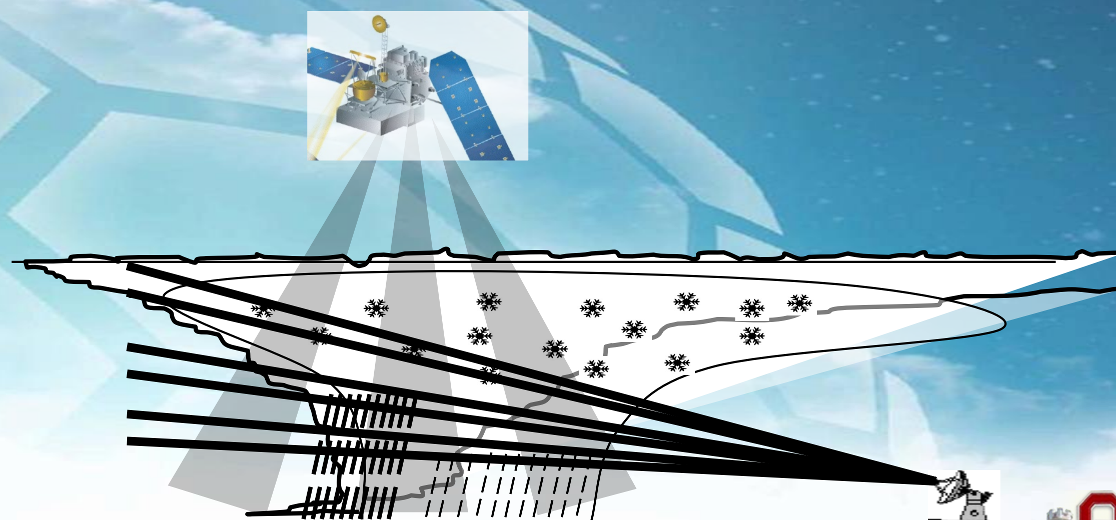
Multi-Radar Multi-Sensor (MRMS) for weather and precipitation

Pierre Kirstetter

with contributions from:
A. Matland



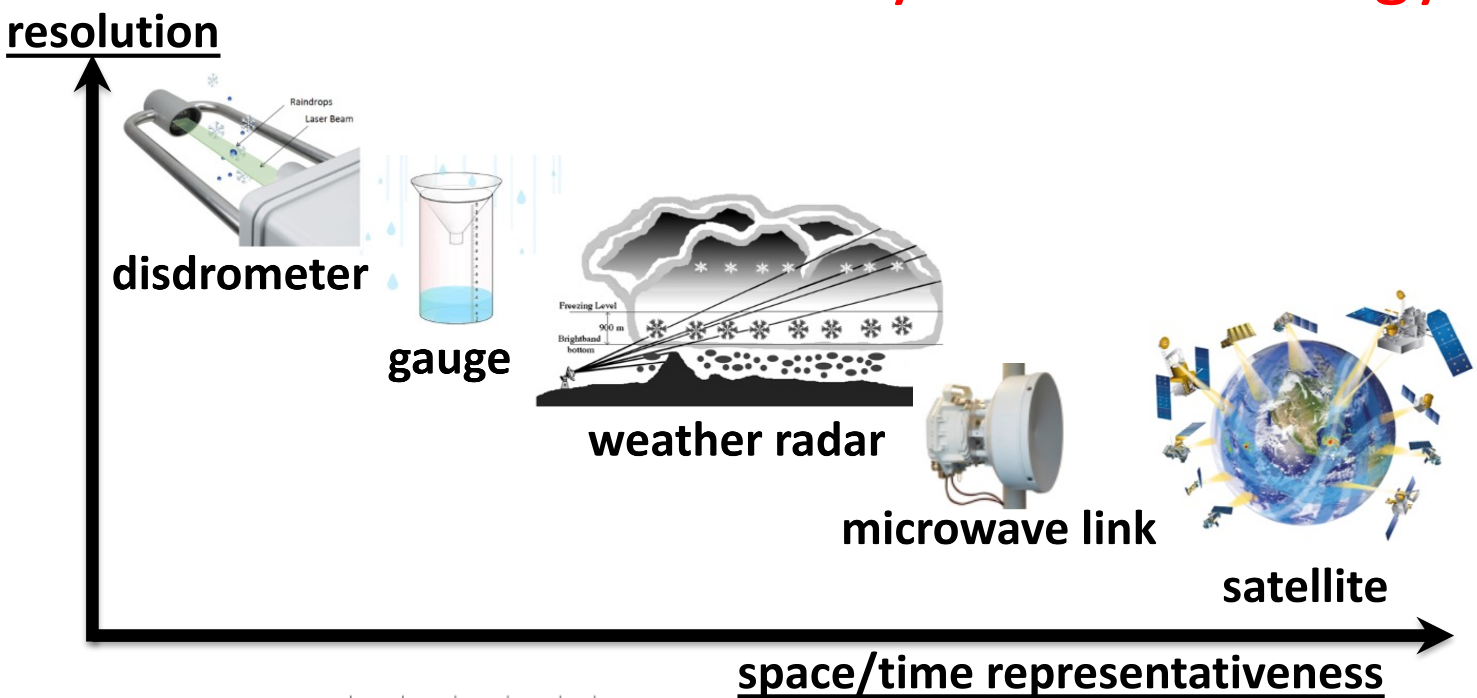
Multi-Radar Multi-Sensor (MRMS) for weather and precipitation

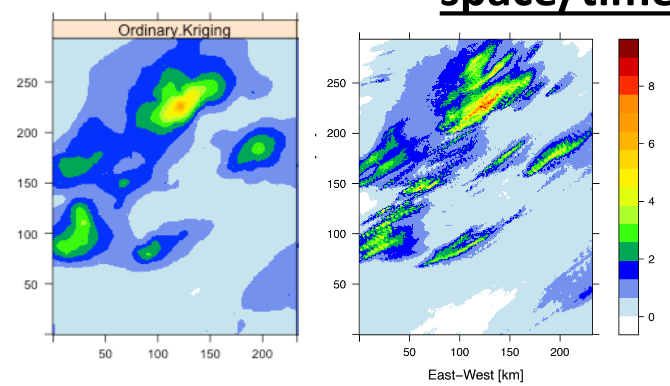
1. **Radar is a cornerstone for understanding global water fluxes**

