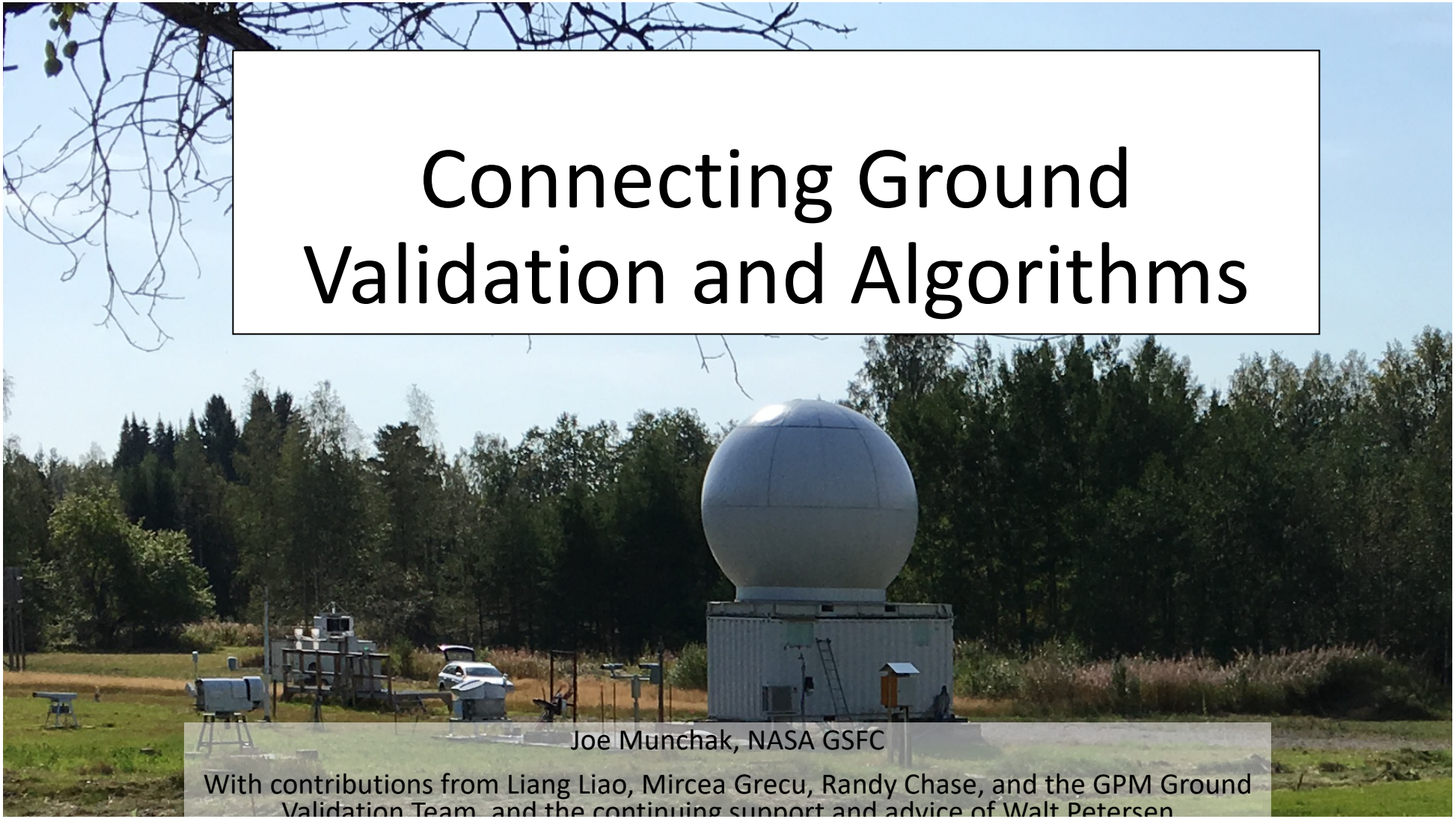
Connecting Ground Validation and Algorithms



