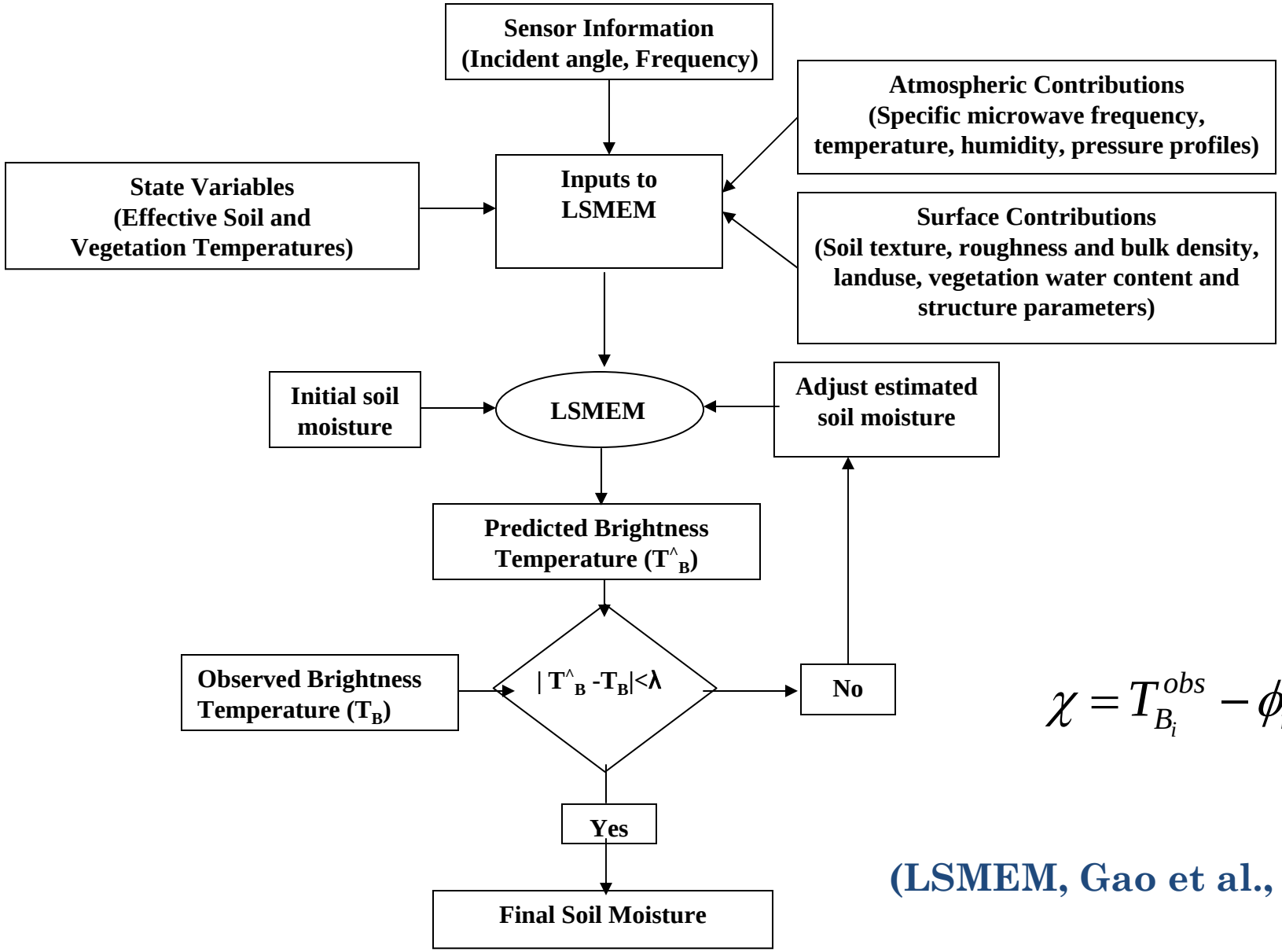
Assessing Strategies for Improved AMSR-E Retrievals and their Continental Scale Evaluation

Eric F. Wood
Princeton University

AMSR-E Science Team Meeting
Asheville, NC
June 28-29, 2011

Satellite Soil Moisture Retrieval Model (LSMEM)



$$\chi = T_{B_i}^{obs} - \phi_i(x)$$

(LSMEM, Gao et al., 2004)

LSMEM Input Datasets

Parameter/variable	Value	Data source	Reference
Soil texture (Sand fraction, clay fraction) and soil bulk density	Spatially distributed constants	ISLSCP-IIO	Hall et al., 2005
Soil surface roughness	0.3	Choudhury et al., 1979	
Vegetation coverage and classification	Spatially distributed, monthly	MODIS MOD-12 MOD-13	Friedl et al., 2002 Huete et al., 2002
Vegetation water content	Spatially distributed, climatology	Based on MODIS LAI and land cover types	Rodell et al., 2004
Water coverage	Spatially distributed constants	MODIS classification	Hansen, et. Al., 2000
Vegetation structure parameter	Constants based on classification	Jackson and Schmugge, 1991	
Vegetation single scattering albedo	0.07	Average value according to Pampaloni and Paloscia, 1986; Ulaby *et al.*, 1983	
Surface temperature	Spatially distributed, hourly	GLDAS/VIC output	Rodell et al., 2004; Sheffield et al., 2006; Liang *et al.*, 1994; 1999

Recent Developments in LSMEM

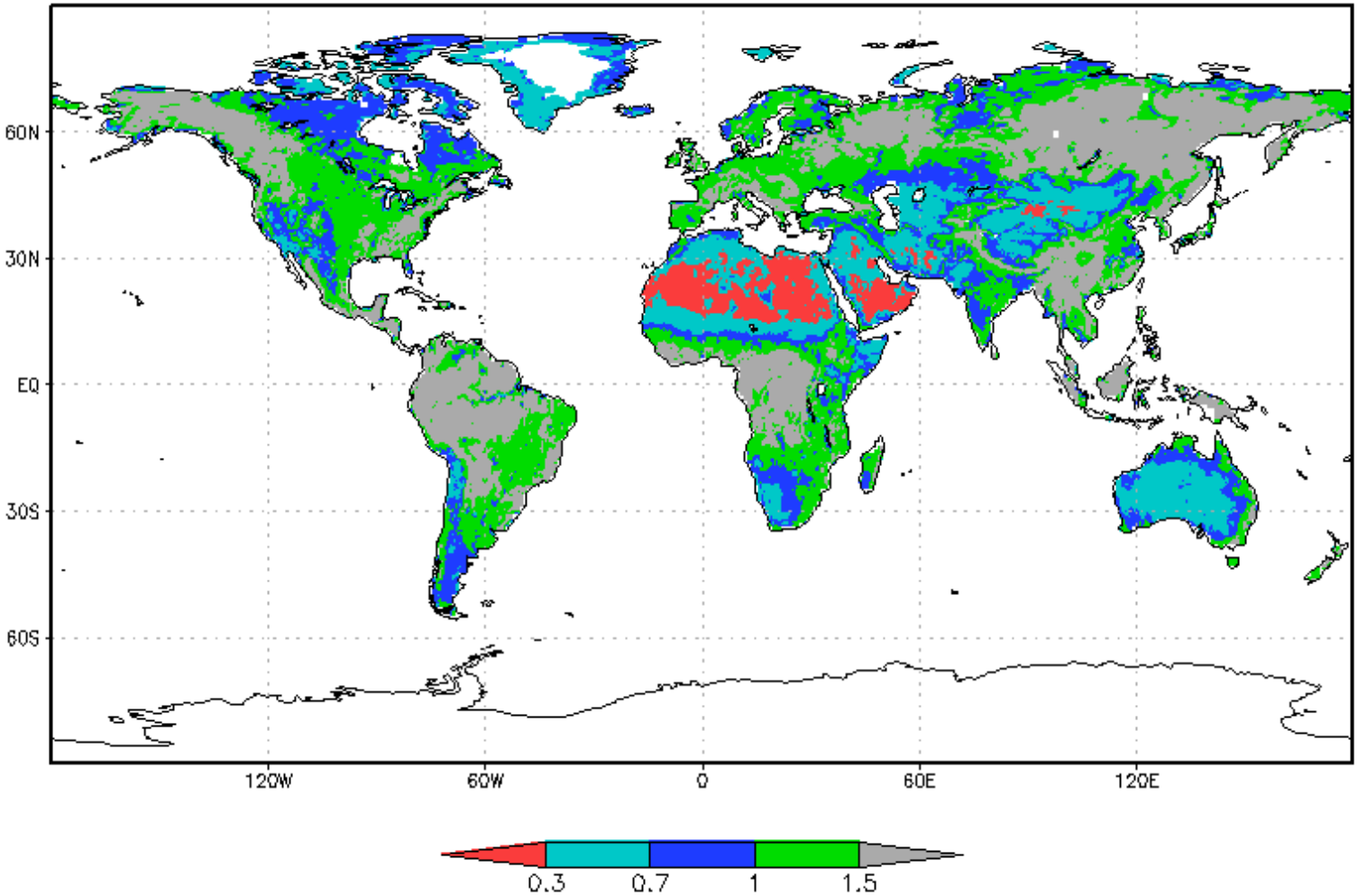
- New Microwave Multi-channel (18.7 & 23.8 GHz) Based Vegetation Optical Depth Dataset (From University of Montana)

