

Potential Role of Land Surface Modeling in Satellite Soil Moisture Validation

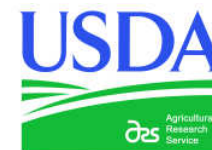
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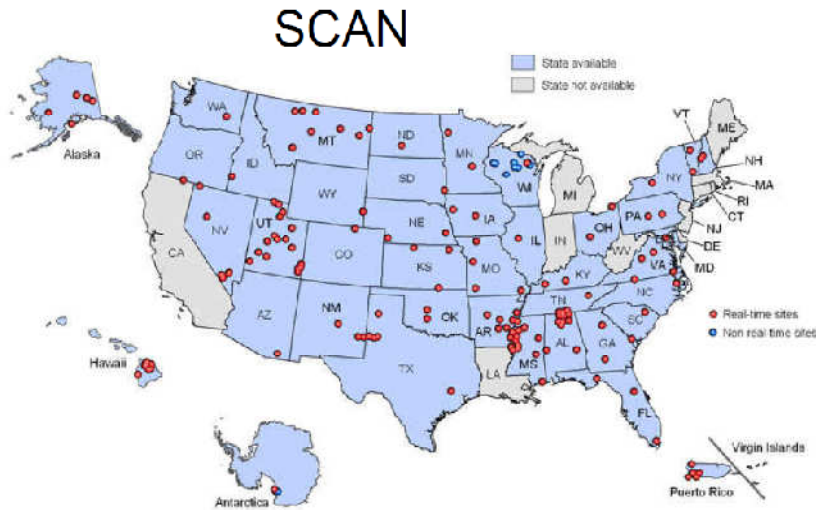
**Thanks: Michael Cosh, Thomas Jackson
and Diego Mirrales**



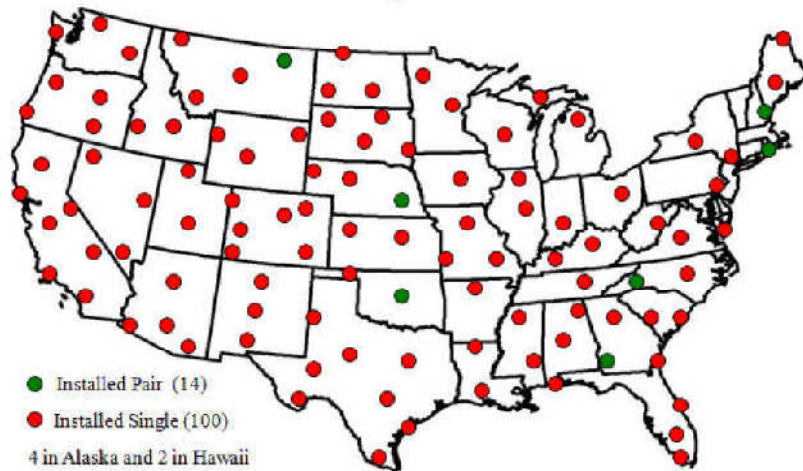
SMAP Cal/Val Workshop, June 2009, Oxnard, CA



