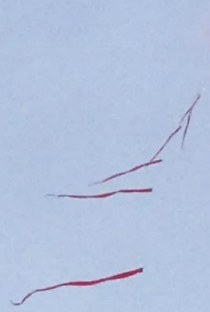
Evaluating Arctic aerosol-cloud interactions using tethered balloon systems



Jessie Creamean, Hagen Telg, Amy Solomon, Gijs de Boer, Matthew Shupe, Allison McComiskey, Fan Mei, Darielle Dexheimer, Beat Schmid, Mark Ivey, John Hubbe, Fred Helsel

Photo by Darielle Dexheimer

ASR Atmospheric System Research

ARM CLIMATE RESEARCH FACILITY

University of Colorado Boulder

NOAA

Pacific Northwest NATIONAL LABORATORY

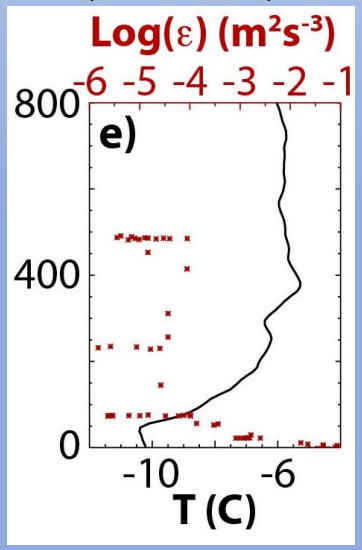
Sandia National Laboratories

ICARUS

Inaugural Campaigns for ARM Research using Unmanned Systems

- UAS and TBS systems at the AMF-3 (Oliktok Point)
- **TBS**: 55 flights (198 hours) during deployments in Oct 2015, Apr 2016, Jun/Jul 2016, Sep 2016, Oct 2016, Nov 2016, Apr 2017, May 2017, Aug 2017, Oct 2017

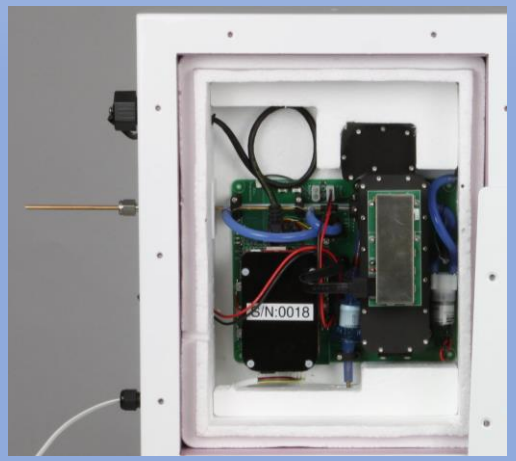
3D sonic anemometer (Oct 2016)



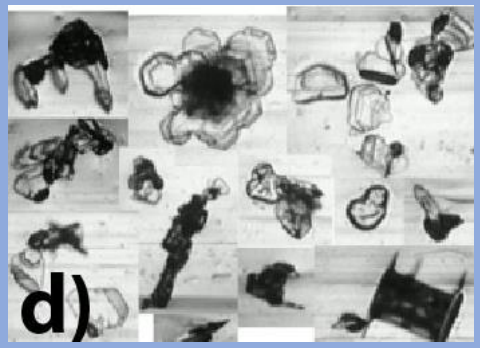
iMet

Condensation Particle Counter (CPC; 0.01 – 1.0 µm)

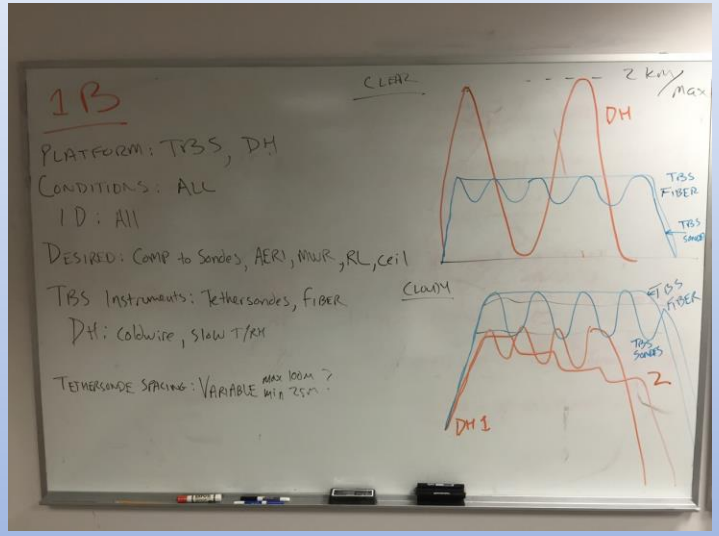
Printed Optical Particle Spectrometer (POPS; 0.15 – 3 µm)

