Goddard IMPACTS Science

Mei Han, Scott Braun

- Study microphysical properties, including the mass-weighted mean diameter (D_m), using the GPM, aircraft radars and in-situ observations.(1 Feb)

Gerald Heymsfield et al.

- Kinematic & dynamic processes associated with snow bands (5 Feb)
- Elevated convection (25 January)
- Physics of banded structures in extratropical systems (1 Feb)

Mircea Grecu et al.

- Retrieval of snow properties from radar measurements (multiple cases)

Stephen Nicholls, John Yorks, et al. (7 Feb)

- Combined lidar/radar retrieval and model investigation of the microphysical characteristics of IMPACTS winter storms (25 Jan, 5 Feb, 7 Feb, 25 Feb, 27 Feb)

Ian Adams et al.

- CoSMIR science – understanding snow polarization signatures. (multiple cases)
- Ice particle shape/orientation, SLC, etc.

Rob Schrom et al.

- Flexible retrieval of snow properties from radar measurements (multiple cases)

COMPARISON OF MICROPHYSICAL PROPERTIES FOR THE IMPACTS 2020 FEB 1ST CASE WITH AIRCRAFT AND GPM DATA AND MERRA-2 REANALYSIS

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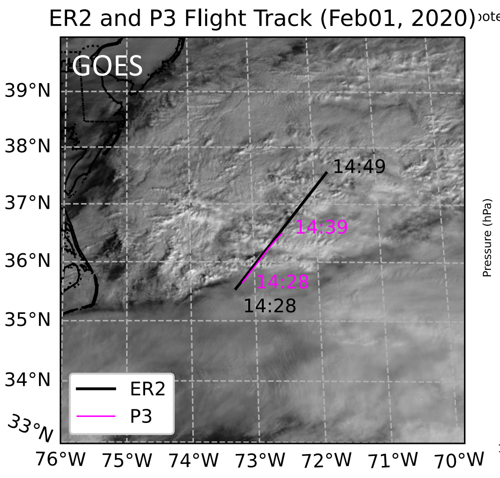
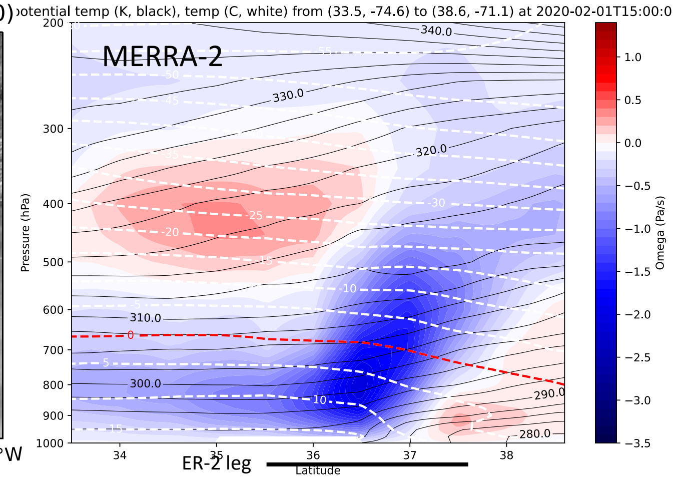
(SEPTEMBER 28, 2021, IMPACTS SCIENCE TEAM MEETING)

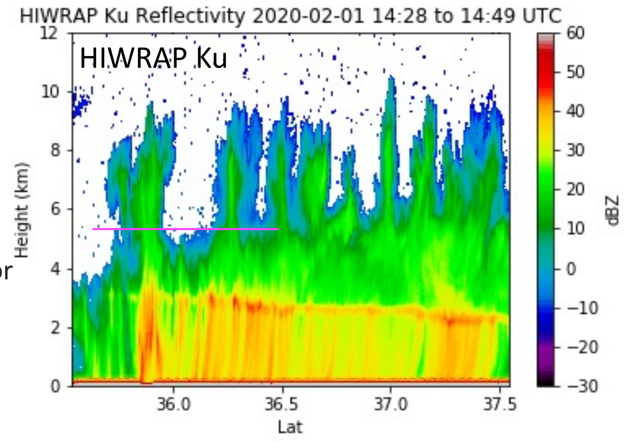
Purpose – study microphysical properties, including the mass-weighted mean diameter (D_m), using the GPM, aircraft radars and in-situ observations.

