Weather Report of the City of Philadelphia

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1 Introduction

This report is based on the TMY3 data collected in Philadelphia，40.08 North, 75.2West.

A typical meteorological year (TMY) data set provides designers and other users with a reasonably sized annual data set that holds hourly meteorological values that typify conditions at a specific location over a longer period of time, such as 30 years. The data is analysised by Climate Consultant.

2 Weather data summary

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	52	100	87	105	114	124	147	114	100	89	77	52	Btu/sq. ft
Direct Normal Radiation (Avg Hourly)	62	129	83	85	79	87	141	83	88	98	110	71	Btu/sq. ft
Diffuse Radiation (Avg Hourly)	29	40	42	49	58	61	47	57	48	40	33	28	Btu/sq. ft
Global Horiz Radiation (Max Hourly)	164	221	261	295	313	301	305	285	258	228	182	143	Btu/sq. ft
Direct Normal Radiation (Max Hourly)	298	281	304	268	296	256	277	252	251	268	265	280	Btu/sq. ft
Diffuse Radiation (Max Hourly)	110	100	131	136	187	139	173	130	119	114	87	96	Btu/sq. ft
Global Horiz Radiation (Avg Daily Total)	493	1044	1031	1386	1631	1837	2142	1547	1230	973	760	484	Btu/sq. ft
Direct Normal Radiation (Avg Daily Total)	590	1353	982	1124	1138	1293	2059	1137	1079	1072	1084	658	Btu/sq. ft
Diffuse Radiation (Avg Daily Total)	283	422	497	656	838	916	694	776	586	445	328	261	Btu/sq. ft
Global Horiz Illumination (Avg Hourly)	1655	3101	2786	3328	3647	3939	4606	3621	3180	2789	2406	1665	footcandles
Direct Normal Illumination (Avg Hourly)	1652	3573	2356	2446	2332	2555	4093	2445	2528	2745	2989	1868	footcandles
Dry Bulb Temperature (Avg Monthly)	26	34	44	54	61	71	76	78	70	56	46	40	degrees F
Dew Point Temperature (Avg Monthly)	17	18	33	43	48	58	64	65	57	45	35	29	degrees F
Relative Humidity (Avg Monthly)	70	51	65	71	65	66	70	67	67	69	67	65	percent
Wind Direction (Monthly Mode)	300	280	310	200	320	240	280	210	310	350	290	330	degrees
Wind Speed (Avg Monthly)	8	8	10	9	8	6	7	5	7	6	7	7	mph
Ground Temperature (Avg Monthly of 3 Depths)	40	37	38	42	52	61	68	72	70	65	56	47	degrees F

As is shown in the chart, the maximum global horizontal radiation happens in July, reaches 147 Btu/sq.ft. And the minimum in Janurary and December, each is 52 Btu/sq.ft. Direct normal radiation and diffuse radiation also reach their maximum number in July.

3 Data Analysis

3.1 Comfort model

California Energy Code comfort Model, 2013 is used as criteria. The definition is listed as below.

1. COMFORT: (using California Energy Code Model)

68.0	Comfort Low - Min. Comfort Dry Bulb Temp (° F)
75.0	Comfort High - Max. Comfort Dry Bulb Temp, up to 50% RH (° F)
80.0	Max. Relative Humidity (measured at Min. Comfort Temp) (%)
66.0	Max. Wet Bulb Temperature (° F)
27.0	Min. Dew Point Temperature (° F)

2. SUN SHADING ZONE: (Defaults to Comfort Low)

68.0	Min. Dry Bulb Temperature when Need for Shading Begins (° F)
100.0	Min. Global Horiz. Radiation when Need for Shading Begins (Btu/sq.ft)

3. HIGH THERMAL MASS ZONE:

15.0	Max. Outdoor Temperature Difference above Comfort High (° F)
3.0	Min. Nighttime Temperature Difference below Comfort High (° F)

4. HIGH THERMAL MASS WITH NIGHT FLUSHING ZONE:

30.0	Max. Outdoor Temperature Difference above Comfort High (° F)
3.0	Min. Nighttime Temperature Difference below Comfort High (° F)

5. DIRECT EVAPORATIVE COOLING ZONE: (Defined by Comfort Zone)

63.8	Max. Wet Bulb set by Max. Comfort Zone Wet Bulb (° F)
48.8	Min. Wet Bulb set by Min. Comfort Zone Wet Bulb (° F)

6. TWO-STAGE EVAPORATIVE COOLING ZONE:

50.0	% Efficiency of Indirect Stage

7. NATURAL VENTILATION COOLING ZONE:

2.0	Terrain Category to modify Wind Speed (2=suburban)
40.0	Min. Indoor Velocity to Effect Indoor Comfort (fpm)
300.0	Max. Comfortable Velocity (per ASHRAE Std. 55) (fpm)
6.6	Max. Perceived Temperature Reduction (° F)
90.0	Max. Relative Humidity (%)
73.0	Max. Wet Bulb Temperature (° F)

8. FAN-FORCED VENTILATION COOLING ZONE:

160.0	Max. Mechanical Ventilation Velocity (fpm)
5.4	Max. Perceived Temperature Reduction (° F)
	(Min Vel, Max RH, Max WB match Natural Ventilation)

9. INTERNAL HEAT GAIN ZONE (lights, people, equipment):

55.0	Balance Point Temperature below which Heating is Needed (° F)

10. PASSIVE SOLAR DIRECT GAIN LOW MASS ZONE:

50.0	Min. South Window Radiation for 10° F Temperature Rise (Btu/sq.f
3.0	Thermal Time Lag for Low Mass Buildings (hours)

11. PASSIVE SOLAR DIRECT GAIN HIGH MASS ZONE:

100.0	Min. South Window Radiation for 10° F Temperature Rise (Btu/sq.f
12.0	Thermal Time Lag for High Mass Buildings (hours)

