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ATTACHMENT 11 to the METEOROLOGICAL FACTUAL REPORT
ANC12IA024

PAED presentation/training module on atypical freezing precipitation events in the Anchorage area

Freezing Drizzle: with no warm layer?

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Introduction

- The state of Alaska is very difficult to forecast for, and can be frustrating if “classic” events do not pan out the way we hope
- Typically freezing precipitation requires a warm layer to ensure supercooled water droplets do not freeze on their journey down to Earth
- Sometimes, this is not the case. Let’s start off with some basics to explain how this can happen.

The Ice Crystal Process

- Water typically freezes at zero degrees Celsius
- Within clouds, water droplets behave differently
- At -10C, you may only have 1 ice crystal per 1 million liquid water droplets
- At -20C, the ratio increases to 50% ice crystals
- Sometimes it takes -40C to get all water to become ice crystals within clouds
- A cloud completely saturated with ice crystals is referred to as "glaciated"

Cloud Phase Transition

- When a cloud is not completely glaciated, the liquid water droplets are called "supercooled"
- The transition from supercooled liquid to glaciated ice crystals begins in the highest /coldest part of the cloud and works down
- Glaciation can begin by conditions within the cloud or from clouds above the supercooled cloud, "seeding" it with ice crystals from above

The Nucleation Process

- For ice crystals to form in clouds, water molecules need a substrate to form the ice lattice
- The Bergeron-Findelsen process describes how ice crystals grow at the expense of supercooled water droplets in a water saturated environment (such as within clouds and areas of high RH)
- The initiation of this process takes place from homogeneous or heterogeneous nucleation

Homogenous Nucleation Process

- Homogeneous nucleation takes place at VERY COLD temperatures WITHOUT ice nuclei
- This nucleation happens as water molecules within a droplet are cooled enough to form very small ice structures (ice embryos)
- Surrounding molecules will attach themselves and add to the crystal lattice
- The smaller the droplet size, the lower the temperature needed to form ice crystals

Heterogeneous Nucleation Process

- Heterogeneous nucleation is the predominant process of ice crystal initiation and takes place WITH ice nuclei in saturated, sub-freezing environments
- **The three types of heterogeneous nucleation:**
- Deposition is when water vapor condenses directly as ice onto ice nuclei w/o liquid phase
- Ice nuclei within a droplet initiate freezing within that droplet during the freezing process
- It also occurs when supercooled water droplets with ice nuclei collide, this is called contact

