Land Surface Characterization for GPM-Era Algorithms

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1. Introduction

One of our focus area during the past year was to complete an emissivity intercomparison study under the auspices of the Land Surface Characterization Working Group (LSWG) which supports the activities of several algorithm teams. Accurate emissivity estimates are needed to advance the current state of precipitation retrievals over land.

2. Emissivity (ε) Intercomparison – Study Parameters

Algorithm Group	Sensor	Targets	Dates	Channels
NASA- GSFC	AMSR-E	All	07/04 - 06/07	All
	SSMI	All	07/04 - 06/07	All
	TMI	SGP, HMT-SE	07/04 - 06/07	All
CNRS	SSMI	All	07/04 – 06/07	All
Meteo-France	AMSU-A	All	07/06 - 06/07	23.8; 31.4; 50.3; 89 GHz
	SSMI	All	07/06 - 06/07	All
NOAA-CICS	AMSU-B/MHS	C3VP	12/05 - 02/07	All
Nagoya University	TMI	SGP, HMT-SE	07/04 - 06/07	All
NOAA-MIRS	AMSR-E	All	08/05 - 06/07	All
	AMSU-A, AMSU-B/MHS	All	08/05 - 06/07	All – AMSU (A & B)
	SSMIS	All	08/05 - 06/07	All
NRL/JPL	WindSat	All	07/04 - 06/07	All

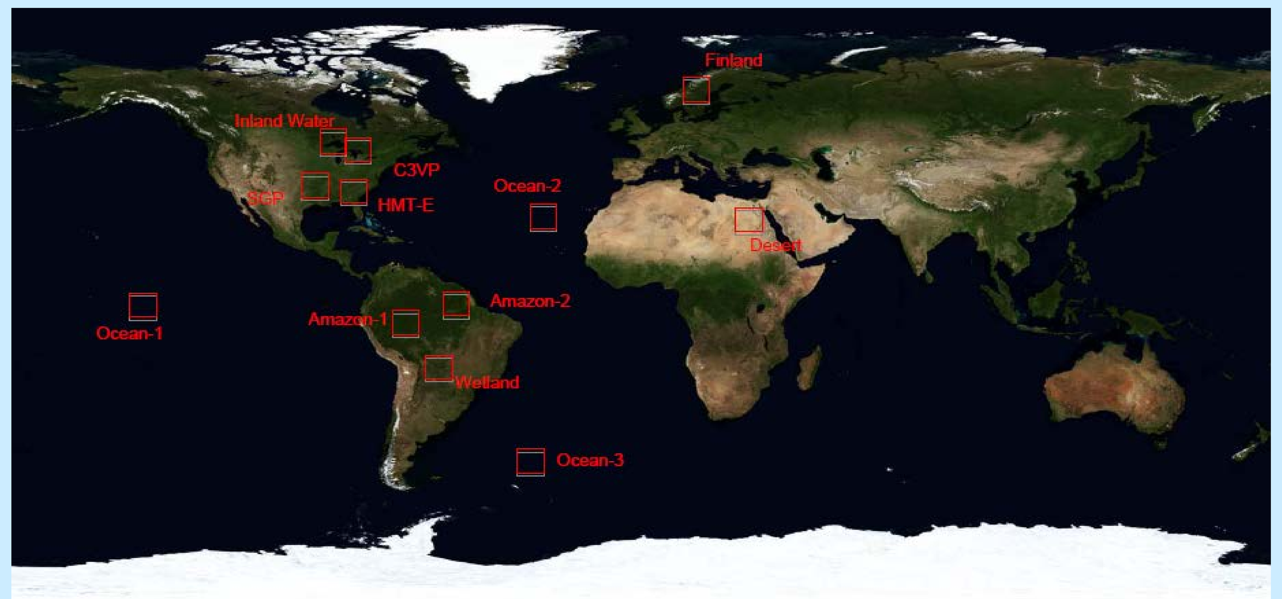
Model Type	Principle	Input Parameters	Advantages	Disadvantages
Land Surface Model	Dense media radiative transfer theory	Surface parameters (soil type, snow properties, etc)	Naturally couples to land surface models	Dependent upon realism of specified surface parameters
Direct observational	Observationally based	Satellite observations, land and atmosphere properties	No surface parameters needed other than temperature	Only works for partially-opaque atmospheric conditions, dependent upon land surface temperature and atmospheric profile and atmospheric model assumptions
Physical Retrieval	Parameterized radiative transfer	Satellite observations	Physical consistency amongst retrieved surface parameters	Parameterizations may not work well above X-band

