AOSC201: Weather and Climate Lab

Week 9: Weather and Air Quality

Section 103/105

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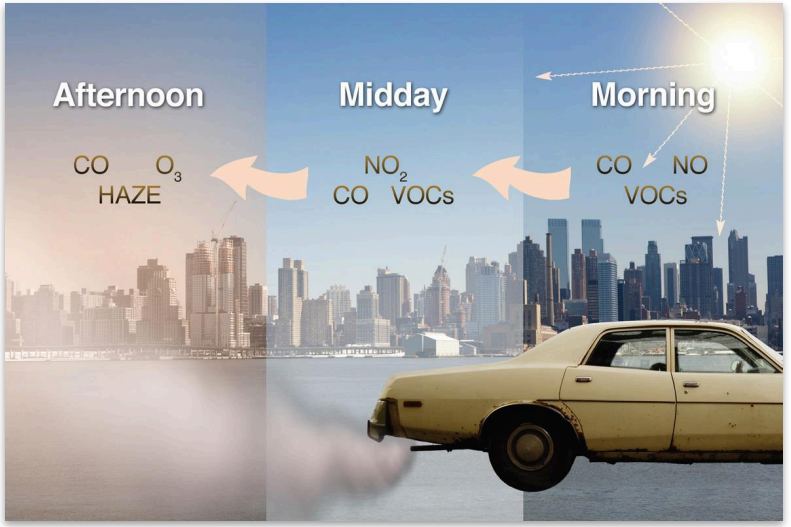
Tropospheric Ozone

- 2015 National Ambient Air Quality Standards (NAAQS): 70 ppb at an 8-hr avg
  - 2008: 75 ppb for 8-hr avg
  - 1997: 80 ppb for 8-hr avg
  - 1979: 120 ppb for 1-hr avg
- Produced by reactions with sunlight, natural gases, and incomplete combustion reaction products
- Peaks mid-afternoon
- Destroyed or dispersed by nitric oxide, titration, wind transport, etc.



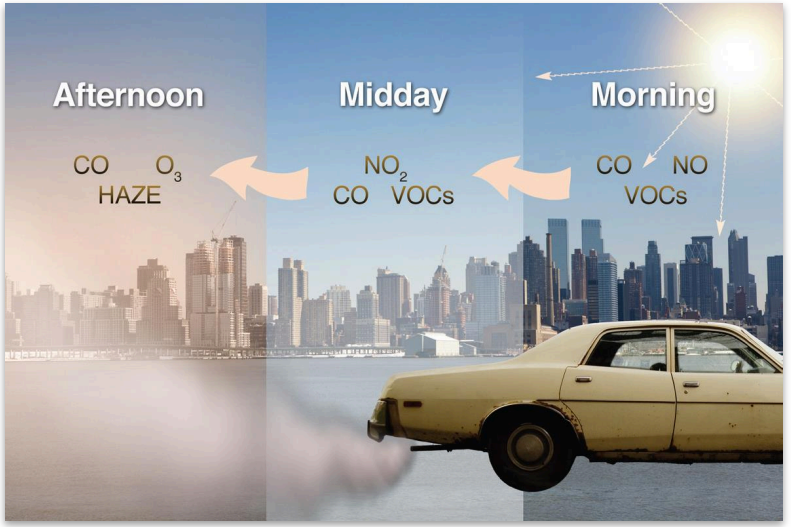
Photochemical smog diurnal evolution

Ozone production and destruction with no hydrocarbons

$$NO_2 + h\nu \rightarrow NO + O$$
$$O + O_2 + M \rightarrow O_3 + M$$
$$NO + O_3 \rightarrow NO_2 + O_2$$

Tropospheric Ozone

- Known to create a great deal of respiratory issues in plants and humans alike
- O_3 diurnal cycle: surface heating begins and interacts with exhaust products to produce ozone towards the afternoon
  - Commonly referred to as photochemical smog



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National Ambient Air Quality Standards (NAAQS)

- **Primary:** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly
- **Secondary:** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings
- **6 criteria pollutants**: ozone, lead, particulate matter (PM10, PM2.5), sulfur dioxide, carbon monoxide, nitrogen dioxide

Current ozone standards (NAAQS)

Pollutant [links to historical tables of NAAQS reviews]	Primary/ Secondary	Averaging Time	Level	Form
Ozone (O_3)	primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years

Air Quality Index (AQI)

- EPA's index for reporting air quality
- The higher the AQI value, the greater the level of air pollution and the greater the health concern
- BP: break points (on your lab manual, pg 53)
- I: index for pollutant p
- Cp: rounded concentration of pollutant

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}}(C_p - BP_{Lo}) + I_{Lo}$$

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: everyone may experience more serious health effects
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

Air Quality Index (AQI) Sample Calculation

For ozone concentration of 30 ppb:

$$x_{ppm} = \frac{x_{ppb}}{1000}$$

$$x_{ppm} = \frac{30\ ppb}{1000}$$

$$x_{ppm} = 0.030\ ppm$$

Ozone Breakpoints (ppm)	AQI
0.000 – 0.064	0 - 50

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}}(C_p - BP_{Lo}) + I_{Lo}$$

$$I_p = \frac{50 - 0}{0.064 - 0.000}(0.030\ ppm - 0.000) + 0$$

$$I_p = 23 \longrightarrow$$

AQI: Good, air quality is considered satisfactory, and air pollution poses little to no risk

HINT: look for your ozone concentration in ppb, convert to ppm, then find what range your concentration fits in in the breakpoints column.

SHOW YOUR WORK!

Calculating 8-hour O_3 averages

$$8\text{hr avg} = \frac{\text{Cp}_{\text{hr 1}} + \text{Cp}_{\text{hr 2}} + \text{Cp}_{\text{hr 3}} + \text{Cp}_{\text{hr 4}} + \text{Cp}_{\text{hr 5}} + \text{Cp}_{\text{hr 6}} + \text{Cp}_{\text{hr 7}} + \text{Cp}_{\text{hr 8}}}{8}$$

- Convert to ppm (conversion on previous slide) for your final answer!!!!
- Do 12am to 4pm
  - You don't need to calculate averages from 5pm to 11pm (see extra directions)
- LAB FREEBIE using chart given in manual/extra directions at 12am:

$$12am_{8hr} = \frac{50\ ppb + 46\ ppb + 40\ ppb + 48\ ppb + 22\ ppb + 20\ ppb + 25\ ppb + 44\ ppb}{8}$$

$$12am_{8hr} = 36.875\ ppb \quad \rightarrow \quad \frac{36.875\ ppb}{1000} \approx 0.036875\ ppm$$

For #1, leave the concentration in ppb in the table!