Properties of Ice Nuclei

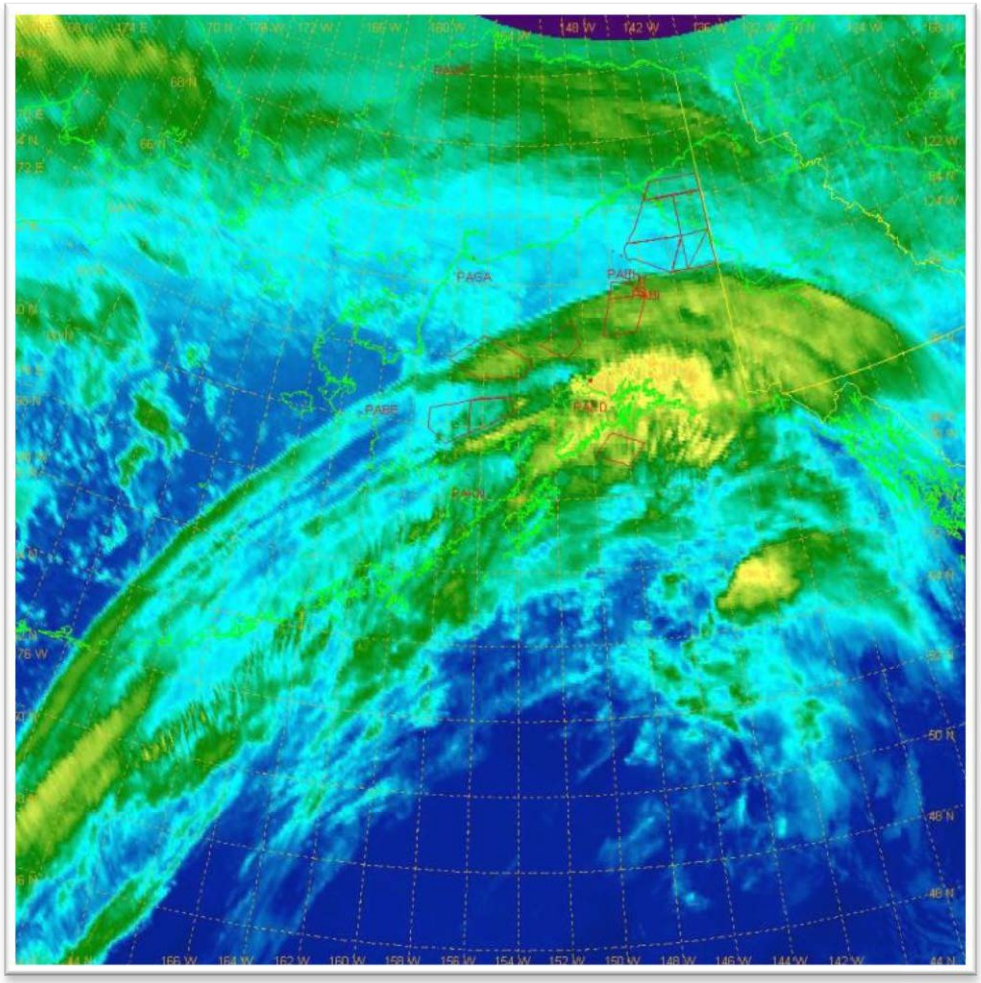
- Ice nuclei (IN) are similar to cloud condensation nuclei (CCN), but IN are in lower concentrations
- Ice nuclei do not become active until they reach a certain temperature below 0C, every type of IN are active at different temperatures
- Active IN concentrations rise as the temperature drops, and also as relative humidity (RH) increases
- The table to the right shows common IN and their activation temps

Common IN and their Activation Temperatures		
Substance	**Activation Temperature (°C)**	**Prevalence**
leaf bacteria	-2.9	found in decaying leaf matter, possibly a prevelant source of IN
silver iodide	-4	used for artificial cloud seeding
kaolinite	-9	common clay mineral
copper sulphide	-7	pollutant
sodium chloride	-8	sea water
volcanic ash	-13	common aerosol
vermiculite	-15	common clay mineral

Relation to Freezing Drizzle

- In an atmosphere with no warm layer, sometimes freezing drizzle still can occur
- Special conditions must exist in order for this scenario to present itself
- If the low level clouds do not become glaciated due to lack of moisture above them (RH activating ice nuclei as in last slide), they remain supercooled liquid droplets
- Despite no warm layer, these supercooled droplets can fall to the surface as –FZDZ
- Pay attention to the scenario presented on the slides ahead for detailed information

