Weather 101
Winter Weather

Cory Mueller

NWS-Nashville Meteorologist

Outline

- How do we get snow
- Types of precipitation
- Forecasting snow
- Detecting winter weather
- Winter weather safety tips

How do Winter Storms Form?

Moisture

- To form clouds and precipitation
- Air blowing across a body of water, such as a large lake or the ocean, is an excellent source of moisture

How do Winter Storms Form?

Lift

- Something to raise the moist air to form clouds and cause precipitation
- Examples
  - Low pressure system (trough)
  - Fronts (The boundary between the warm and cold air masses)
  - Air flowing up a mountainside
  - Cold air flowing over a large warm body of water such as the Great Lakes

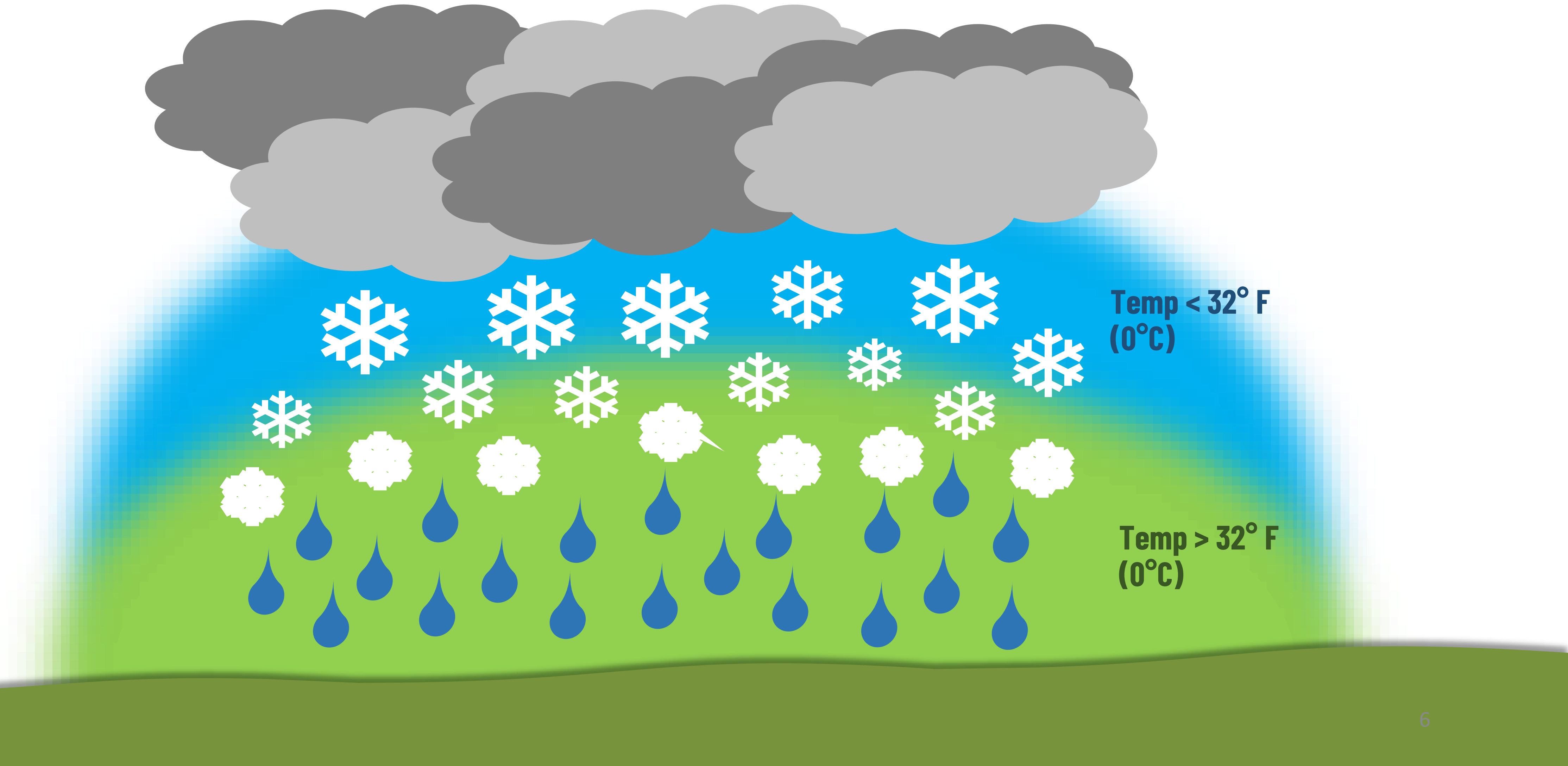
How do Winter Storms Form?

Cold Air

- Below freezing temperatures in the clouds and near the ground are necessary to make snow and/or ice

