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Impact of Near-real-time Satellite Observations on Simulations of Noah LSM in NLDAS

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Outline

- **Background/Objectives**
- **Data Sets**
  - Current input data for Noah LSM
  - Near-real-time input data for Noah LSM
  - In situ data for validation
  - Input data differences
- **Methodology**
  - Noah LSM runs
  - Simulation results comparison
- **Results and Discussion**
  - Impacts on soil moisture simulations
  - Impacts on flux simulations
- **Summary**

Background/Objectives

Background

- Current inputs to Noah LSM in NLDAS are static maps of multi-year climatological averages
- Real time satellite data products are becoming increasingly available from various satellite sensors
- NRT observations are more representative of actual surface conditions, especially at shorter time scales

Objectives

- Analyzing the impact of NRT satellite observations of land surface parameters on soil moisture (SM) simulations from the Noah LSM
- Aiming at improving the reliability of NLDAS information fed into the operational U.S. drought monitoring data products

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Data Sets

Conventional and NRT Data Sets for Noah LSM

	Temporal Resolution	Spatial Resolution	Data Source
GVF^C	Static 5-year avg	0.144 deg	AVHRR
GVF^R	8-day composite	1 km	MODIS
$Albedo^C$	Static 5-year avg	0.144 deg	AVHRR
$Albedo^R$	8-day composite	1 km	MODIS
$Insolation^C$	Hourly	0.125 deg	NLDAS-2 NARR
$Insolation^R$	Hourly	0.125 deg	GSIP
	C: current	R: near-real-time	

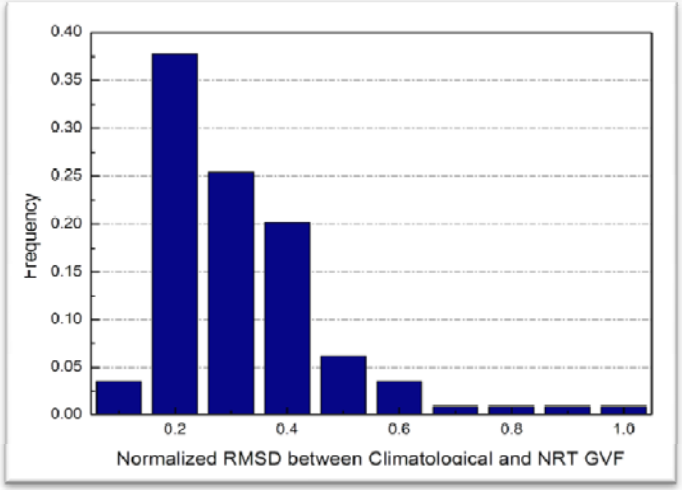
Data Sets

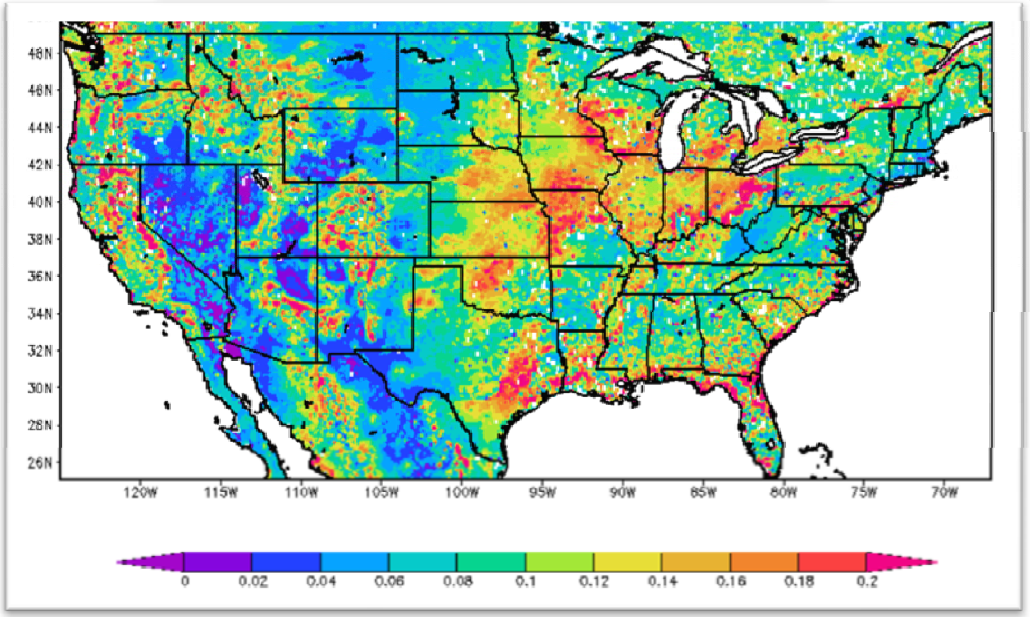
- **In situ data for flux validation**
  - U.S. Climate Reference Network (USCRN)
- **In situ data for soil moisture validation**
  - Soil Climate Analysis Network (SCAN)