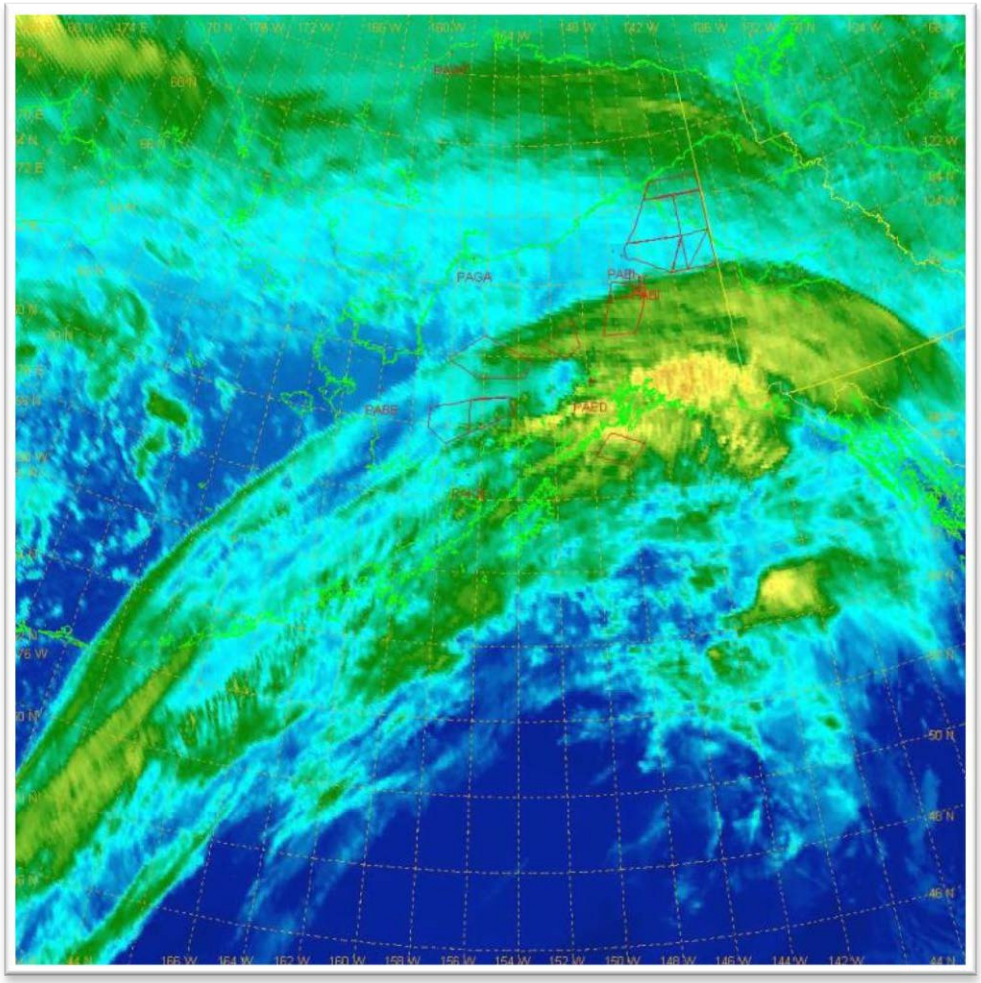
06 MARCH 2012 IR METSAT 0546Z



Cold cloud tops exist over Anchorage bowl, observing light snow at Elmendorf AFB at this point.

The surface temperature is M10C through the scenario, and there are no warm layers in the atmosphere.