Modeling contribution to point/footprint up-scaling problem



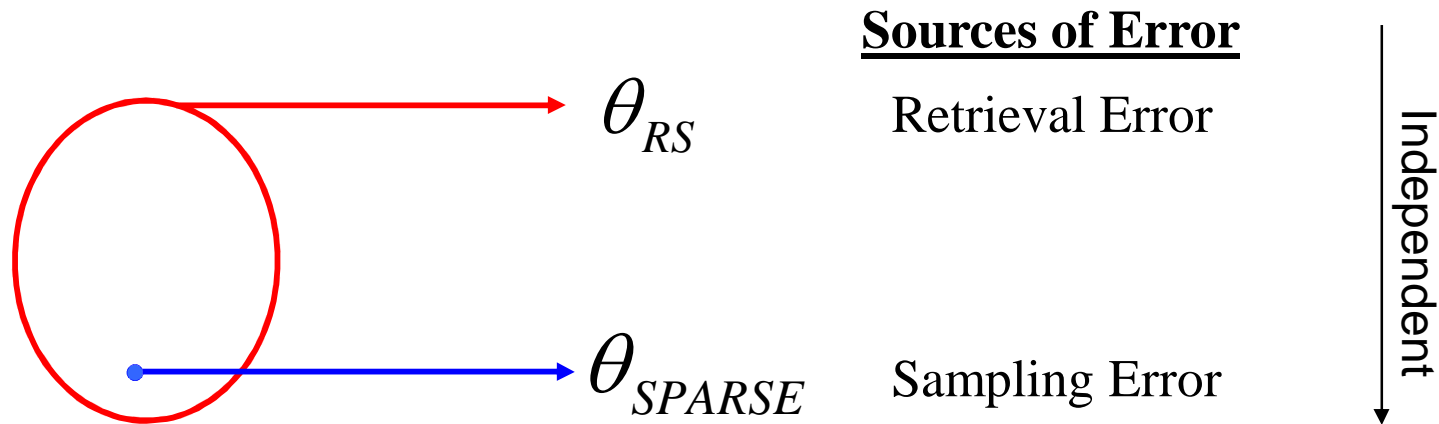
USCRN September 2008



To overcome (reasonable) skepticism, model-based approaches must be:

- 1) Robust to the inevitable presence of model error.
Cannot assume modeling errors are \ll RS errors.
- 2) Verified using available high-density ground networks.

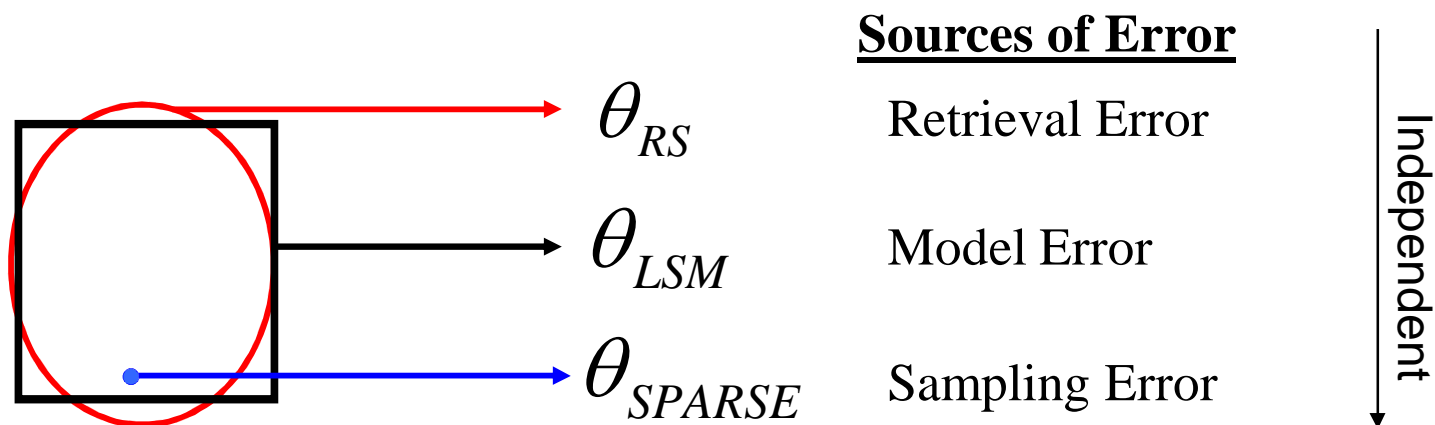
“Traditional” Ground-Based Validation:



“Traditional” Validation:

$$\underbrace{MSE(\theta_{RS}, \theta_{SPARSE})}_{\text{Available}} = \underbrace{MSE(\theta_{RS}, \theta_{TRUE})}_{\text{Validation Goal}} + \underbrace{MSE(\theta_{SPARSE}, \theta_{TRUE})}_{\text{Sampling Error}}$$

Application of Triple Co-Location:

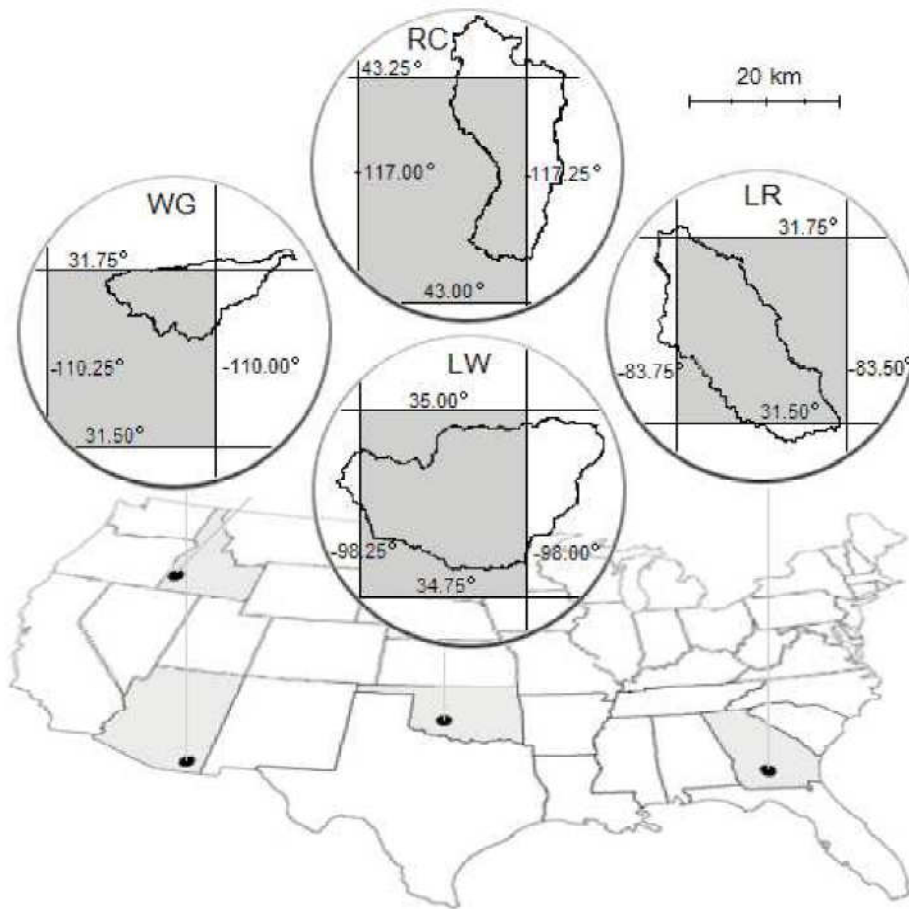


“Triple Co-Location” Validation (Scipal et al., 2009):

$$\overline{(\theta_{SPARSE} - \theta_{RS})(\theta_{SPARSE} - \theta_{LSM})} = MSE(\theta_{SPARSE}, \theta_{TRUE})$$

$$\underbrace{MSE(\theta_{RS}, \theta_{SPARSE})}_{\text{Available}} = \underbrace{MSE(\theta_{RS}, \theta_{TRUE})}_{\text{Validation Goal}} + \underbrace{MSE(\theta_{SPARSE}, \theta_{TRUE})}_{\text{Sampling Error}}$$

