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**
  - ***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 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 tropospause.**
- **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.**
- **In weather observation a distinction is made between *mist* and *fog*. The distinction is based on visibility.**
  - **It is *mist (BR)* if visibility is greater than or equal to 5/8 SM (1000 m)**
  - **It is *fog (FG)* if visibility is less than 5/8 SM (1000 m).**

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*.**

SKY COVER

- ***Clear* – No Clouds (coded as CLR or SKC)**
  - **CLR is used for automated reports, and indicates that the sky is clear below 12, 000 feet. There may be undetected clouds above that height.**
  - **SKC is used for non-automated reports where there are definitely no clouds in the sky.**
- ***Few* – up to ¼ (coded as FEW)**
- ***Scattered* up to ½ (coded as SCT)**
- ***Broken* – over ½, but less than total (coded as BKN)**
- ***Overcast* – total (coded as OVC)**
- ***Obscured* – sky cover not discernible due to obscuration (fog, smoke, blowing sand, etc.)**
  - **In METAR this is coded as VVhhh where hhh is the vertical visibility, or VV/// which means vertical visibility not determined.**
  - **A *partial obscuration* is when 1/10 to 9/10 (but not all) of the celestial dome is obscured.**
- ***Thin* – Used when at least half of the clouds at a particular level are transparent.**
  - **Thin is coded with a minus sign before the sky cover (e.g., –BKN200)**

CEILING

- ***Ceiling* is the height of the lowest layer of clouds at which sky cover is broken or overcast, and is not classified as *thin*.**
  - **An obscuration also counts as a ceiling, with the ceiling being the vertical visibility into the obscuration.**
  - **A *partial* obscuration *<u>does not</u>* count as a ceiling.**
- **Examples**

`SCT120 OVC250` – Ceiling would be 25,000 feet

`SCT120 BKN150 OVC250` – Ceiling would be 15,000 feet

`BKN080 BKN150 OVC250` – Ceiling would be 8,000 feet

`-BKN080 SCT 120 BKN150 OVC250` – Ceiling would be 15,000 feet

`VV004` – Ceiling would be 400 feet