Appendix Slides

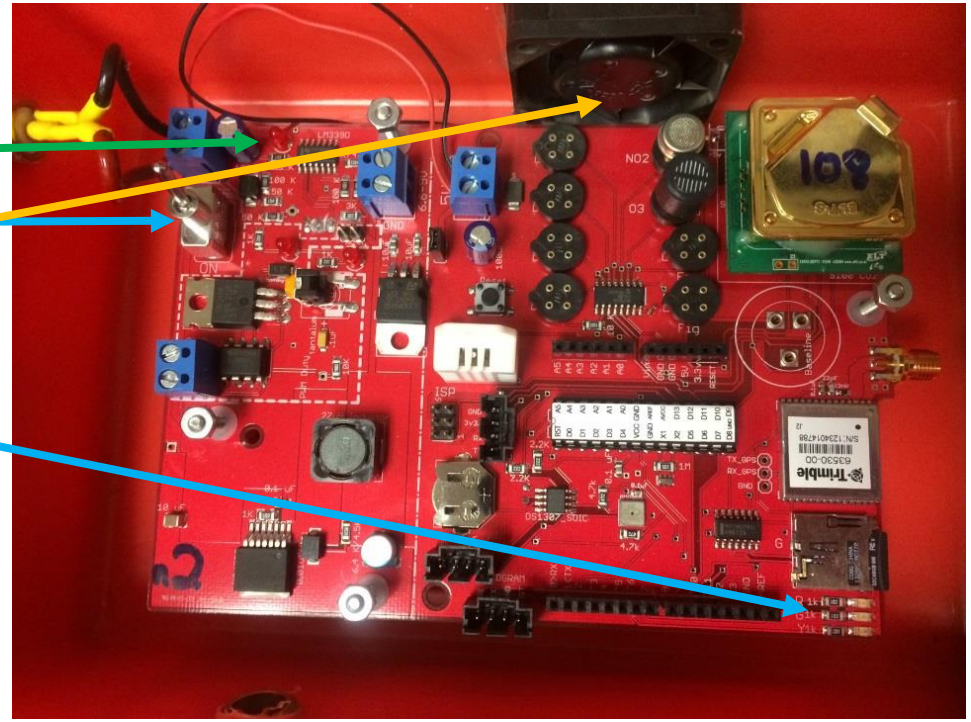
Appendix 1: More Information on the Technology (Pods)

- **Operational Info:** How the Pods work, how you can look at data
- **Sensors:** How they work
- **Calibration:** Raw vs. calibrated data

Operational Info

- Pods record data every ~5-25 seconds, depending on the settings
- Data is recorded to a mini–SD card on the board (bottom right corner of image)
- Powered by using a power adapter OR a battery

- **Checks:**
  - Is this light on?
  - Turn pod on
  - Is the fan running?
  - Are these lights flashing ~once every 5-10 seconds?
  - If so, then the pod is collecting data

