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.

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).

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.

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