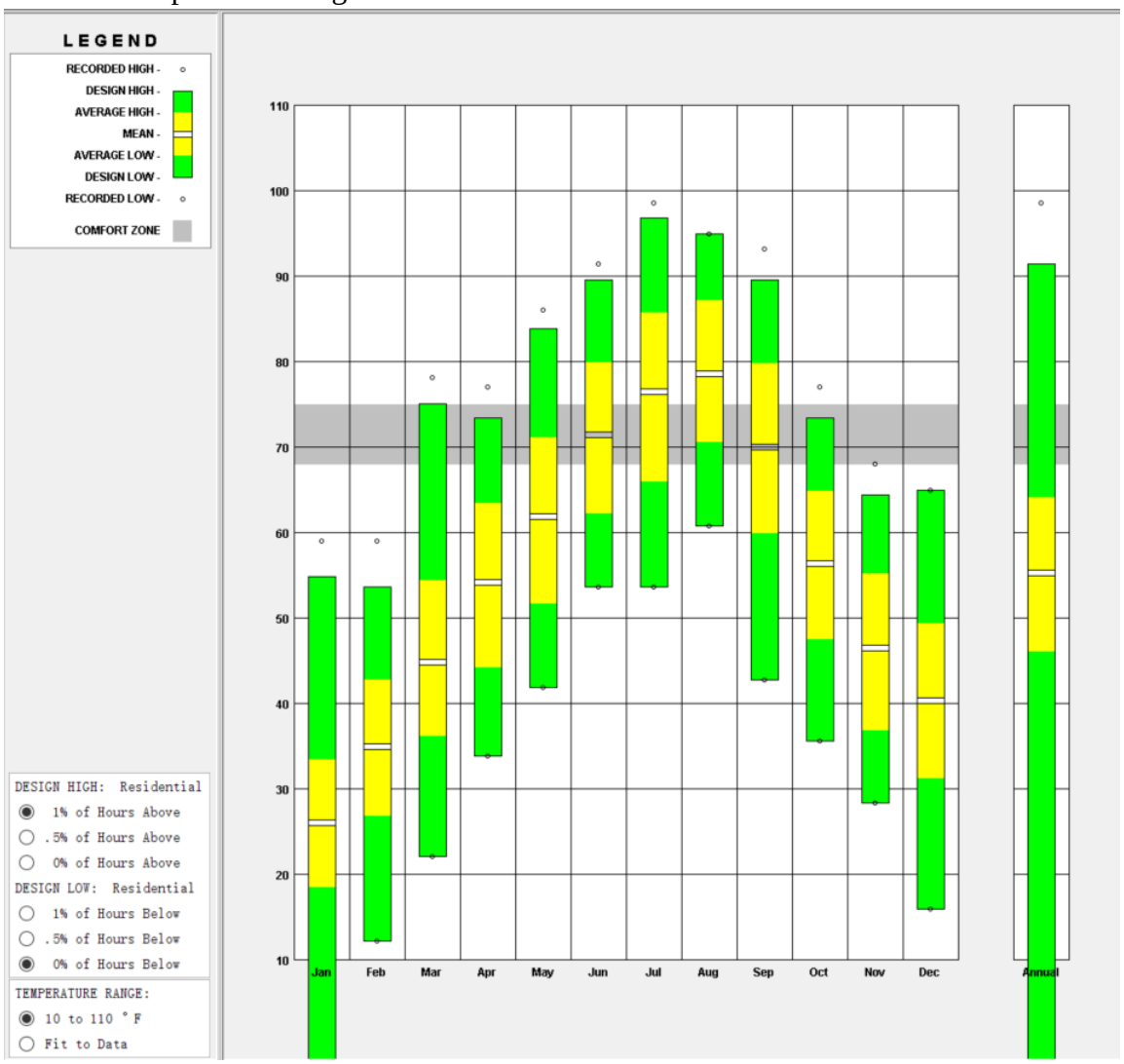
12. WIND PROTECTION OF OUTDOOR SPACES:

19.0	Velocity above which Wind Protection is Desirable (mph)
20.0	Dry Bulb Temperature Above or Below Comfort Zone (° F)

13. HUMIDIFICATION ZONE: (defined by and below Comfort Zone)

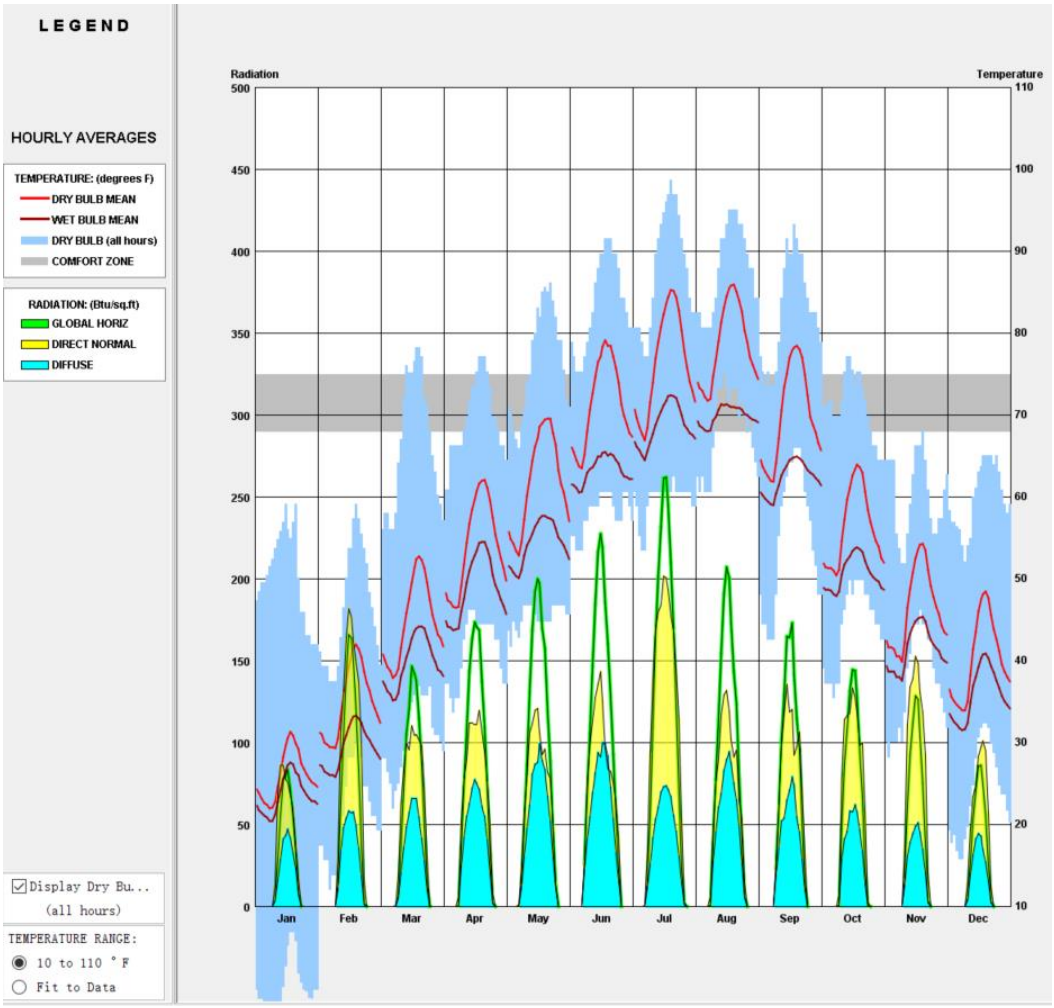
14. DEHUMIDIFICATION ZONE: (defined by and above Comfort Zone)