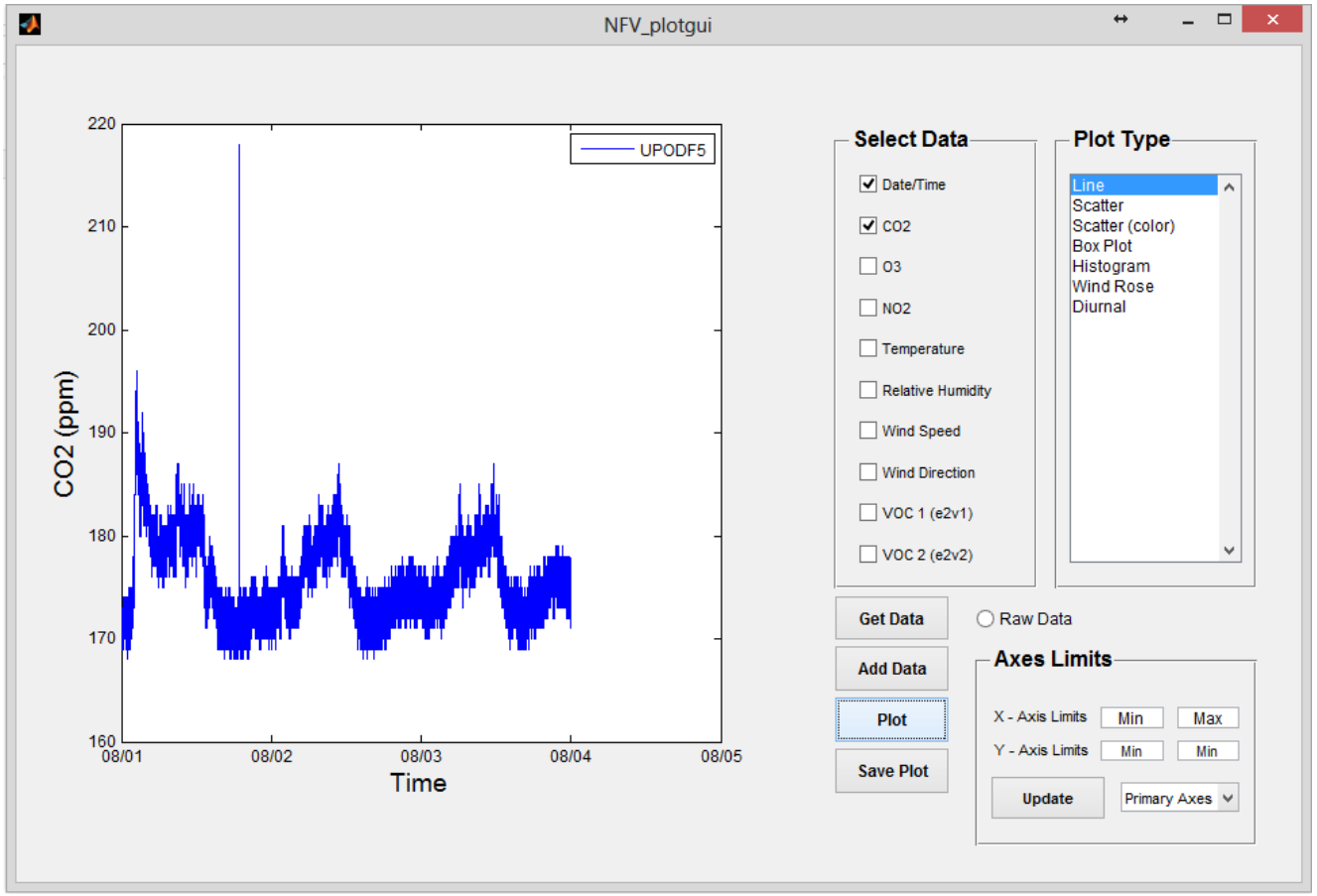


FYI: plenty of space on the SD card

Operational Info

Data files can be viewed in Excel OR in "Plotter Tool"

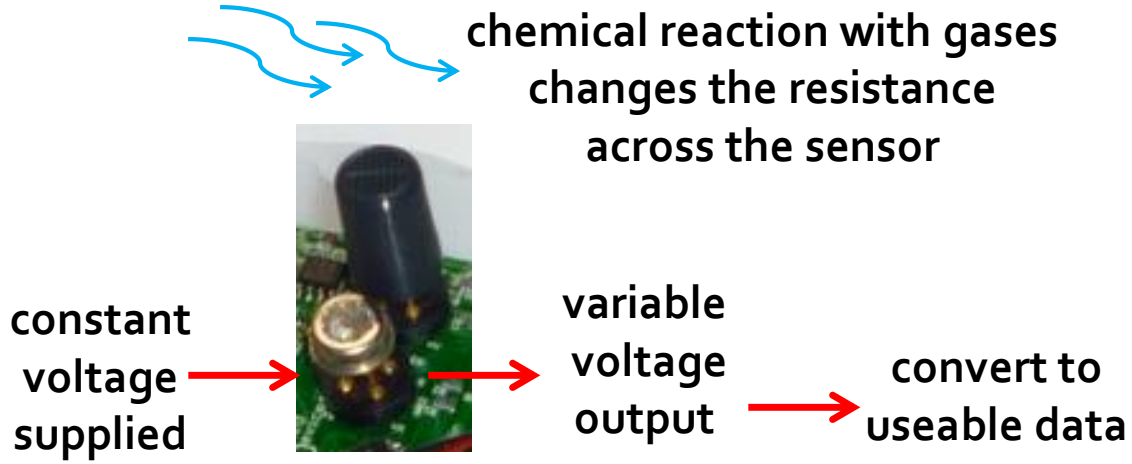
- **Excel** gives you:
  - More flexibility
  - More analysis tools (statistics)
- **Plotter Tool**:
  - Reduces the time required to load data files into Excel
  - Able to plot large amounts of data
  - *Problems*: If the data file did not write perfectly, it will not load (for example, stray characters)
  - Downloadable for free from wiki site at: **Citizenscienceairqualitymonitoring.pbworks.com**



The Sensors

Metal Oxide Semi-Conductor

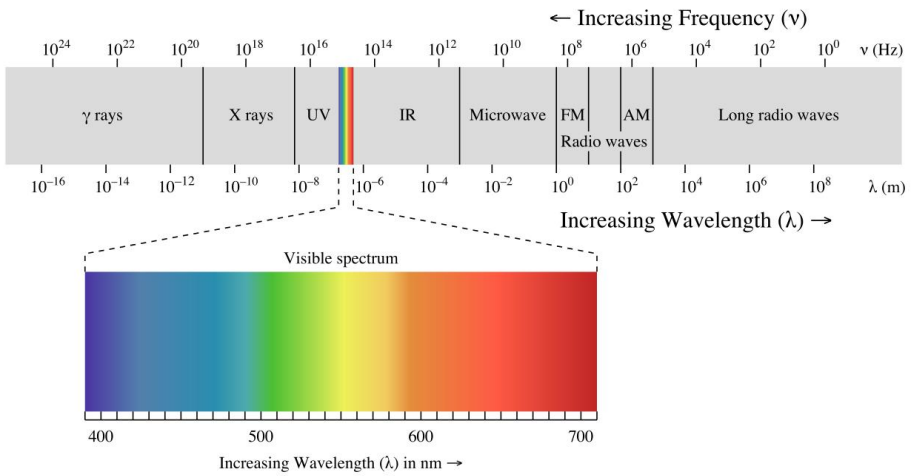
- *Pros*: affordable (≈$5-10), easy to implement, easy to use, available for a variety of pollutants
- *Cons*: temperature and humidity effects, cross-sensitivities, requires intensive sensor characterization and data processing

