ARCH633 Environmental Systems I

Assignment 1:
Philadelphia Weather Report

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Basic Information

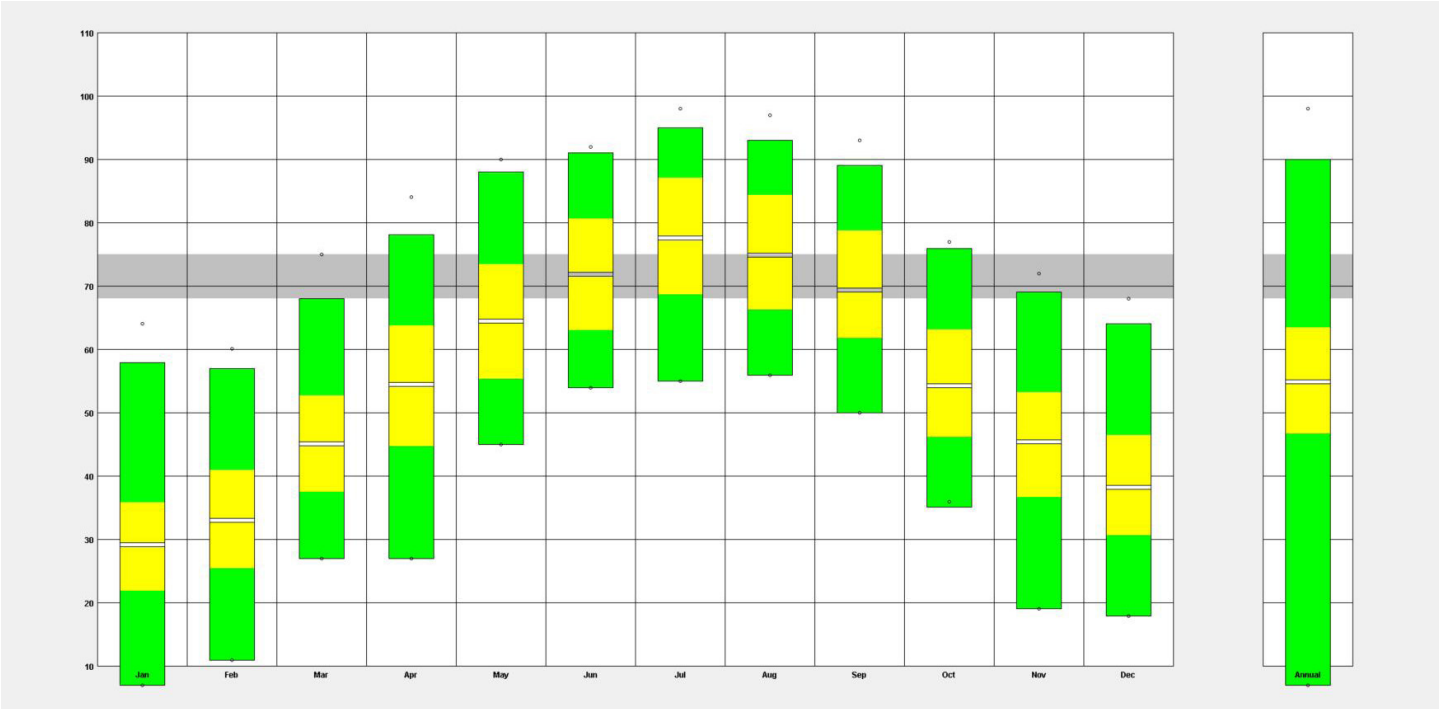
Location: Philadelphia International Airport, PA, USA
Latitude / Longitude: 39.87° North, 75.23° West
Time Zone from Greenwich: -5
Data Source: TMY3
Station Number: 724080 WMO
Elevation: 6 ft
Comfort Model: California Energy Comfort Model, 2013

Weather Data Summary

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	67	82	102	115	126	134	124	131	112	95	72	60	Btu/sq.ft
Direct Normal Radiation (Avg Hourly)	103	105	105	104	98	102	88	109	107	112	93	94	Btu/sq.ft
Diffuse Radiation (Avg Hourly)	29	33	43	48	57	59	62	57	46	40	34	28	Btu/sq.ft
Global Horiz Radiation (Max Hourly)	160	225	272	292	302	310	294	288	267	228	172	145	Btu/sq.ft
Direct Normal Radiation (Max Hourly)	294	294	286	302	268	279	267	292	271	296	292	290	Btu/sq.ft
Diffuse Radiation (Max Hourly)	86	114	128	146	143	156	151	143	152	106	90	76	Btu/sq.ft
Global Horiz Radiation (Avg Daily Total)	639	865	1210	1515	1792	1981	1811	1783	1383	1036	705	559	Btu/sq.ft
Direct Normal Radiation (Avg Daily Total)	978	1106	1243	1370	1390	1518	1276	1484	1321	1219	915	866	Btu/sq.ft
Diffuse Radiation (Avg Daily Total)	286	343	514	632	825	879	903	775	566	438	340	264	Btu/sq.ft
Global Horiz Illumination (Avg Hourly)	2106	2591	3220	3653	3983	4241	3962	4143	3541	2968	2237	1894	footcandles
Direct Normal Illumination (Avg Hourly)	2725	2917	2970	3008	2848	3001	2583	3207	3099	3130	2519	2438	footcandles
Dry Bulb Temperature (Avg Monthly)	29	32	45	54	64	71	77	74	69	54	45	38	degrees F
Dew Point Temperature (Avg Monthly)	19	20	31	37	50	60	65	63	58	42	36	24	degrees F
Relative Humidity (Avg Monthly)	68	59	60	56	64	70	69	70	71	67	72	60	percent
Wind Direction (Monthly Mode)	310	300	300	310	70	240	240	230	0	240	280	300	degrees
Wind Speed (Avg Monthly)	11	8	10	10	8	7	7	9	8	8	10	10	mph
Ground Temperature (Avg Monthly of 3 Depths)	41	38	39	42	52	60	67	70	69	64	56	48	degrees F