2. **Multi-Radar Multi-Sensor and space missions**

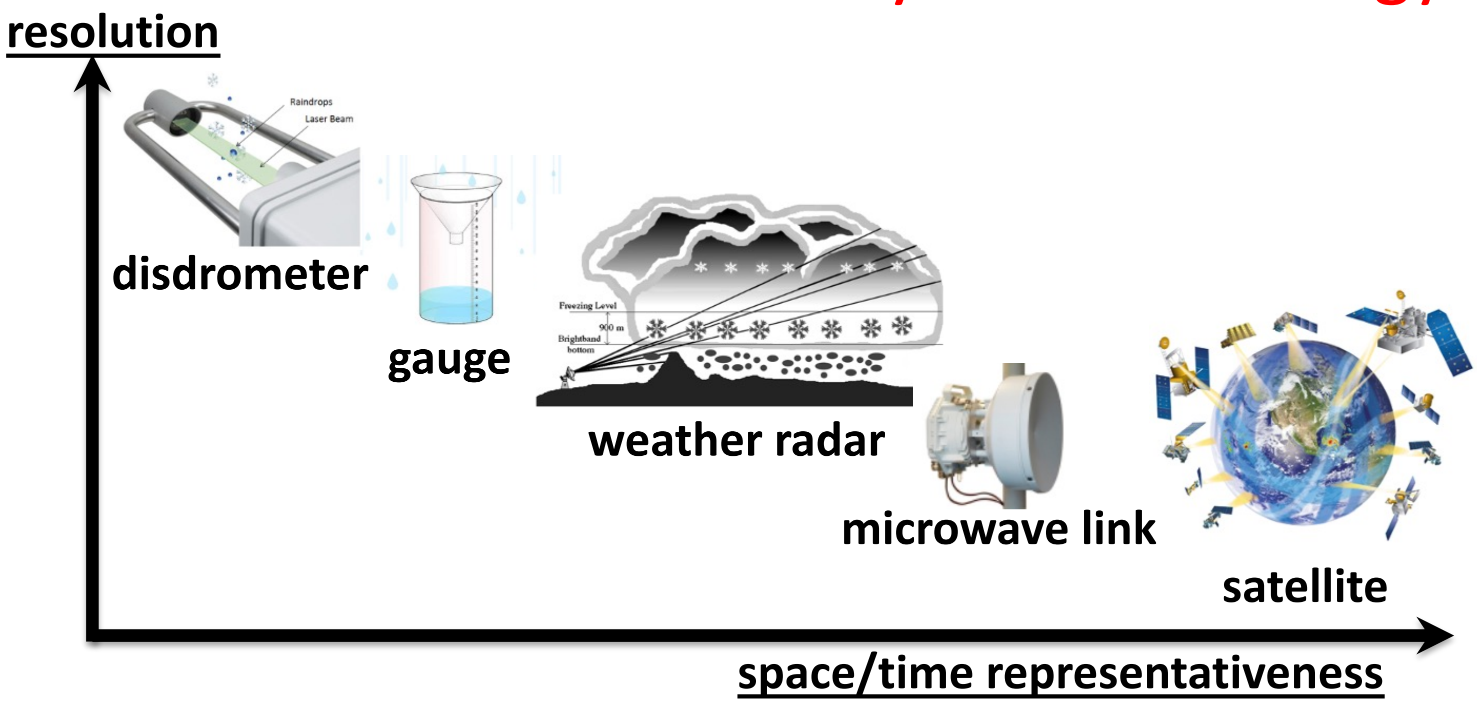
3. **Emerging radar technology for QPE**

Some considerations in radar hydrometeorology



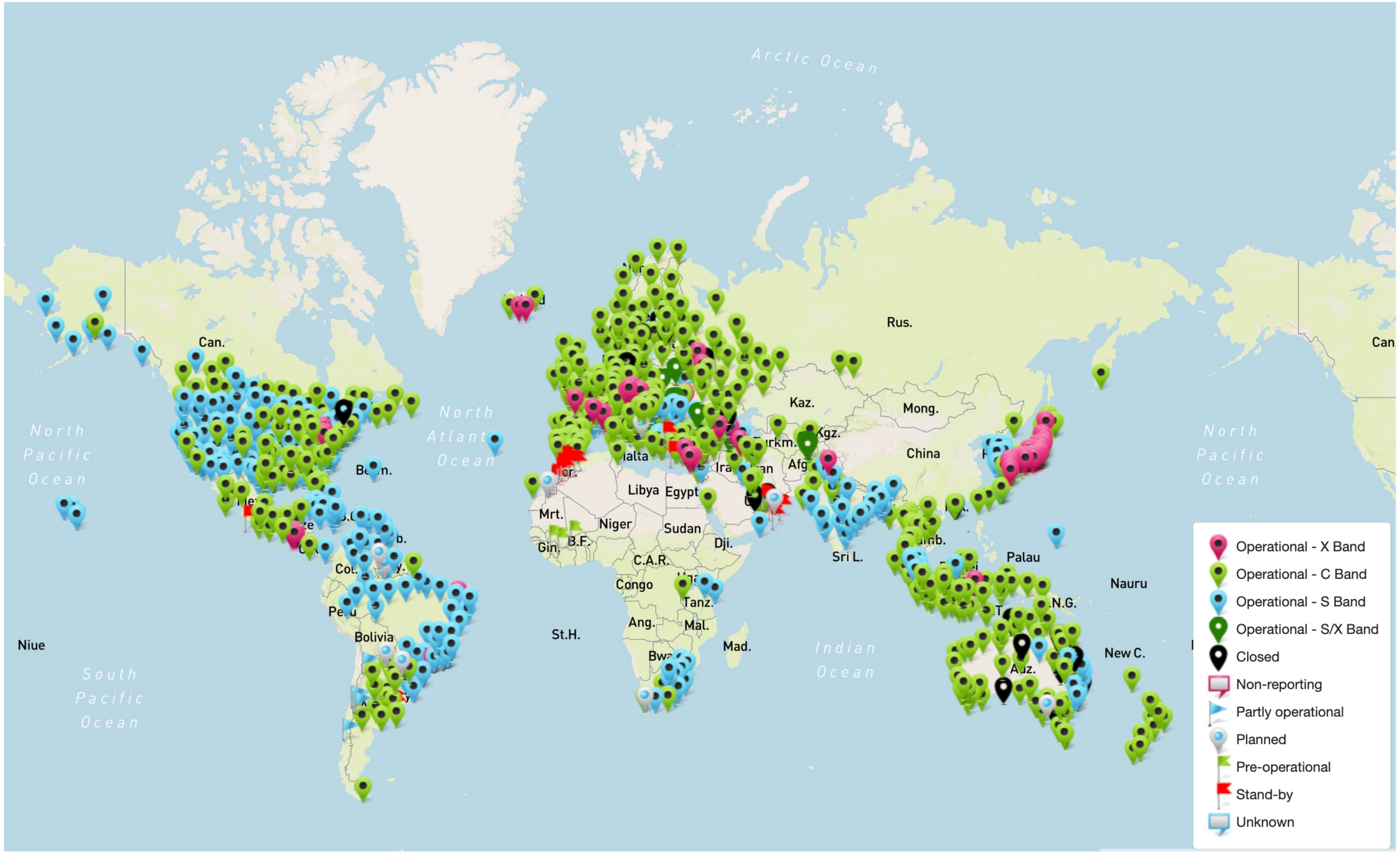


Some considerations in radar hydrometeorology



- **Fine depiction of the spatial distribution of precipitation**
- **Covers a large range of precipitation scales in 3D**
- **Bridges across scales and sensors**

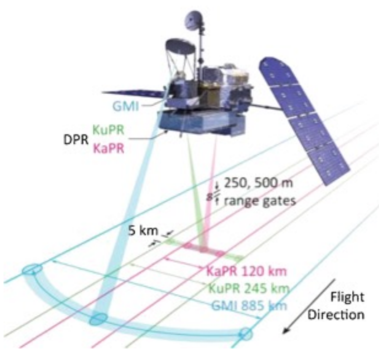
A cornerstone for understanding global water fluxes