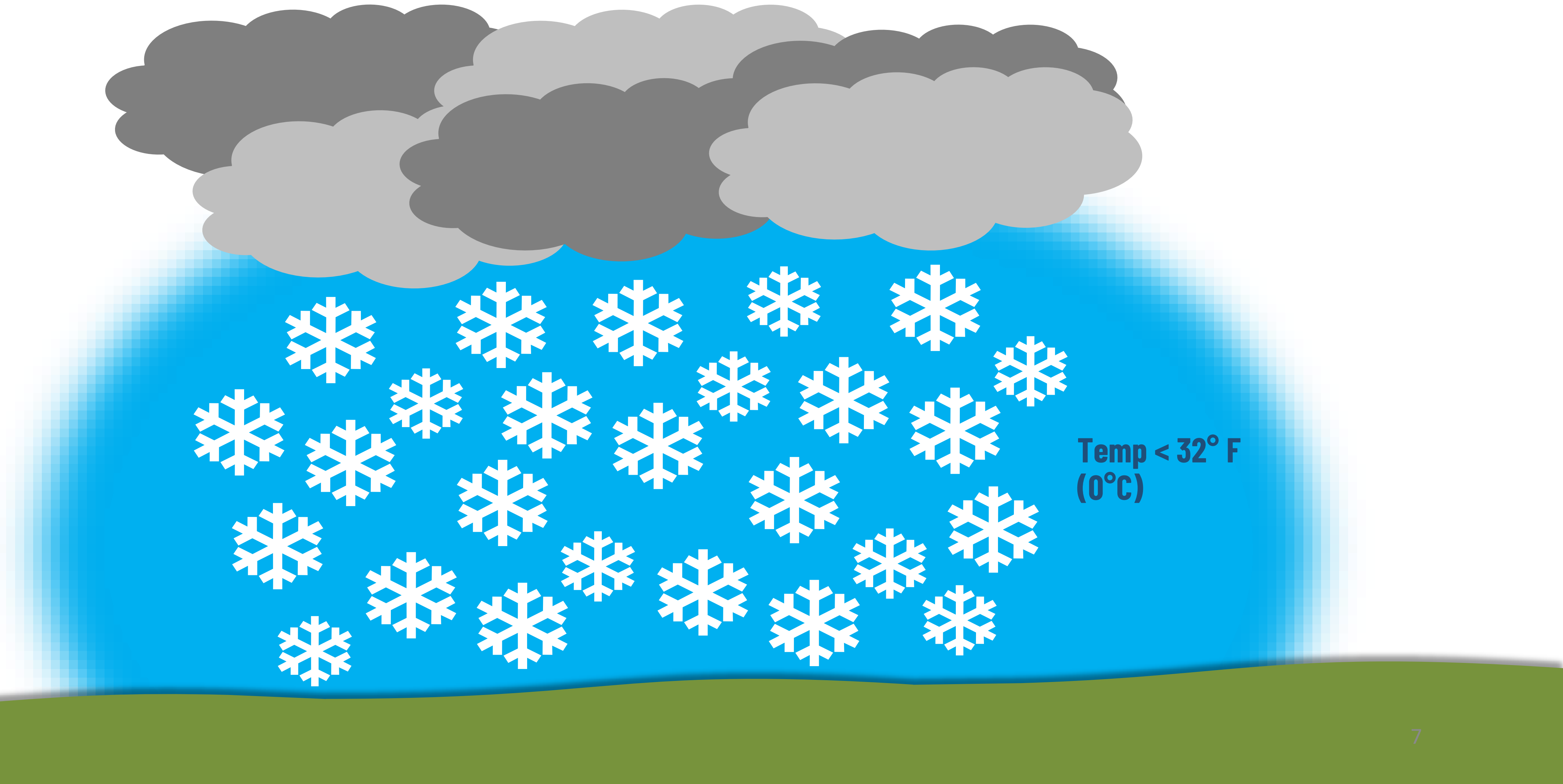
Precipitation Type

All Rain



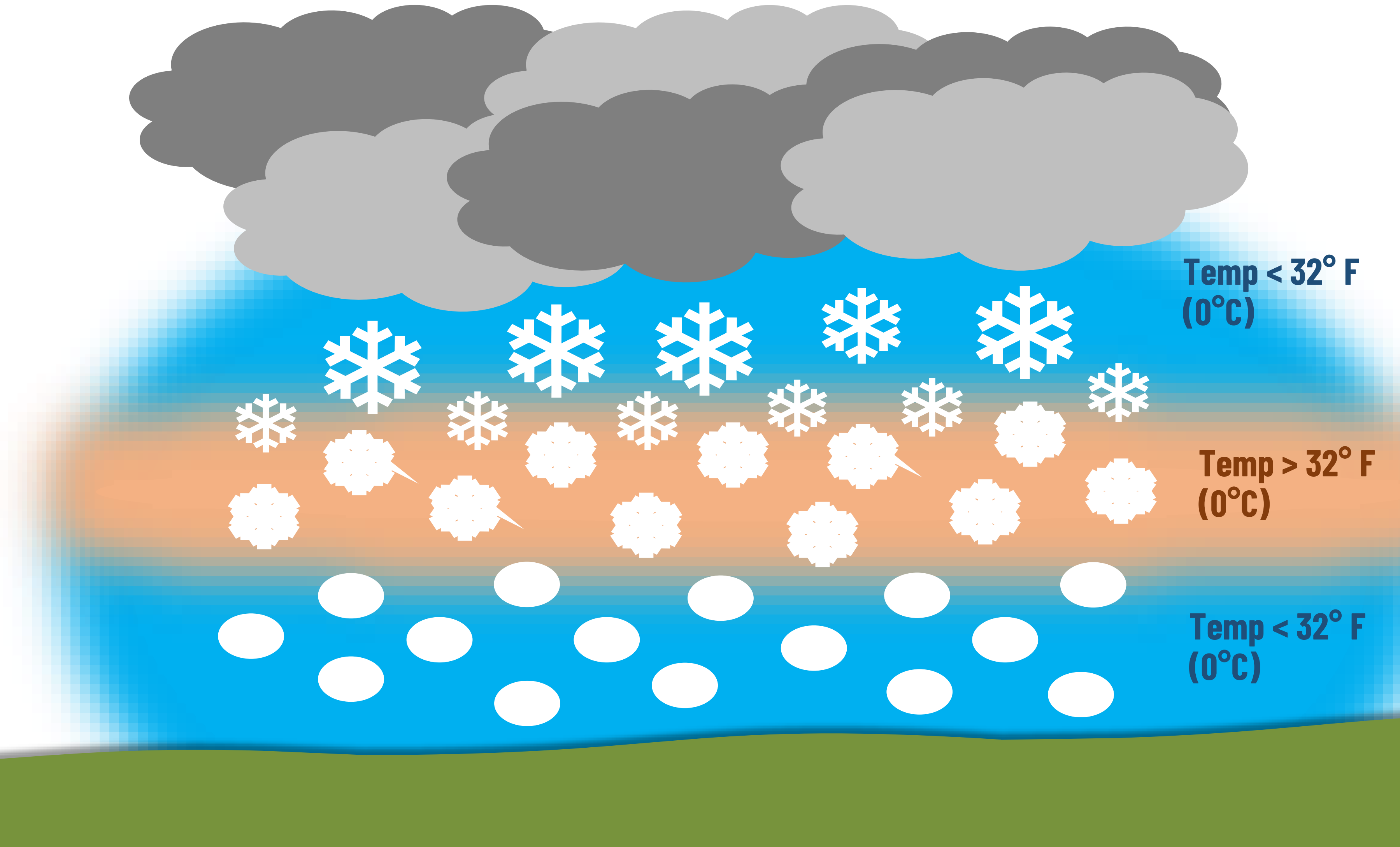
Precipitation Type

All Snow



Precipitation Type

Sleet



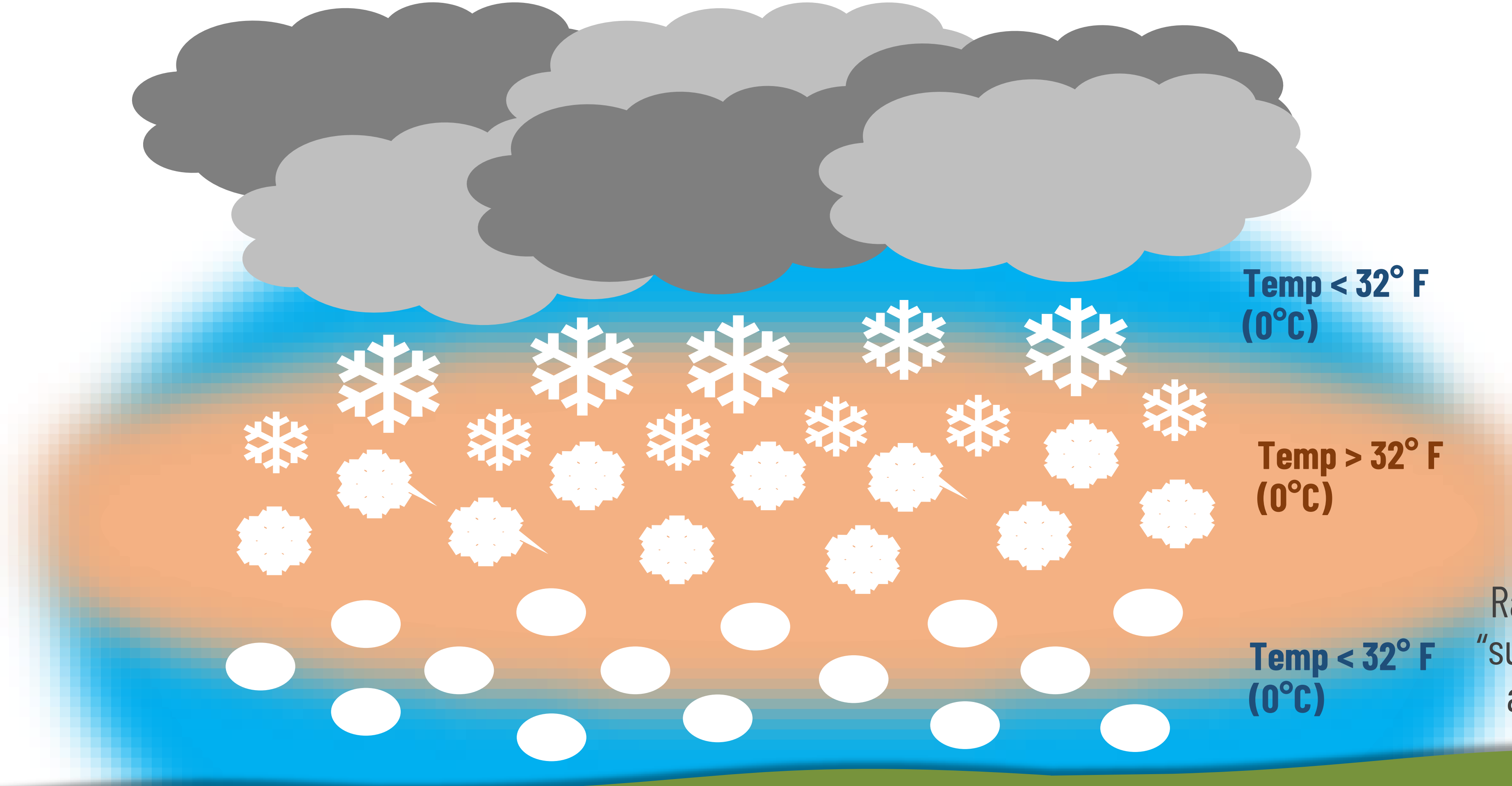
All snow

Partly melted snow

Partly frozen drops refreeze and become SLEET

Precipitation Type

Freezing Rain



All snow

Snow melts completely

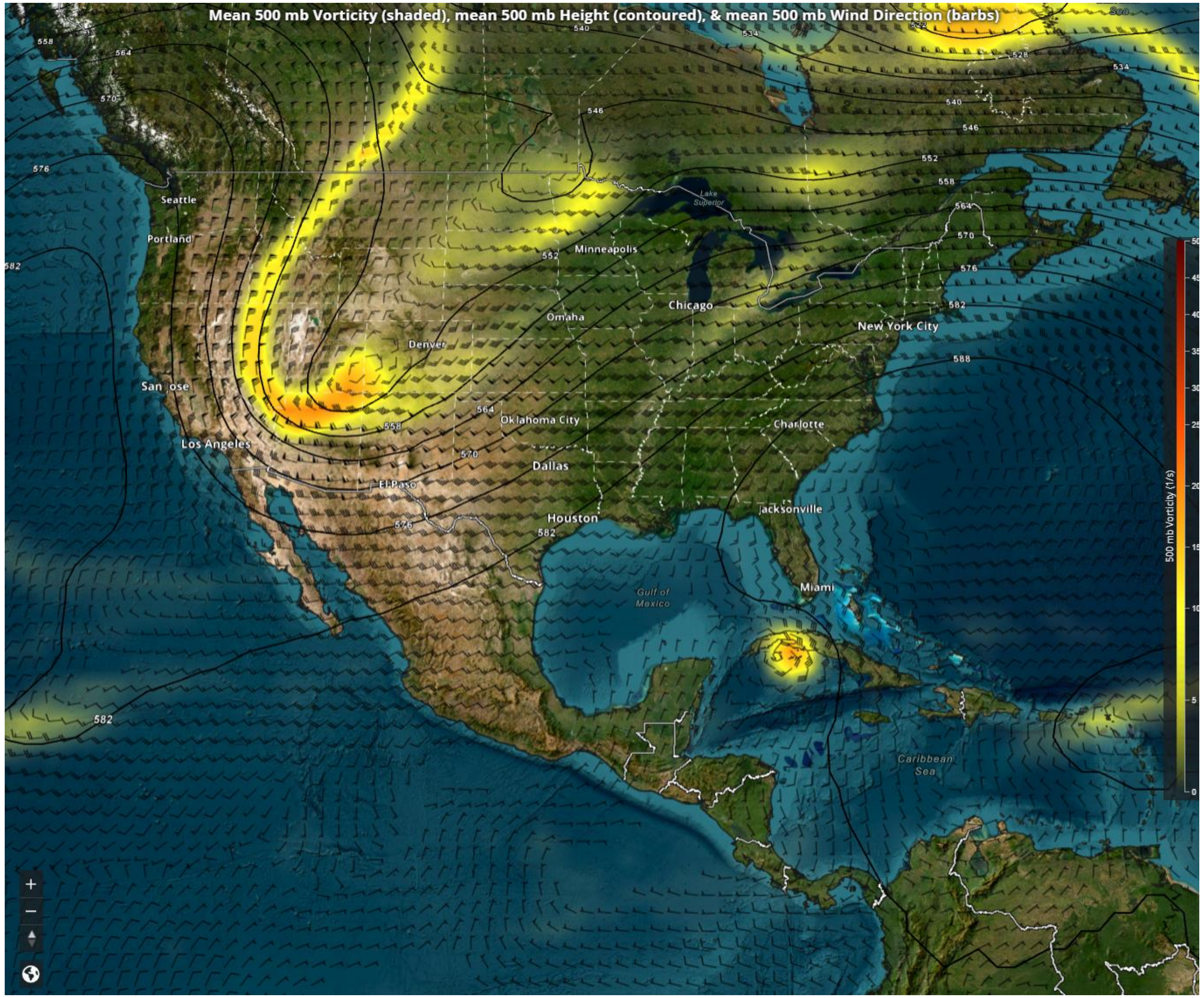
Rain drops become "supercooled" in cold air and freeze on contact cause FREEZING RAIN

Forecasting Snow

- Forecasting snow can be very complicated
- There is a lot you have to look at
- Little changes in track and temperature can make major differences in the forecast

