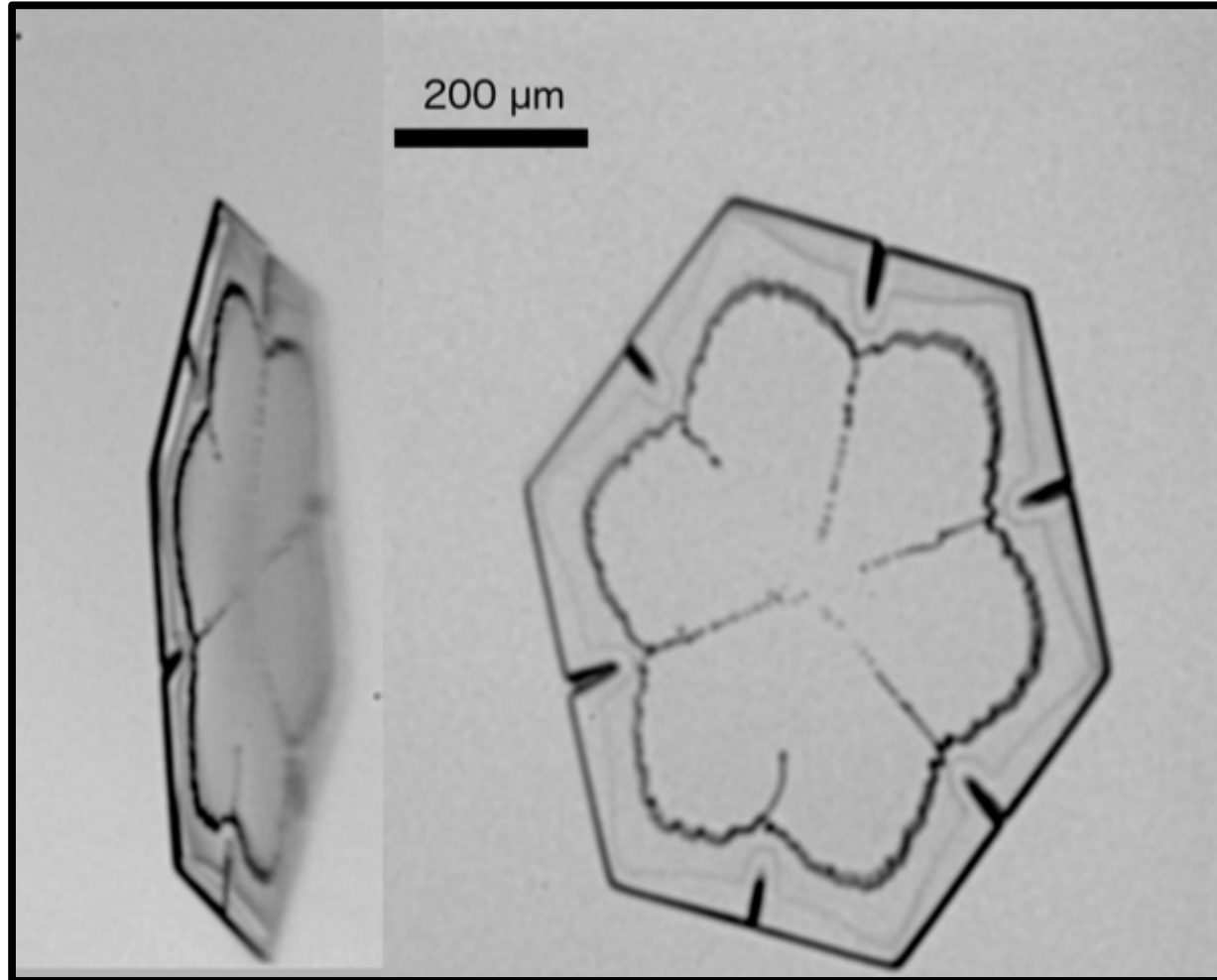
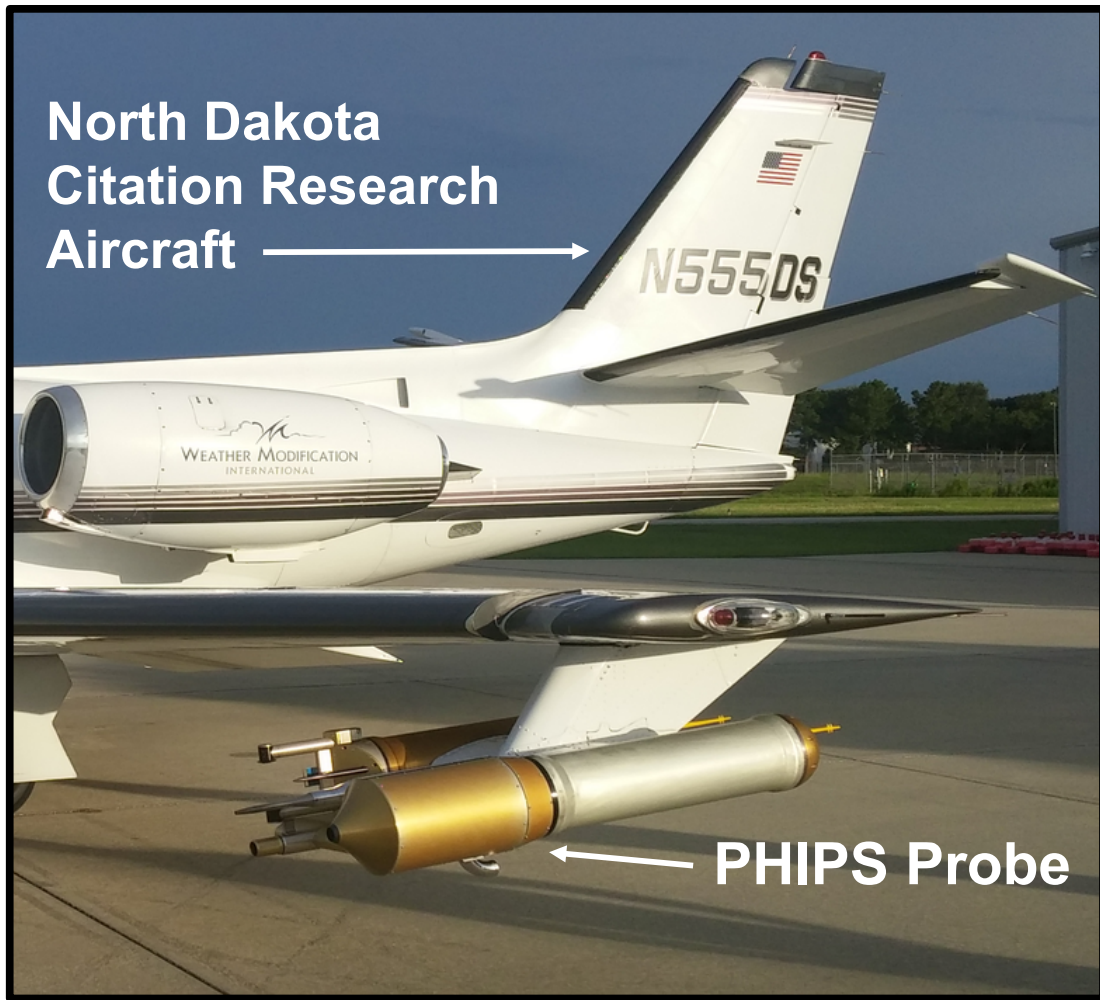