Joe Munchak, NASA GSFC

With contributions from Liang Liao, Mircea Grecu, Randy Chase, and the GPM Ground Validation Team, and the continuing support and advice of Walt Petersen

Overview of GPM Field Campaigns

Contributions to:
C3VP (2006)
LPVEX (2010)
ICE-POP (2018)

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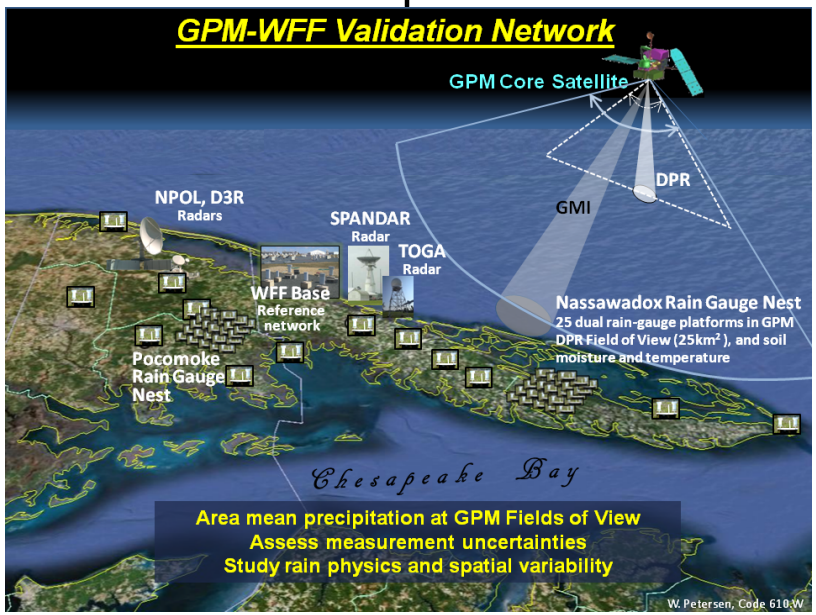
Summary of Field Campaigns

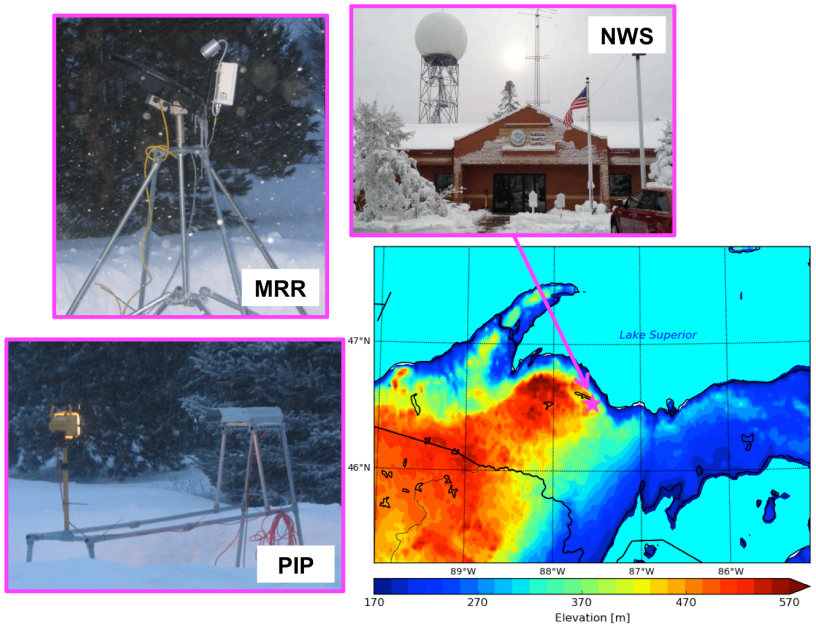
Field Campaign	Aircraft Obs	Dedicated Ground Radar	Ground Instruments
MC3E Apr-May 2011	ER-2 (73 hours) UND Citation (42.6 hours)	NPOL D3R X-SAPR, C-SAPR KAZR, SACR	PARSIVEL (17) Gauge pairs (16) 2DVD (7)
GCPEX Jan-Feb 2012	DC-8 (14 flights) UND Citation (11 flights) NRC Convair-580 (5 flights)	D3R MRR2 W-/X-band profiling	PARSIVEL (10) 2DVD (5) PIP (3) POSS (5) Pluvio (9)
IFLOODS Mar-Apr 2013		MRR NPOL D3R XPOL	PARSIVEL (14) Gauge Pairs (18) 2DVD (6)
IPHEX May-Jun 2014	ER-2 (18 flights) UND Citation (20 flights)	NPOL D3R NOXP	PARSIVEL (24) Gauges (108) 2DVD (5)
OLYMPEX Nov-Dec 2015	ER-2 (11 flights) DC-8 (17 flights) UND Citation (15 flights)	NPOL D3R EC X-band DOW MRR (4)	PARSIVEL (15) Gauge Pairs (25) 2DVD (3) PIP

