Calibration of forward models for the dynamic estimation of land microwave emissivity for GPM

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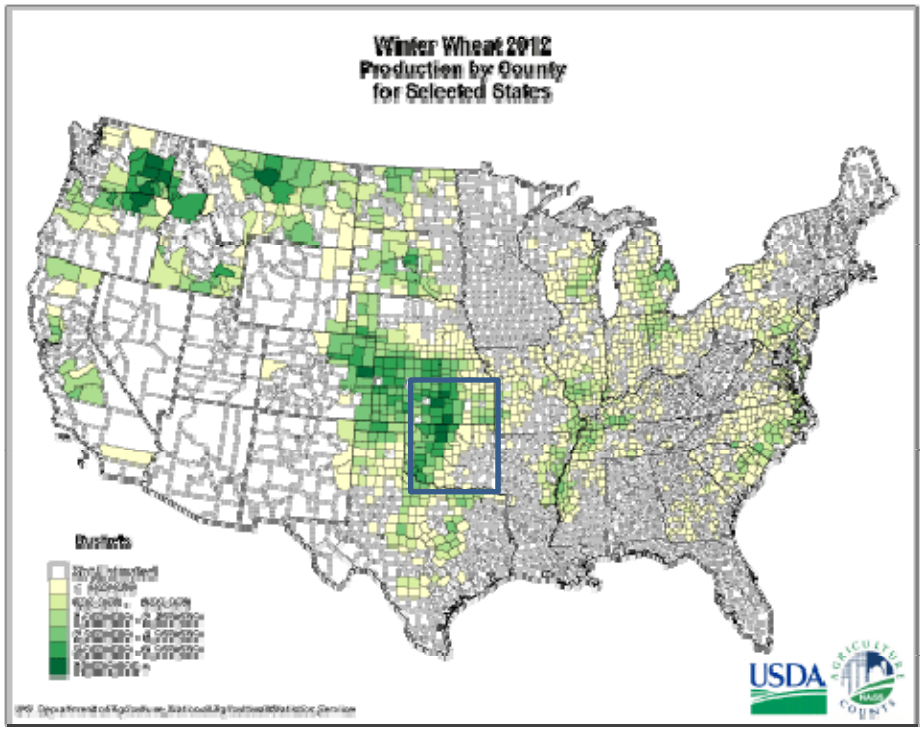
A forward model able to capture emissivity dynamics?

- Several S2 approaches being investigated by LSWG group (regression, empirical, physical, hybrid, …)
- Approach here:
  - Joint calibration of a land surface model (LSM) and microwave emissivity model (MEM) to high quality emissivity retrievals

Setup



- **Computational platform: NASA GSFC Land Information System (LIS)**
- **Running resolution:** 0.25 degree
- **Domain:** SGP (34,-100 to 39,-95)
- **LSM:** Noah 3.3
- **MEM:** CRTM2 (land emissivity module)
- **Input datasets:**
  - Forcings: NLDAS2
  - LAI: MODIS-RT (8-day product)
- **Calibration/Validation dataset:** Cloud-cleared AMSR-E retrievals (Ringerud, 2013)

Calibration period: 2008 warm season (Apr-Sep)
Validation period: Aug. 2004 - July 2011 (excluding calibration period)
Calibration specifics:

Method: Genetic Algorithm (GA) as embedded in LIS optimization subsystem (LIS-OPT)
Objective function: Minimize sum of squared differences between retrieved and simulated ("least squares")
Channel combinations calibrated to: 10.65V/10.65H