Ice Crystal Growth



PHIPS images of plate crystal.

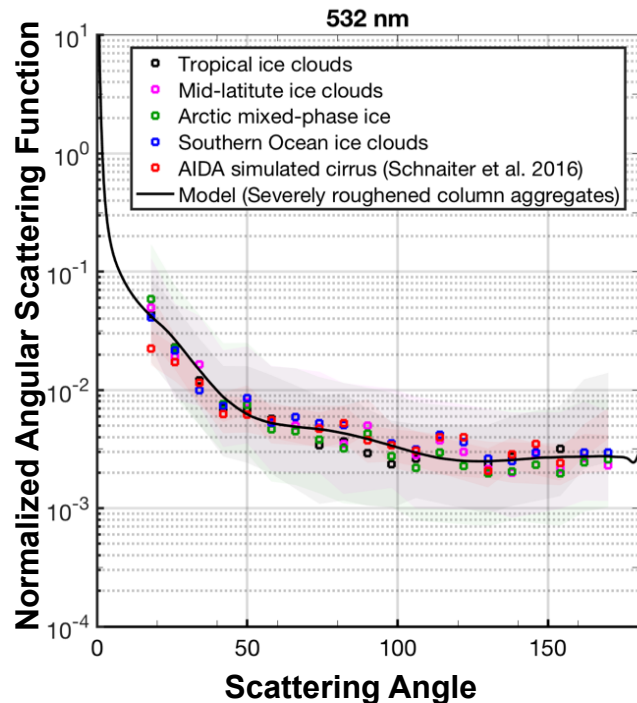
Particle Habit Imaging and Polar Scattering (PHIPS) Probe



