

ENTHALPY Measurements at UCSD and Application to Building Ventilation

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What is ENTHALPY?

- Also known as “Heat Content.”
- Enthalpy (h) of moist air include:
 - **Sensible Heat:** enthalpy of the dry air.
 - **Latent Heat:** enthalpy of the evaporated water.
- Specific “h” of moist air can be expressed as:

$$h = h_a + q * h_w$$

h_a = specific enthalpy of dry air (kJ/kg)
h_w = specific enthalpy of moist air (kJ/kg)
Q = humidity ratio (kg H2O/kg Air)

Overall Equation:

$$h = 1.006 \text{ (kJ/kg.}^\circ\text{C)} * T + Q(\text{kg/kg}) [1.84 \text{ (kJ/kg.}^\circ\text{C)} * T + 2,502 \text{ (kJ/kg)}]$$

Source: Engineering Toolbox

How Can Air ENTHALPY Be Used?

- Air enthalpy can be used to improve efficiency and reduce energy usage in conventional Heating, Ventilation, and Air Conditioning (HVAC) Systems.

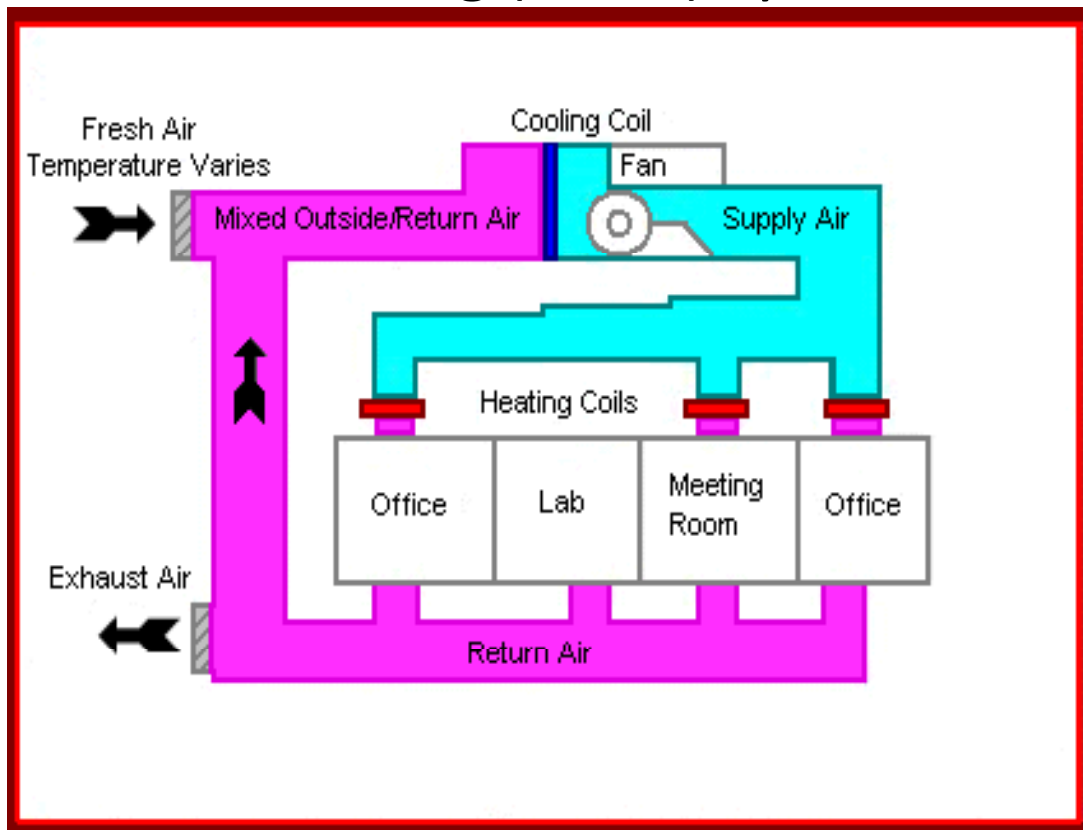


Diagram Source: University of Virginia

- New HVAC controllers are smartly designed.
 - Cooling: If outside air enthalpy is less than enthalpy of return air, outside air flow is maximized. If outside air enthalpy is greater than enthalpy of return air, outside air flow is minimized.
- ASHRAE CODE-55
 - Indoor wind speed of 0.8 m/s can offset a temperature rise of about 2.6°C (4.7°F).
 - Upper limit of comfort = 0.012 humidity ratio.