Methodology



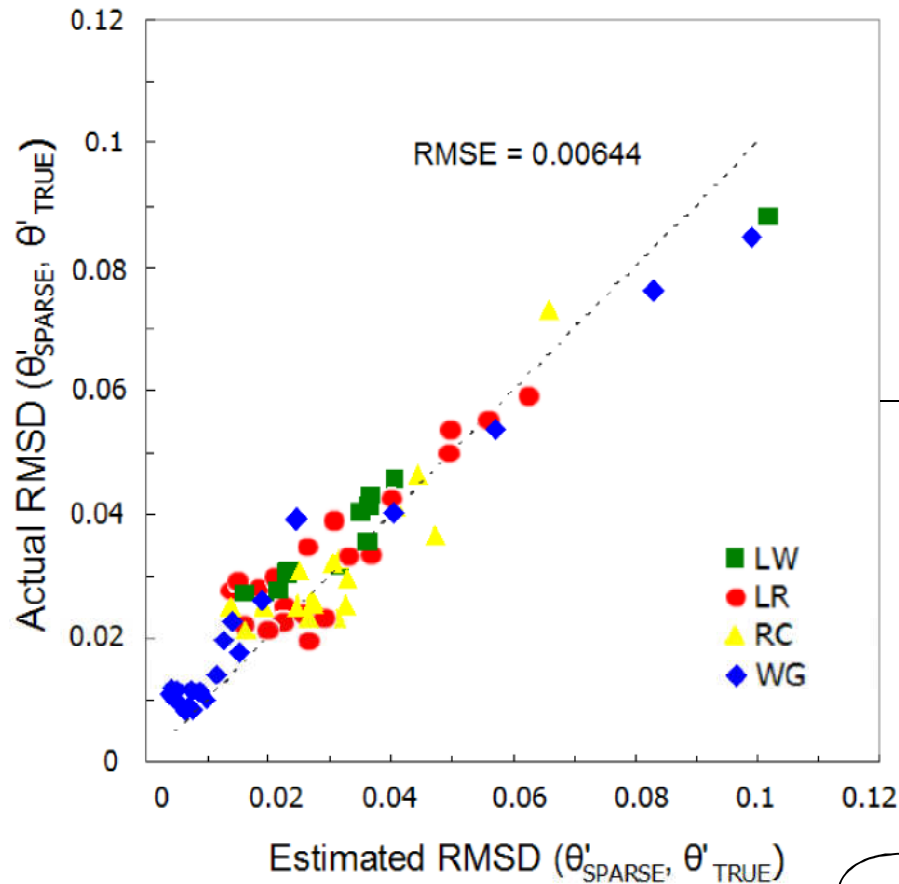
Daily time series from July 2002 to December 2007

- 1) NOAA Land Surface Model with NLDAS forcing.
- 2) Jackson SCA AMSR-E soil moisture product.
- 3) Jackson/Cosh high-density soil moisture datasets from ARS watershed sites.
- 4) Seasonal cycles removed from all soil moisture products.

SPARSE = 1 station within each watershed.

TRUE = Comparison to average of all measurements within watershed.

Estimating Sampling Errors – NOAH Point Model



Have:

- 1 ground obs.
- NOAH model
- AMSRE retrieval

$$\underbrace{MSE(\theta_{RS}, \theta_{SPARSE})}_{\text{Available}} = \underbrace{MSE(\theta_{RS}, \theta_{TRUE})}_{\text{Goal}} + \underbrace{MSE(\theta_{SPARSE}, \theta_{TRUE})}_{\text{Sampling Error}}$$