3.2 Temperature Range



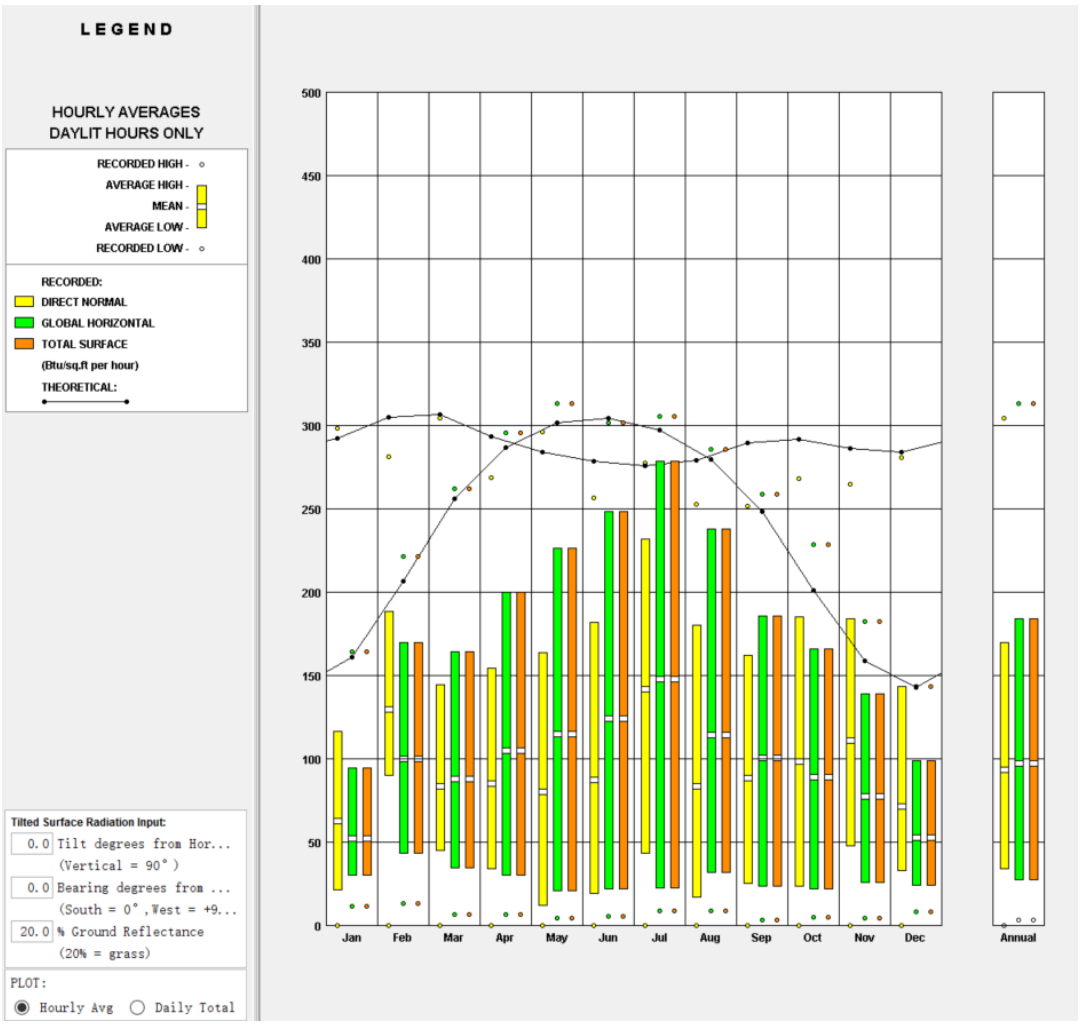
In June and September, the mean temperature is in the comfort zone. In July and August the mean temperature is slightly above the comfort zone. The rest months all have the mean temperature below the comfort zone, among which January is the coldest month. From this chart we realize that dealing with the relatively cold weather will be a more important issue in designing building in Philadelphia.

3.3 Temperature Hourly Averages



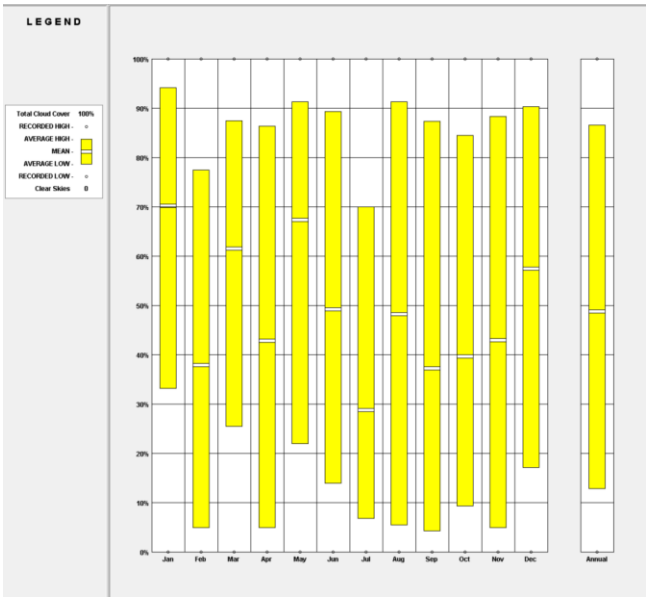
The radiation reaches the maximum number in July as well, implying that the radiation effects should be taken care of at the same time of high temperature in summer.