Objective: Compare a variety of ε retrieval techniques (denoted by different colors in tables to the left) using (as best as possible) common input data sets (7/04 – 6/07) over a diverse set of surfaces (see map below).

Questions: How similar or different are the ε estimates? For which frequencies and surfaces? For which type of retrieval?

Focus Targets: HMT-SE, SGP and C3VP sites; results only shown in this poster for SGP (most homogeneous) and C3VP (most diverse)

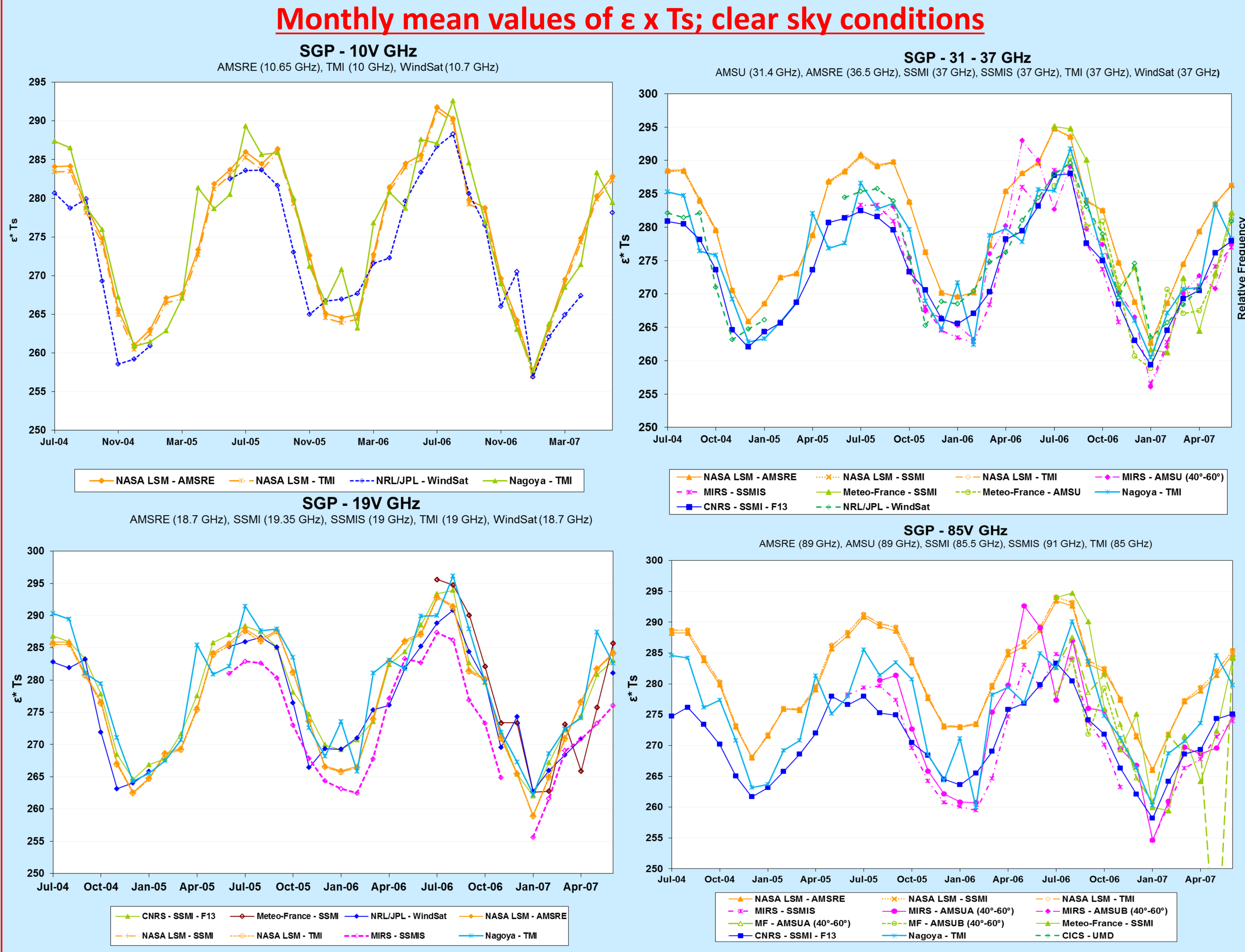
$$TB_{\nu,p} = T_u + \tau_\nu [\varepsilon_{\nu,p} T_s + (1 - \varepsilon_{\nu,p}) T_d] \quad \& \quad \varepsilon_{\nu,p} = (TB_{\nu,p} - T_u - \tau_\nu T_d)/[\tau_\nu (T_s - T_d)$$