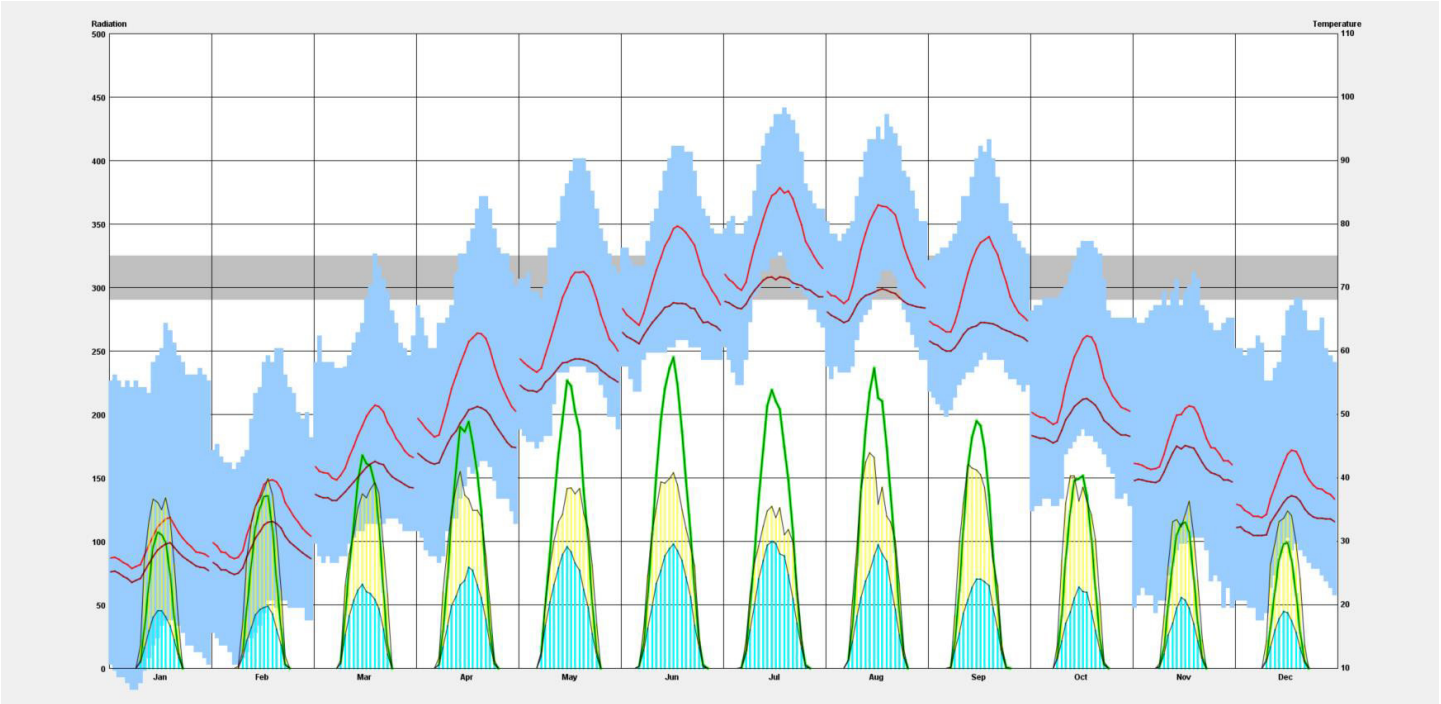
Tools: Climate Consultant 6.0
Data Source: https://energyplus.net/weather-location/north_and_central_america_wmo_region_4/USA/PA/USA_PA_Philadelphia.Intl.AP.724080_TMY3

Chart 1: Temperature Range



Legend

Chart 2: Monthly Diurnal Averages



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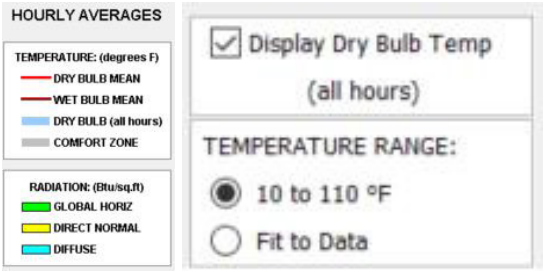
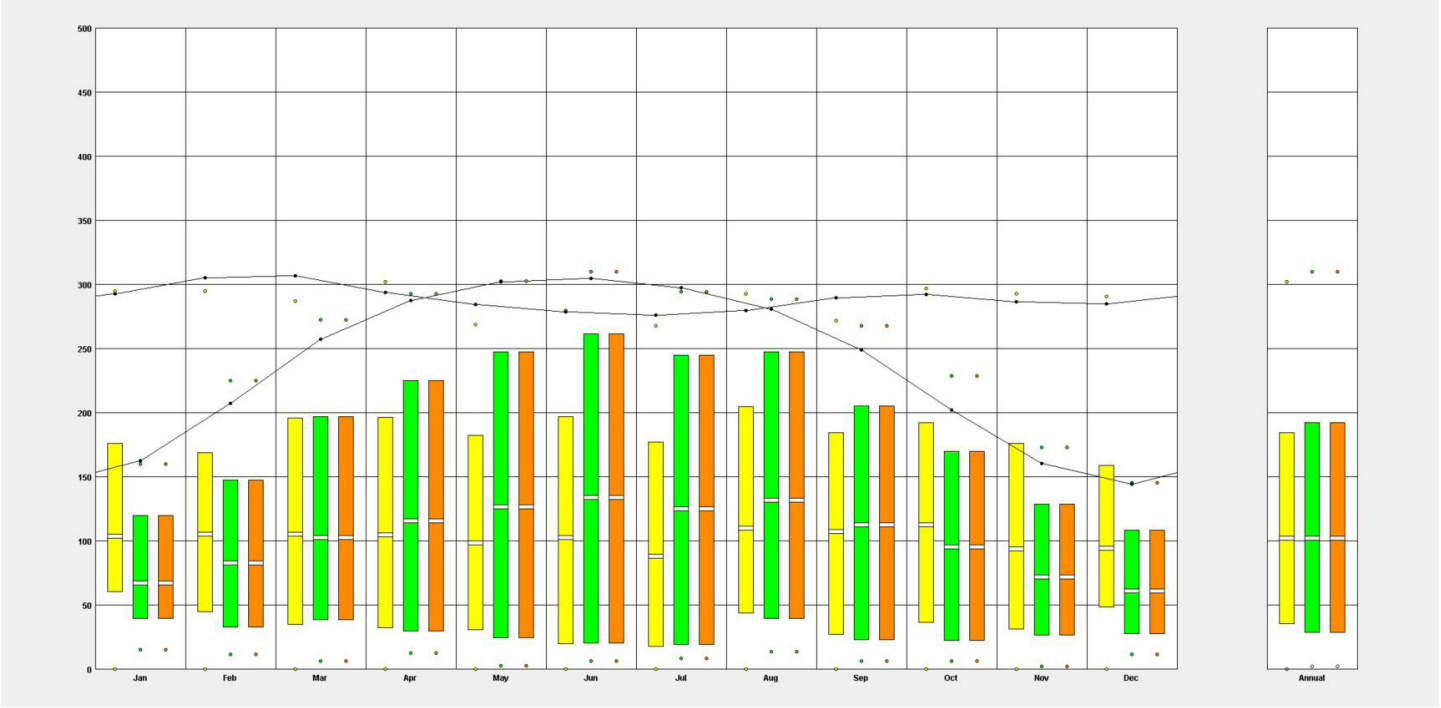