3.4 Hourly Averages Daylit Hours Only



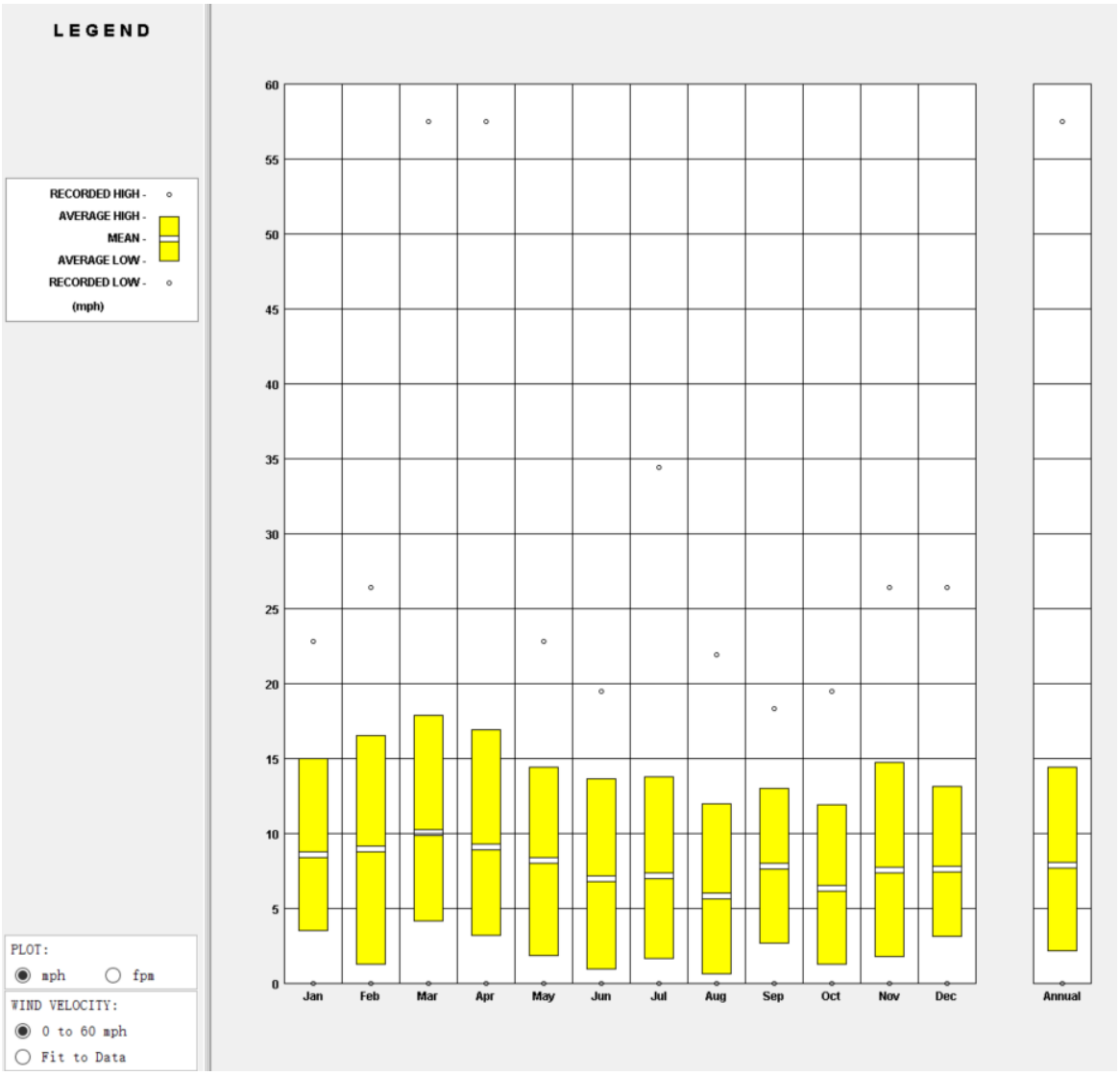
The hourly average daylight reaches the peak in summer, yet the maximum daylight is still below the theoretical range. The building designed in Philadelphia should consider absorbing more daylight inside, especially in winter.

3.5 Sky Cover Range



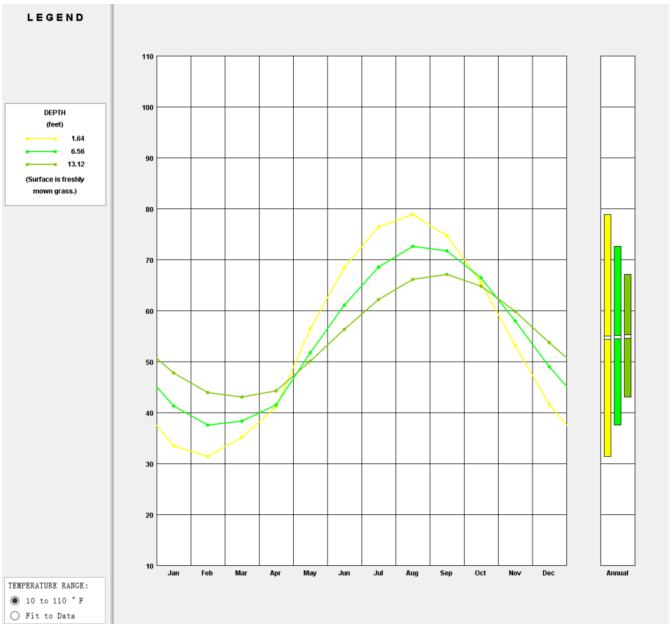
The sky cloud cover is usually above 30%, and no clear monthly pattern can be found.