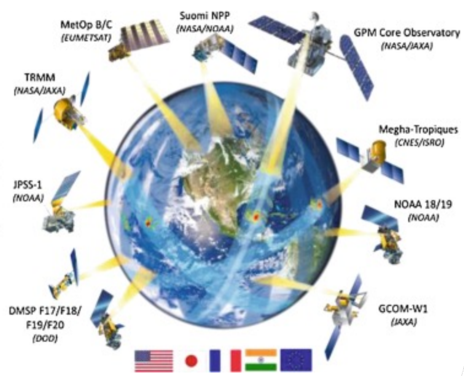


courtesy WMO

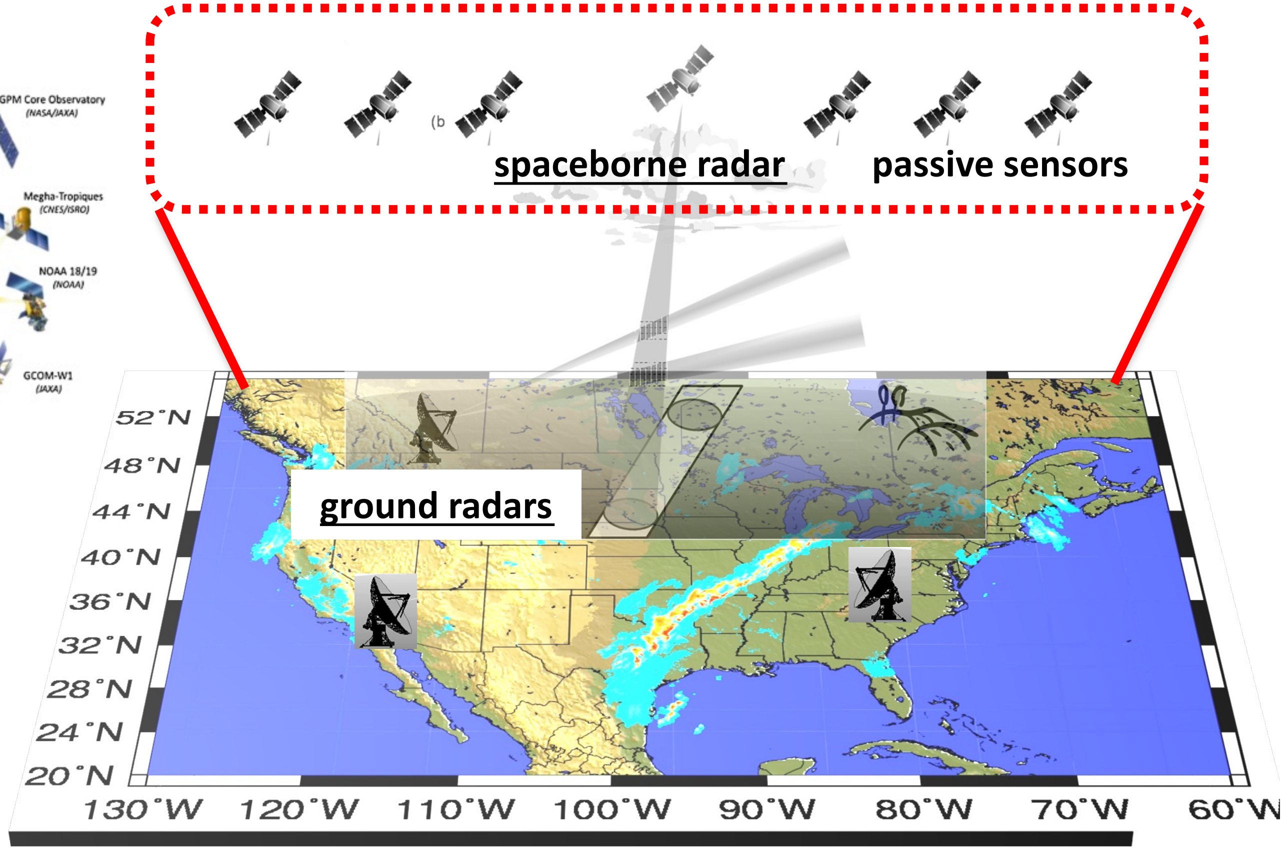
A cornerstone for understanding global water fluxes

Calibrate/Validate satellite precipitation constellation

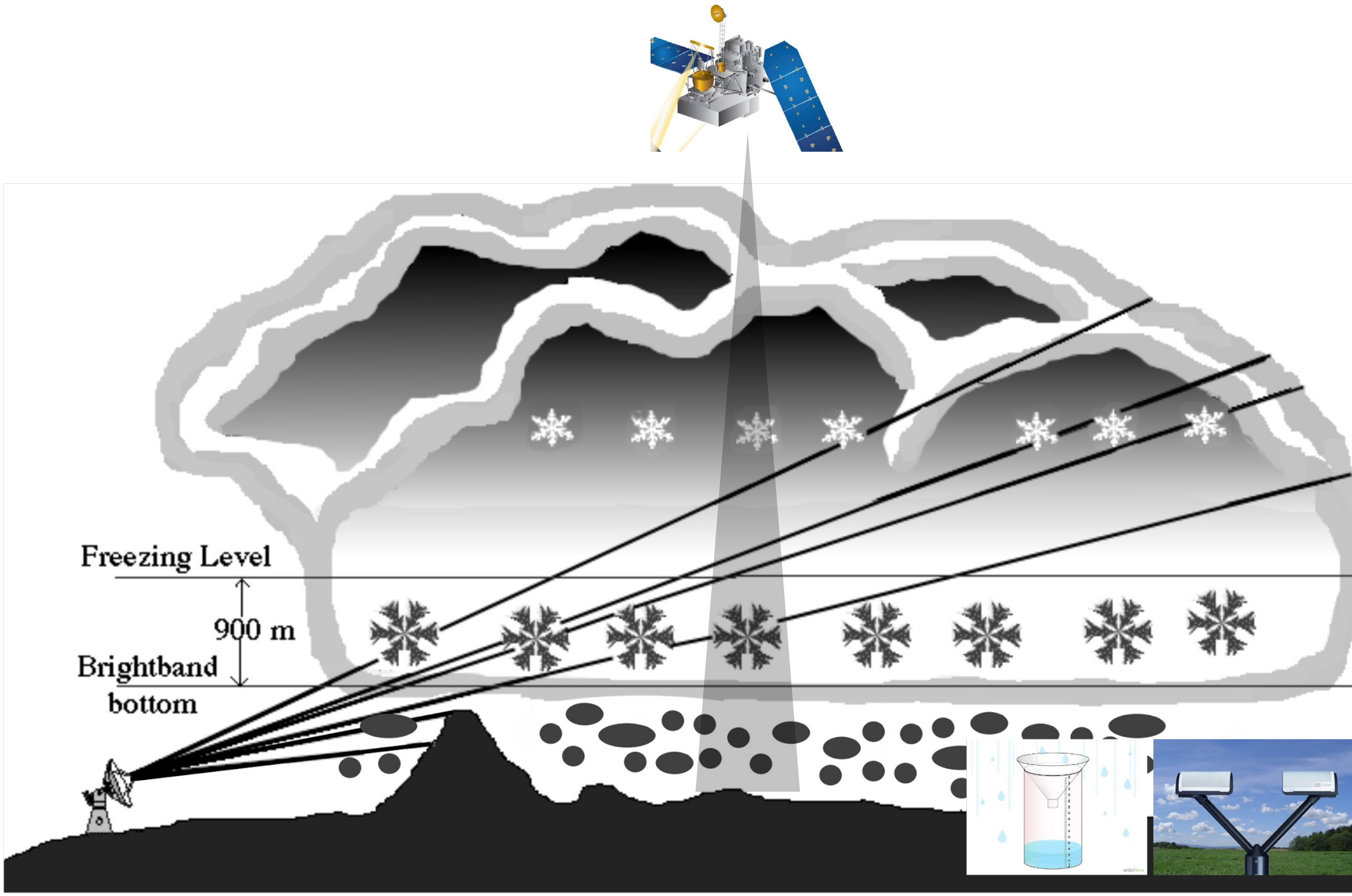


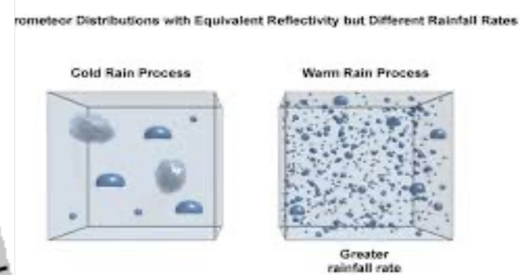


Support/supplement with suborbital observations



A cornerstone for understanding global water fluxes





Multi-Radar/Multi-Sensor (MRMS)