Results here shown for validation period only

Noah3.3-CRTM2EM parameters

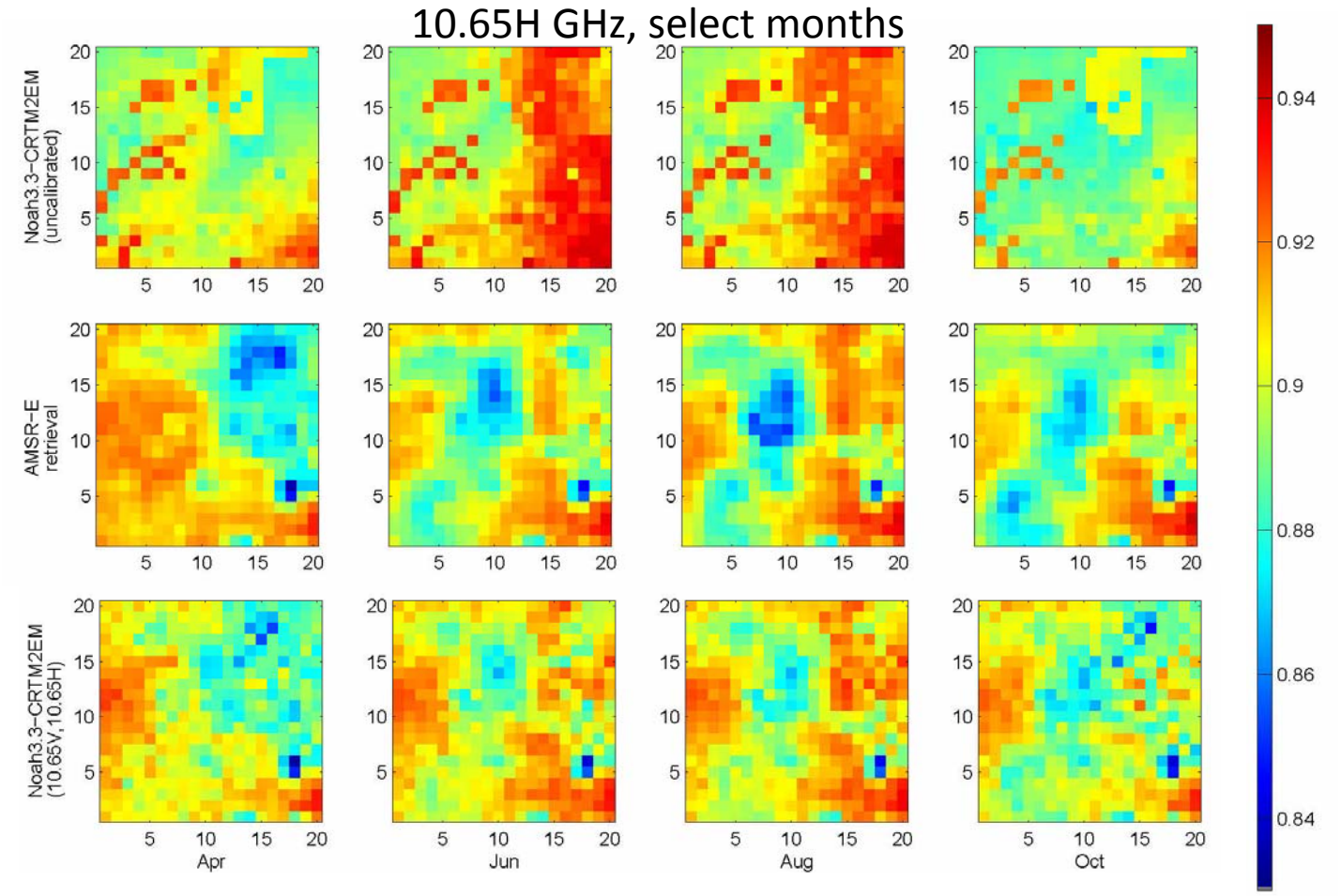
Noah 3.3 parameter	Low	High
SMCMAX	0.1	0.6
PSISAT	0.01	3.2
DKSAT	5.00E-07	3.00E-05
DWSAT	6.00E-07	2.40E-05
BEXP	2.75	12
QUARTZ	0.02	0.95
RSMIN	40	1000
RGL	30	150
HS	36	55
Z0	0.01	0.99
LAI	0.05	6.5
CFACTR	0.1	2
CMCMAX	1.00E-04	2.00E-03
SBETA	-4	-1
RSMAX	2000	10000
TOPT	293	303
REFDK	5.00E-07	3.00E-05
FXEXP	0.2	4
REFKDT	0.1	10
CZIL	0.05	0.8
CSOIL	1.26E+06	3.50E+06
FRZK	0.1	0.25
SNUP	0.01	0.1
SMCREF	0	0.5
SMCDRY	0	0.15
SMCWLT	0	0.15
F1	-11	0.17
SLOPE	0	1
EMISS	0.8	1

