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

- 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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  - Simulation results comparison
- Results and Discussion
  - Impacts on soil moisture simulations
  - Impacts on flux simulations
- Summary
## Data Sets

### Conventional and NRT Data Sets for Noah LSM

<table>
<thead>
<tr>
<th></th>
<th>Temporal Resolution</th>
<th>Spatial Resolution</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVF&lt;sup&gt;C&lt;/sup&gt;</td>
<td>Static 5-year avg</td>
<td>0.144 deg</td>
<td>AVHRR</td>
</tr>
<tr>
<td>GVF&lt;sup&gt;R&lt;/sup&gt;</td>
<td>8-day composite</td>
<td>1 km</td>
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</tr>
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<tr>
<td>Insolation&lt;sup&gt;C&lt;/sup&gt;</td>
<td>Hourly</td>
<td>0.125 deg</td>
<td>NLDAS-2 NARR</td>
</tr>
<tr>
<td>Insolation&lt;sup&gt;R&lt;/sup&gt;</td>
<td>Hourly</td>
<td>0.125 deg</td>
<td>GSIP</td>
</tr>
</tbody>
</table>

C: current  R: near-real-time
In situ data for flux validation
- U.S. Climate Reference Network (USCRN)

In situ data for soil moisture validation
- Soil Climate Analysis Network (SCAN)
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
### 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
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

Noah SM Simulations with Conventional inputs

Noah SM Simulations with NRT inputs

In-situ SM observations

RMSE, Correlation

RMSE, Correlation

Differences
1. Nor RMSE
2. Correlation
3. Anomaly Cor

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

<table>
<thead>
<tr>
<th>Variables</th>
<th>Average Normalized RMSE improvement (%)</th>
<th>Maximum Normalized RMSE improvement (%)</th>
<th>Number (%) of improved sites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface</td>
<td>Rootzone</td>
<td>Surface</td>
</tr>
<tr>
<td>GVF</td>
<td>1.10</td>
<td>1.58</td>
<td>1.8</td>
</tr>
<tr>
<td>Albedo</td>
<td>0.08</td>
<td>0.10</td>
<td>0.2</td>
</tr>
<tr>
<td>Insolation</td>
<td>5.24</td>
<td>4.42</td>
<td>8.85</td>
</tr>
<tr>
<td>GVF, albedo and insolation</td>
<td>0.61</td>
<td>1.20</td>
<td>1.88</td>
</tr>
</tbody>
</table>
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!