Input Data Differences

GVF

- Frequency of normalized RMSD between conventional and NRT GVF over SCAN sites
  - ✓ Over 35 percent of SCAN sites show 20% difference
- RMSD between current and NRT GVF over 2000 – 2012 period
  - ✓ The RMSD can be as large as 0.2 in northern Missouri and central Ohio

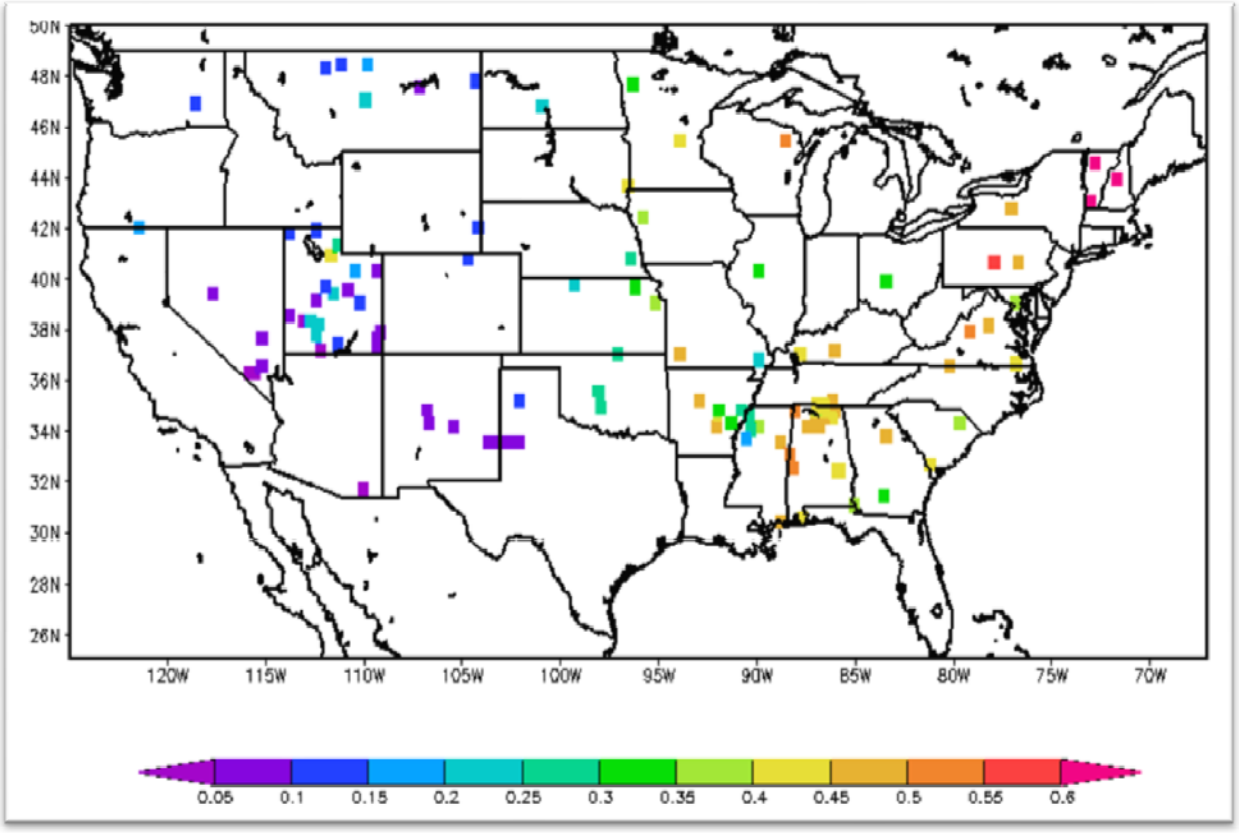




Input Data Differences

Albedo

- CONUS mean AMD of is 0.28
- Bigger differences can be found over the eastern U.S., which gradually decreased from eastern to western part of CONUS