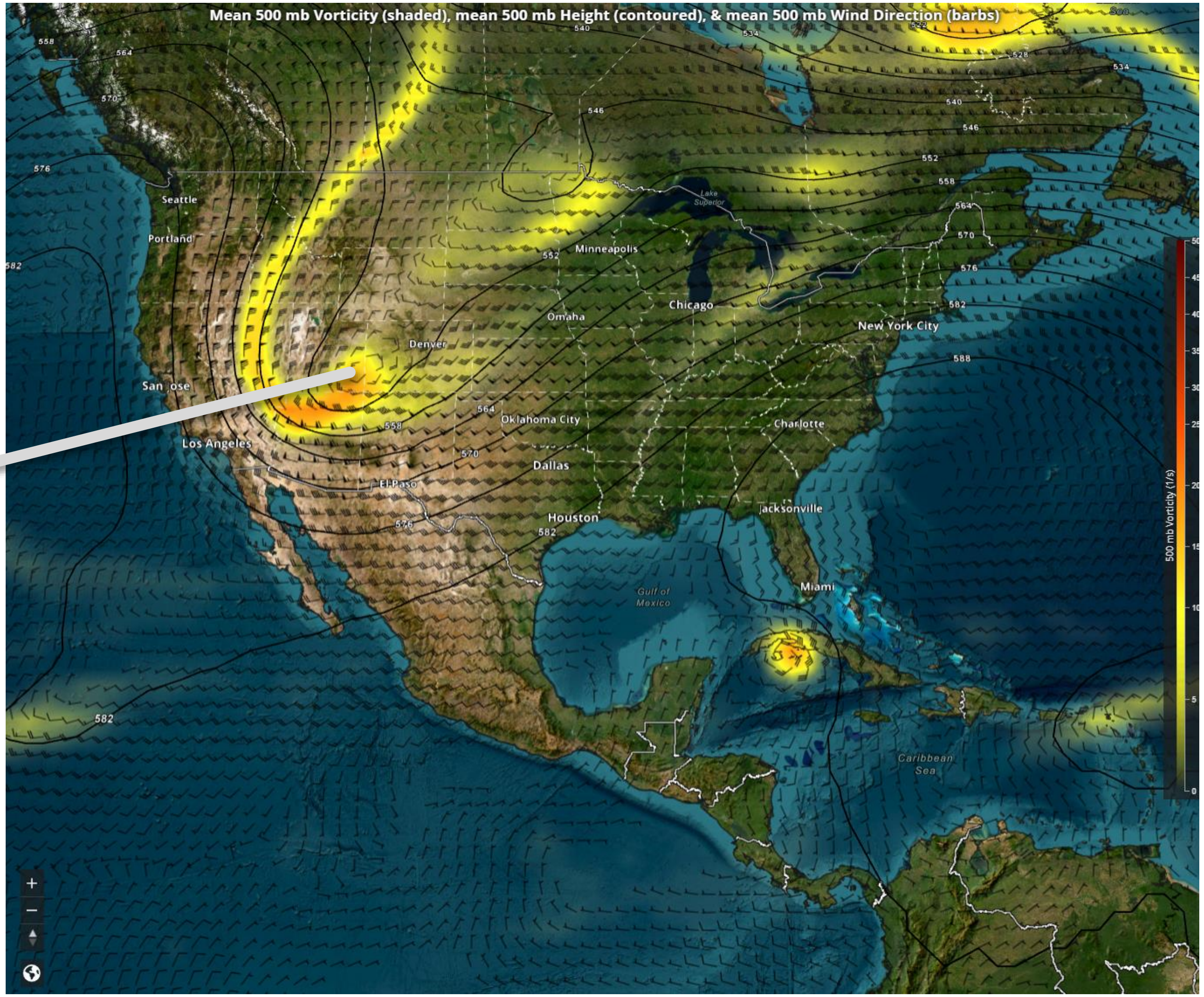
Forecasting Snow

Lift



Forecasting Snow

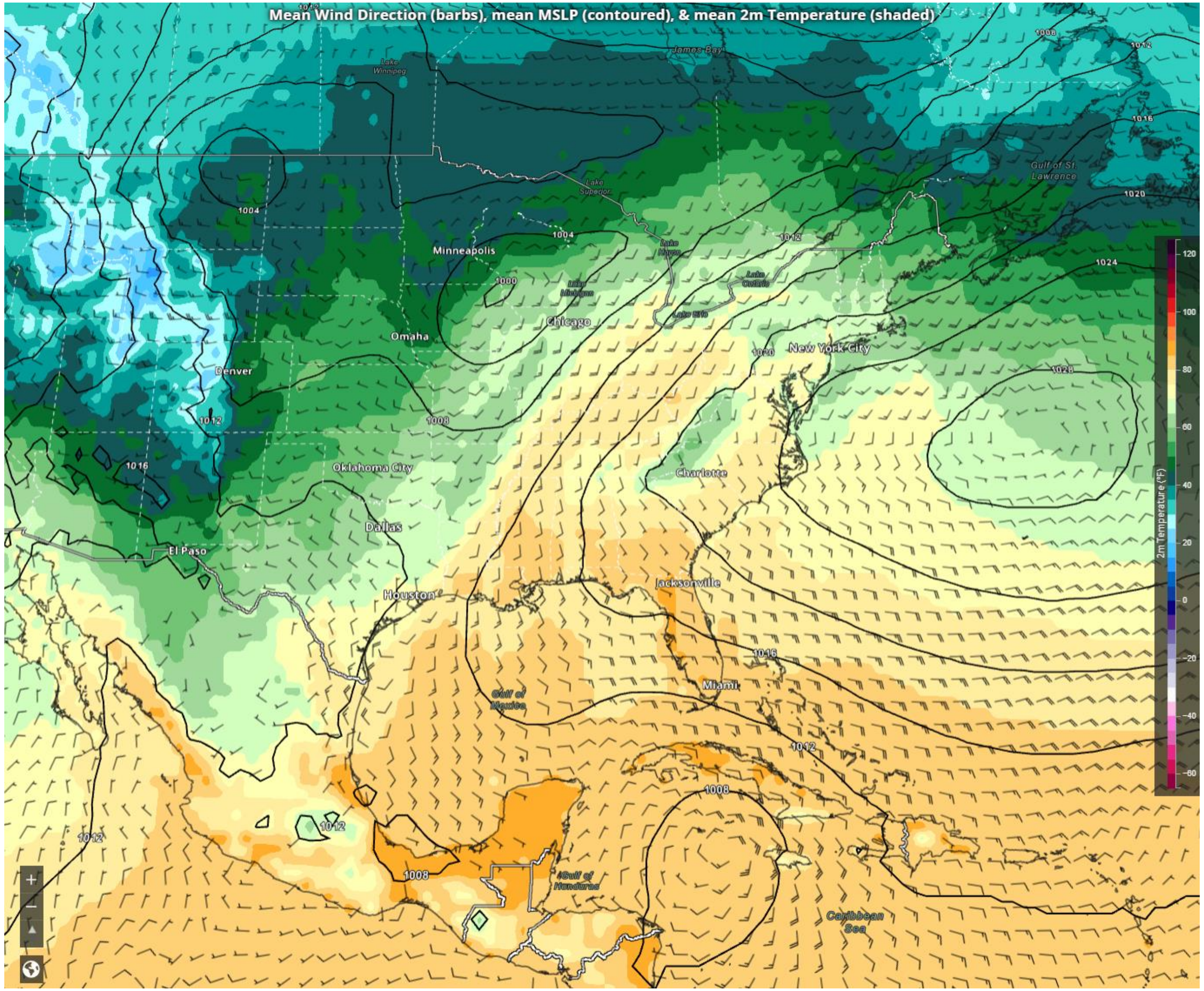
Lift



Trough, promotes lift in the atmosphere

Forecasting Snow

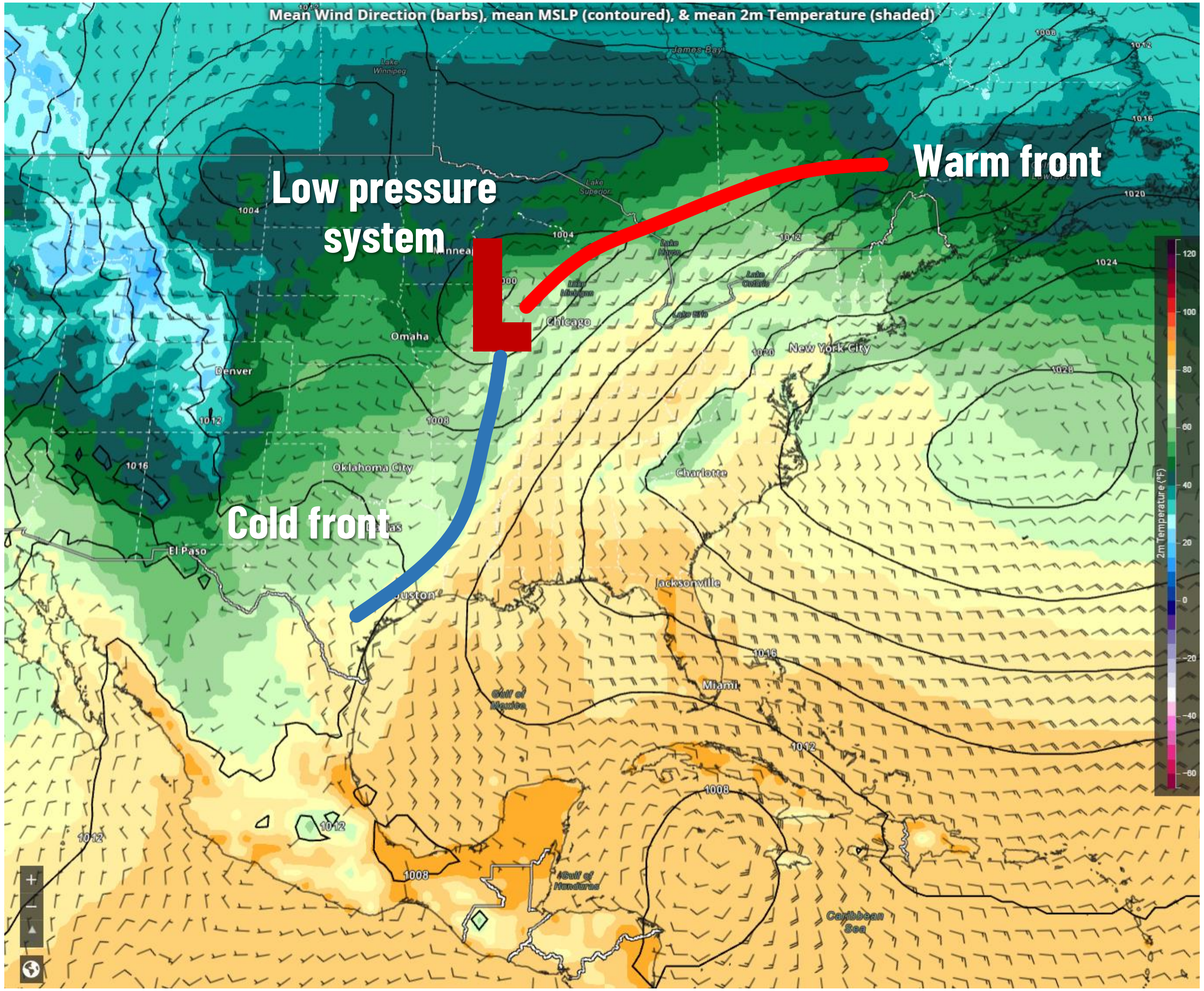
Lift



Forecasting Snow

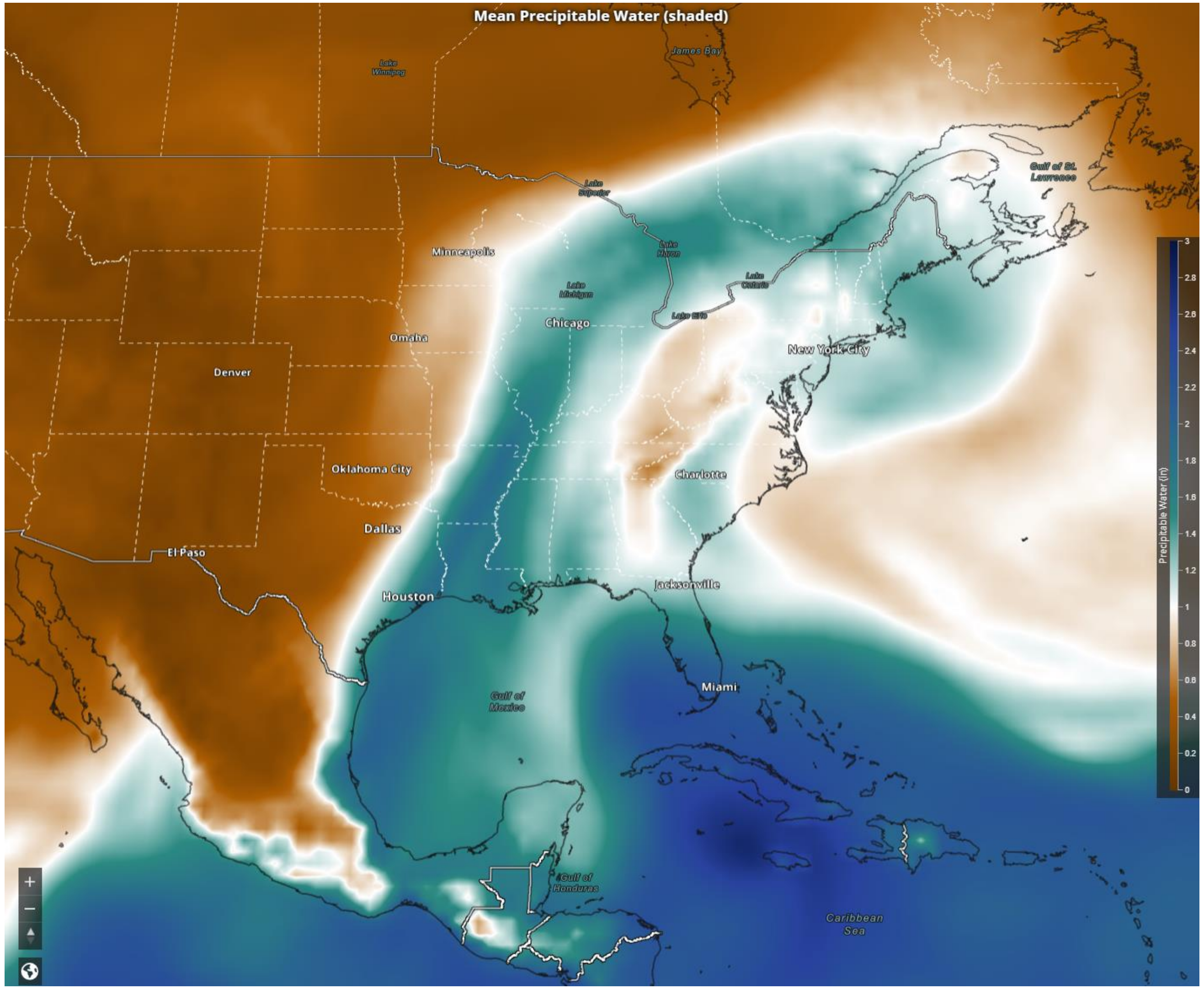
Lift

Fronts, also promotes lift in the atmosphere



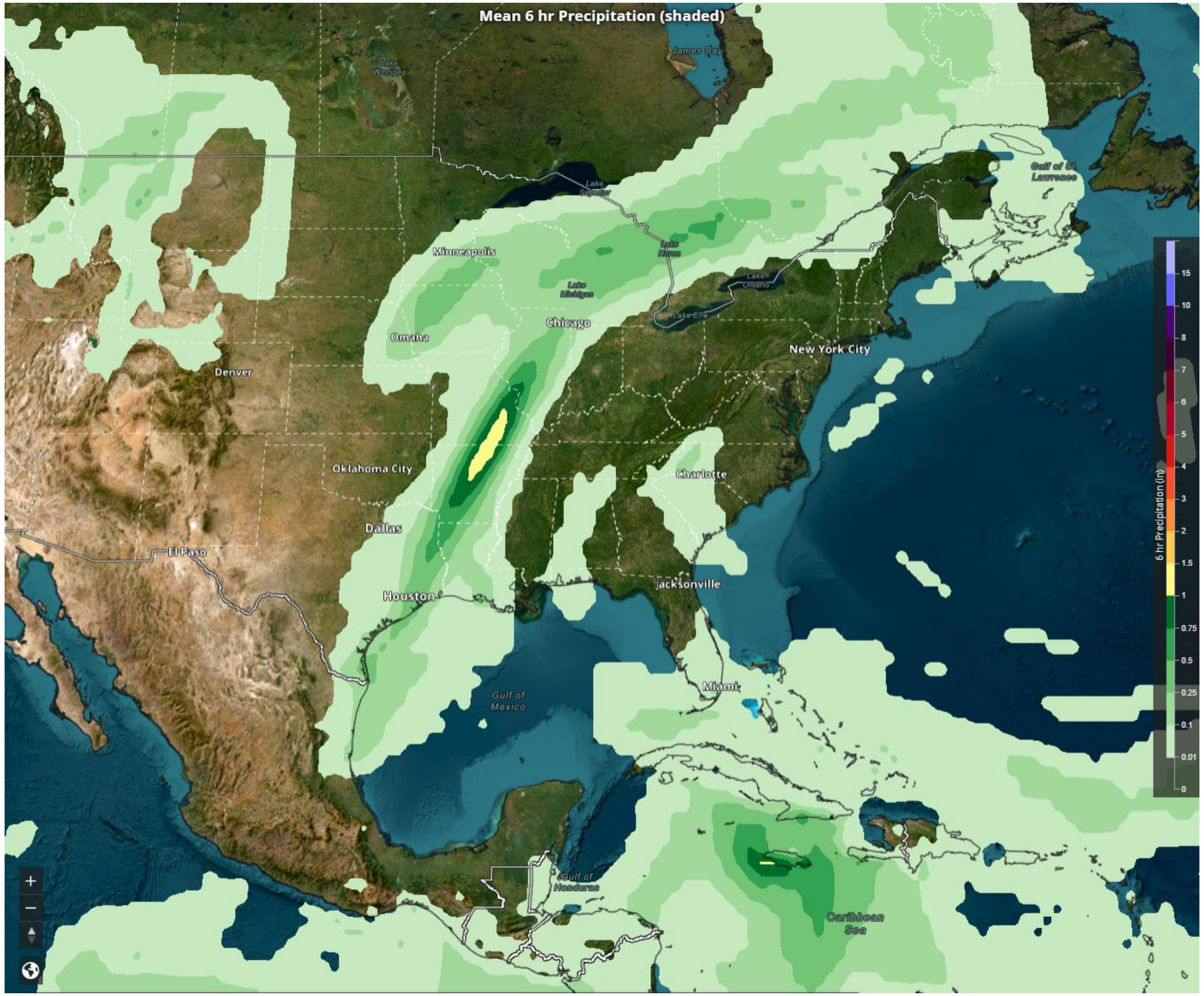
Forecasting Snow

Moisture



Forecasting Snow

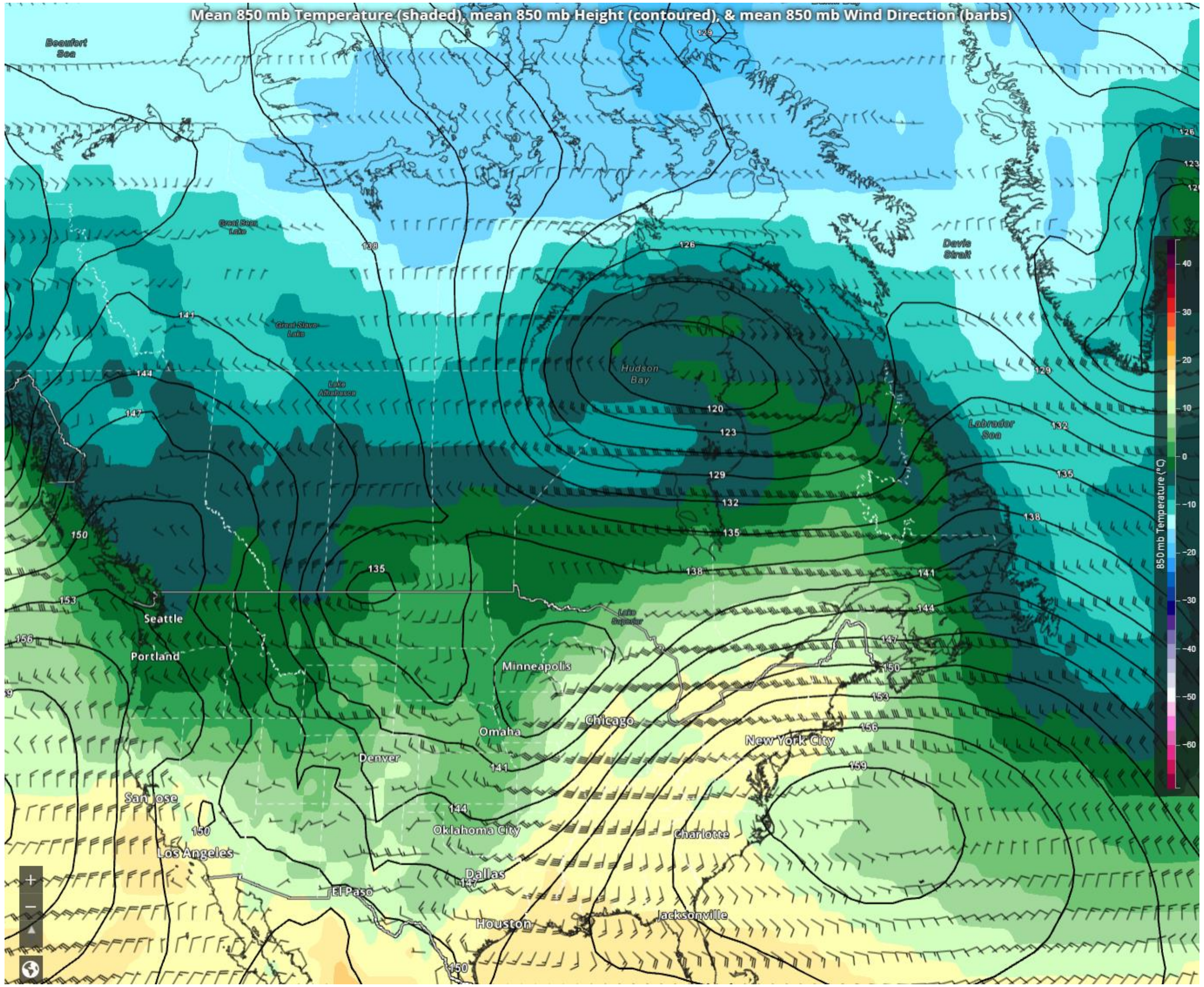
Moisture



Forecasting Snow

Cold Air

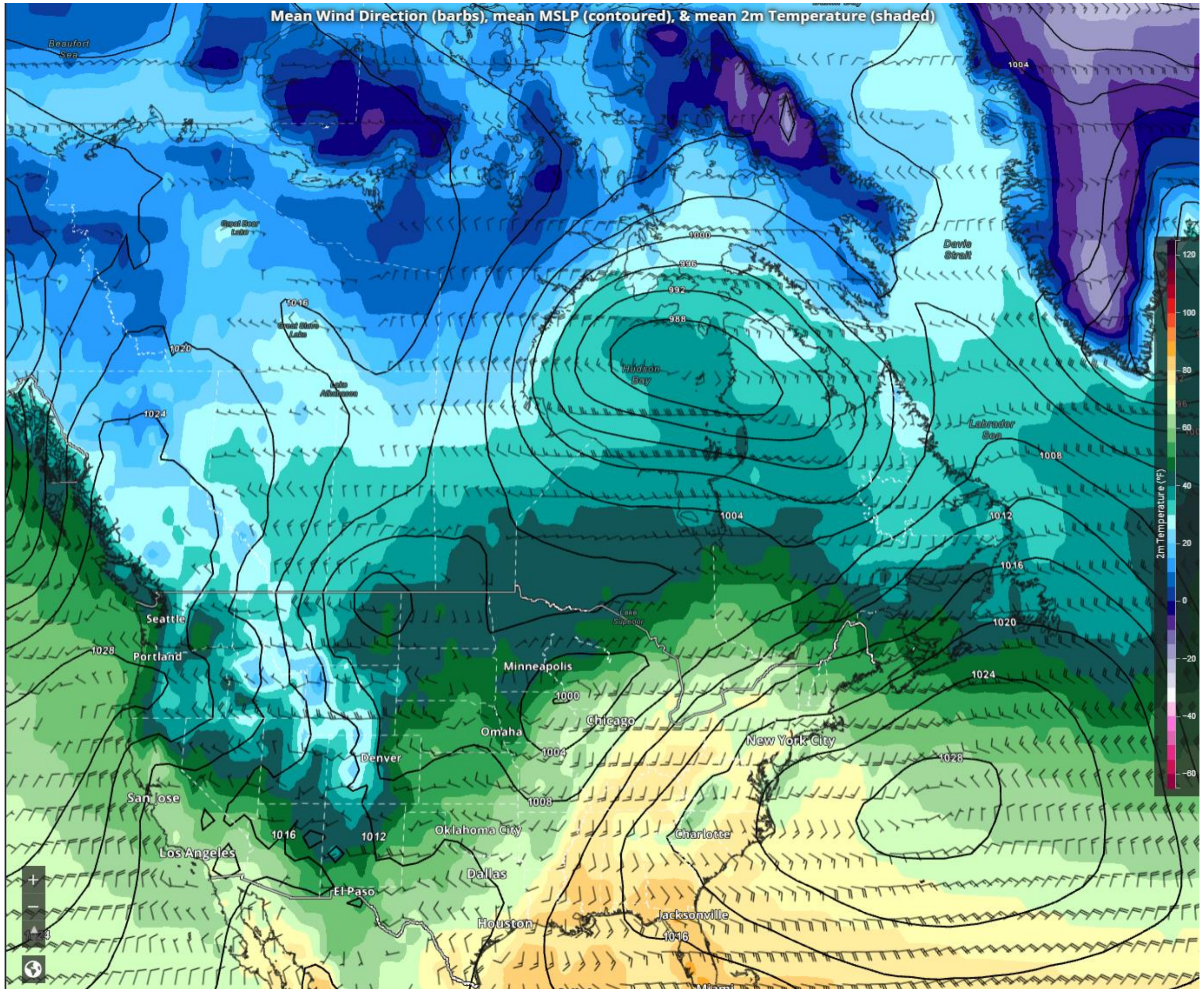
If temperatures above the surface are below freezing or not