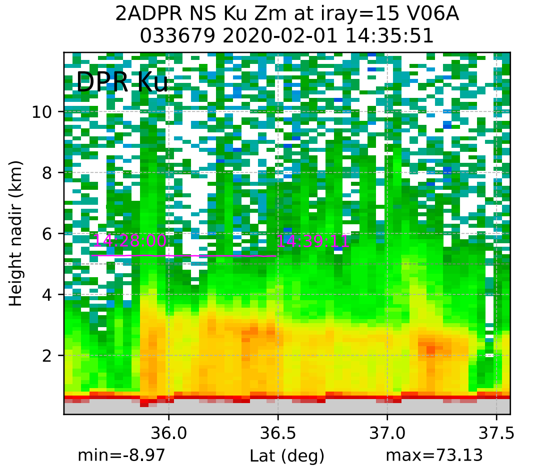
Analysis:

- A 21-minutes long ER-2 and a 11-minutes long P-3 flight legs were closely along a fixed DPR incident angle.
- GOES ABI radiance shows fine-scale streaks of cloud feature, corresponding to higher reflectivity regions in the GPM radar swath.
- MERRA-2 analysis shows updraft along a sloped frontal zone in the region of cloud and precipitation.
- Generating cells in the HIWRAP Ku and DPR Ku Z_m reflectivities appear similar
- The P-3 flight leg went across 2-3 generating cells near a height of 5260 m – coincident with 8 DPR pixels (for the retrieved D_m)
- The HVPS3 D_m (based on liquid equivalent diameter of solid particles) calculated with two m-D relationships are close to each other (gray and black lines)
- The GPM CORRA retrieved D_m with both Ku and Ka (MS, black dots) or with Ku only (NS, open blue dots) is somewhat larger than the HVPS3-derived.