Ongoing Data Collection

Wallops



Marquette



Plus partner international sites (CARE, Hyytiälä, …)

What do algorithms need from GV?

Direct validation

- Compares algorithm output to a comparable ground-based measurement
- Metrics upon which mission success is measured
- Example: use ground-based radar to evaluate attenuation-corrected Z, R, D_m

Physical Constraints

- GV data can, and should, be used to inform algorithm assumptions, but with caveats:
  - Algorithms contain many wrong but useful models
  - Acceptable performance is often achieved by balancing incorrect assumptions (local minimum)
- Examples: Default R-D_m relationship, N_w pdf

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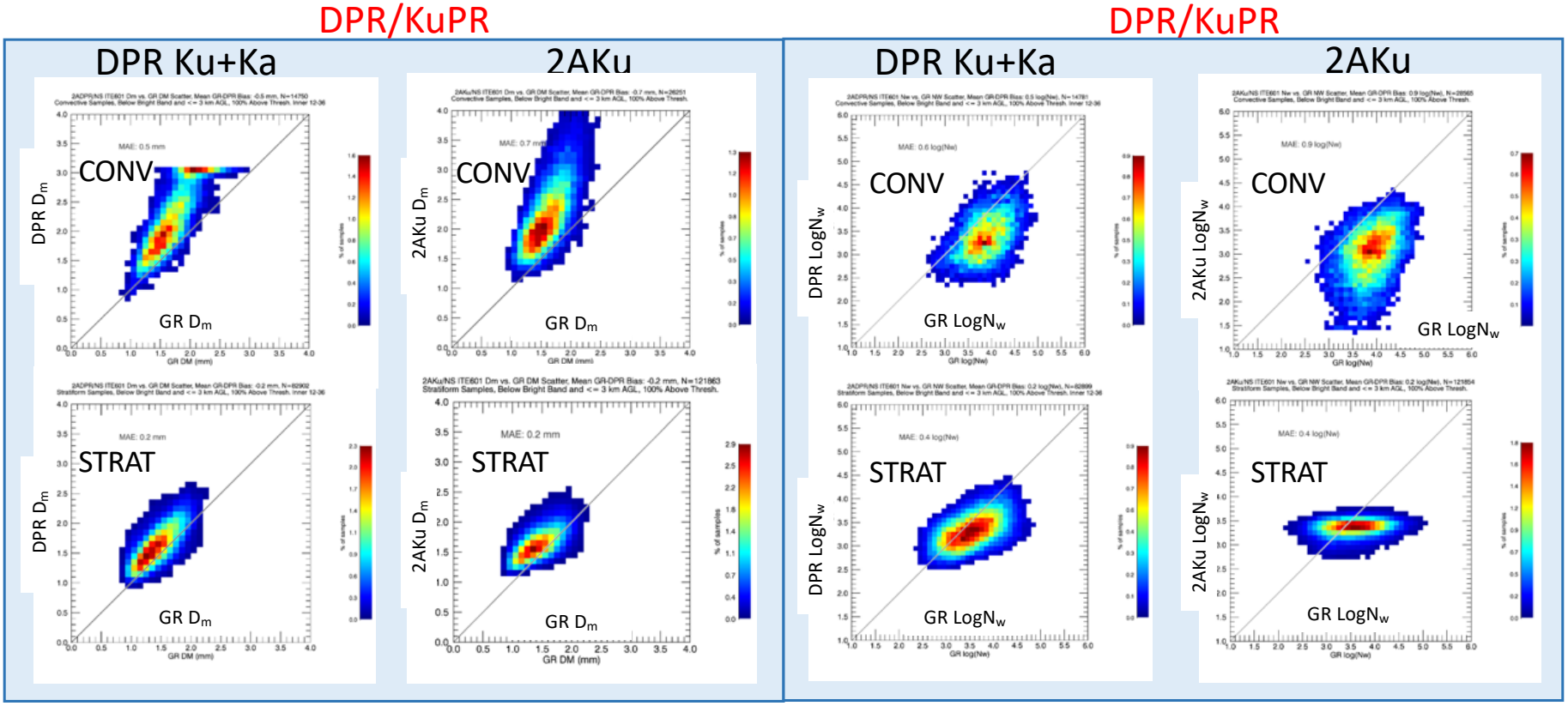
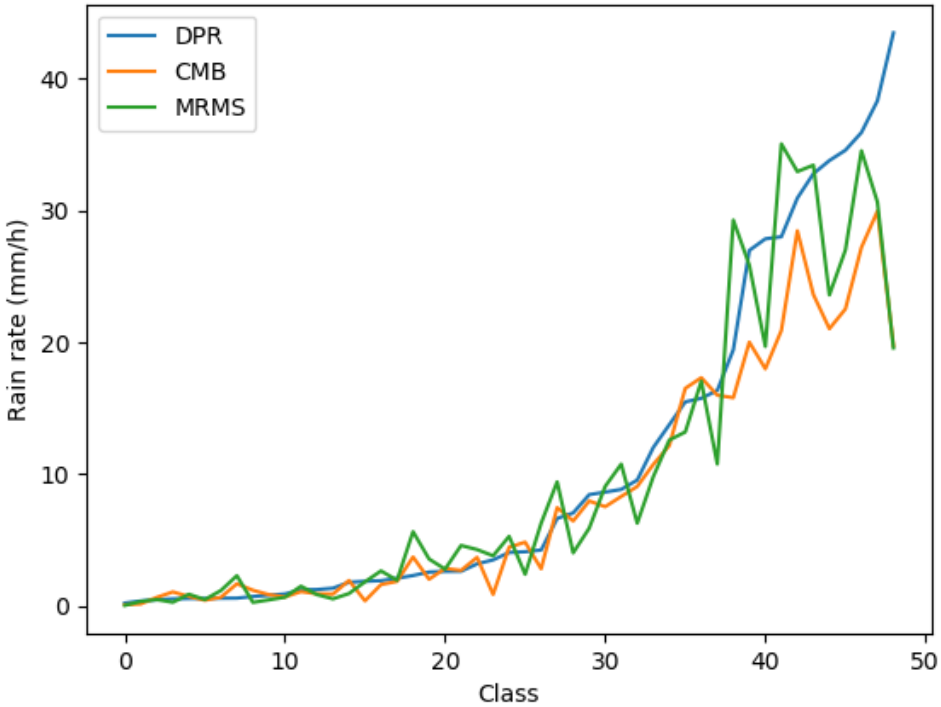
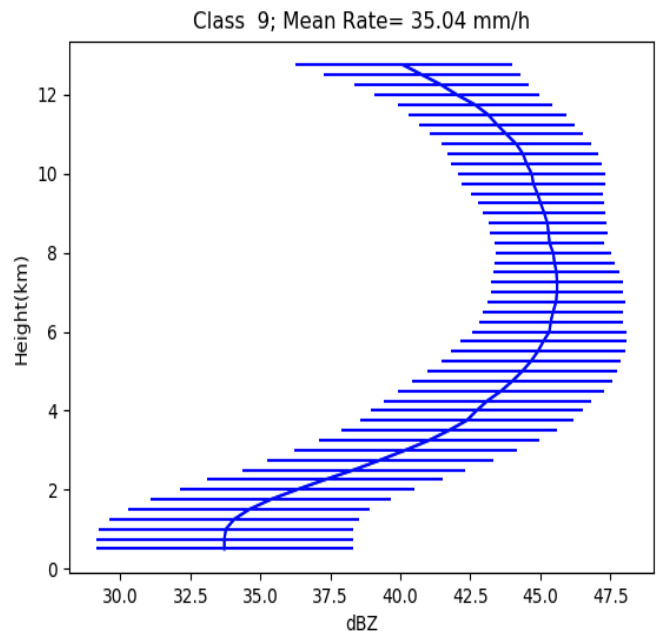
Direct Validation: Ground Radar vs. GPM DPR