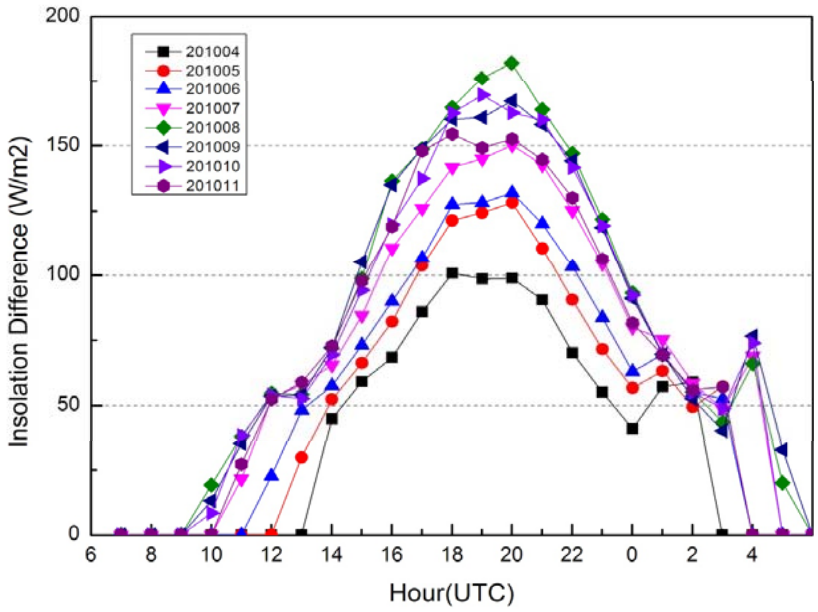


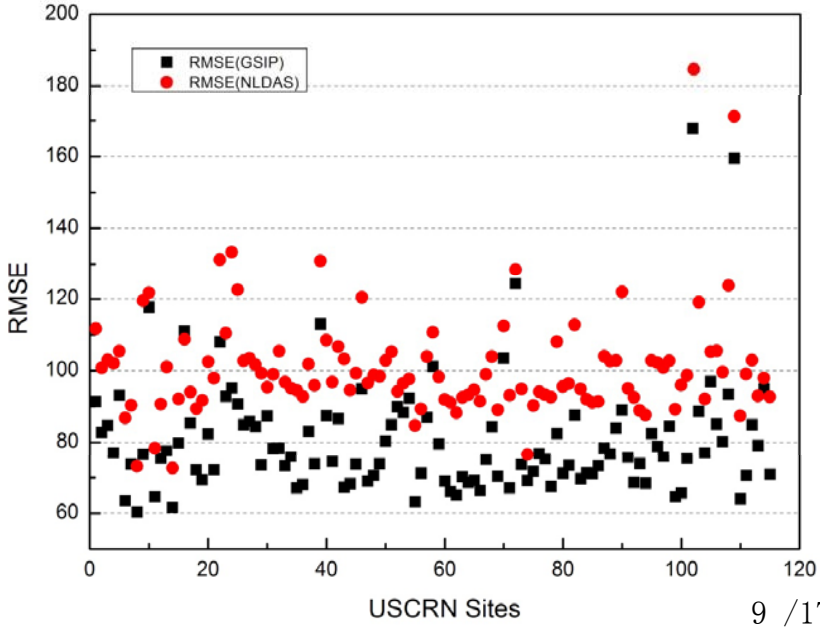
Absolute mean difference between conventional and NRT albedo over SCAN sites for the period of 2000 – 2012

Input Data Differences

Insolation

- Hourly insolation RMSD over warm season
- GSIP and NLDAS insolation data sets are further validated against 115 USCRN in-situ solar insolation
- GSIP insolation are closer to ground observed insolation compared to NLDAS (NARR) insolation