- Microwave 36.5 (~37) GHz Vertical Polarization based Surface Temperature

- Microwave based mask files for snow cover, active rain, dense vegetation, RFI

- Implementation of a post calibration technique

Vegetation Optical Depth



Average Global Vegetation Optical Depth (VOD) calculated from AMSR-E measurements for the period June 2002 to December 2009.

VOD Algorithm can be found at Jones et al., 2009; 2010

Surface Temperature

➢**Microwave 37 GHz Vertical Polarization based Surface Temperature**

Estimated using a calibrated water-energy land surface model.

(Note that LST is not an ECV. NWP surface temperatures is usually biased due to their assimilation system and air temperature bias correction algorithms.)

- For the Night-time Overpass

  $$Ts = 0.893*Tb37V + 44.8$$

- For the Day-time Overpass

  $$Ts = 0.898*Tb37V + 44.2$$

where Ts is the effective temperature (~0-1 cm Ts)

Surface Mask

- **Microwave based mask files for snow cover, active rain, dense vegetation, RFI**

Snow:
(both of the following must be true)
Tb37V < 250 K
tb37V - tb18V < -3 K

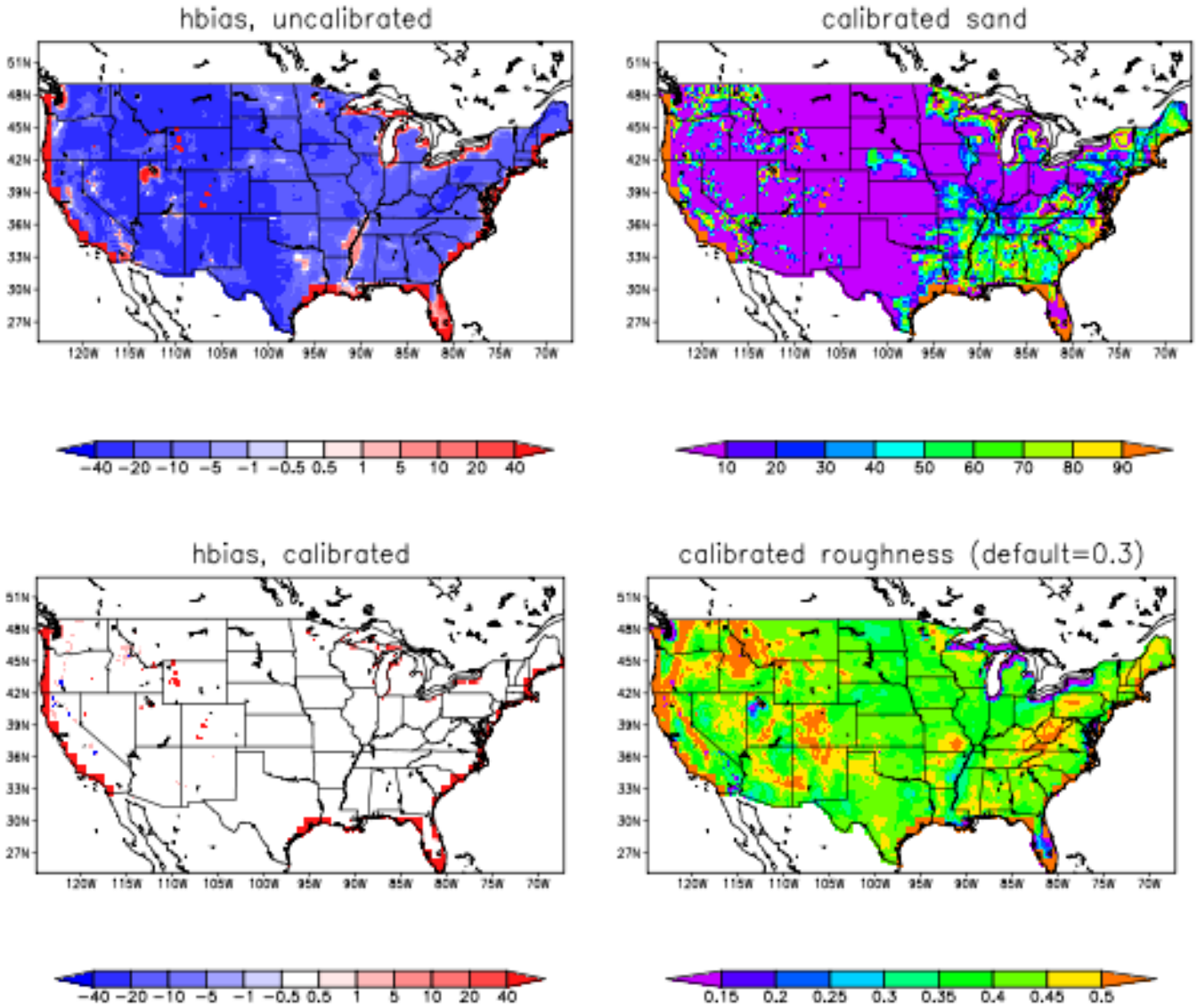
Precipitation:
Tb23H - Tb89H > 1 K
Tb85V < 249 K

Dense Vegetation:
Based on Vegetation Optical Depth Data

RFI (10.7 GHz):
(if at least one of the following is true)
Tb10V - Tb10H < 0
Tb18H - Tb10H + 5 < 0
Tb18V - Tb10V + 5 < 0

Open water:
Screened for < 50 % open water with MODIS 1-km land cover aggregated to 25 km

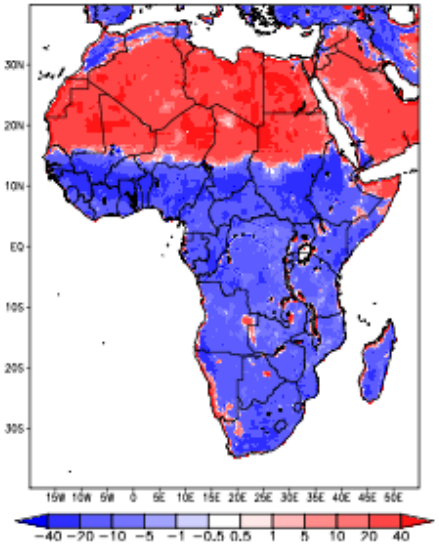
LSMEM Calibration over USA



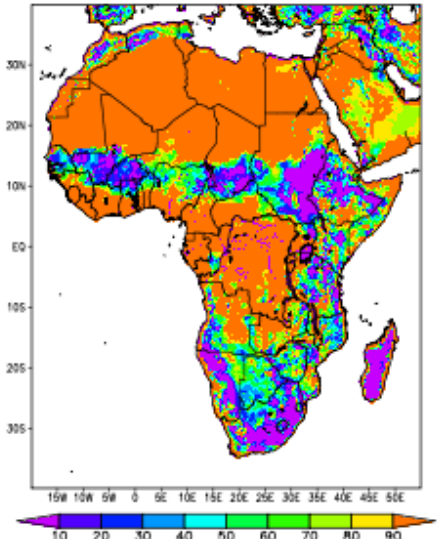
Mean Bias in the LSMEM predicted un-calibrated and calibrated Brightness Temperatures and corresponding input sand percentage and roughness for the entire calibration period.