*Courtesy of Walt Pertersen 2018-PMM Science Meeting.

A closer look at the convective rain bias:





*Courtesy of Mircea Grecu

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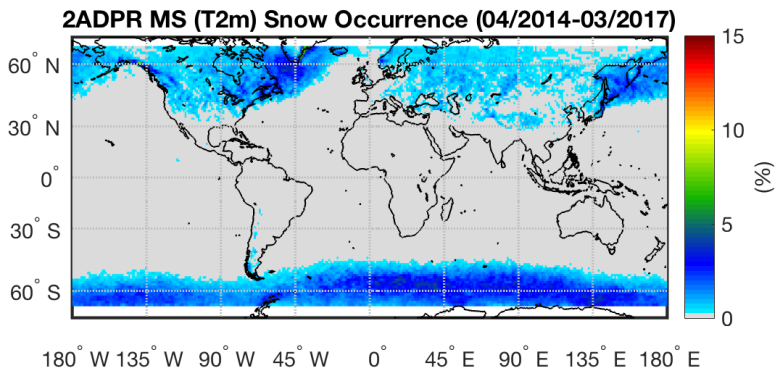
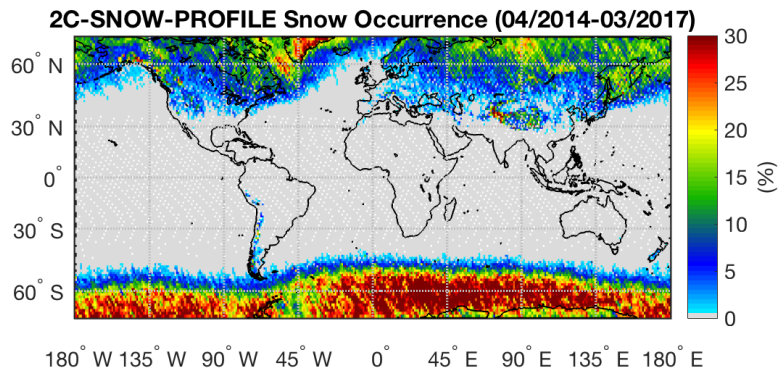
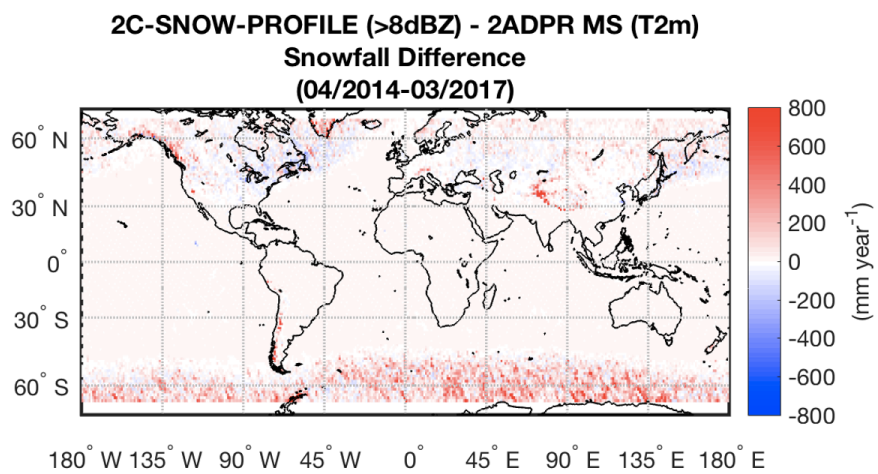
Falling snow detection & estimation discrepancies:

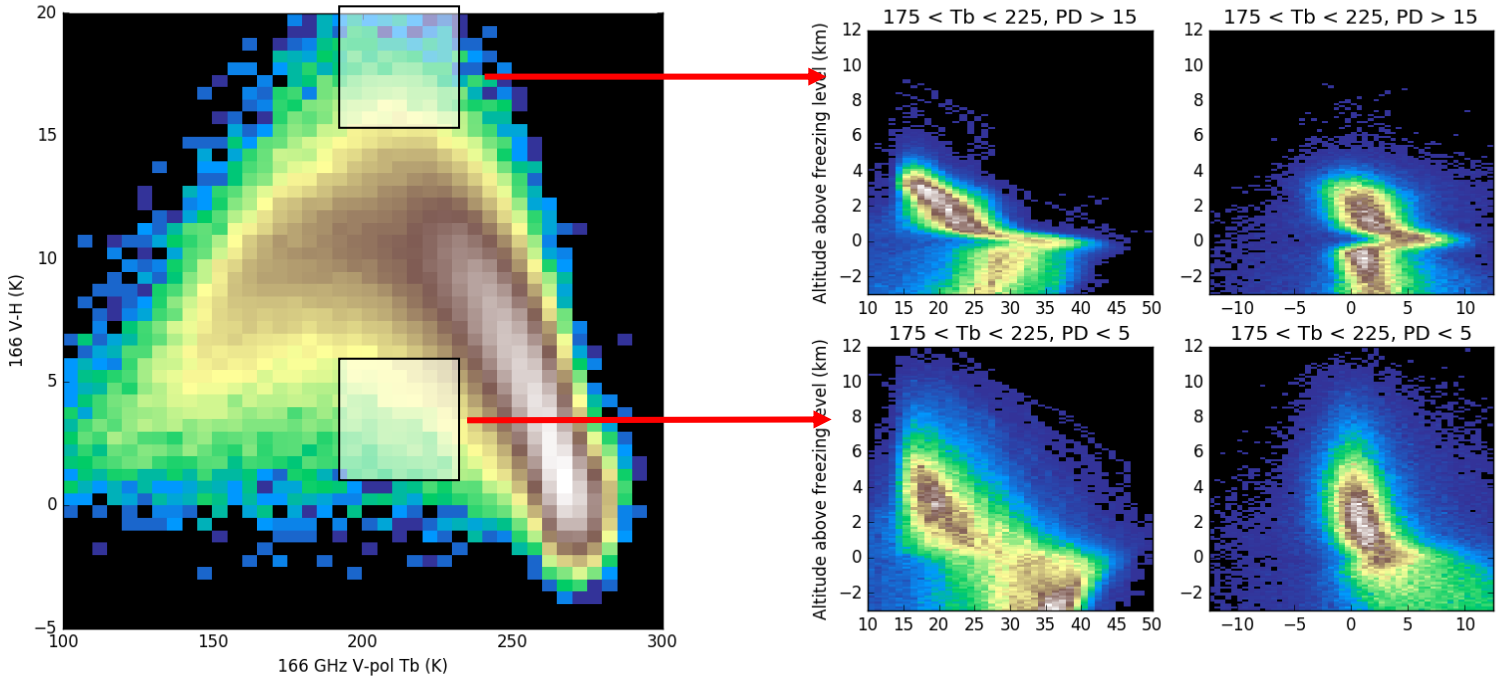






Skofronick-Jackson, G., M. Kulie, L. Milani, S.J. Munchak, N.B. Wood, and V. Levizzani, 2019: Satellite Estimation of Falling Snow: A Global Precipitation Measurement (GPM) Core Observatory Perspective. *J. Appl. Meteor. Climatol.*, **58**, 1429–1448

Algorithm Physical Assumptions: What could be improved?