Source: ASHRAE

UCSD Room Temperature Settings

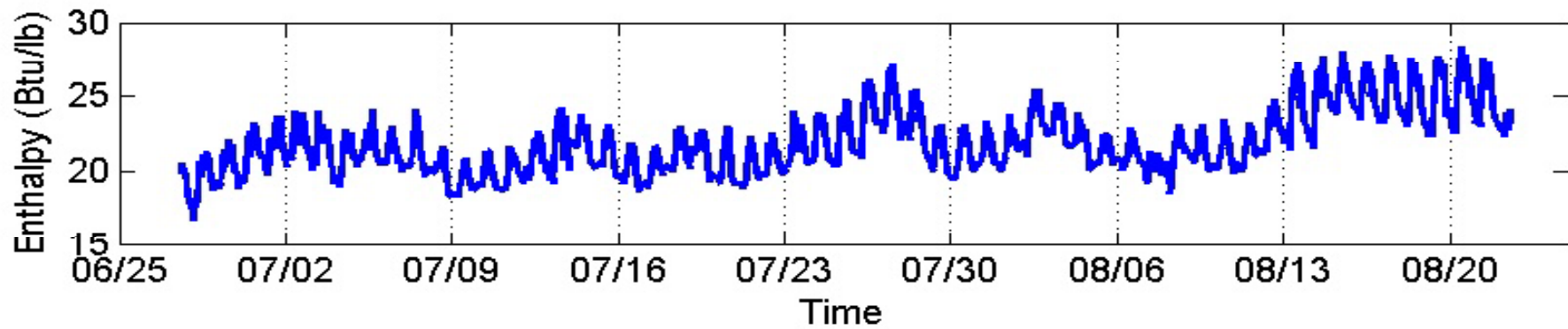
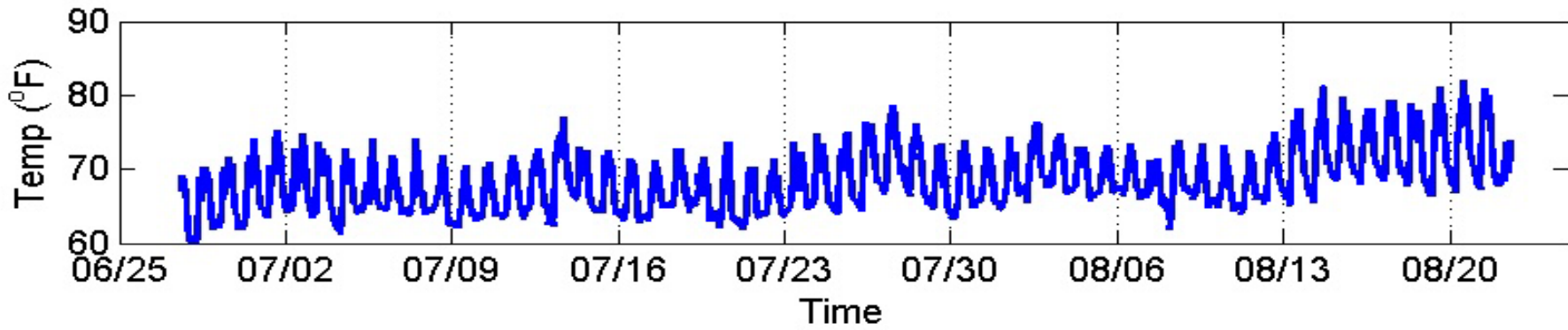
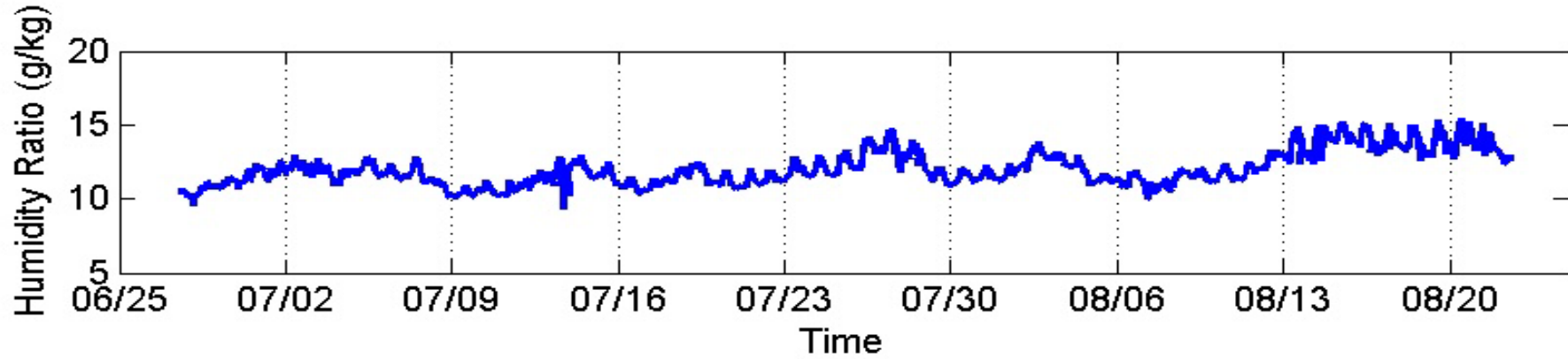
Office/Administrative Spaces

Setting	Heating Mode	Cooling Mode
Occupied 6 a.m. – 6 p.m. weekdays	Keeps temperature above 70°	Keeps temperature below 74°
	No heating or cooling occurs between 70° and 74°	
Standby 4:30–8 p.m. weekdays	Keeps temperature above 68°	Keeps temperature below 76°
	No heating or cooling occurs between 68° and 76°	
Unoccupied 8 p.m.– 6 a.m. 7 days a week	Keeps temperature above 66°	Keeps temperature below 78°
	No heating or cooling occurs between 66° and 78°	