3.6 Wind Velocity Range

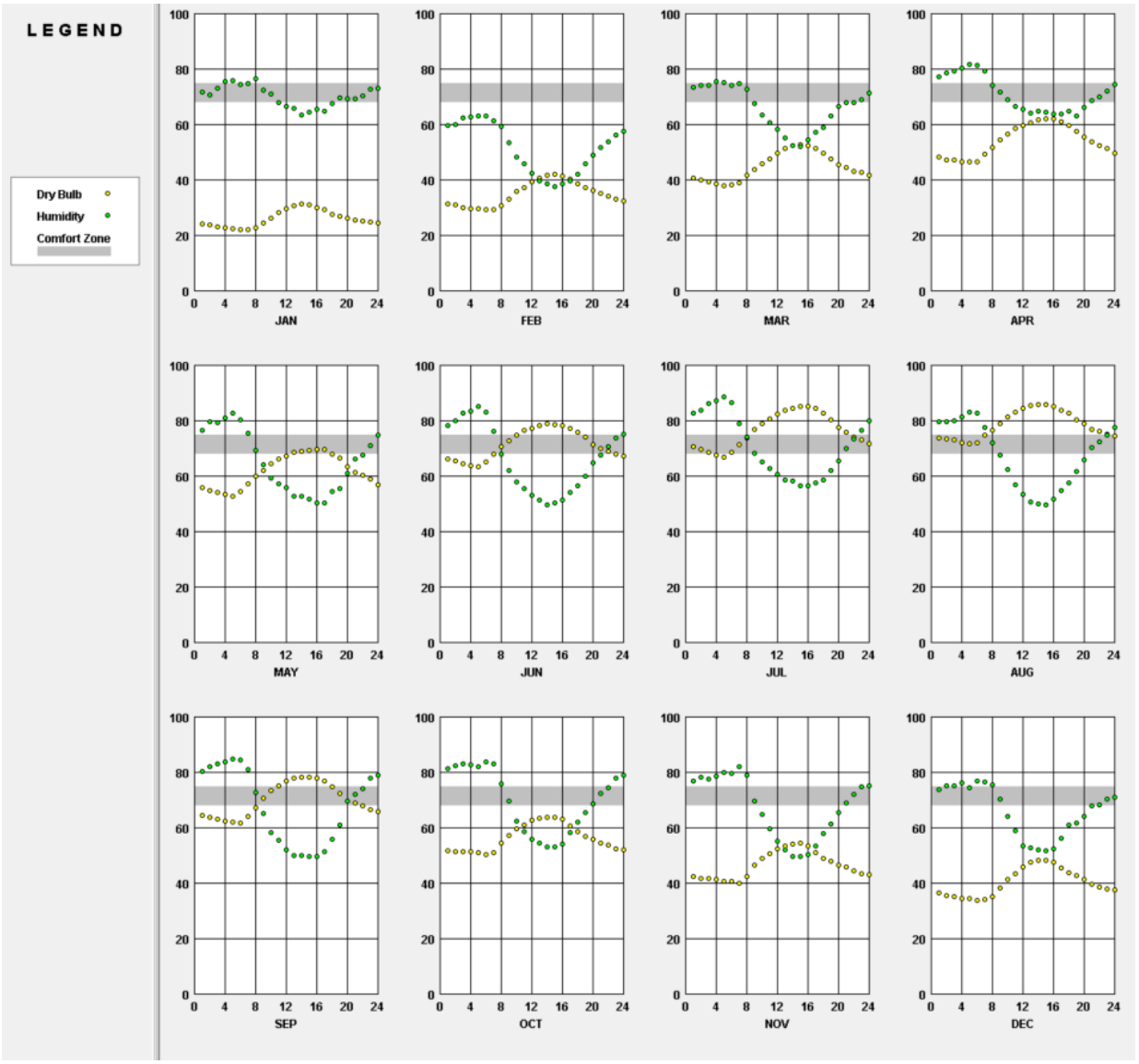


The wind velocity range doesn't have a clear seasonal pattern either, usually under 10 mph and above 5 mph.