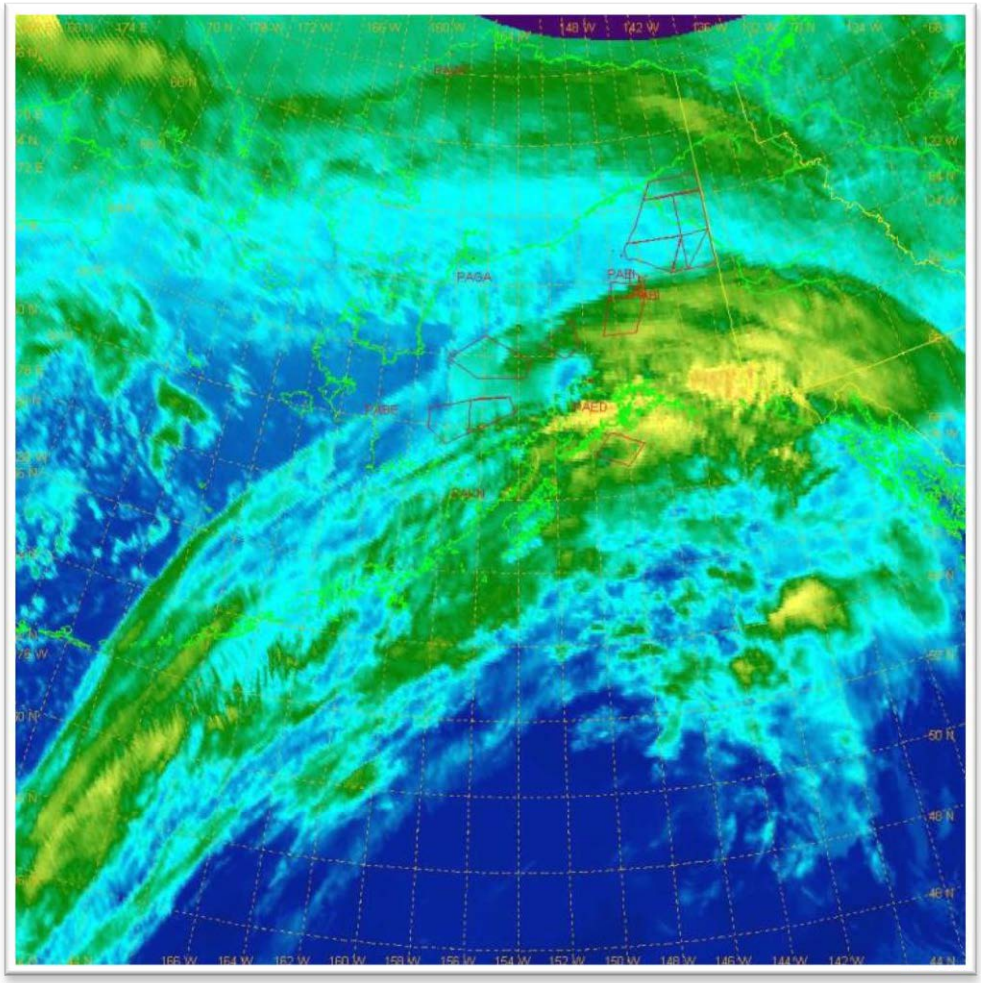
06 MARCH 2012 IR METSAT 0631Z



Upstream of the Anchorage bowl, an area of lower (warmer) cloud tops is seen.

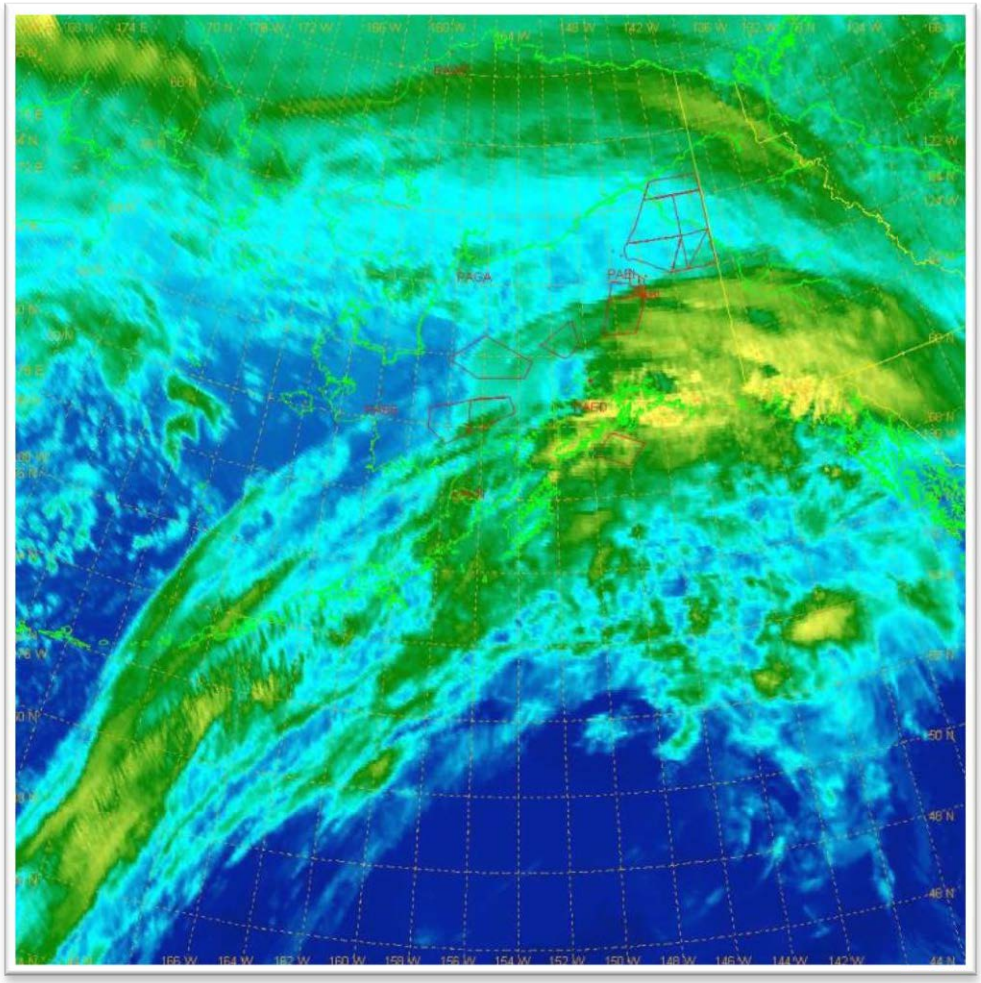
This is an indication of a loss of “glaciation” that the upper level clouds seed to the lower level clouds.