Labs

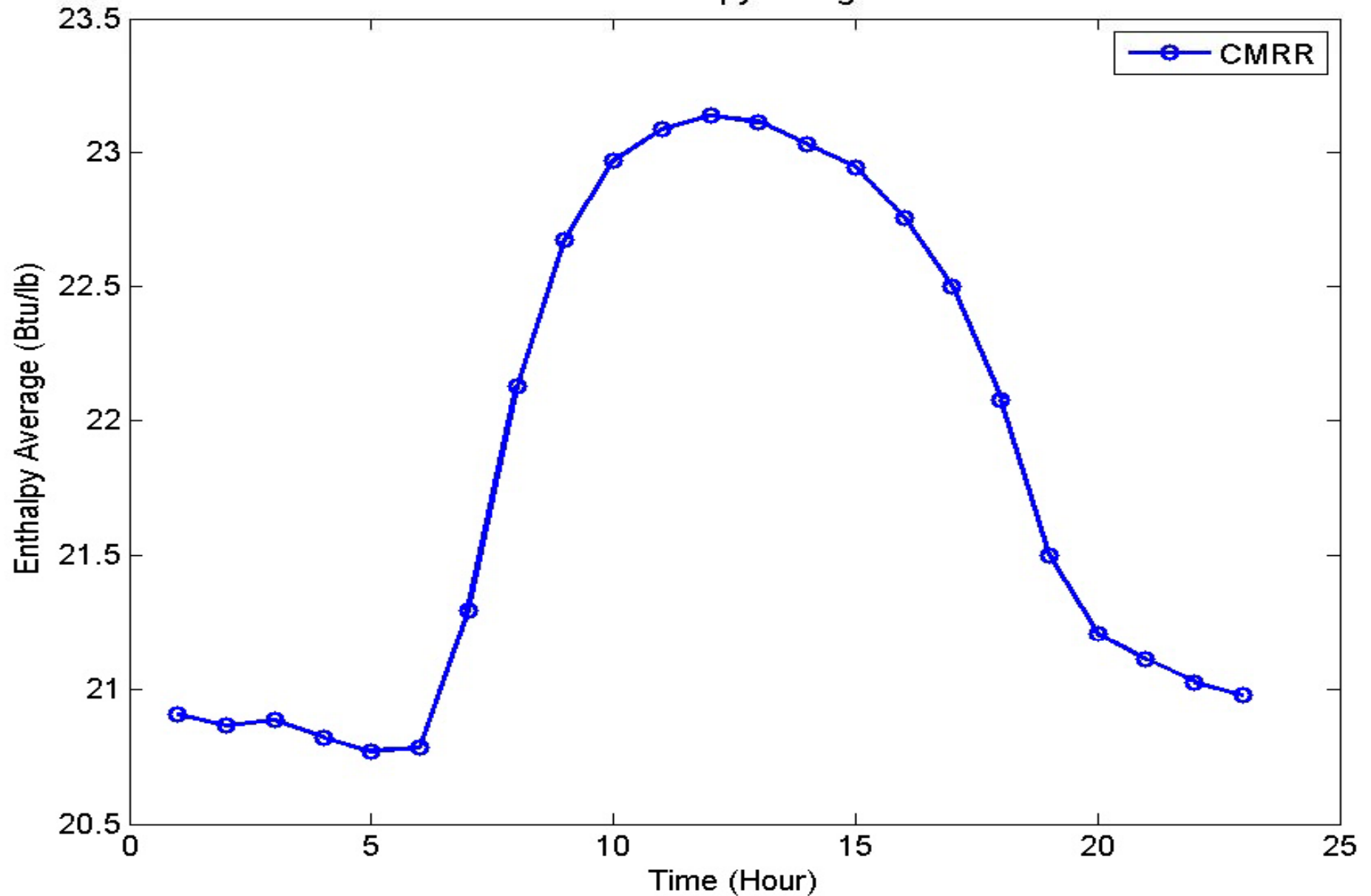
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	No heating or cooling occurs between 68° and 76°	