- Measure the angular light scattering function of individual cloud particles that are identifiable as belonging to a particular habit.
 - ➔ Improved remote sensing observations.
- Obtain high resolution stereo-graphic images with sufficient detail to improve understanding of riming and aggregation processes.
 - ➔ Improved cloud micro-physical modeling.
- Provide reliable phase identification on small and intermediate sized cloud particles.
 - ➔ Improved understanding of precipitation.

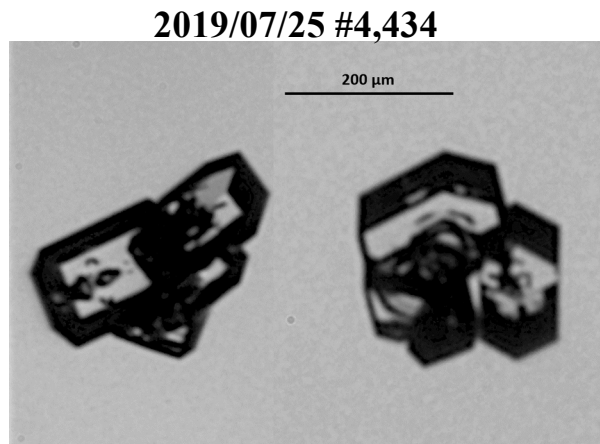
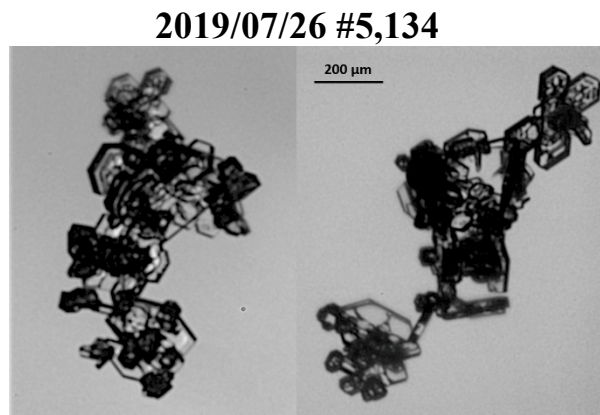
Measurements and Observations of the PHIPS Probe

Angular Light Scattering Function



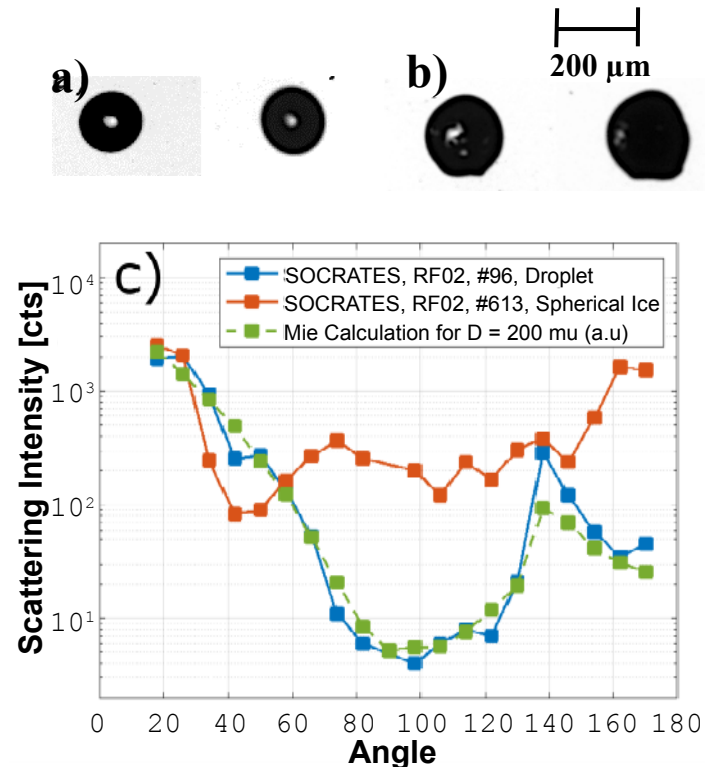
Averaged angular scattering functions from different campaigns, which was used to validate the MODIS C6 ice optical model (Järvinen et al., 2018).