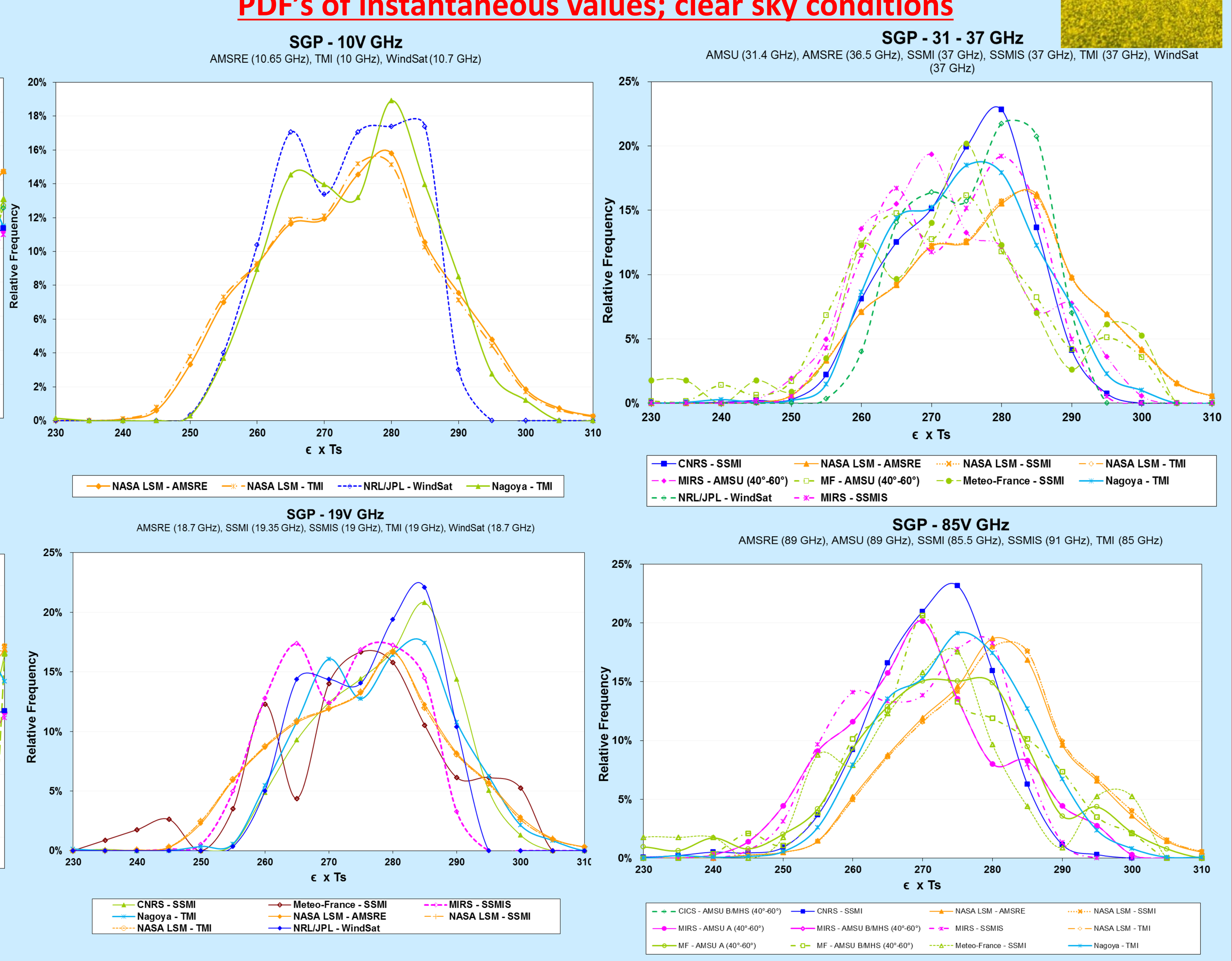
3. Results – SGP (35 N, 97 W)