We have evidence for oriented particles in stratiform precipitation…what is the impact on Z-IWC relationships?

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Algorithm Physical Assumptions: What could be improved?

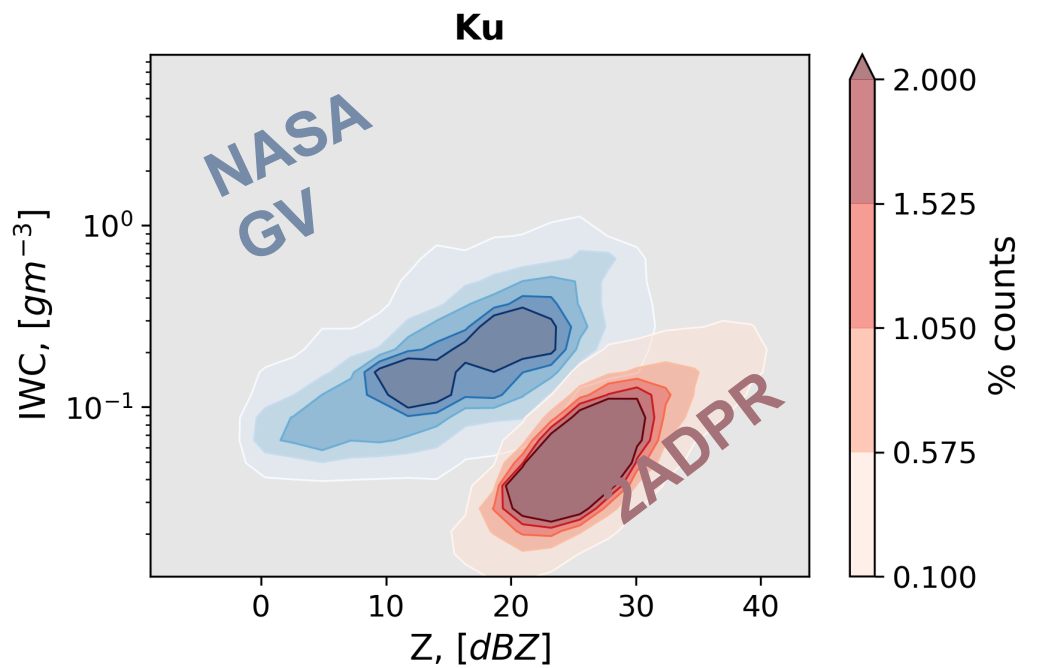
2ADPR, 2AKu, 2AKa, are low by a factor of 7-10

2ADPR:
Made from 21 orbitals*, $T_{surf} < 5°C$, $T_{gate} \leq 0$
***Orbitals are not collocated to GV**