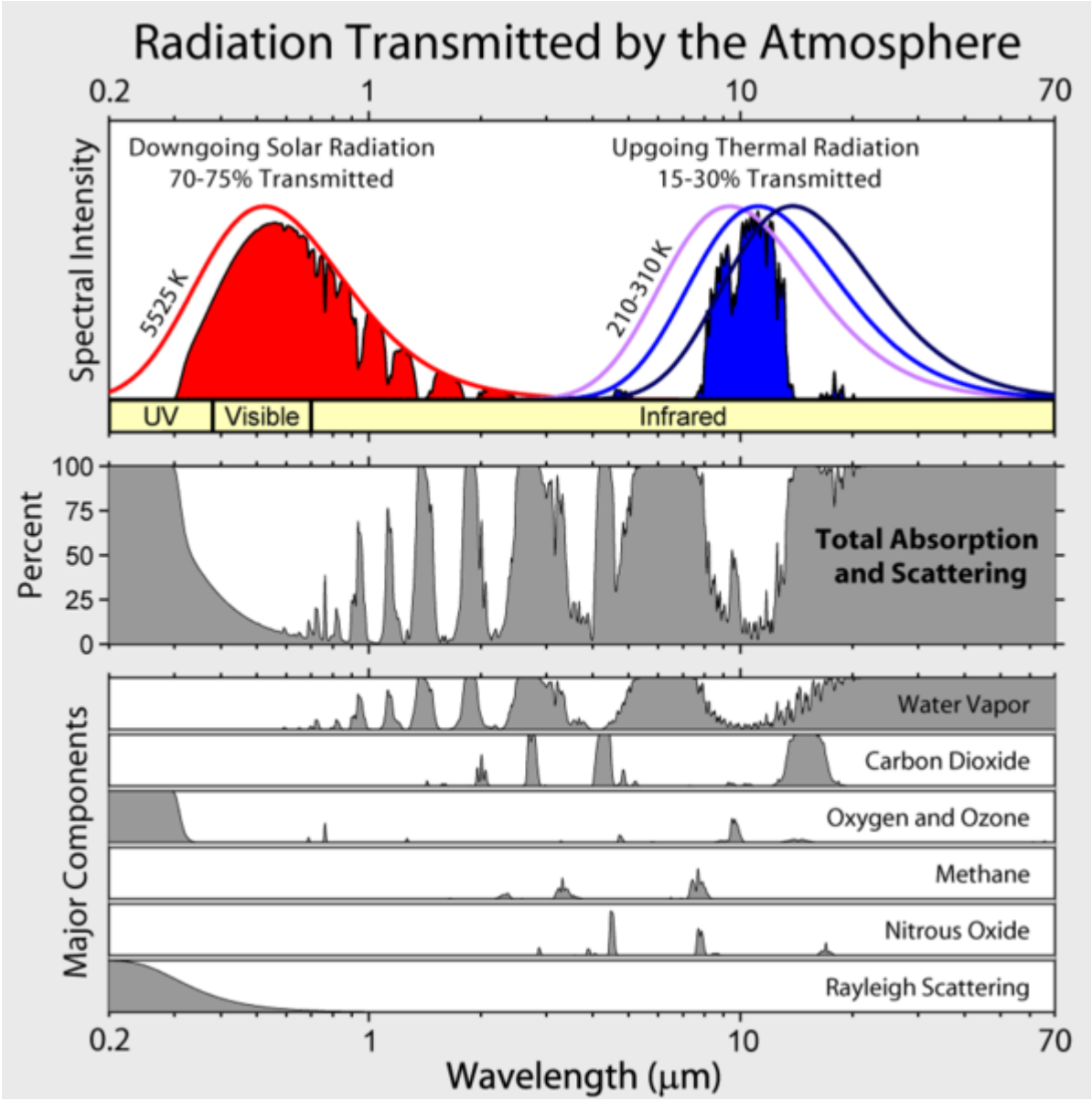


The Sensors

Non-Dispersive Infrared

- Slightly more expensive ($40)
- Less subject to temperature and humidity effects
- Utilizes *optical properties* to measure gas concentration (light absorbance by a gas, at specific wavelengths)





An Important Note about Data Analysis and Calibration

- **Raw sensor data directly from the Pod is in the form of voltages**
- **Calibration enables us to convert the voltages to concentration values**
- **Analyzing raw signal is possible and useful, especially for:**
  - **short-term class activities/demos (it is immediately available)**
  - **indoor data**
  - **or when you are seeing substantial amounts of pollutants**