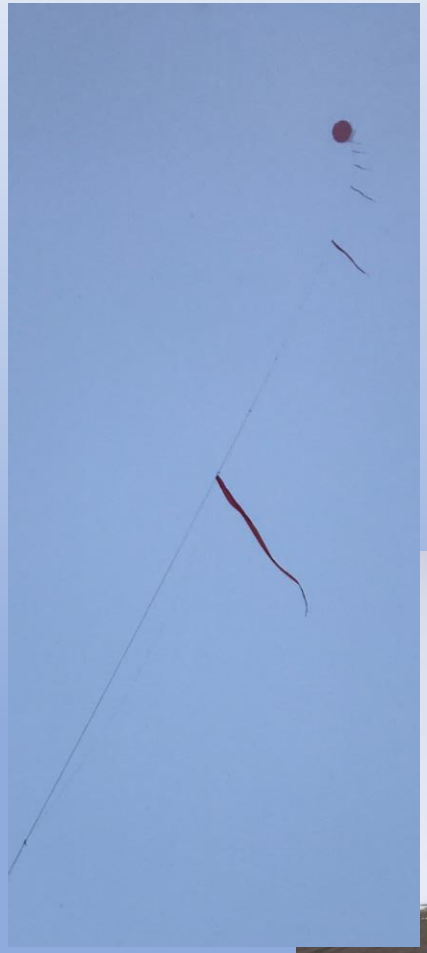


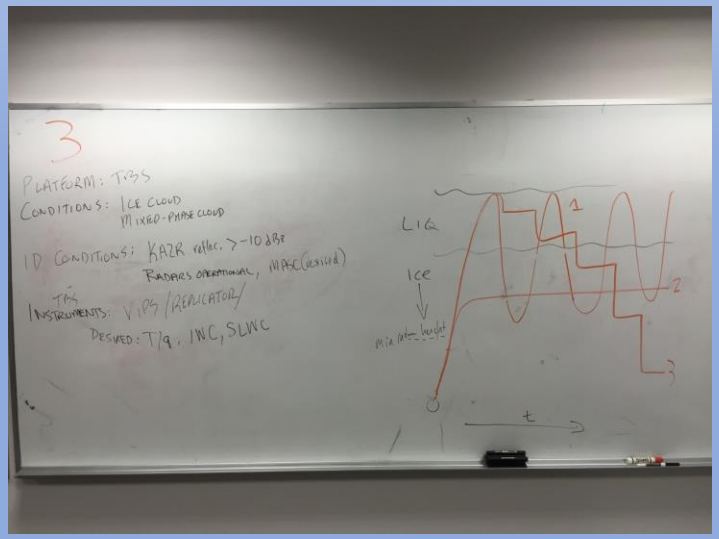
Video Particle Sampler (VIPS; Oct 2016; 20 – 2000 µm)