Chart 3: Radiation Range



Legend

HOURLY AVERAGES
DAYLIT HOURS ONLY

RECORDED HIGH -
AVERAGE HIGH -
MEAN -
AVERAGE LOW -
RECORDED LOW -

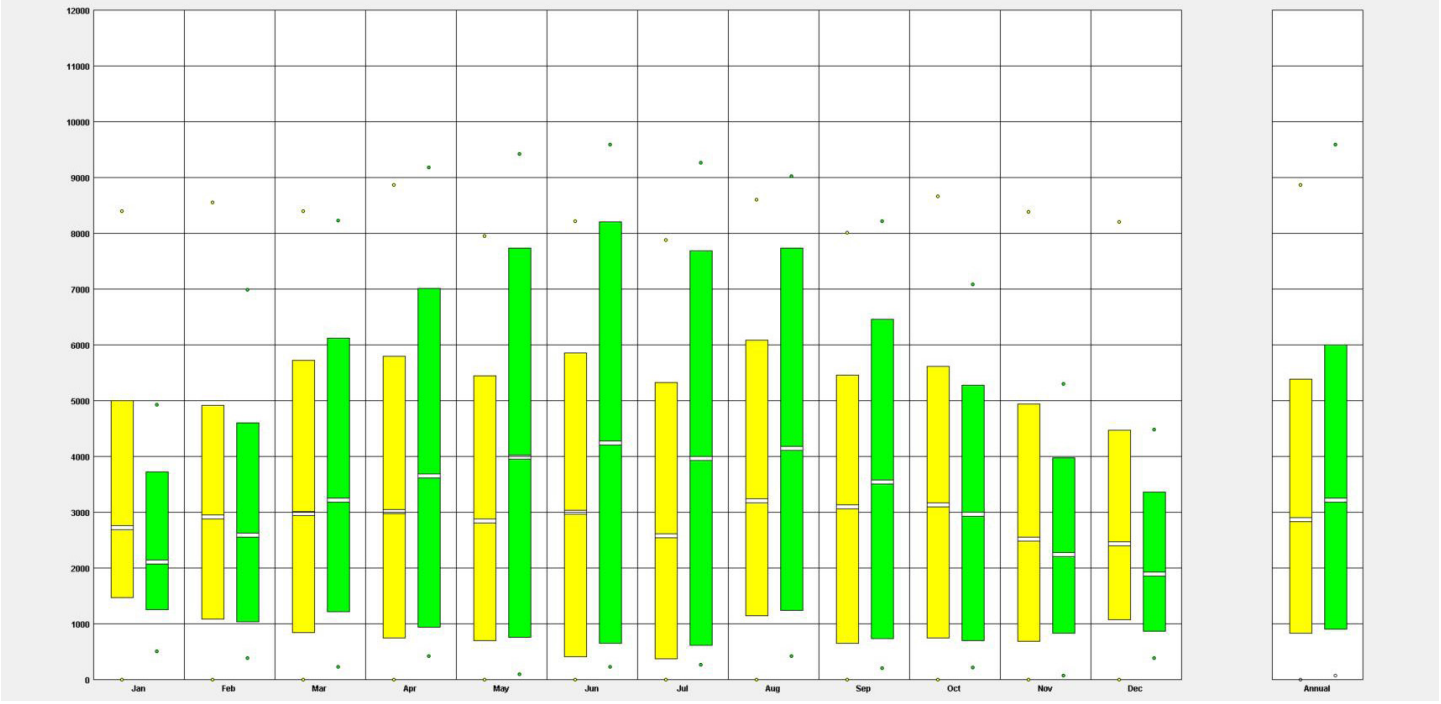
RECORDED:
DIRECT NORMAL
GLOBAL HORIZONTAL
TOTAL SURFACE
(Btu/sq.ft per hour)
THEORETICAL:

Tilted Surface Radiation Input:

0.0 Tilt degrees from ...
(Vertical = 90°)
0.0 Bearing degrees fr...
(South = 0°,West ...
20.0 % Ground Reflecta...
(20% = grass)

PLOT:
Hourly Avg Daily Total

Chart 4: Illumination Range



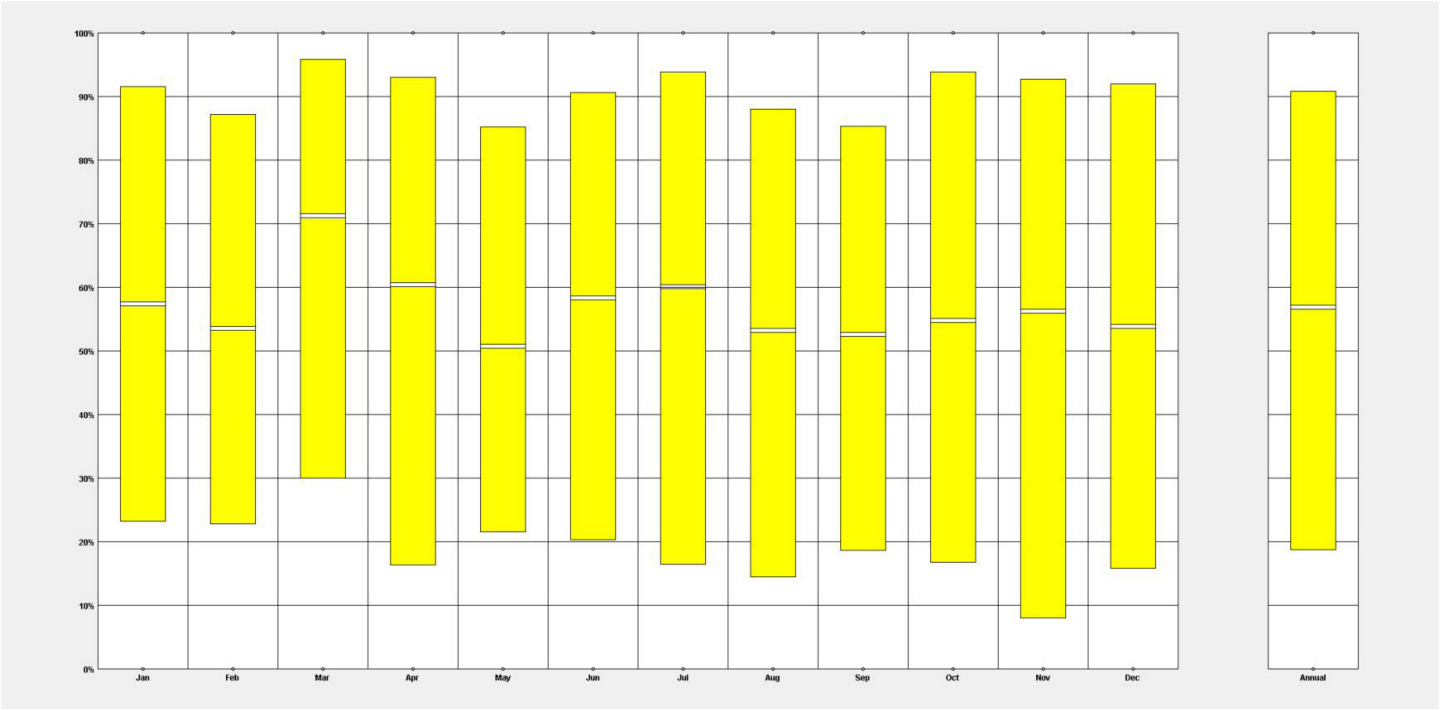
Legend

HOURLY ILLUMINATION
DAYLIT HOURS ONLY

RECORDED HIGH -
AVERAGE HIGH -
MEAN -
AVERAGE LOW -
RECORDED LOW -

RECORDED:
DIRECT NORMAL
GLOBAL HORIZONTAL
(footcandles)