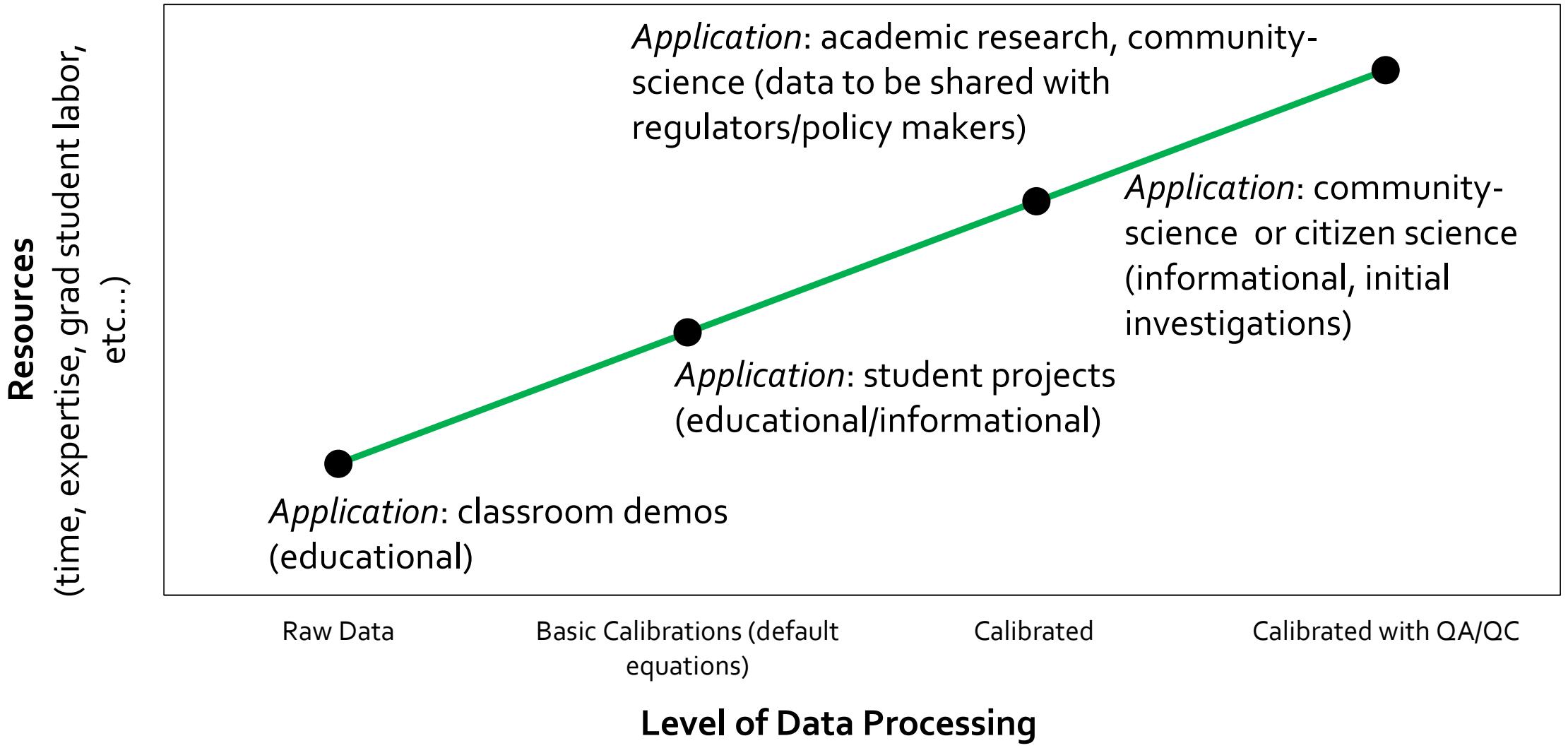
Why is this? The change in pollutant is likely going to be more significant than the change in temperature or humidity, which means the data trends will be driven by pollutants and *qualitative* analysis is possible (or examining relative changes rather than numerical concentrations)

An Important Note about Data Analysis and Calibration

- **Calibrated data** is in the form of **concentration** (such as ppm or ppb)
- Analyzing **calibrated data** is necessary, especially:
  - If you are trying to *quantitative* analysis
  - If you are collecting data in an environment with large changes in temperature or humidity
  - If you wish to share your data beyond your project

Also, different levels of calibrated data exist; see the next slide ➔

Different Levels of Data Quality



Appendix 2: Data Examples

- **Calibration example**
- **Carbon dioxide data example**
- **Ozone data example**