3.7 Ground Temperature (Monthly Average)

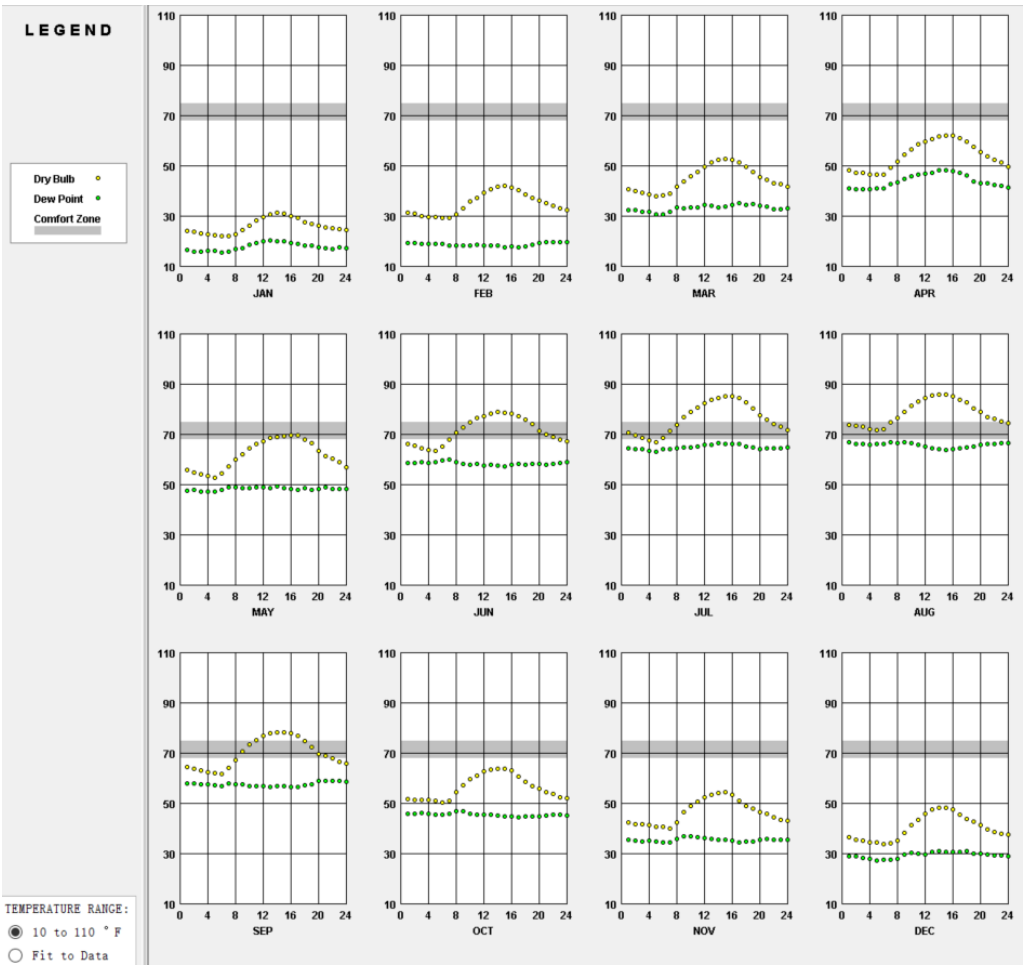


3.8 Dry Bulb X Relative Humidity



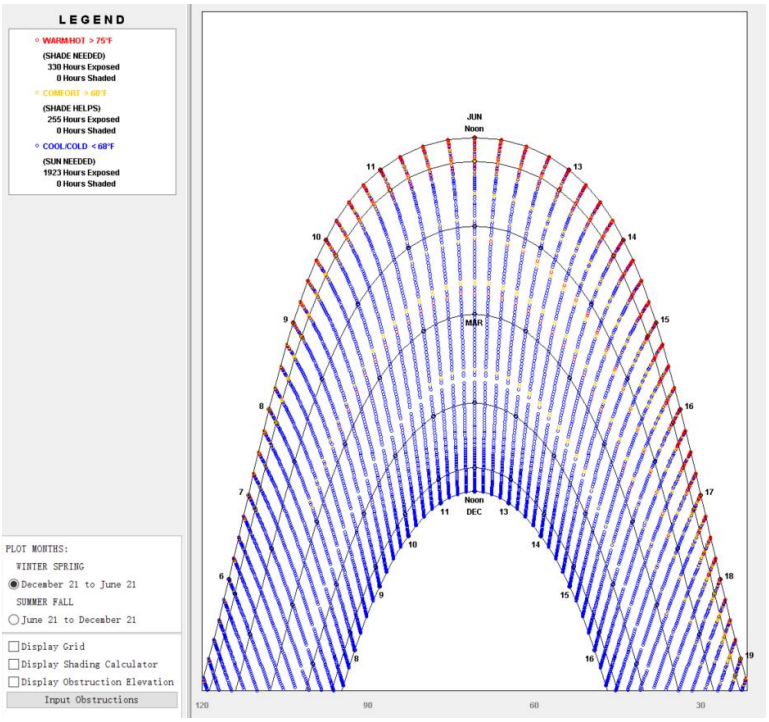
The humidity is usually on or below the comfort zone. The dry bulb temperature is on the comfort zone in June, July, August and September, during the rest of the year the temperature is lower, which confirms that dealing with lower temperature should be a more important problem.

