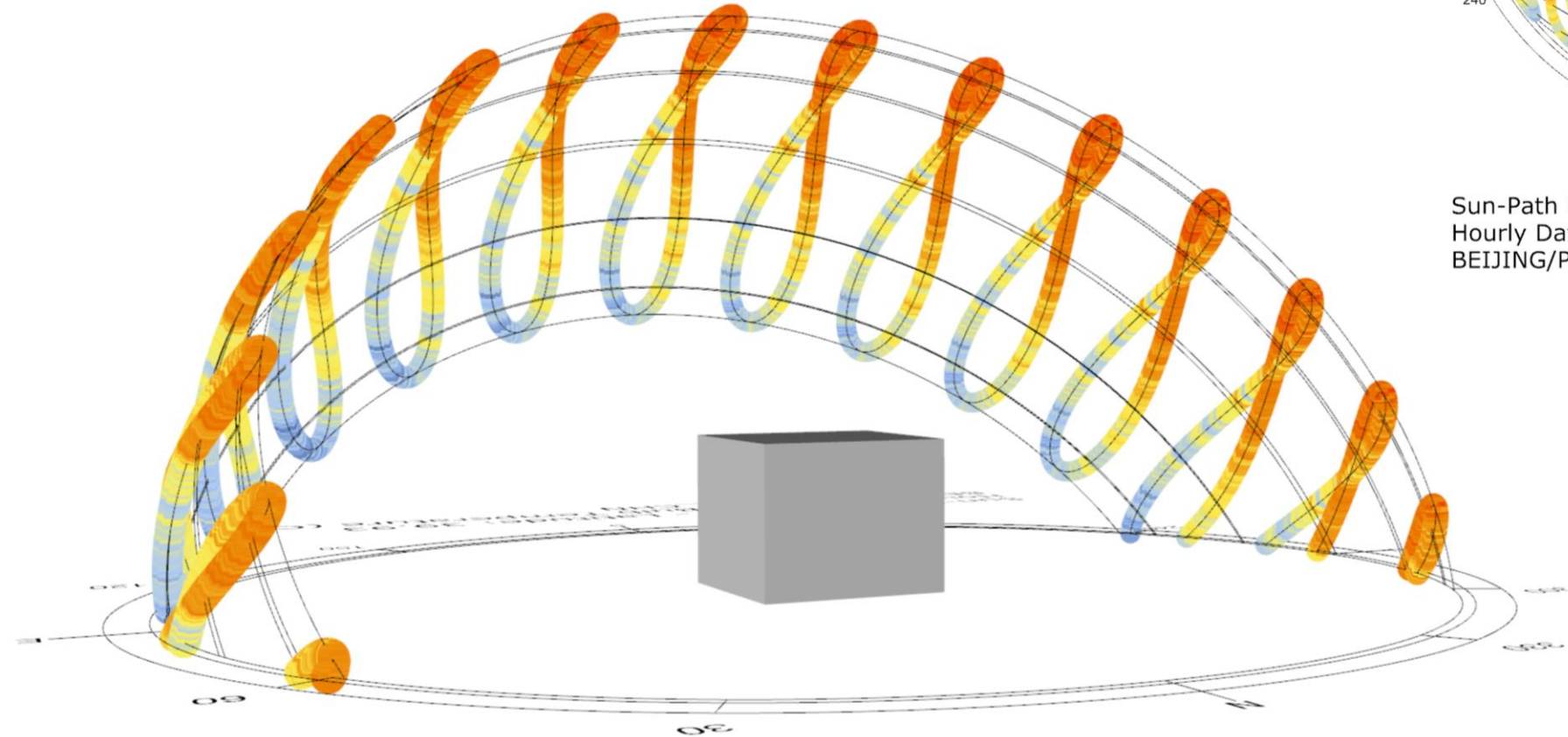
Sun-Path Diagram - Latitude: 39.93
21 DEC 12:00, ALT = 26.57, AZM = 176.75

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 bulb 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 $18-22\text{ }^{\circ}\text{C}$

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.

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.

The screenshot displays the CCWorldWeatherGen Excel spreadsheet, which is used for adapting EPW weather files to future climate scenarios. The interface is organized into four main sections:

- EPW weather file selection:** This section prompts the user to specify the EPW file to transform. It includes a button labeled "Select EPW File for Morphing" and a table showing the current EPW baseline weather file for morphing.
- HadCM3 scenario timeframe selection:** This section prompts the user to select a HadCM3 A2 scenario ensemble timeframe. It includes radio buttons for 2020's, 2050's (selected), and 2080's, along with a "Load Scenario" button. A table lists the closest four HadCM3 96x73 grid points to BEIJING/PEKING, CHN.
- EPW weather file morphing:** This section prompts the user to click a button to start the morphing procedure. It includes a button labeled "Start Morphing Procedure" and a table showing the current morphed EPW weather file.
- EPW/TMY2 weather file generation:** This section prompts the user to click the appropriate button for EPW / TMY2 file generation. It includes buttons for "Generate Climate Change EPW Weather File", "Generate Climate Change TMY2 Weather File", and "Generate Present-Day TMY2 Weather File form EPW data".

At the bottom of the spreadsheet, there is a section for copyright notes and disclaimer of warranties, stating that the tool is provided free of charge and without the required baseline weather files and/or climate change scenario data. It also includes copyright and licensing notes, stating that the original weather files used for generating climate change adapted weather data may be copyrighted material.

Updates to file (As of Sep 27):

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

