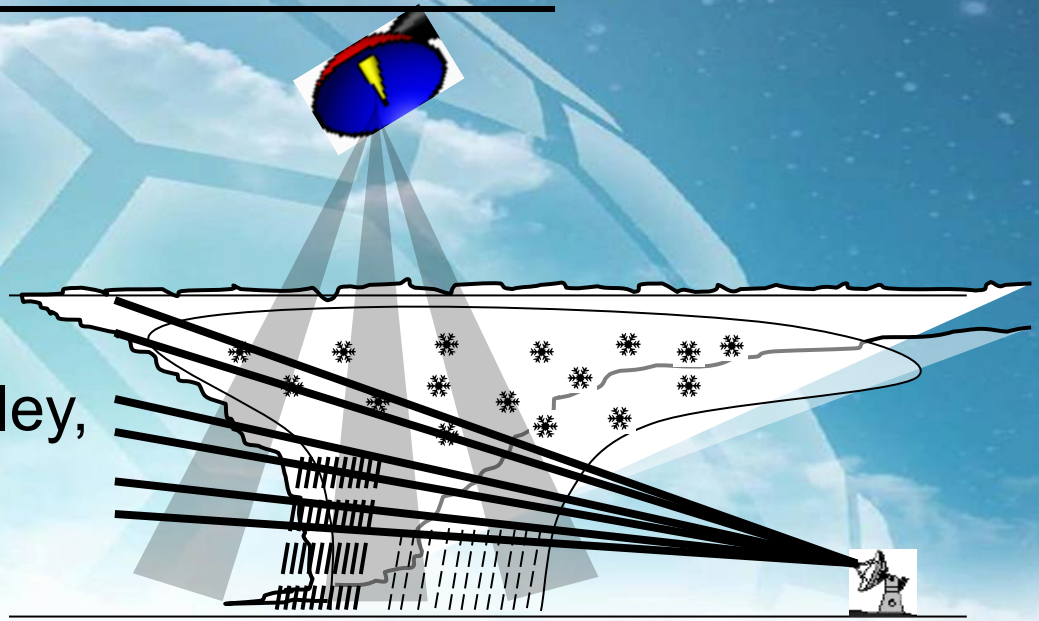
Comparing GPM with Multi-Radar Multi-Sensors: toward bridging Level-2 and Level-3 precipitation products

Pierre-Emmanuel Kirstetter



with contributions of:
A. Gebregiorgis, J.J. Gourley,
Y. Hong, N. Carr,
W. Petersen, M. Schwaller

Comparing GPM with MRMS:
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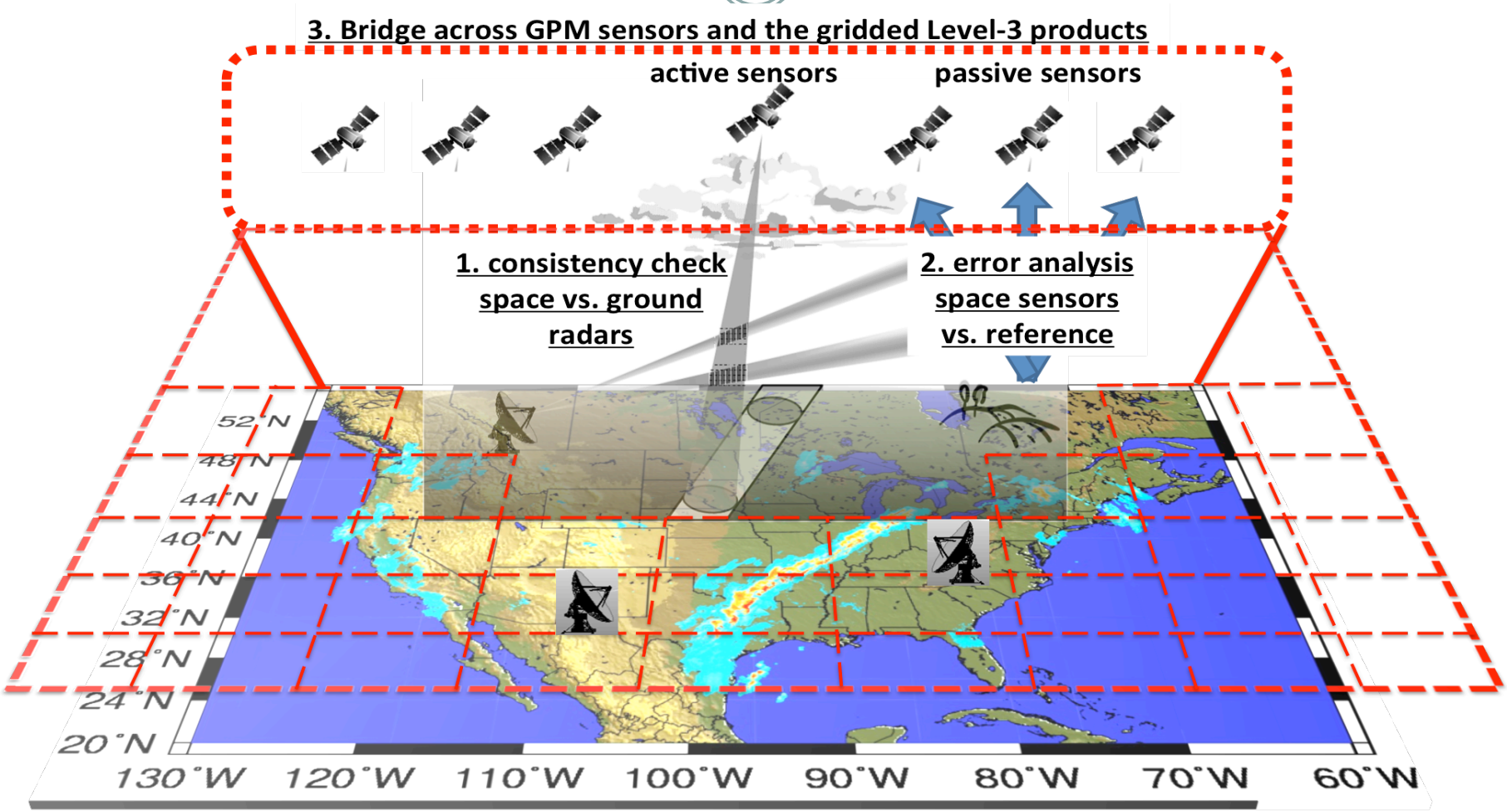


Comparing GPM with MRMS:
toward bridging Level-2 and Level-3 precipitation products

1. Reference from Multi-Radar Multi-Sensor

2. Level 2 analysis

3. Level 3 analysis

Comparing GPM with MRMS: toward bridging Level-2 and Level-3 precipitation products

1. **Reference from Multi-Radar Multi-Sensor**
   - **Quality controls & scale adjustment**
   - **Consistency between Level 2 & 3**
   - **Perspectives**

2. **Level 2 analysis**

3. **Level 3 analysis**

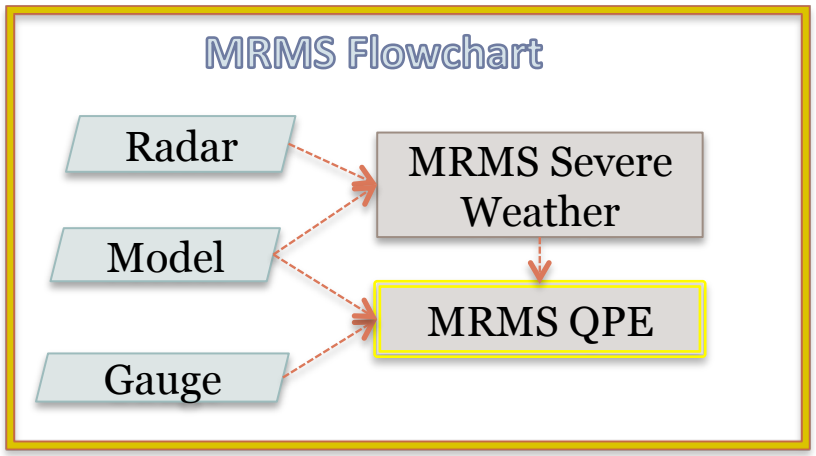
Overview of the Multi-Radar Multi-Sensor (MRMS) System

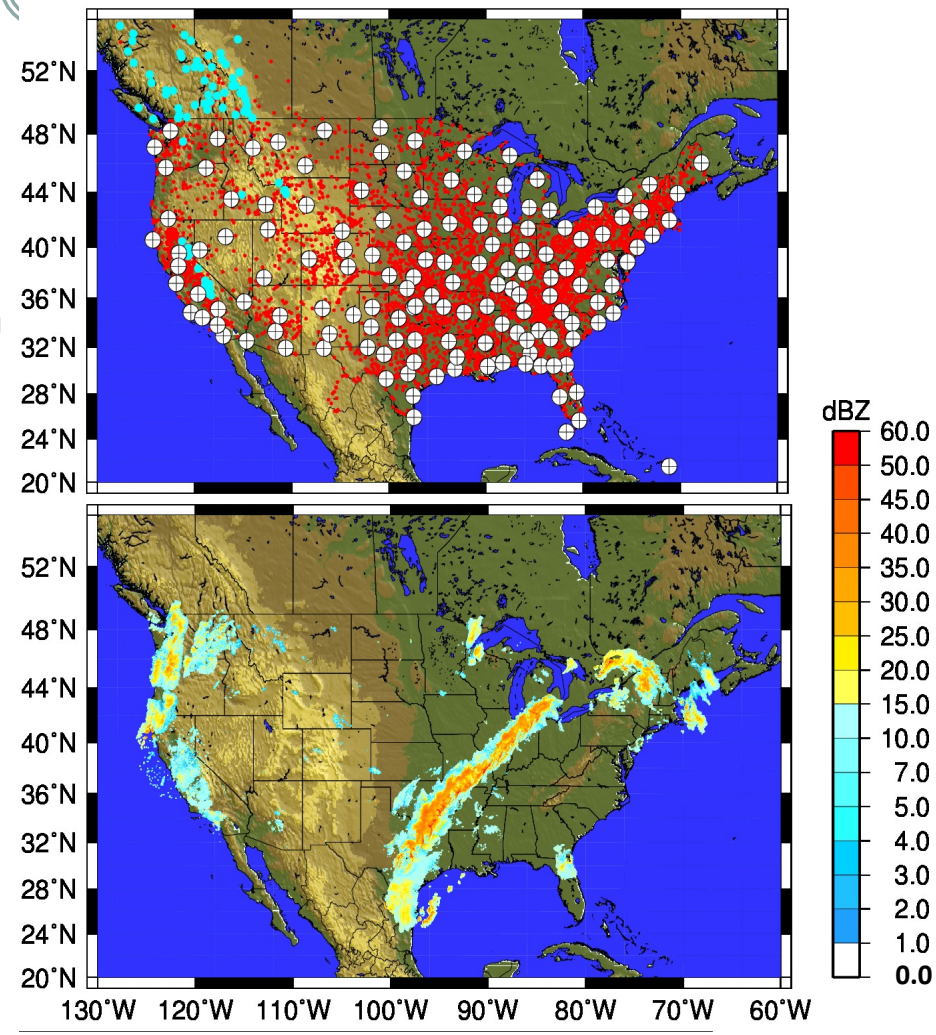
Domain: 20-55°N, 130-60°W

Resolution: 0.01°, 2 min update cycle

Data Sources:

~180 polarimetric radars every 4-5min
~9000 gauges every hour
- RAP model hourly 3D analyses





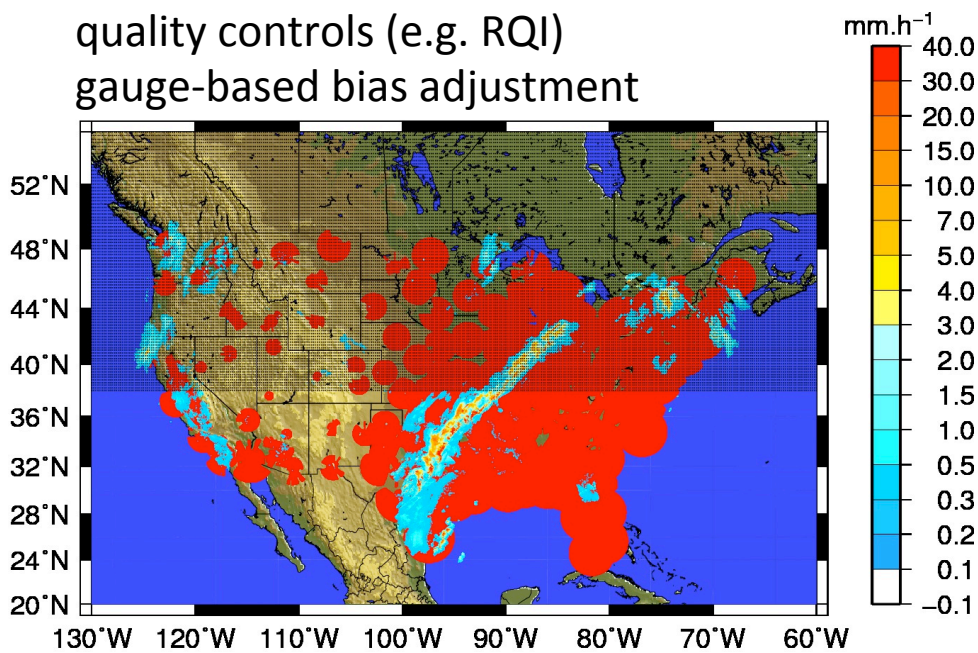
frontal system at 0800 UTC on 11 April 2011

A reference is derived from Multi-Radar Multi-Sensor quality controls

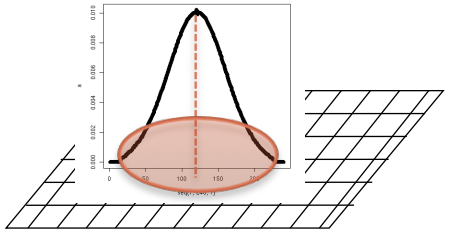
#1: <u>prerequisites</u>:

- **refine reference precipitation as much as possible**
- **adapt (upscale) to the resolution of the satellite**

quality controls (e.g. RQI)
gauge-based bias adjustment



satellite footprint
(DPR: ~5km resolution)



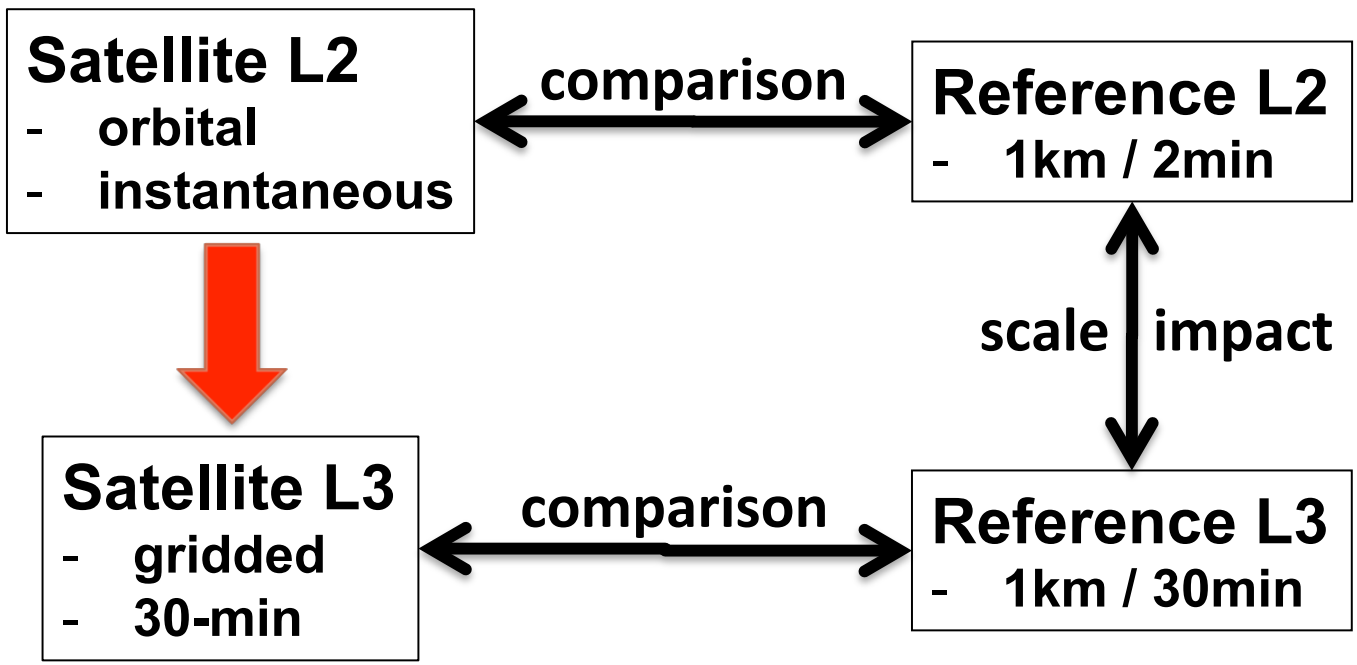
Q3 grid (~1km resolution)

<u>Output</u>: - improved data quality steps ⇔ increased consistency between space and reference

A reference is derived from Multi-Radar Multi-Sensor

consistency between Level 2 & 3

- **Multi-level purpose products**
  - Level 2 (GPM constellations): 1km/2min, precipitation rates, types (snow), quantity and quality control
  - Level 3 (3B42, IMERG): 1km/1h, precipitation rates, liquid/frozen, quantity and quality control



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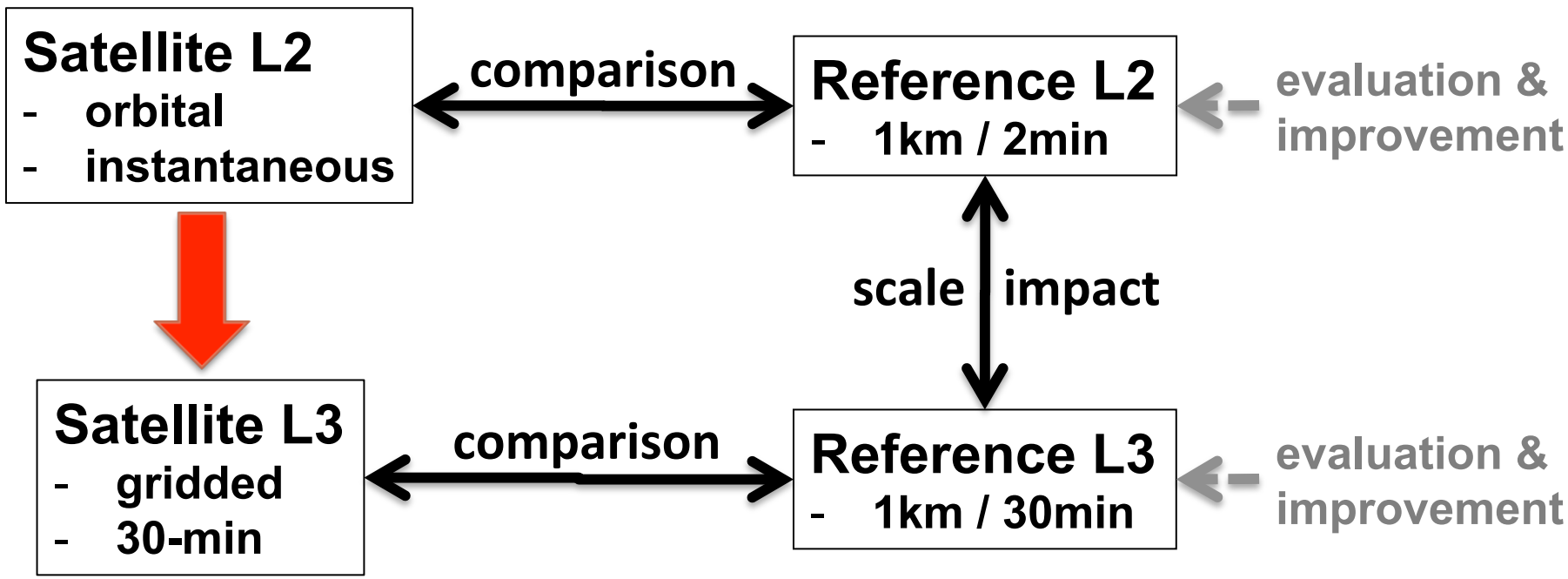

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- **Dissemination**
  - Website http://gpm.ou.edu
  - Reference products delivered to NASA GSFC/Wallops
  - Evaluation of the reference http://wallops-prf.gsfc.nasa.gov/NMQ/index.html