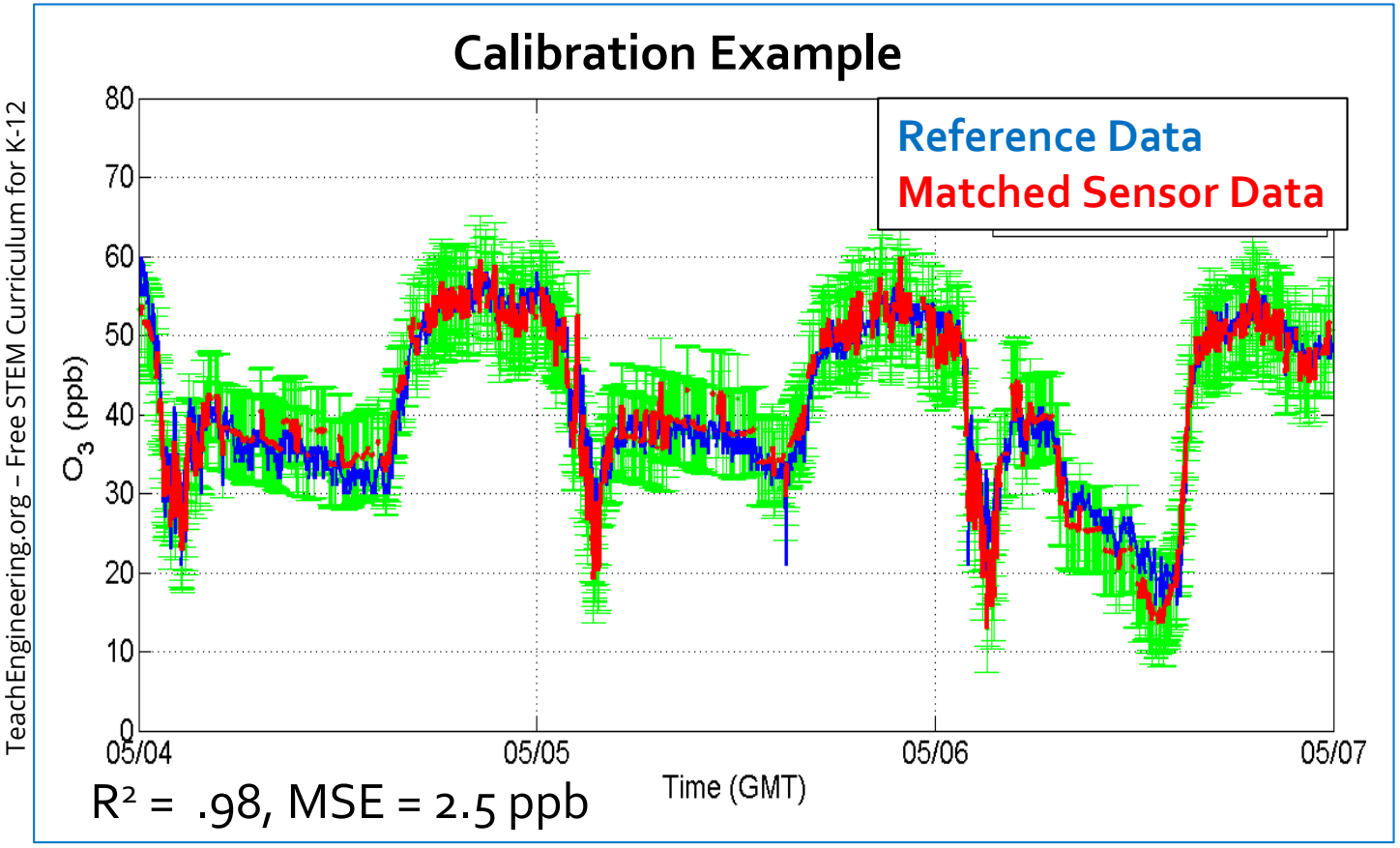
Data Examples

What a calibration looks like…

Similar to *y* = *mx* +*b***

We use linear equations or models to convert our data

y (concentration)* = m_1*voltage + m_2*temperature + m_3*humidity + *b

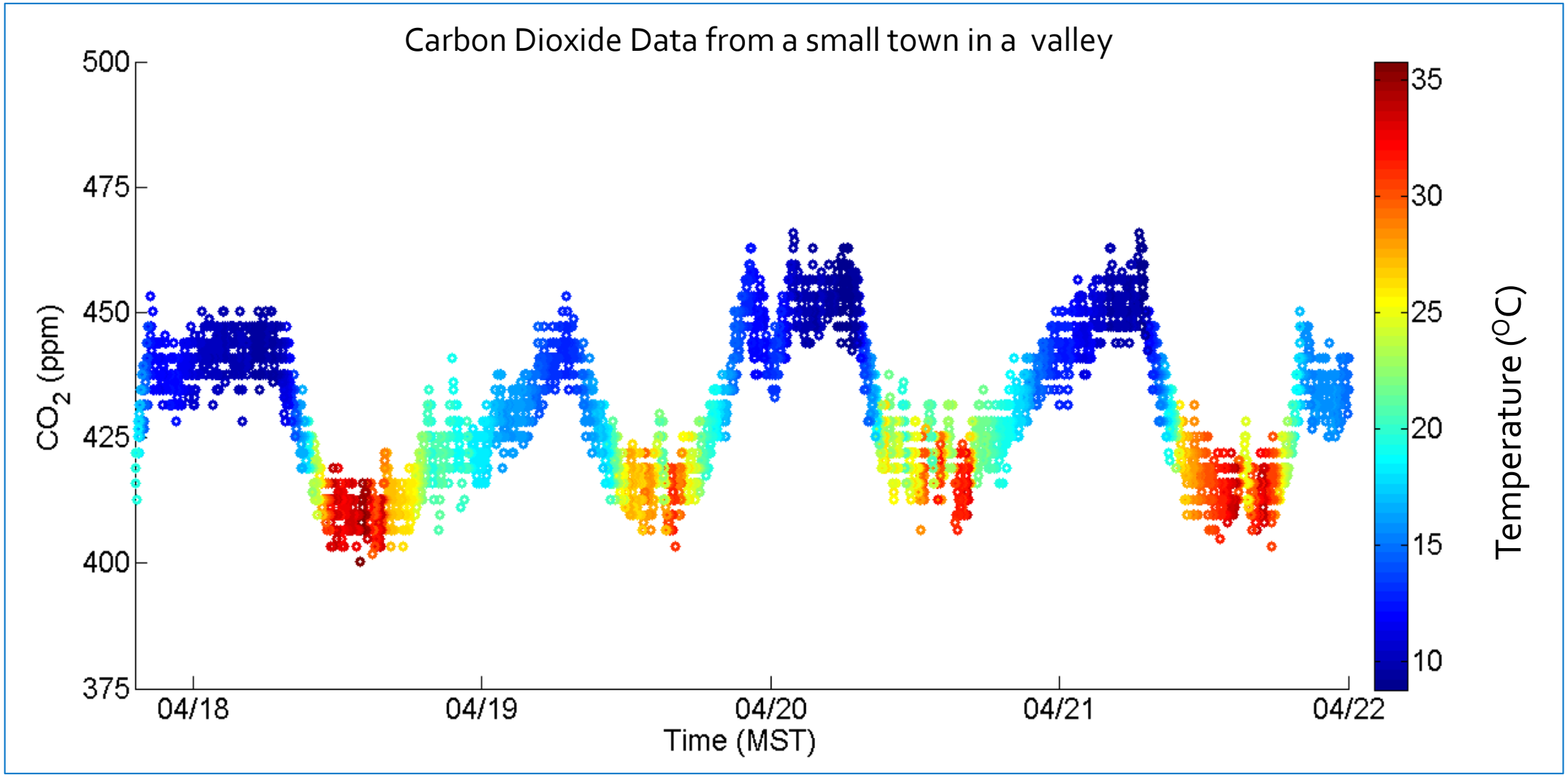


- To calibrate our sensors we need both an *independent* variable and *dependent* variable