Agricultural region of pastures and wheat fields; experiences seasonal changes in vegetation. Subjected to prolonged periods of dry weather in the summer, strong convective rains in the springtime and occasionally heavy snowfall in the winter. Homogeneous, mostly flat terrain.

Monthly mean values of ε x Ts; clear sky conditions



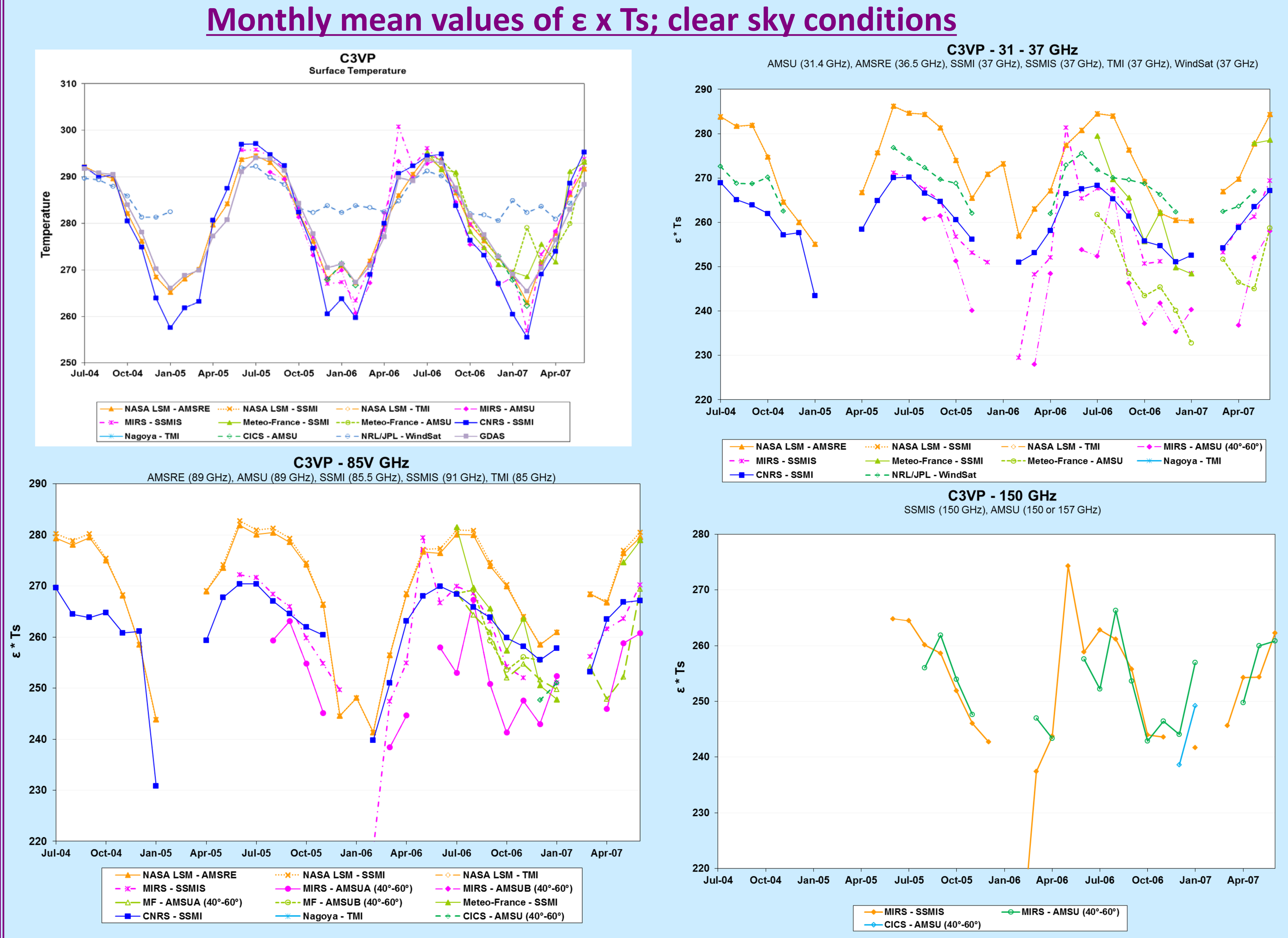
PDF's of instantaneous values; clear sky conditions