TBS flight planning & deployments







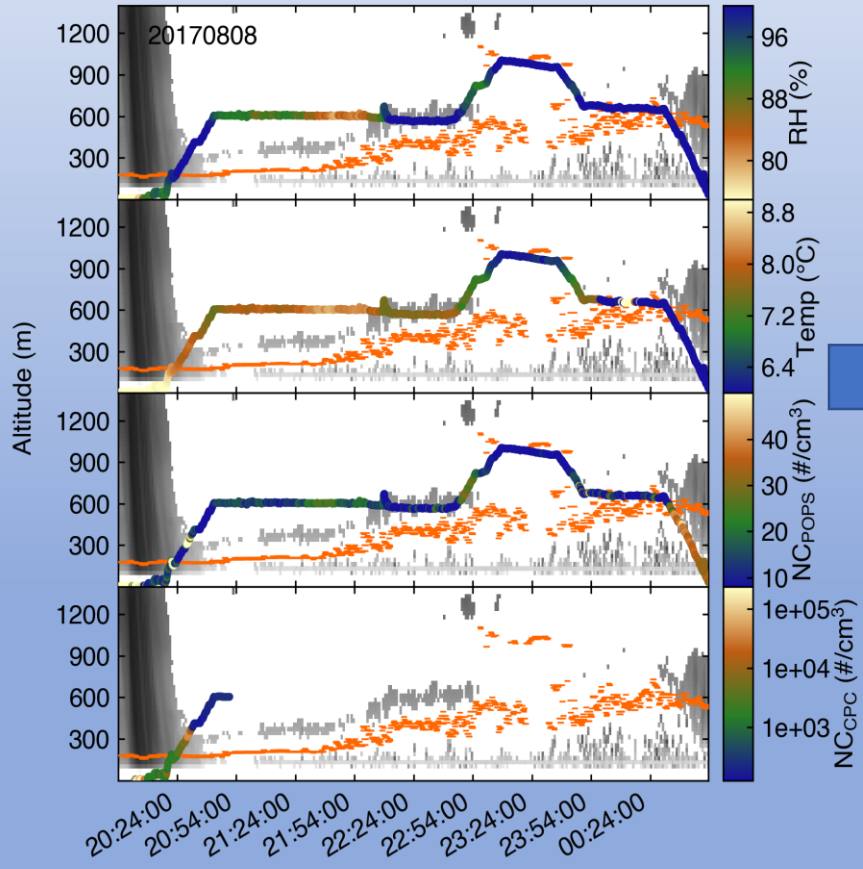
Photos from Gijs de Boer and Darielle Dexheimer