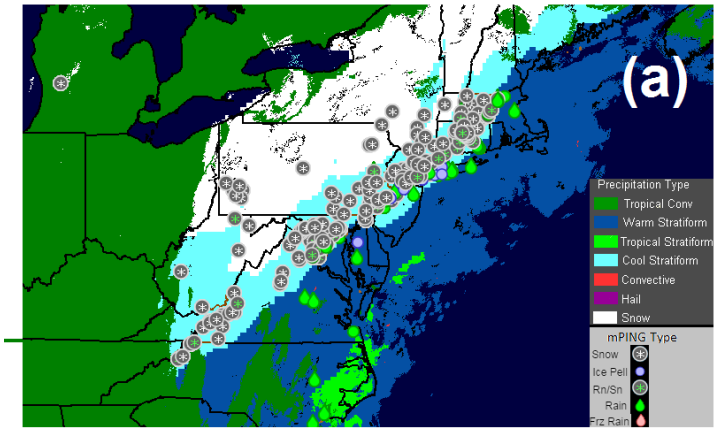
- **Perspectives**
  - Improved quality controls (Gauge Quality Index)
  - Improved resolution (MRMS-L3 @ 30min)
  - Probabilistic information: precipitation phases and rates
  - Merging with the VN Ground Validation system

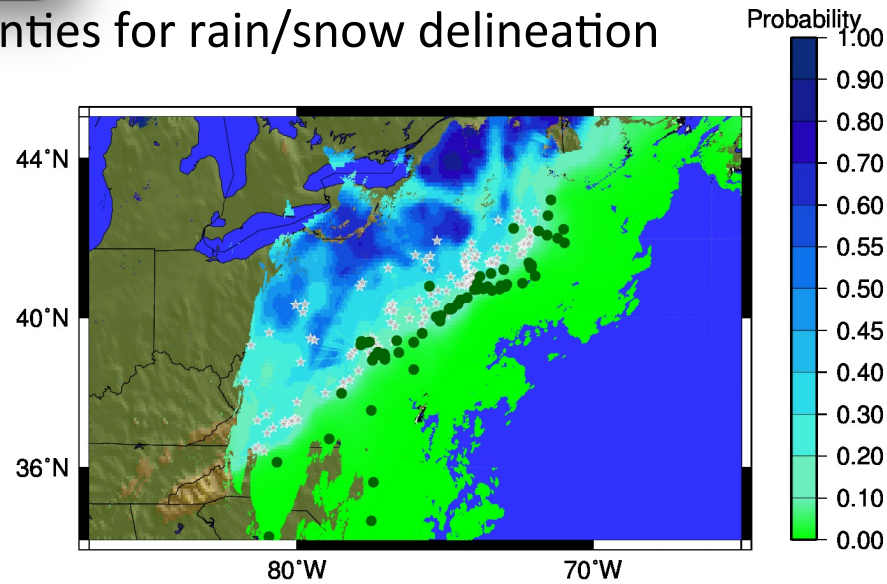
Reference perspectives: probabilistic rain/snow delineation

MRMS surface precipitation phase (NEXRAD+RAP) + mPING

- "Crowdsourcing" **M**eteorological **P**henomena **I**ndication **N**ear the **G**round (mPING)

- Diagnostic/prognostic model of uncertainties for rain/snow delineation





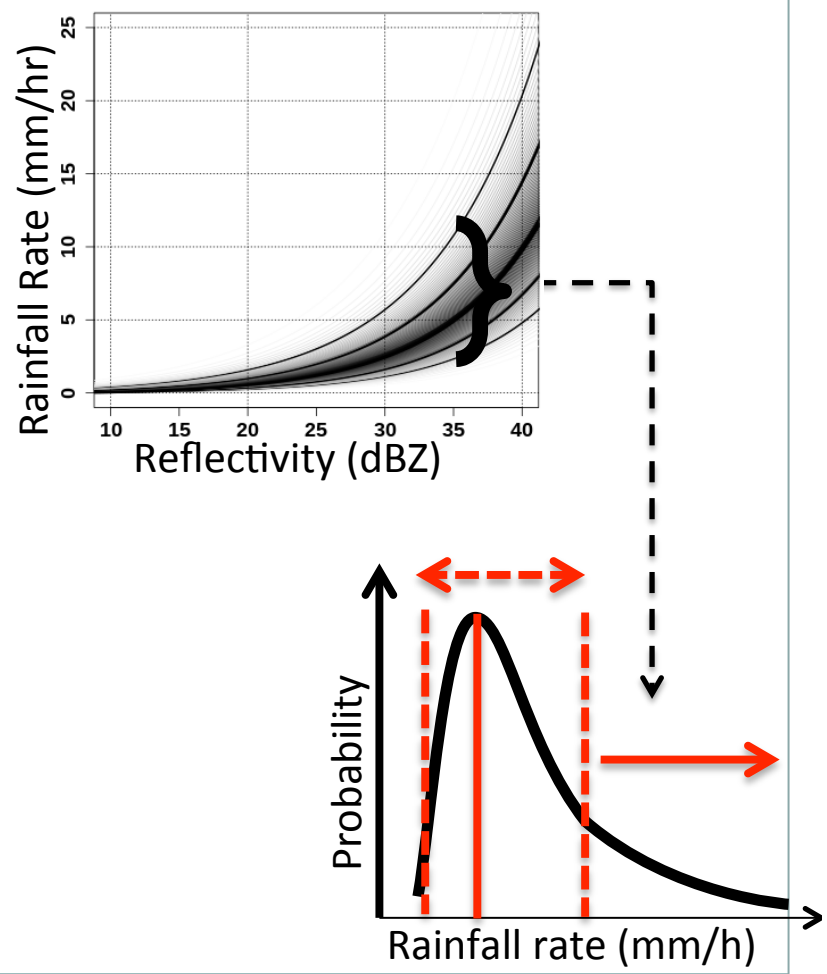
Jaunet, Kirstetter et al., *prep.* : Development of a surface probabilistic product segregating rain and snow, JAMC

Reference perspectives: probabilistic QPE at 1km/2min

PRORATE

PRORATE: Probabilistic QPE using Radar Observations of Rate And Typology Estimates

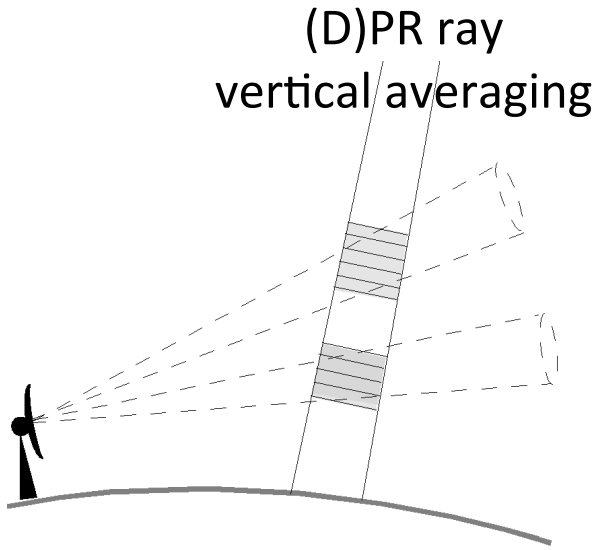
- **Provides the PDF of precipitation rates at 1 km/5 min scale given reflectivity and precipitation types**
- **Removes bias from deterministic QPEs**
- **Provides expected values for deterministic users**
- **Provides uncertainty estimates**
- **Provides exceedance probability for extreme thresholds for risk analysis**



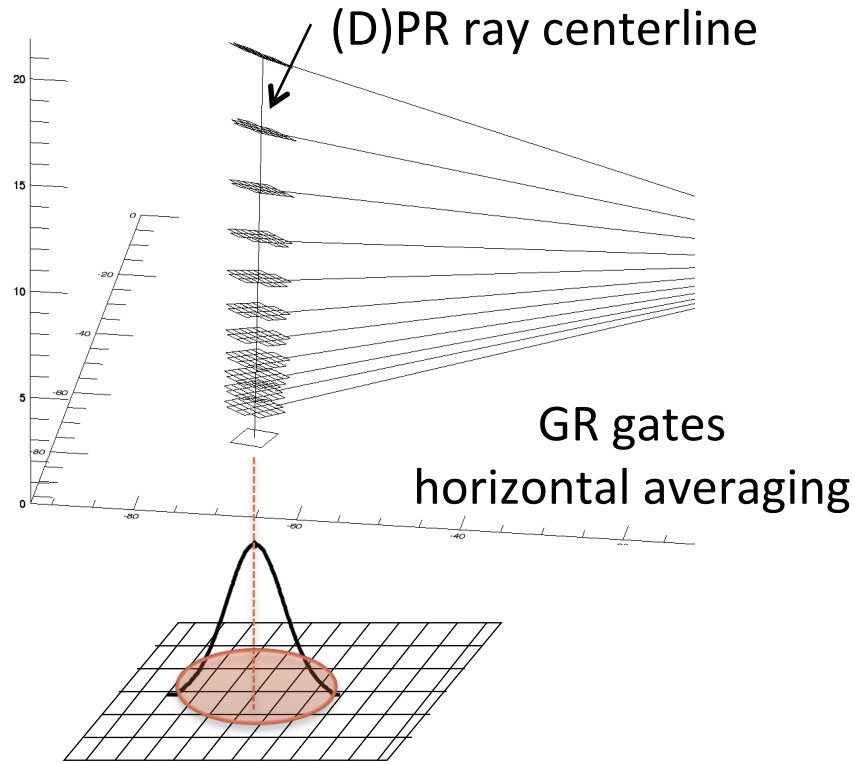
Kirstetter et al. 2015: Probabilistic Precipitation Rate Estimates with Ground-based Radar Networks, WRR

Reference perspectives: building the column over the U.S.