3.9 Dew Point

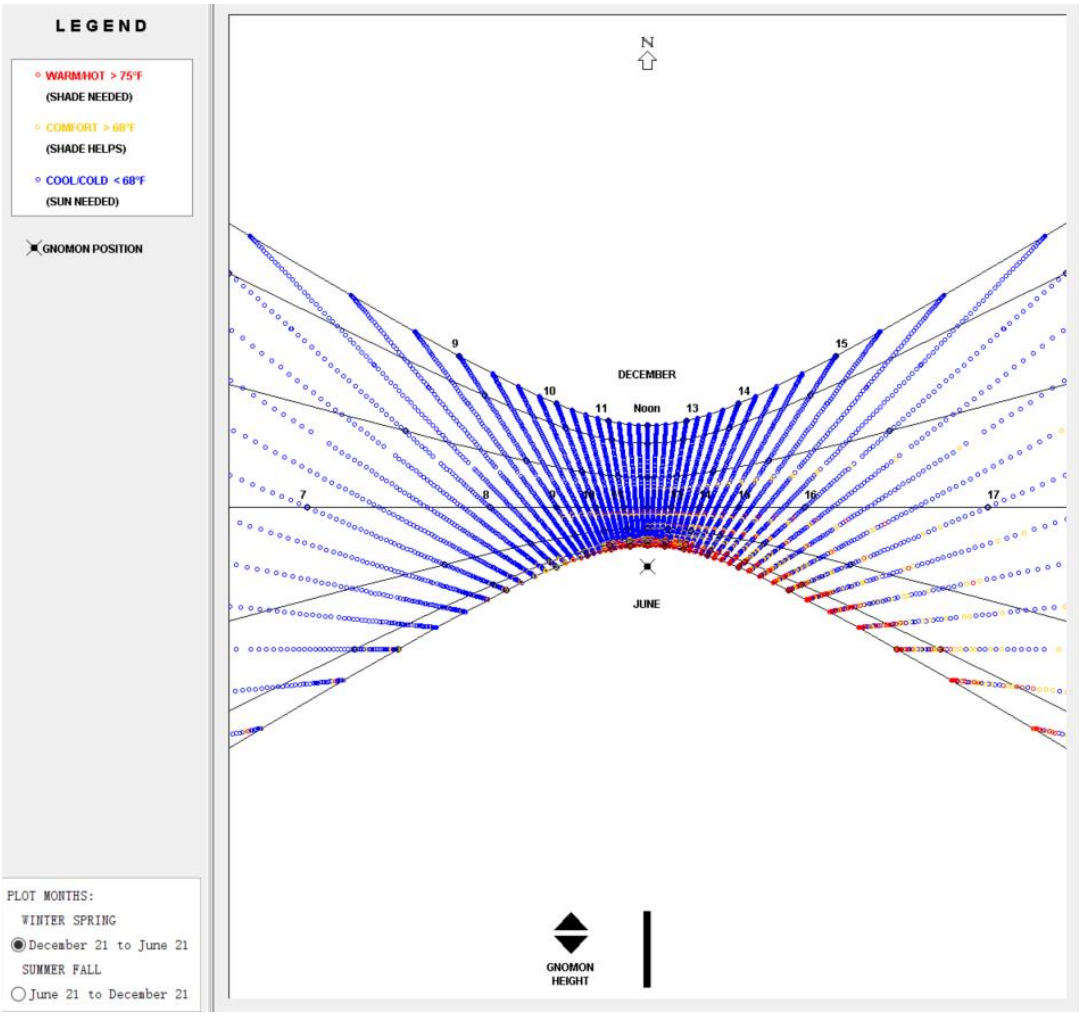


The dew point is always below the comfort zone during the year.