LSMEM Calibration over Africa

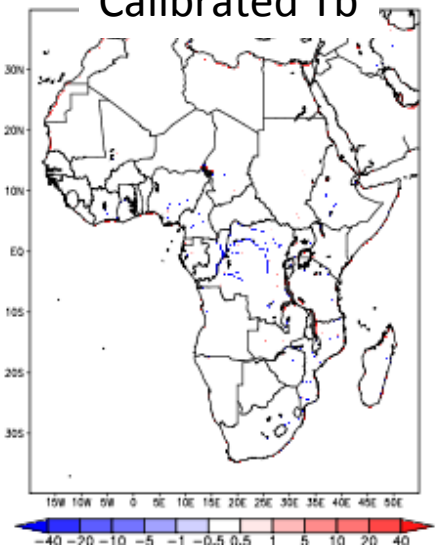
Uncalibrated Tb



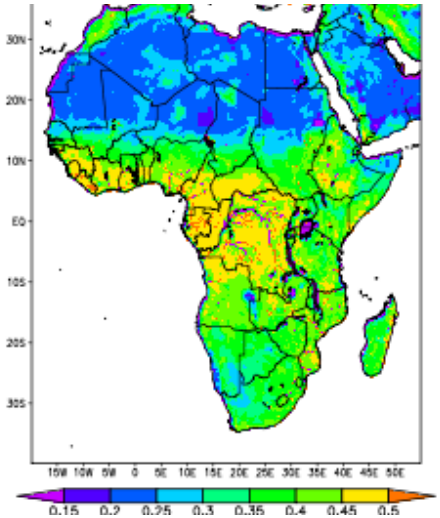
Calibrated Sand



Calibrated Tb



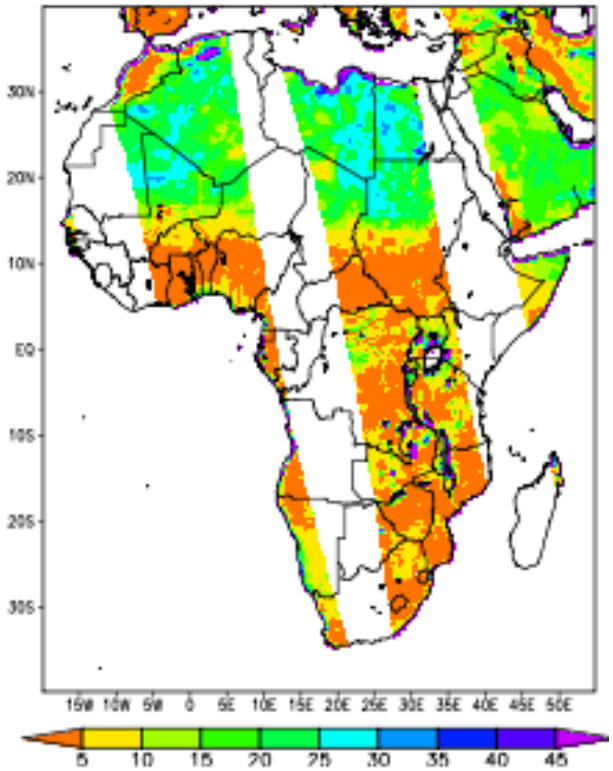
Calibrated roughness



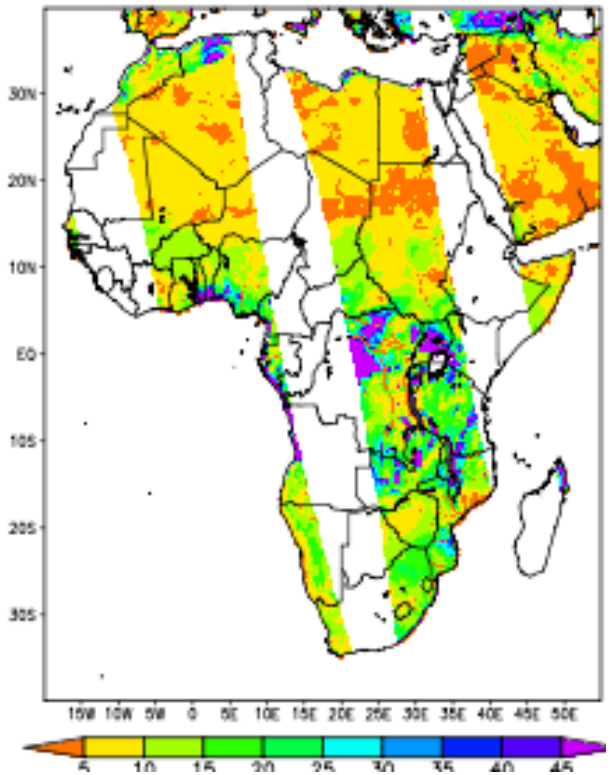
Mean Bias in the LSMEM predicted un-calibrated and calibrated Brightness Temperatures and corresponding input sand percentage and roughness for the entire calibration period.