Stereo-graphic Images



Stereo image pairs obtained within Cirrus cloud anvils over Florida.

Phase Identification



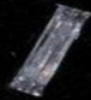
Stereo image pairs of a droplet (a) and a quasi-spherical ice particle (b), and the corresponding angular scattering function (c) (Waitz et al., AMT in preparation).

Ice Crystal Types (Many Methods)

Needle



Column



Bullet Rosette



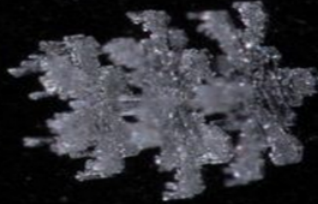
Capped Column



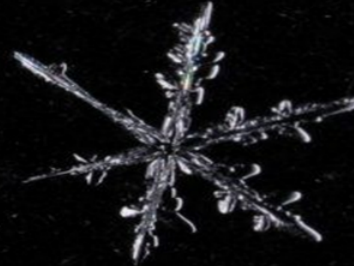
**Stellar Dendrite
with Light Riming**



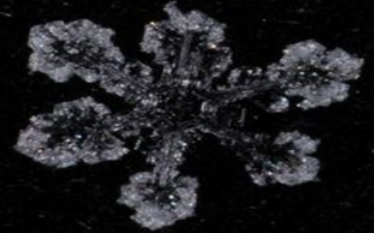
**Triple
Capped Column**



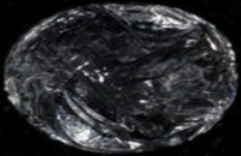
Dendrite



**Sectored Plate
with Light Riming**



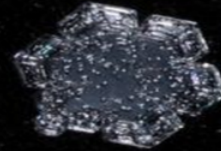
Ice pellet



Sectored Plate



**Plate with
Light Riming**



Plate

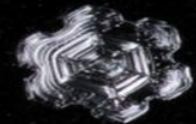
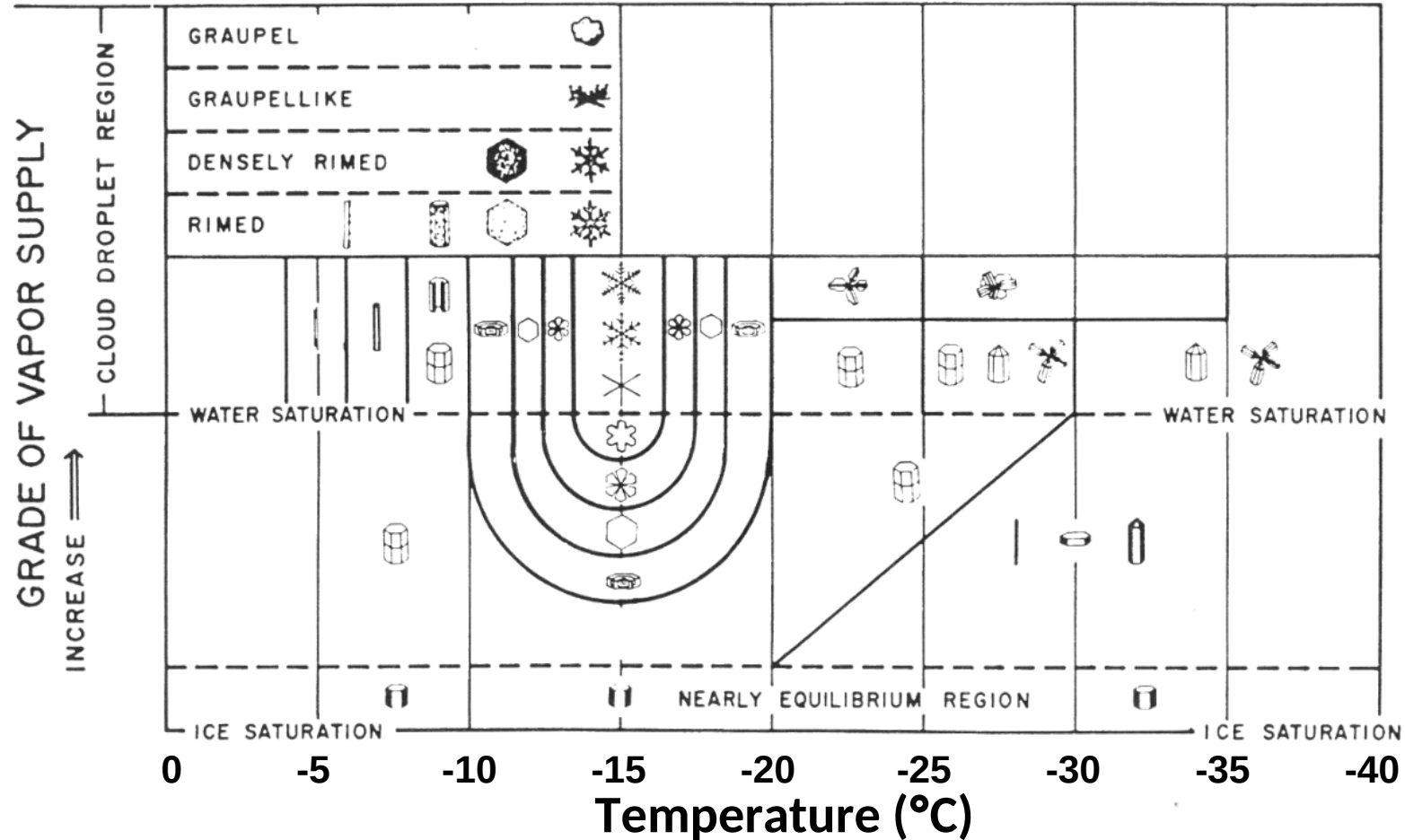