Forecasting Snow

Cold Air

Does the cold temperatures at the surface line up with the cold temperatures above the surface



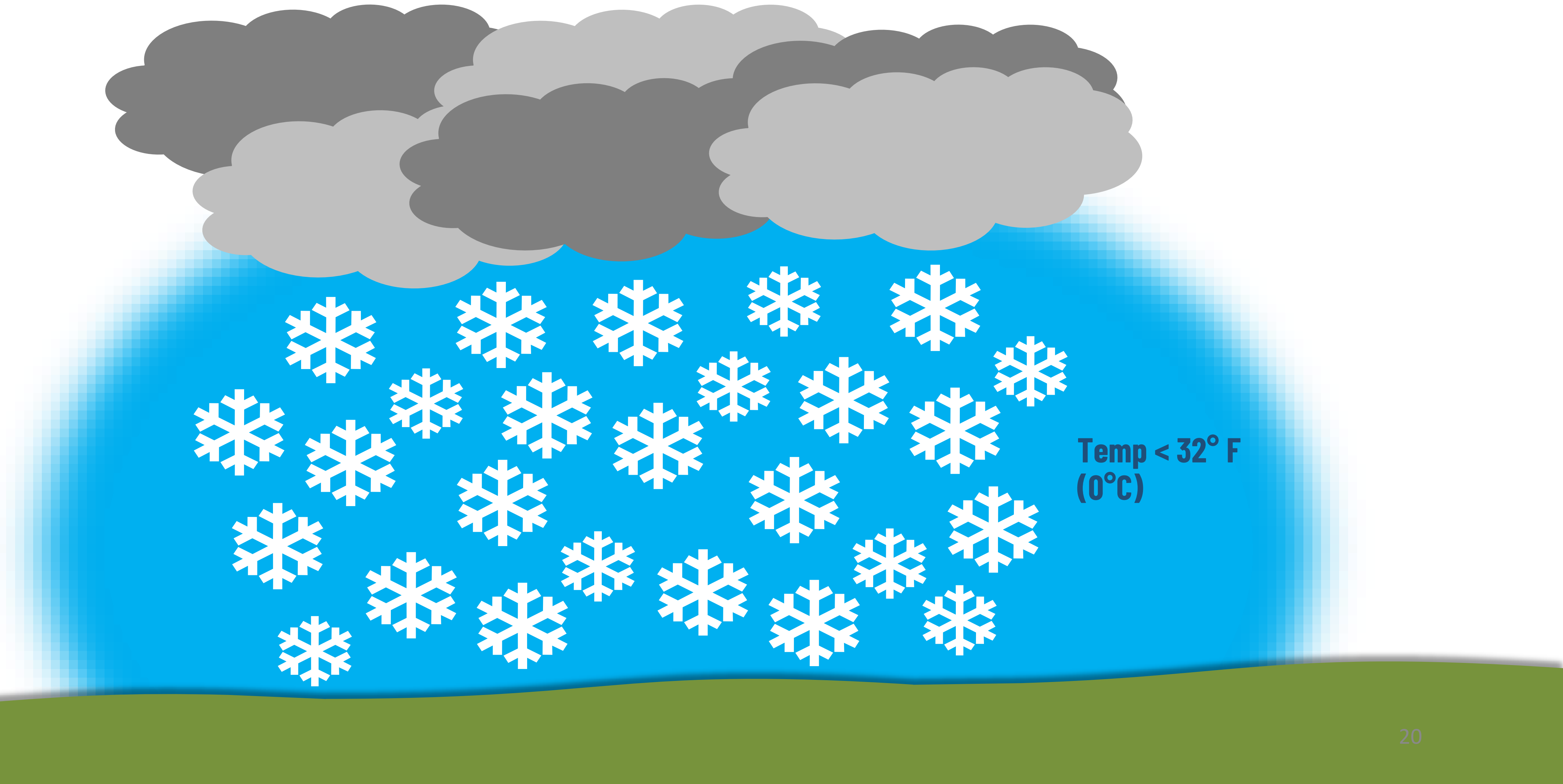
Forecasting Snow

Looking at Atmospheric Soundings

- A sounding is a measurement of the vertical distribution of physical properties of the atmospheric column such as pressure, temperatures, wind, and more.
- 70 NWS offices launch weather balloons twice per day (00 and 12z) that produce these soundings with live conditions
- You can also view model forecast soundings from weather models