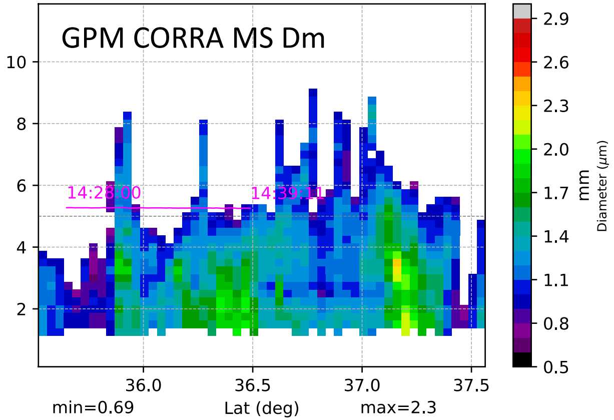


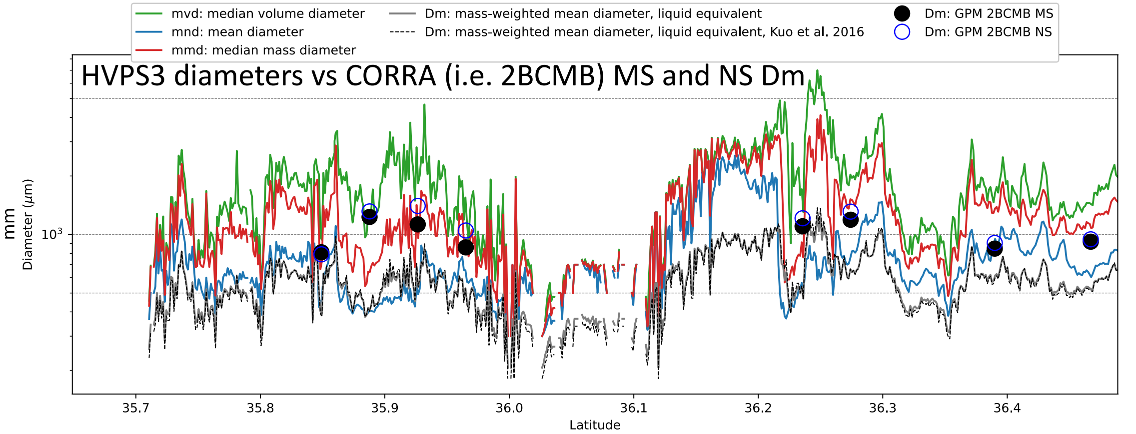




Summary:

- This study is our first attempt to understand the microphysical properties of the frontal precipitation and generating cells in the Feb 1st case.
- Preliminary analysis shows a reasonable comparison between the CORRA retrieved D_m and the HVPS3 derived value
- Future work includes comparison of the HIWRAP retrievals and more aircraft data. We may consider other cases and in-depth modeling analysis.

