

Arc-753-001-Building Performance Simulation

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Final Project Report phase I

Pegah Mathur

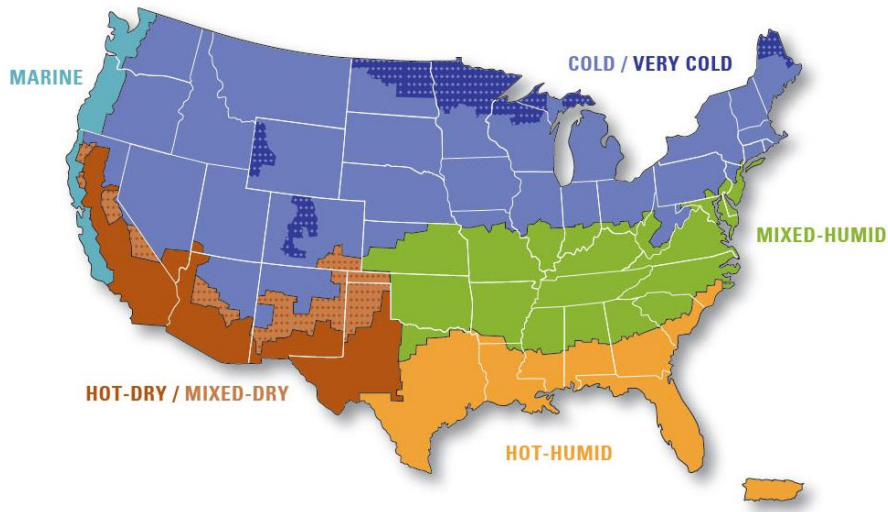
Arch-753-001 Building Performance Simulation

A Report for the Climate of Miami

Pegah Mathur

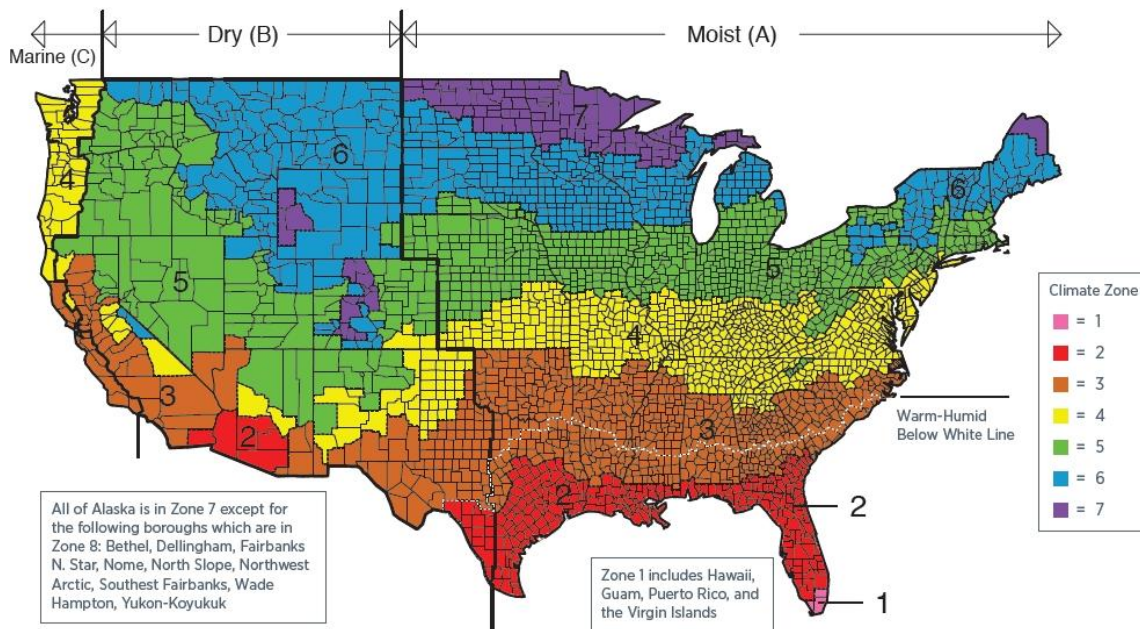
Dec, 2015

Miami



(laboratory, 2010)

As showed in the map above Miami,FL is located in the Hot-humid area of the United states.



(laboratory, 2010)

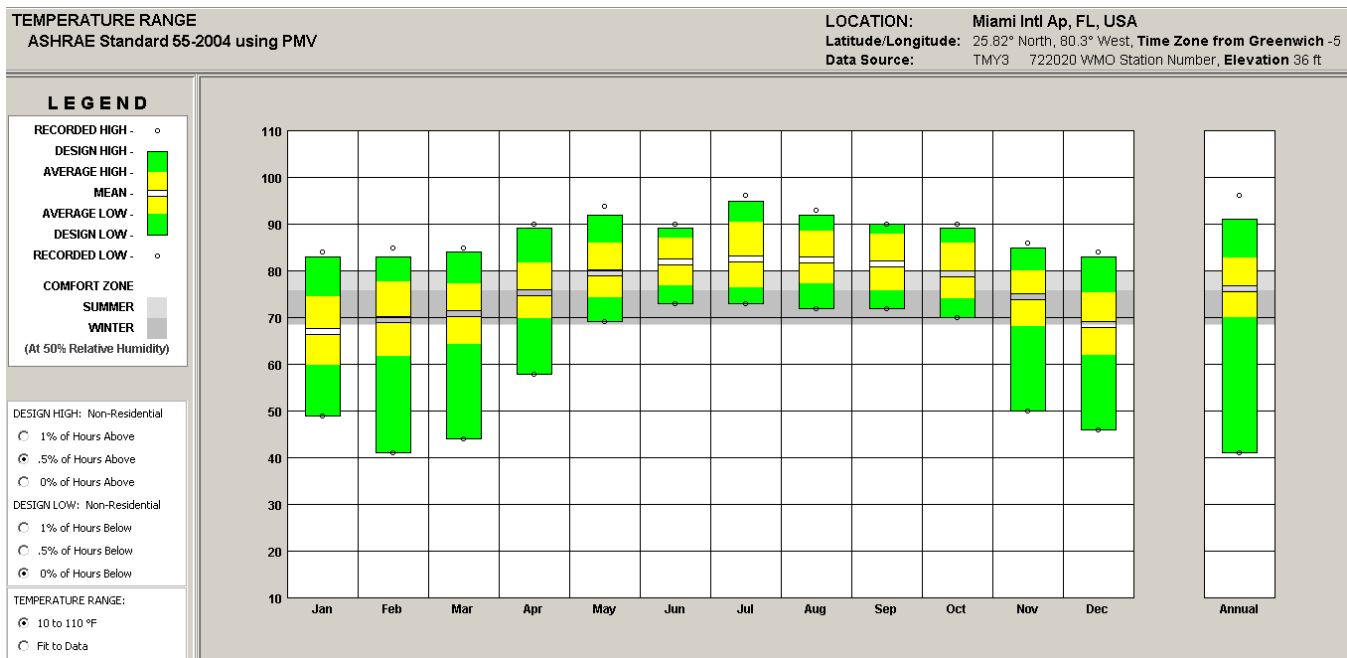
Hot-Humid Climate

The hot-humid climate is referred to the climate that the annual precipitation is more that and always one of the following condition happens:

- The wet bulb temperature is about 67 F (19.5 C) or higher for more than 3000 hours during the six warmest and successive months of the year
- The wet bulb temperature is about 73 F (23 C) or higher for more than 1500 hours during the six warmest and successive months of the year

