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

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Extended Abstract

Soil moisture (SM) plays a critical role in the land-atmosphere water and energy exchange (Chang et al. 1991, Entin et al. 2000, Frye et al. 2010a, b). Current U.S. operational weekly/monthly drought monitoring data products use soil moisture simulations of several land surface models (LSMs) including the Noah LSM in the North America Land Data Assimilation System (NLDAS) as input (Koster 1994, Chen et al. 1996, Koren et al. 2000, Wood et al. 1997, Mitchell et al. 2004). Accuracy of these simulations relies on the precision and representativeness of surface parameters and meteorological forcing data (Abramopoulos 1988). Most of the surface parameters and model inputs implemented in the current NLDAS setting are static datasets generated from multi-year climatological averages. Real time satellite data products are becoming increasingly available from various satellite sensors, which are more representative of actual surface conditions, especially at shorter time scales. This study aims at analyzing the impact of the near-real-time (NRT) satellite observations of land surface parameters on soil moisture (SM) simulations from the Noah LSM in order to improve the reliability of NLDAS information fed into the operational U.S. drought monitoring data products. Specifically, the near-real-time satellite observations examined in this study include the GOES Surface and Insolation Products (GSIP) hourly solar insolation, MODIS albedo and MODIS Green Vegetation Fraction (GVF; derived from LAI).

In the first part of this study, the differences between climatological values and NRT observations of these parameters are quantitatively demonstrated. The analysis is then carried out using the Noah LSM (version 3.2) (Ek et al. 2003, Mitchell 2005, Barlage et al. 2010) in the NASA Land Information System (LIS) framework (Kumar et al. 2006, 2008). GSIP real time insolation observations are used to replace the insolation forcing in NLDAS. MODIS NRT albedo and LAI, converted to GVF before insertion into the Noah LSM, are used to replace the static seasonal surface albedo and monthly green fraction datasets. To demonstrate the values of assimilating NRT satellite observations, Noah LSM simulations using the static climatological datasets and with real-time satellite observations are carried out with identical meteorological forcing data and compared against in-situ SM measurements. This study demonstrates that using NRT observations as the Noah LSM inputs improves the surface and root-zone SM simulations according to their comparisons with in-situ SM measurements.

Error! Reference source not found. summarizes the normalized RMSE improvement (along with the maximum improved cases) for all the validation SCAN sites over the research period for the Noah simulations with single insertion of NRT GVF, albedo, insolation and all three NRT parameters combined as well. The numbers of improved SCAN sites are also listed in the table in percentage.

To summer up, among the three parameters studied in this work, the insertion of NRT insolation has the greatest impact on model SM simulations by improving the normalized RMSE by 5.24% to surface SM and 4.42% to rootzone on average. Even though the impact of NRT albedo on SM estimates is limited, validation results still show the slightly positive improvement by 0.08% to surface SM and 0.1% to rootzone. The magnitude of improvement after the insertion of NRT GVF is between that of insolation and albedo, with 1.1% to surface and 1.58% to rootzone SM. Overall, 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.

Table 1 Validation summary

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