Precipitation Processes

- **Rainfall occurs when raindrops become so large, gravity cannot keep them in the air.**
- **In warm clouds (clouds having temperatures greater than 0°C), the collision-coalescence process produces precipitation.**
- **Collision**
    - **The largest drop (i.e., the collector drop) will collect some of the drops in its path when it falls.**
- **Coalescence**
    - **When a 'collector drop' and smaller drop come together, two things can happen:**
        - **They can combine to form a single, larger drop.**
        - **They can bounce apart.**
    - **Most times, the two drops stick together.**
        - **This is known as 'coalescence'.**
- **Collision and Coalescence is the primary method for producing precipitation in the Tropics.**
- **In the middle latitudes, clouds that produce precipitation usually have freezing temperatures.**
    - **As a result, precipitation is usually created by another mechanism.**
        - **This involves the coexistence of ice crystals and supercooled water droplets.**
        - **This is known as the Bergeron-Findeisen process, or just the 'Bergeron process' for short.**
- **Bergeron process**
    - **In a cloud where ice crystals and supercooled droplets (liquid droplets in subfreezing environments) coexist, the rate of condensation onto the liquid droplet equals the rate of evaporation.**
        - **As a result, some of the water vapor in the air is deposited directly on the ice crystal.**
        - **Afterwards, this will result in the liquid droplet evaporating.**
        - **When the liquid droplet evaporates, even more deposition occurs on the ice crystals.**
        - **Very simply, ice crystals continue to grow as the supercooled droplets evaporate.**

Forms of Precipitation

- **Snow**
    - **Forms from the growth of ice crystals through deposition.**
    - **Reaches the surface as snow if it never melts from the cloud base all the way to the ground.**

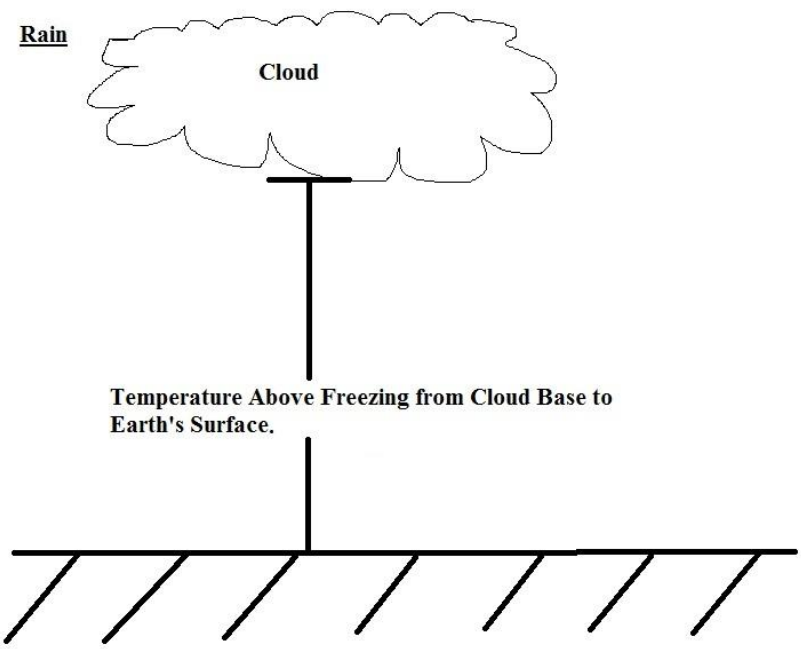
- **In the eastern United States, there is a rather sharp cut-off in annual snowfall south of 40°N latitude.**
    - **This is due to the lack of major snowstorms on a year-to-year basis south of that latitude.**

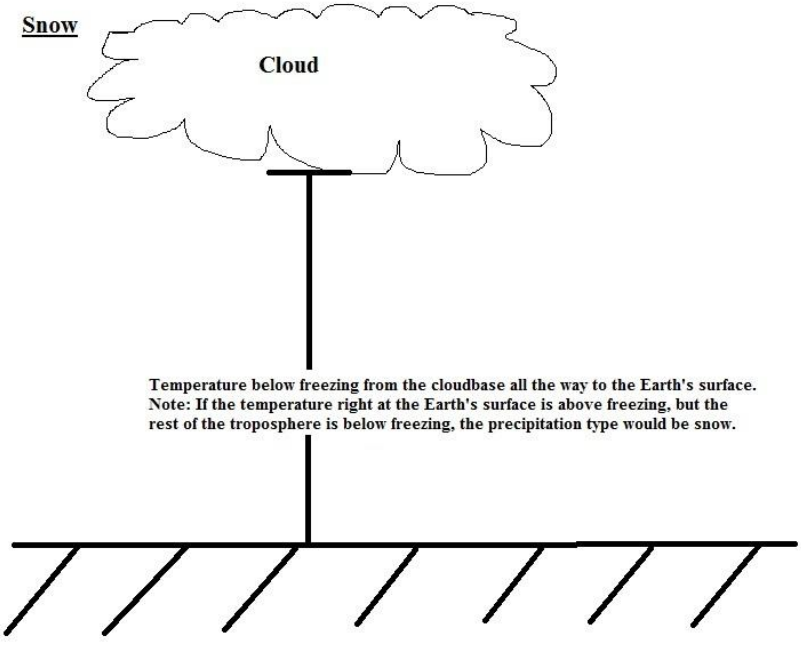
- **Rain**
    - **Observed when precipitation falls from a cloud base with the temperature from the cloud base all the way to the surface above freezing.**
        - **Even if the base of the cloud is below freezing (precipitation formed by the Bergeron process), precipitation at the surface can end up being rain if the air at the surface has a sufficient depth above 0°C (the freezing point).**
- **Hail**
    - **Ice pellets in concentric layers.**
    - **Forms when a water droplet is carried in an updraft to a portion of the thunderstorm where the temperature is below freezing.**
        - **As a result, hail begins to form.**
    - **When the hailstone is too heavy for the updraft, it begins to fall toward the base of the thunderstorm where the temperature is above freezing.**
        - **As a result, the hailstone collides with liquid droplets. Therefore the hailstone has a coat with liquid water.**
    - **If the same hailstone is again carried by an updraft to a portion of the thunderstorm where the temperature is below freezing, the coat of liquid water freezes to form a second layer of ice.**
        - **This process continues until the updraft cannot carry the hailstone and it falls toward Earth.**
- **Sleet**
    - **Begins at the cloudbase as a snowflake. As it falls through the atmosphere it encounters a thin layer where the temperature is above 0°C.**
        - **As a result, it partially melts.**
    - **As it approaches the Earth's surface, if the temperature is below 0°C, it can re-freeze and therefore become sleet (also known as an ice pellet).**
    - **Develops along warm fronts.**
- **Freezing Rain**
    - **Develops when the temperature profile is above freezing from the base of the cloud all the way to just above the surface of the Earth.**
        - **As a result, it leaves the cloud as rain and remains rain until it hits the ground where**

