# An Observationally-Based Method for Stratifying *a-priori* Passive MW Brightness Temperature Observations in a Bayesianbased Precipitation Retrieval Framework

Joe Turk, Ziad Haddad, Pierre Kirstetter, Yalei You, Sarah Ringerud

PMM Land Surface Group Discussions May 24, 2017

# **Previous Studies**

- A main constraint on the interpretation of passive microwave TB is the "background" – the surface emissivity, or more generally, the joint surface and atmospheric state (e.g., water vapor).
- Previous publications demonstrated that a the emissivity principal component (EPC) structure could be fairly well estimated by nonlinear combinations of all TB.
- From this, the emissivity vector (10-85 GHz), column vapor and Tsfc can be reconstructed and is fairly accurate under "cloud-free" conditions.
- Exploit low-end DPR sensitivity to separate "no-cloud" TB observations
- Apply the EPC to all scenes, then separate the EPC structure using the GPM radar profile to find "cloud" and "no-cloud" scenes.



Turk, F.J., Haddad, Z.S. & You, Y., 2016, Estimating Non-Raining Surface Parameters to Assist GPM Constellation Radiometer Precipitation Algorithms, *J. Atmos. Oceanic Technol.*, 33(2016), pp. 1333-1353.

# Extension to All Scenes, not just no-cloud

- The previous work suggests that the emissivity PC structure (EPC) can classify self-similar surface conditions around the world, jointly with the associated variability in the total column vapor and surface temperature, directly from the TB observations.
- As clouds and precipitation creep into the TB scenes, the EPC structure is displaced from its no-cloudy range.
- Suggests an alternative way to separate or cluster a large database for efficient Bayesian-based inversion techniques, which otherwise are computationally unrealistic for GMI and other sensors (GMI= 650K TB pixels/orbit). No ancillary data, surface class or land/ocean algorithm separation required.
- The a-priori dataset should be extensive enough to capture the full range and frequency of occurrence of all underlying variability in nature...surface conditions, rain conditions, weather systems, etc.

# One-Year (Sept 2014-Oct 2015) Matched DPR-GMI

- One full year of pixel-matched GMI and DPR data was created. Each orbit (5800 orbits) was written to a file as sequential binary record structures with TB, DPR profile, EPC, MERRA2 data, precipitation estimates from the current DPR and CMB (DPR+GMI) GPM algorithms, etc.
- From this, the histograms of the first four EPCs were determined, and divided into ten equal-density spaced bins. Defines a data "cube" with N=10000 indices.
- Each record (850M total) was appended to its associated index file.
  2% overlap was used for computational efficiency.
- Nothing is lost here....simply a reorganization of the dataset to make the search in EPC space much faster.
- In practice, the required index files are first identified, then only these files are opened one time (all pixels for index file 1, then all pixels for index file 2, etc).

## **Weighting of Candidate Solutions**

#### Distance in EPC space

$$d_{EPC} = \frac{1}{N} \sum_{i=1}^{N} \left( \left( u_{i}^{obs} - u_{i}^{DB} \right) / \sigma_{i}^{DB} \right)^{2} \quad N = 11$$
  
$$d_{TB} = \frac{1}{N} \sum_{i=1}^{N} \left( \left( TB_{i}^{obs} - TB_{i}^{DB} \right) / \sigma_{i}^{DB} \right)^{2} \quad N = 9 \text{ or } 13$$

Distance in TB space

#### **TPW** search

Weighting done by proximity to column water vapor, Ts (or T2m) values, the same TELSEM class index, and distance in TB space.

#### **EPC** search

Weighting done in EPC space only.

Both search methods interrogate the identical database

Use the TELSEM index for evaluation purposes.

$$\hat{R}_{EPC} = \sum_{i=1}^{N} w_i R_i^{DB} / \sum_{i=1}^{N} w_i$$

#### **GPM** overpass near the Texas-Louisiana border

18 April 2016, near 1228 UTC



#### **GMI** Pixel at Location "B" (TPW-based search)



## GMI Pixel at Location "B" (TPW-based search) TB from top 100 candidates in search



#### **GMI** Pixel at Location "B" (EPC-based search)



### GMI Pixel at Location "B" (EPC-based search) TB from top 100 candidates in search



#### Comparison of TPW and EPC (using CMB precip)



## GMI Pixel at Location "B" (EPC-based search) Locations of top 100 candidates in search



#### Overall Performance (Relative to GMI-Matched MRMS) (seven months between Nov 2015 and Sep 2016)