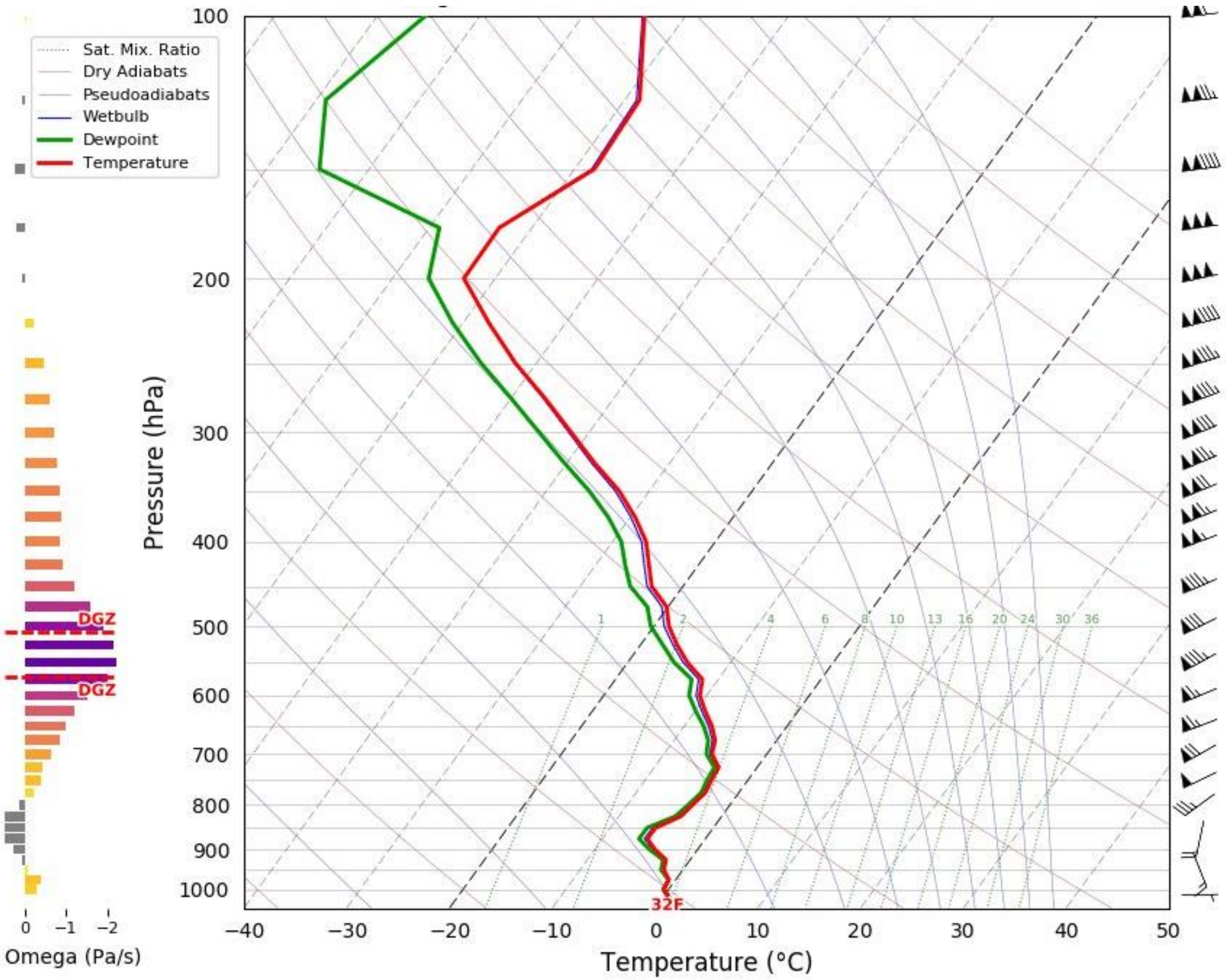
Precipitation Type

All Snow



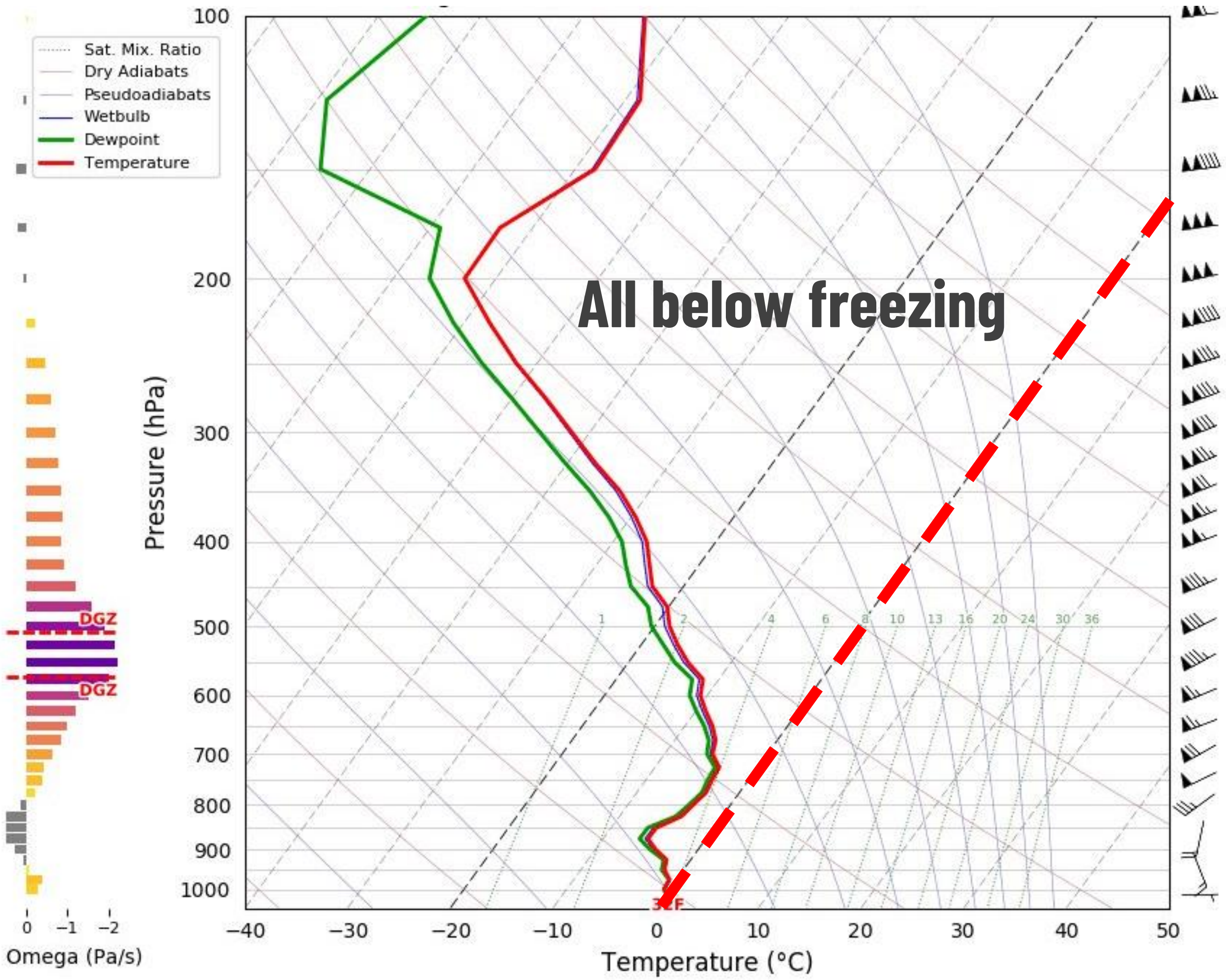
Forecasting Snow

All Snow Sounding



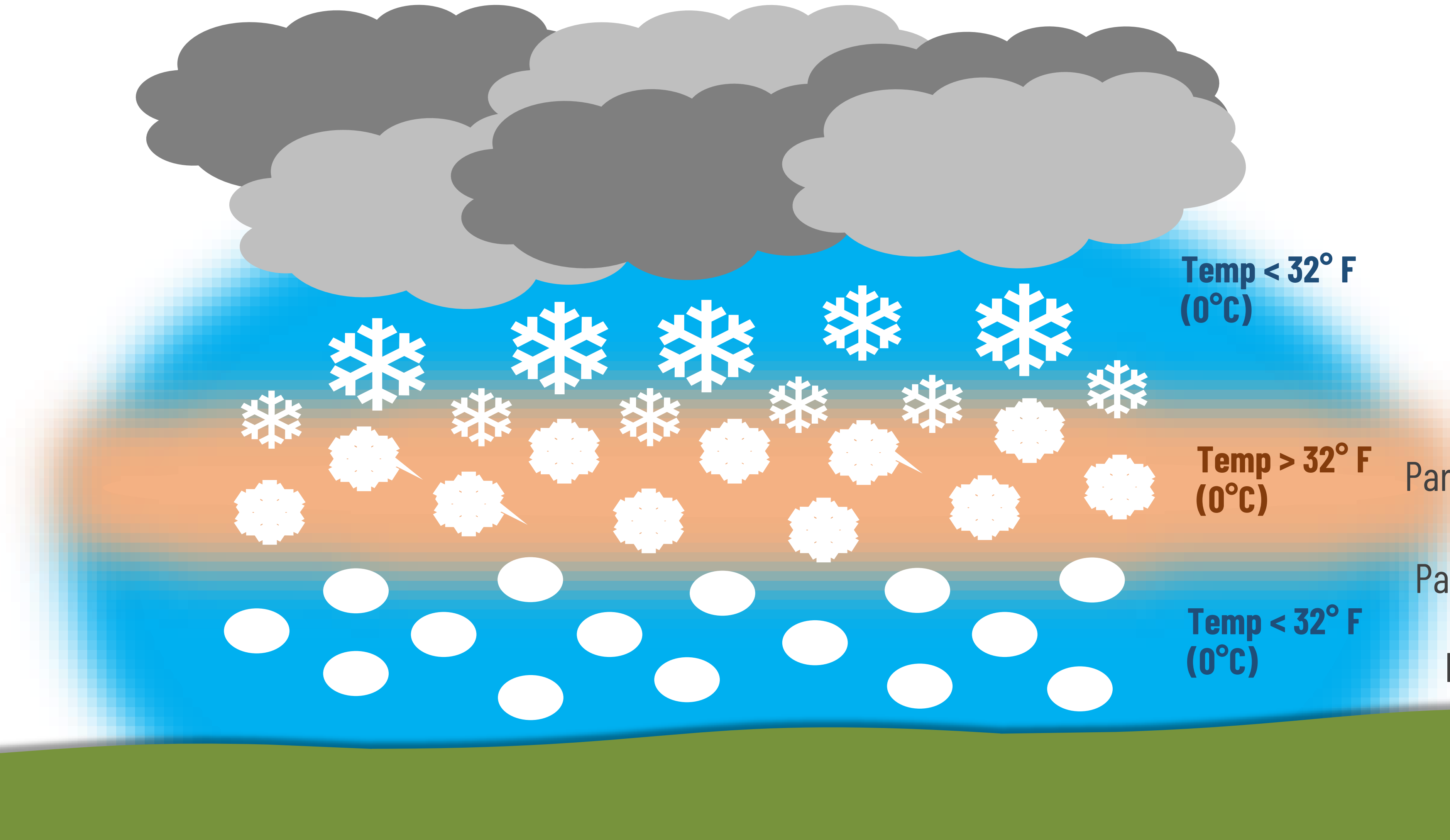
Forecasting Snow

All Snow Sounding



Precipitation Type

Sleet



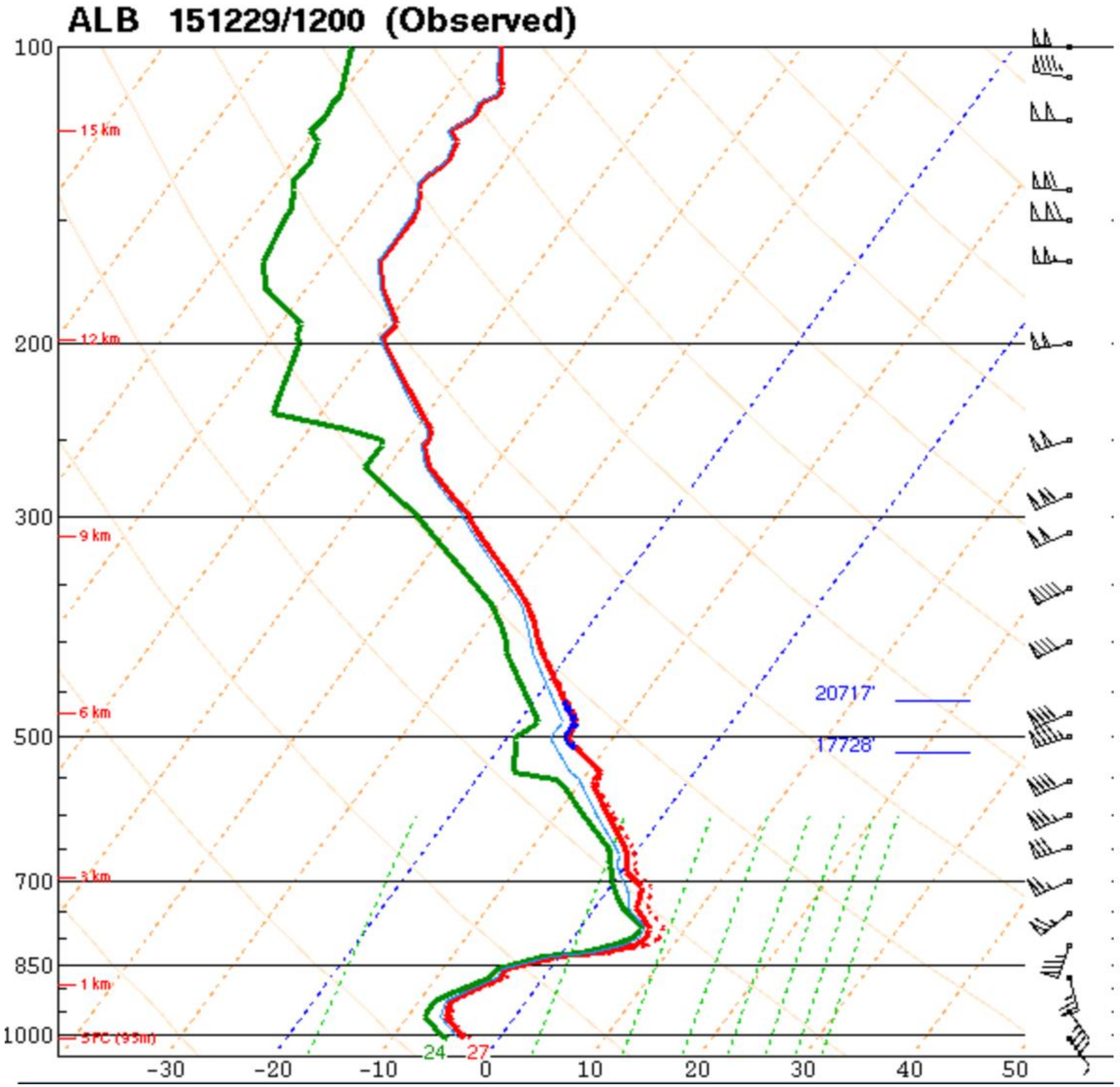
All snow

Partly melted snow

Partly frozen drops refreeze and become SLEET

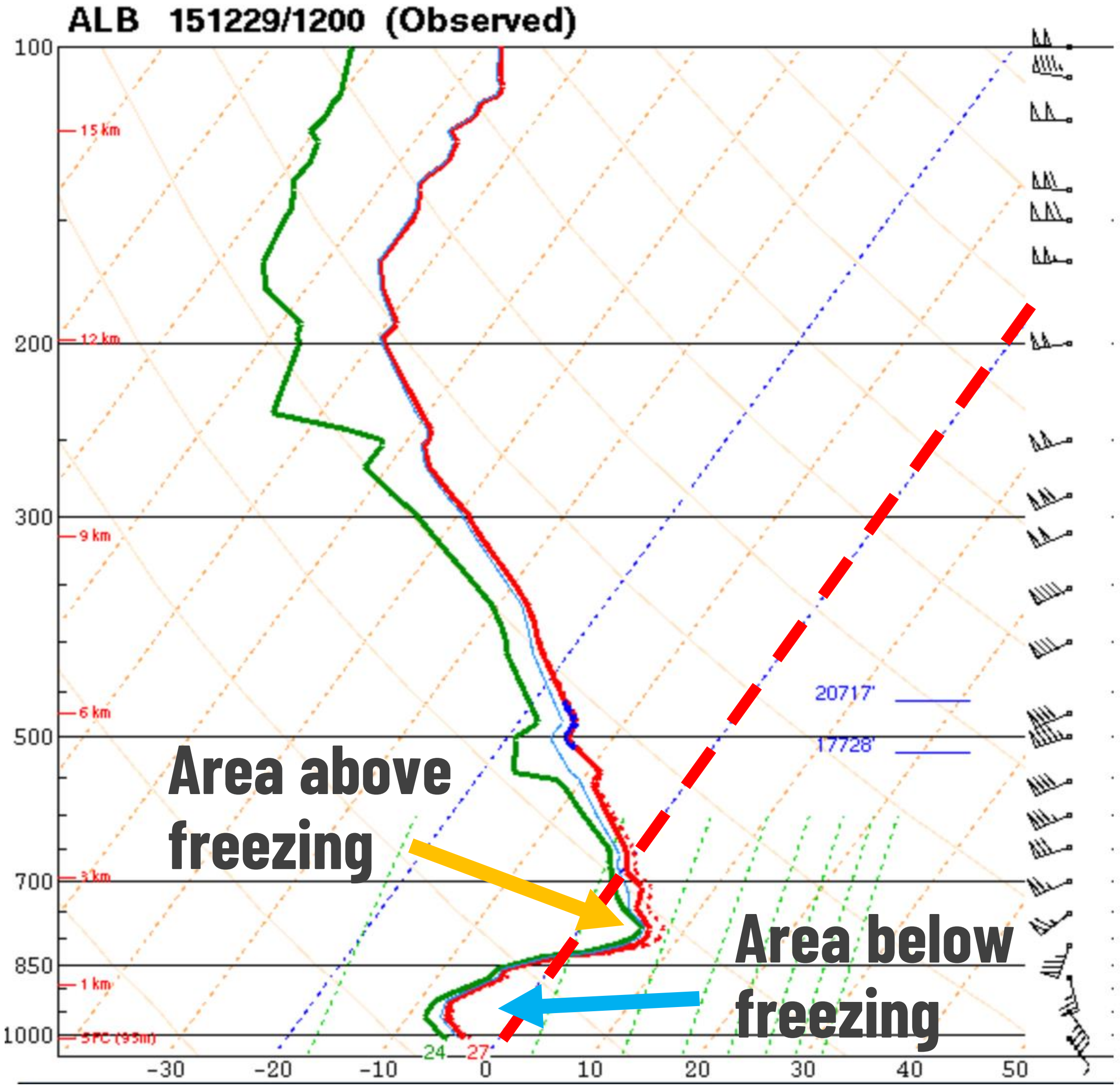
Forecasting Snow

Sleet



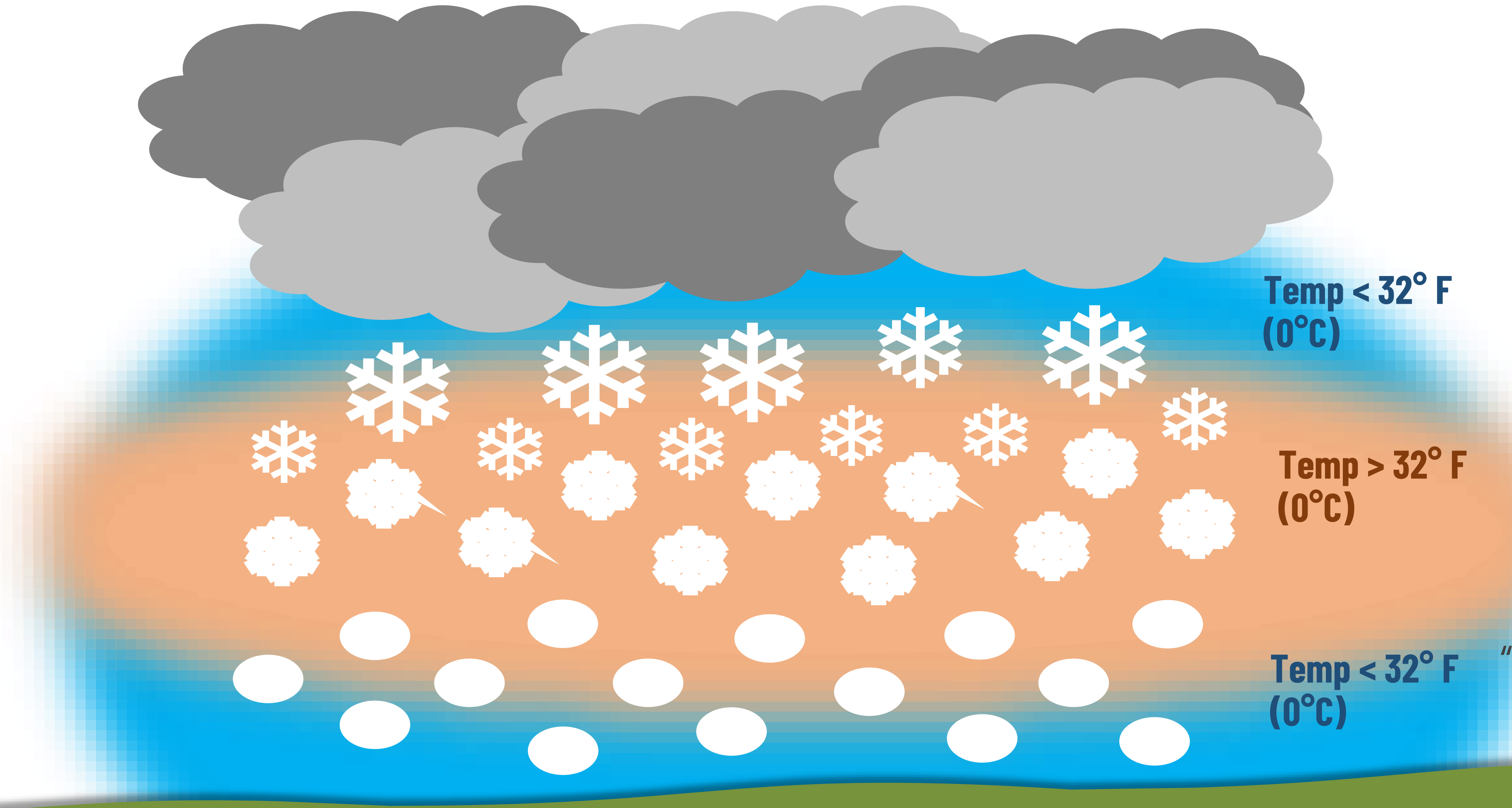
Forecasting Snow

Sleet



Precipitation Type

Freezing Rain



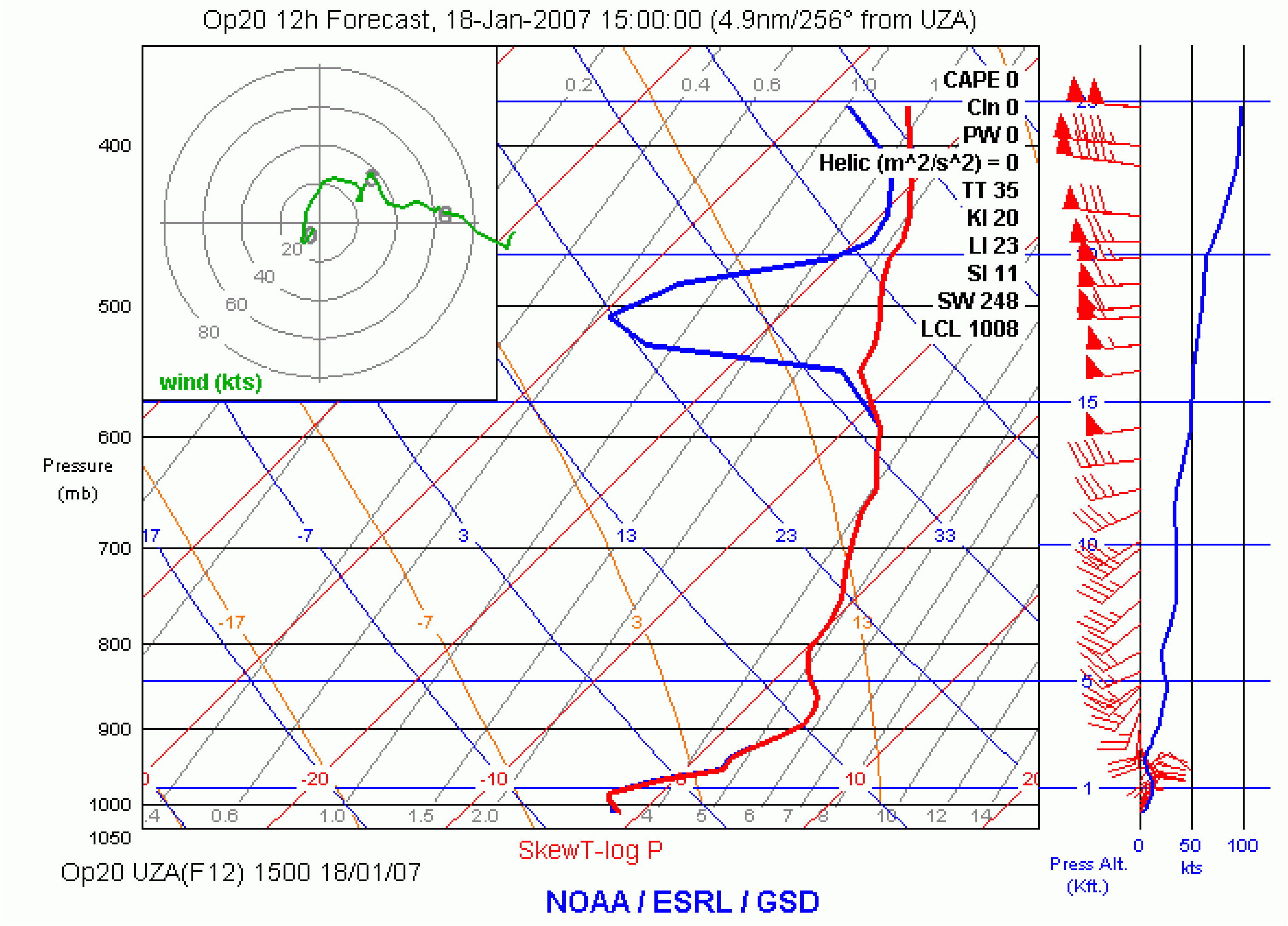
All snow

Snow melts completely

Rain drops become "supercooled" in cold air and freeze on contact cause FREEZING RAIN

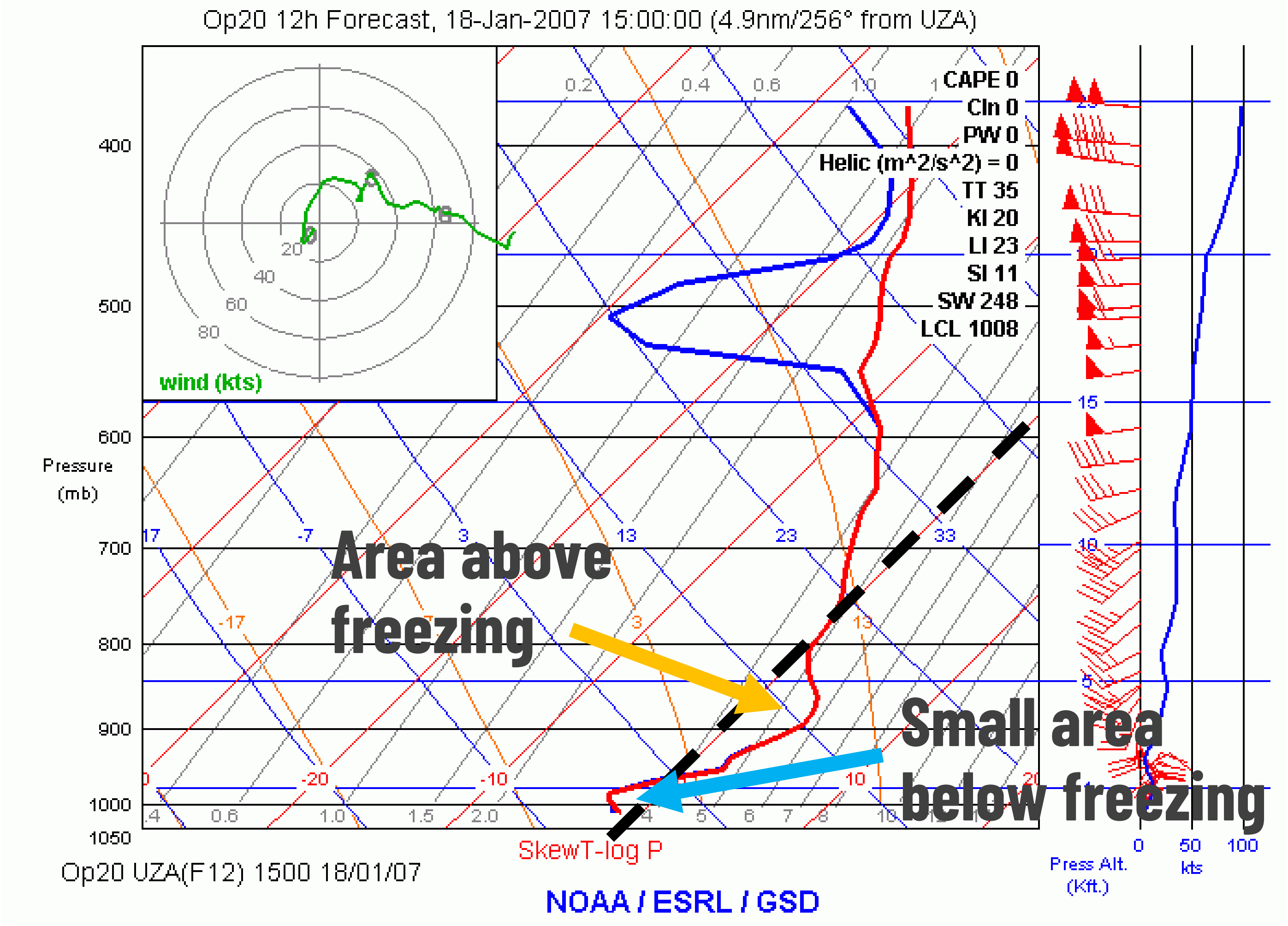
Forecasting Snow

Freezing Rain



Forecasting Snow

Freezing Rain



Forecasting Snow

Looking at Atmospheric Soundings

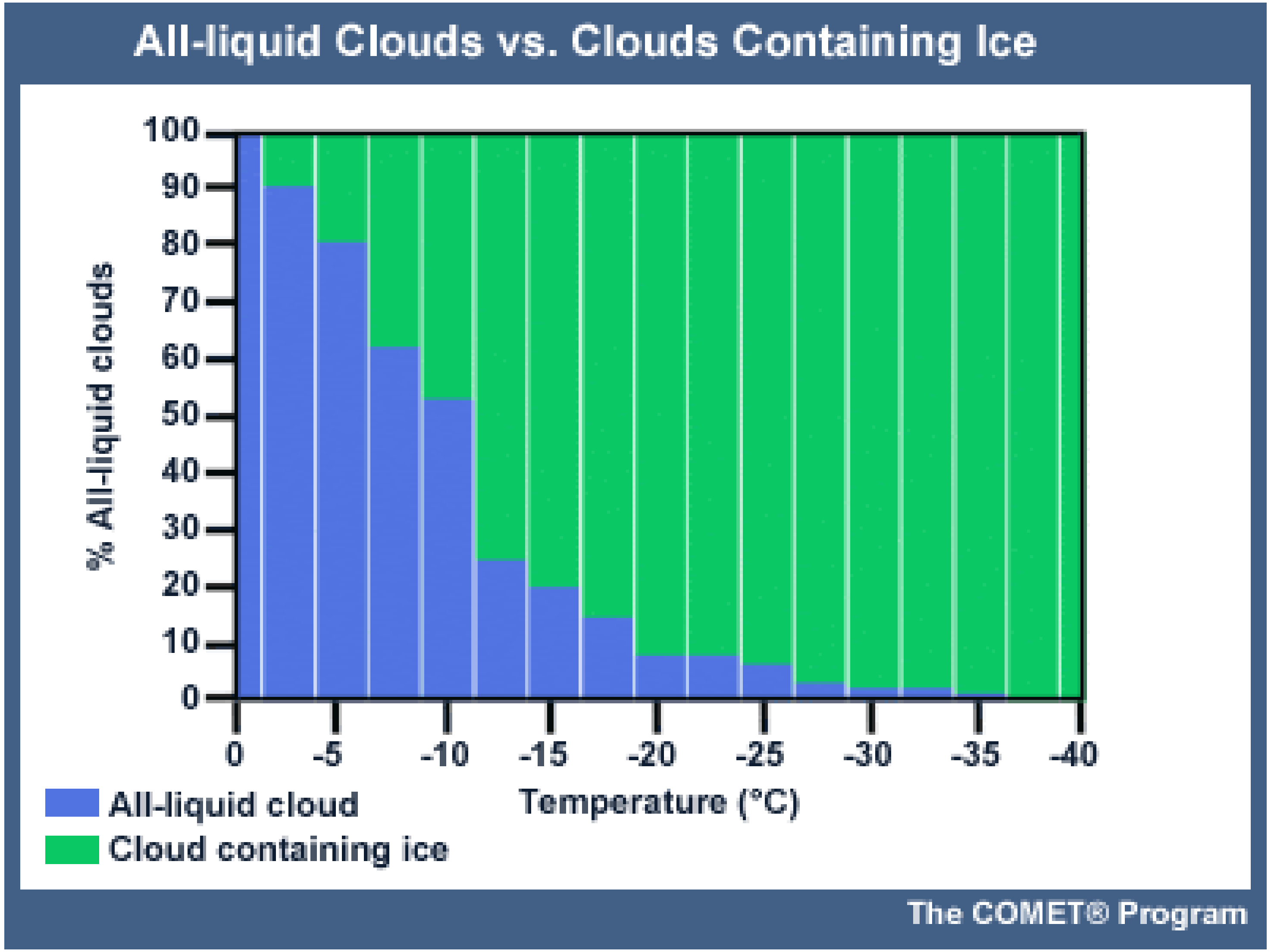
- Another reason to look at soundings is to see if the dendritic growth zone (-12 to -18° C) is saturated