Methodology

Noah LSM and LIS implementation

NASA Land Information System

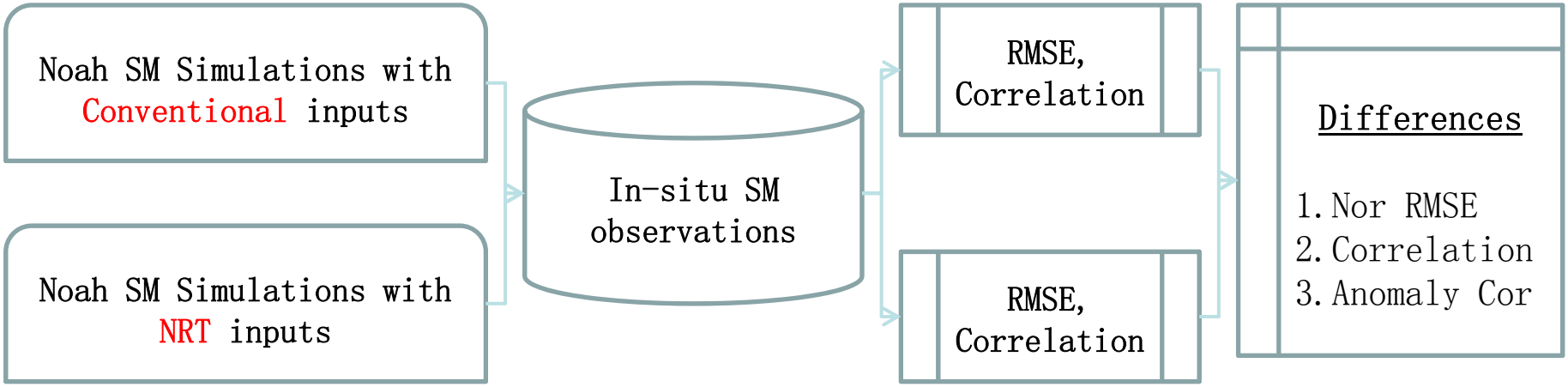
- ✓ Version 6.1; LIS

Noah LSM (version 3.2)

- ✓ Four-layer soil moisture (0-0.1m, 0.1-0.4m, 0.4-1m and 1m-2m)
- ✓ NLDAS-2 Forcing
- ✓ CONUS domain at 0.125 degree spatial
- ✓ Growing season (April to Oct., 2000 - 2012)