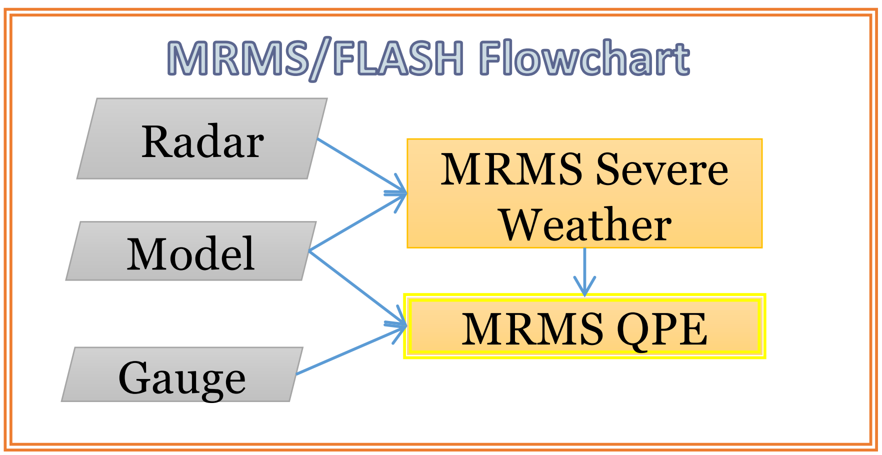
Domain: 20-55° N, 130-60° W

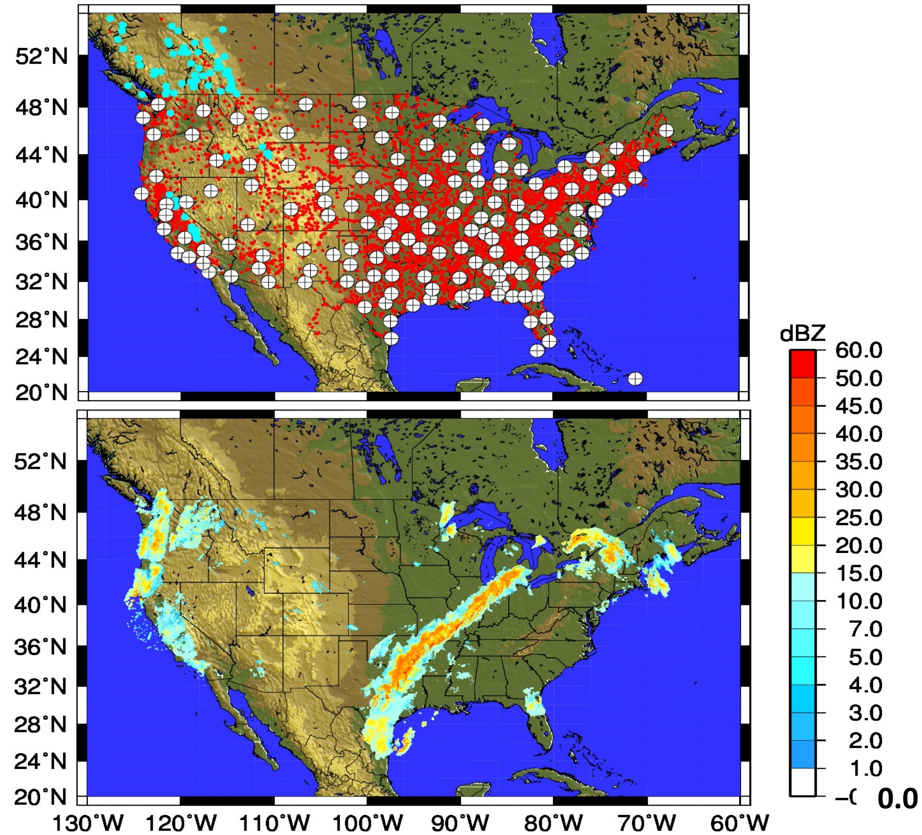
Resolution: 0.01° , 2 min update cycle

Data Sources:

~180 radars every 4-5min
~18000 gauges every hour
RAP model hourly 3D analyses

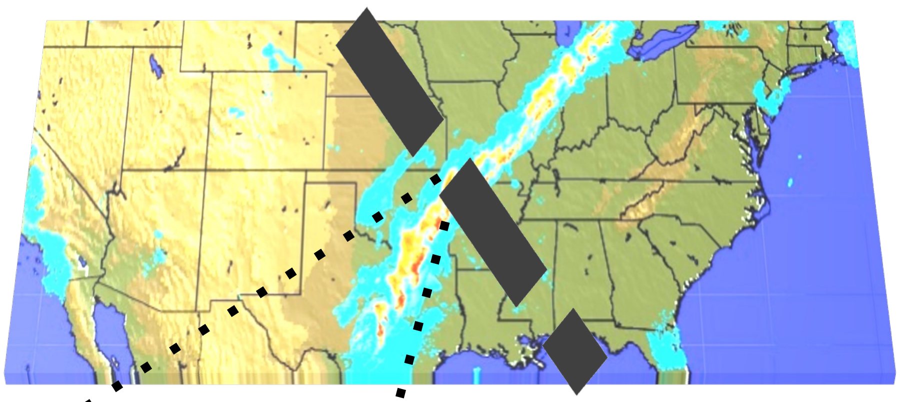
~225,000 data pairs

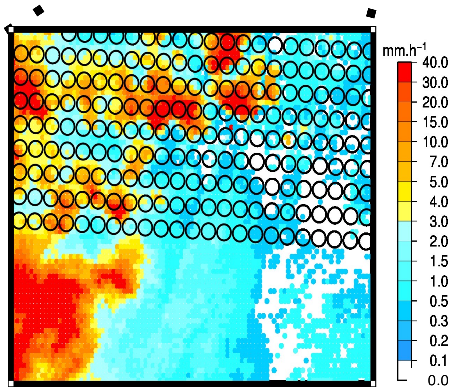


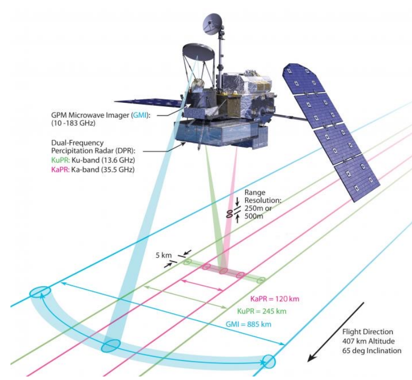


frontal system at 0800 UTC on 11 April 2011

Multi-Radar Multi-Sensor and space missions







IFOV precipitation features

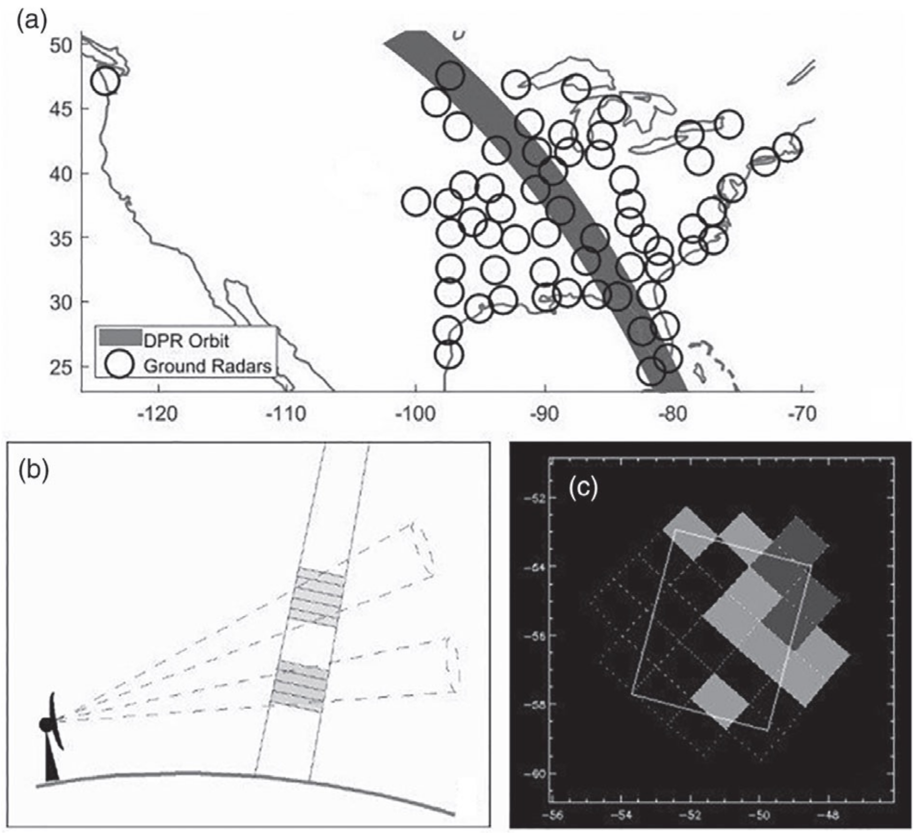
- intermittency
- type
- rate variability

Assessing spaceborne precipitation estimates over diverse conditions, e.g.,

- precipitation
- surfaces
- environmental conditions
- climatologies

Exploring precipitation process signatures in spaceborne radar observations

Refine the Dual-frequency Precipitation Radar (DPR) microphysical relevance



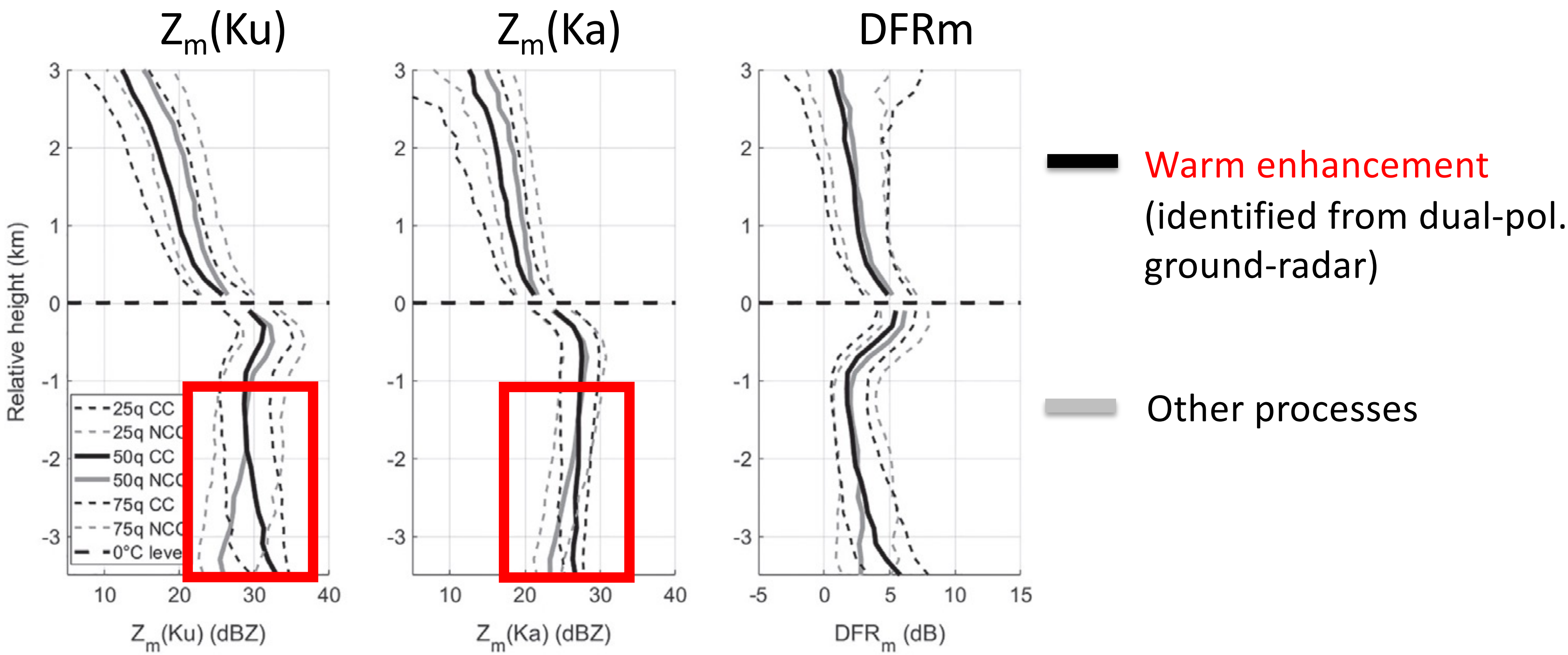
- distribution of WSR-88D GRs
- 6 February 2015 GPM orbit track

VN framework:
(b) DPR beam intercepting GR beams
(c) schematics of a waffle of GR bins
See also Oral 4B.1

Morris and Schwaller (2011)

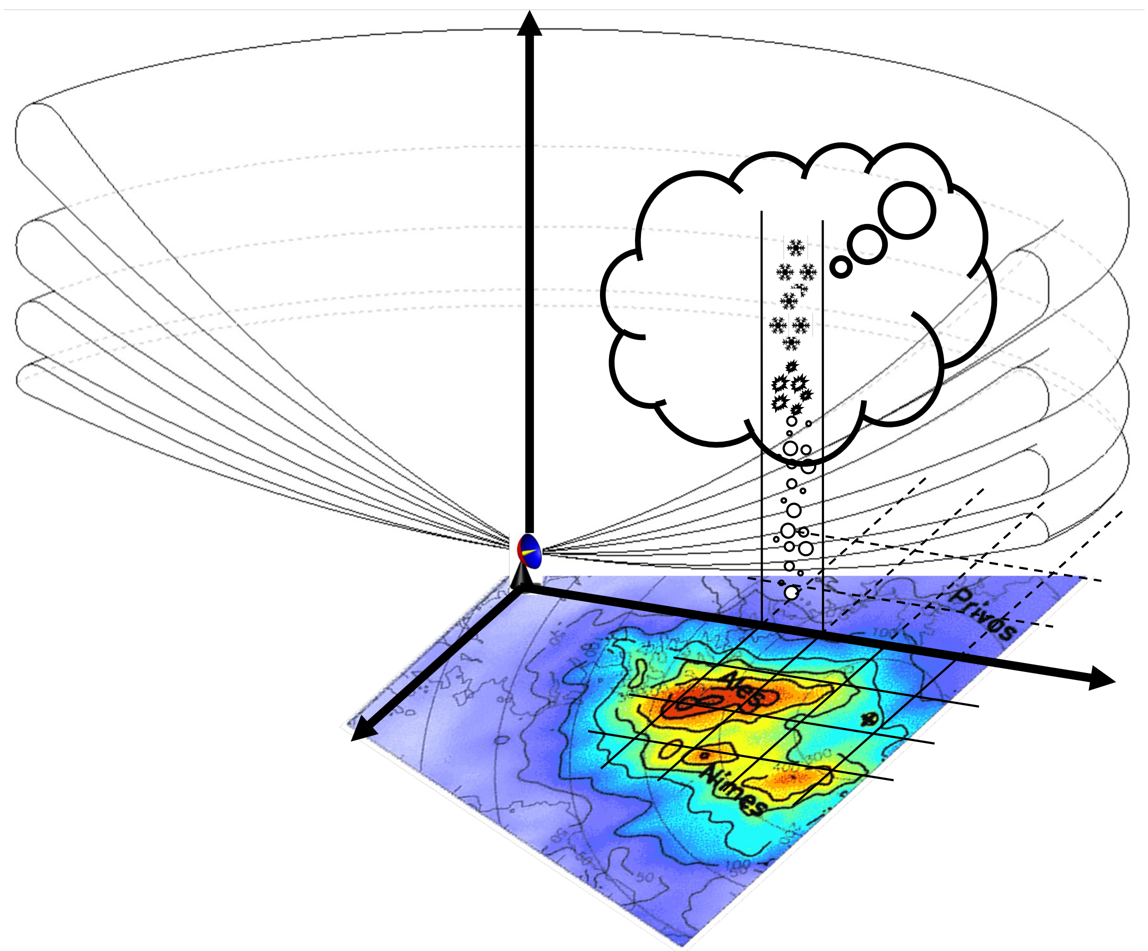
Exploring new process signatures in DPR observations