NASA GV:
Made from APR-Nevzorov colocations in OLYMPEX/GCPEX

Courtesy of Randy Chase

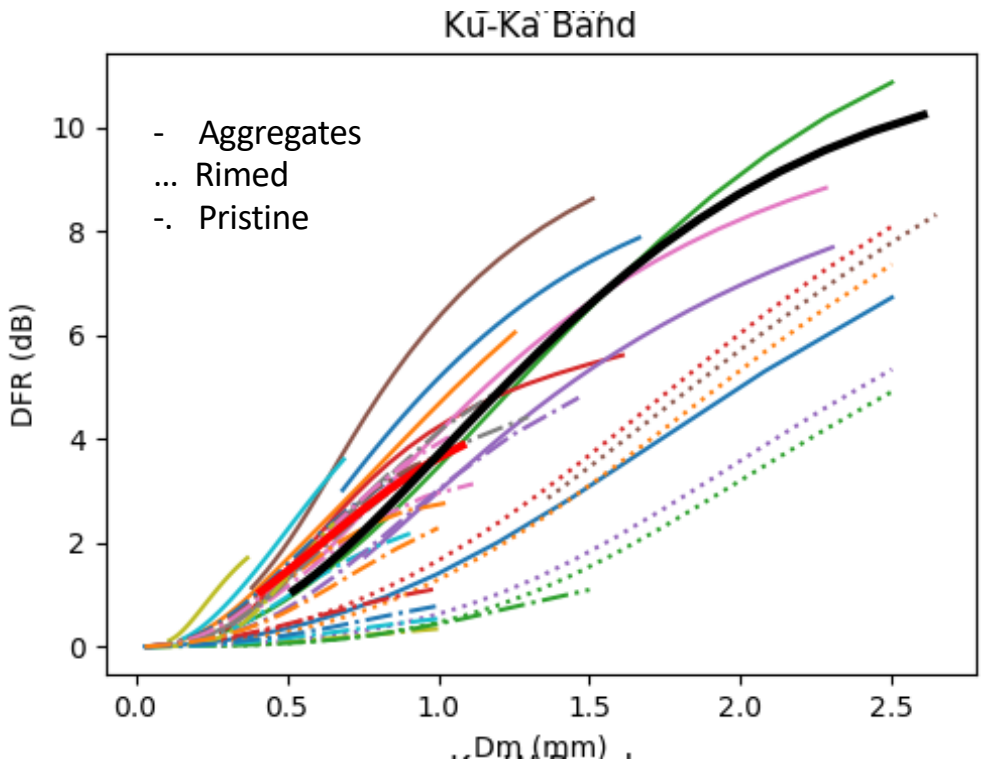
Adapted from Chase et al. in prep.



Algorithm Physical Assumptions: Ice scattering tables

Dual-frequency measurements alone are insufficient to characterize particle size in ice phase (even after converting to melted equivalent diameter). Particle density and geometry assumptions are important. Ability to identify rimed particles by other means (profile shape, BB characteristics) may reduce ambiguities.

Source: OpenSSP and ARTS single scattering databases.



Wish list for GV studies – Combined Algorithm Perspective

1. Comprehensive clustering of profiles by VN rain rate and bias (VN)
2. Are there any reliable predictors for NUBF from large-scale observable data? Can we identify slanted precipitation columns? (VN, MRMS, airborne radar)
3. Snow bias analysis – first separate detection/quantification, then do regime dependent analysis of bias using:
   a) large scale dataset, but need to be careful about lowest level (VN, MRMS)
   b) GV sites with vertically pointing radar and PIP/Pluvio to get detailed microphysics
4. Autocorrelation of N_w (vertical and horizontal), pdfs of N_w by environment and rain type (NPOL/D3R, MRR, 2DVD)
5. Snow microphysics constraints (N_w, density, orientation/aspect ratio for different environments/ptypes) to refine scattering tables (PIP)
6. Better informed extrapolation of profiles below clutter – particularly when there is a phase change (MRR)

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https://www.colorado.edu/event/calval2020/

The University of Colorado Boulder is proud to host the:

NASA GPM Cal/Val and Algorithm Symposium
March 24-26, 2020
University of Colorado Boulder

Meeting is “invitation only”. Yet, all are welcome!

Contact Christopher Williams for “invite” or other information.

No registration fee. Yet, register so that we can get hotel block rates.

Web page is active: https://www.colorado.edu/event/calval2020/

Sponsored by:

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Ann and H.J. Smead Department of Aerospace Engineering Sciences

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