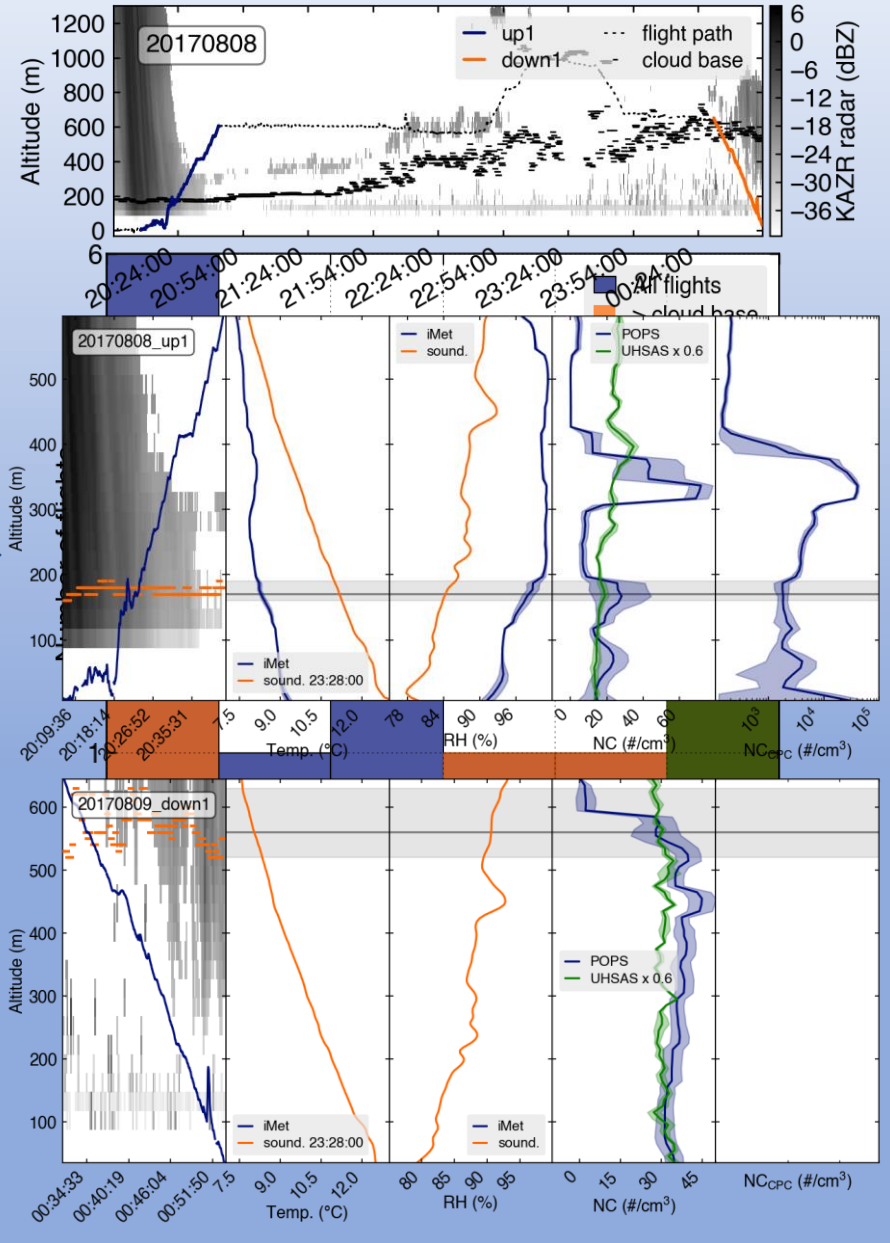
Ongoing ICARUS TBS projects

- Project 1: Are ground-based aerosol measurements representative of aerosol vertical distributions?
- Project 2: To what extent to clouds redistribute aerosols?
- Project 3: Do aerosols above or below cloud have a larger impact on cloud microphysics and evolution?

Project 1: Ground vs. aloft aerosol

Hagen Telg



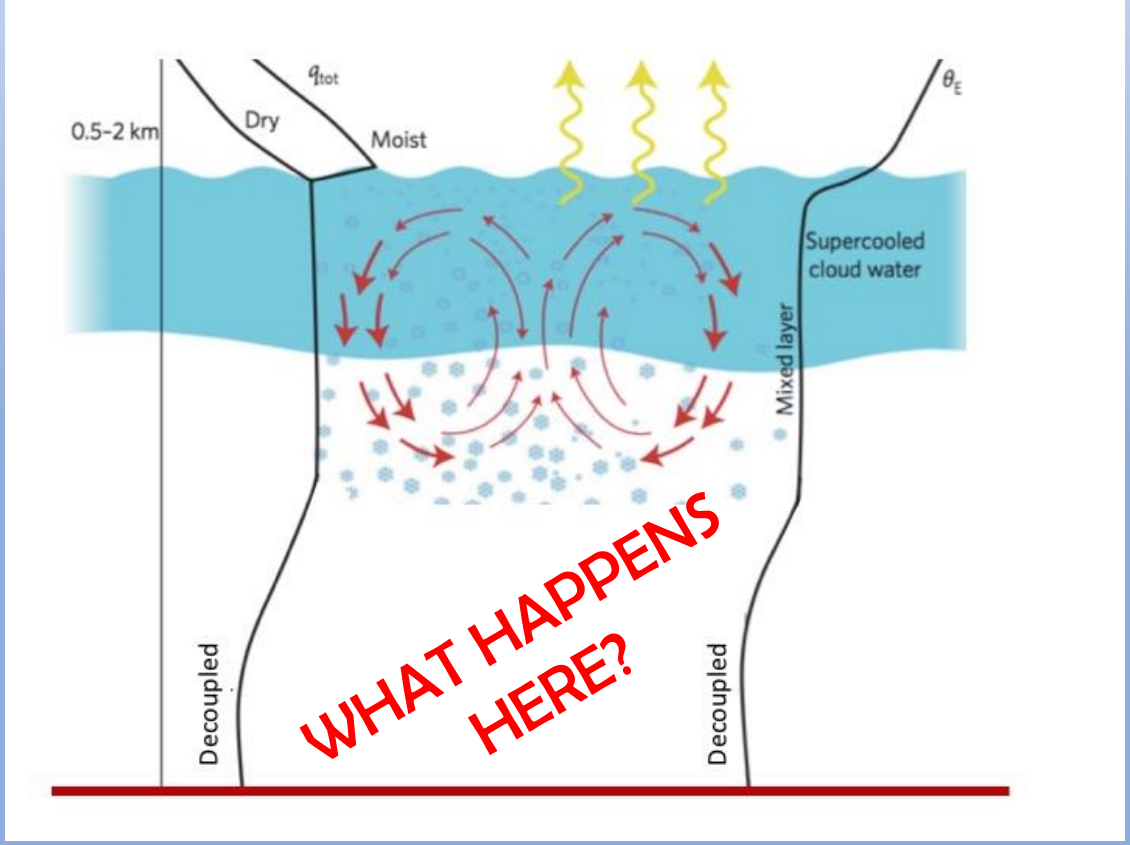


Project 2: Aerosol redistribution

Gijs de Boer

Question: How do Arctic stratiform clouds contribute to the vertical redistribution of aerosol particles?