Specific enhancement signatures of warm processes in DPR profiles



Porcacchia et al. (2019)

Emerging radar technology



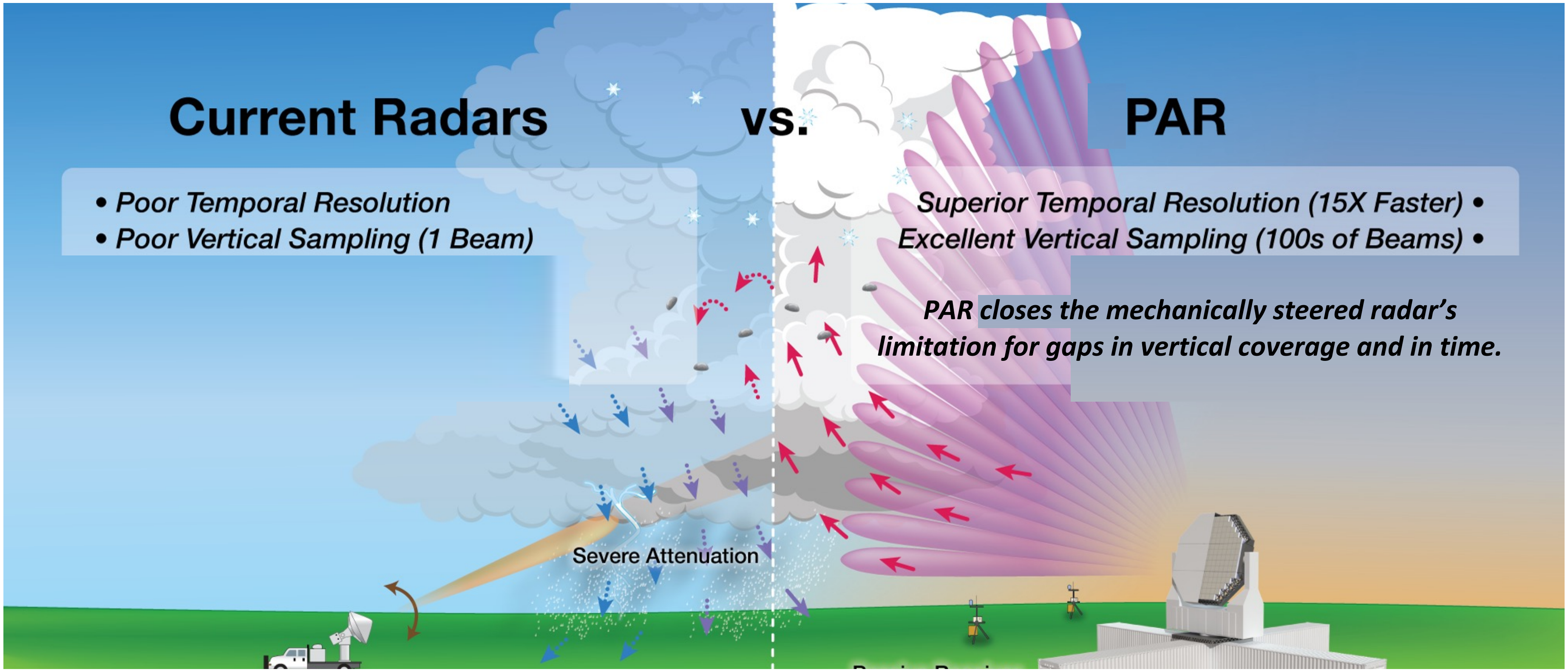
Resolution / representativeness:

timescale:	~ 5-10 min
spatial resolution:	~ 1 km
range:	~ 150 km

Filling the space and time gaps with

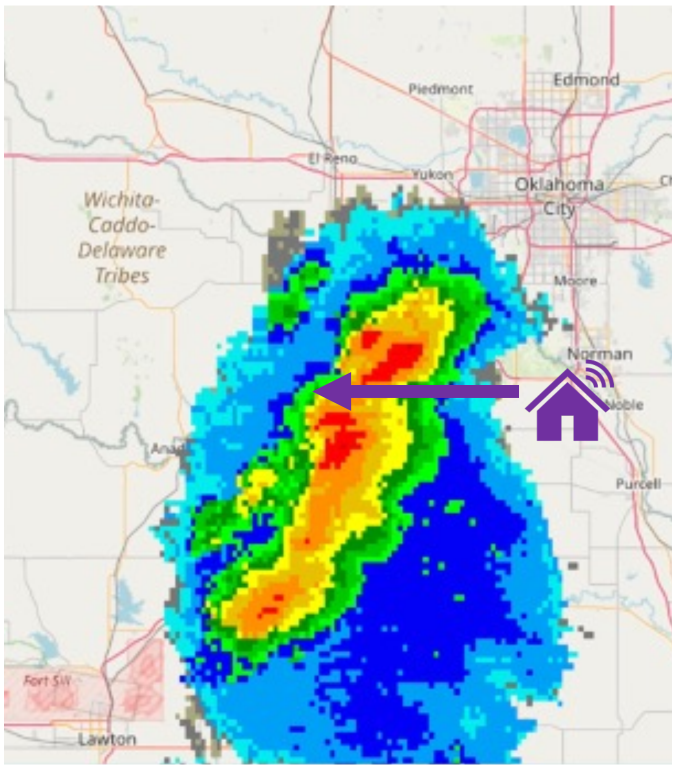
Phased-Array radar technology

Mechanically steered radars generate time-separated discontinuous samples of vertical changes to hydrometeors in the atmosphere



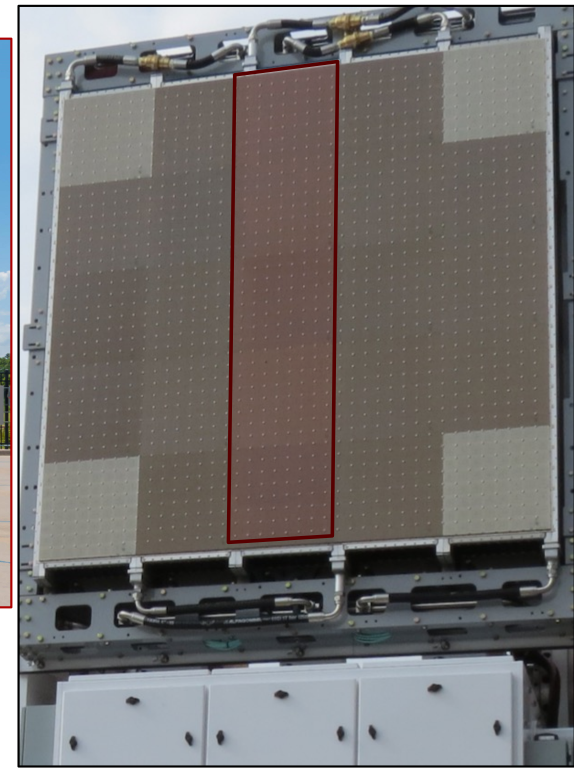
Pseudo-continuous vertical profiles of polarimetric radar variables can be interpreted in terms of **microphysics**, **processes**, and **fluxes**.