CRTM parameter	Low	High
SIGMA	0.2	20
LEAF_THICK	0.035	0.28
WATER_CONTENT_PER_LAI	0.05	0.3
SSALB_FACTOR	0.85	1.1
BGF_FIXED	0	0.4
K_LAI2VGF	0.2	2

→*Both LSM and MEM parameters are poorly specified*

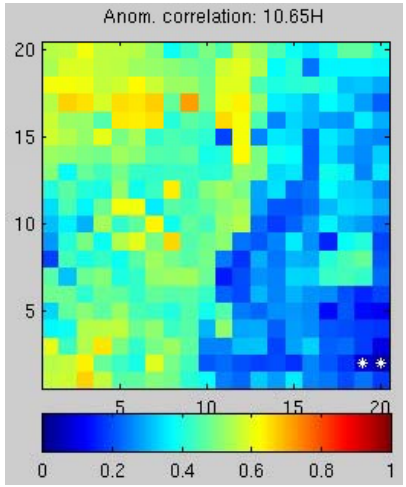
→*The values are iteratively adjusted in direction of improved match to retrievals (using LIS-OPT subsystem)*

Calibration leads to improved spatial correlation

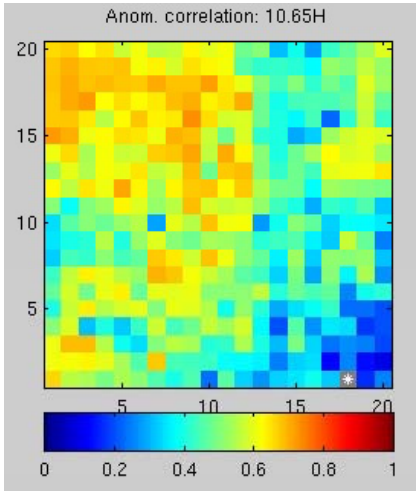


Anomalies better captured / Error reduced

Un-calibrated

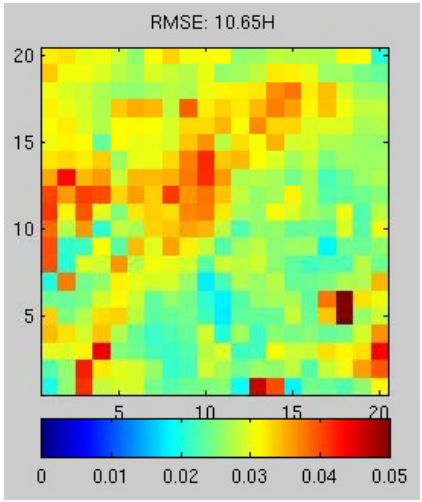


Calibrated

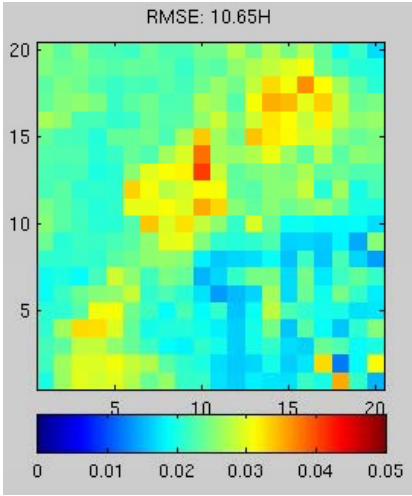