Timeseries Measurements at CMRR STATION

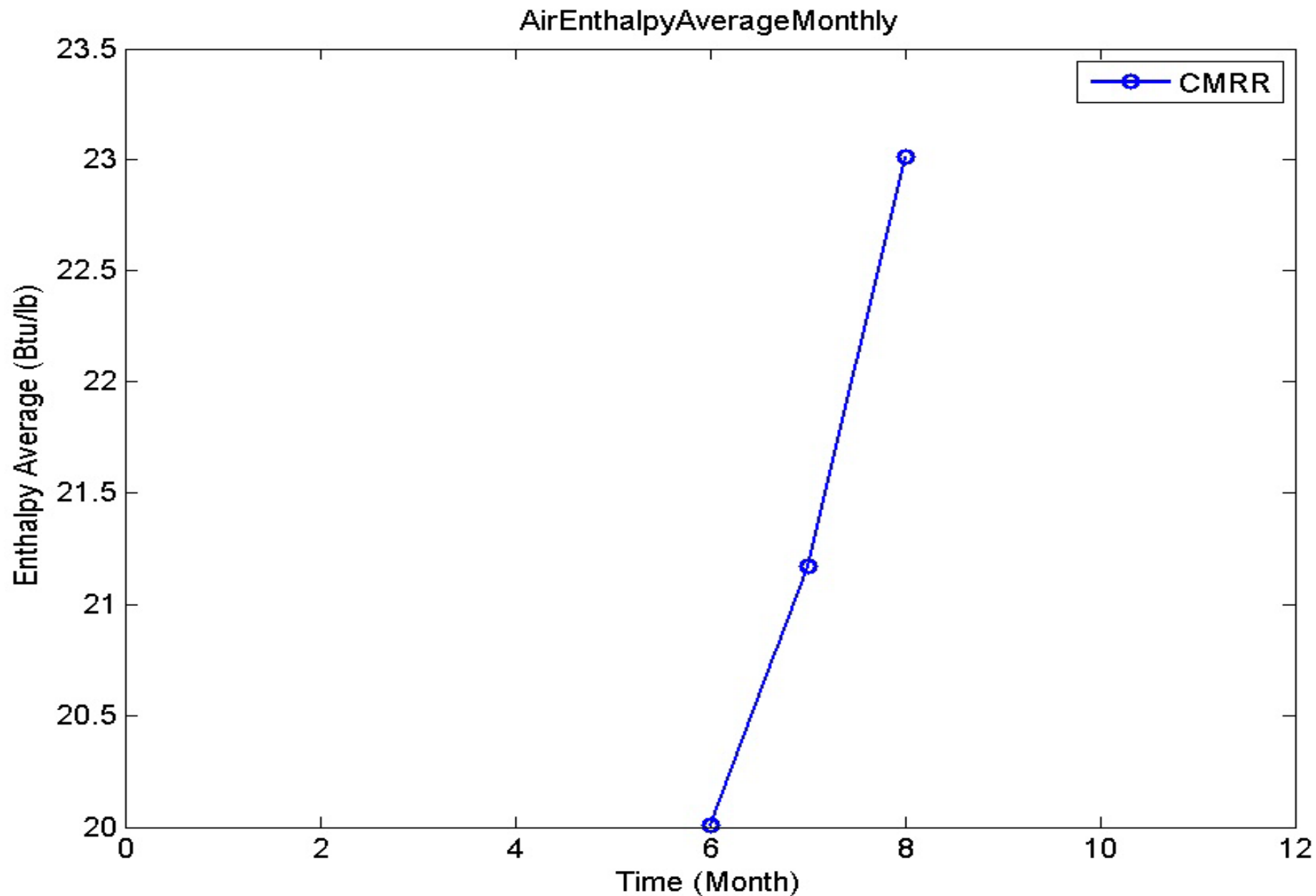


Average Diurnal Variation in Enthalpy at CMRR

AirEnthalpyAverage