06 MARCH 2012 IR METSAT 0716Z



The colder cloud tops continue to decrease and move off to the east of the Anchorage bowl.

06 MARCH 2012 IR METSAT 0801Z

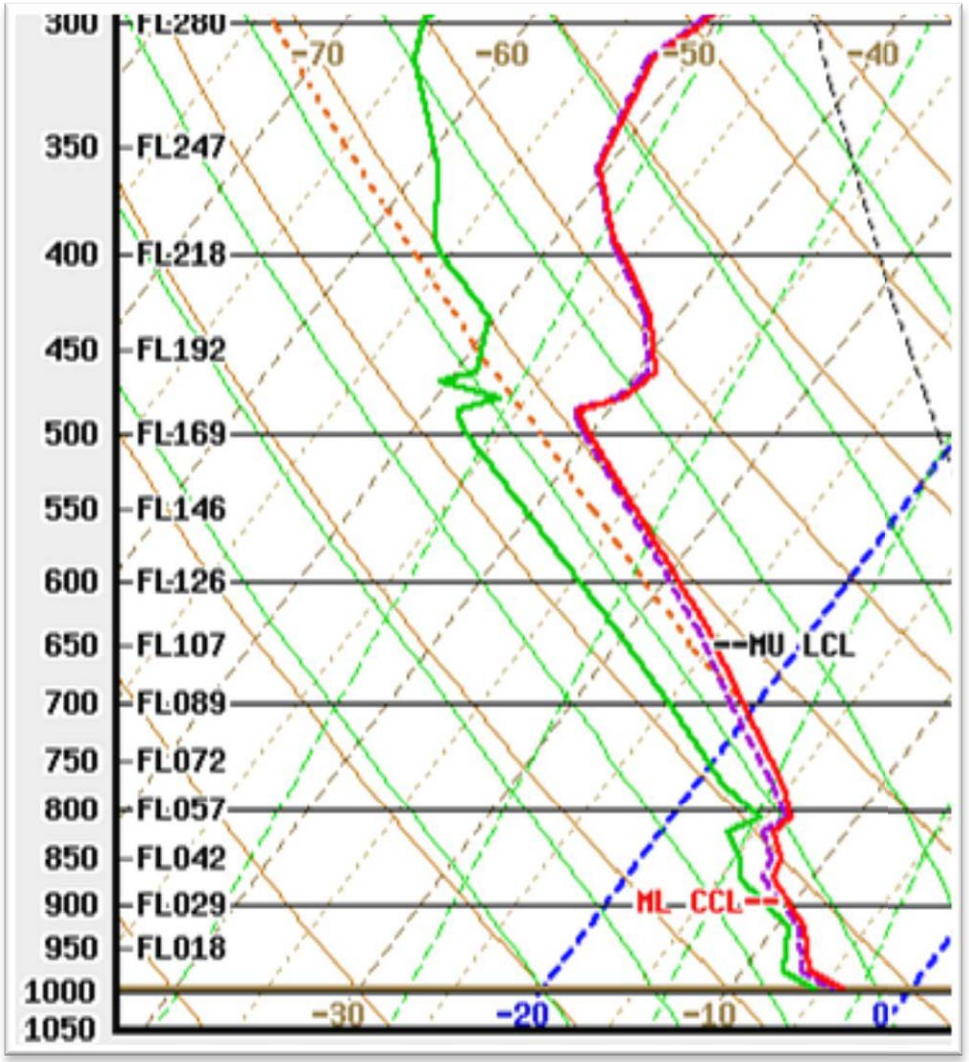


At 0759z, Elmendorf AFB, Anchorage Intl, and Merrill Field all begin to report -FZDZ.

Now that the higher clouds cannot seed the lower clouds with ice nuclei, all of the supercooled water droplets fall as they are.

At the surface, this is reported as –FZDZ without any warm layer existing whatsoever.

