

ESCI 241 – Meteorology
Lesson 9– Clouds and Fog

References and Reading: MT Chapter 7

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 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*.**
 - **In the absence of condensation nuclei the relative humidity can get up to 400% without condensation occurring.**
 - **If the relative humidities over 100%, the air is said to be *supersaturated*.**
- **Not all particles in the atmosphere can be condensation nuclei. Only those that have an affinity for 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, or about 500,000 droplets in a 2 liter soft-drink bottle sized parcel.**

CLOUD CLASSIFICATION

- 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 droplet in a 2-liter soft-drink bottle!
- 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 DESCRIPTIONS

- 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
 - *Alto cumulus* – 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 light precipitation.
 - *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 long, continuous precipitation.
- **Clouds of vertical development**
 - *Cumulus Humilis* – Individual, puffy masses that can grow vertically into towers or domes.
 - *Cumulus Congestus* – Strongly sprouting cumulus with sharp outlines and sometime with great vertical development (often referred to as *towering cumulus*)
 - *Cumulonimbus* – Cumulus clouds with great vertical development (usually fills the entire troposphere). Produces rain, hail, and lightning. An *anvil head* is often formed at the top where the cloud presses against the tropopause.
- **Other variations and descriptive terms**
 - *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.
 - *Lenticularis* – this means lens shaped, and refers to the flat, “flying saucer” or “pancake” clouds often seen downwind of mountains. Associated with strong turbulence. *Pilots beware!*
 - *Cumulus Humilis* – small cumulus with slight vertical growth.

- *Cumulus Congestus* – cumulus of great vertical extent (resembling cauliflower).
- *Pileus* – cap cloud above or surrounding a cumuliform cloud.

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
 - *Advection fog* – results from warm, moist air moving (advecting) over a cooler surface
 - *Upslope fog* – results from air being lifted and cooled orographically
- 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. Sometimes called “sea smoke”.
 - *Frontal fog* – formed from rain falling through cool air and evaporating.

DEW AND FROST

- *Dew* is formed by condensation onto a surface that has cooled below the dew point of the surrounding air.
- 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*.