Merging MRMS reference with the VN Ground Validation system



Courtesy R. Morris
and M. Schwaller



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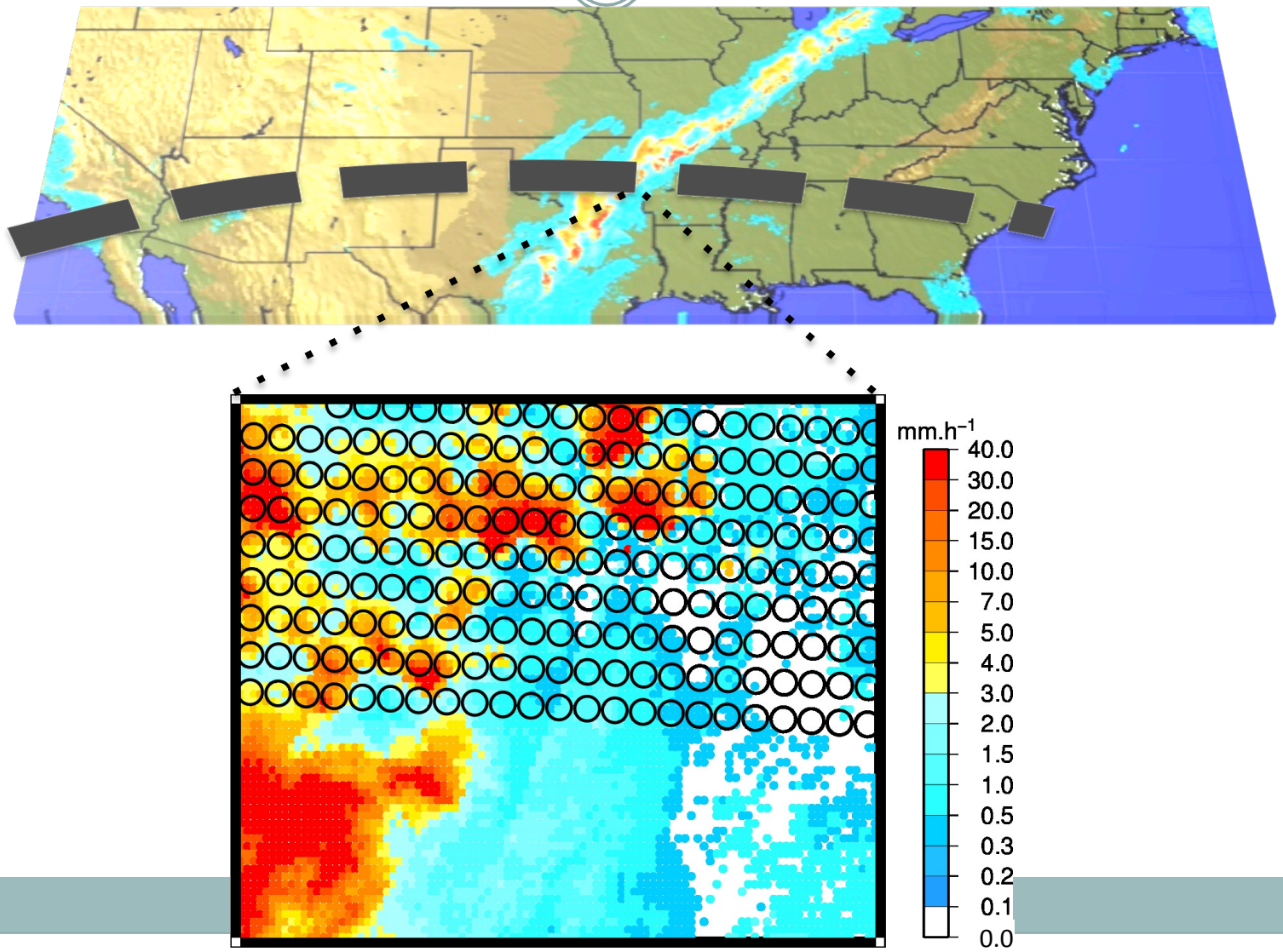
2. **Level 2 analysis**

3. Level 3 analysis

Level 2 analysis

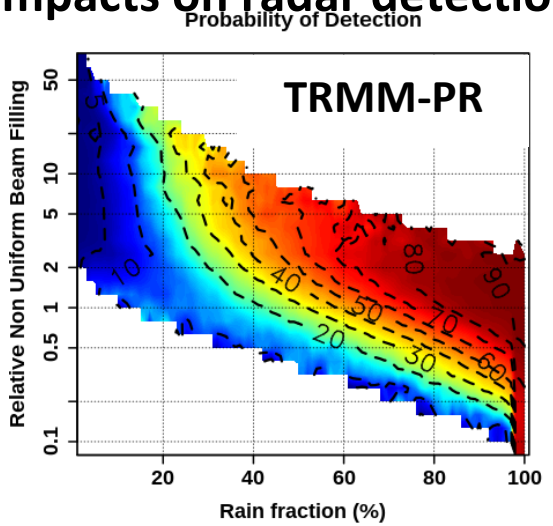
Reference Precipitation features

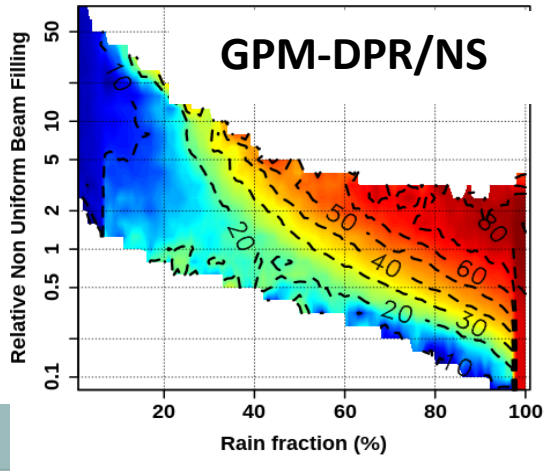


Level 2 analysis

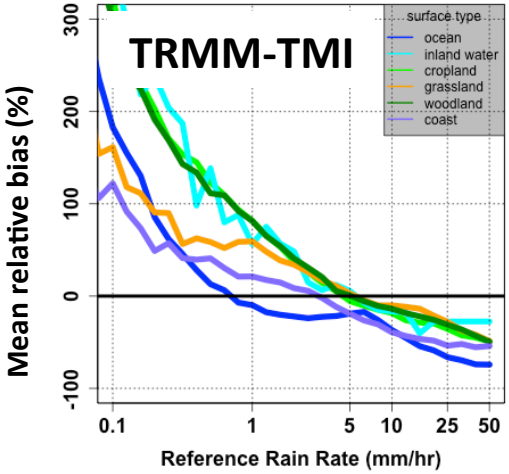
Diagnostic: biases & uncertainty = f (reference)

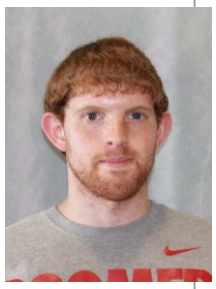
Non-Uniform Beam Filling impacts on radar detection

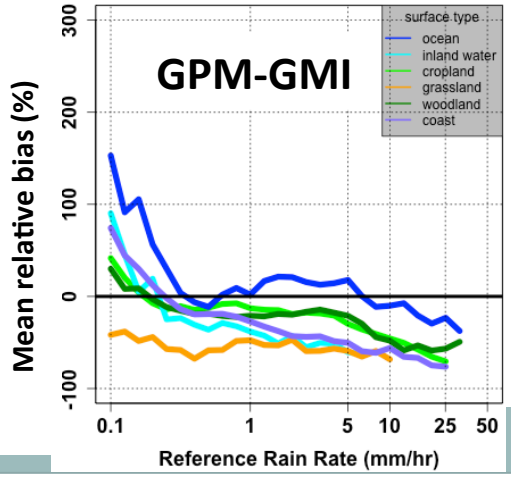




Precipitation magnitude and surface impact on PMW retrieval bias







Comparing GPM with MRMS: toward bridging Level-2 and Level-3 precipitation products

1. Reference from Multi-Radar Multi-Sensor

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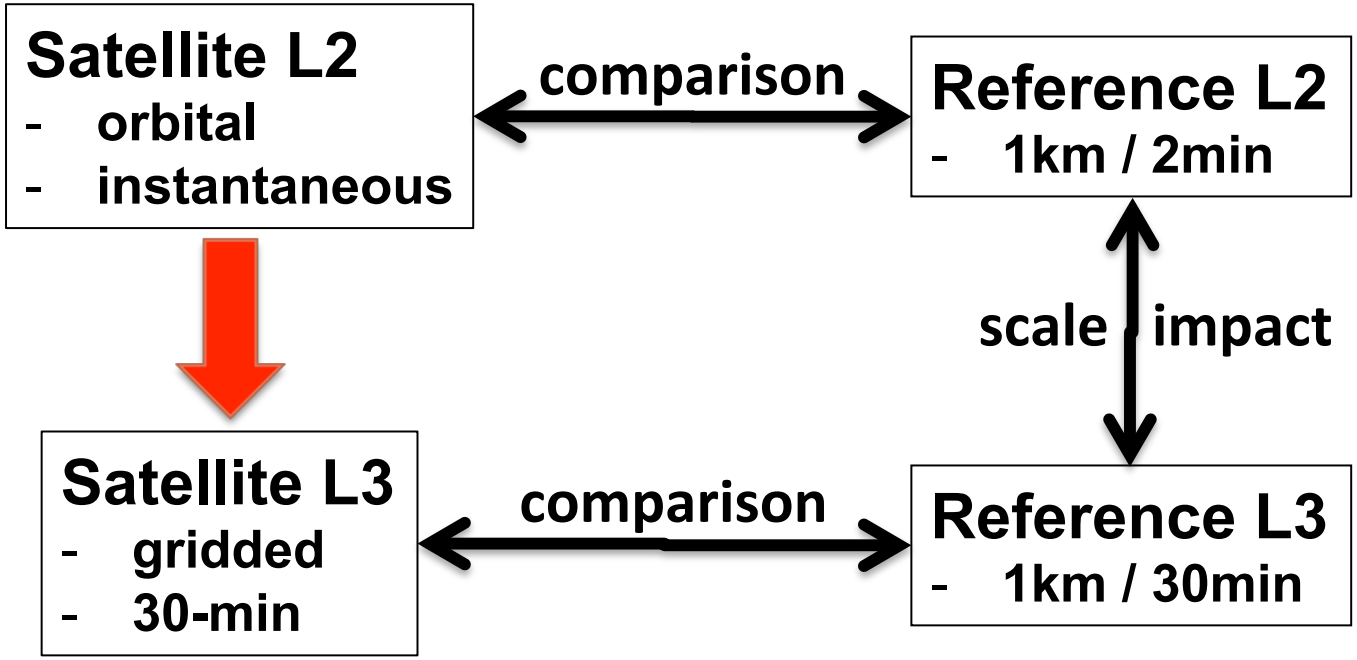
3. **Level 3 analysis**
   - **Impact of the reference precipitation**
   - **Breaking down by Level-2 component**
   - **TRMM versus GPM**