Temperature

Temperature Range

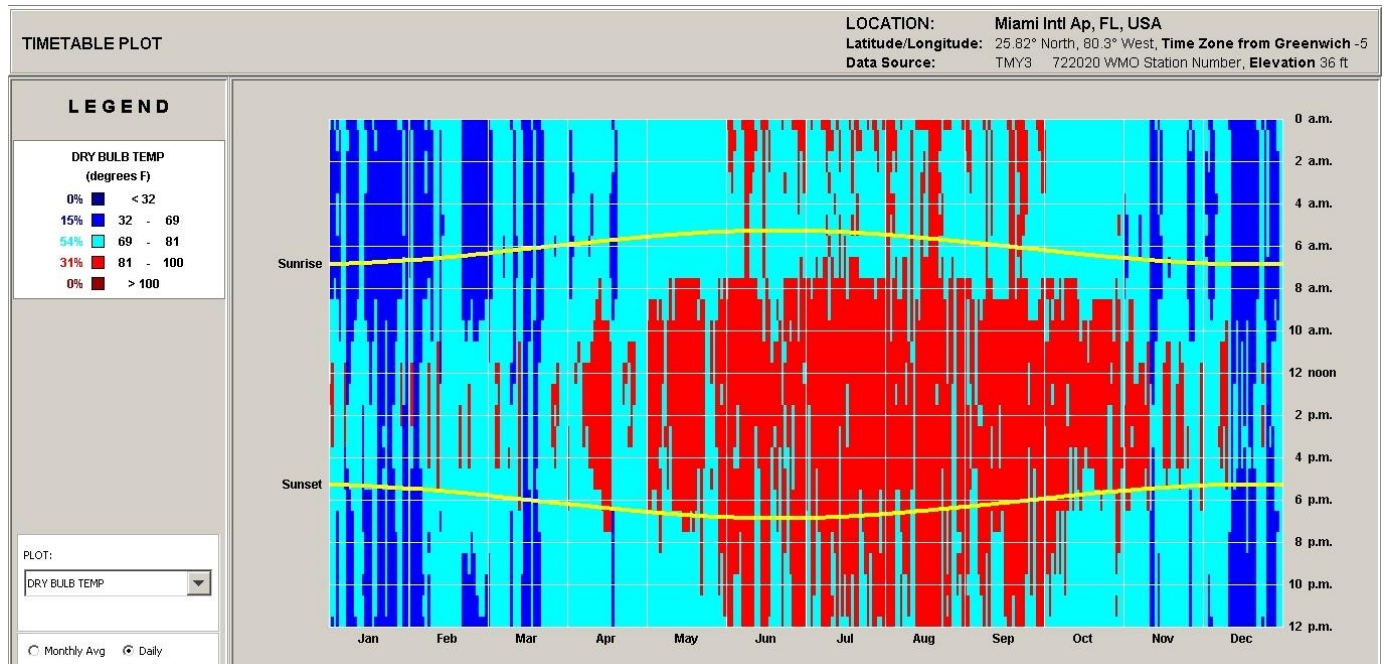


Monthly Diurnal Average:

Monthly diurnal average which shows the temperature cycle during the day and also the radiation on the site.

The differences between the average in dry bulb temperature and wet bulb temperature in February and January shows the weather is dryer in these months during the year.

The Time table plot shows the annual temperature during hours in a day.



This plot shows that during the daytime in summer and parts of April until late October, the temperature mostly is higher than 81 F , which is above the comfort zone. This happens mostly during the daytime and during the time in which people are at work, offices and educational purpose buildings.

Heating and Cooling Degree Day

Miami Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Temperature	67.2	68.5	71.7	75.2	78.7	81.4	82.6	82.8	81.9	78.3	73.6	69.1	75.9
Avg. Max Temperature	75.2	76.5	79.1	82.4	85.3	87.6	89.0	89.0	87.8	84.5	80.4	76.7	82.8
Avg. Min Temperature	59.2	60.4	64.2	67.8	72.1	75.1	76.2	76.7	75.9	72.1	66.7	61.5	69.0
Days with Max Temp of 90 F or Higher	0.0	0.0	< 0.5	1.0	4.0	10.0	16.0	16.0	10.0	2.0	0.0	0.0	61.0
Days with Min Temp Below Freezing	< 0.5	0.0	< 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	< 0.5	0.0

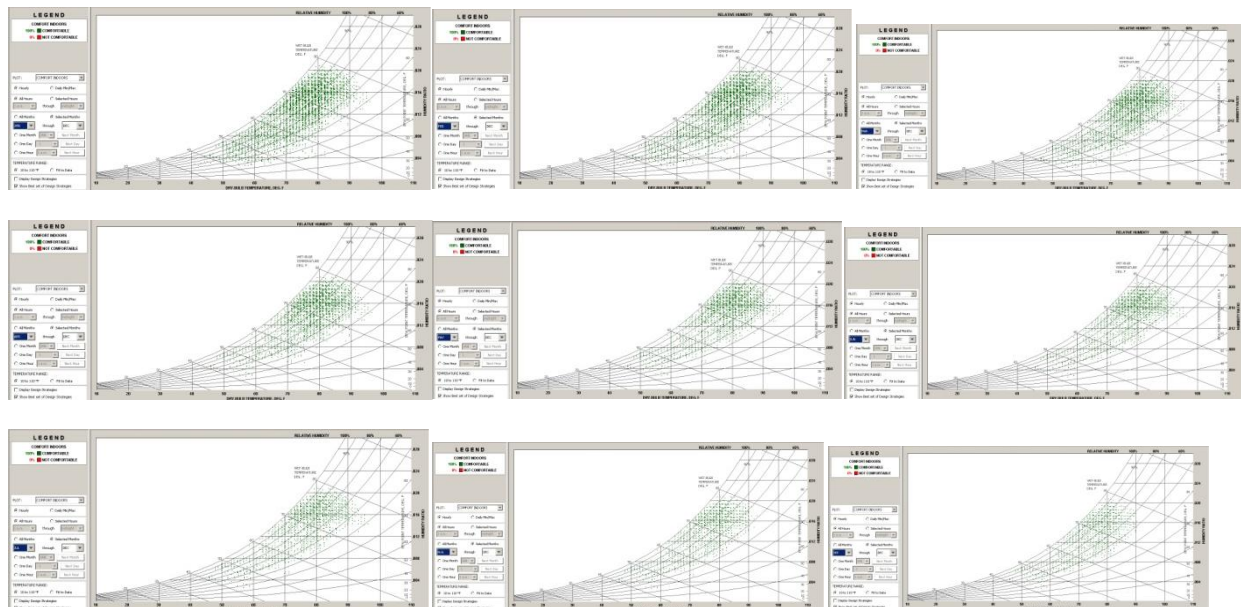
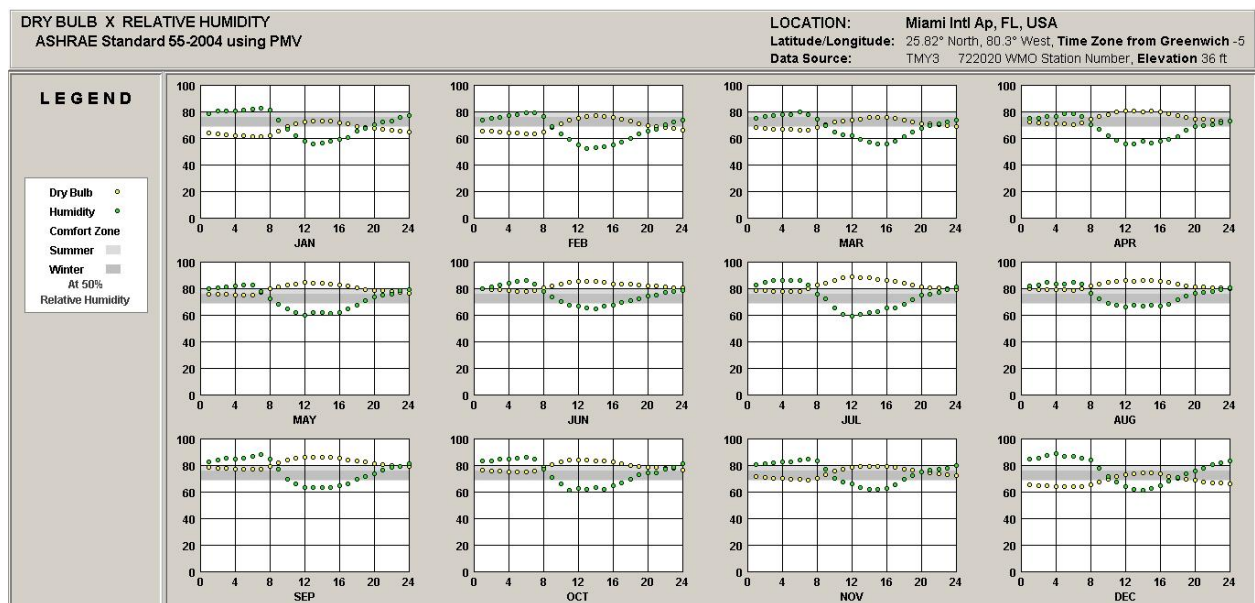
Miami Heating and Cooling	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Heating Degree Days	88.0	51.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	41.0	200
Cooling Degree Days	156	149	221	306	425	492	546	552	507	412	264	168	4198

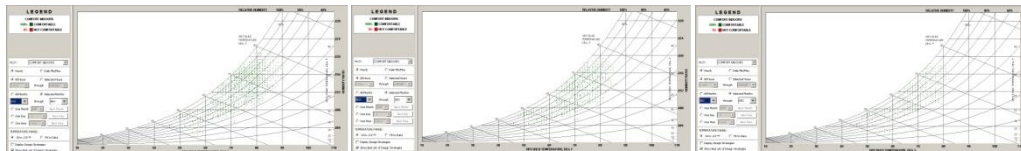
Looking at Miami Heating degree days, indicates that generally, heating is not needed seriously in this climate as even in January as coldest month as shown in the chart, the heating degree days are only 88 days (night time) which would be about 2.5 C/F heating day degree needed, while it is also stated that the cooling degree days (daytime) are more (mostly double times) in winter , in January.