Hypothesis: When decoupled from the surface, cloud-driven dynamics and precipitation processes result in the accumulation of aerosol in the stratified layer below cloud.



From Morrison et al., 2012

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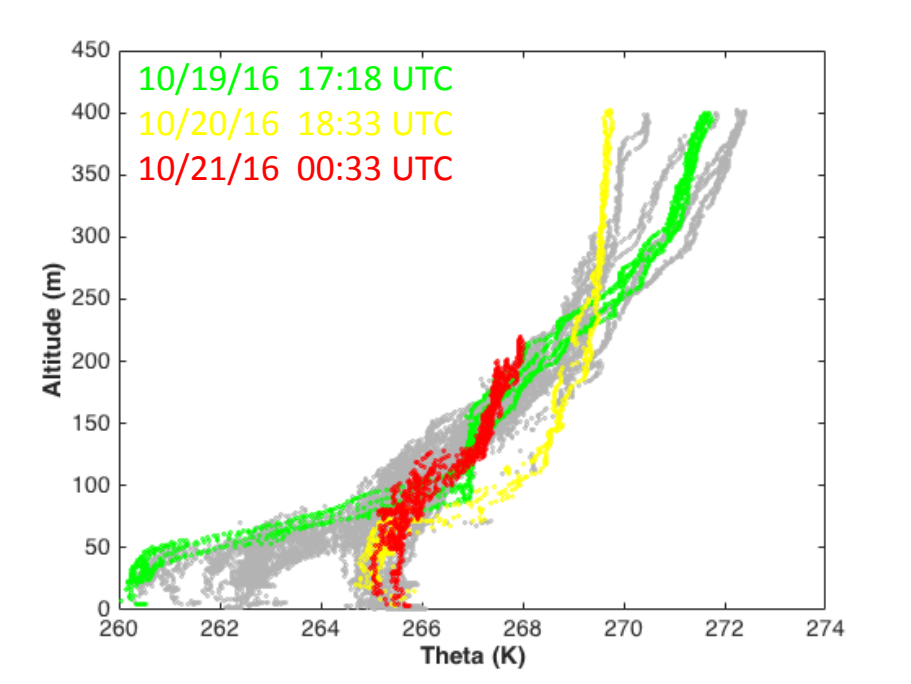
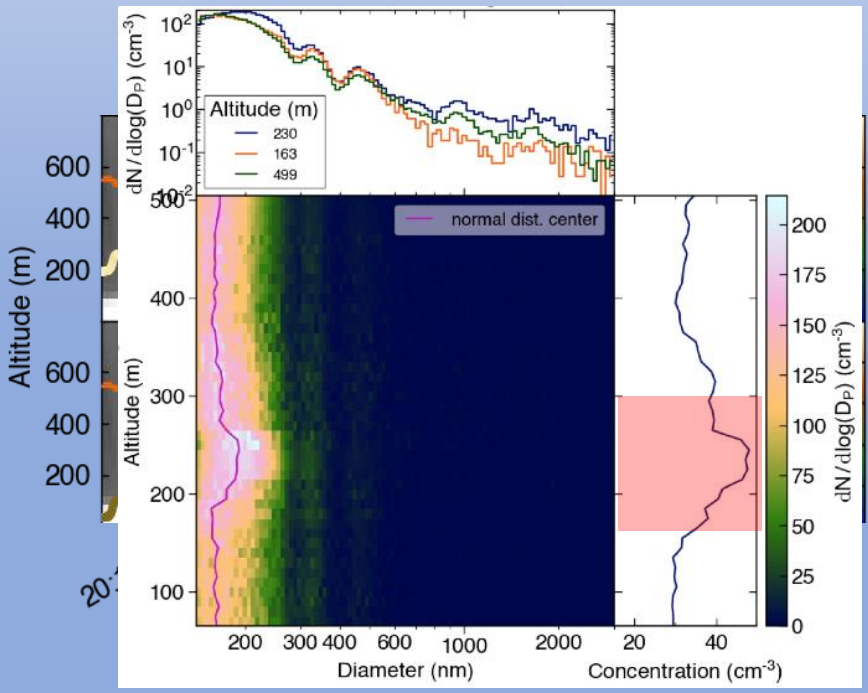
Observational Evidence from TBS and UAS measurements