Image adapted from University of Manitoba.

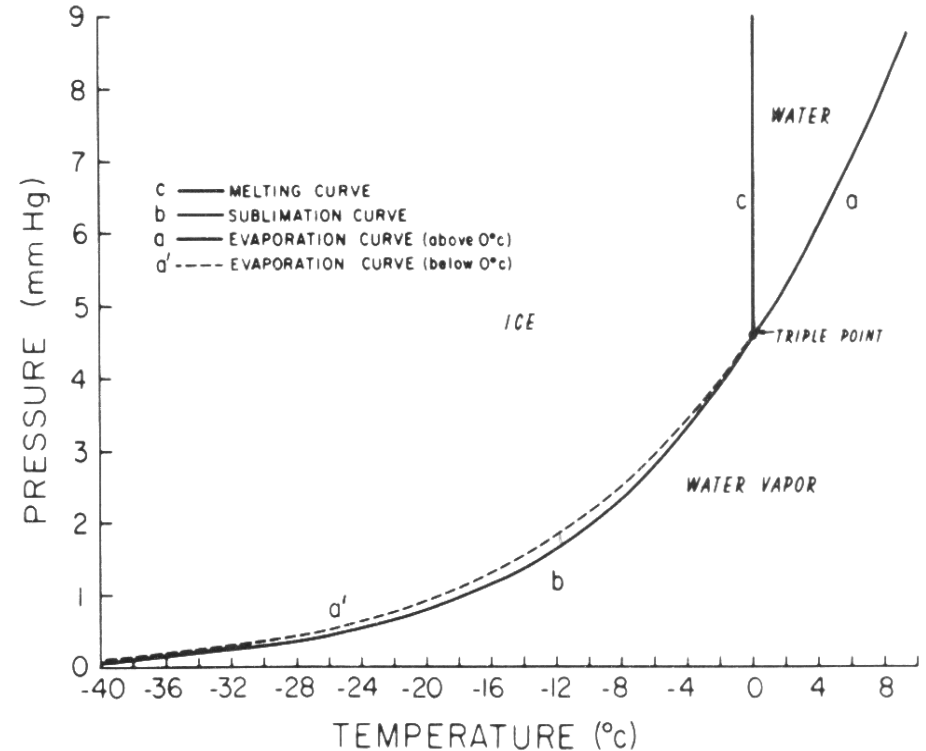
Crystal Habit Formation



Habit depends on air temperature and vapor supply during formation.

Clausius Clapeyron Equation

- Previous discussion related the vapor pressure in equilibrium with a pure, plane water (liquid) surface to temperature.
- If the water is frozen, however, the water molecules are held more securely to the surface and the amount of vapor in equilibrium with that surface is less.



Difference Affects Growth Rates

High Vapor Pressure

Lower Vapor Pressure



Diffusion



Mixed Cloud (Ice and Liquid)

- Ice crystals will grow rapidly.
- Water droplets will evaporate.
- Large fraction of the ice crystals falling as precipitation tend to be stellar types, even though they form in a very narrow region of the temperature/ humidity conditions possible in clouds.
- Also get a large number of plate types of crystals.