- This zone is where snow is created in a cloud
- If this zone is not saturated you will not get snow
- If this areas takes up a large part of the cloud you will get very efficient snow (heavy snow)

Supercooled Water

How can water stay in liquid form below 32°F?

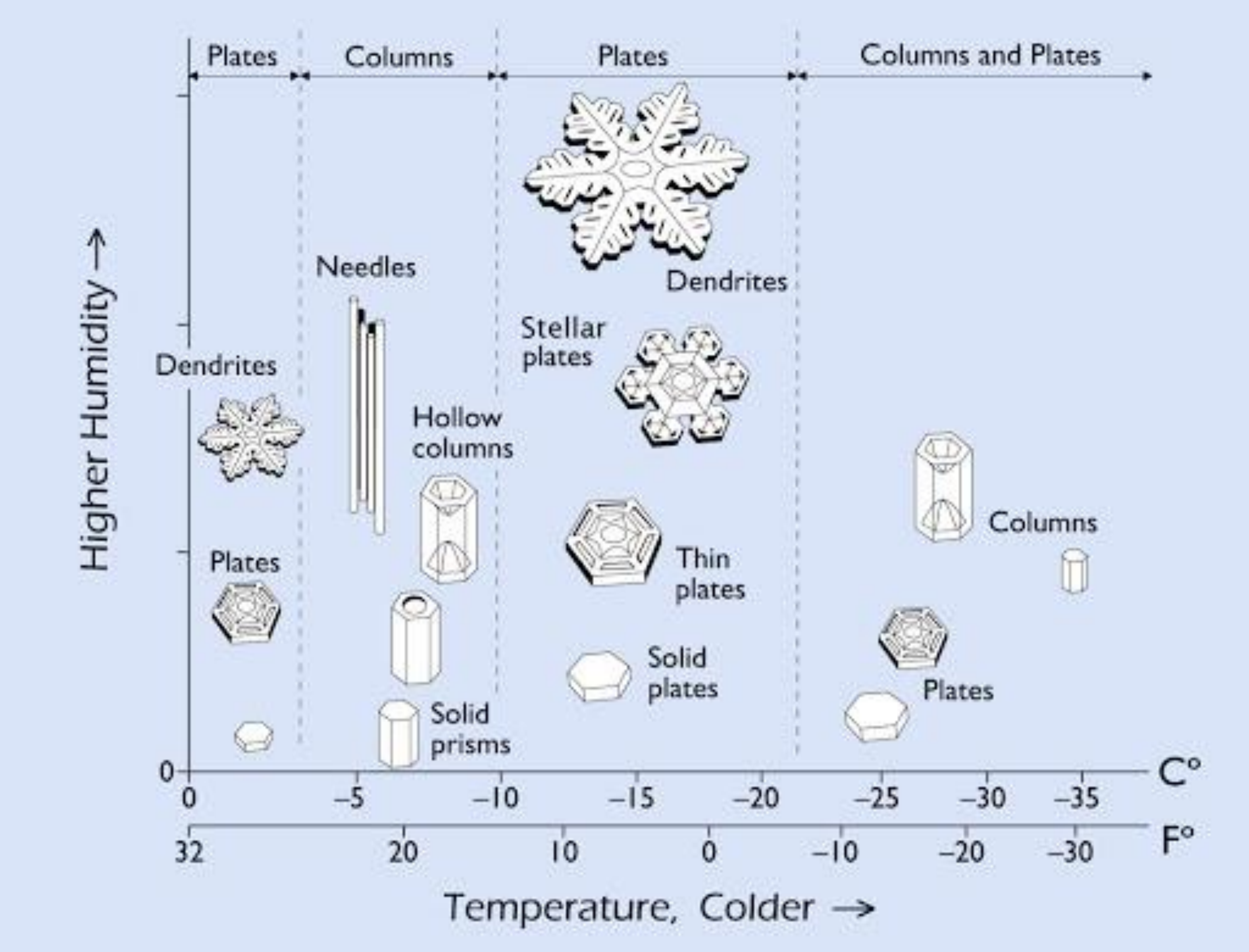
- Water needs ice nuclei, or a surface to freeze on warmer than -40°C and below 0°C. Water in the atmosphere below 32F (0°C) is known as supercooled water
- Fortunately, there are plenty of particulates in the atmosphere that water uses to form ice crystals (even ice crystals themselves serve as an ice nuclei)
- Supercooled water in the atmosphere usually doesn't get below -20°C as other ice crystals, or particulates in the air, freeze supercooled water before that temperature
- Once supercooled water comes into contact with other ice crystals or ice nuclei (at activation temp or below) the water will freeze!