Humidity

Humidity is identified as important as temperature in terms of the comfort definition. Low percent of humidity will result in dry air, while too much humid weather would make occupants feel muggy and uncomfortable.

Miami, as stated in the climate zone, is considered as Hot and humid and as showing in the dry bulb and relative humidity chart, and also the psychometric chart below the average percent of relative humidity is between 60% to 85% during the whole year. In the other words, humidity never goes below 58% even in coldest months of the winter on January and February.





Precipitation

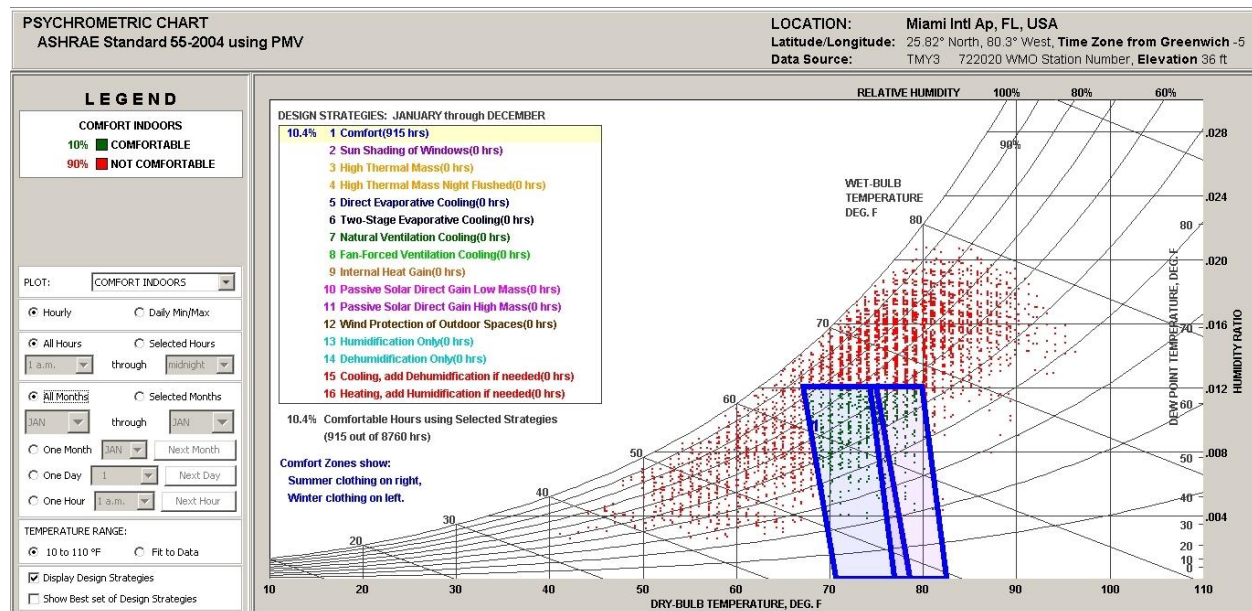
Miami Precipitation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (inches)	2.0	2.1	2.4	2.9	6.2	9.3	5.7	7.6	7.6	5.6	2.7	1.8	55.9
Days with Precipitation 0.01 inch or More	7.0	6.0	6.0	6.0	10.0	15.0	16.0	17.0	17.0	14.0	8.0	7.0	131
Monthly Snowfall (inches)	0.0	0.0	0.0	0.0	< 0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	< 0.05

From the Miami precipitation data above, it can be found out that most precipitation occurs during summer time as all the hot and humid climates.

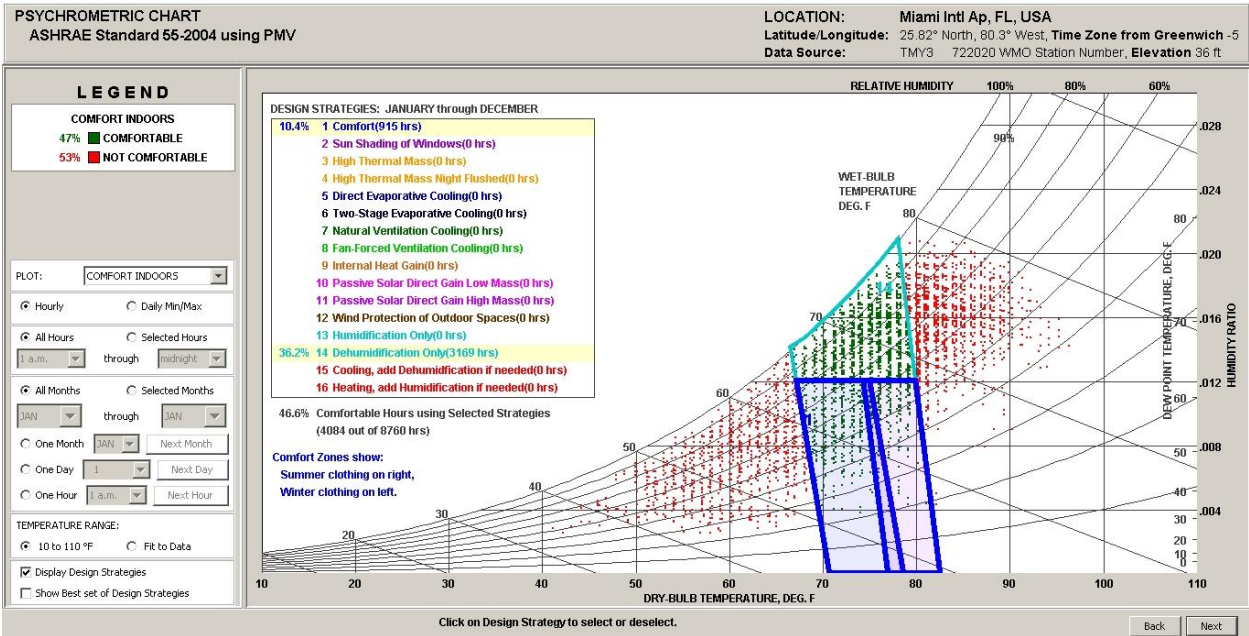
Psychrometric Chart

Data shown on psychrometric chart includes the temperature (dry bulb and wet bulb) and also the Humidity (Relative and absolute). Psychrometric chart can be used to identify the occupant comfort zone in the area and design necessary passive design strategies to raise the comfort level. (<http://sustainabilityworkshop.autodesk.com>, 2015)

At very first we can see the most weather through the year in Miami is hot and moist. It is shown in the psychrometric chart that the humidity through the whole year is high and in all months is between the range of 60% to 100%.



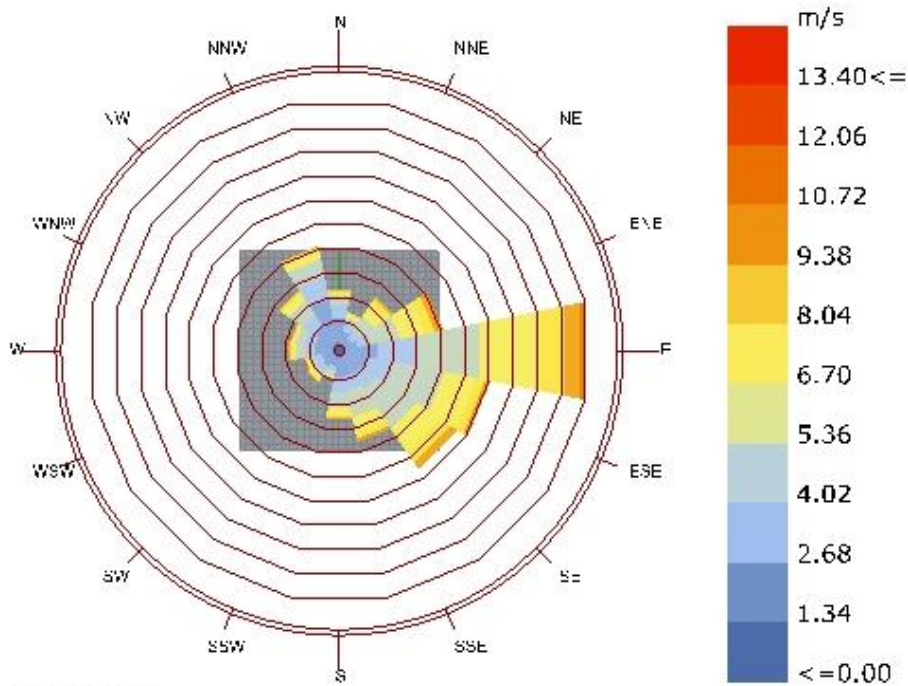
It is understood from the psychrometric chart above that without any strategy applied into the building design, the occupants' comfort in this building with use of summer or winter clothing is only about 10.5% of times, which is a very low rate.