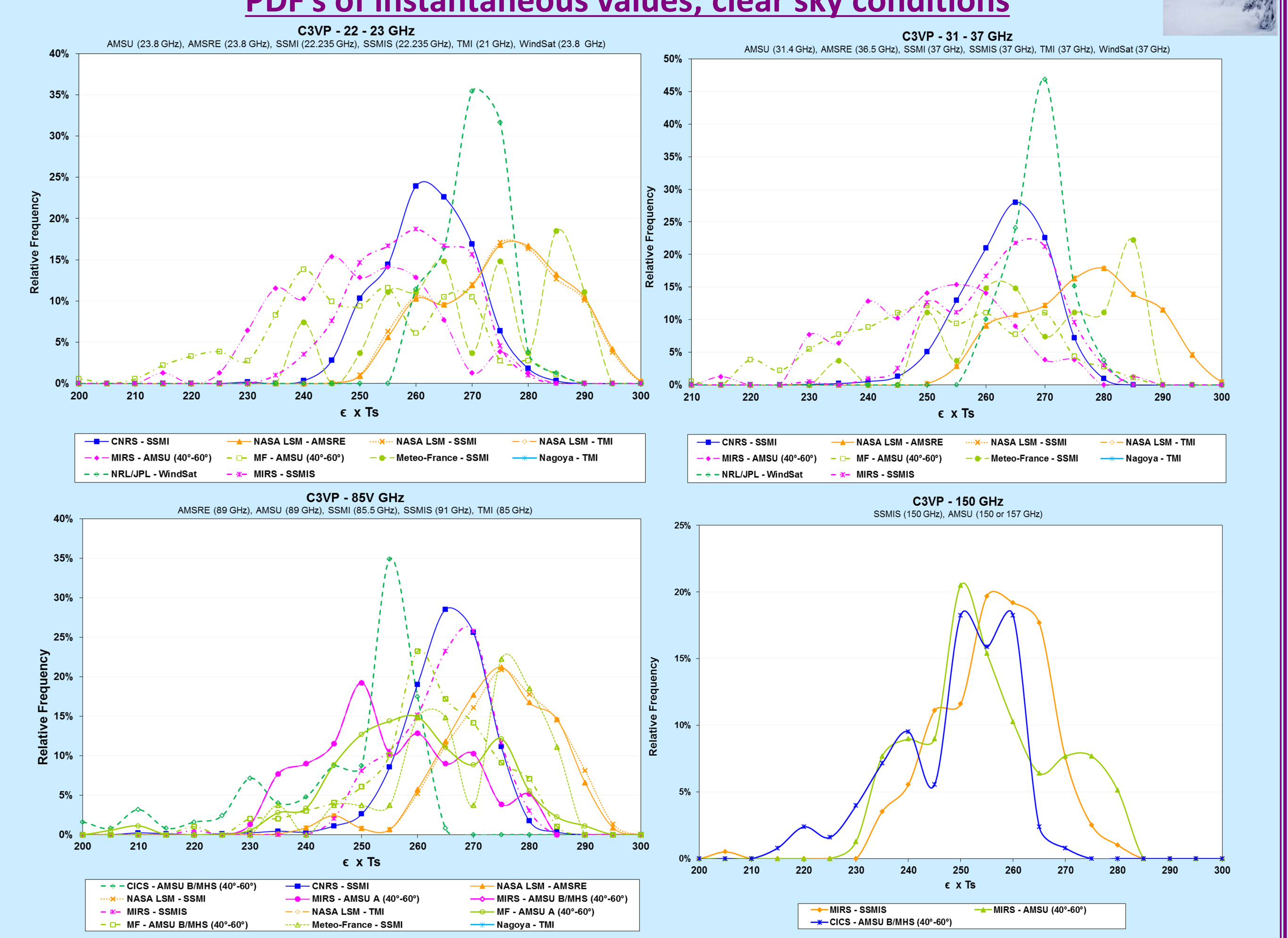
4. Results – C3VP (44N, 80W)

