Bridging the Global Precipitation Measurement (GPM) Level II and Level III precipitation using Ground Validation Multi-Radar/Multi-Sensor (GV-MRMS)

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Context

Characterization of satellite surface precipitation estimates and bridging Level-2 GPM core, constellation and combined Level-3 estimates. Needed in water cycle and extreme events studies, weather and climate prediction; over land in flood prediction and water resources.

Objectives

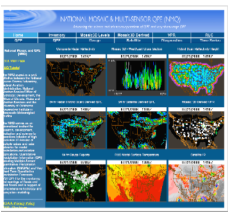
- use the Ground Validation Multi-Radar/Multi-Sensor (GV-MRMS; Kirstetter et al. 2018a) to provide a consistent reference research framework for creating conterminous US (CONUS)-wide comparison benchmark of precipitation retrievals across the GPM core and constellation satellites.
- cross-platform characterization acts as a bridge to intercalibrate active and passive microwave measurements from the GPM core satellite to the constellation satellites and propagate to Level-3 precipitation products.

Space sensors and products

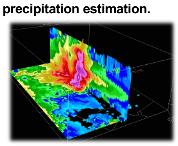
TRMM-PR/TMI, GPM-DPR/GMI, SSMIS, AMSR-2, DMSP-SSM/I, MHS, ATMS, IMERG

Background: MRMS

MRMS provides 3D reflectivity mosaics and QPE products over CONUS at 1-km²/2-min resolution



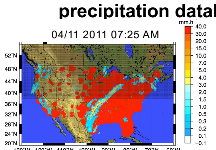
Real-time platform to develop, test, and assess advanced techniques in quality control, data integration and precipitation estimation.



http://nmq.ou.edu

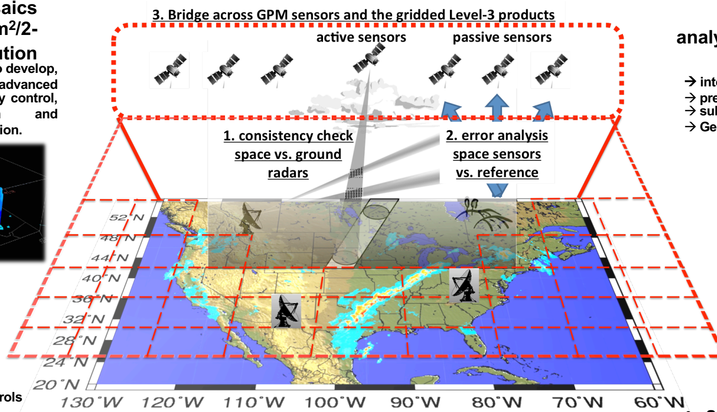
Reference precipitation

Establish a trustworthy reference precipitation database in real-time



products: 2A25 & 2A12
period: March-October 2011
sample: 500 000+

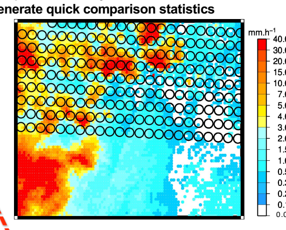
- → gauge adjustment
- → quality/quantity controls
- → precipitation types
- → matching the resolution of each sensor/product
- → active & passive Level 2, Level 3
- → used in GPROF at launch algorithm



Comparison

analyze precipitation features sampled by satellite sensors

- → intermittency
- → precipitation phase & types
- → sub-pixel variability
- → Generate quick comparison statistics

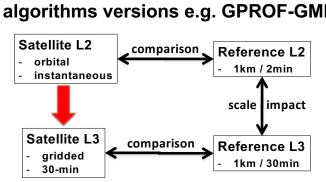


Disseminating data

- **algorithm development & validation purposes (DPR & GMI)**
- **active/passive/combined level-2 and level-3 precipitation products**