Methodology

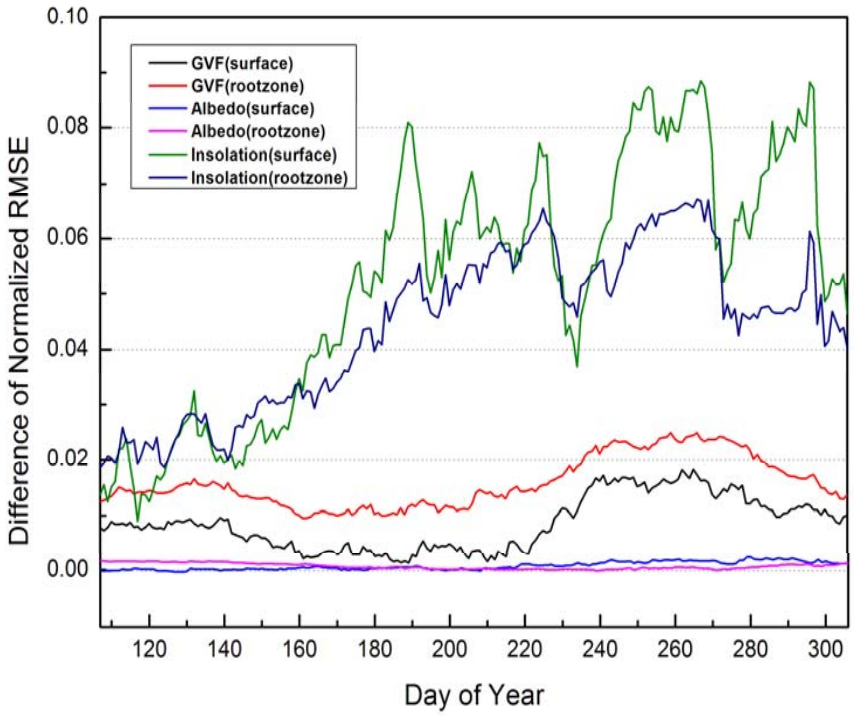
Comparison of Noah LSM simulations

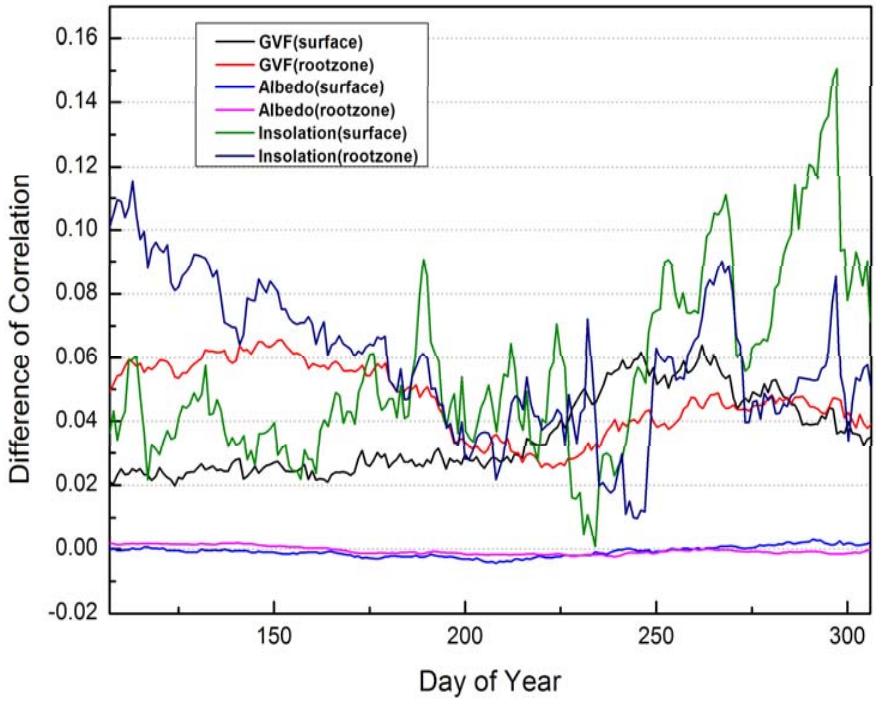


Positive (negative) values represent added (degraded) skill by assimilating NRT observations