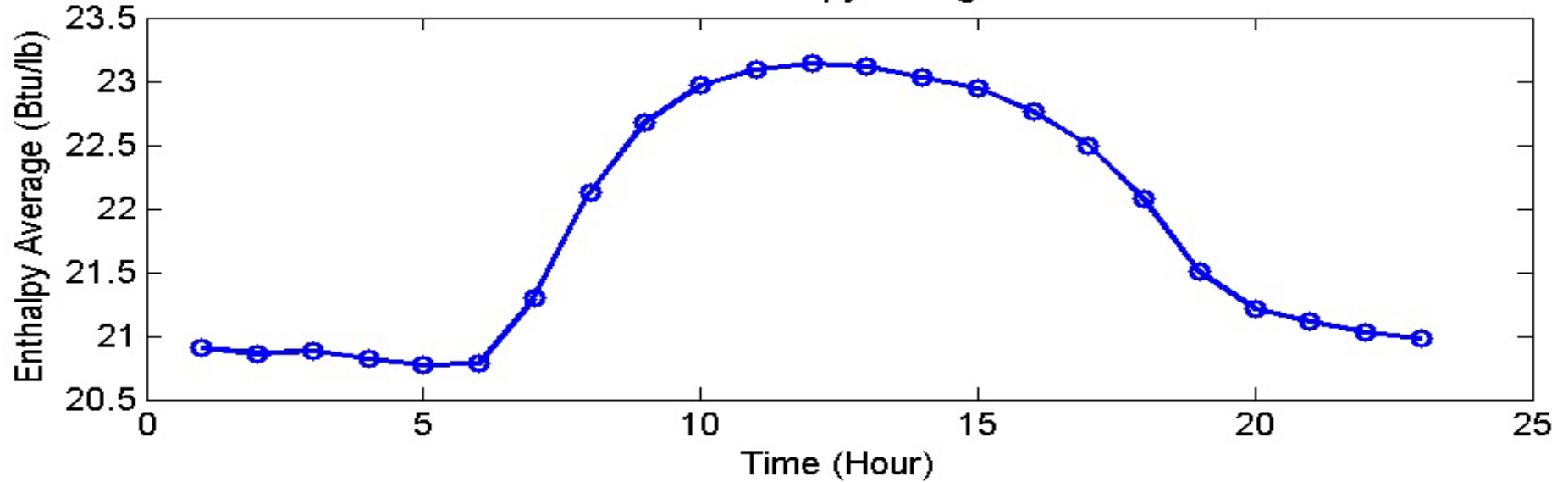


Average Monthly Variation at CMRR

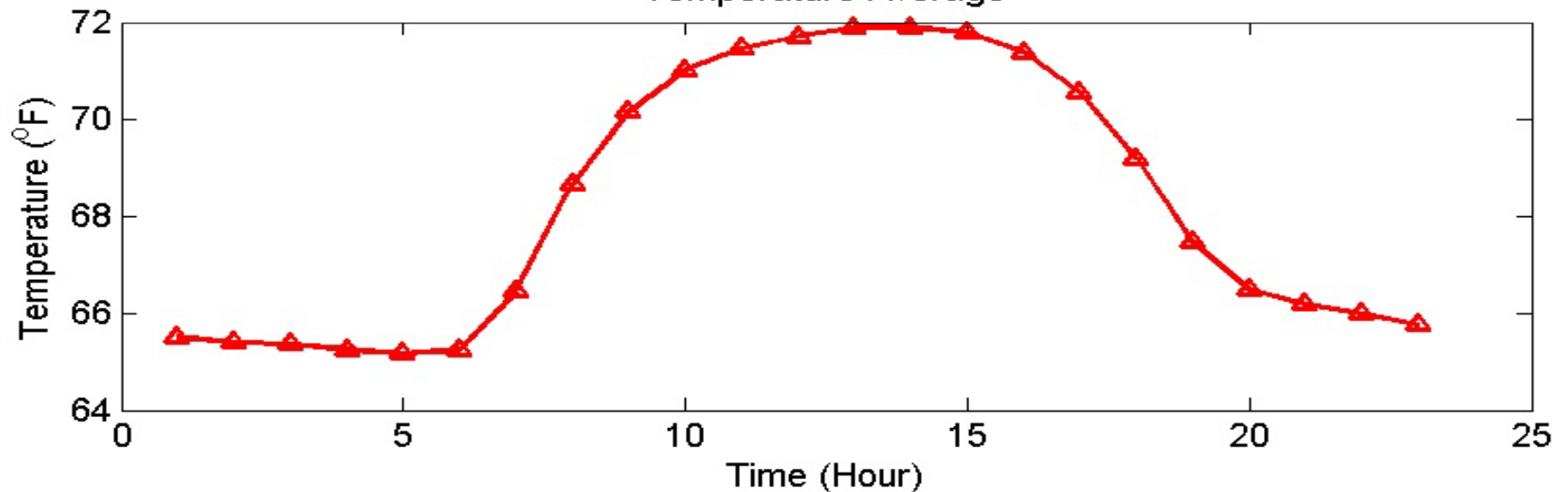


Temperature Versus Enthalpy