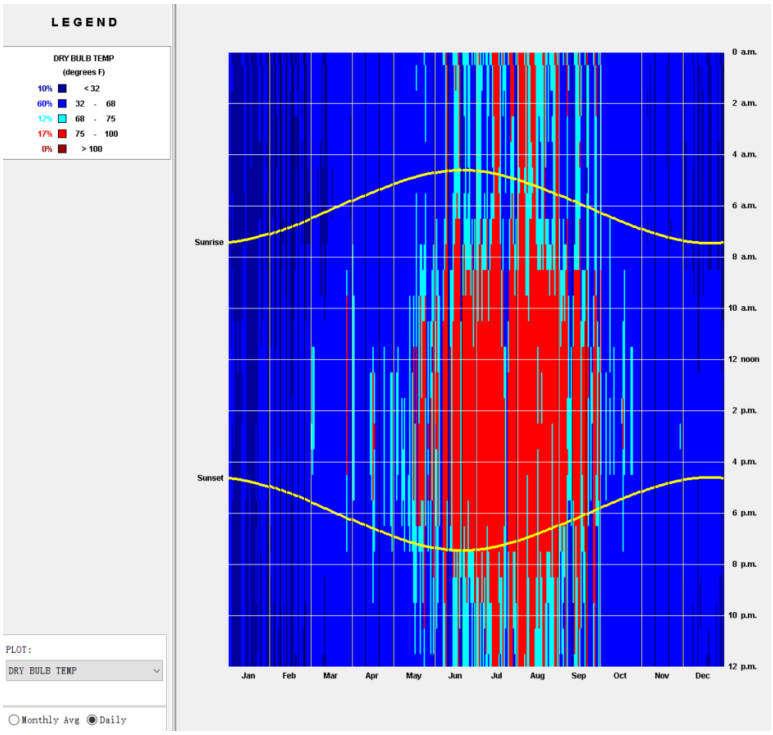
3.10 Sun Shading Chart



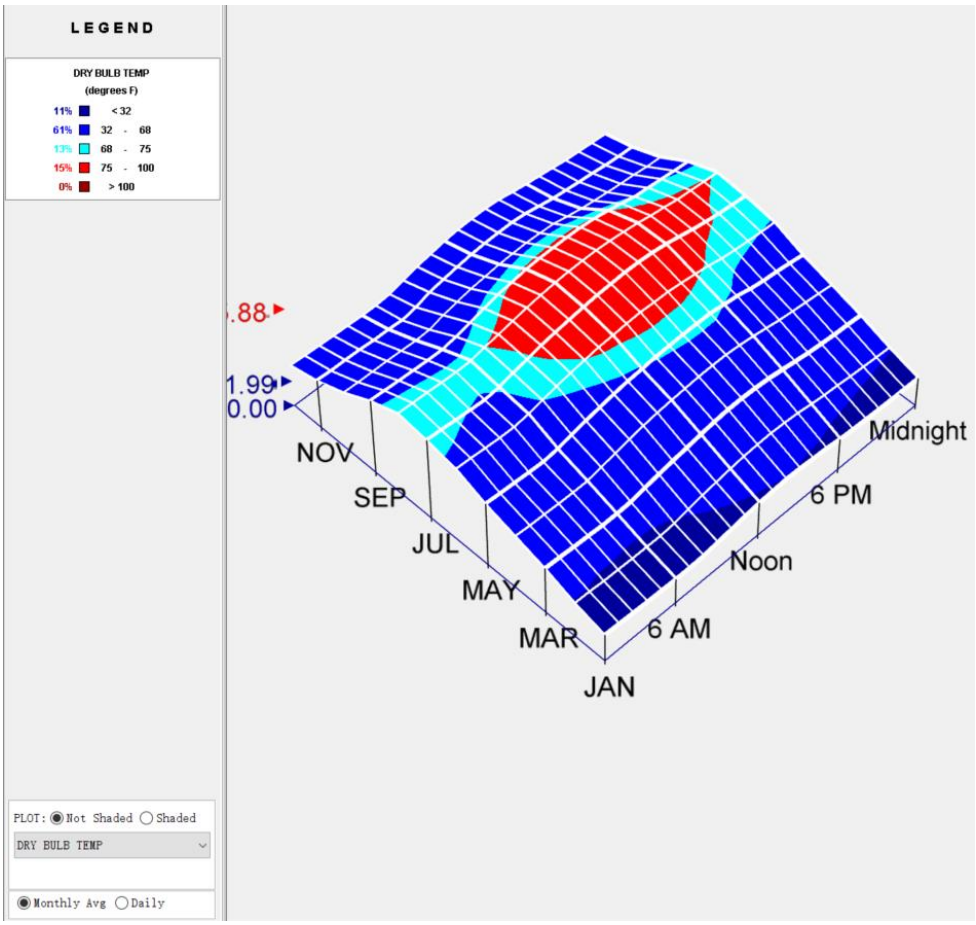
3.11 Sun Chart



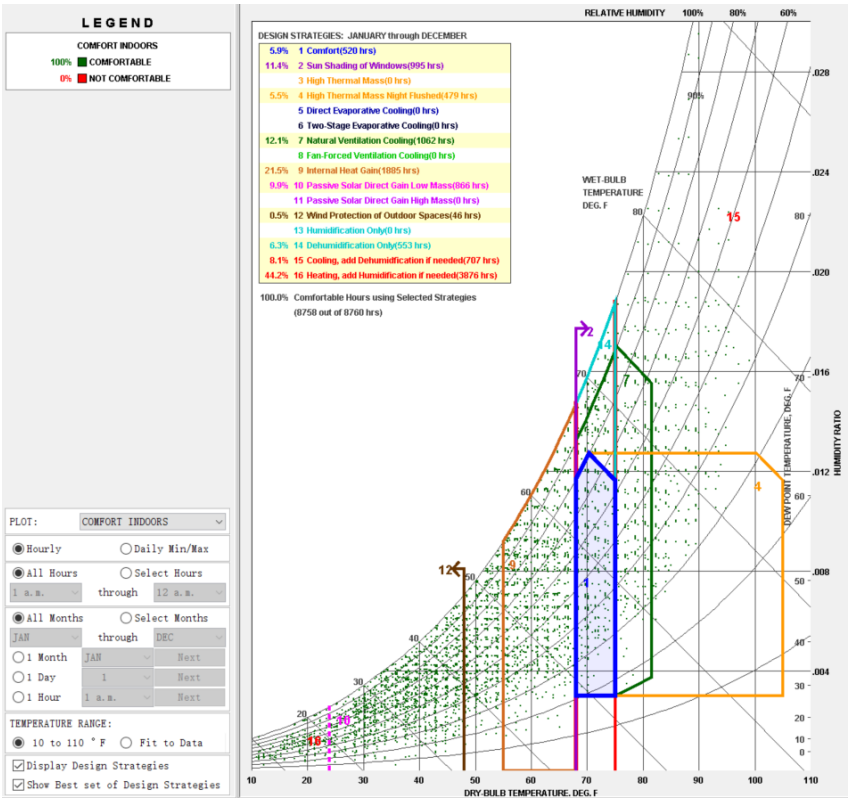
3.12 Time Table Plot



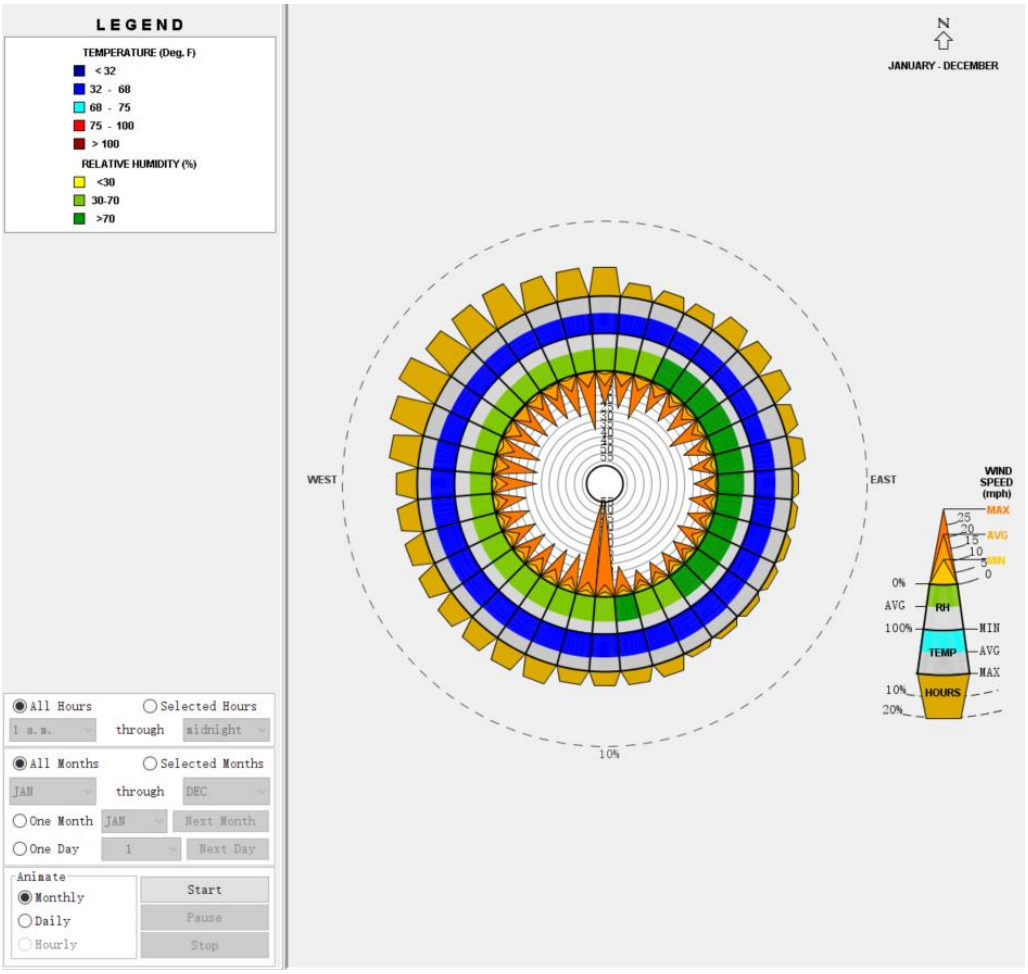
3.13 3D Charts



3.14 Psychrometric Chart



3.15 Wind Wheel



4. Passive Design Strategies

a. Due to the relatively lower radiation and daylight in winter, most of the glass area should be facing south to maximize winter sun exposure. Low-E glass should be installed on west, north and east while clear glass on south. Due to the sun shading chart and radiation chart, overhangs should be designed on to shade in summer.

b. Insulation should be installed to prove cost efficiency and increase inside occupant comfort. Temperature in Philadelphia varies greatly between day and night, super insulation can keep the indoor temperature more uniform.

c. Garages and storage areas can be located on the side of the building facing cold wind in winter to add insulation.