Adding dehumidification as a strategy to decrease the raises the comfort zone up to 36% which proves that the main issue in Miami climate is about the high level of humidity through the whole year.

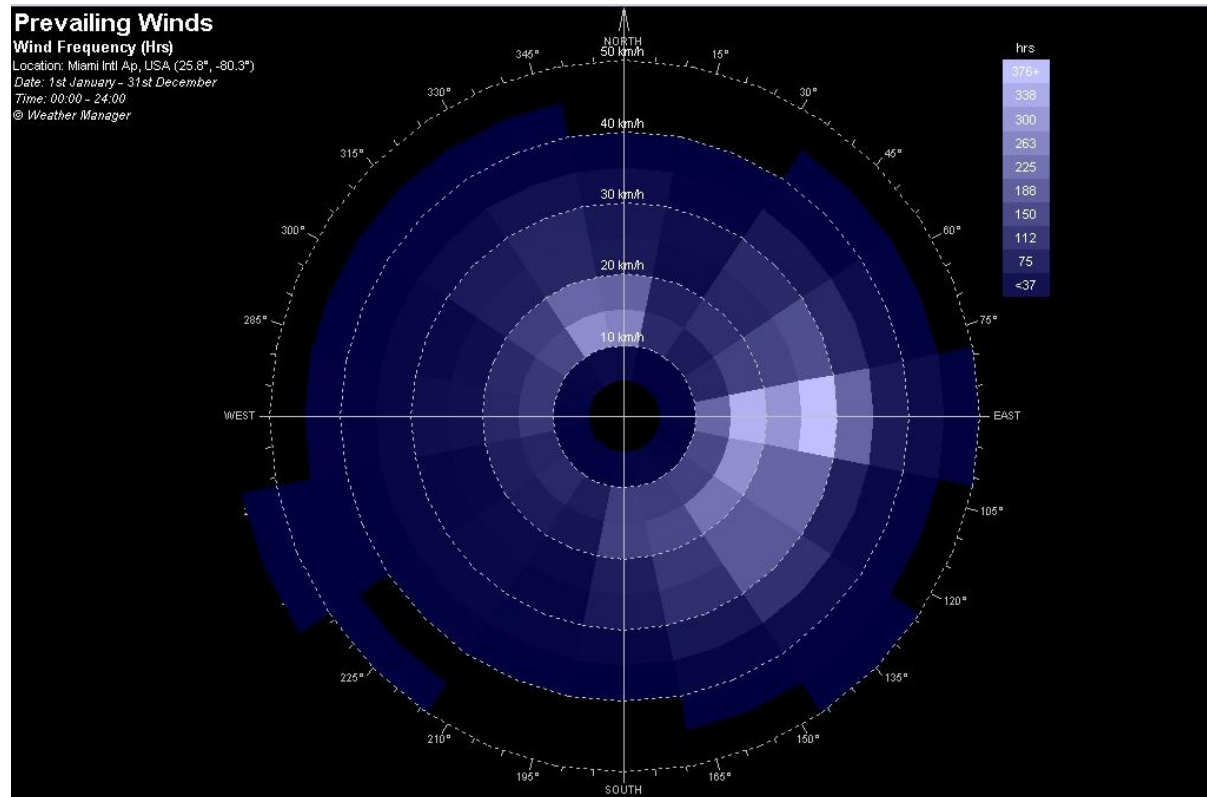
Wind rose

The wind rose diagram below shows the frequency, direction and also the speed of the wind in hours during the whole year. It is shown that the wind with a speed in comfort zone mostly is from east and north west and in early hours of the day. Totally, the comfort area of wind rose is very small percent of the whole year and about 150 hours.



Wind-Rose
Miami Intl Ap_FL_USA
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 5.84% of the time = 512 hours.
Each closed polyline shows frequency of 1.7%. = 150 hours.

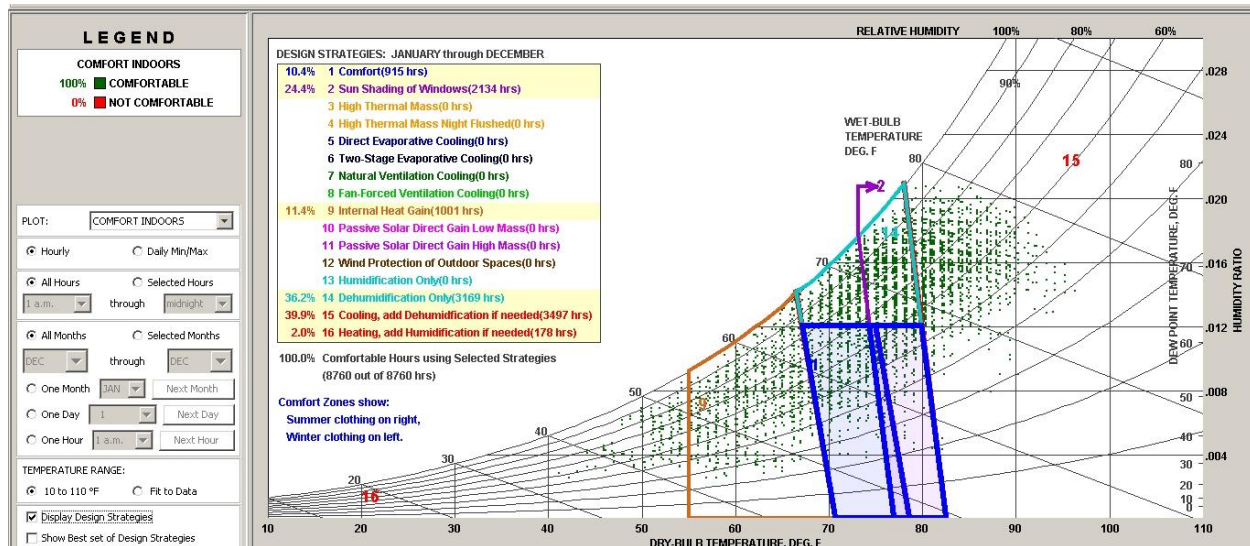
In the prevailing wing graph below, this also can be seen.



The wind-rose here is showing the frequency of the wind through the whole year. Circles here indicate the wind speed and the radials show the wind direction. The colored parts of each spoke represent the hours of wind rose on that direction and speed.

Recommended Strategies for design in Miami Climate

As shown in Psychrometric chart, the most important issue in the hot and humid climate of Miami which is confronting the comfort, is humidity. As the higher temperature gets, the more humidity it can hold, the high temperature of the area increases the feeling of humidity and eventually muggy.



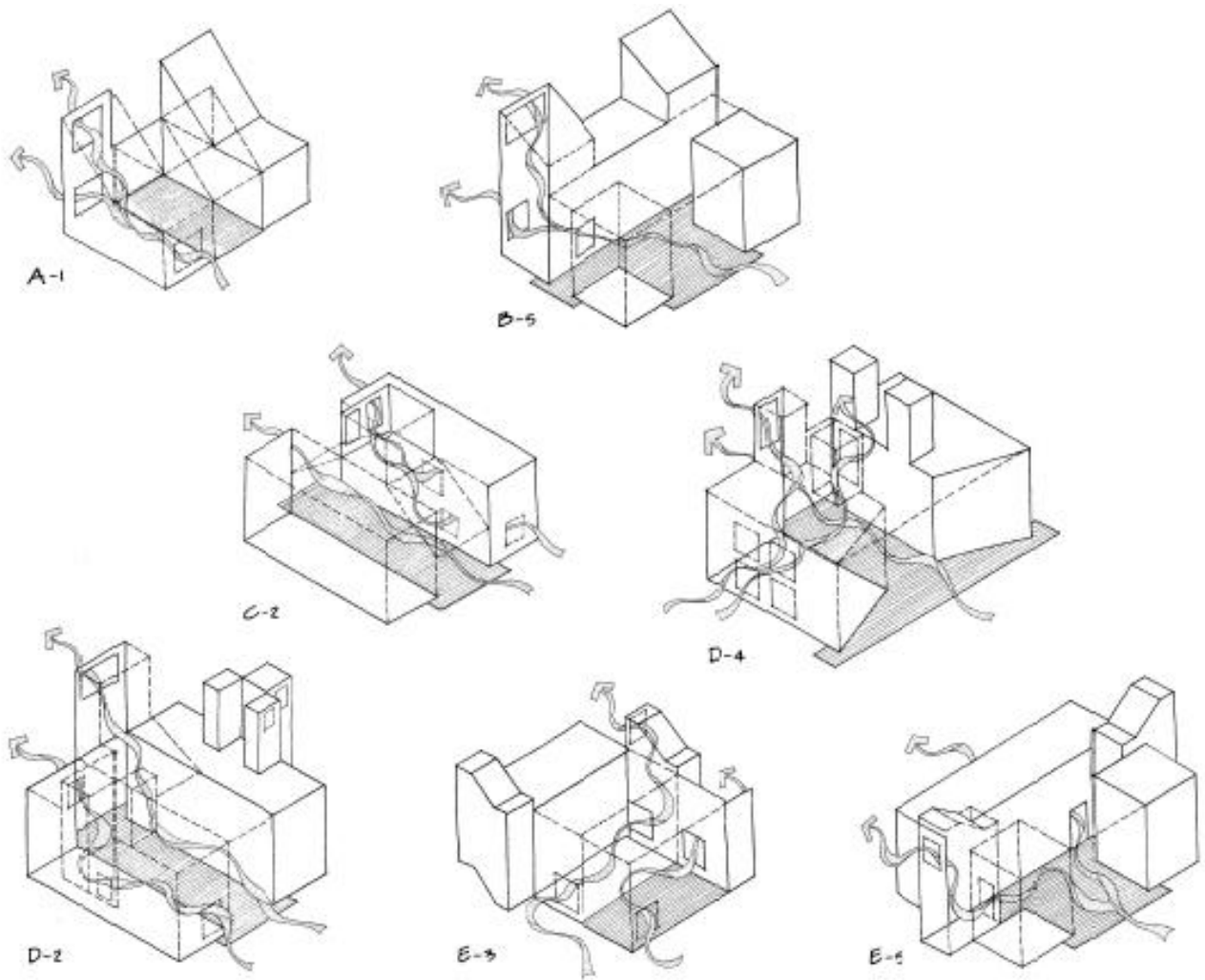
Passive strategies for design in hot and humid climate :