- Warmer colors indicate improvement

Un-calibrated

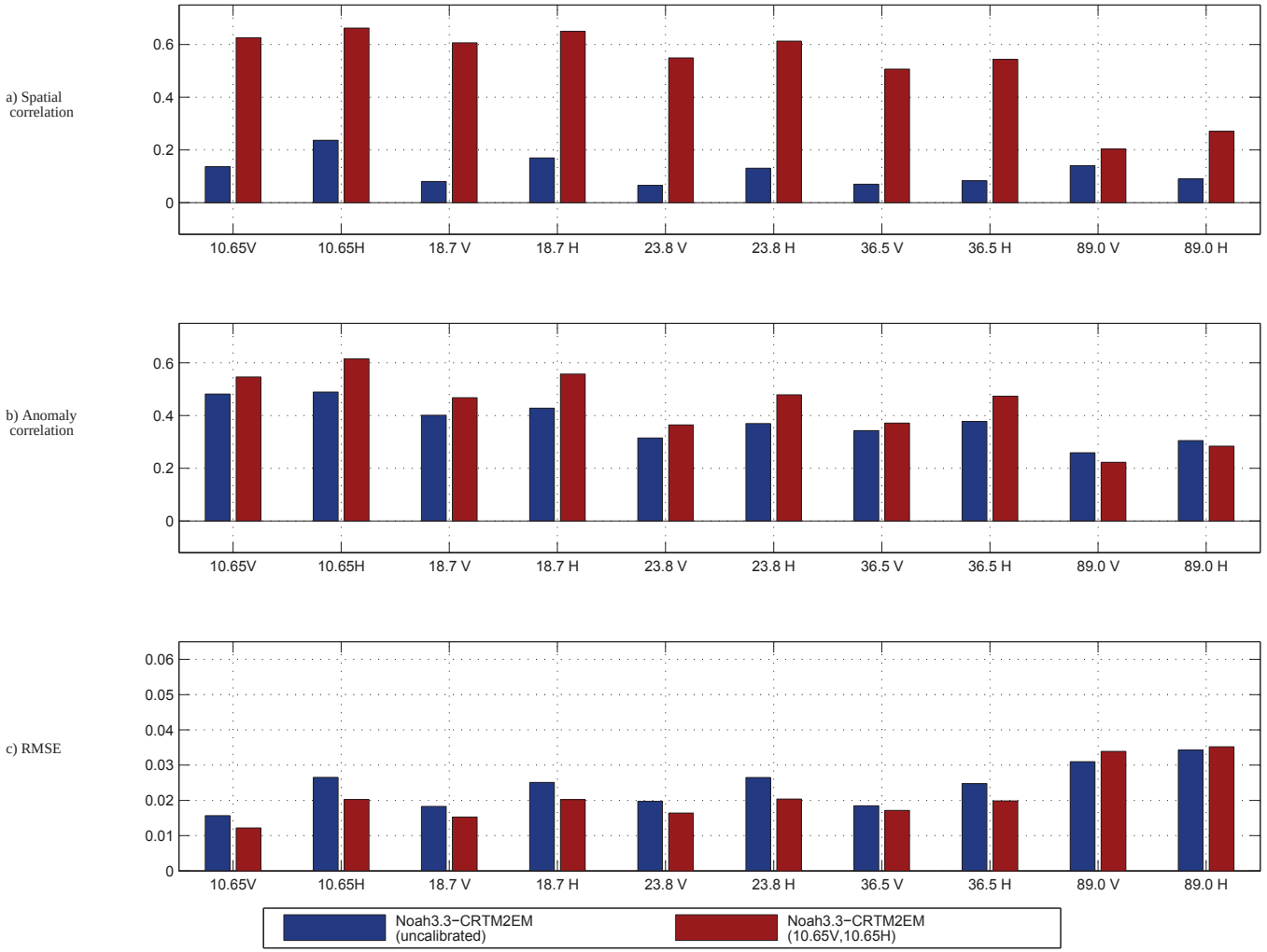


Calibrated



- Colder colors better
- Areas of greater variability in emissivity, have greater error (crops)

Improvements hold across channels



- Spatial correlations greatly improved
- Anomaly correlations (monthly) improved (89 exception)
- Avg. RMSE reduced to 0.021

Conclusions

- Calibrated Noah3.3-CRTM2EM yields ~0.02 RMSE and spatially coherent fields
- Achieved with relatively short calibration period (1 warm season)
- Improvements to models/opt setup can likely achieve further gains—this is a first cut analysis