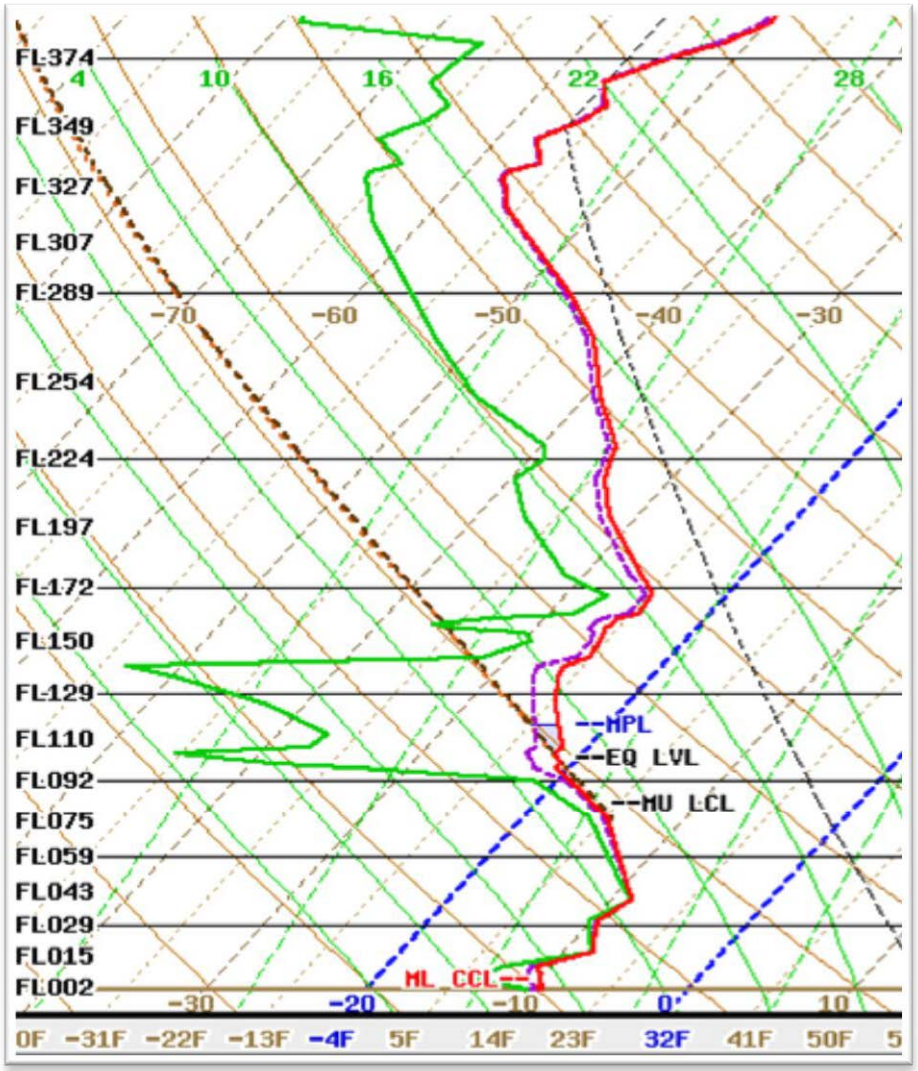
06 MARCH 2012 PANC SKEW-T 00Z



The 00z Observed Skew-T from PANC is not favorable for a heterogeneous nucleation freezing drizzle scenario.

The temp-DP spread in the mid levels remains < 10C, which means the RH is high enough for ice nuclei to glaciate the lower clouds, which is why light snow was falling.

06 MARCH 2012 PANC SKEW-T 12Z



The 12z Observed Skew-T from PANC tells a different story.

Above 090 feet, the atmosphere dries out significantly (>10C DPD), and is very moist below 090 feet.

The lower clouds are all supercooled water droplets, and with little ice nuclei present or much glaciation occurring, these droplets fall to the ground.

Final Notes

- The above scenario occurred until approximately 20z that day on and off. It was mixed with snow at times, due to occasional glaciation of the lower level clouds.
- If you use this slideshow, the “Below 0C Freezing Precipitation Checklist” located on the forecasting clipboard, the TN 98-002, and proper vigilance, there is a greater chance of forecasting this event.

References:

-TN 98-002
-COMET Module: Topics in Precipitation Forecasting
-Below 0C Freezing Precipitation Checklist