1. **Natural Ventilation:** In this climate the only ventilation which would perform is **central stack ventilation** combined with cross-ventilation, which is designed by openings in opposite directions in tall ceilings. In this way, stack ventilation bunches the rooms to use central stack ventilation and the outside to form a cross-ventilated breeze way through the entire building.



Logan House, Tomba, Miami, FL

2. **Shading:** First passive strategy is to prevent the sun radiation come in. It is showed clearly in psychrometric charts that proper Shading has a great influence on decreasing the daytime high temperature in this climate.

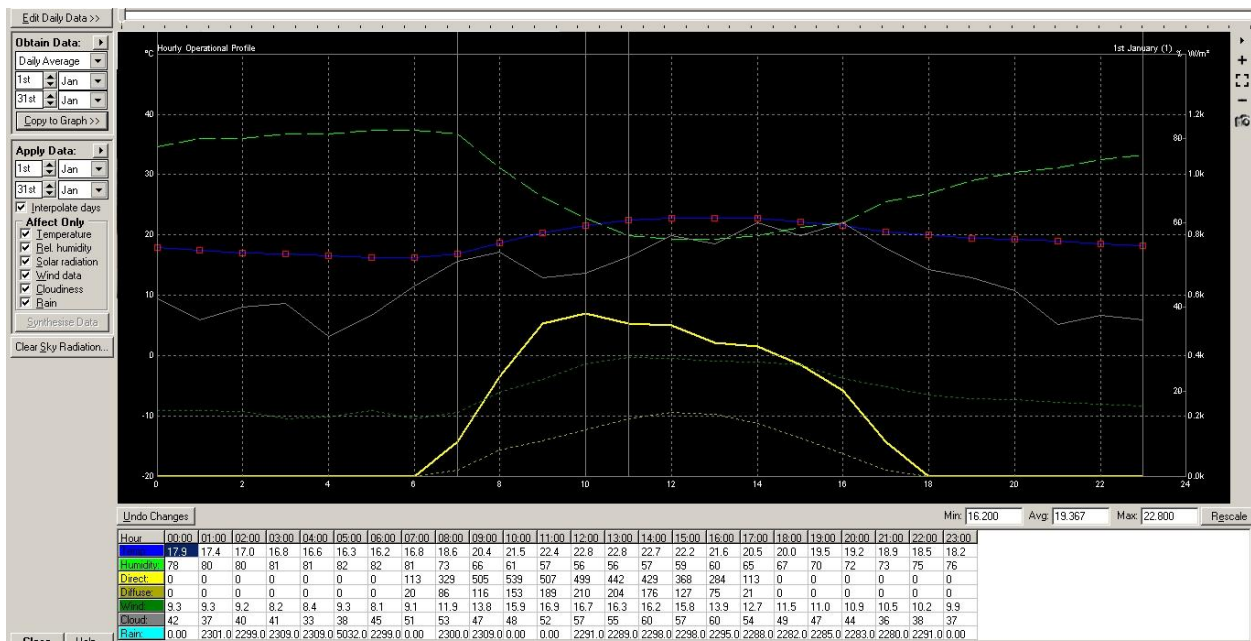


Scheme of natural ventilation strategies

Active Strategies for Design in hot and humid climate:

1. **Dehumidification:** The first and the most crucial strategy recommended to be applied in this climate is dehumidification. decreasing the percentage of humidity in the air will result in more comfort feeling during the day and the night.
2. **Cooling:** As the temperature mostly does not go below 68 F during the year in Miami, cooling seems to be inevitable and very much important in creating more comfort hours during the day.

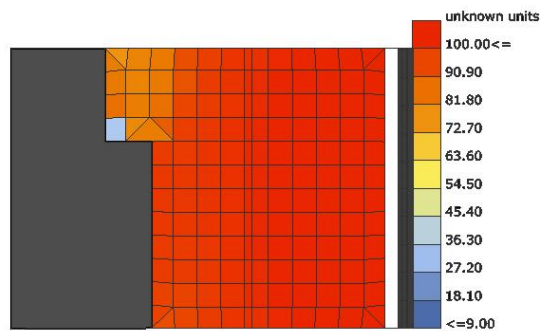
Climate report for offices and residential buildings



Base Case

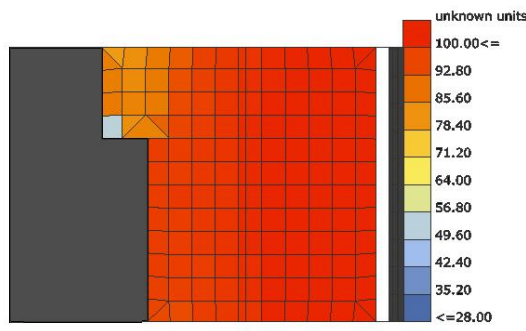
Orientation _ Annual Daylighting

- Orientation of the room is being assessed for finding the best orientation for daylighting.



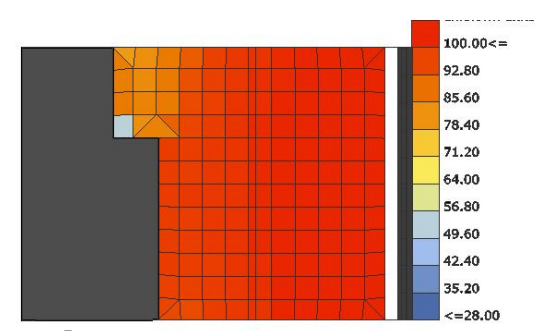
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45



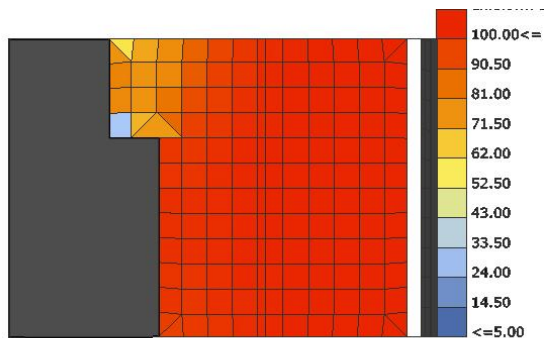
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90



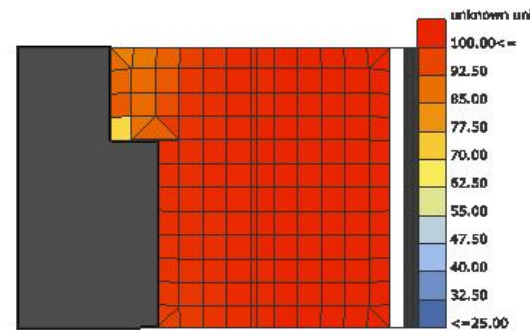
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0