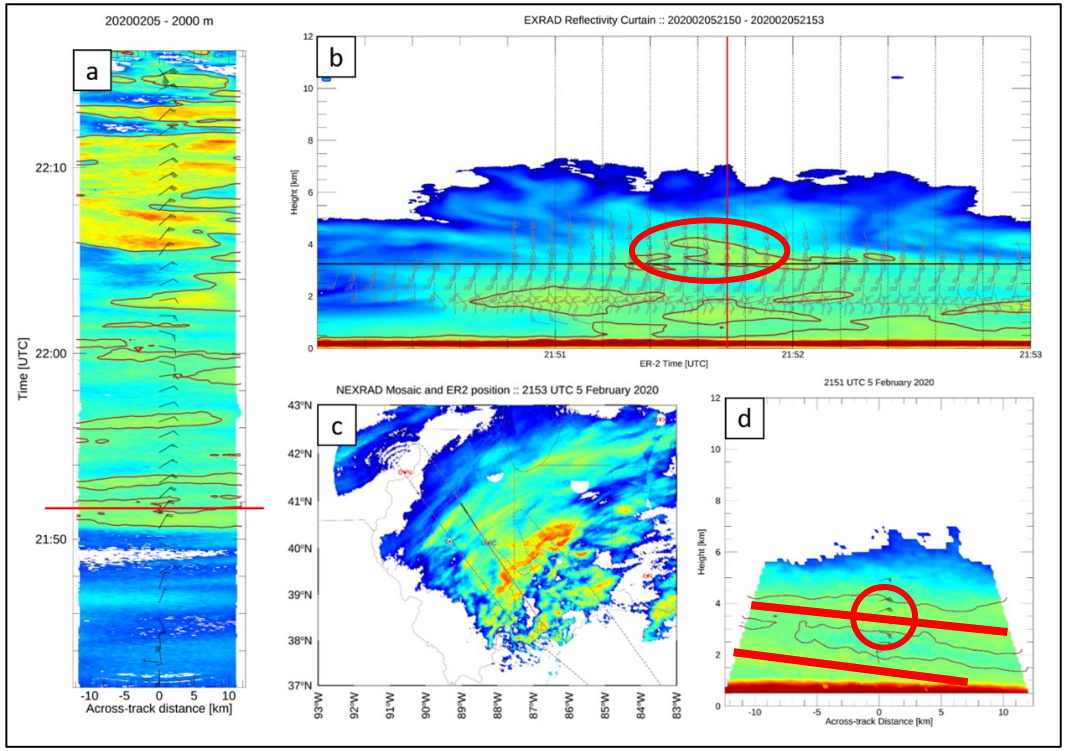


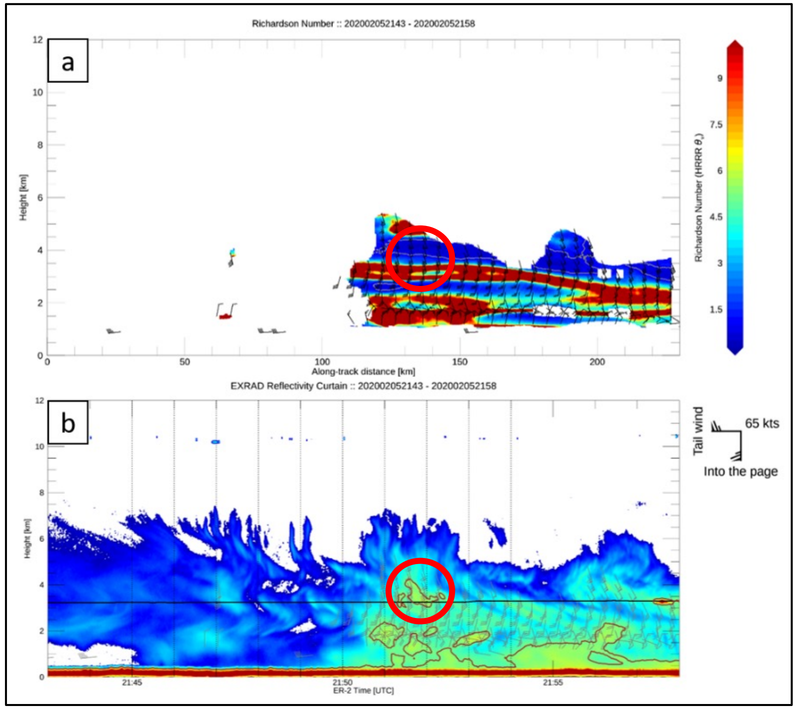


A Study of the Kinematic and Dynamic Processes associated with Mesoscale Snowbands in a Midwest United States Snowstorm on 5 February 2020

Charles N. Helms[a,b] and Gerald M. Heymsfield[a]

[a]NASA Goddard Space Flight Center, [b]NASA Postdoctoral Program (USRA)





Goal:

- Examine the processes responsible for maintaining mesoscale snowbands

Method:

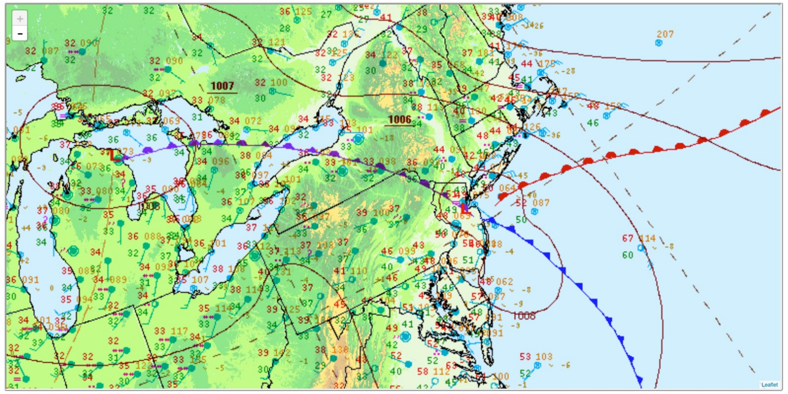
- Combine EXRAD radar data (reflectivity, Doppler, VAD winds) with in-situ observations and models

Early Results

- Reflectivity features tilt downshear with height: precipitation trailing a generating cell?
- K-H instability not supported by Richardson number calculation, but model may be smoothing out the thermodynamics