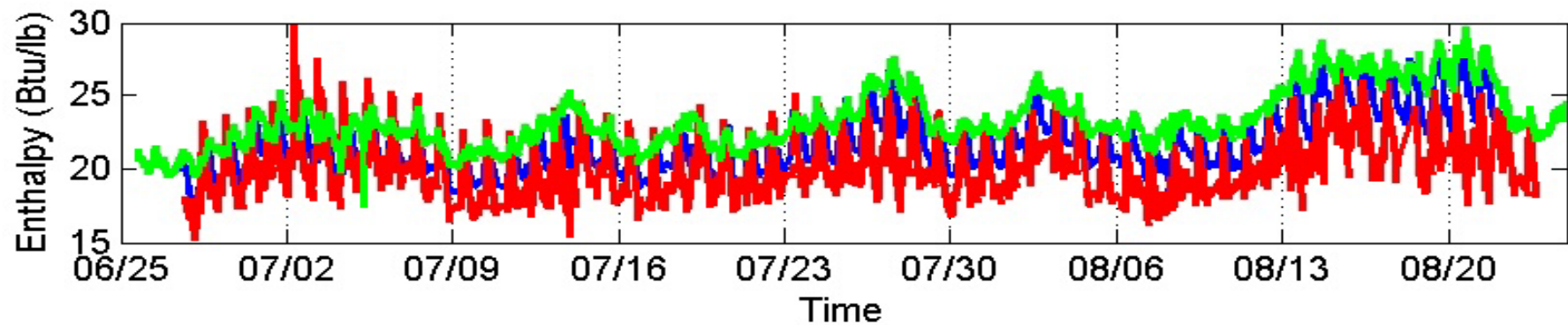
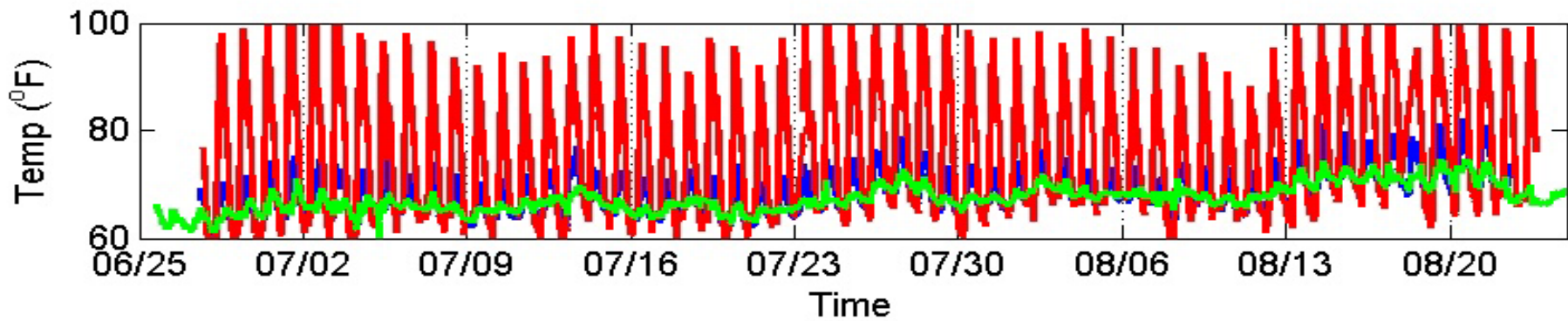
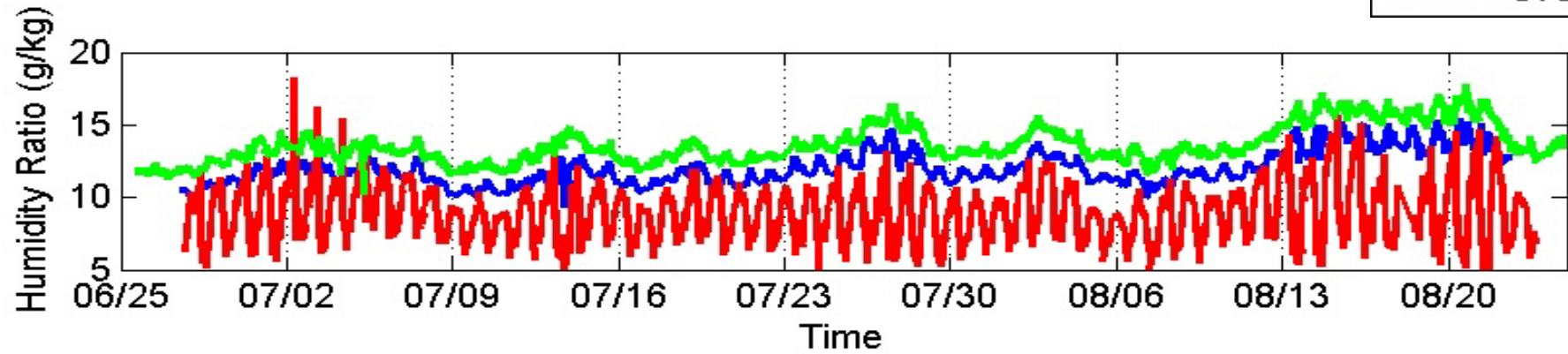
AirEnthalpyAverage