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135



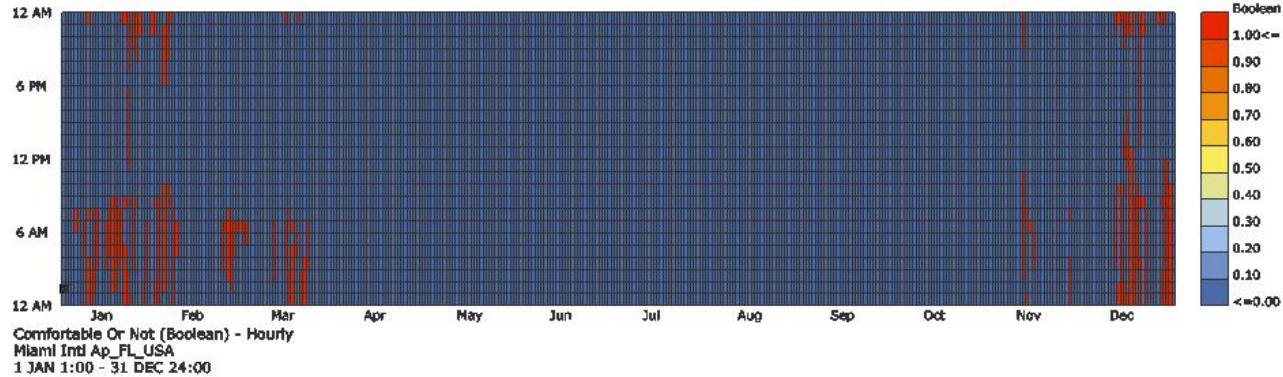
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270

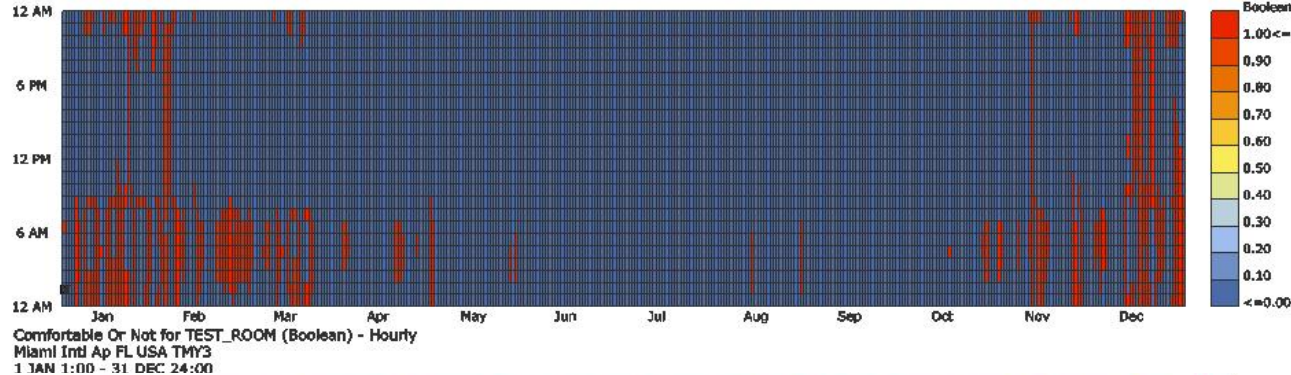
0/ SDA:98.53
45/SDA:97.79
90/SDA:
135/SDA:97.79
270/SDA: 98.53

Base Case Orientation _ Comfort

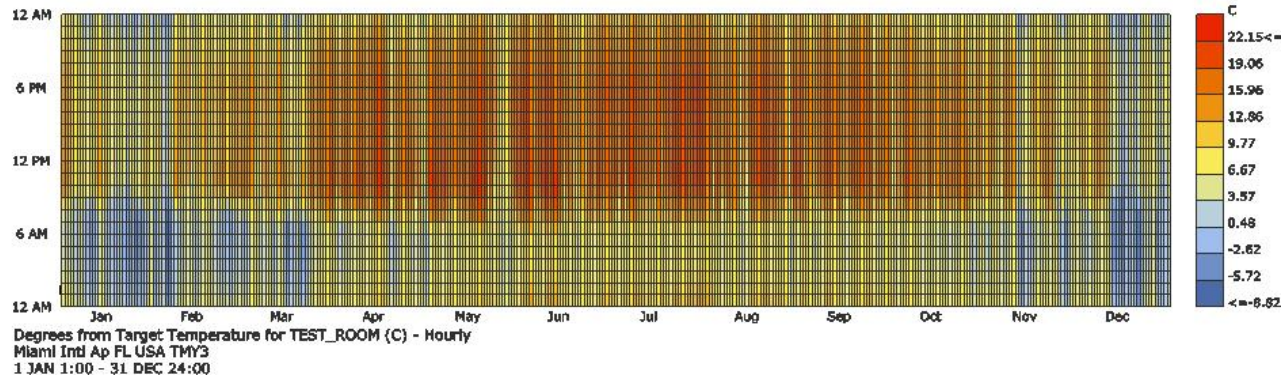
- Orientation of the room is being assessed for finding the best orientation for most comfort.



Base/ Orientation: 0
PMV



Adaptive Comfort:
9.7%

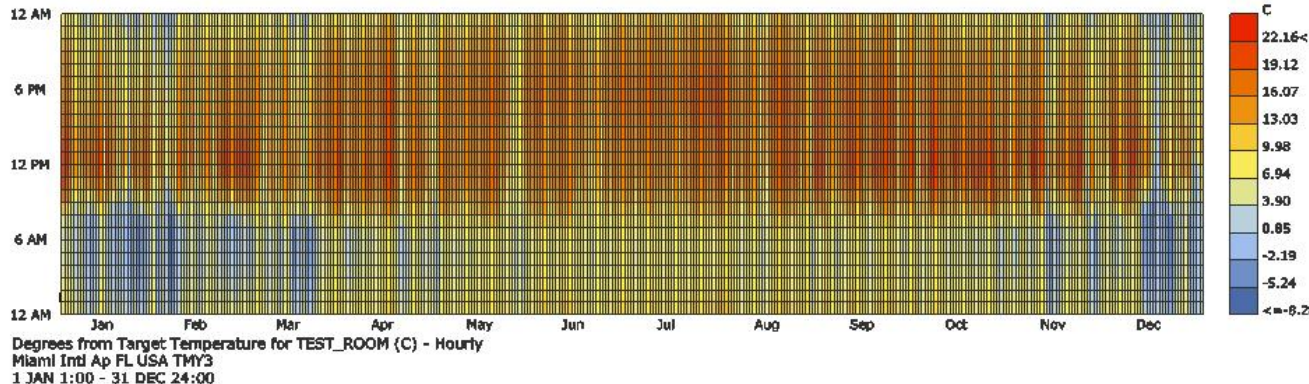
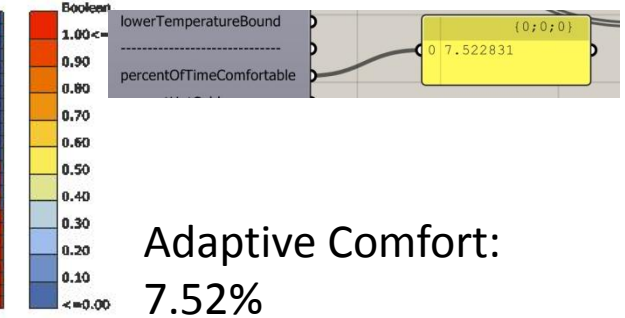
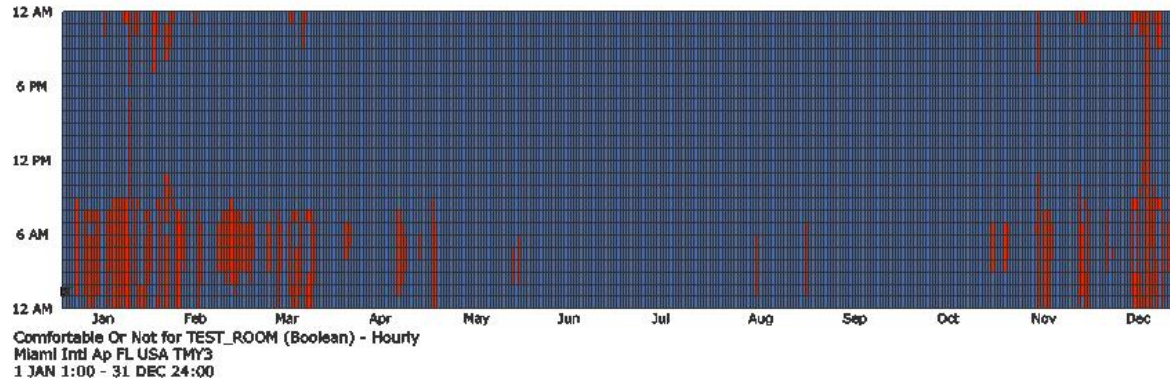
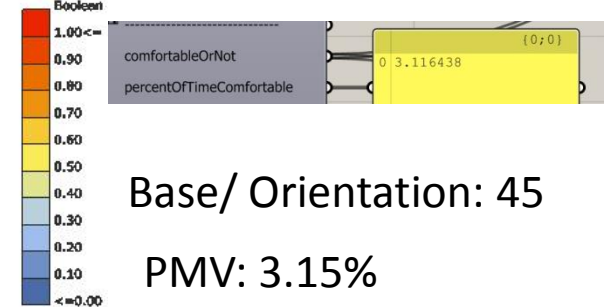
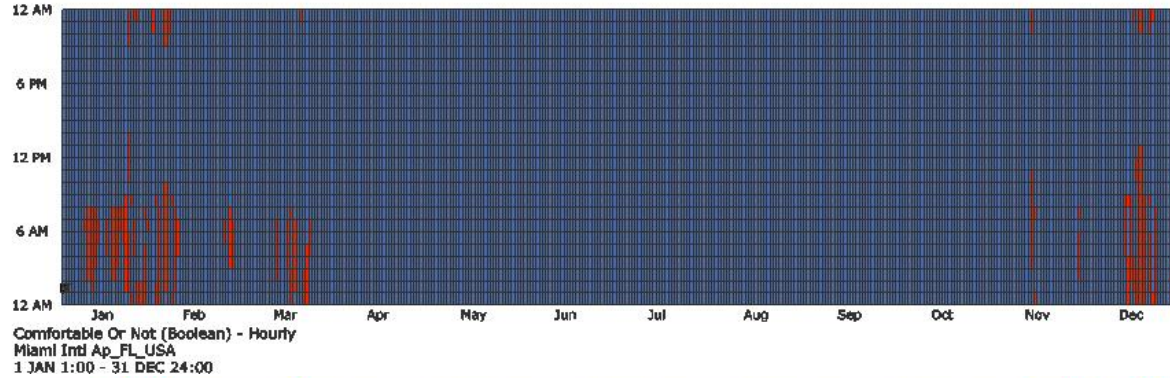


