**ESCI 107 – The Atmosphere**
**Lesson 6– Clouds and Fog**

**Reading: *Meteorology Today*, Chapter 5**

## FORMATION OF CLOUDS

- **When air becomes saturated with water vapor, any excess water vapor condenses to form clouds**
- **The air can become saturated either by:**
  - **addition of water vapor**
  - **cooling the air**
- **A common way for air to become saturated in order to form a cloud is for it to be lifted and *adiabatically* cooled via one of the four methods of lifting**
  - **orographic lifting**
  - **frontal wedging**
  - **convergence**
  - **convective lifting**
- **In order to condense, there must be a surface for the water to condense onto. In the atmosphere, tiny dust, dirt, or smoke particles serve as these surfaces. They are known as *condensation nuclei*.**
  - **If the air contained no condensation nuclei, than the relative humidity could get much greater than 100% without condensation occurring. This is called *supersaturation*.**
- **Not all particles in the atmosphere can be condensation nuclei. Only those that can absorb water (called *hygroscopic* nuclei) are effective as condensation nuclei.**
  - **Condensation can also occur on other surfaces, such as grass, cars, and windows. This is known as *dew*.**
- **Clouds are composed of a large number of very small droplets of water. The droplets are so small that they do not fall, but remain suspended in the air.**
  - **A typical cloud will have a droplet concentration of a few hundred per cubic centimeter. That equals about 500,000 droplets in a 2 liter soft-drink bottle!**

**CLOUD CLASSIFICATION**

- **Clouds are classified in two ways, by *height* and by *form*.**
- **Classification by form**
  - ***Cirriform* – Cirriform clouds are very high, thin, and wispy. They are composed mostly of ice crystals.**
  - ***Cumuliform* – These clouds are puffy, and develop vertically. They generally have flat bottoms. There are often individual cloud units. They are associated with unstable atmospheres.**
  - ***Stratiform* – These clouds are generally flat and spread out (sheet like). There may be breaks in the clouds, but no distinct, individual clouds. They are associated with stable atmospheres.**
- **Classification by height**
  - ***High clouds* – bases are above 20,000 feet**
  - ***Middle clouds* – 6500 to 20,000 feet**
  - ***Low clouds* – bases below 6500 feet**
  - ***Clouds of vertical development* – clouds which do not fit nicely into one of the three height categories above.**

**CLOUD TYPES DESCRIBED**

- **High clouds**
  - ***Cirrus* – delicate, icy filaments. Often form "mare's tails"**
  - ***Cirrostratus* – transparent veil, often smooth and covering much of the sky. This cloud produces a *halo* around the sun or moon.**
  - ***Cirrocumulus* – white patches with very small cells or ripples. Often has a regular pattern. Gives a "mackerel sky" (looks like fish scales).**
- **Middle clouds**
  - ***Altocumulus* – similar to cirrocumulus, but are lower, have larger cells, and are composed of water drops rather than ice crystals.**
  - ***Altostratus* – grayish smooth clouds covering most of the sky. Sun is usually visible, but not distinct, as though you are looking at it through frosted glass. *There is no halo!***

- **Low clouds**
  - ***Stratus* – Low, uniform cloud that covers much of the sky. It may produce drizzle.**
  - ***Stratocumulus* – Similar to stratus, though the bottom has long, parallel rolls or cellular structure.**
  - ***Nimbostratus* – Forms when stable air is forced to rise. A dark, low, uniform cloud, similar to stratus, but with precipitation (rain, snow, etc.).**
    - **If a stratus cloud is producing rain or snow, then it is a nimbostratus. However, if it is producing only drizzle, or nothing at all, then it is a stratus.**
- **Clouds of vertical development**
  - ***Cumulus humilis* – Individual, puffy masses that can grow vertically into towers or domes.**
  - ***Cumulus congestus* – Tall, puffy, massive cumulus, but consists entirely of liquid water (no ice in upper-part of cloud).**
  - ***Cumulonimbus* – Cumulus clouds with great vertical development (usually fills the entire troposphere), and with ice in the upper-part of the cloud.**
    - **Cumulonimbus produces rain or snow showers, and may have hail, and lightning.**
    - **An *anvil head* is often formed at the top where the cloud presses against the tropopause.**
- **Other variations and description**
  - ***Uncinus* – this means hooked shaped, and is the technical term for cirrus with mare's tails.**
  - ***Fractus* – refers to stratus or cumulus clouds that are broken into smaller, ragged pieces, usually underneath.**
  - ***Mammatus* – rounded protuberances on the undersides of cumulonimbus clouds, or under the anvil head of a cumulonimbus cloud.**
    - **A sign of very unstable atmospheres, this is often seen with severe thunderstorms.**

- *Lenticular* – this means lens shaped, and refers to the flat, "flying saucer" or "pancake" clouds often seen downwind of mountains. Associated with strong turbulence.

**FOG**

- **Fog is a cloud with its base at or very near the ground.**
  - **Usually it is a stratus cloud that is touching the ground.**
- **Fog can be formed in one of two ways**
  - **By cooling the air until it reaches saturation**
  - **By evaporating water into the air until it reaches saturation**
- **There are five types of fog. They all look similar, but are formed differently.**
- **Fogs formed by cooling**
  - ***Radiation fog* – results from radiation cooling of the ground and air next to the ground**
    - **Ideal conditions are light winds and clear skies.**
    - **Most common type of fog in Lancaster County**
  - ***Advection fog* – results from warm, moist air moving (advecting) over a cooler surface.**
    - **Common on Pacific Coast.**
    - **Also occurs over ocean when air from warm ocean blows over cooler ocean.**
  - ***Upslope fog* – results from air being lifted and cooled orographically**
    - **Can occur even with a gentle slope**
- **Fogs formed by evaporation**
  - ***Steam fog* – results when cool air moves over warm water. Similar to the steam formed over a cup of hot coffee. Also called *sea smoke*.**
  - ***Frontal fog* – formed from rain falling through cool air and evaporating.**
    - **Often occurs during and after frontal passage**

**DEW AND FROST**

- ***Dew*** **is formed by condensation onto a surface that has cooled below the dew point of the surrounding air.**
- **Ideal conditions are clear skies and light or calm wind.**
- **If the dew point is below freezing, then instead of condensing, the water vapor undergoes *deposition* and forms *frost*.**
- **Dew forms first on grass because the grass also releases moisture through *transpiration*.**