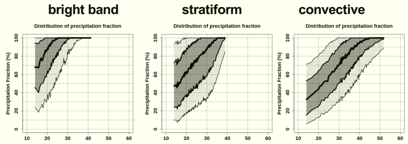
Brigding between sensors and products

→ between active and passive sensors, e.g. GPM-DPR vs. GPROF-GMI
→ between algorithms versions e.g. GPROF-GMI V04 vs. GPROF-GMI V05

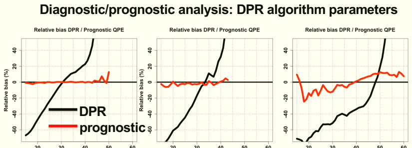


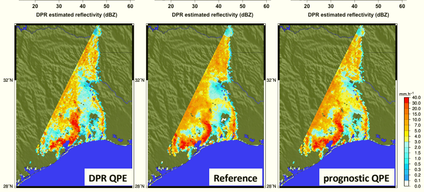
Active sensors: GPM Dual-frequency Precipitation Radar

Diagnostic analysis: intermittency within the DPR footprint



Diagnostic/prognostic analysis: DPR algorithm parameters





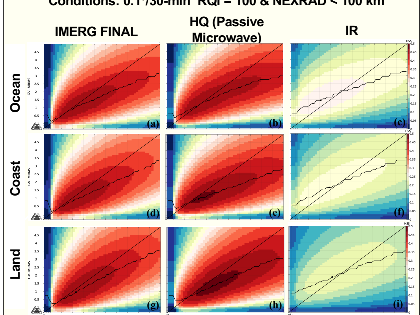
Storm system at 12:30 UTC on 18 April 2016 near Houston

Evaluation over the period June 2014 – Sept. 2016 (4M+ matched DPR-MRMS estimates)

	brightband		stratiform		convective	
	Bias (%)	Correlation	Bias (%)	Correlation	Bias (%)	Correlation
DPR	+5.5 %	0.44	-19.5 %	0.36	-15.5 %	0.30
Prognostic	+0.05 %	0.60	-1.5 %	0.46	+3.5 %	0.53

IMERG – Land - Coast – Ocean evaluation

2D Heidke Skill Scores GV-MRMS vs. IMERG
Conditions: 0.1°/30-min RQI = 100 & NEXRAD < 100 km

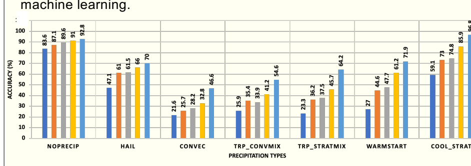


- ➢ The HQ component shows generally better agreement with GV-MRMS than IMERG FINAL, than IR.
- ➢ IMERG final shows slightly better agreement with GV-MRMS over ocean than land.
- ➢ Surprisingly HQ shows better agreement over Land and Coast than over Ocean.
- ➢ IR shows better agreement over Ocean, than over Coast than over Land.

Integrated Multi-satellitE Retrievals for GPM

Satellite-based quantitative precipitation estimation (QPE) requires more than just one deterministic "best estimate" to adequately cope with the intermittent, highly skewed precipitation distribution. A new approach called Probabilistic QPE using Infrared Satellite Observations (PIRSO) is proposed to advance the use of uncertainty as an integral part of QPE. PIRSO precipitation probability maps outperform conventional deterministic QPE by mitigating biases like PERSIANN-CCS used in IMERG. PIRSO quantifies uncertainty needed for precipitation ensembles and multisensor merging and advances the monitoring of precipitation extremes for hydrometeorological hazards (Kirstetter et al. 2018b).

Like most of the operational merged products, IMERG uses IR estimates based on only one channel. The impact of multi-spectral observations from GOES-16 on precipitation type identification is investigated through machine learning.



- ➢ Consistent improvement observed in the classification performance with more channels. This result encourages to use more ABI channels.
- ➢ There is a significant jump in the accuracy for most precipitation types by adding the WV channel T6.2 to the IR T11.2.

Relevance and Broader Impact :

- Evaluation & development of GPM precipitation
- propagation of uncertainties in Level 3 precipitation

Any question or comment? Please contact me at:
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