ESCI 107/109 – The Atmosphere
Lesson 8 – Air Pressure

Reading: *Meteorology Today*, Chapter 8

AIR PRESSURE

- **Air pressure is the pressure exerted by the weight of air above us. At sea level it is roughly 14.7 lbs per square inch. This means that a column of air 1 square inch in diameter, extending all the way to the top of the atmosphere, weighs 14.7 lbs.**
- **Pressure decreases with altitude, because as you go up there is less atmosphere above you.**
- **To calculate the force caused by pressure, we multiply pressure by area.**
  - **For example, your textbook is roughly 8 in by 10 in, so it has an area of about 80 square inches. The downward force exerted by the atmosphere on the book is 14.7 (lbs in^{-2}) x 80 (in^2) = 1176 lbs!**
- **With so much weight on the textbook, how can you lift it from your desk?**
  - **Because pressure acts in all directions, not just in one.**
  - **There is air underneath your textbook, in the very small spaces between the book and the desk, pushing up on the book. The upward force from this pressure cancels the downward force on top of the book.**
- **If one side of an object experiences a different pressure than the opposite side, then the forces from the pressure won't cancel, and there will be a net force from higher pressure to lower pressure.**

STANDARD SEA-LEVEL PRESSURE

- **A pressure of 14.7 lbs per square inch is also known as *1 atmosphere* (abbreviated as *atm*), because it is the pressure exerted by our atmosphere at sea level. Thus, a pressure of 29.4 lbs per square inch would be 2 atm.**
- **A column of water 33 feet (10 meters) deep exerts the same pressure as our entire atmosphere!**
- **A column of mercury 1-inch square and 29.92 inches tall weighs 14.7 lbs. It thus exerts a force of 14.7 lbs in^{-2}, which is equal to the pressure of the atmosphere at sea level.**

- **Thus, we can use a column of mercury as a *barometer* (an instrument that measures atmospheric pressure). The greater the height of mercury in a closed tube, the greater the atmospheric pressure. We express the pressure as *inches of Hg*.**
- **Standard sea-level pressure is then 29.92 inches of Hg.**

- **Another unit commonly used for atmospheric pressure is the *millibar* (abbreviated *mb*).**
  - ***1 atm = 1013 mb = 29.92 in. Hg*.**

BAROMETERS

- **There are two main types of barometers**
  - ***Mercury barometer***
  - ***Aneroid barometer***
- **A device that records pressure automatically throughout the day on a chart is a *barograph***
- **A barometer can also be used to determine altitude. This is known as a *pressure altimeter*, and is what airplanes use to determine altitude.**

PRESSURE MAPS

- **In order to compare the pressure at two locations their station pressure must be reduced to sea level. Otherwise, stations in mountainous areas would always appear to be under low-pressure systems.**
- **Sea-level pressure is plotted on weather maps, and lines connecting locations having the same pressure are drawn. These lines of constant pressure are called *isobars*.**
- **If the isobars are closed off, they delineate either an area of *high* or *low* pressure, depending on whether the pressure is higher or lower in the middle of the closed isobars.**
  - **An elongated area of high pressure is called a *ridge*.**
  - **An elongated area of low pressure is called a *trough* or *trof*.**

- **On upper-level charts, instead of mapping the pressure distribution at a constant altitude we work on surfaces of constant pressure, and draw lines of constant *height* of the pressure surface above sea-level.**
  - **If the height contours are closed off, they delineate either a *high* or a *low*, depending on whether the heights are higher or lower in the middle of the closed contours.**
  - **An elongated area of high heights is called a *ridge*.**
  - **An elongated area of low heights is called a *trough* or *trof*.**
- **An area of high or low pressure on a constant altitude map is equivalent to an area of high or low heights on a constant pressure surface map.**

RELATION OF PRESSURE WITH DENSITY AND TEMPERATURE

- **Pressure is actually caused by the collision of air molecules against the surface**
- **There are two factors that influence the number of collisions there will be against a surface**
  - **Density – density is the mass of air in a unit volume. *As density increases, so does pressure (if temperature is constant).* This is because there are more air molecules to collide against the surface.**
  - **Temperature – *As temperature increases, so does pressure (if density is constant).* This is because as temperature increases, each air molecule has more energy, and the collisions have more force.**