Results

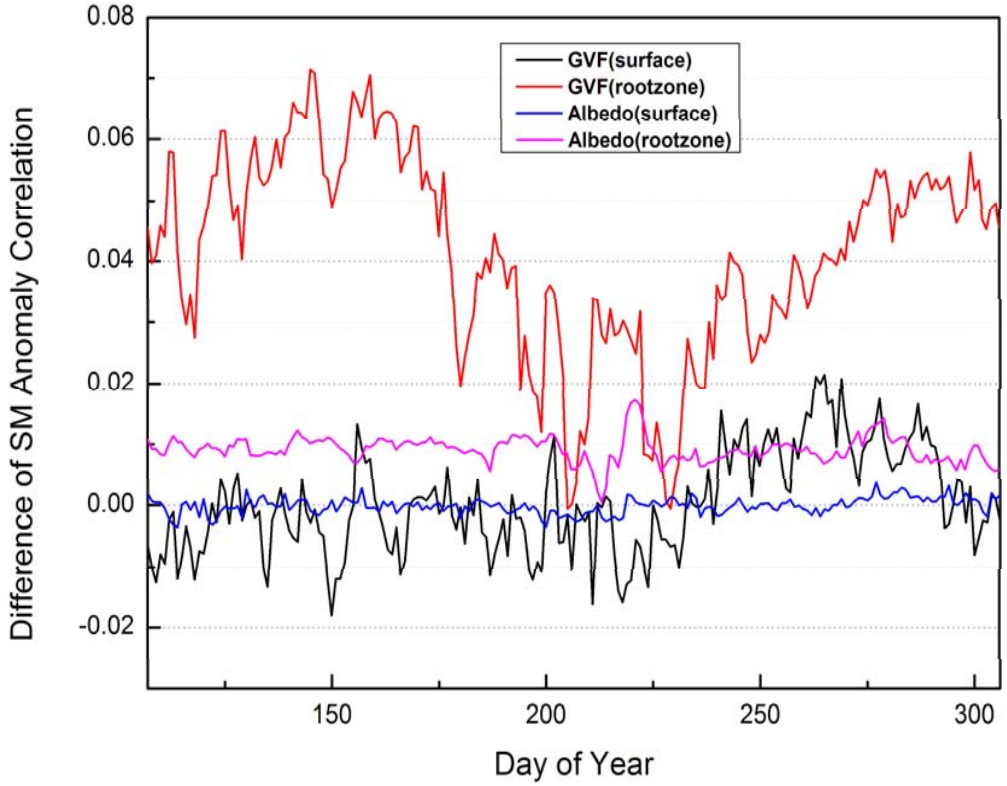
Normalized RMSE and Correlation



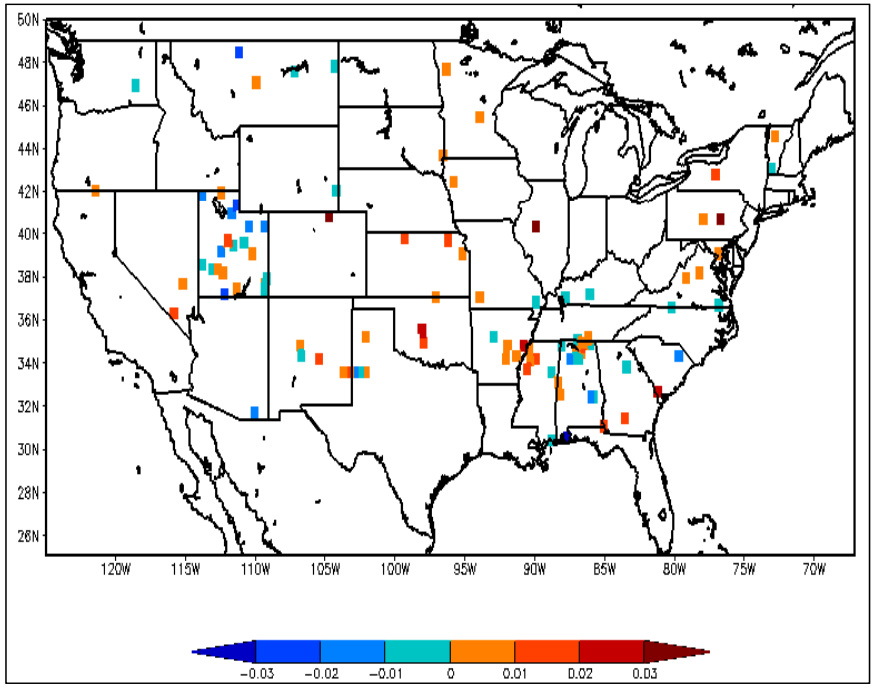


Results

Anomaly Correlation



Spatial Distribution



Results

Improvements of soil moisture from Noah LSM using NRT inputs

Variables	Average Normalized RMSE improvement (%)		Maximum Normalized RMSE improvement (%)		Number (%) of improved sites	
	Surface	Rootzone	Surface	Rootzone	Surface	Rootzone
GVF	1.10	1.58	1.8	2.5	61.4	85.7
Albedo	0.08	0.10	0.2	0.17	85.1	68.4
Insolation	5.24	4.42	8.85	6.71	75.3	76.6
GVF, albedo and insolation combined	0.61	1.20	1.88	2.46	56.1	55.3

Discussion

Online vs Offline LSM

- ✓ All results in this study were obtained from offline runs of Noah LSM using LIS.
- ✓ Impacts of using NRT input data for LSM with the LSM coupled to an atmospheric model (e.g. NCEP GFS or NAM) may be more significant

Summary

- Multi-year average data currently used in Noah LSM as input are not always representative to the reality, especially at shorter time scales (daily and hourly)
- The magnitude of differences between current input and NRT observations is quantitatively evaluated. The long term NRT GVF, albedo and insolation plays critical role in the enhancement of SM estimates from Noah LSM
- A series of Noah simulations of soil moisture are obtained using current input data or NRT input data separately over the growing season between 2000 and 2012, and SM estimates are compared against in-situ observations

Summary

- Validation results show the insertion of NRT parameters has overall positive impact on SM simulations for both surface and rootzone SM estimates from Noah LSM
- NRT solar insolation has the greatest impact, followed by GVF and albedo
- Improvements can be detected to more than 60% the total SCAN sites with single assimilation of NRT parameters and more than 55% with all three parameters combined
- More comprehensive impact studies are needed using LSM-GFS/NAM coupled model runs

Thanks for your attention!