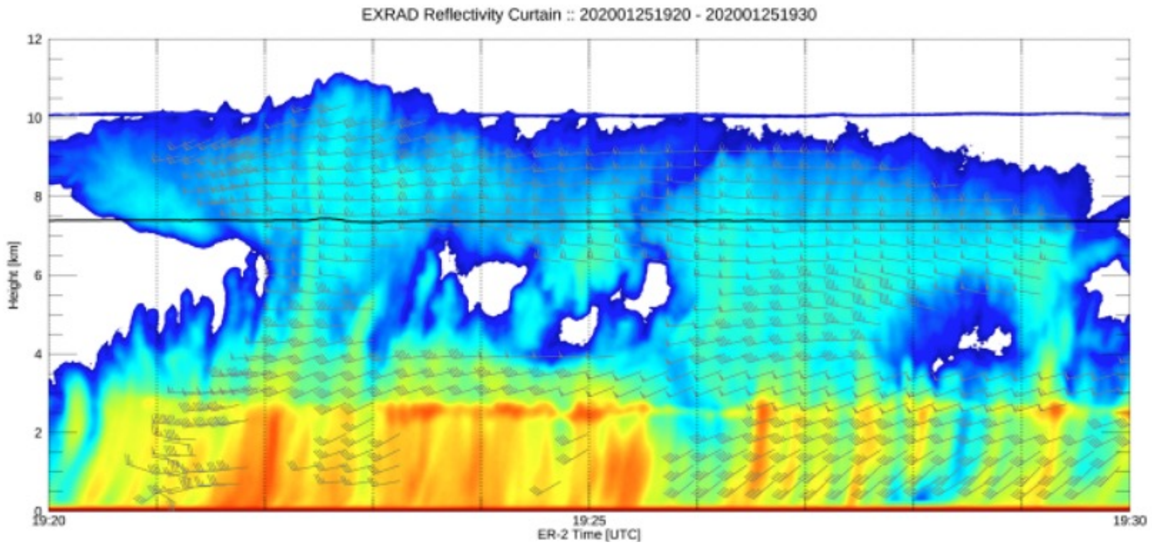
Frontal Convection 25 January 2020

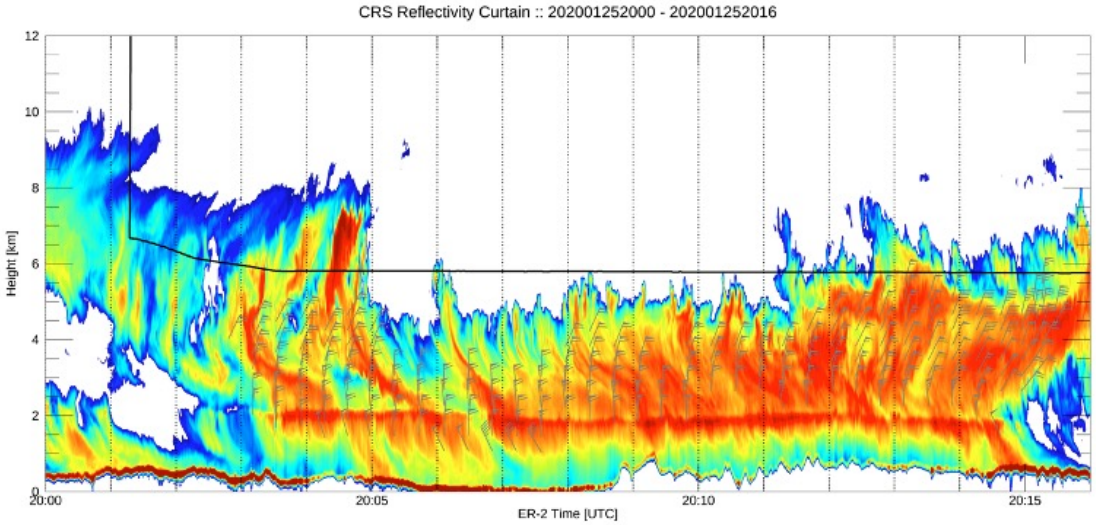
G. Heymsfield, C. Helms, S. Guimond, A. Heymsfield, and A. Bansemer



Most of mission was over warm occlusion but early part of flight was over warm front.

