Using Large-scale Environment to Improve Passive Microwave Estimates of Heavy Precipitation

Veljko Petković¹,², Christian Kummerow¹, David Randel¹, Jeffrey Pierce¹, John Kodros¹

¹Cooperative Institute for Research in the Atmosphere (CIRA)  
Colorado State University, Fort Collins, Colorado

²Cooperative Institute for Climate and Satellites-Maryland (CICS-MD)  
University of Maryland, College Park, Maryland; veljko@atmos.colostate.edu

CICS Science Meeting November 2017
Earth System Science Interdisciplinary Center University of Maryland, College Park
**Flood event**

Satellite
- Radar overpass match only
- Radar native resolution
- Best estimate (radar+gauge+QC)

**Non-flood event**

**Z-R**
- Flood event: $70 \, R^{1.6}$
- Non-flood event: $240 \, R^{1.6}$

**GPROF bias**
- Flood event: $-60\%$
- Non-flood event: $-20\%$

**Regime**
- Flood event: Well-organized
- Non-flood event: Scattered, Average

Global Distribution of Regional Biases of GPROF Retrieval

Total Lightning Activity [flashes km$^{-2}$ yr$^{-1}$] by the Lightning Imaging Sensor
period 1998-2013

Mean daily rain rate differences between PR and TMI
Separate 1° x 1° raining scenes into: **Shallow**, **Deep-Unorganized** and **Deep-Organized** systems using:

- Radar top echo height
- Convective rainfall
- Raining fraction

(Elsaesser et al. 2010, *J. Climate*)

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Large-scale Environment to Regime and Bias Link

Regime-related environment:
- CAPE
- Shear
- Low-level humidity
- Vertical distribution of humidity
- Aerosol concentrations

Source: Era-Interim

Relative frequency of occurrence [%]

- Low CAPE
- Medium CAPE
- High CAPE

Large-scale Environment to Regime and Bias Link

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Results - Redistribution of the \textit{a priori} Elements Weights

Original

CAPE

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Change in Bayesian weight distribution (New – Org.)
Results - Improving the Quality of Heavy Precipitation Estimates

Precipitation Bias Improvement
top 10% rainfall rate

21% of mean rain rate bias removed

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Results- Improving the Quality of Heavy Precipitation Estimates

Original bias: -28%
New Bias: -13%
Original Correlation: 0.66
New Correlation: 0.77
MRMS mean rain rate: 3.89 mm h\(^{-1}\)
Original mean rain rate: 2.87 mm h\(^{-1}\)
New mean rain rate: 3.47 mm h\(^{-1}\)
Results - Impact to the Overall Performance of the Retrieval

Original Bias: -13%
New Bias: -10%
Original Correlation: 0.75
New Correlation: 0.80
MRMS mean rain rate: 0.57 mm h\(^{-1}\)
Original mean rain rate: 0.50 mm h\(^{-1}\)
New mean rain rate: 0.51 mm h\(^{-1}\)
Summary - Conclusions

**Problem:**
- Passive microwave satellite rainfall retrievals over land are often biased due to limited information content of the observation vector.

**Hypotheses:**
- Large-scale environment can compensate for lack of information by eliminating non-relevant elements of the a priori information.

**Results:**
- Variability in cloud microphysics is responsible for the biases.
- Precipitation regimes (level of system organization) have distinct bias preference.
- Large-scale environment links well to precipitation regime type.
- 30% - 40% of the bias can be removed by implementing information on large-scale environment into the algorithm.
Literature