Chart 5: Sky Cover Range



Legend

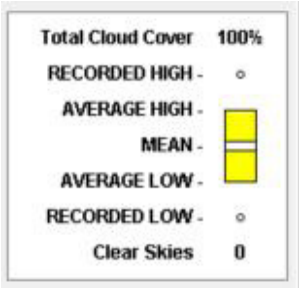
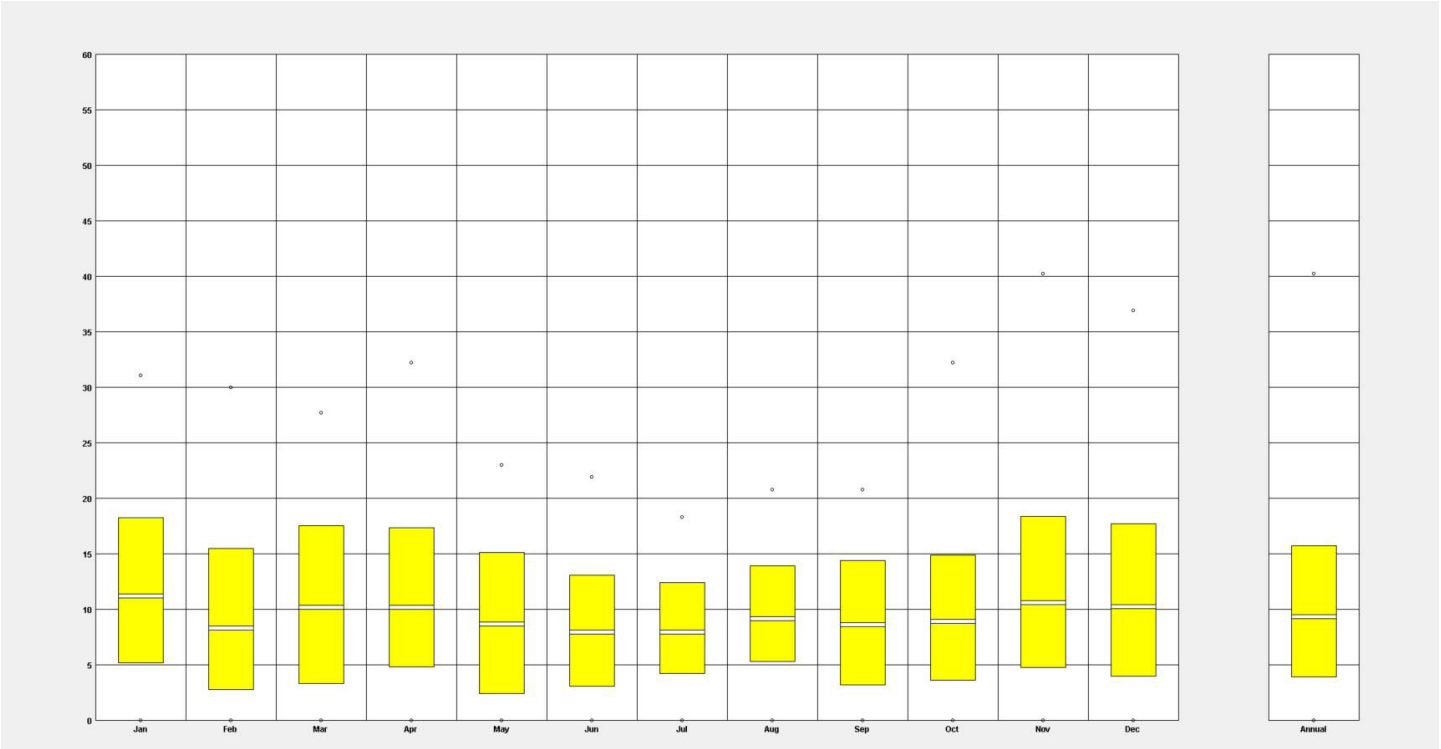


Chart 6: Wind Velocity Range



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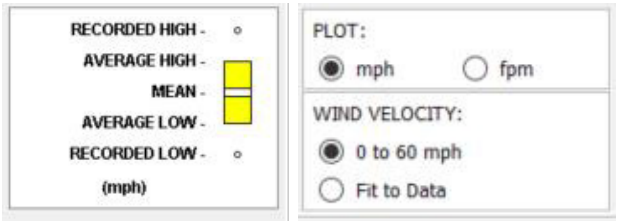
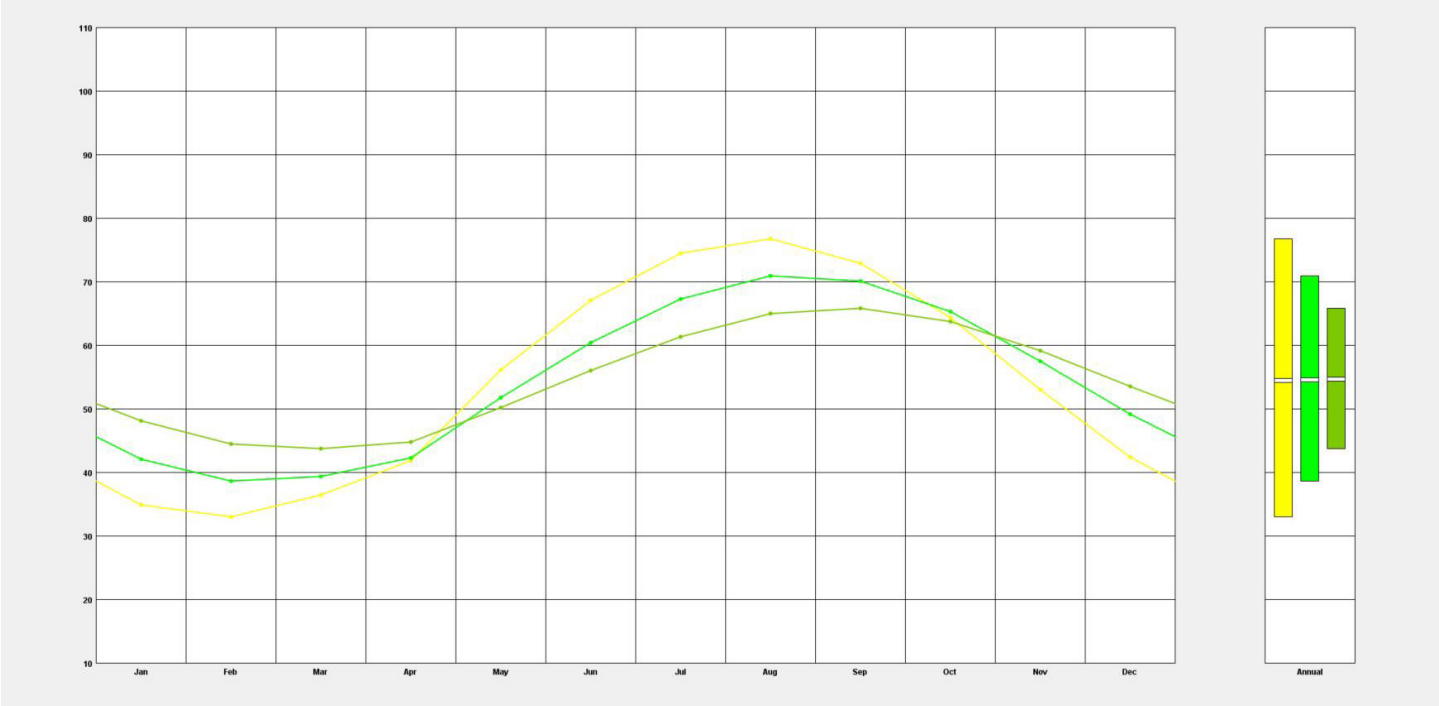