- Characterize the weak & strong elevated convection
- Vertical motions & horizontal winds
- Origins of convection
- Microphysics in convection





The Physics of Banded Structures in Extra-Tropical Systems: A Combined Remote Sensing and Modeling Perspective from NASA IMPACTS 2020

Steve Guimond (UMBC and NASA/GSFC) sguimond@umbc.edu

GOAL: Help address major science objectives related to understanding bands and system

- *Key structures, spatial and temporal scales*
- *Dynamical processes (fluid + precipitation)*
- *Guidance for remote sensing instruments and sampling*

Datasets (Focus on Febuary 1, 2020 case)

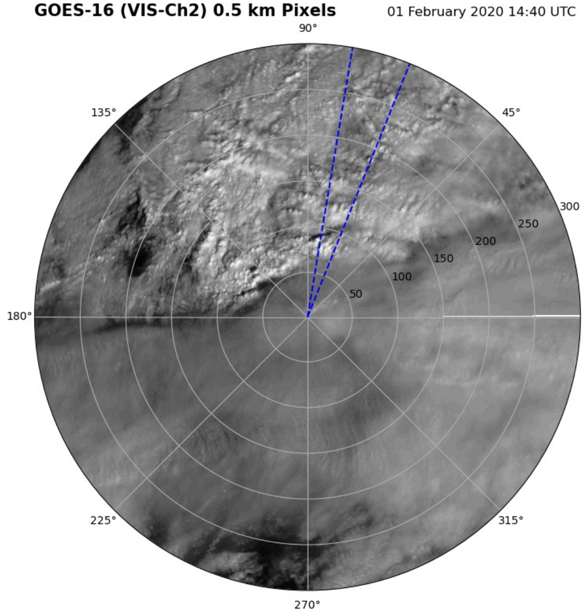
- *WRF modeling on multiple scales down to 74 m*
- *Remote sensing of 3D winds, clouds and precipitation*
    - *EXRAD, GOES-16, CoSMIR*

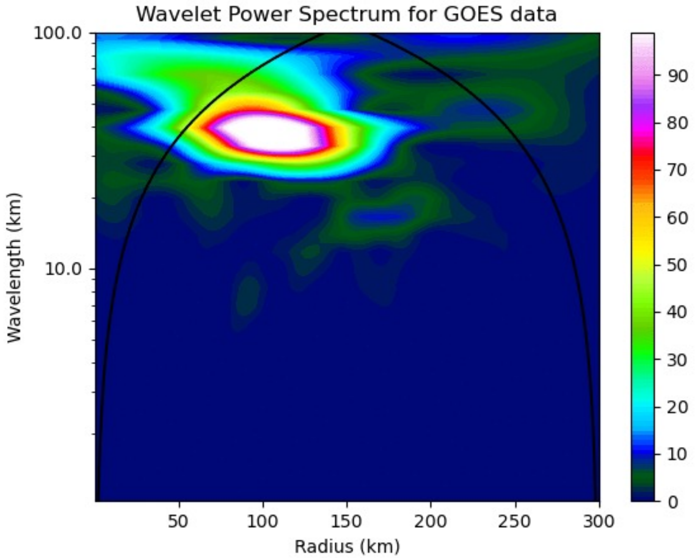
Methodology (Ongoing)

- *Dynamical budget analysis for total precipitation mass, TKE and possibly other quantities*
- *Framework follows Guimond et al. (2011) and Guimond et al. (2020)*

Preliminary Findings

- *Dominant/secondary bands have radial wavelengths of ~ 40 km/15 km; secondary growth/decay on 20 – 30 min scales*
- *Observed upscale merger of secondary with dominant band*
- *Intense, deep inflow in convective bands feeding vortex intensification*





CoSMIR Science

- Implemented AI/ML retrievals
  - Quantile Regression Neural Networks
  - Address sparseness issues of GPROF-like Bayesian retrievals
  - Integrated and profile quantities
  - Observational and model training sets give consistent results
- Investigating relationship between storm structure and polarization
  - 166-GHz Tbs sensitive to altitudes with dendrite growth and aggregation
  - See poster: Adams, day 1, number 4,