LSMEM Results

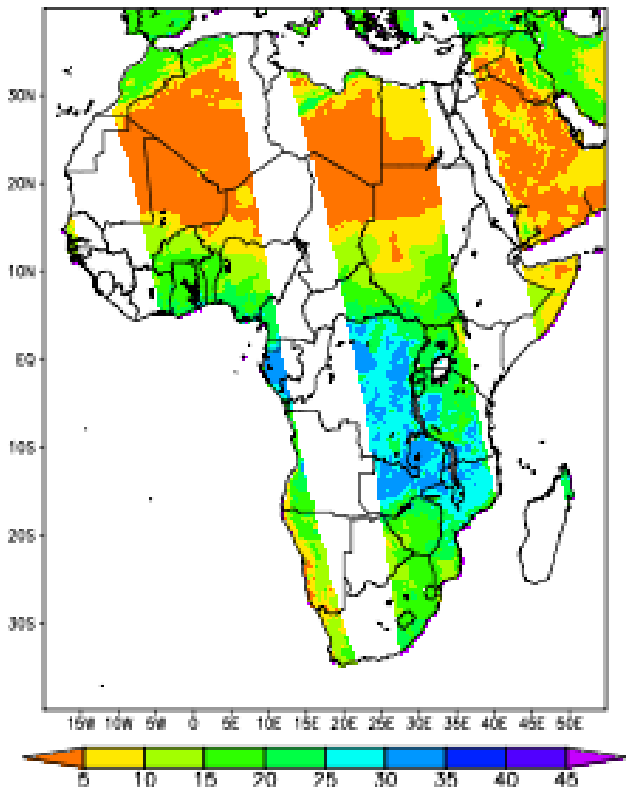
SM uncalibrated



SM calibrated

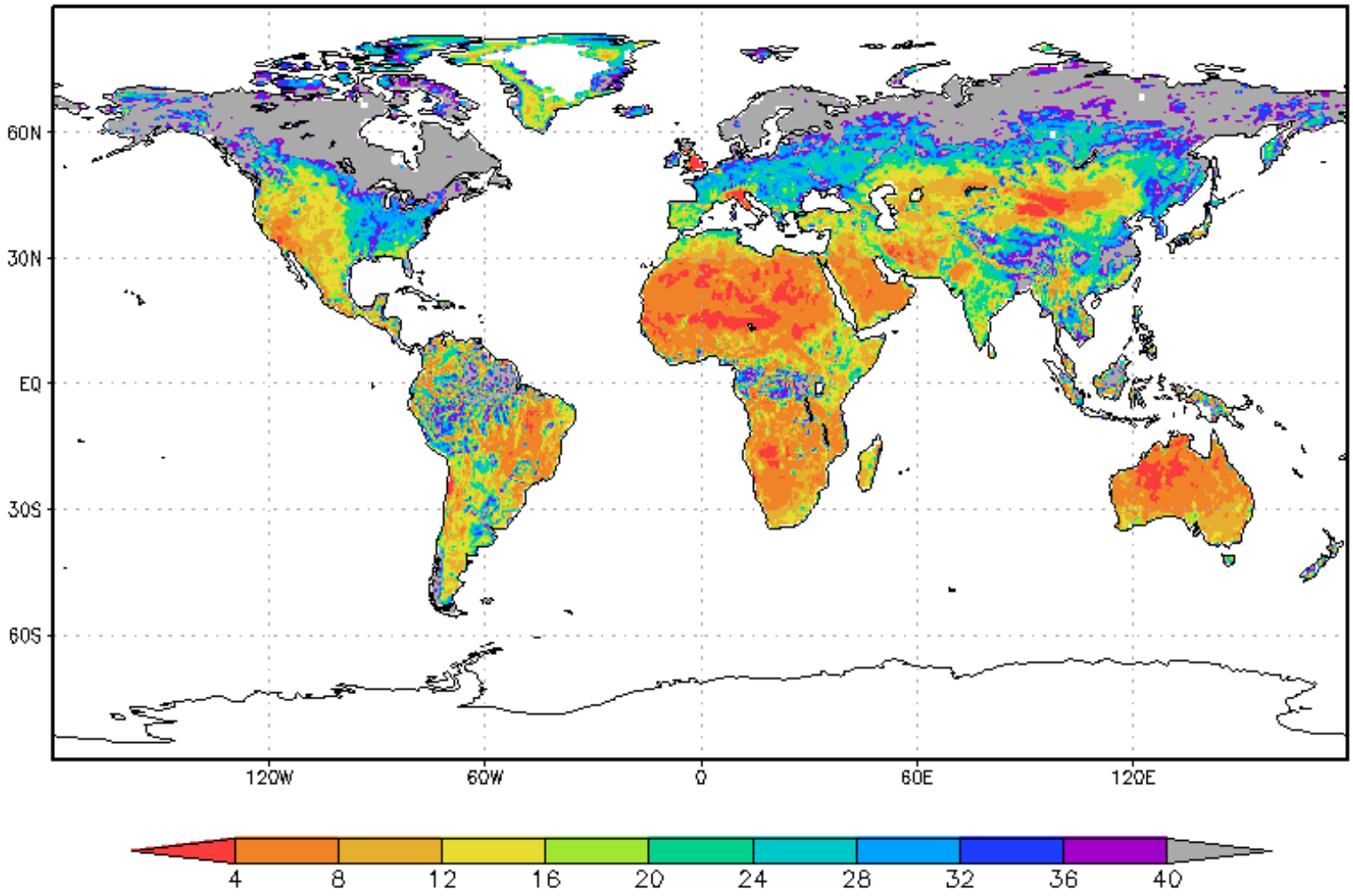


SM (VIC LSM)



LSMEM retrieved un-calibrated and calibrated soil moisture on April 3, 2003.

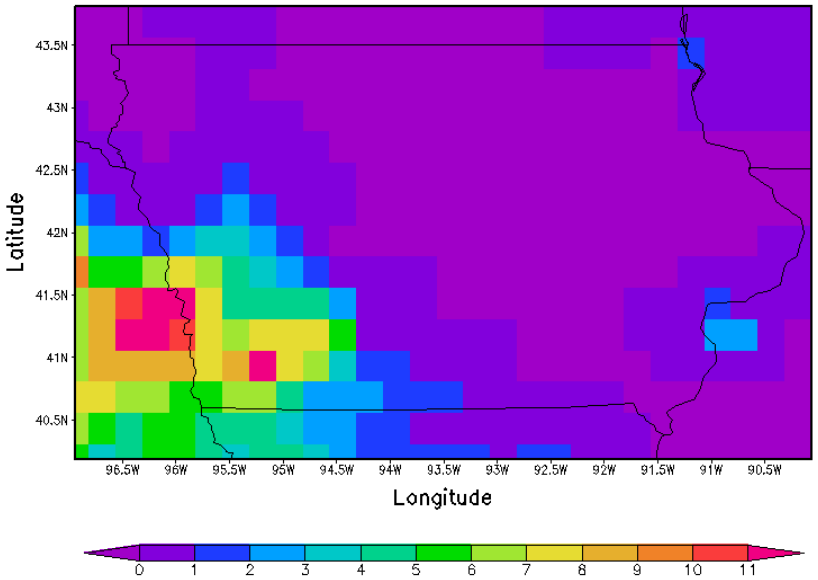
LSMEM Calibrated Results



Average Global Volumetric Soil Moisture (% vol/vol) calculated from AMSR-E measurements for the period June 2002 to December 2009.

