Calibration to improve forward model simulation at GPM frequencies over the U.S. Southern Great Plains

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Background

Improved characterization of land surface microwave emissivity promises to improve over-land precipitation retrievals. Physically-based, or "forward", models yield dynamic estimates that reflect current land surface conditions. Unfortunately, evaluations of forward models find predictive power lacking (Ringerud et al., 2014). A major source of error in these models is poor parameter specification, which calibration can address.

MWE = "Microwave emissivity"
LSM = "Land surface model"
MEM = "Microwave emissivity model"

1. Forward modeling & parameter uncertainty

- radiative (albedo, ...)
- vegetative (LAI, ...)
- thermal (quartz, ...)
- soils (porosity, ...)
- ...

Many of these properties are poorly specified

-surface roughness
- leaf thickness
- water content per LAI
- ...

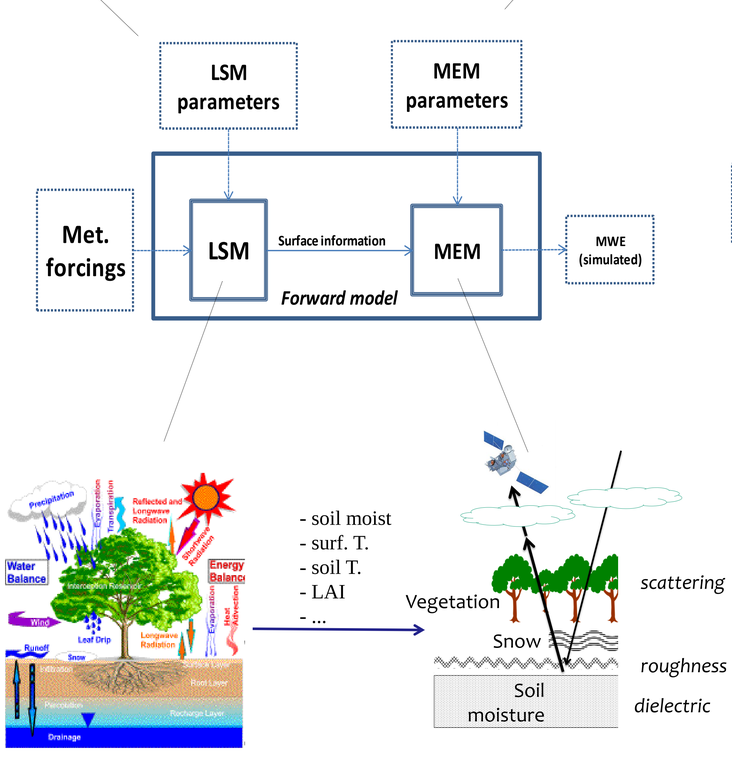

Figure 1. A forward model couples an LSM to an MEM. The LSM, driven by meteorological forcings and enforcing water and energy balance, generates the land surface states required of the MEM. The LSM parameters affecting soil moisture are specified on a very limited empirical basis (Harrison et al., 2012) as are other LSM parameters. Important MEM parameters are similarly poorly specified (Weng et al., 2001).

2. Calibration experiment

Spatial domain:	U.S. Southern Great Plains (SGP;34:39 lat, -100:-95 lon)
Forward models:	Noah 3.3-CRTM, Noah 3.3-CMEM
Reference dataset:	Cloud-cleared AMSR-E retrievals (Ringerud, 2014)
Calibration period	2008 warm season (1APR2008-30SEP2008)
Validation period:	7 years snow-free (1JUL2004-31JUL2011)
Run resolution:	0.25 deg., hourly LSM time step

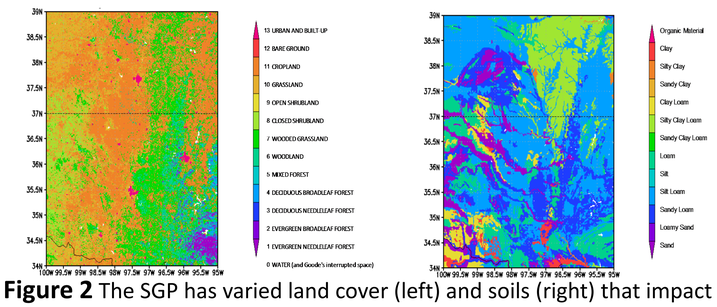

Figure 2 The SGP has varied land cover (left) and soils (right) that impact soil moisture and vegetation dynamics, and in turn, the dynamics of emissivity

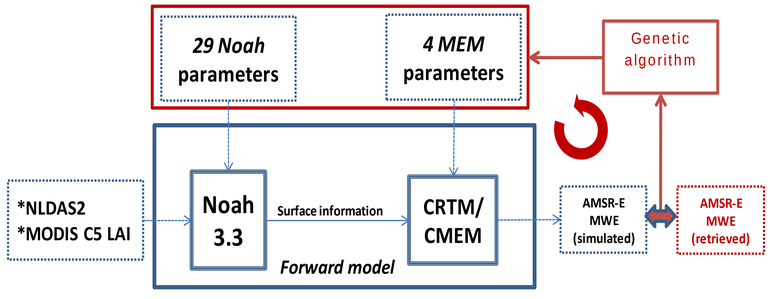

Figure 3 LIS configuration for calibration experiment.