DataHawk2 Theta Profiles



TBS POPS Size Distribution Profiles

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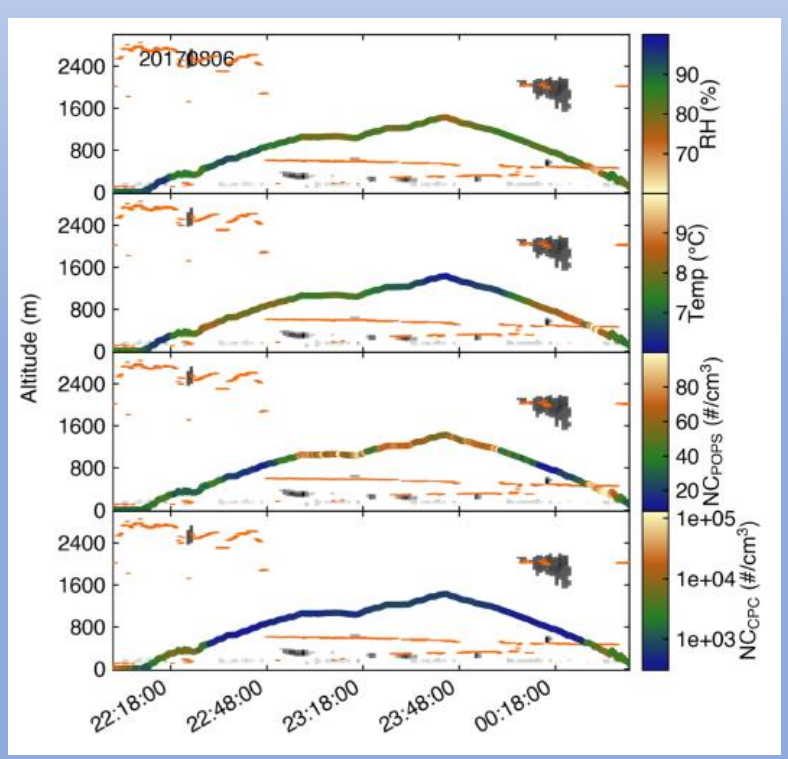
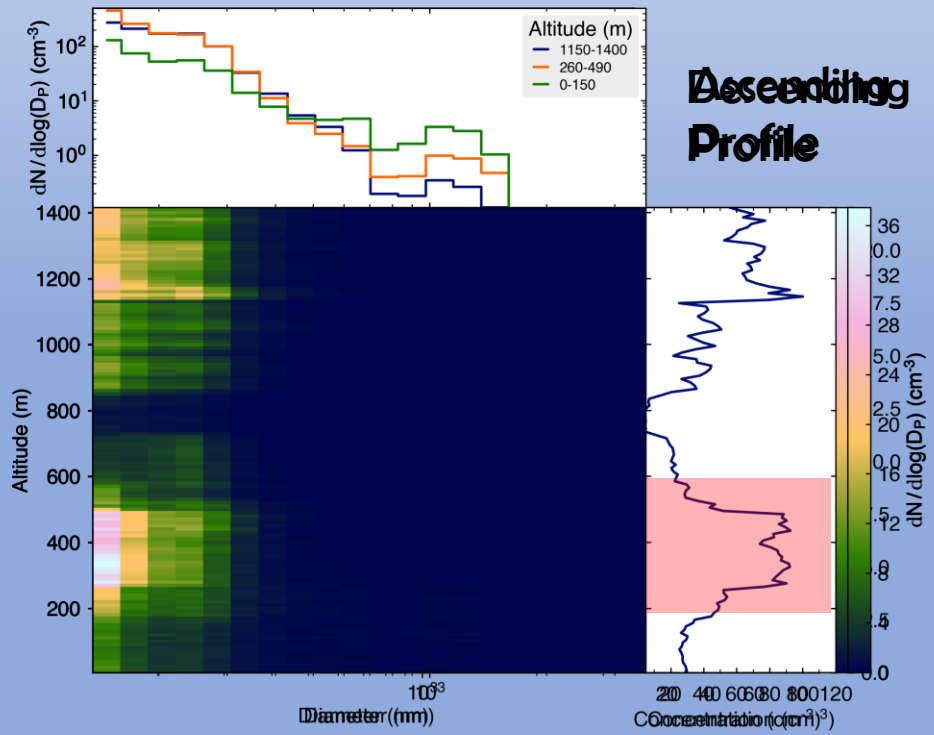