- We get the *dependent* variable from a higher quality monitor that we want our data to match
- Then we can solve for our *coefficients* (slopes and y-intercept)
- Then we can use this model to predict the concentration or dependent variable for new data collected in the field

Data Examples

What can we learn from this data?

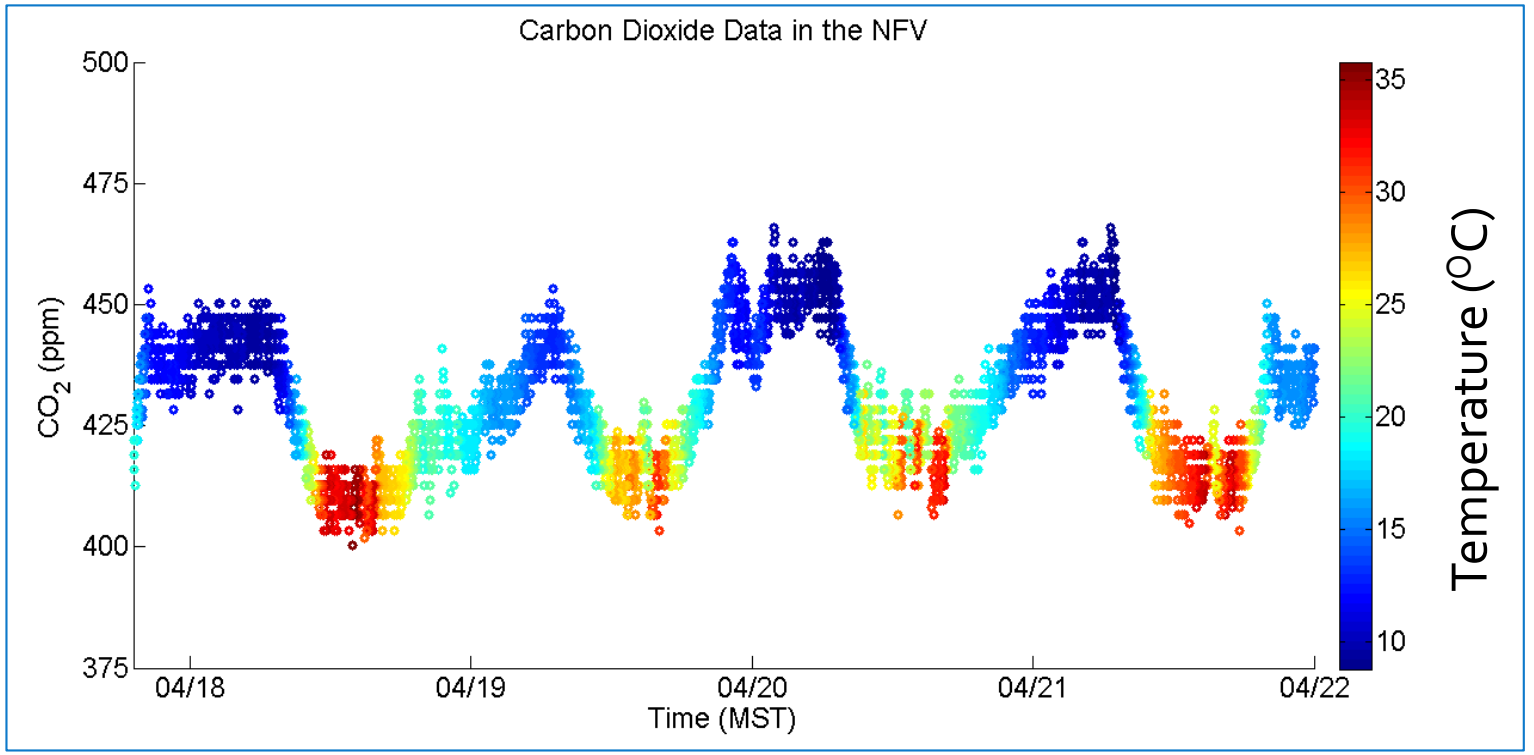
- **Do you see a daily pattern?**
- **How does the pattern relate to temperature?**