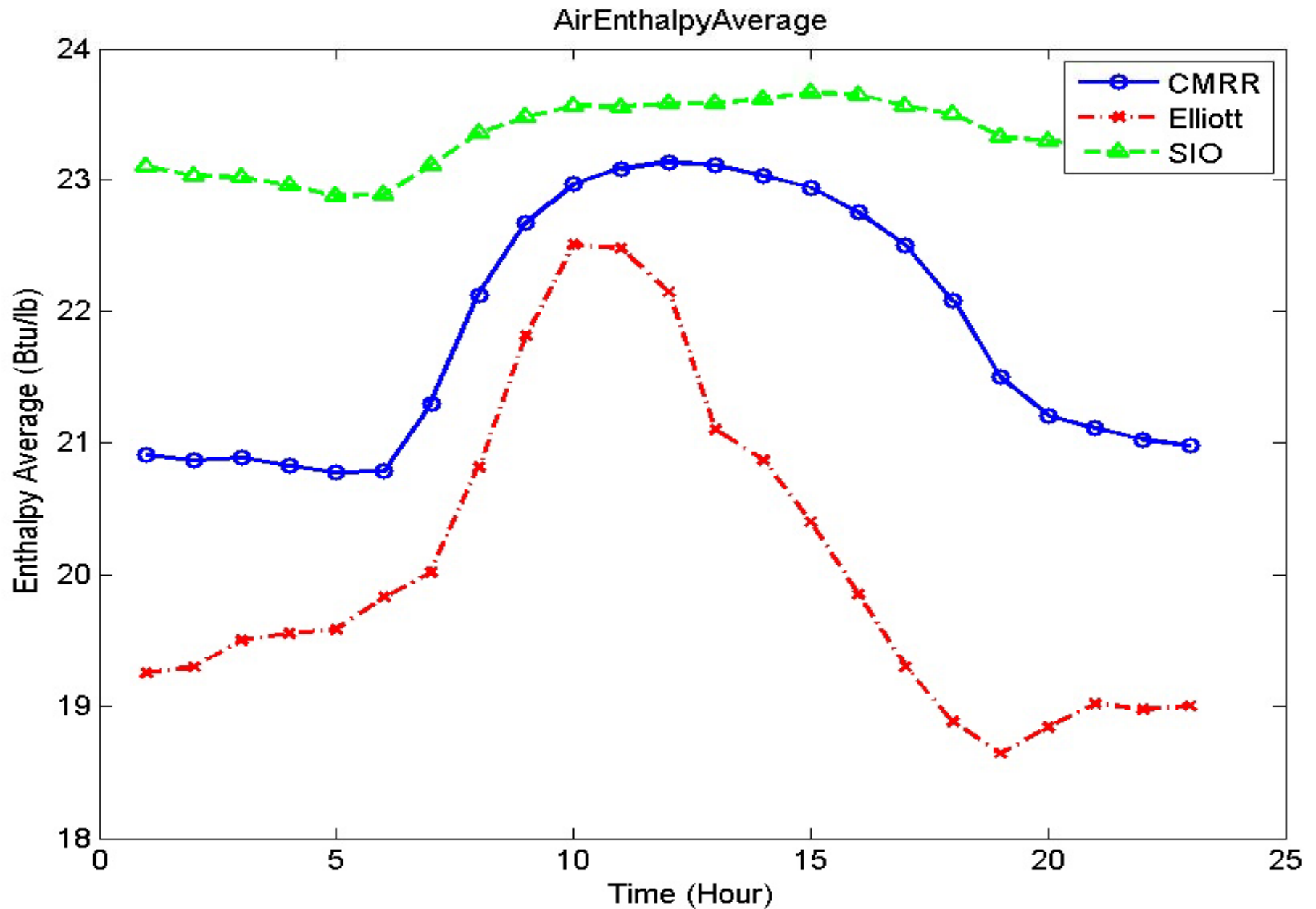
Temperature Average



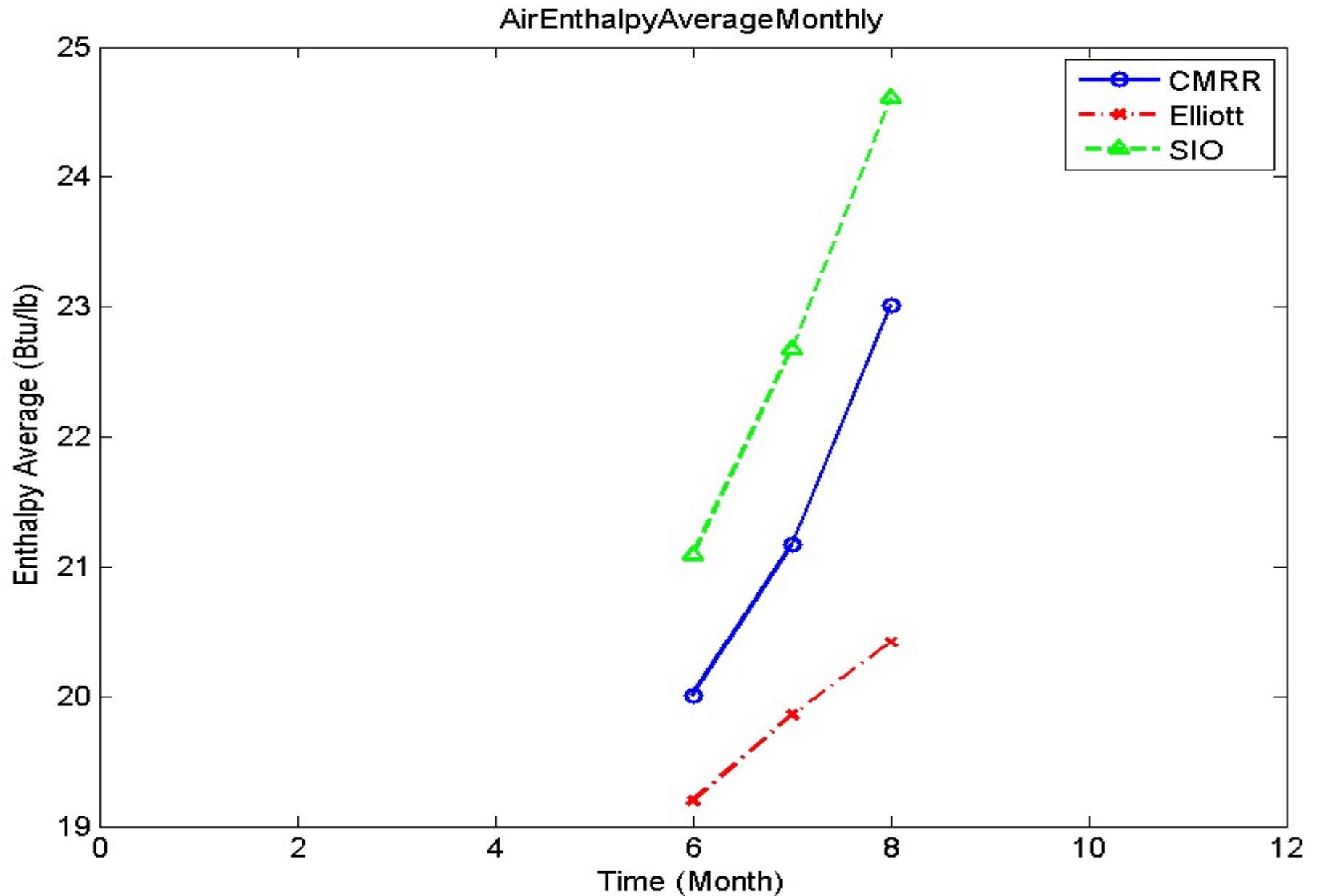
Timeseries Measurements



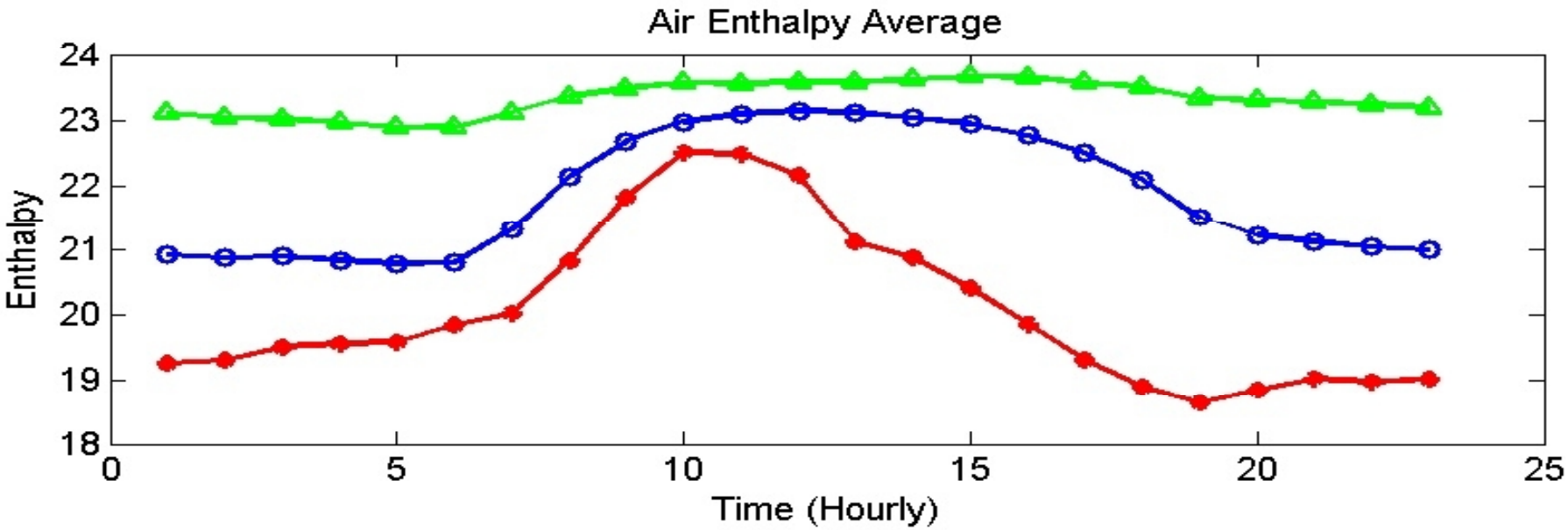
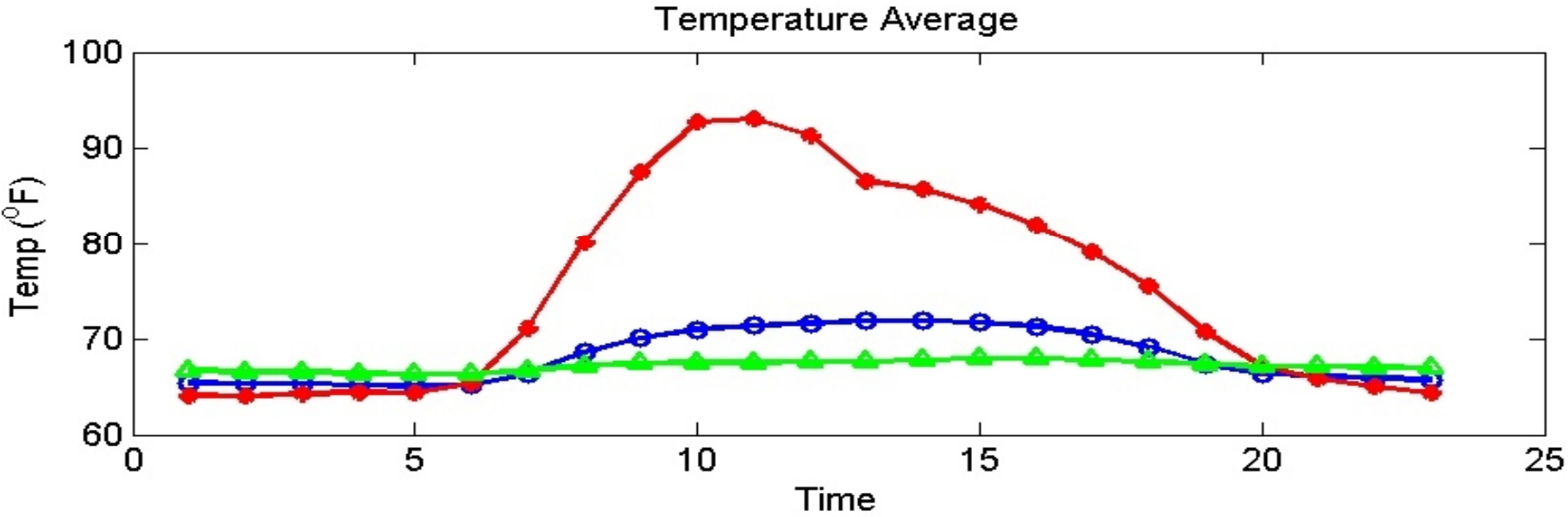
Average Diurnal Variation in Enthalpy



Average Monthly Variation



Temperature Vs. Enthalpy



Works Cited

- http://www.engineeringtoolbox.com/enthalpy-moist-air-d_683.html [Slide 2]
- <http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1003&context=cedr/cbe> [Slide 2]
- <http://utilities.fm.virginia.edu/energy/Clark%20Poster.pdf> [Slide 3]
- <http://blink.ucsd.edu/Blink/External/Topics/Policy/0,1162,16614,00.html> [Slide 4]