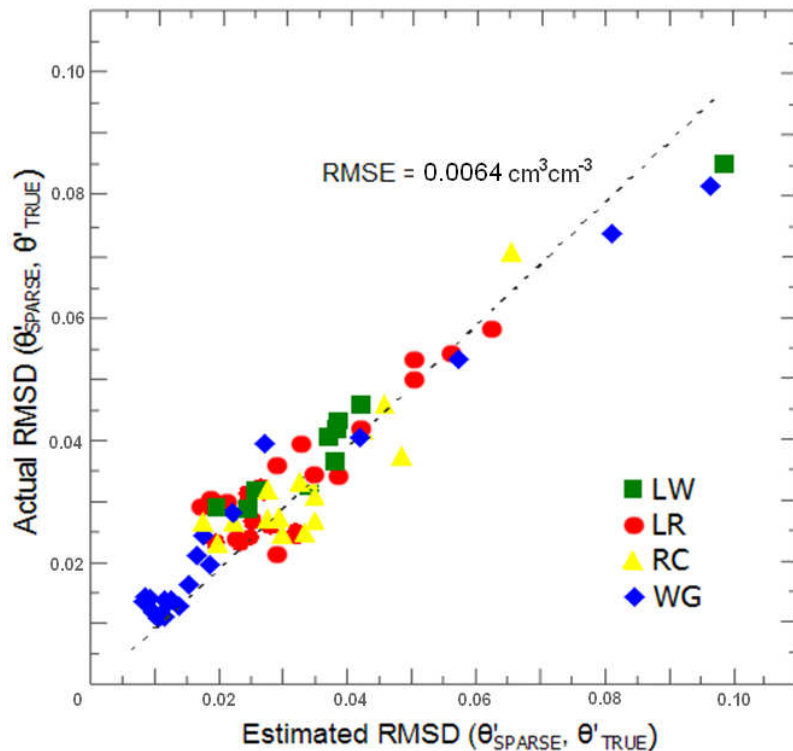
Available

Goal

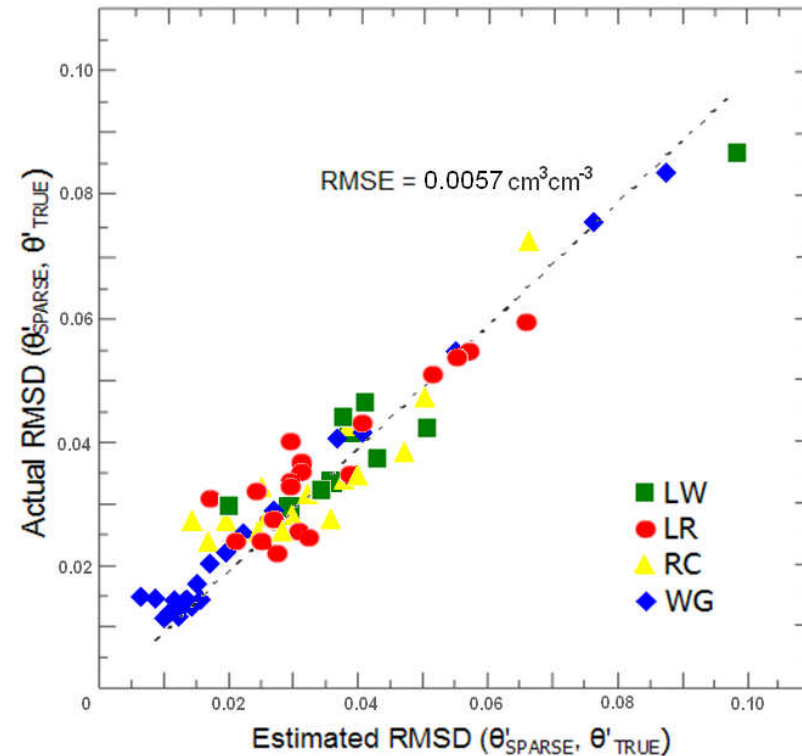
Sampling Error

Estimating Sampling Errors – 1-D API Point Model

“LSM” based on NOAH

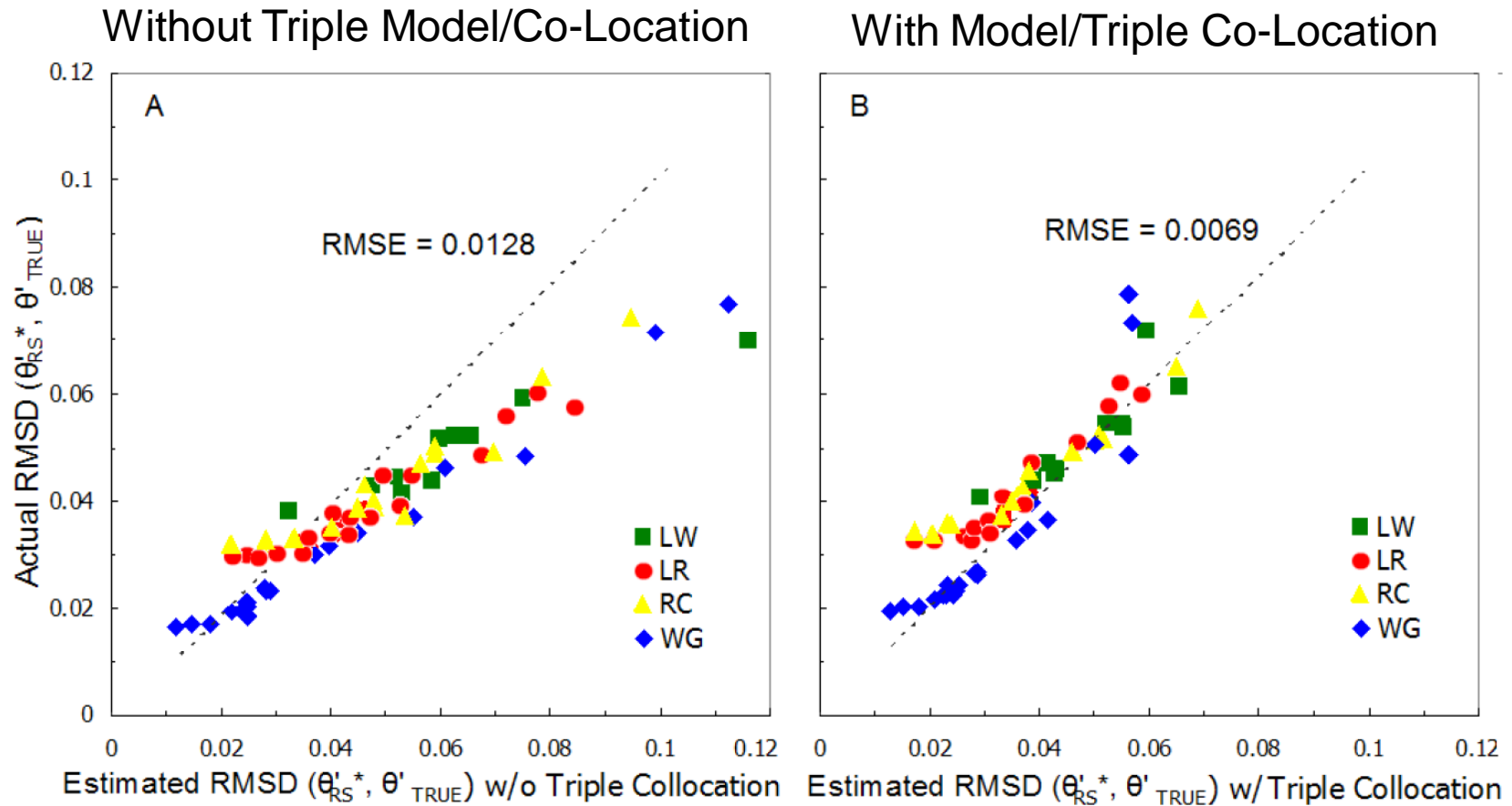


“LSM” based on API



Results rely on the independence – not accuracy – of LSM predictions. Comparable results can be obtained with complex (NOAH) and simple (API) models.

AMSR-E Validation with one station plus Triple Co-Location:



Summary

- 1) 1 obs/footprint can replicate dense network RMSE to within $0.007 \text{ cm}^3 \text{ cm}^{-3}$.
- 2) Approach is based on point-scale modeling....does not require distributing modeling.
- 3) Approach is robust (i.e. unbiased) with respect to the magnitude and/or auto-correlation structure of modeling error; however large or spectrally “red” errors will increase data length requirements.
- 4) Requires pre-processing removal of biases and works best when seasonal cycles are removed.
 - Will not help if sampling site is biased with respect to footprint.
 - Potential synergy with time stability approaches?
- 5) Especially valuable for Level 4 Soil Moisture?

Miralles, D.G., W.T. Crow and M.H. Cosh, “Using triple-collocation to up-scale soil moisture error statistics,” *Geophys. Res. Lett.*, in preparation, 2009.

Thank you...