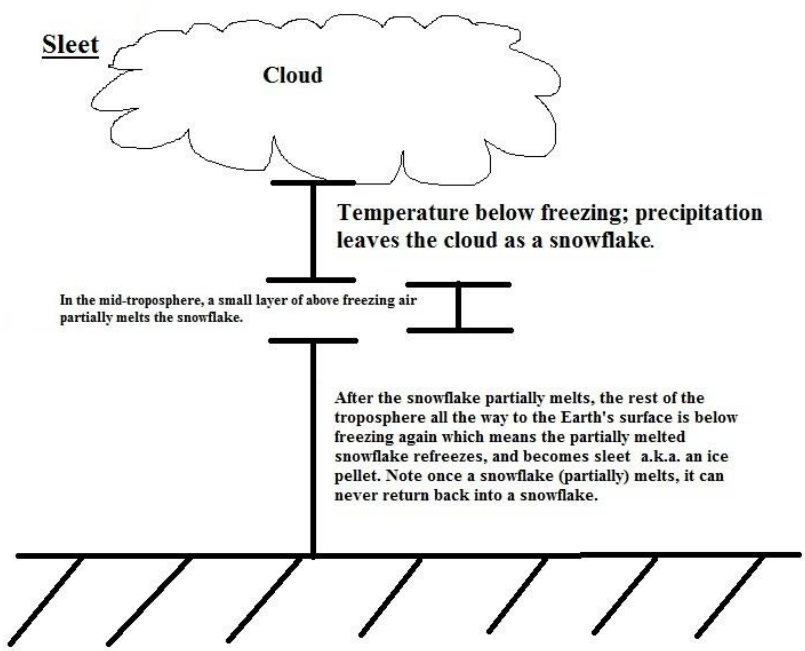
temperatures are below 0°C, which means the rain instantly freezes on contact.

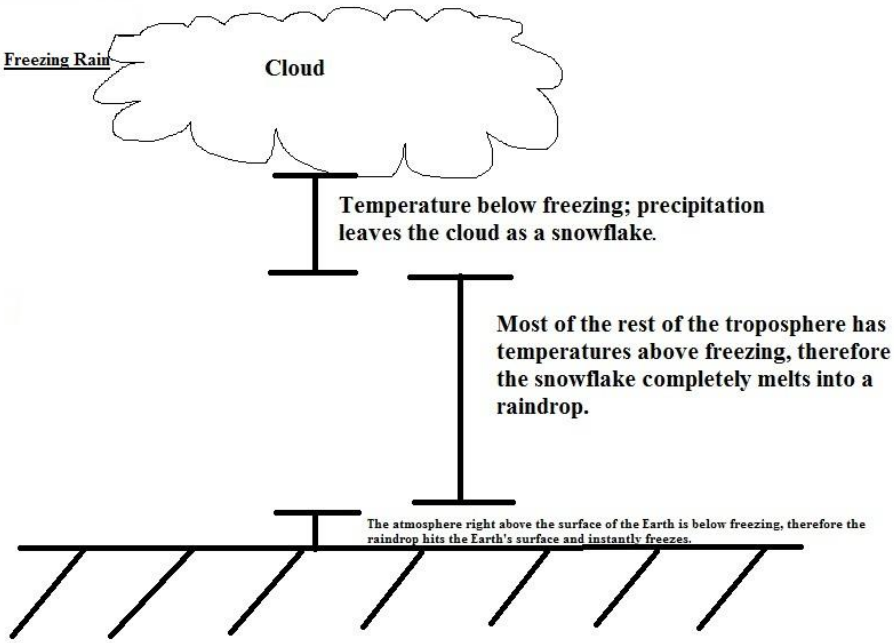
Helpful Link:

http://weather.cod.edu/sirvatka/bergeron.html






Sleet
Cloud
Temperature below freezing; precipitation leaves the cloud as a snowflake.
In the mid-troposphere, a small layer of above freezing air partially melts the snowflake.
After the snowflake partially melts, the rest of the troposphere all the way to the Earth's surface is below freezing again which means the partially melted snowflake refreezes, and becomes sleet a.k.a. an ice pellet. Note once a snowflake (partially) melts, it can never return back into a snowflake.


Freezing Rain
Cloud
Temperature below freezing; precipitation leaves the cloud as a snowflake.
Most of the rest of the troposphere has temperatures above freezing, therefore the snowflake completely melts into a raindrop.
The atmosphere right above the surface of the Earth is below freezing, therefore the raindrop hits the Earth's surface and instantly freezes.