SMAP Data Assimilation at NASA SPoRT

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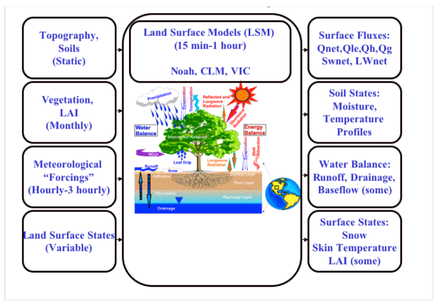
Overview

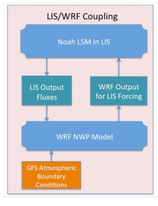
The NASA Short-Term Prediction Research and Transition (SPoRT) Center maintains a near-real-time run of the Noah Land Surface Model within the Land Information System (LIS) at 3-km resolution. Soil moisture products from this model are used by several NOAA/National Weather Service Weather Forecast Offices for flood and drought situational awareness. We have implemented assimilation of soil moisture retrievals from the Soil Moisture Ocean Salinity (SMOS) and Soil Moisture Active/Passive (SMAP) satellites, and are now evaluating the SMAP assimilation. The SMAP-enhanced LIS product is planned for public release by October 2016.

Tools and Data

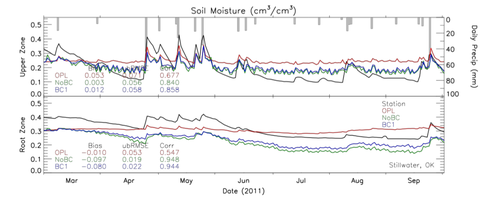


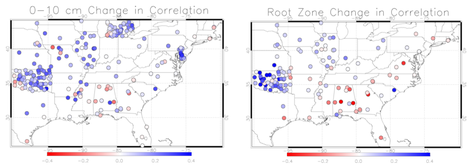
LIS (Kumar et al. 2006) is a modeling framework that incorporates several land surface models (LSMs) and allows the use of a variety of datasets. We use the Noah LSM, which is driven by meteorological forcing data. Model states are updated via Ensemble Kalman Filter data assimilation of SMOS and/or SMAP soil moisture retrievals.

Name	AMSR-E	SMOS	SMAP		
Agency	NASA/JAXA	ESA	NASA		
Launch	2002	2009	Jan. 2015		
Orbit	Polar	Polar	Polar		
Sensor Type	Passive	Passive	Passive	Active (Failed July 2015)	Combined (limited duration)
Frequency	6.9 GHz (C-band)	1.4 GHz (L-band)	1.41 GHz	1.2 GHz	
Resolution	56 km	35-50 km	36 km	**3 km**	9 km
Accuracy	6 cm^3/cm^3	**4 cm^3/cm^3**	**4 cm^3/cm^3**	6 cm^3/cm^3	**4 cm^3/cm^3**



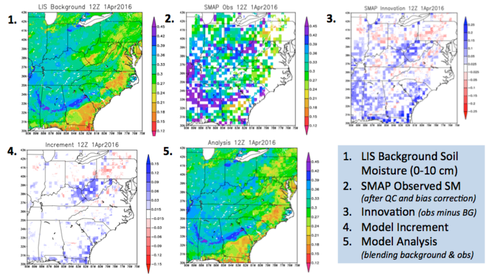
SMOS Validation



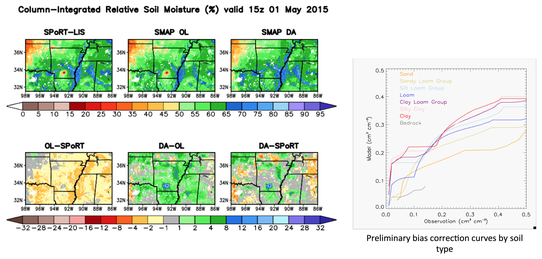


Results from *in situ* validation of SMOS assimilation in LIS (Blankenship et al., 2016). There were statistically significant improvements in station-analysis correlations over the central and southeastern US. Other metrics showed smaller impacts, possibly due to representativeness errors inherent to comparing station (point) measurements to grid cell averages. The SMOS-enhanced LIS also improved (increased) the dynamic range of the soil moisture over the season at many locations.

SMAP Data Assimilation



The first example illustrates the combining of background and (quality controlled, bias corrected) observations to produce a new model state (analysis).

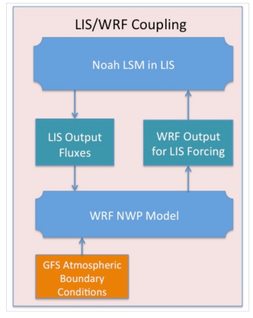


Preliminary bias correction curves by soil type

In this example over the southeastern USA, a problem with gauge quality control in the NLDAS-2 forcing data resulted in dry precipitation "bullseye" in the baseline SPoRT LIS run (left panel). After a month of SMAP retrieval assimilation, this anomaly is greatly reduced. This type of correction is made possible by a location-independent CDF-matching methodology. BIas correction curves for separate soil type categories are shown on the right.

Planned Work

Model Validation and Coupled Runs



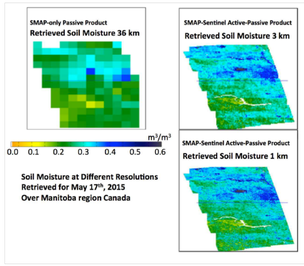
We plan to evaluate the impact of SMAP data assimilation of LIS model fields and on coupled short-term weather forecasts (using WRF) over CONUS and East Africa.

The table shows a summary of planned data assimilation experiments including forcing and validation data.

Region	CONUS	East Africa
LIS Forcing	NLDAS-2	GDAS
LIS Soil Moisture Validation	North American Soil Moisture Database	Mpala Cal/Val site
WRF T, Td, Wind Validation	MADIS	WMO Network
WRF Precip Validation	MRMS	IMERG

Downscaling and Higher Resolution Products

- Observations are currently much coarser than the model resolution. Some avenues of improving the resolution are being explored.
- Downscaling by applying the background variability to the observations
- The 25-km Enhanced SMAP product (Backus Gilbert interpolation, planned for Dec. 2016)
- The 1-3 km Enhanced SMAP-Sentinel product, planned for Mar. 2017. This product uses the ESA Sentinel 1 synthetic aperture radar constellation (1A and 1B) to achieve high resolution but with a revisit time of several days.



Vertical Layers

SMAP retrievals are representative of the top 5 cm or less, but the typical Noah top model layer is 10 cm. This may introduce regime-dependent biases between observations and model values, as the top 10 cm are not necessarily uniform. We will explore the impact of splitting the top model layer into two layers.

Fire Threat for Alaska

Based on discussions with WFO partners in Alaska,, where the skill of rainfall analyses can be lacking, we are performing an exploratory LIS DA run in Alaska to assess the possibility of using LIS to monitor fire threat.

References

- Blankenship et al., 2016: Assimilation of SMOS Retrievals in the Land Information System, IEEE Trans. Geosci. Rem. Sens. (in press).
- Kumar, S.V. et al., 2006: Land Information System - An interoperable framework for high resolution land surface modeling. Environmental Modelling and Software, 21, 1402-1415.