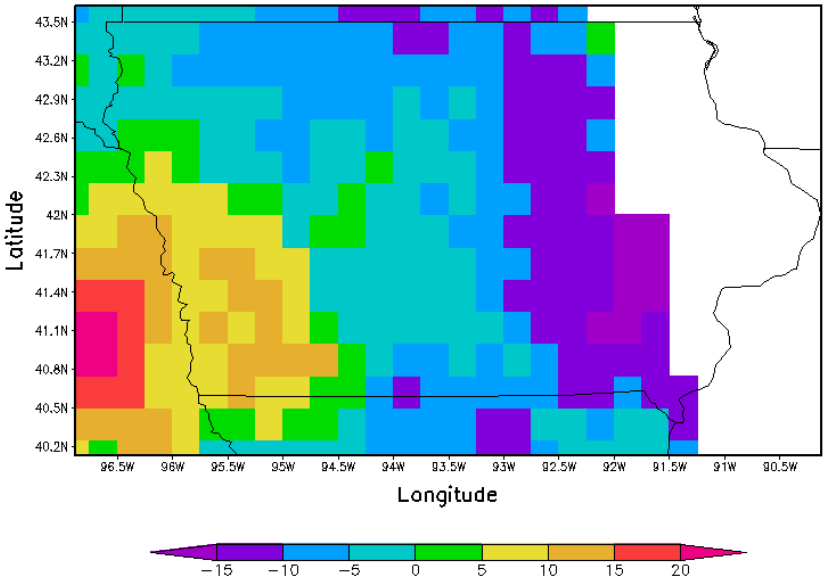
LSMEM SM – Precipitation Coherence Maps

Precipitation



April 7, 2003

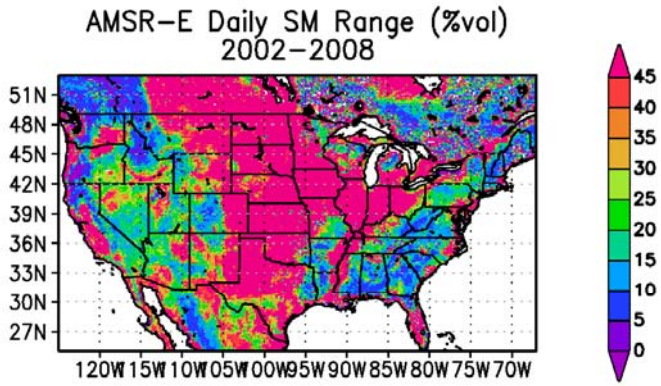
Soil Moisture

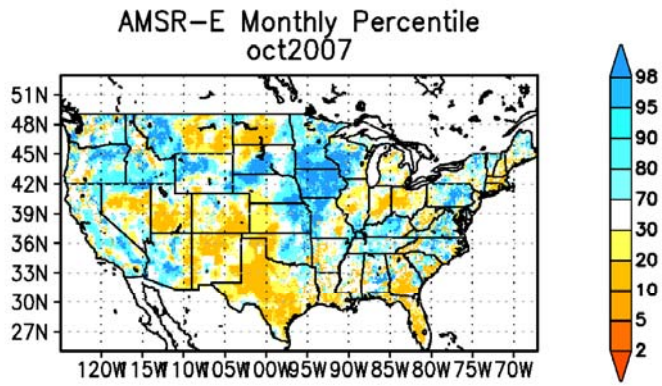


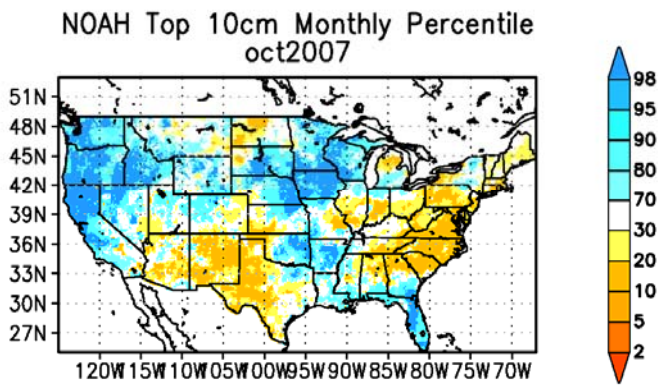
April 7 - 6, 2003
difference

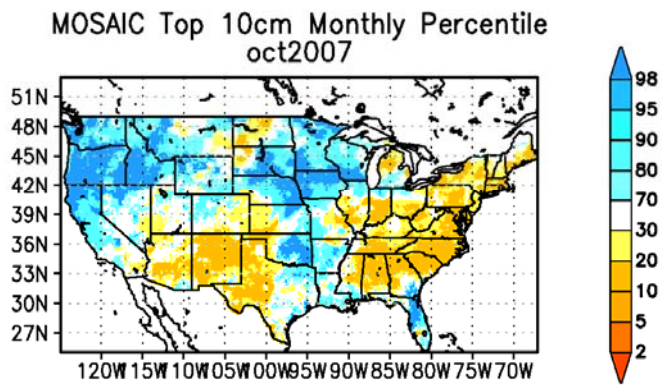
Merged rain gage – WSR-88D rain radar based daily accumulated precipitation (mm) and change in soil moisture based on LSMEM retrievals from AMSR-E 10.65 GHz brightness temperatures.

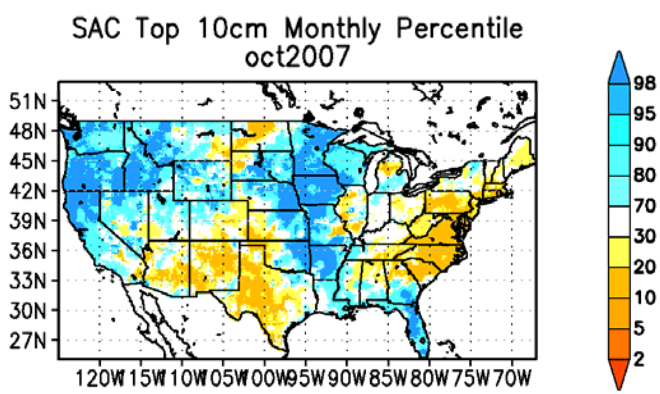
LSMEM SM Drought monitoring (with LSM)