Level 3 analysis

Objective: mitigate propagation of Level 2 biases to Level 3 precipitation products

- satellite Level 3 developers have specifically required the inclusion of error and uncertainty fields

- **unique framework to tackle this outstanding issue**

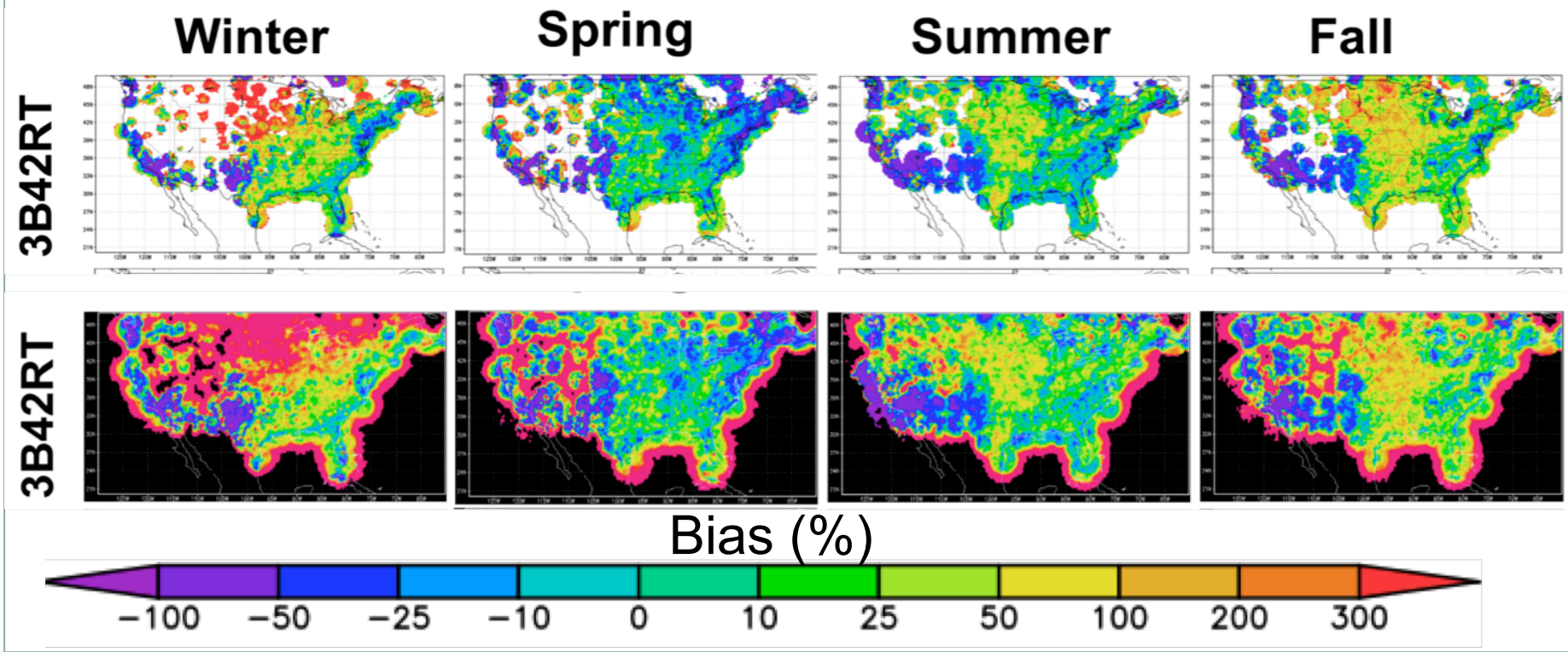


Level 3 analysis

impact of the reference precipitation

3B42RT bias relative to reference

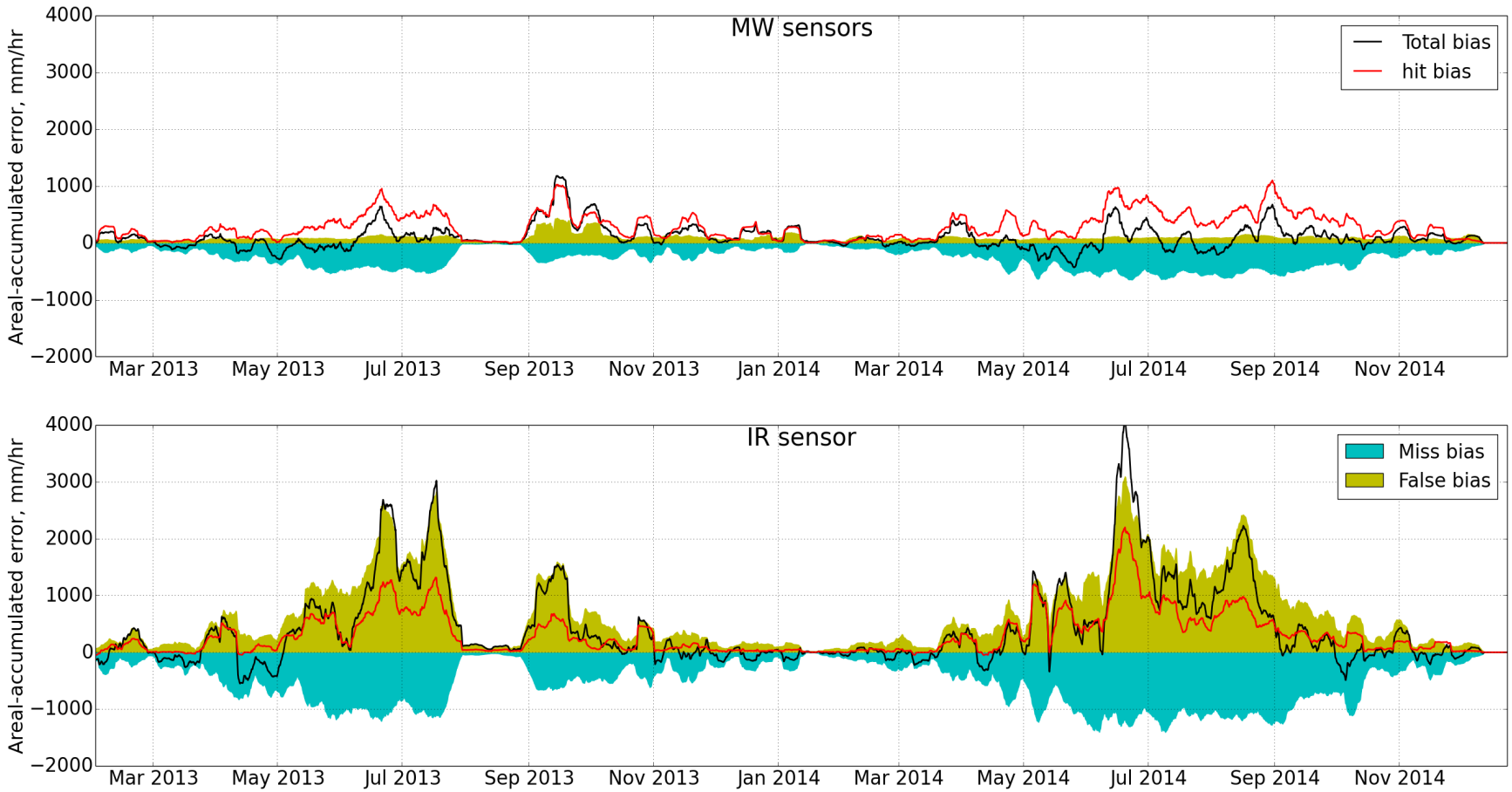
- best reference quality (QI = 100%) - top panels
- Lower reference quality (QI <= 100%) - bottom panels



Level 3 analysis

breaking down by component

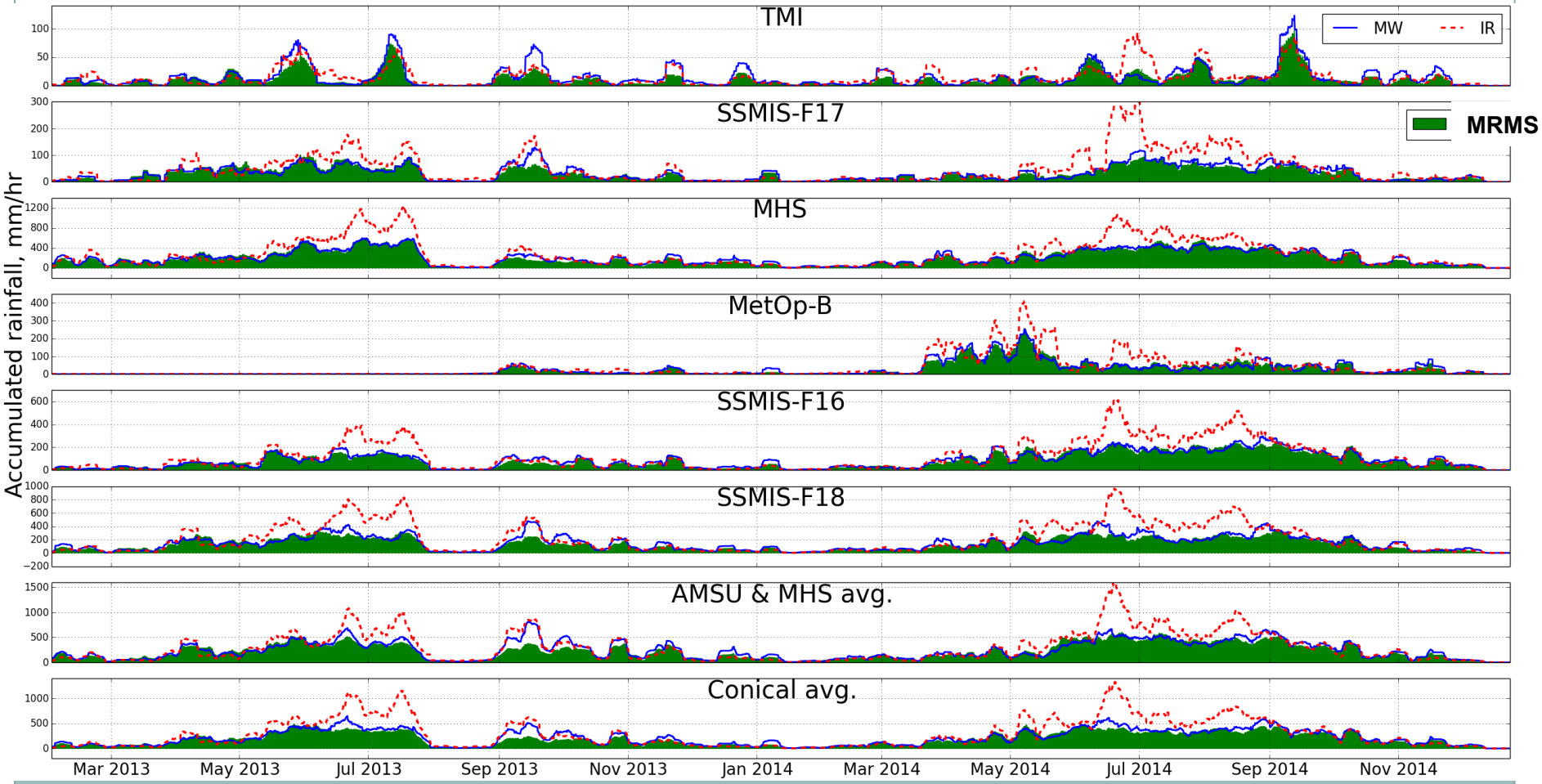
3B42RT error components for MW and IR estimates