Degrees from target

Base Case

Orientation _ Comfort

- Orientation of the room is being assessed for finding the best orientation for most comfort.

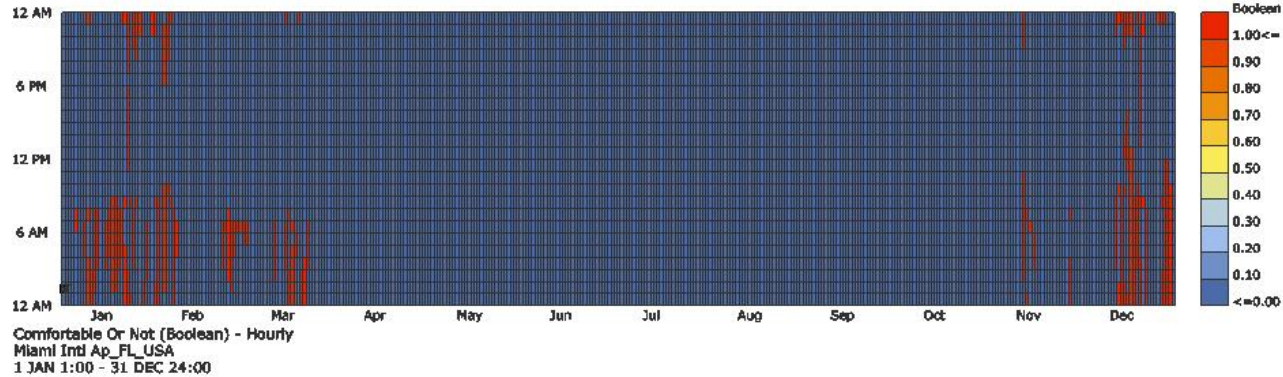


Degrees from target

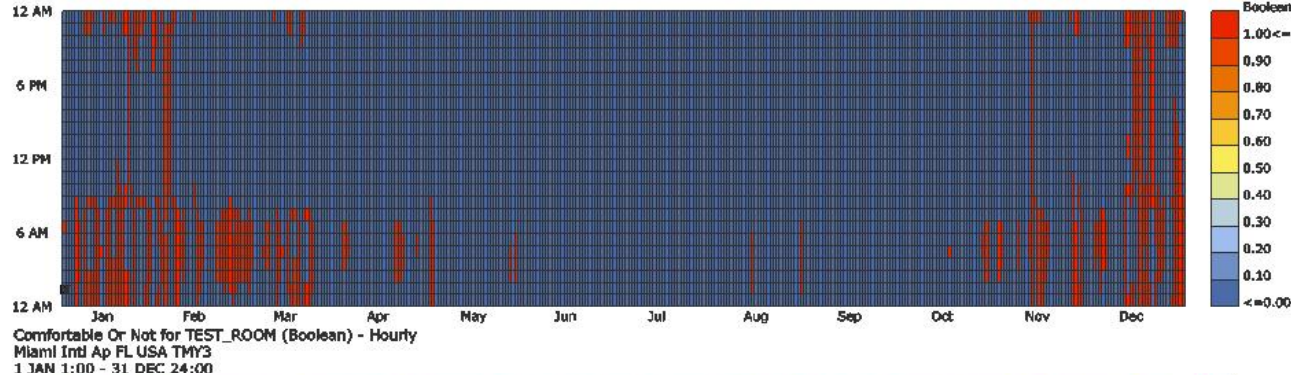
Base Case

Orientation _ Comfort

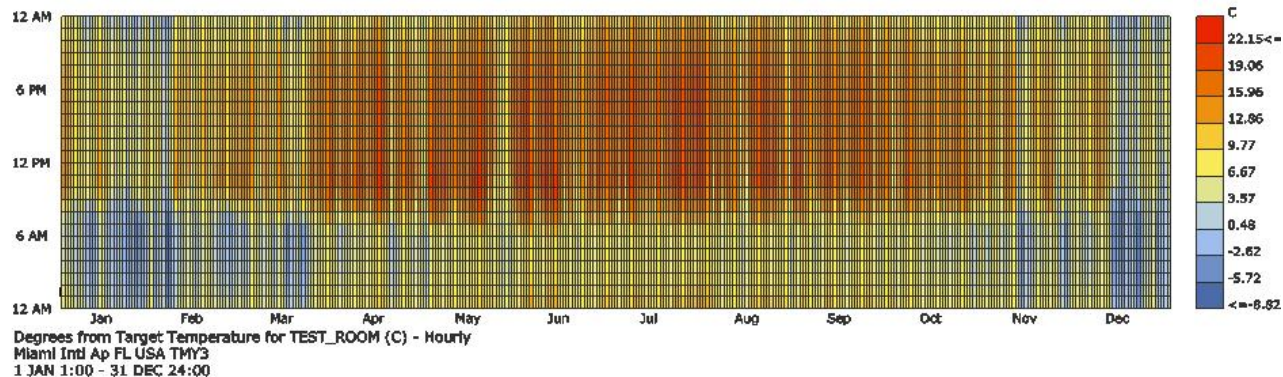
- Orientation of the room is being assessed for finding the best orientation for most comfort.



Base/ Orientation: 90
PMV



Adaptive Comfort:
9.7%

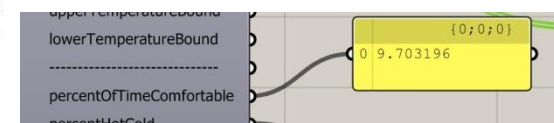
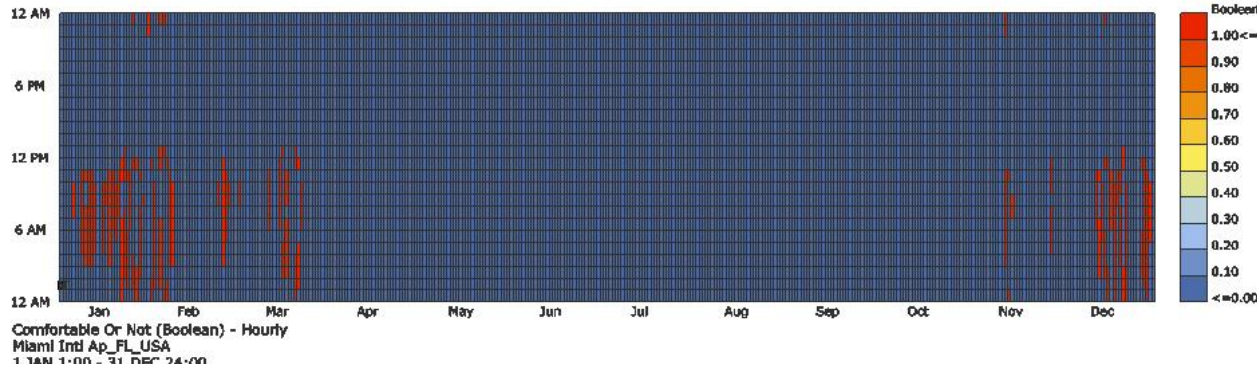