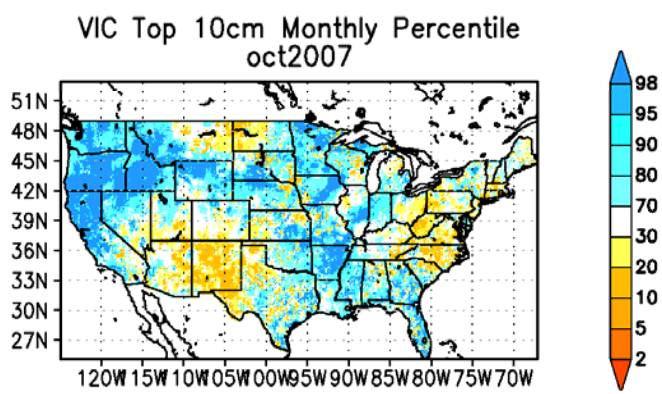




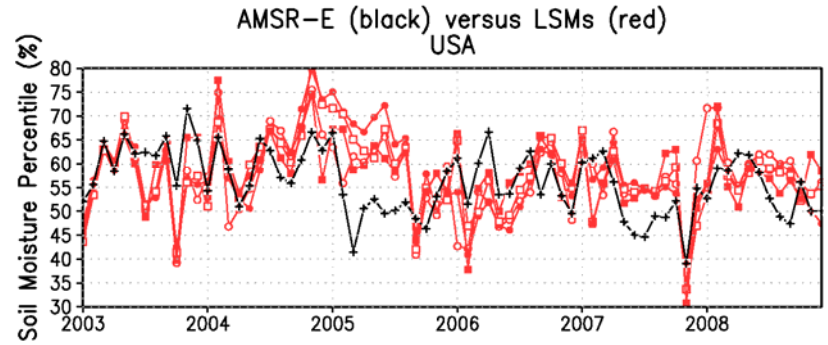


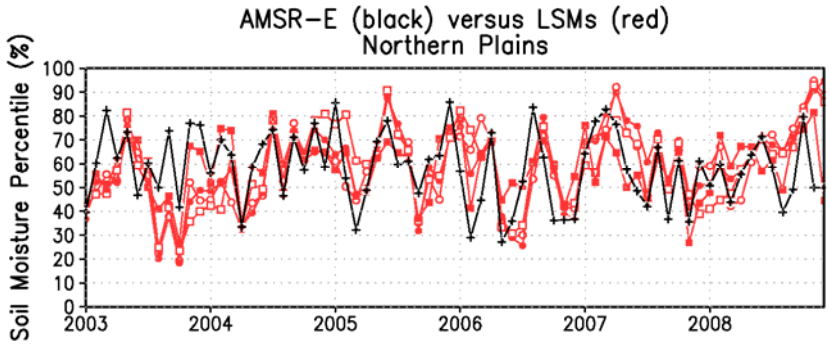


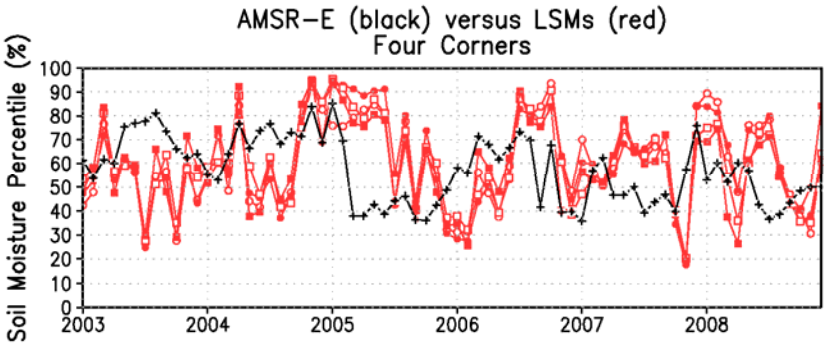


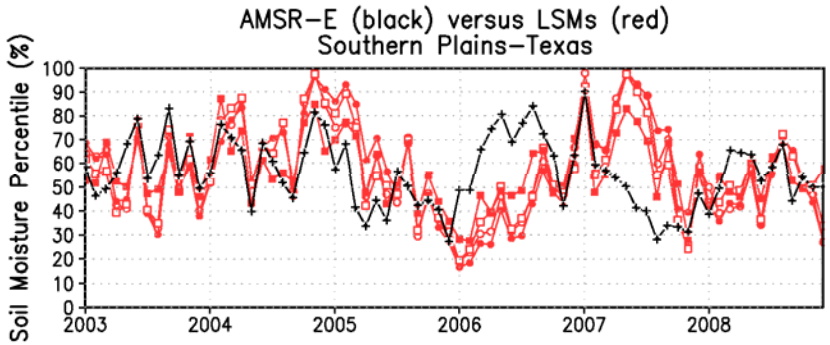


LSMEM SM Drought monitoring (versus LSM)

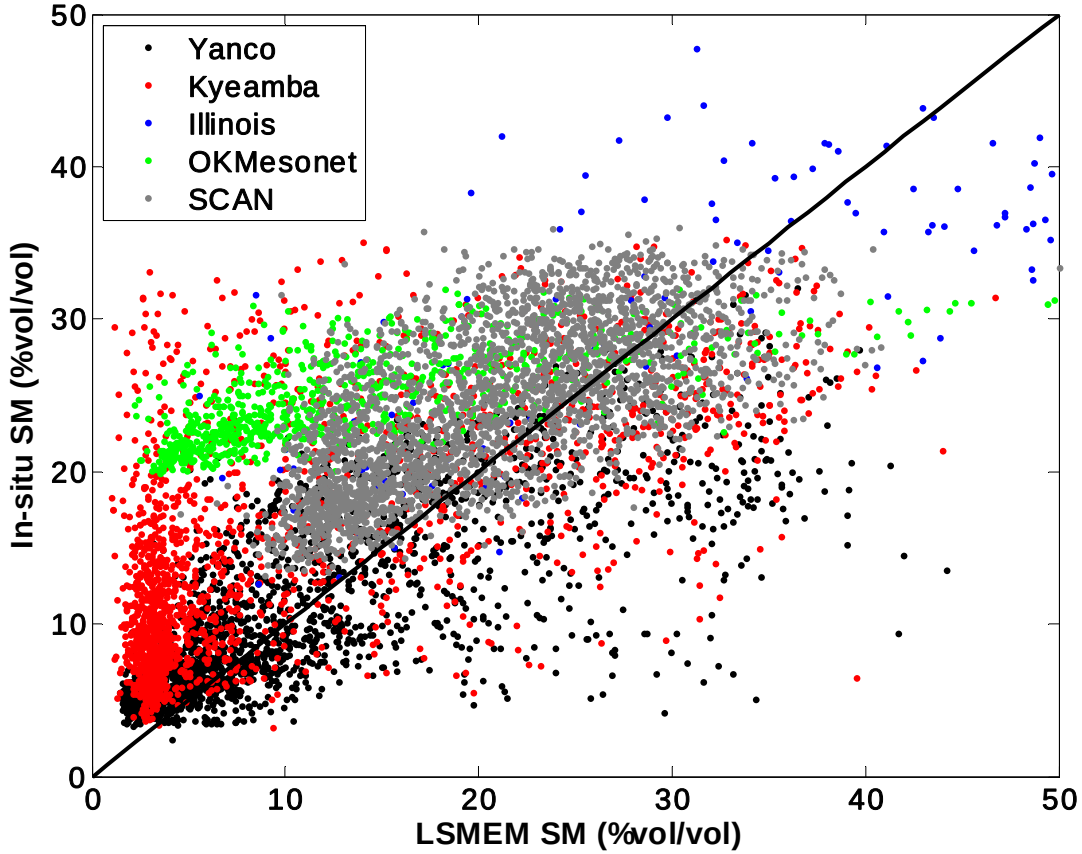








LSMEM Results using in-situ data

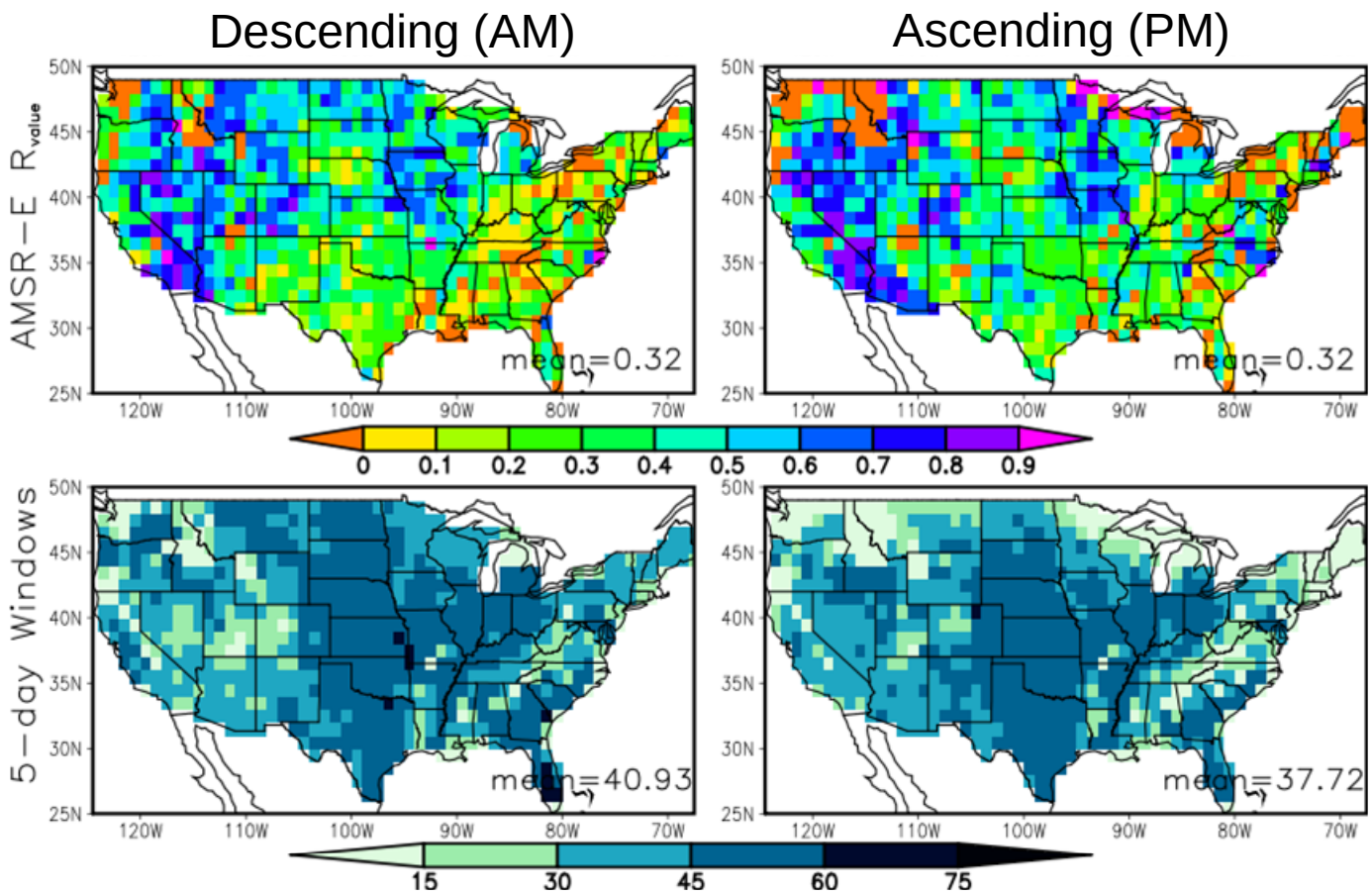


Scatter plot of daily volumetric soil moisture (% vol/vol) between LSMEM and various in-situ locations (N=11244).