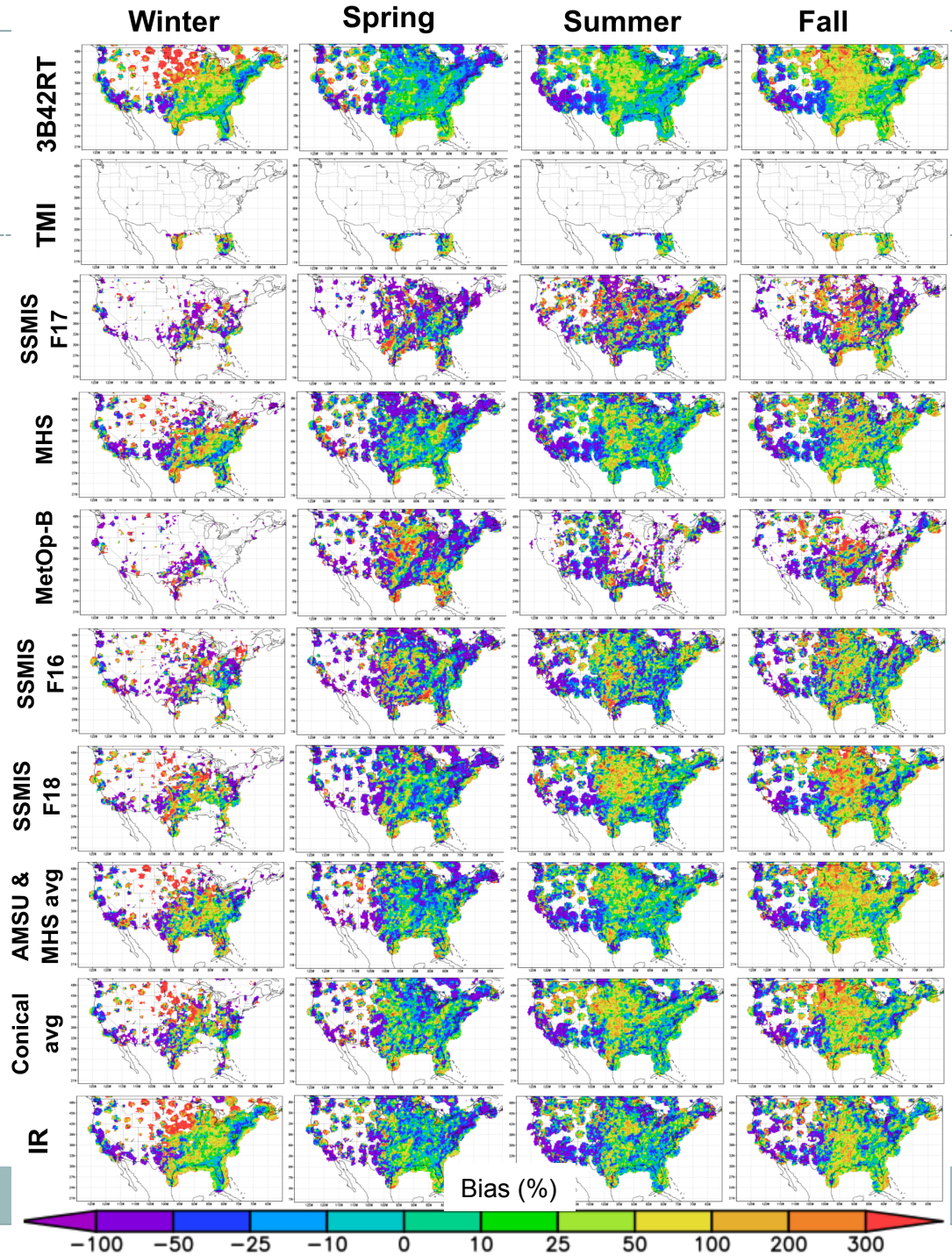
Level 3 analysis

breaking down by component

3B42RT rainfall accumulations by sensor versus MRMS



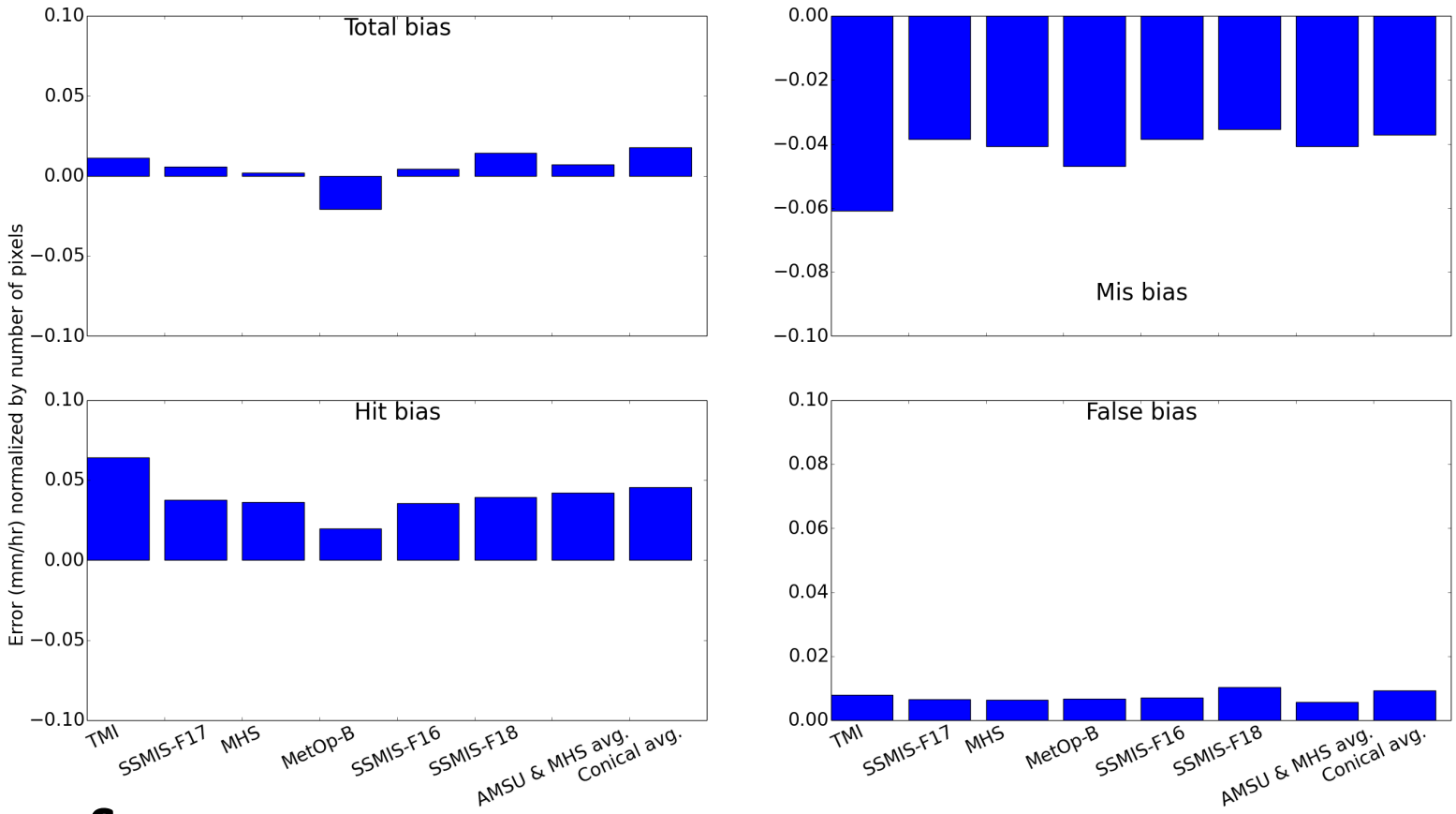
3B42RT bias maps



Level 3 analysis

error contribution by sensor

Best reference quality

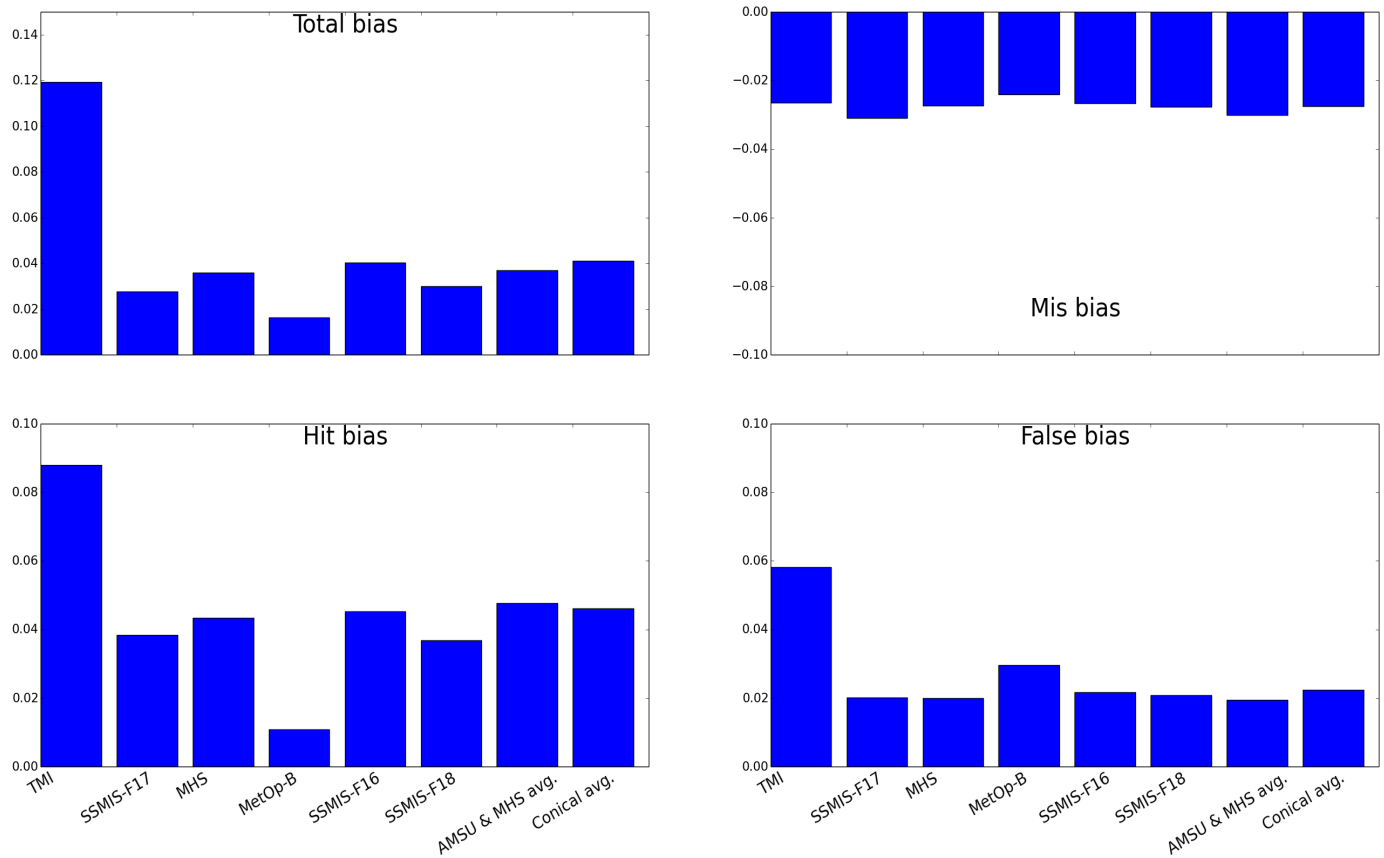