Precipitation processes and fluxes observed by PAR
Courtesy A. Matland (poster #21)



May 11th, 2023 - supercell case

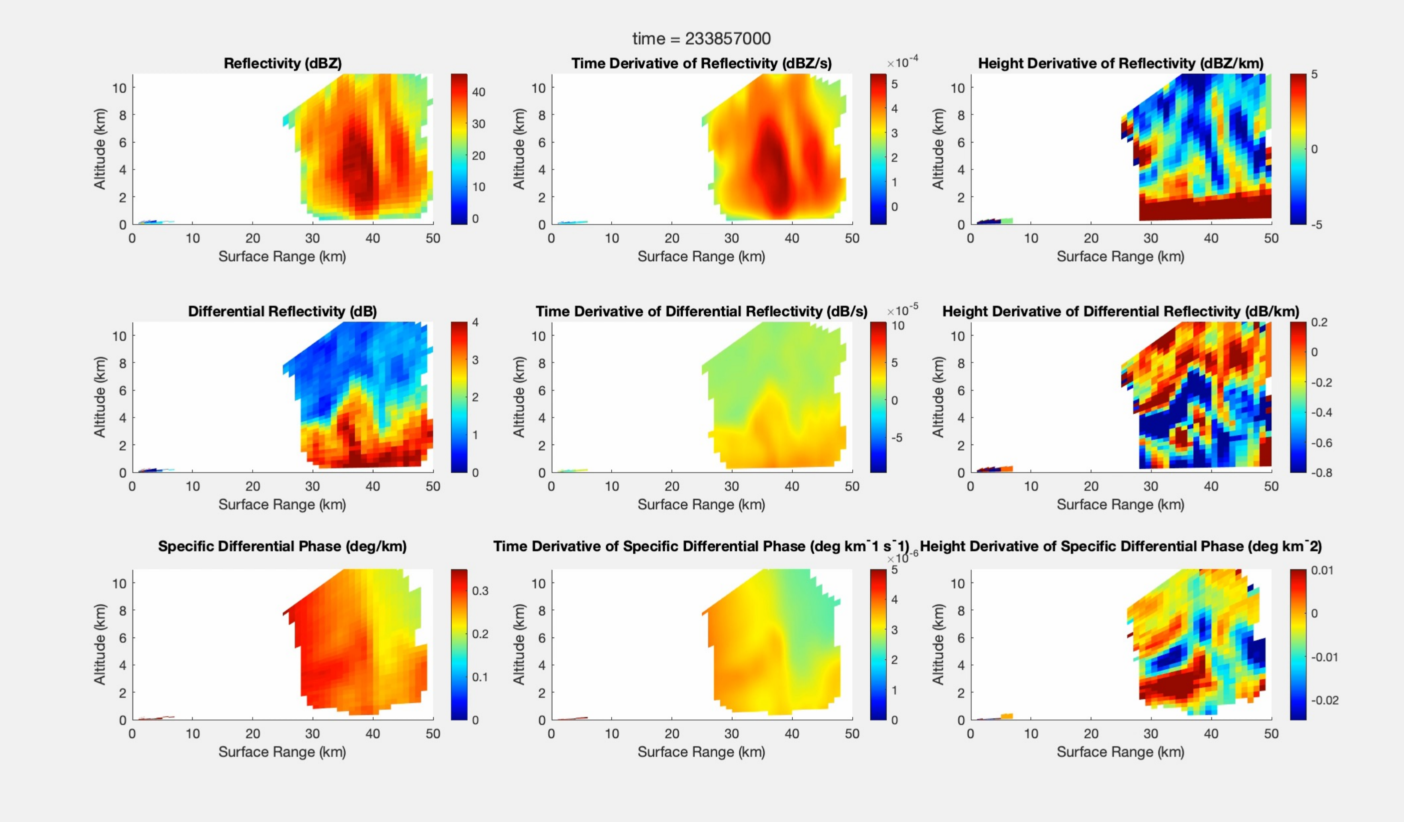
Operating Frequency	2.7-3.1 GHz
Number of Elements	40 x 40
Beam-pointing	+/-45 deg AZ/EL
Pulse Width (τ)	100 us at 10% duty cycle
Beamwidth at 3 GHz	2.58 deg
Polarization	Dual-Pol, RHCP, LHCP



R. D. Palmer *et al.*, "Horus—A Fully Digital Polarimetric Phased Array Radar for Next-Generation Weather Observations," in *IEEE Transactions on Radar Systems*, vol. 1, pp. 96-117, 2023, doi: 10.1109/TRS.2023.3280033.

Precipitation processes and fluxes observed by PAR Courtesy A. Matland (poster #21)

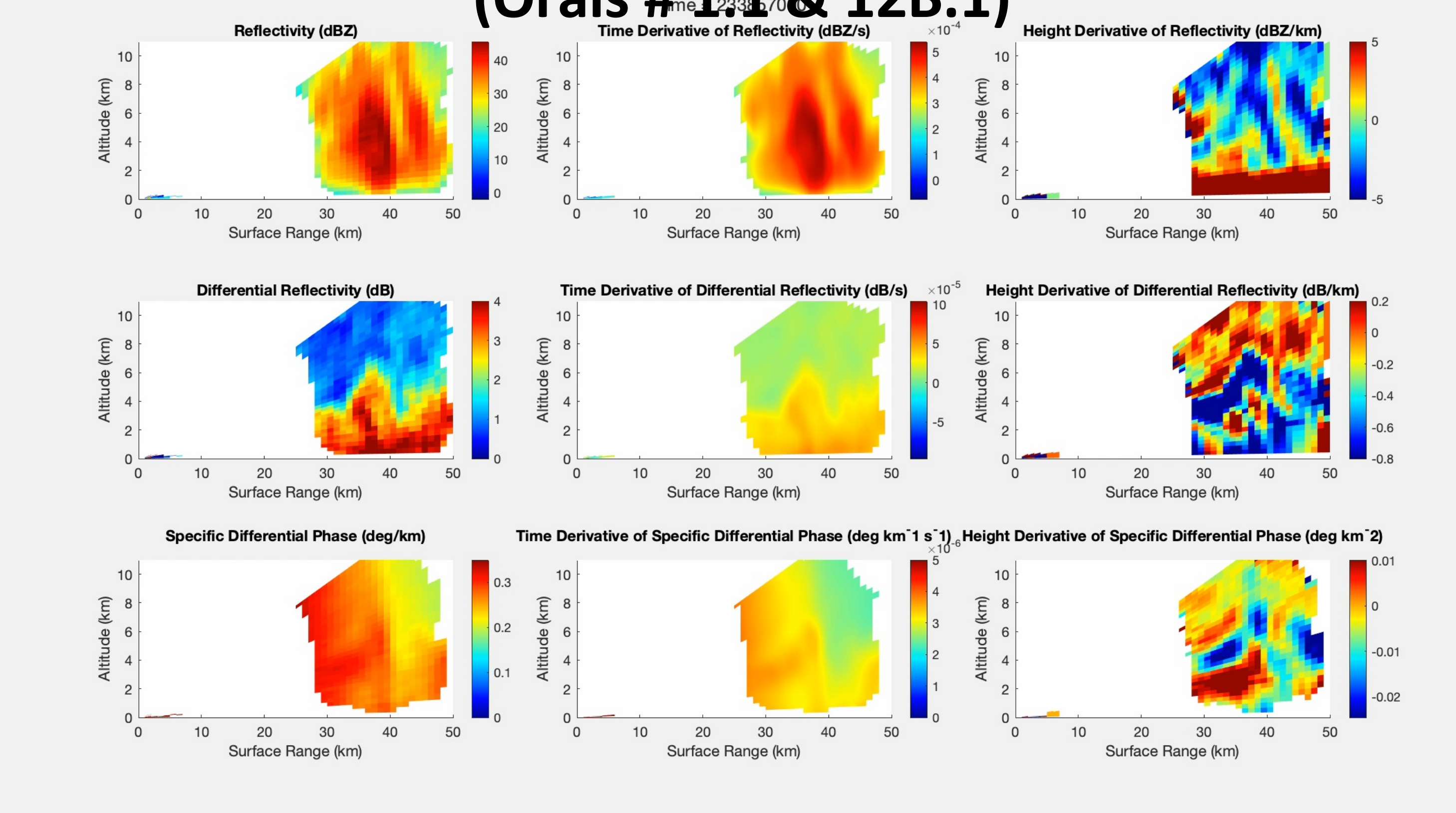
PAR spatially and temporally continuous observations of the atmosphere allow for the utilization of **time** and **height derivatives (uniquely derived from PAR)**