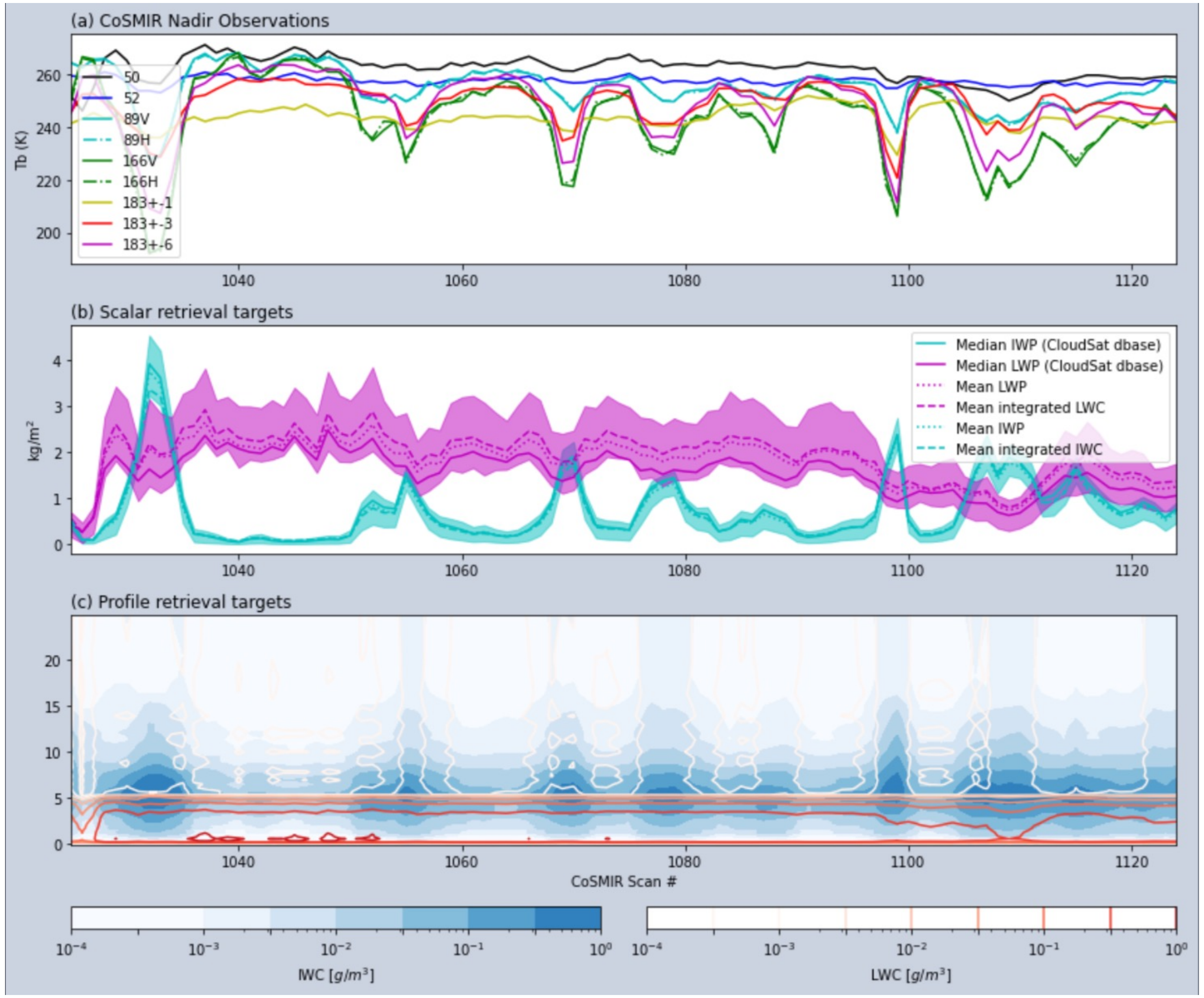
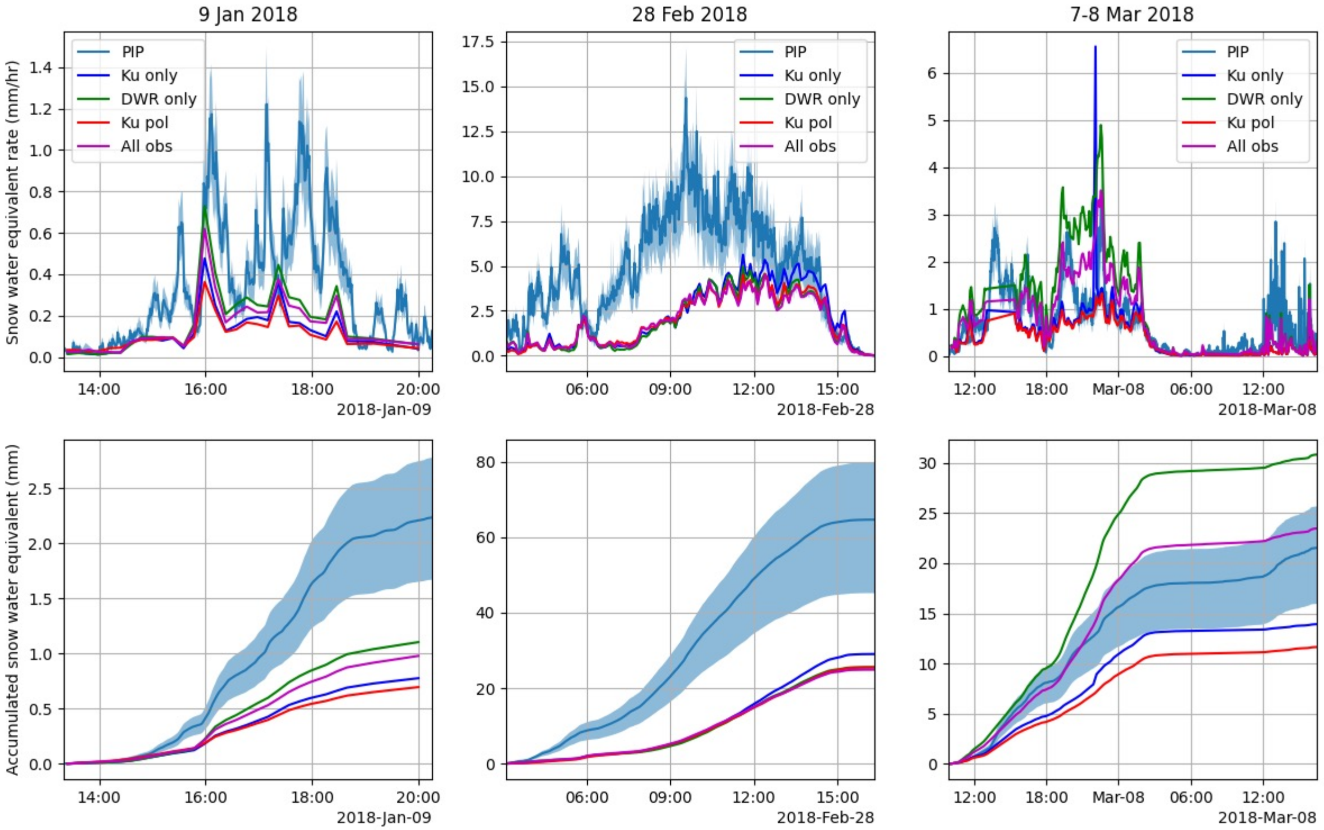


figure credit: Joe Munchak

Flexible retrieval of snow properties from radar measurements



Munchak et al. (2021)

- Munchak et al. (2021) retrieval of snow microphysical properties from radar measurements (example with ICE-POP data).
- Compares favorably with PIP-derived physical properties during heavier snowfall (e.g., snow-water-equivalent shown in figure).
- Flexibility in retrieval with different measurement platforms (e.g., airborne, ground-based, multi-frequency, dual-pol).
- Improved radar forward model simulations from OpenSSP (Kuo et al. 2016) oriented particles.
- Plan to use complementary ER2 radar measurements and/or D3R data to supplement IMPACTS analysis.

Questions?