Summer season

Level 3 analysis

error contribution by sensor

Lower reference quality

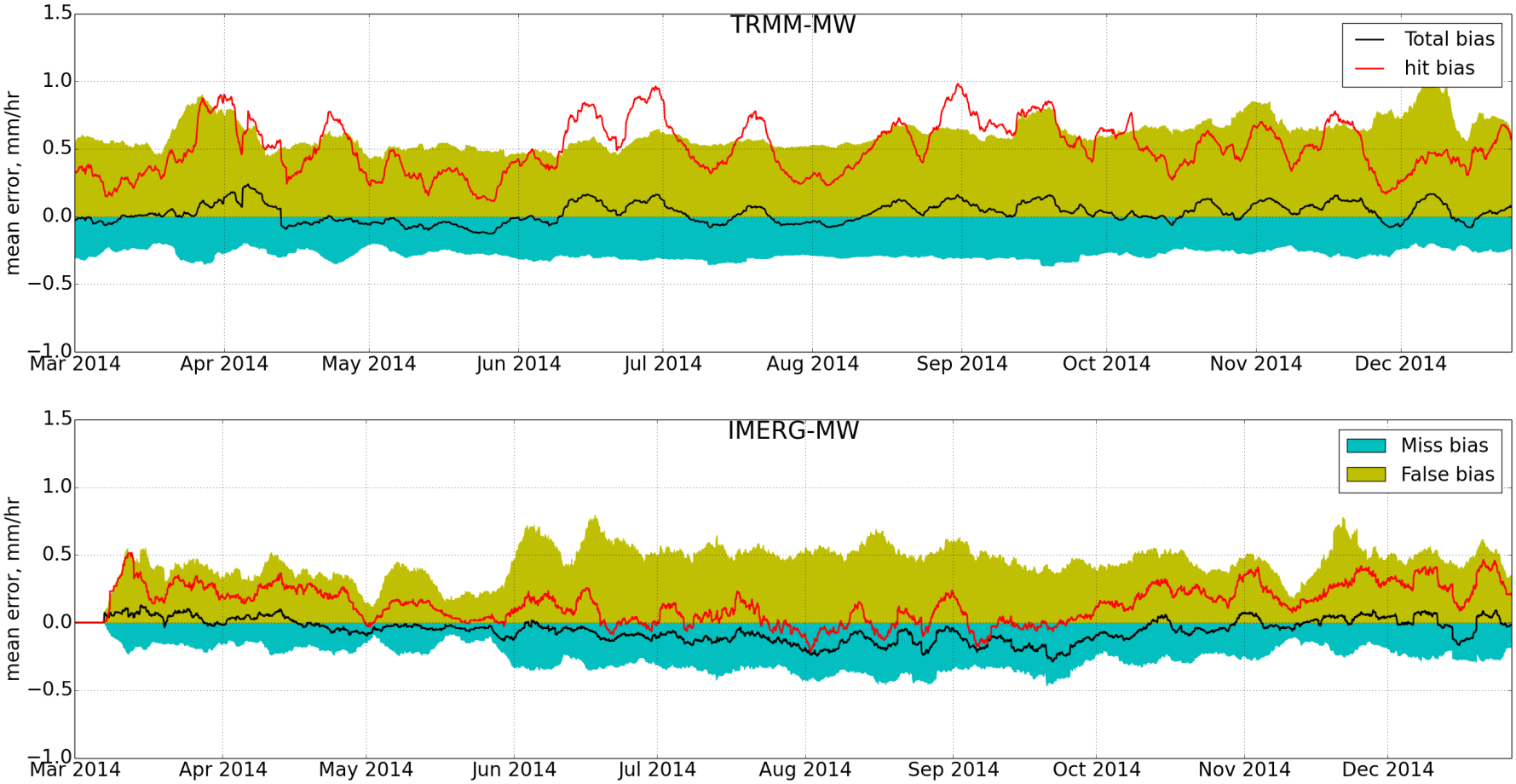


Summer season

Level 3 analysis: TRMM versus GPM

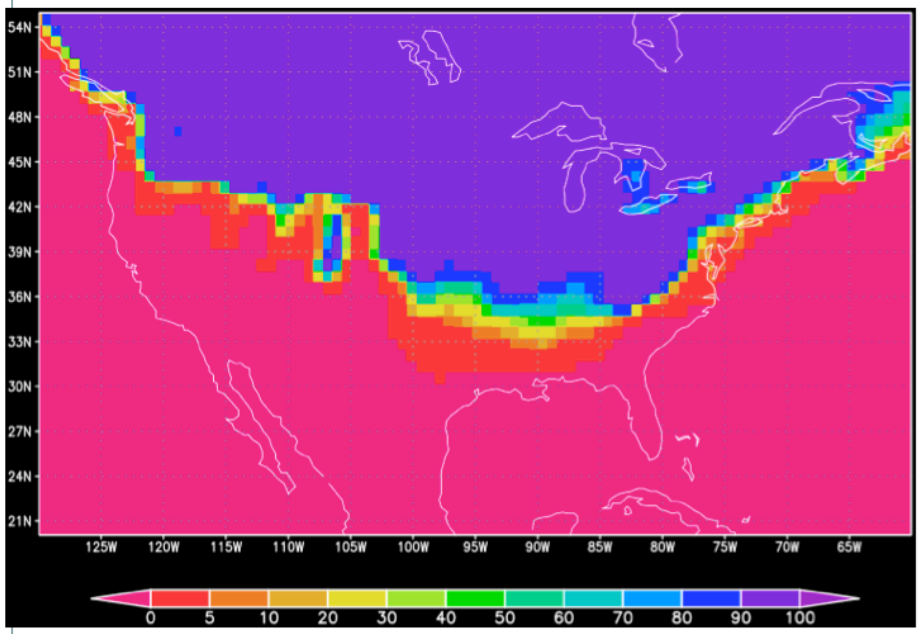
Average error components of 3B42RT and IMERG MW estimates