Supercooled Water

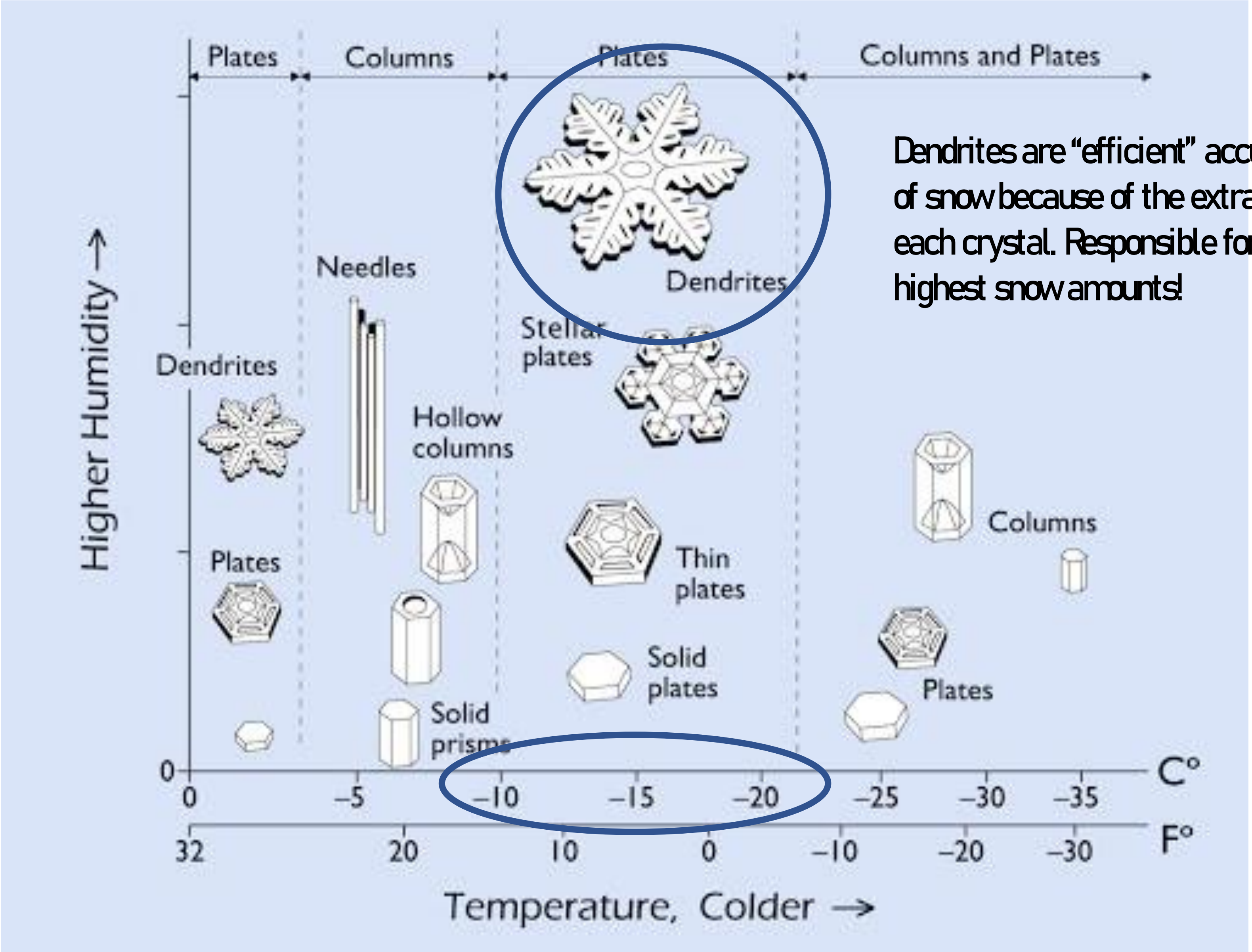


When temperatures in a cloud are above -10°C it's mostly liquid and not ice, this is why we look to see if the snow growth zone is saturated (meaningg the temperature of the cloud is below -10°C)

Snow Crystals



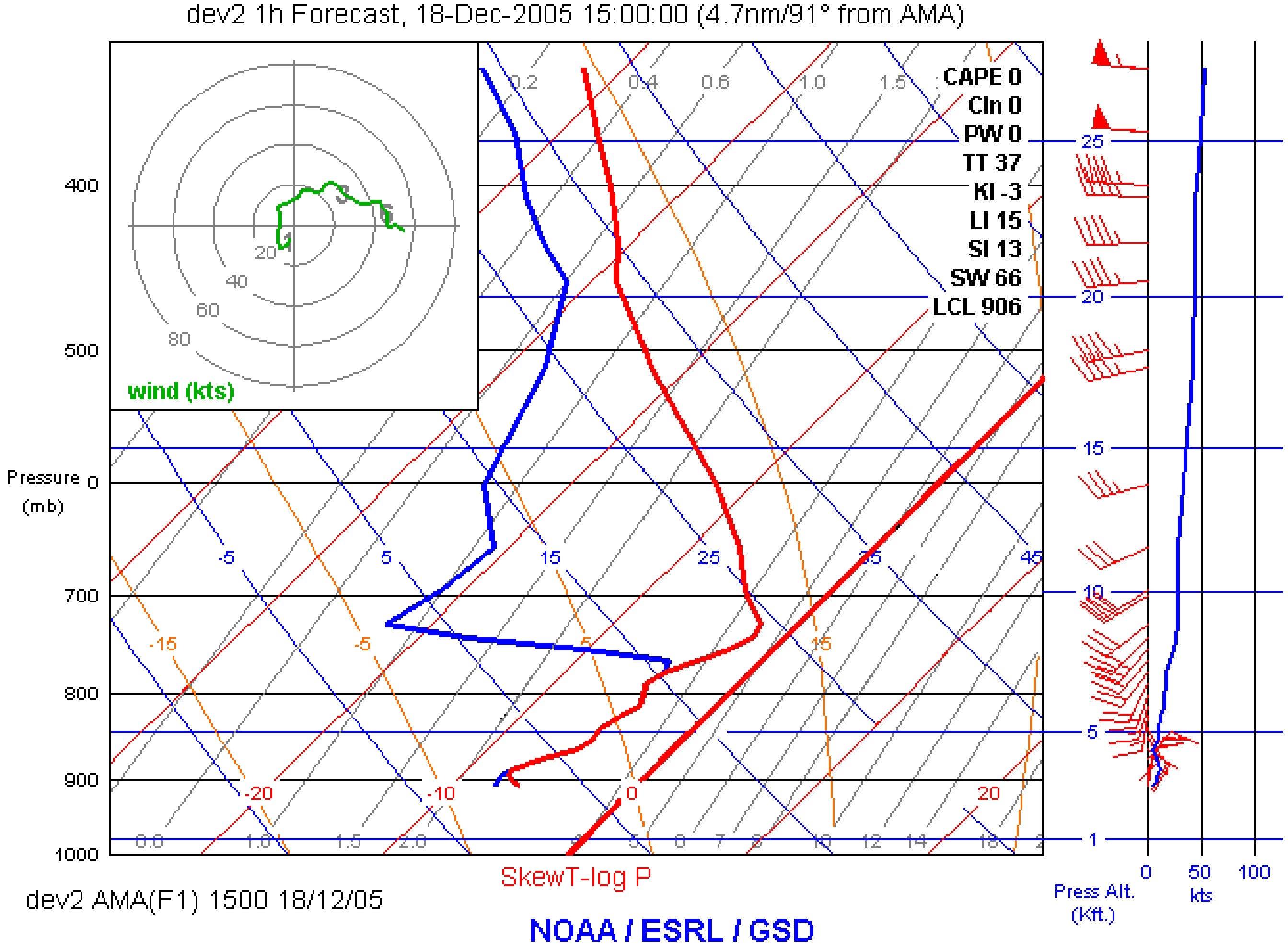
Snow Crystals



Dendrites are "efficient" accumulators of snow because of the extra "space" within each crystal. Responsible for most of the highest snow amounts!

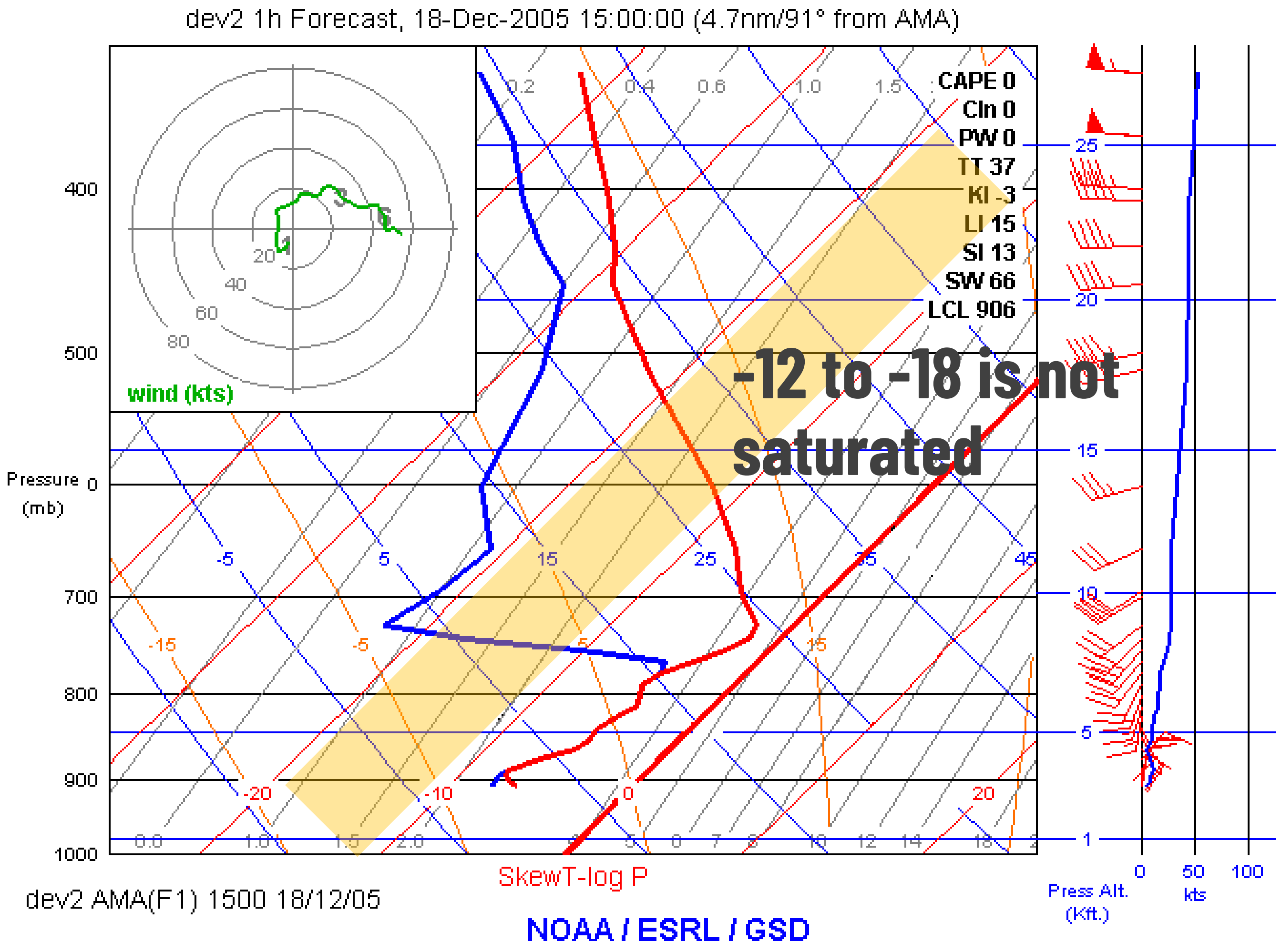
Forecasting Snow

Freezing Drizzle or Freezing Rain



Forecasting Snow

Freezing Drizzle or Freezing Rain



Forecasting Snow

Snow Ratios

- This is simply the amount of liquid that would result if you melted the snow that accumulates
- It can have a big impact on the amount of snow that accumulates at the surface!
- A typical snow ratio that you may hear quite a bit is 10:1, or "10 to 1"
  - This means if 1 inch of snow occurs, there is 0.10" (one tenth of an inch) of liquid water that is contained within the snow. If 10 inches of snow occurs, 1 inch of liquid water is contained within the snow, etc.
  - This snow ratio is only correct about 25% of the time
  - Observational studies have shown freshly fallen snow to have snow ratios of 3:1 all the way up to 100:1!
- The temperature profile of the atmosphere has a big impact on snow ratios

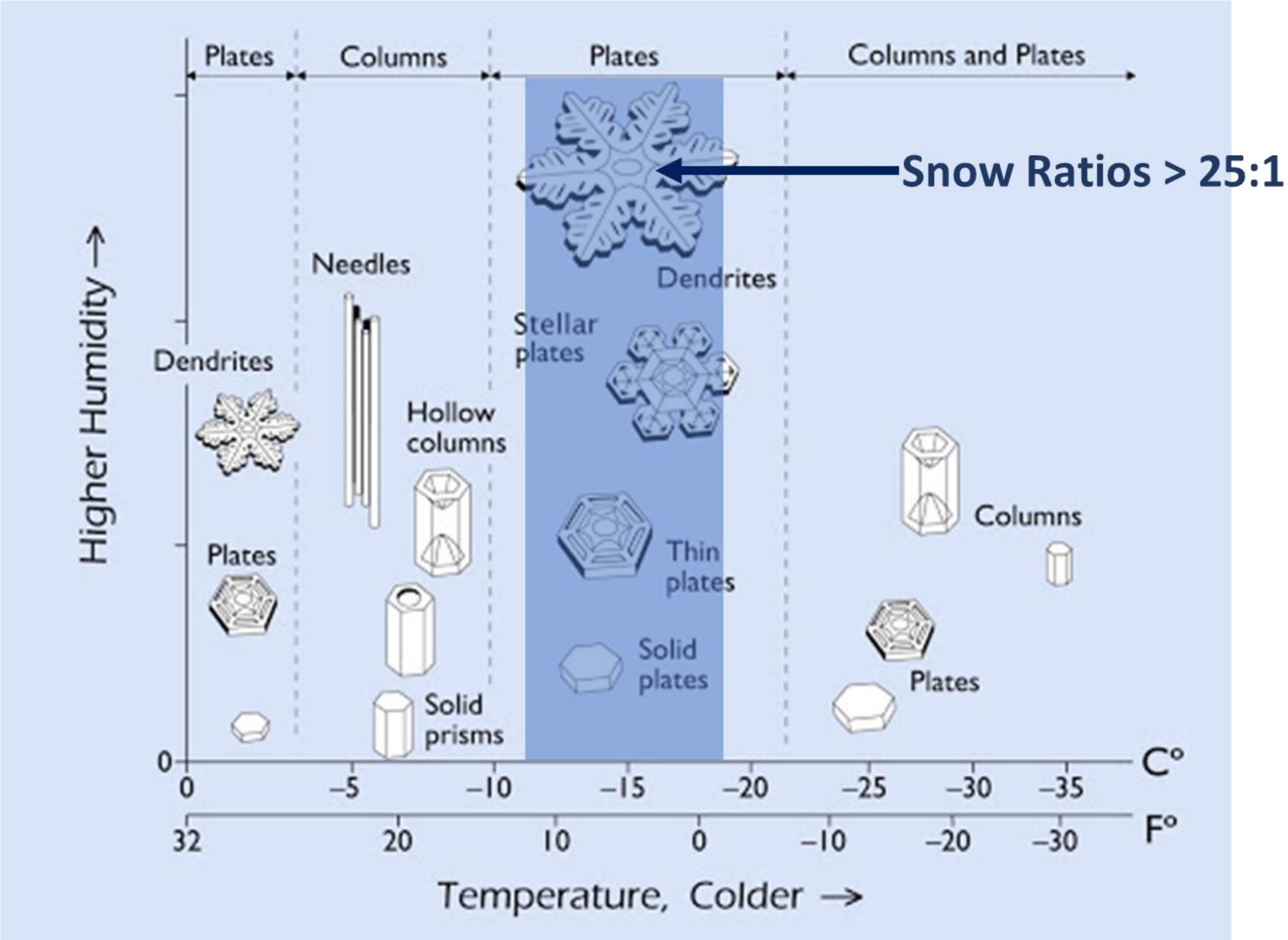
Forecasting Snow

Snow Ratios

- Think of snow ratio as how “heavy” the snow is
  - 6:1 snow is heavy, wet snow. Very heavy and wet when shoveling!
  - 11:1 snow is around average for our area
  - 30:1 or higher snow is very light, usually you can brush it away with a broom or blows easily in the wind!

