Lecture 15
Chapters 5 & 6

• Announcements
• Troposphere
• Thermodynamics
The Atmosphere

- Our atmosphere behaves pretty much as an ideal gas, where gravity determines its volume
Troposphere

- Layer of the atmosphere closest to the earth.
- It is 99% N₂ and O₂
- H₂O, Ar and CO₂ are the only other gases present in amounts greater than 0.01%
- H₂O composition can vary depending on the atmospheric conditions --- weather
Vapor Pressure

- In a closed container, a gas will evaporate until it reaches a dynamic equilibrium.
- At dynamic equilibrium, the pressure of the gas in the closed container is called the vapor pressure, \( vp \).
- The vapor pressure depends on temperature.
- So what about for the earth’s atmosphere?
Relative Humidity

- Most of the time, the atmosphere contains less water vapor than the maximum amount it can hold.

- The amount of water in the earth’s atmosphere is called relative humidity.

\[ p_{H_2O} < \nu p_{H_2O} \]

- \( p_{H_2O} \) is the partial pressure of water present in the atmosphere

Relative Humidity = \( \left( \frac{p_{H_2O}}{\nu p_{H_2O}} \right) \times 100 \)
Dew Point

- The formation of dew and fog are the result of relative humidity.
- Warm air with a high relative humidity may cool.
- When the air temperature falls below a certain temperature, some water must condense from the atmosphere.
- This temperature is called the dew point.
What does vapor pressure have to do with weather?

- Where does energy come from to form hurricanes?

- Ahh, but this is thermodynamics. We’ll come back to this in a minute.
Nitrogen dioxide absorbs energy from sunlight and decomposes to NO and O. O atoms are very reactive and will react with O₂ to form ozone, O₃ (highly toxic and reactive). Both O₂ and O₃ react with hydrocarbons to produce harmful pollutants sometimes referred to as photochemical smog.
• Almost ½ of our electricity is generated by burning coal
• But coal contains not only carbon, but also other elements: S, H, O, and N

\[
S \text{ (s, from coal)} + O_2 \text{ (g)} \rightarrow SO_2 \text{ (g)}
\]
• In the presence of dust particles or UV light, SO\(_2\) will react with oxygen to form SO\(_3\)
In humans, prolonged exposure to SO\textsubscript{2} diminishes lung capacity and aggravates respiratory problems. At 0.15 ppm, people with existing problems will be incapacitated. At 5 ppm, everyone will experience breathing difficulties. Also, SO\textsubscript{2} and SO\textsubscript{3} can react with water to produce acid rain.

\[
\begin{align*}
\text{SO}_2 (g) + \text{H}_2\text{O} (g) & \rightarrow \text{H}_2\text{SO}_3 (\text{mist}) \\
\text{SO}_3 (g) + \text{H}_2\text{O} (g) & \rightarrow \text{H}_2\text{SO}_4 (\text{mist})
\end{align*}
\]

How do you remove SO\textsubscript{2} at an energy plant before it reaches the atmosphere?

\[
\text{SO}_2 (g) + \text{CaO} (s) \rightarrow \text{CaSO}_3 (s)
\]
OK, so what about Thermodynamics?

- Thermodynamics is the study of the flow of energy
- This explains loads of everyday stuff
  - Cars
  - Electricity
  - The chemistry of life
  - Basically everything
  - Even the weather…

- Let’s talk about the thermodynamics of hurricanes
Today

• Pack up for the weekend!

By Wednesday

• Read first half of Chapt 6 – we will go fast
• Start CAPA #9

Remember: You are done with the homework when you understand it!