Resolution: 0.5° / 3h

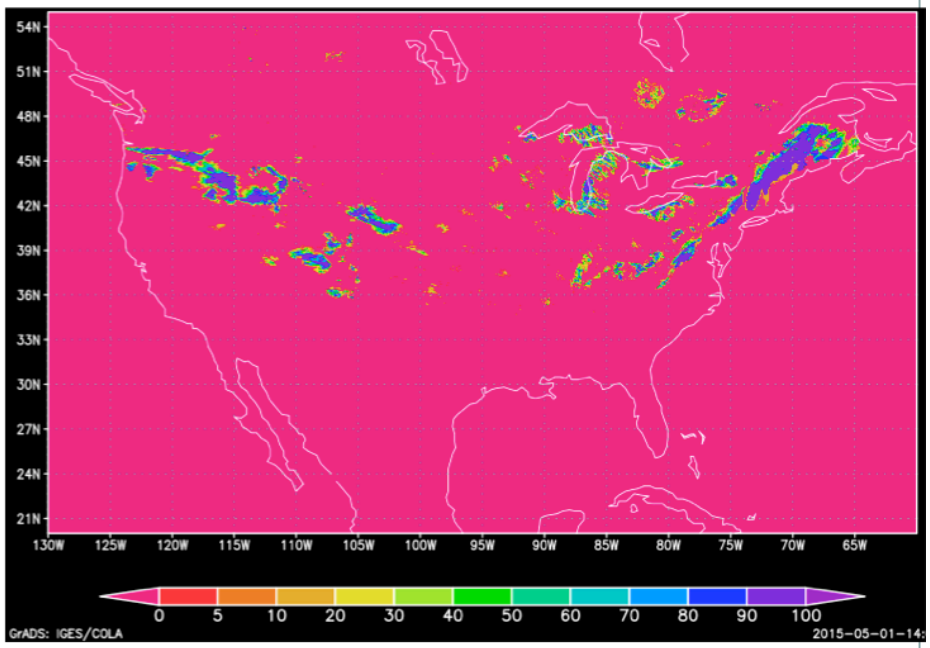


Level 3 analysis: Snow

IMERG



Radar

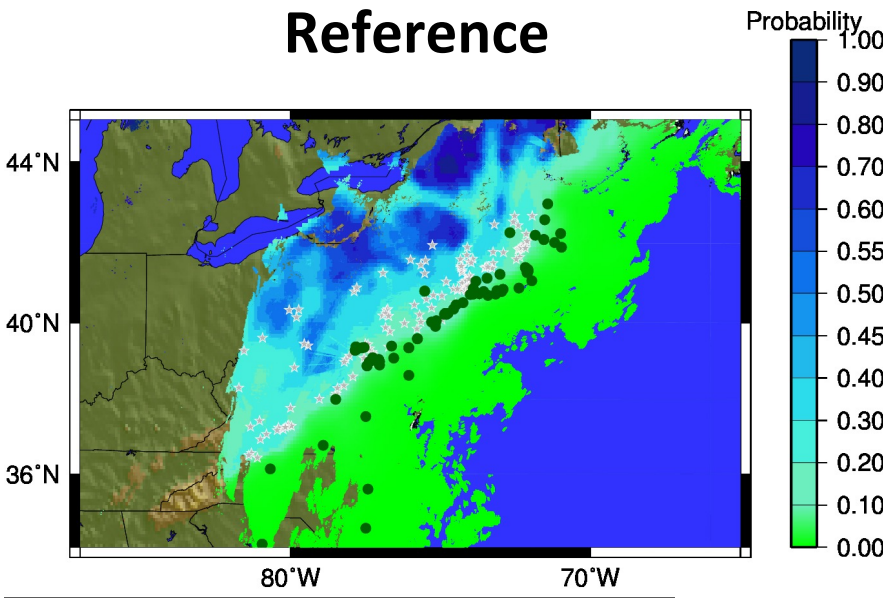


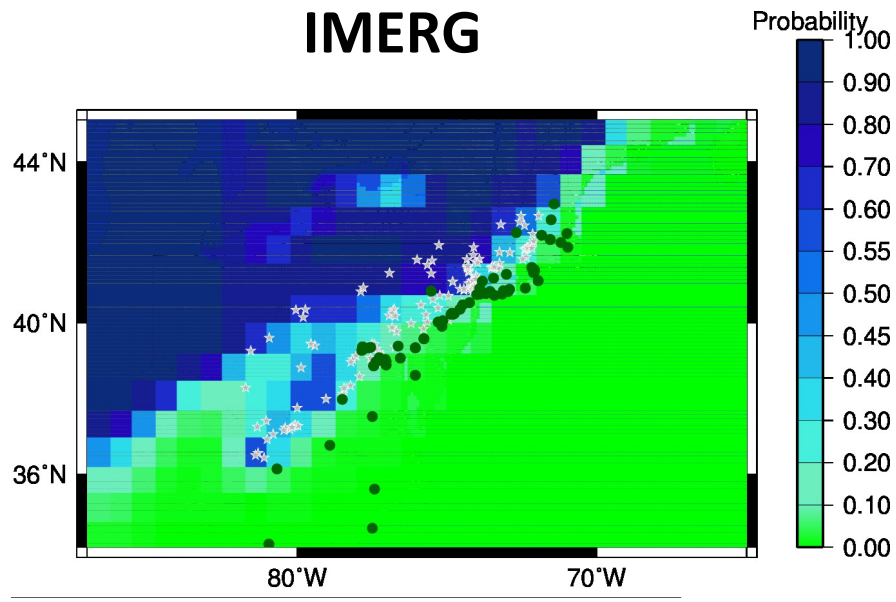
14 Nov 2014 @ 21:00

IMERG: Probability of Snow

Reference: hourly frequency of snow occurrence

Level 3 analysis: Snow





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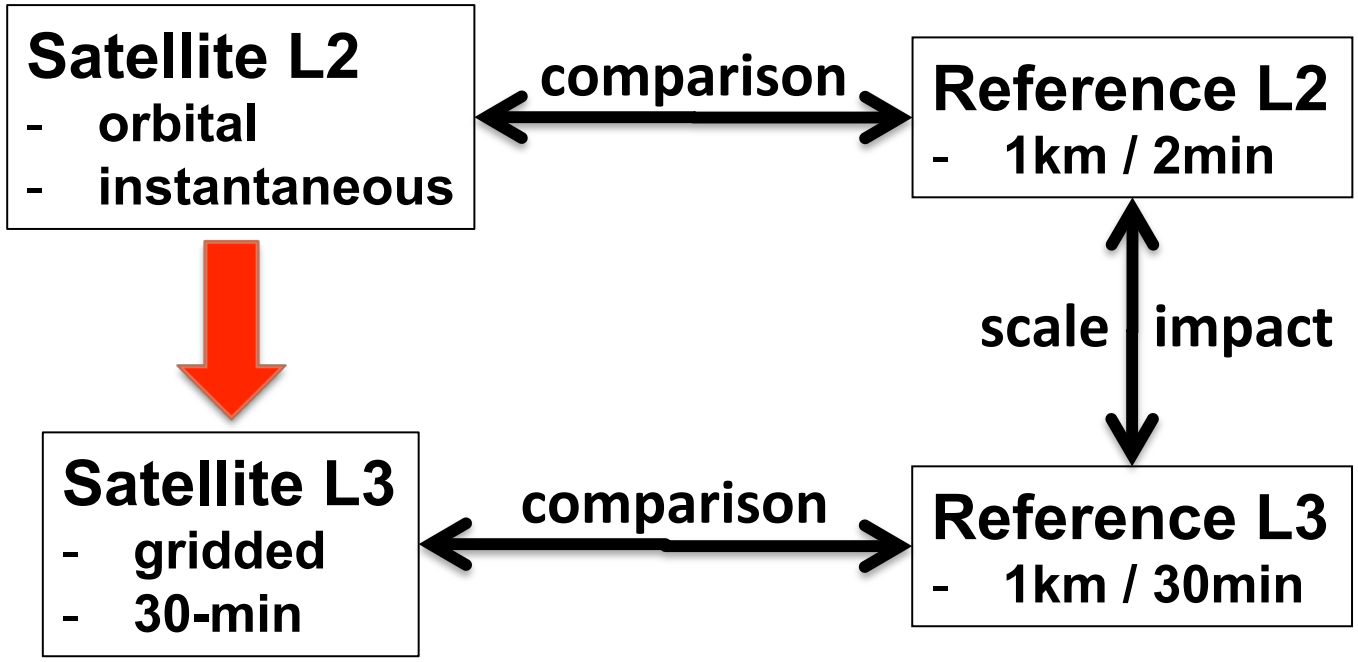
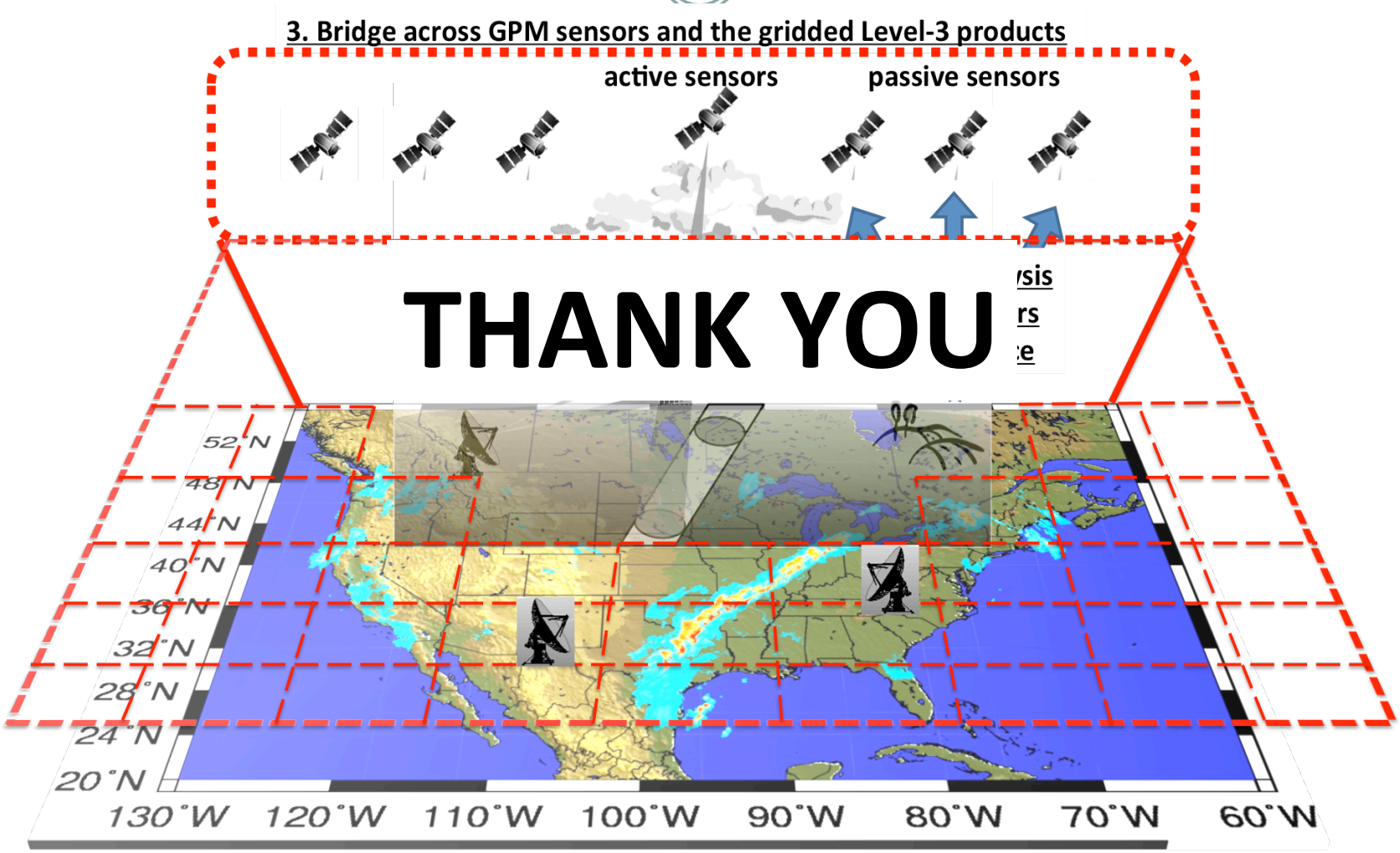
Perspectives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