Chart 7: Ground Temperature (Monthly Average)



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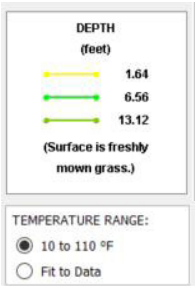
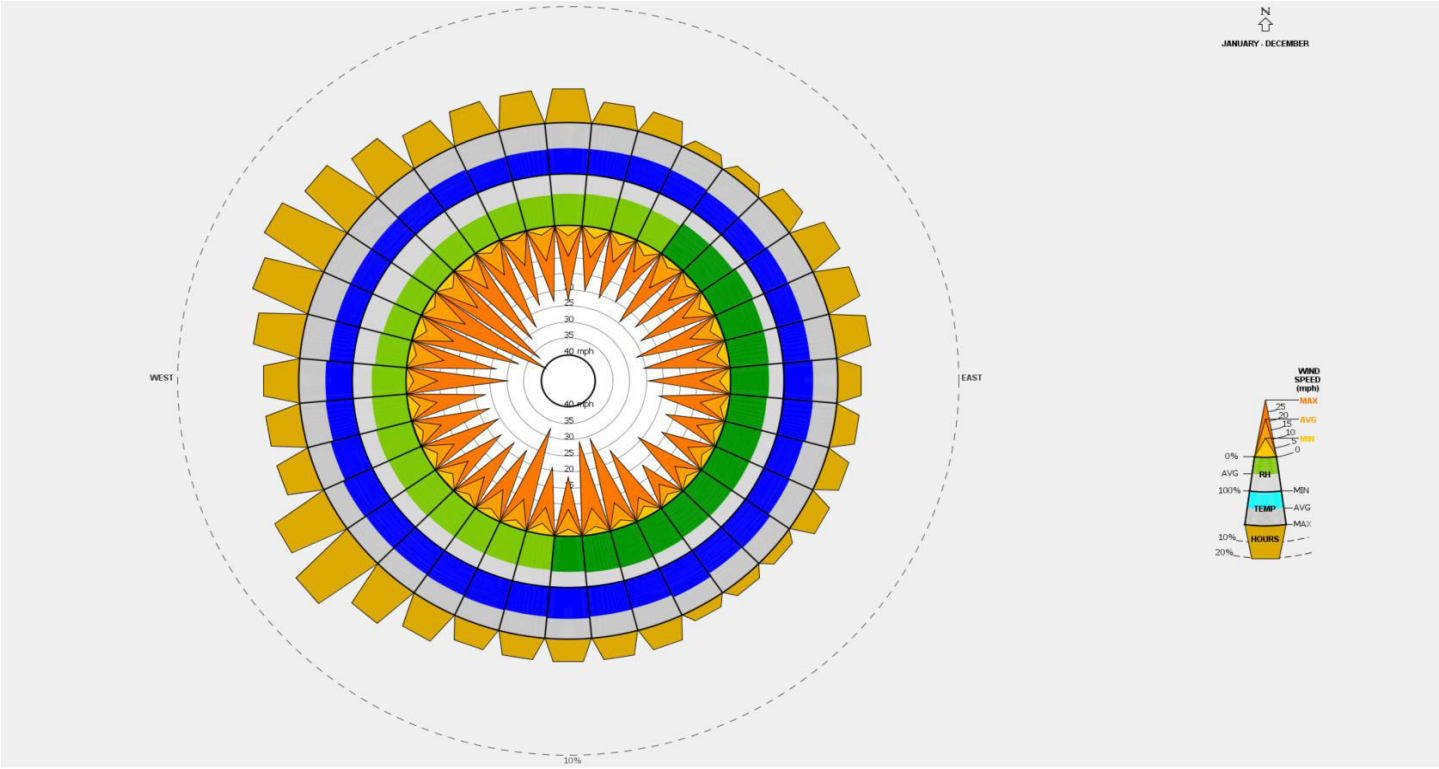