Data Examples

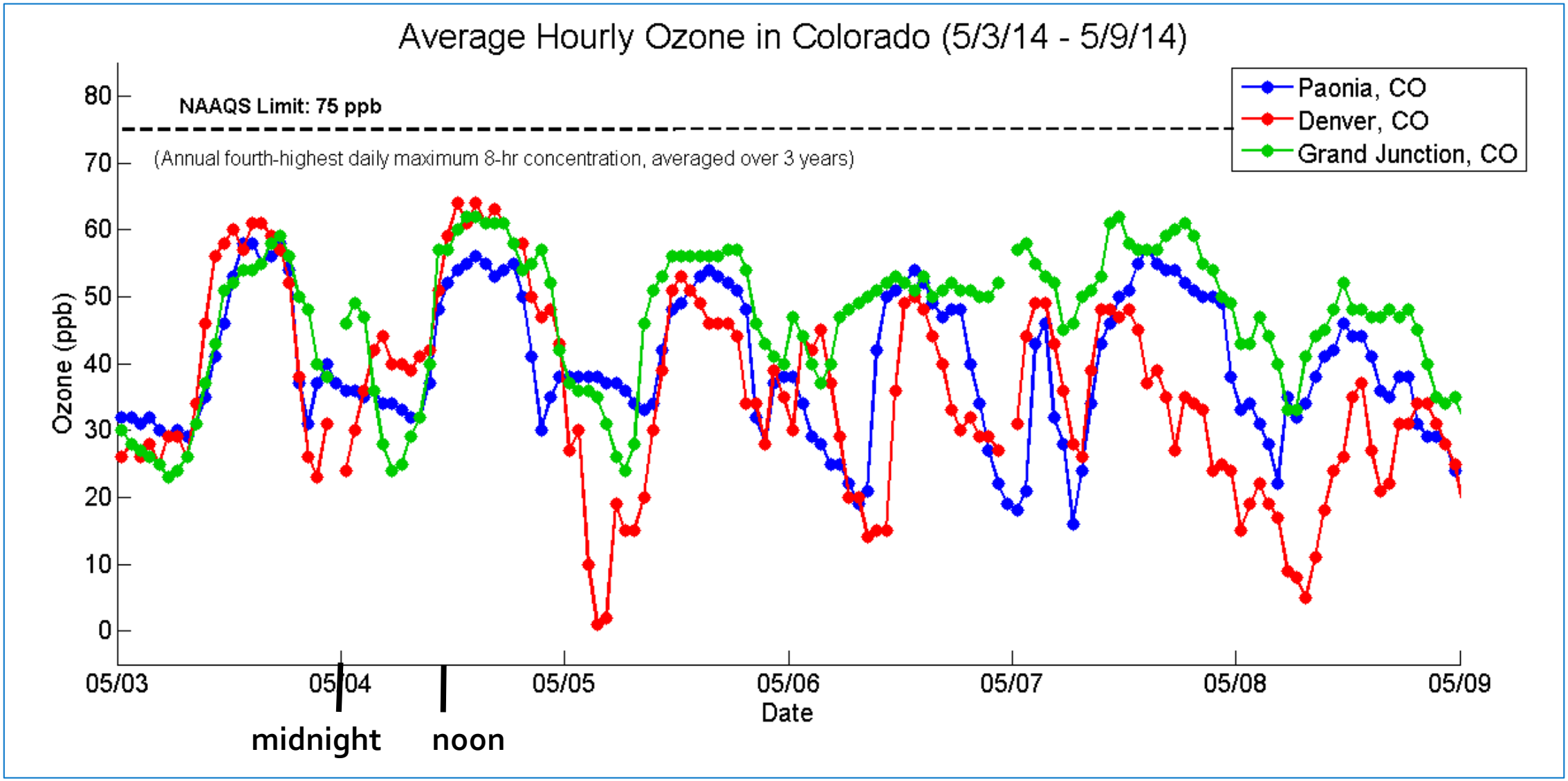
- **Observations**
  - CO2 is highest when temperature is at its lowest
  - CO2 peaks at night
  - Following the warmest day, there is the lowest night time CO2