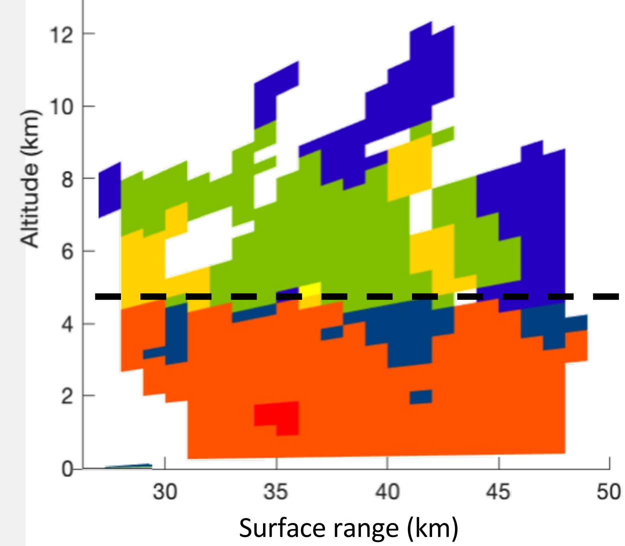
Precipitation processes and fluxes observed by PAR
Courtesy A. Matland (poster #21)

Microphysics **Fluxes** **Processes**

(Orals # 1.1 & 12B.1)



Process classification (time = 233857000)



Summary

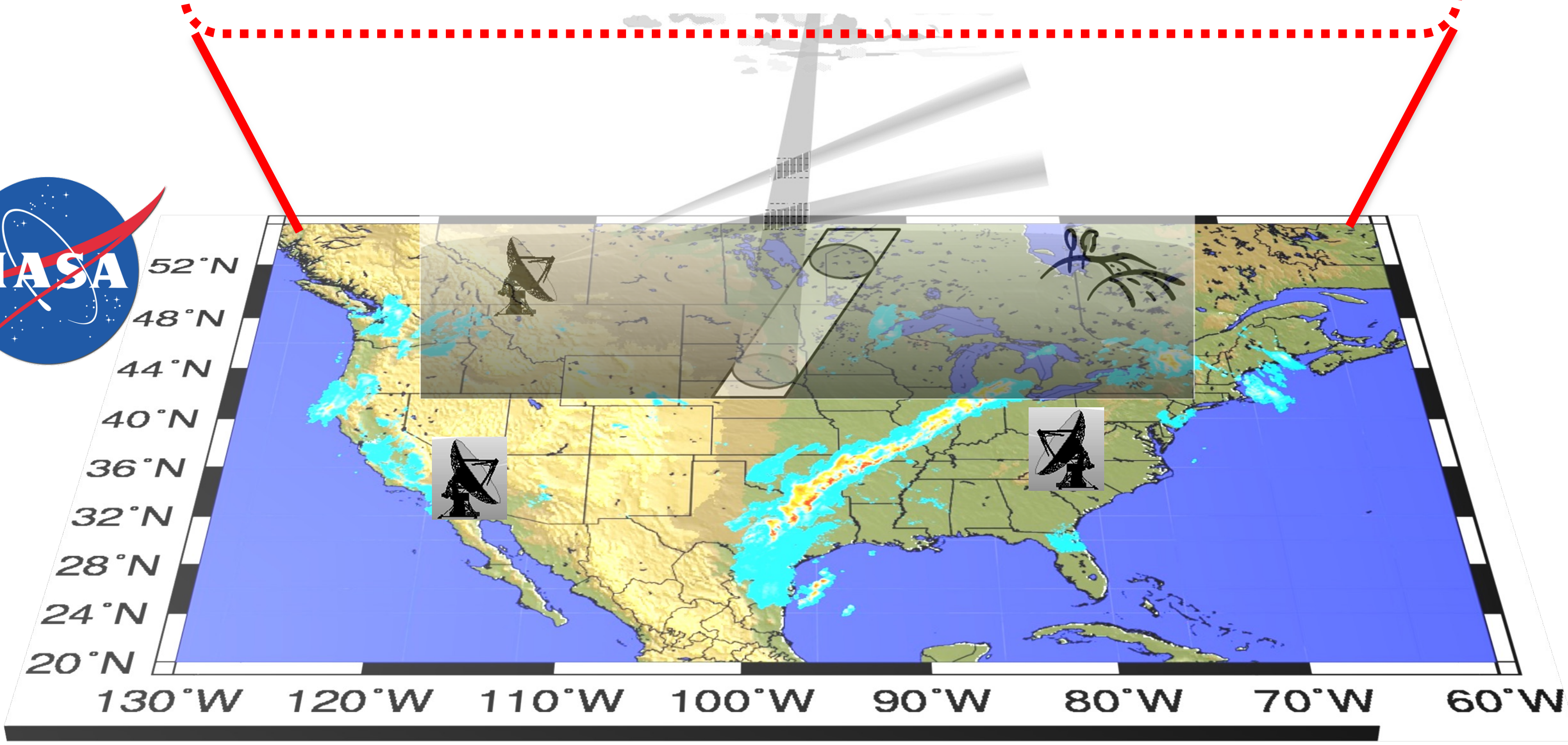
1. Weather radar provides a unique 3D perspective on atmospheric precipitation.

2. The Multi-Radar Multi-Sensor system mosaics radar network observations and covers a broad range of scales.

3. Increasing role of radar bridging across sub-orbital and orbital precipitation science and applications – cornerstone for global water fluxes. The complementarity of ground-based and spaceborne instruments is key.

4. Phased-Array radar technology opens the door for new approaches by providing much needed space and time continuity to capture precipitation processes and fluxes. Other technologies such as multi-static radars have a role to play.

THANK YOU


52°N
48°N
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20°N
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120°W
110°W
100°W
90°W
80°W
70°W
60°W