Chart 8: Wind Wheel



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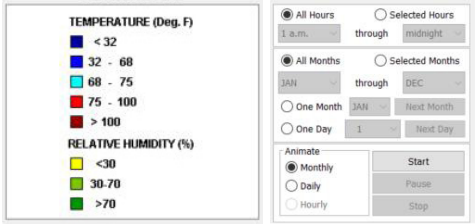
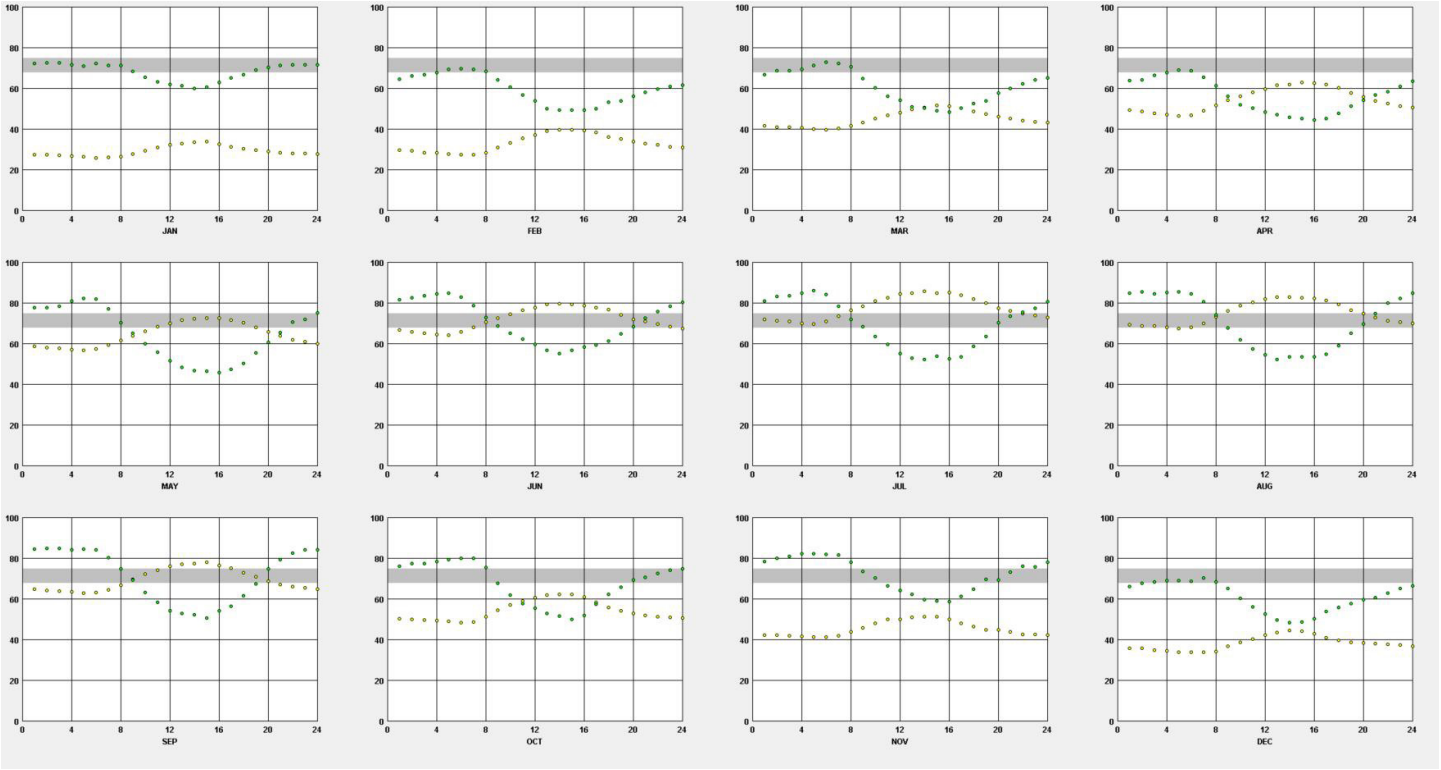
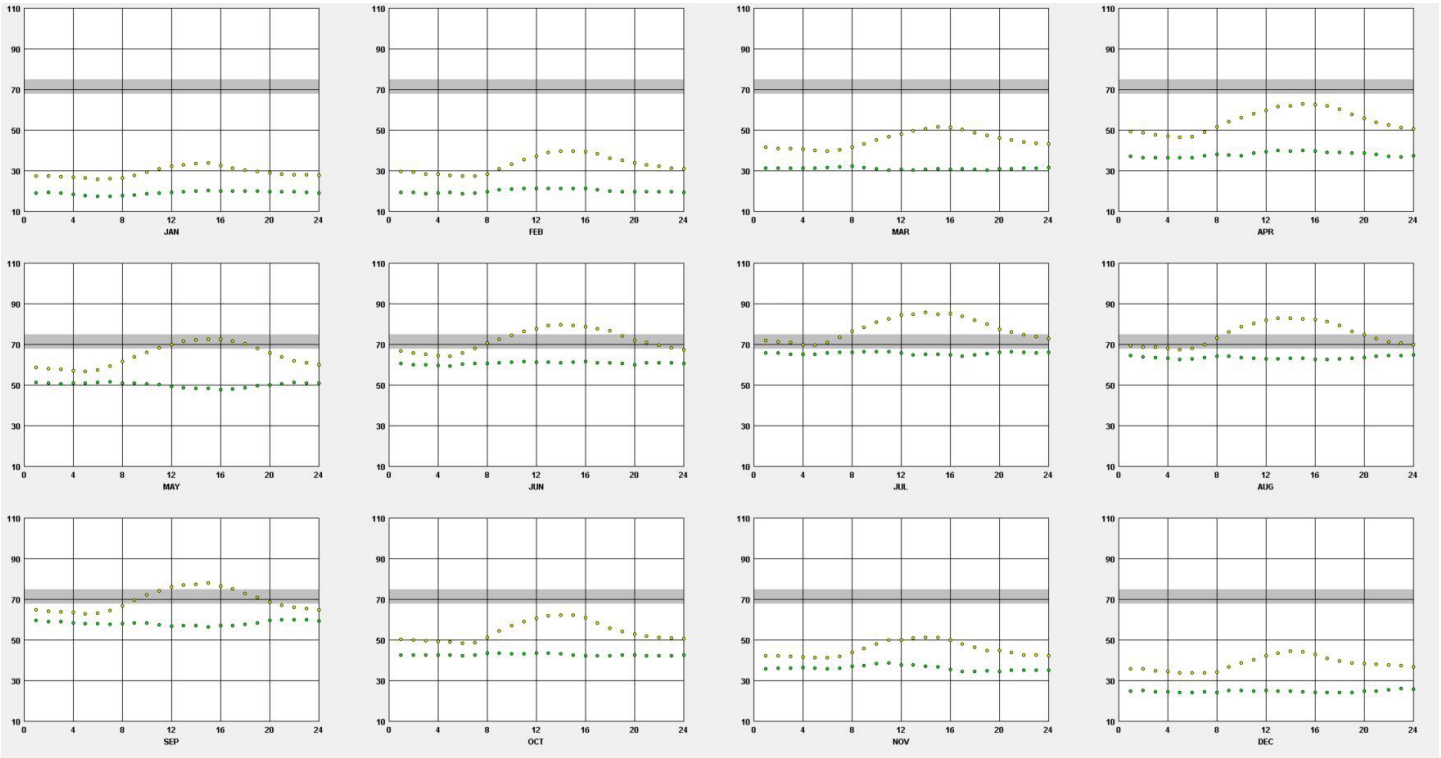


