Review of Winter Precipitation Guidelines

1000-500 mb Thickness:
The 1000-500 mb thickness is often used as a broad, first guess for the rain-snow line. The higher the surface elevation, the higher the 1000-500 mb thickness can be and still have snow. For a surface elevation of under 1000 ft, a 5400 m thickness value approximates the rain-snow line, but for an elevation of 3700 ft, 5460 m works better as a snow discriminator.

If a deep isothermal layer at or below 0 C exists in the low-levels (with cold, saturated air above), then snow can occur at 1000-500 mb thickness values greater than 5400 m (perhaps even 5460-5480 m). This is because the isothermal layer (i.e., temperatures constant with height) would result in a higher mean layer temperature and higher thickness values. As long as there is sufficient cold air aloft for ice crystal formation, heavy snow will often occur with a deep isothermal layer close to 0º C and a 1000 to 500 mb thickness greater than 5400 meters due to relatively high precipitable water values. **Please note that while this is often the most talked about thickness consideration, it is the least useful.

1000-700 mb Thickness:
This is a better indicator of the rain-snow line than is 1000-500 mb thickness. A 1000-700 mb thickness of about 2840 m is the critical value for the rain-snow line at elevations less than 1000 ft but that increases to 2860 m for elevations of 3000 ft. Again, for deep isothermal layers near 0º C, snow can occur at higher 1000-700 mb thickness values, so be sure to closely evaluate forecast soundings in addition to (or even more so than) thicknesses when determining precipitation type. While 1000-700 mb thickness is useful to help differentiate between rain and snow, the layer must be subdivided to determine the potential for sleet and freezing rain.

1000-850 mb Thickness:
The 1000-850 mb layer can be used in conjunction with 850-700 mb thickness to help determine sleet and freezing rain potential. However, this should not replace an analysis of current and forecast soundings, and surface temperatures. For shallow cold air events (such as arctic air or cold air damming), the 1000-850 mb layer will not represent the strength of the subfreezing layer well (i.e., freezing rain may occur despite a thickness value over 1300 m).

Critical values:
Less than 1290 m: The entire layer is below freezing so frozen or freezing precipitation will occur.

1290-1300 m: Small part of the layer is at or above freezing but frozen or freezing precipitation still is likely

1300 m: Part of the layer is above and part is below 0 C; critical value for differentiating precipitation type; all precipitation types possible.

Greater than 1300 m: Significant portion of the layer is above 0 C, so rain is favored unless evaporative cooling in an unsaturated layer can sufficiently cool the layer.

850-700 mb Thickness:
The 850-700 mb layer is used in conjunction with 1000-850 mb thickness to determine sleet and freezing rain potential. The 850-700 mb layer often approximates the depth and strength of the elevated melting layer in freezing precipitation regimes.

Critical values:
Less than 1540 m: The entire layer is below freezing so snow or rain should occur.

1540 m: Part of the layer is above and part is below 0 C; critical value for differentiating precipitation type; all precipitation types possible.

1540-1555 m: Significant portion of the layer is above 0 C, so freezing rain or sleet is favored if a subfreezing layer exists below this layer, or rain is favored if warm air resides below.

More than 1555 m: Most or all of the layer is above 0 C, so complete melting should occur with rain or freezing rain at the surface, depending on low-level temperatures.

Determining Winter Precipitation Type via Forecast Soundings

Assuming fairly cold temperatures
Assuming enough vertical motion for precipitation to occur

1. **Check for moisture (Dew Depression < 5°C) in the snow growth region (-12°C to -18°C)**
   a. Temps warmer than °C – all liquid water
   b. Temps between 0°C and -10°C – mostly supercooled water
   c. Temps between -12°C and -18°C – large snowflake growth
   d. Temps colder than -20°C – small ice crystal growth

2. **Check for any melting layers (warmer than 0°C)**
   a. Temps between 0°C and +1°C – very little melting, so the snowflake retains its identity as a snowflake (wet snow)
   b. Temps between +1°C and +3°C – partial melting, so there is mostly liquid water with an ice nucleus. No longer identifiable as a snowflake. (sleet becomes more likely)
   c. Temps warmer than +3°C – complete melting, so there is all liquid water. (rain or freezing rain now likely)

3. **Check for any secondary sub-freezing layers (dependent upon whether or not there were any melting layers)**
   a. A deep freezing layer means that precipitation will likely reach the ground as sleet if only partial melting occurred in the melting layer and/or precipitation will reach the ground as freezing rain if complete melting occurred in the melting layer.
   b. A shallow freezing layer means that precipitation will likely reach the ground as freezing rain if either partial or complete melting occurred in the melting layer.

4. **Check for any significant dry layers (Dewpoint Depressions greater than 10-15°C minimum, greater than 20°C is definitely significant)**
   a. A deep and very dry layer will promote evaporation or sublimation of precipitation prior to reaching the ground.

5. **Check the temperatures at the surface for any precipitation accumulation that might occur.**

Additional Forecast Sounding Considerations

- What is the depth of the layer with a wet bulb temperature above freezing?
  - If the depth of the surface based melting layer is < 900 ft, precipitation will most likely be snow at the surface
  - When the freezing level is > 1200 ft complete melting will likely occur and rain will fall at the surface. However, melting layers of 1500-4500 feet may still result in sleet if there is a layer of subfreezing air below, and the ice nuclei remain
  - Melting depends on the size of the snowflake

- What is the wet bulb temperature of the cold layer?
  - If the temperature is < -10º C, freezing nuclei are sufficiently abundant, and enough time is spent in the cold layer, either snow or sleet can occur (not common)
  - Freezing rain is favored if complete melting occurs and cold layer is warmer than -10º C

- What is the depth of the cold layer?
  - Not nearly as important as temperature

Precipitation Type

- Dependent on cloud microphysics--will supercooled droplets or ice crystals form? (freezing rain vs. snow)
- Dependent on the vertical temperature structure
  - Best evaluated through soundings and forecast soundings since critical thickness values miss important details.