Complex site in terms of geography and weather; it's on the northwest side of Lake Ontario and is a mixture of land, water, forests, woodlands and grasslands. Pronounced winter season with extended snow cover; a certain challenge for GPM!

Monthly mean values of ε x Ts; clear sky conditions



PDF's of instantaneous values; clear sky conditions



5. Summary and Next Steps

Although we are still analyzing the results, we can provide some general conclusions based on this initial study:

- **Better agreement is found at the more homogeneous sites (SGP), during vegetated conditions, and at lower frequencies.**
  - **This offers promise is using the emissivity directly in retrieval algorithms under these "known" conditions**
  - **The rain/no-rain distinction is likely still to be problematic given the spread seen amongst the different estimates**
- **Worse agreement is found at the more complex sites (C3VP), during cold seasons, and for higher frequencies.**
- **The uncertainty amongst the estimates is further compounded by potential uncertainties due to (and in order of importance):**
  - **Insufficient precipitation screening**
  - **Land surface temperature**
  - **Sample sizes during cloudy conditions**
  - **Number of layers used in atmospheric contribution calculation**
- **There is some indication that the retrieval type (direct, inversion, physical) also is a factor in the results.**

Next steps?

- **Re-examine the data to remove "outliers" (and to understand their causes)**
- **Look at the other sites, including deserts and rain forests**
- **Examine further the impact due to actively precipitating conditions**
  - **Can we quantify the errors in precipitation rate as a function of surface and atmospheric conditions?**

References

- Hernandez, C., R. Ferraro, and C. Peters-Lidard, 2011: An evaluation of microwave land surface emissivities for use in precipitation algorithms. *3rd Workshop on Remote Sensing & Modeling of Surface Properties, Beijing, China, October 2011*
- Ferraro, R. and members of the PMM Land Surface Characterization Working Group, 2011: An evaluation of microwave land surface emissivities over the continental U.S. to benefit GPM-era precipitation algorithms, *to be submitted, IEEE Trans. Geo. Rem. Sens.*