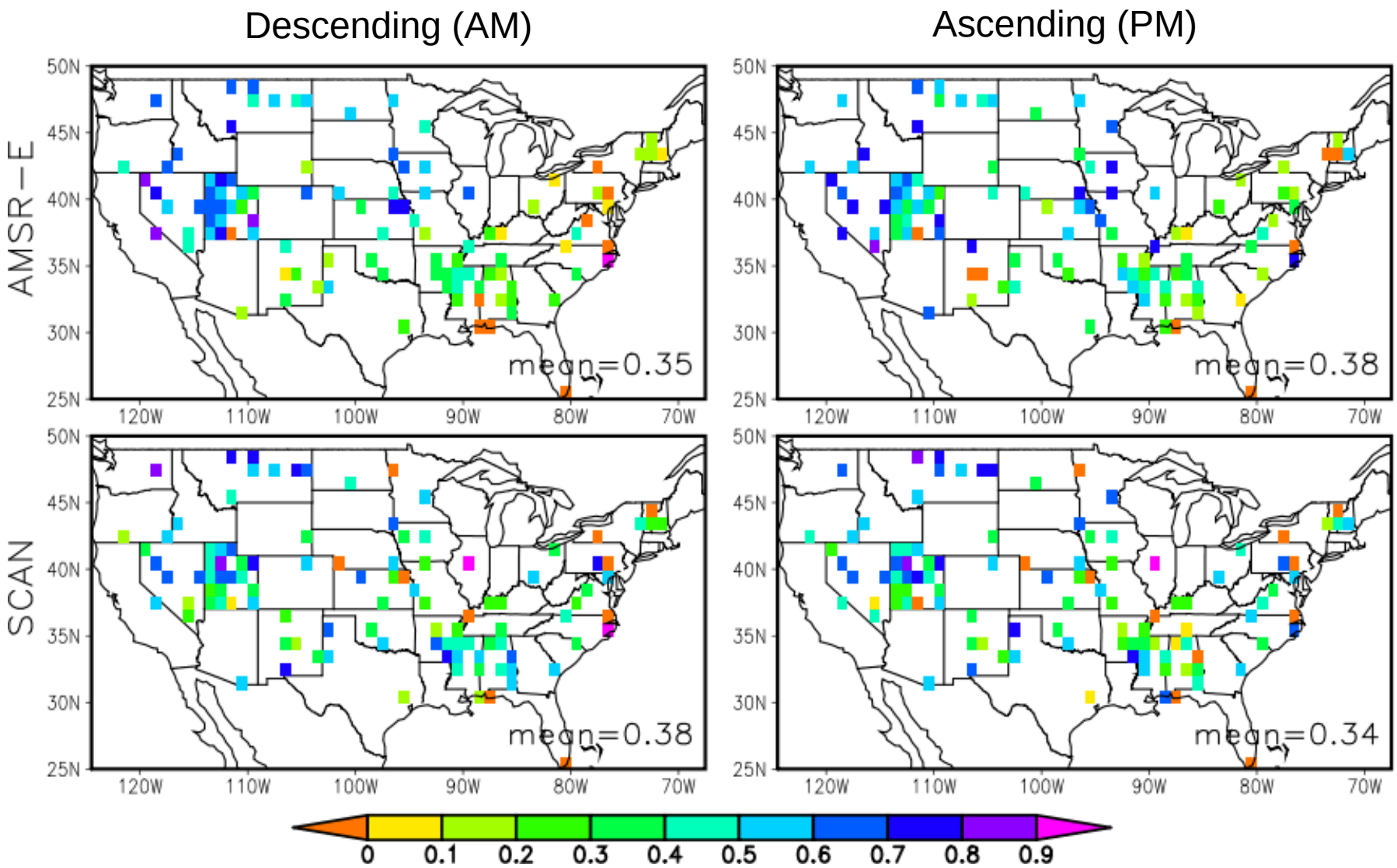
LSMEM Results at Continental Scales

Continental scale evaluation was carried out using the approach of Crow (2007)
(Crow, W. T., 2007: A novel method for quantifying value in spaceborne soil moisture retrievals, *J. Hydromet.*, **8**(1), 56–67.)

Basically, the "skill" of the soil moisture is assessed when its assimilated into a simple LSM forced with poor-quality precipitation data. Results below only using 2010 data.