- **Possible Explanations**
  - Boundary layer
  - Temperature inversions
  - Emissions from home heating



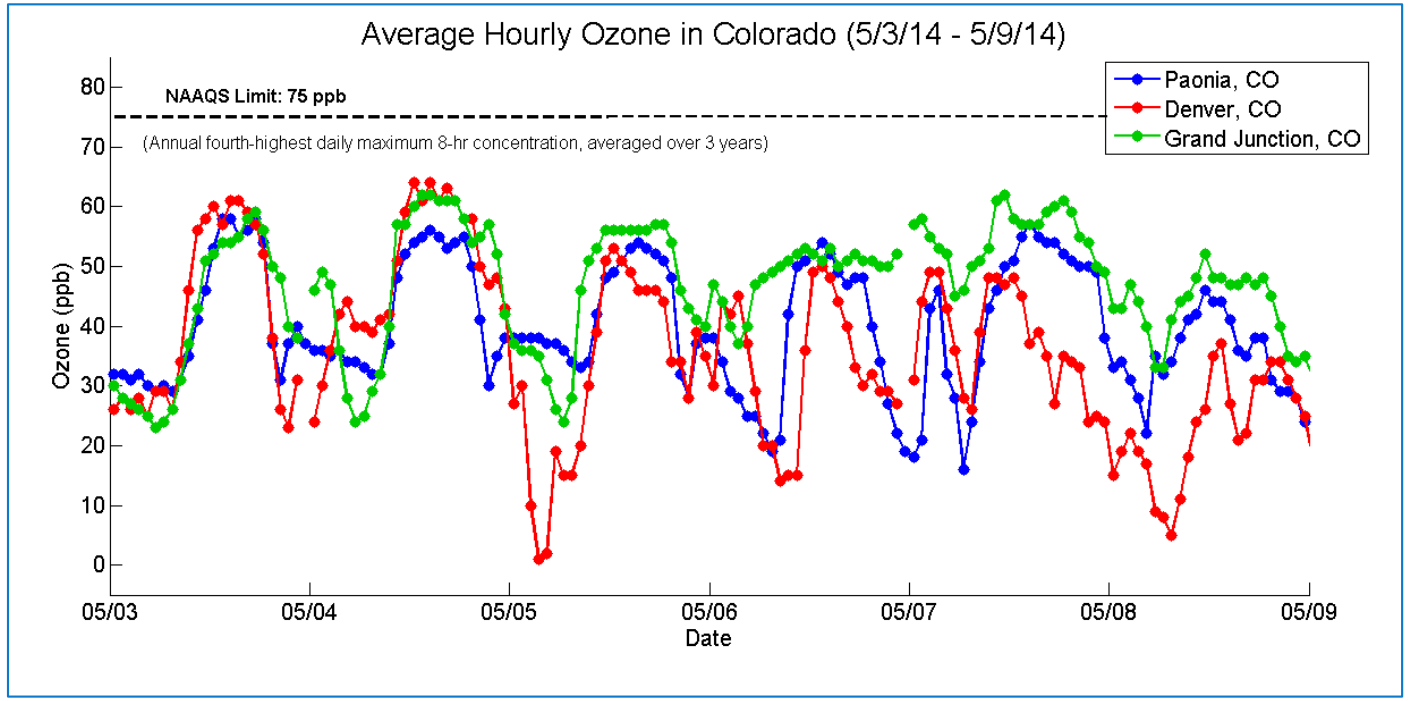
Data Examples

How can you explain the diurnal trend in the beginning of this data set? Any interesting observations?



Data Examples

- **Diurnal Trend**
  - The chemistry of ozone formation requires **sunlight**
  - Ozone is continually being formed and broken down
    - **Sunlight** – formation is favored
    - **No sunlight** – destruction is favored
  - Destruction of ozone requires NOx; if not enough NOx, ozone can "hang around"



- **Observations**
  - Little variance between three locations
  - Ozone typically peaks in urban areas in the summer (thus, lack of sunlight might be limiting production in Denver)
  - Background ozone = 30-40 ppb, in uninhabited areas (naturally occurring VOCs can assist in its production)
  - Ozone is more of a regional issue than a local one because it takes more time to form and decay