2. Calibration Results

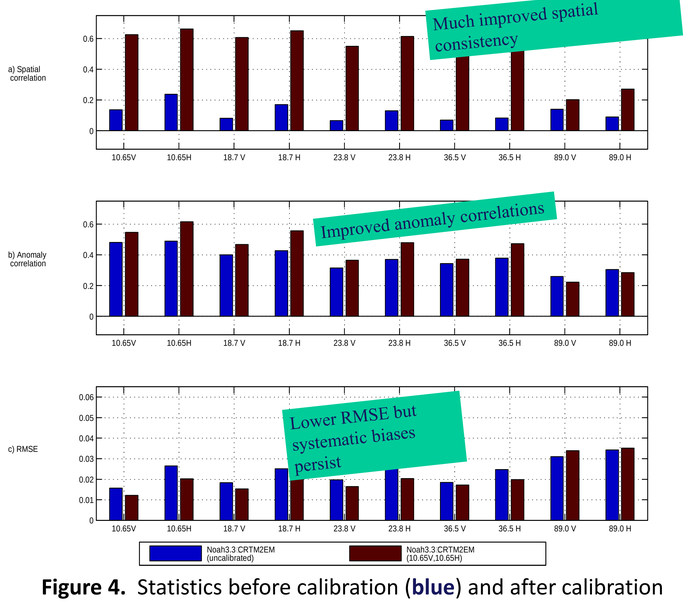

Figure 4. Statistics before calibration (**blue**) and after calibration (**maroon**). Results above are shown for Noah3.3-CRTM2 calibrated to (10.65V,10.65H).

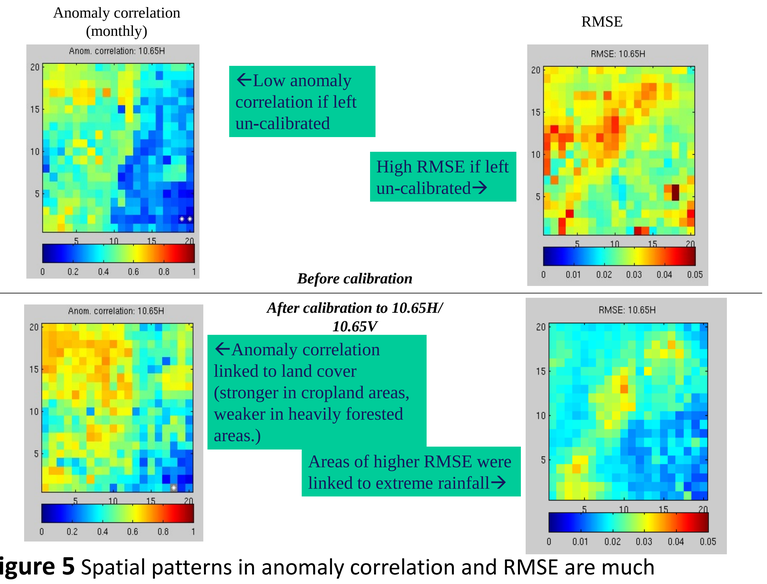

Figure 5 Spatial patterns in anomaly correlation and RMSE are much improved, as shown here for 10.65H GHz with Noah-CRTM

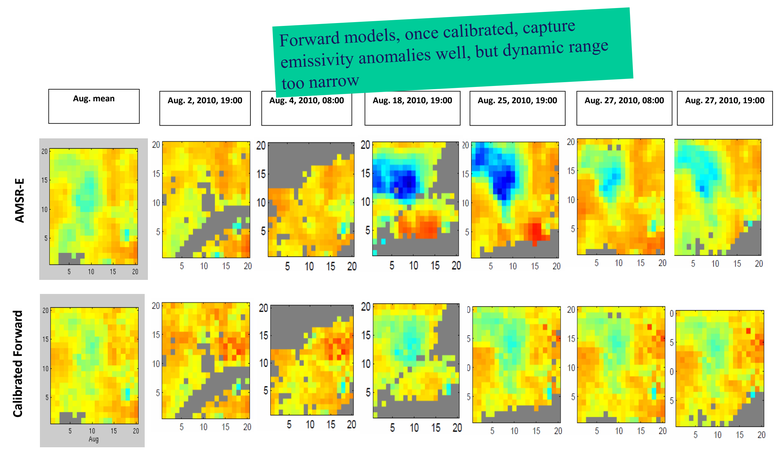

Figure 6 Instantaneous images of emissivity in August 2010 for 10H GHz

Conclusions

Calibration significantly improves the agreement of forward modeled and retrieved emissivity. Calibrated Noah3.3-CRTM yields ~0.02 RMSE (as averaged across channels) and yields spatially coherent fields. Calibrated Noah3.3-CMEM3 results (not shown) are very similar. Improvements were achieved with a short calibration period (1 warm season). Forward models can be improved with attention to LSM and MEM modeling deficiencies.

References

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