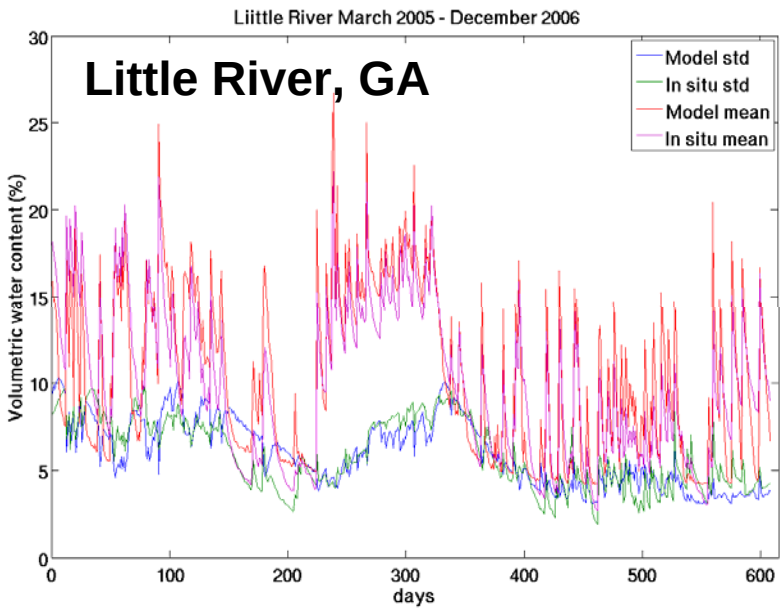


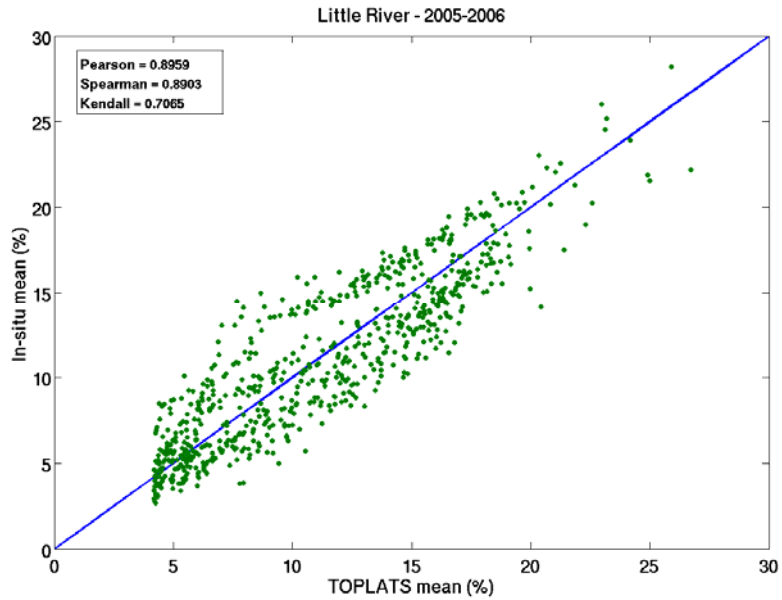
LSMEM Results at Continental Scales

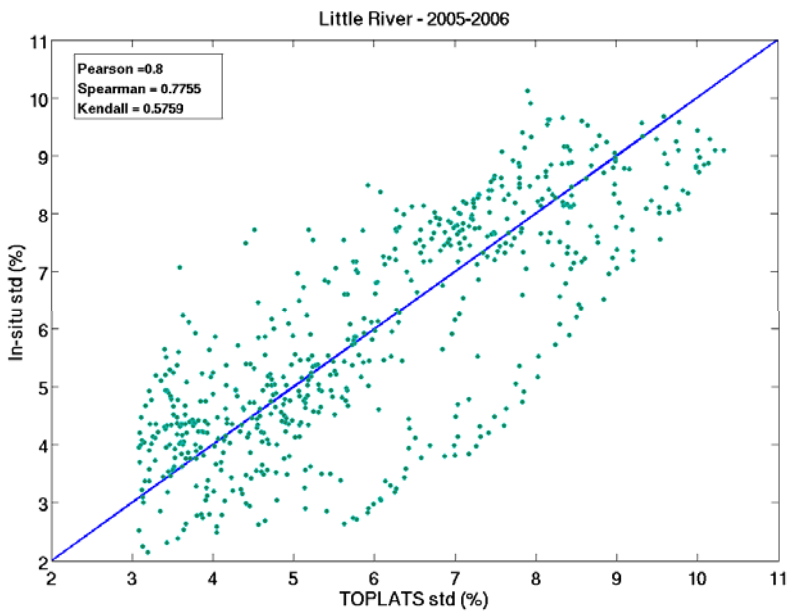


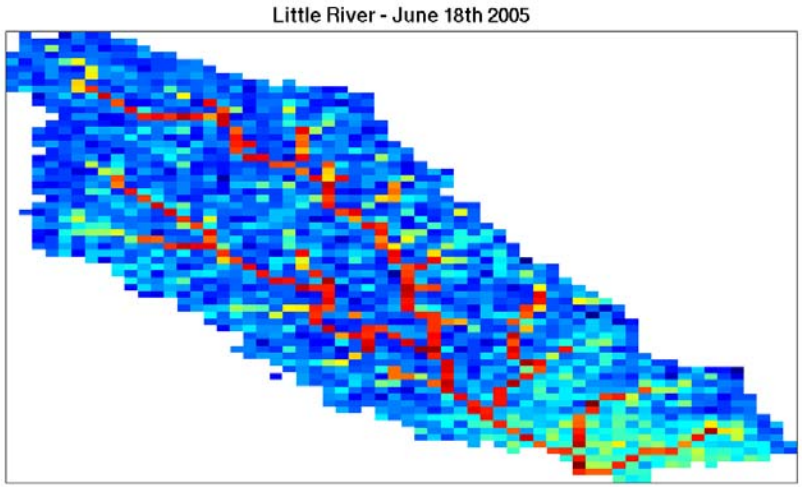
Note that the SCAN sites are essential equally skillful when applied at large scales

Can LSMs be Used to Assess SM at Continental Scales?



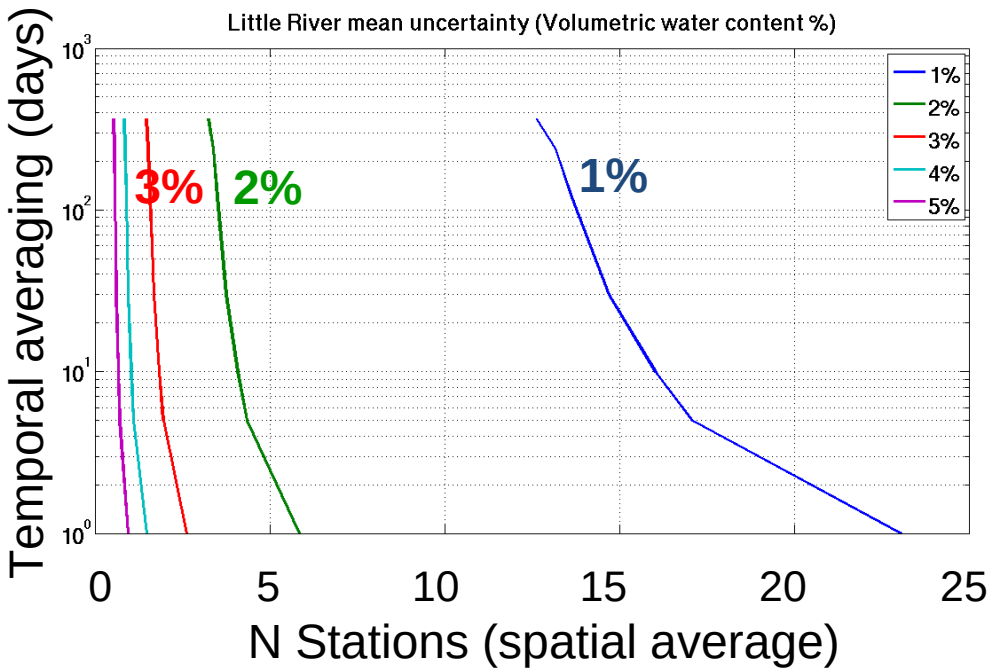


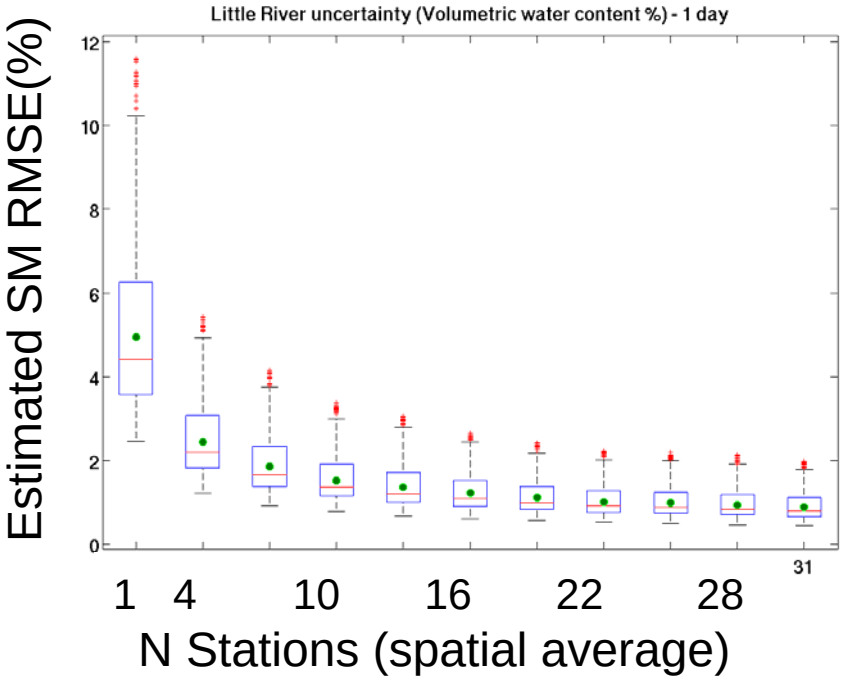




Space-time sampling tradeoff for SM validation

Little River, GA





Summary

1. Improved retrievals can be obtained when limited calibrations is carried out. The most sensitive parameter is roughness, which is problematic to estimate at AMSR-E scales. The calibrated parameters are well within literature values.

2. Continental-scale evaluation is a challenge due to limited in-situ data. Potential approaches include using LSM with topographic parameterizations to scale in-situ data to larger scales.