TBS T, RH, POPS and CPC Profiles

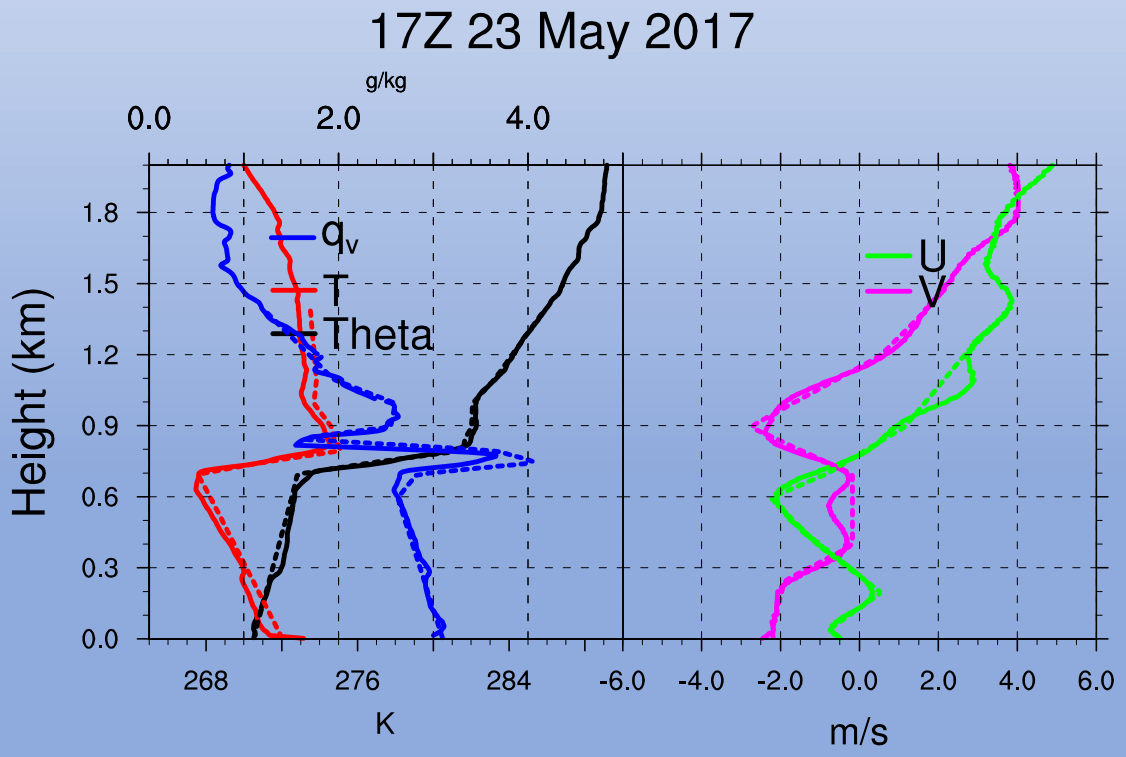


TBS POPS Size Distribution Profile

Project 3: Aerosol-cloud interactions

Amy Solomon

Goal: Testing hypotheses on cloud-processing of aerosols.



1. Using passive aerosols to understand the redistribution of aerosols by cloud-driven mixing and relation between cloud-top and surface layer aerosol distributions
2. Using prognostic CCN to study the impact of aerosol layers aloft on cloud structure and lifetime

Solid line = 17Z May 23 2017 Sonde
Dash line = Initial Model Fields

Future directions

- Project 1: Are ground-based aerosol measurements representative of aerosol vertical distributions?

  Continue evaluating each flight and look at statistics for all flights.

- Project 2: To what extend to clouds redistribute aerosols?

  Evaluate case studies in further detail via vertical mixing from radar and sonic anemometer and explore the use of LES in confirming aerosol mass distribution.

- Project 3: Do aerosols above or below cloud have a larger impact on cloud microphysics and evolution?

  Study the impact of aerosol layers above and below the cloud-driven mixed layer on cloud structures and lifetimes by using aerosol data for parameterizations.