Chart 9: Dry Bulb X Relative Humidity



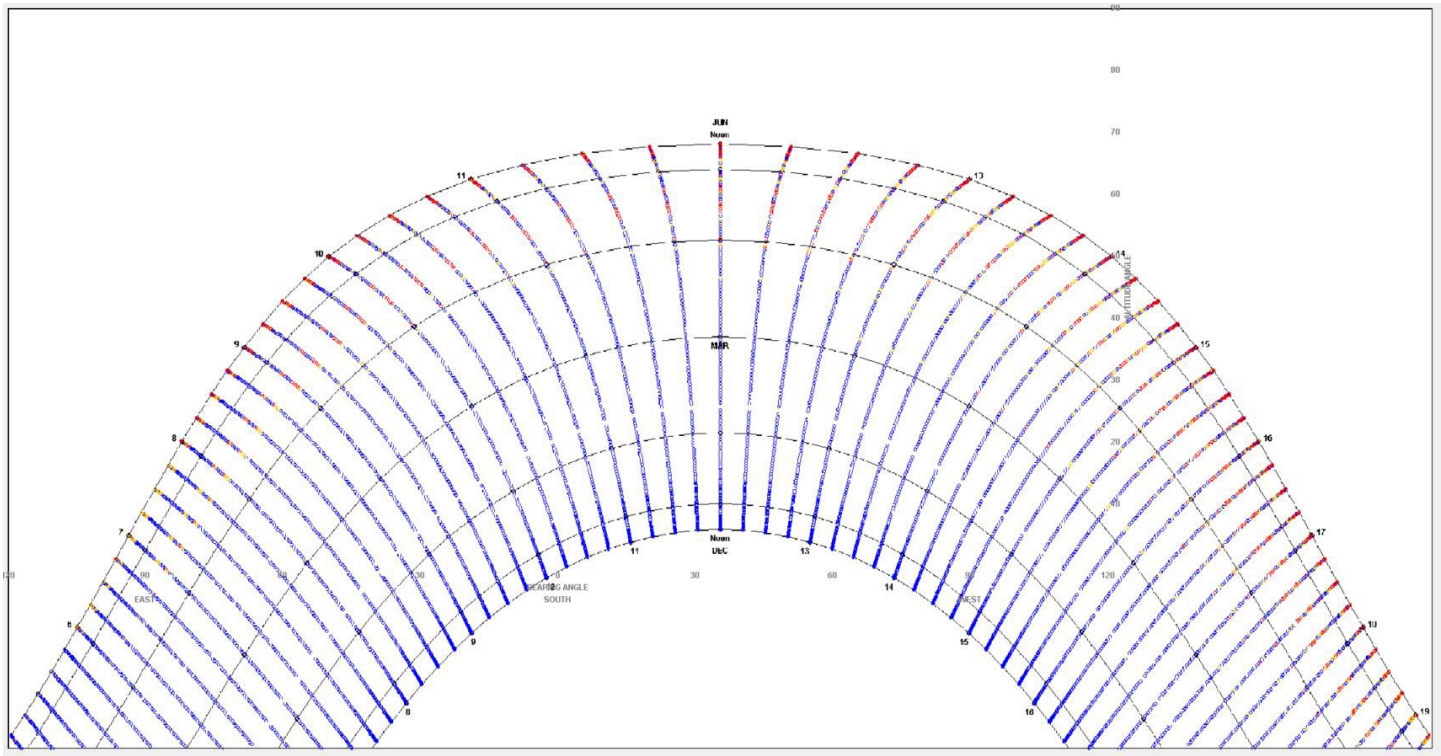
Legend

Chart 10: Dry Bulb X Dew Point



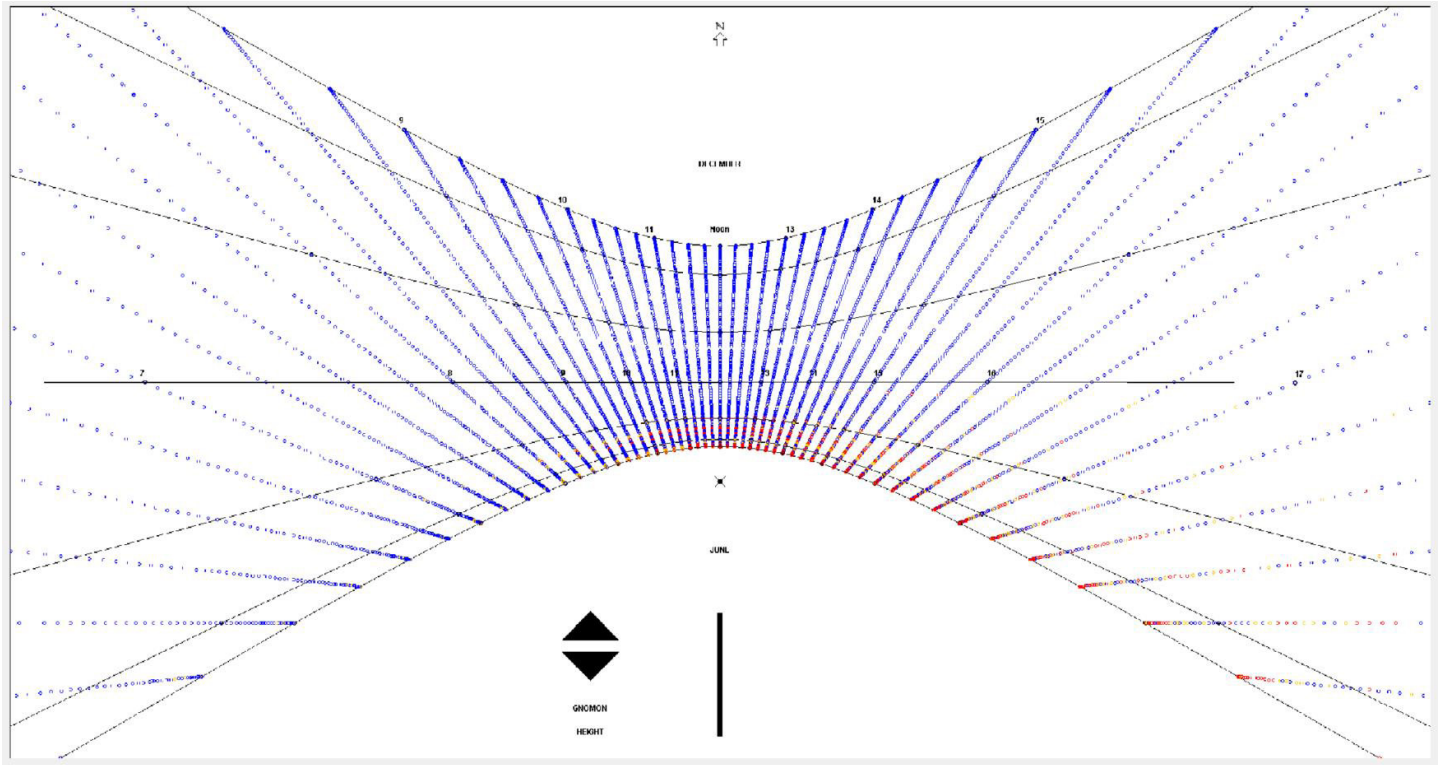
Legend

Chart 11: Sun Shading Chart



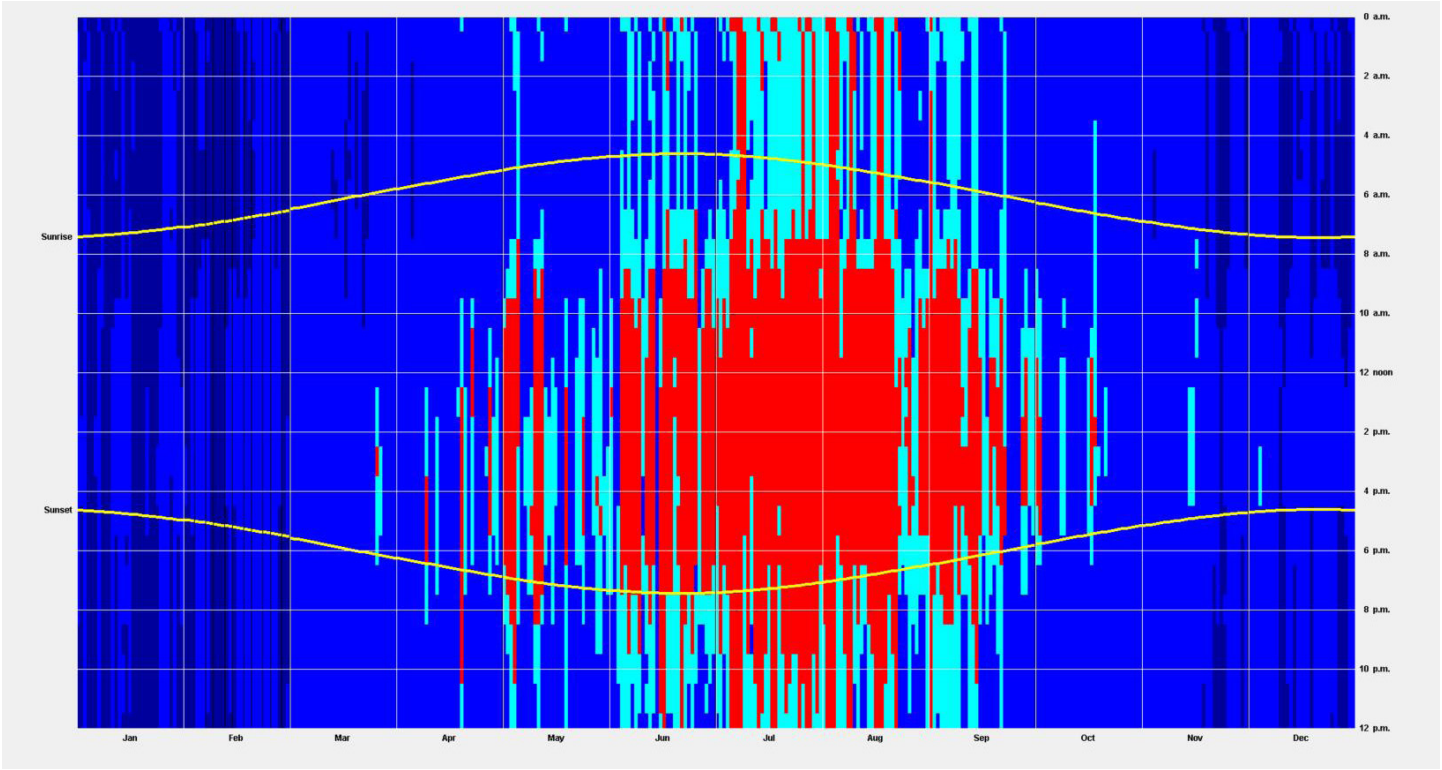
Legend

Chart 12: Sun Chart



Legend

Chart 13: Timetable Plot



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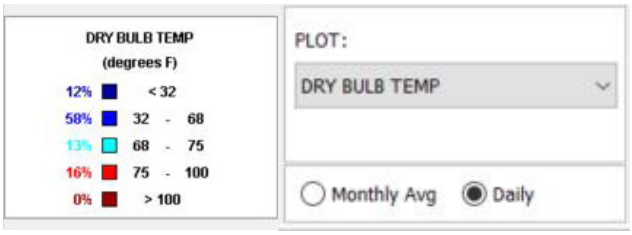
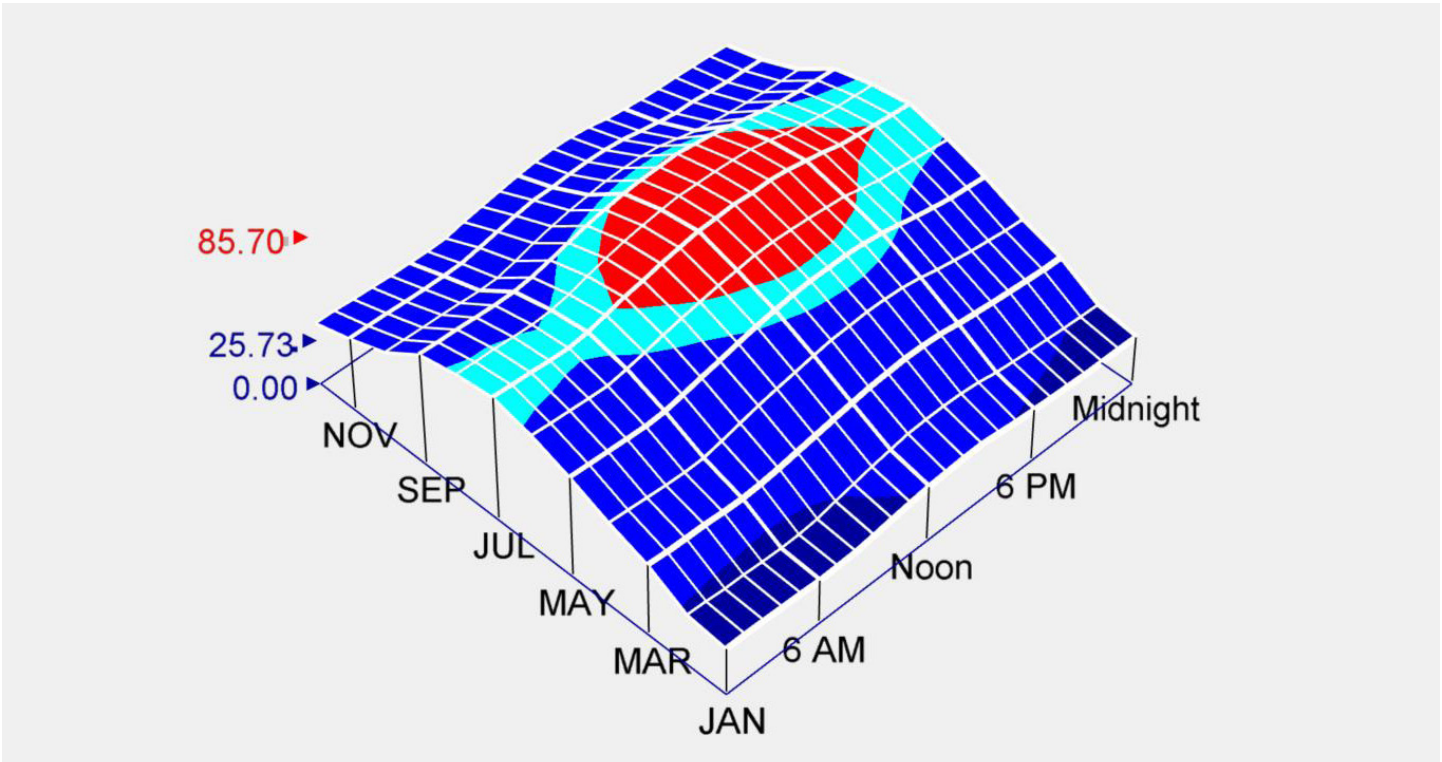


Chart 14: Sun Chart



Legend

3 Most Important Passive Design Strategies

1. The first strategy is to maximize the use of natural ventilation. Although the wind speeds in Philadelphia are not so high according to Chart 6 and Chart 8 Wind Wheel, the passive natural ventilation strategies can introduce outdoor fresh air into the interior space. At the same time, wind and buoyancy caused by air temperature differences create air pressure differences throughout occupied spaces. Therefore, buildings in Philly can be designed to enhance these air flow and take advantage of them rather than work against them. The methods to achieve natural ventilation includes operable windows, orientation, building shape, openings to corridors, double facades and so on.

2. The second strategy is passive heating. From Chart 1, 2 & 7, we can see that the temperature of Philadelphia in winter is pretty low and lowest temperature is under 0°C. Therefore, the design strategy of passive heating to harness solar radiation and capture the internal heat gains could add additional thermal energy to the building. Buildings in Philly could combines a well-insulated envelop with other elements, in order to minimize energy losses and store solar gains. To use high-performance windows, operable external shading, thermal mass, good insulation or minimize infiltration are all helpful.

3. The third passive design strategy is about daylighting. According to Chart 4 Illumination Range and Chart 11 Sun Shading, how to keep the balance between making use of natural sunlight and overheating the building is worth to consider into the design. Overall, daylighting could maximize the use and distribution of diffused daylight throughout a building's interior to reduce the need for artificial electric lighting. The window size, placement, lighting shelves or skylight may be necessary for the design.