Degrees from target

Base Case

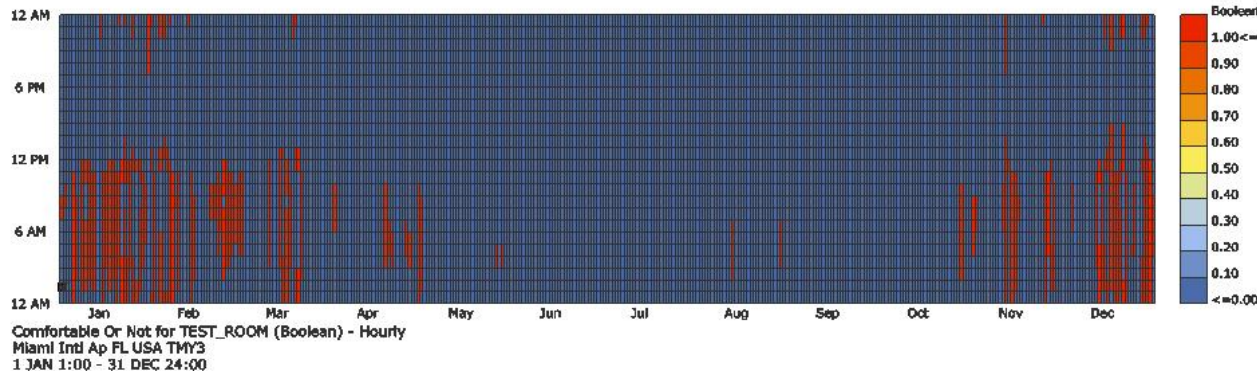
Orientation _ Comfort

- Orientation of the room is being assessed for finding the best orientation for most comfort.

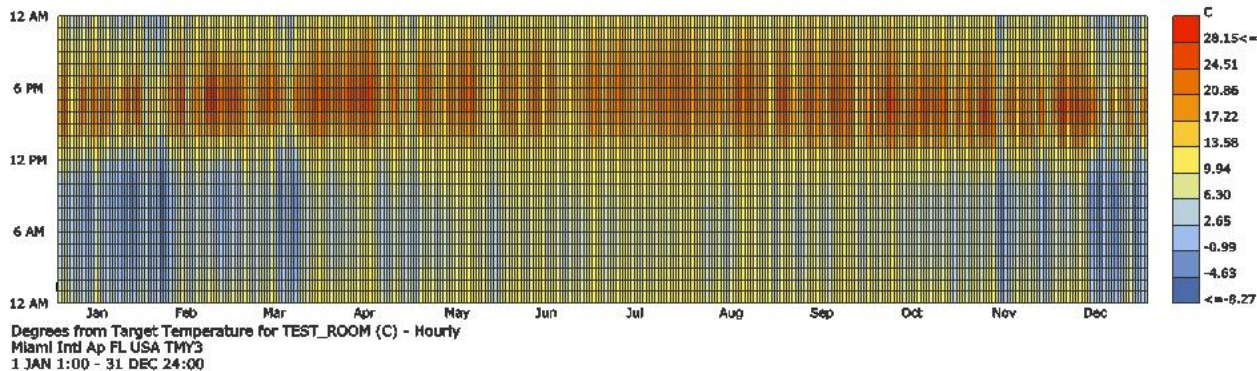


Base/ Orientation: 135

PMV



Adaptive Comfort:
9.7%

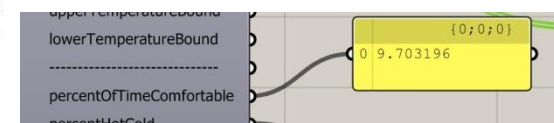
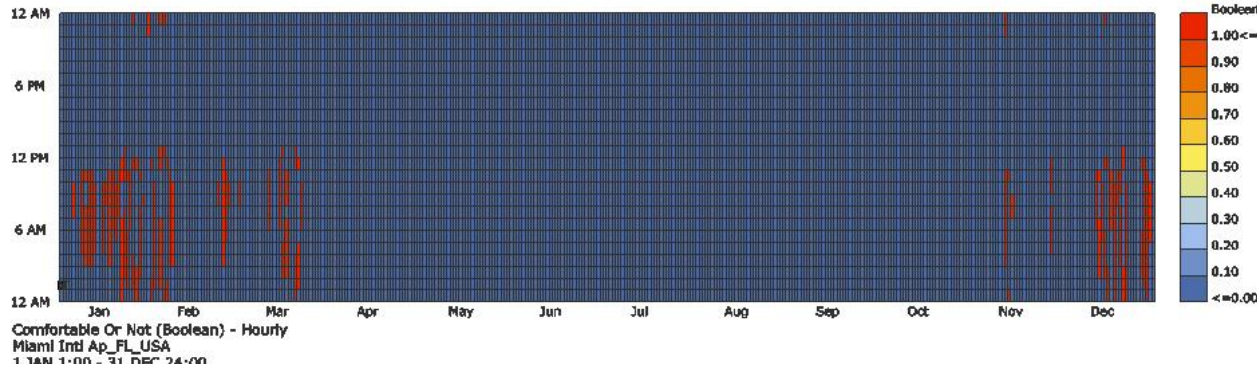


Degrees from target

Base Case

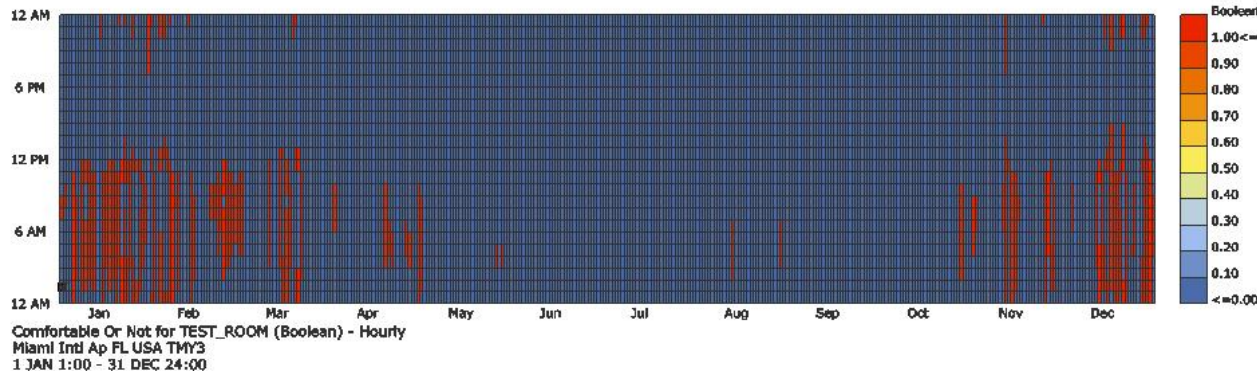
Orientation _ Comfort

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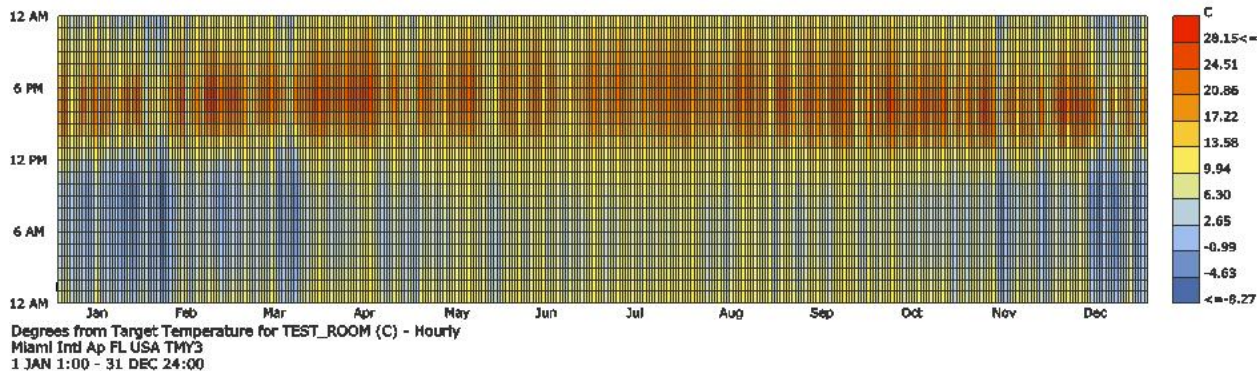
Base/ Orientation: 135

PMV



Adaptive Comfort:

9.7%



Degrees from target

Problem solving process