Forecasting Snow

Snow Ratios



Forecasting Snow

- We can look at all this information from many different forecast models
- We can also look at model forecast ensembles to get an idea of possible solutions, confidence, and scientific probabilities of seeing something including snow or freezing rain

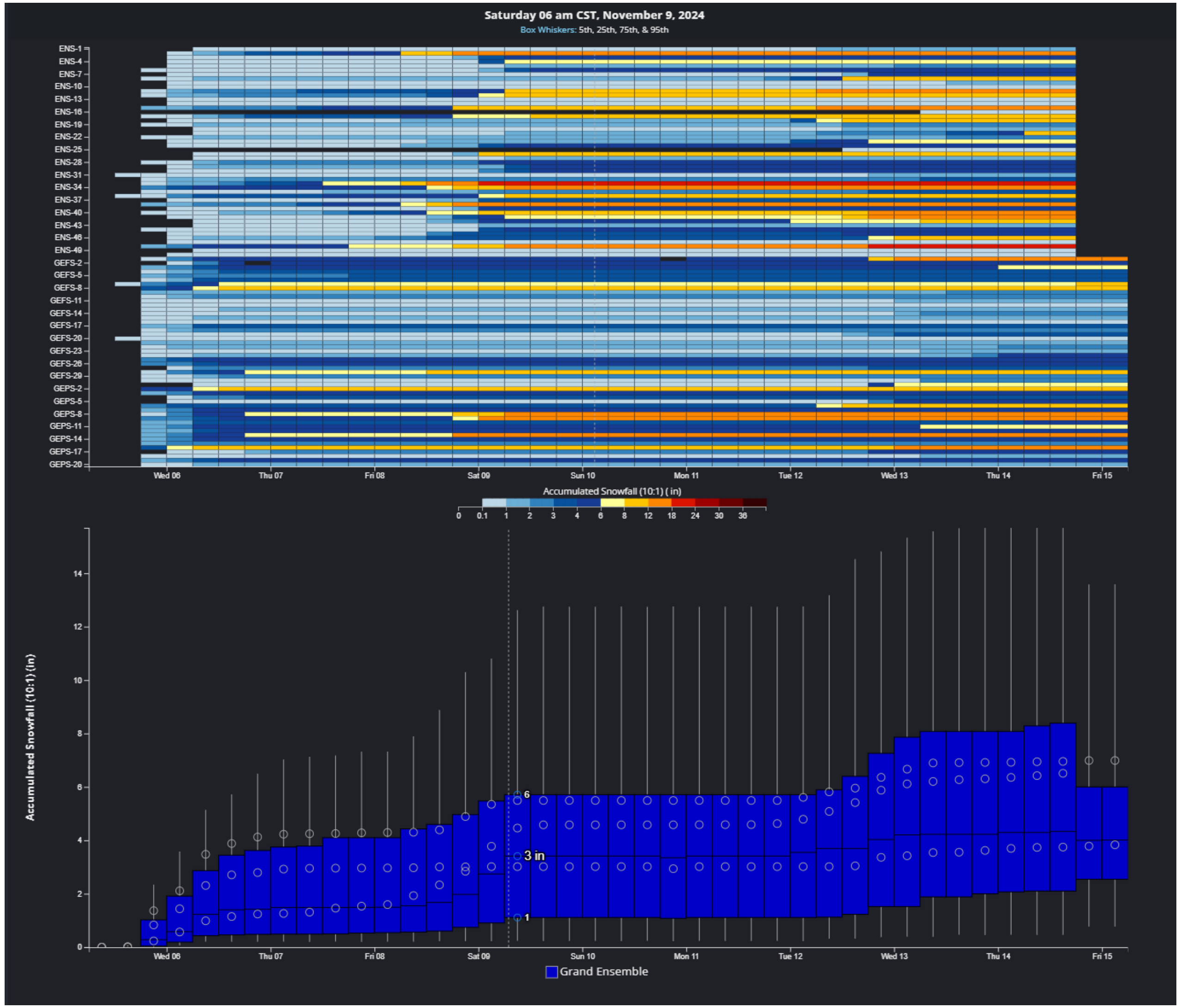
Forecasting Snow

Ensembles

- Ensemble forecasting is a method used in or within numerical weather prediction. Instead of making a single forecast of the most likely weather, a set (or ensemble) of forecasts is produced. This set of forecasts aims to give an indication of the range of possible future states of the atmosphere.
- We run the same model 30-50 times slightly changing the initial conditions, this gives us many different solutions, some similar some very different

Forecasting Snow

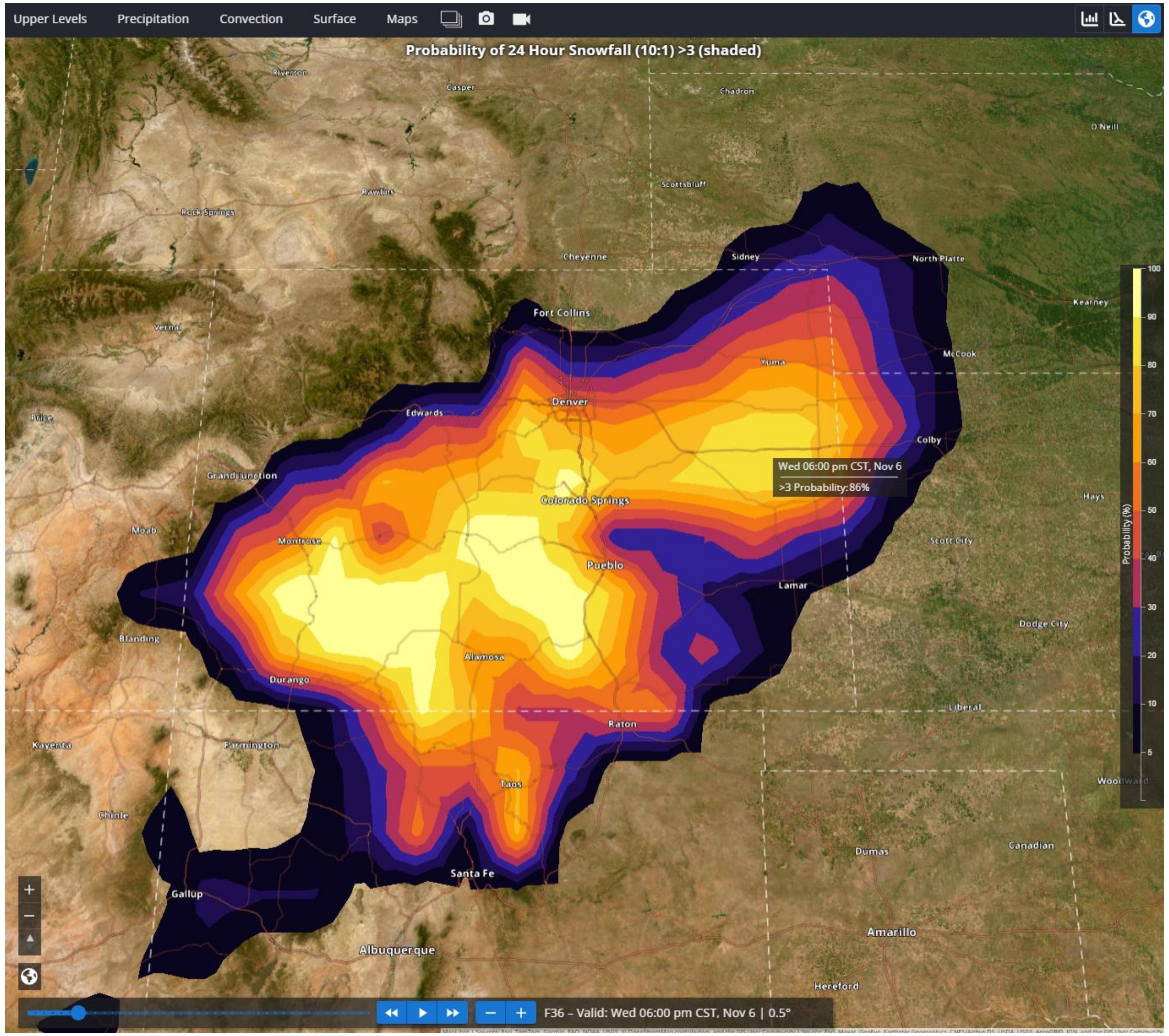
Ensembles



- Can get a more scientific range of forecast parameters such as snow
- The 50th percentile is the best guess for the forecast (50% of the members are above this number and 50% of the members are below this number)
- Generally you take the 25th to 75th percentile to get a range
- If you have a wide range it isn't always valuable to the public and the forecast
- A wide range can also indicate uncertainty in the forecast

Forecasting Snow

Ensembles



- Can produce probability above a specific threshold
- Example: Chances of seeing 3"+ of snow

Detecting Winter Weather

Satellite

- Images are very useful tools for determining cloud patterns and movement of winter storms. By looping a series of satellite pictures together, forecasters can watch a storm's development and movement

Radar

- Is critical for tracking the motion of precipitation and dual-polarized radars can help determine what kind of precipitation is falling

Surface Observations

- Looking at weather station data for precipitation type, temperature and more and lining it up with upper air and radar data

Dual Poll Radar

Satellite

- Images are very useful tools for determining cloud patterns and movement of winter storms. By looping a series of satellite pictures together, forecasters can watch a storm's development and movement

Radar

- Is critical for tracking the motion of precipitation and dual-polarized radars can help determine what kind of precipitation is falling

Surface Observations

- Looking at weather station data for precipitation type, temperature and more and lining it up with upper air and radar data

Snowy Weather Patterns

Atmospheric River

Panhandle Hook or Low

Nor'easter

Alberta Clipper

Lake Effect Snow

Winter Safety Tips

Most deaths from winter storms are not directly related to the storm itself

- People die in traffic accidents on icy roads
- People die of heart attacks while shoveling snow
- People die of hypothermia from prolonged exposure to cold

Driving in the Snow

Slow down! Leave extra space between you and other cars

Accelerate and decelerate slowly. Allow extra time to stop.

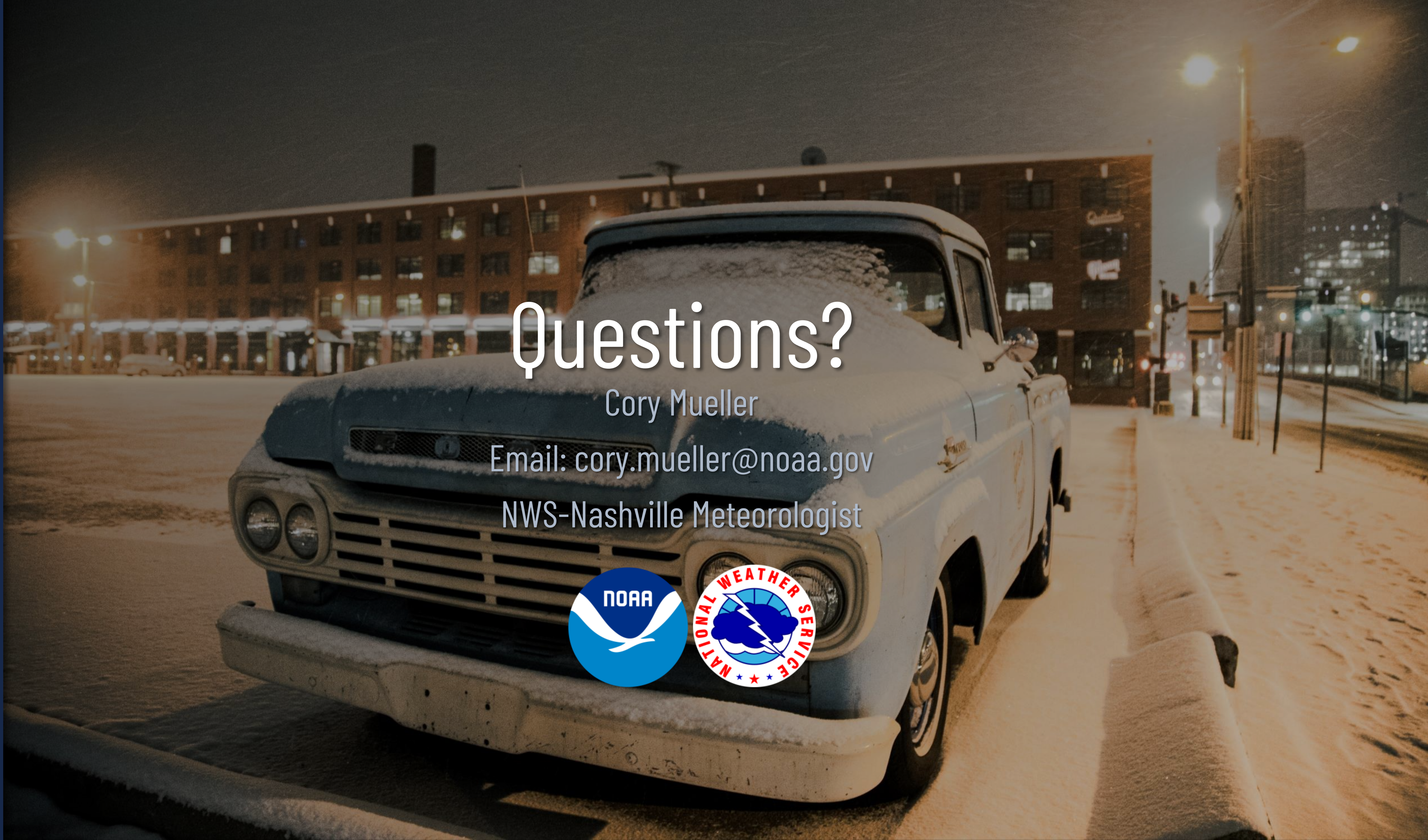
Plan on delays and allow additional time to get to your destination

Have an emergency kit that includes boots and warm clothes

Use your headlights even during the day

Shoveling Snow

- Wear warm clothes such as boots, hat, mittens and cover any exposed skin
- Take your time and take breaks if you are tired
- Don't over exert yourself
- Stay hydrated



Questions?

Cory Mueller

Email: cory.mueller@noaa.gov

NWS-Nashville Meteorologist