Preparations for Assimilating Land Surface Observations from GOES-R, NPP/VIIRS and AMSR2 in NCEP NWP Models

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ABSTRACT

Operational observations of land surface temperature (LST), soil moisture (SM), green vegetation fraction (GVF), solar radiation (RS), surface type (ST) and albedo are/will be available from the next generation of Geostationary Operational Environmental Satellite-R series (GOES-R), the Suomi National Polar Partnership (NPP), and the Global Change Observation Mission 1st-Water (GCOM-W1) satellites. The primary usage of these observations is to improve numerical weather prediction (NWP). To prepare the utilizations of these satellite data in the NWP models of NOAA NCEP, various data assimilation utilities are being developed collaboratively by NESDIS Center for Satellite Applications and Research (STAR) and NCEP Environmental Modeling Center (EMC). LST and RS observations from GOES-R will be assimilated into an Atmosphere-Land Exchange Inversion (ALEXI) model to estimate evapotranspiration (ET) and a soil moisture proxy (SM_TIR). Real time GVF, albedo and ST observations will be used to replace those climatologic data currently used in the Noah land surface model (LSM) of NCEP. An ensemble Kalman filter (EnKF) is installed in the Global Forecast System (GFS) to assimilate soil moisture observations from the Advance Microwave Scanning Radiometer-2 on GCOM-W1. The poster describes how these data assimilation utilities are developed and what assimilation results using existing satellite observations have been obtained.

ALEXI Model and Assimilation of LST, GVF and Solar Insolation from GOES/GOES-R Satellites

Land surface temperature (LST), green vegetation fraction (GVF) and solar radiation (Rs) are/will be generated from GOES Imagers or future GOES-R Advanced Baseline Imager (ABI) at up to 2km spatial resolution. The Atmosphere-Land Exchange Inversion (ALEXI) model uses these observational to estimate surface energy fluxes (including evapotranspiration-ET) and in turn a soil moisture (SM) estimate for each of these higher resolution pixels. Converting the short memory LST satellite observations into a longer memory SM estimate through ALEXI model avoids the low stability issue with the direct assimilation of LST into a land surface model (LSM). ALEXI model will be routinely run at NOAA-NESDIS to assimilate the GOES/GOES-R observations to provide stable estimates of ET and SM for NCEP NWP models.

LIS and Noah LSM Assimilation of GVF/NDVI, Albedo, LST and ST from VIIRS of NPP and Future JPSS Satellites

Current operational runs of Noah LSM at NCEP are using historical means of GVF and albedo from either AVHRR or MODIS. ST data are from these sensors. Satellite LST data has not been used in the operational runs at all. The Noah LSM implemented in NASA's Land Information System (LIS) is run at NESDIS to test the impacts of the near real time (NRT) GVF, albedo, ST data from NPP/VIIRS. LST data from VIIRS will be assimilated through the Ensemble Kalman Filter (EnKF) within LIS which is being semi-coupled with GFS runs (See Fig. 1 for current GFS runs with or without the NRT satellite data assimilation).

EnKF and Noah LSM Assimilation of SM Data from GCOM-W/AMSR2

Before the semi-coupling of LIS and GFS for Noah LSM assimilations of satellite land data products, a simplified Ensemble Kalman Filter (EnKF) has been hard wired within GFS through GSI to assimilate microwave satellite soil moisture retrievals. Fig. 2 depicts the structure of the EnKF-GFS system. Results of using the EnKF-GFS system to assimilate ESA SMOS soil moisture data product is shown in Fig. 3.

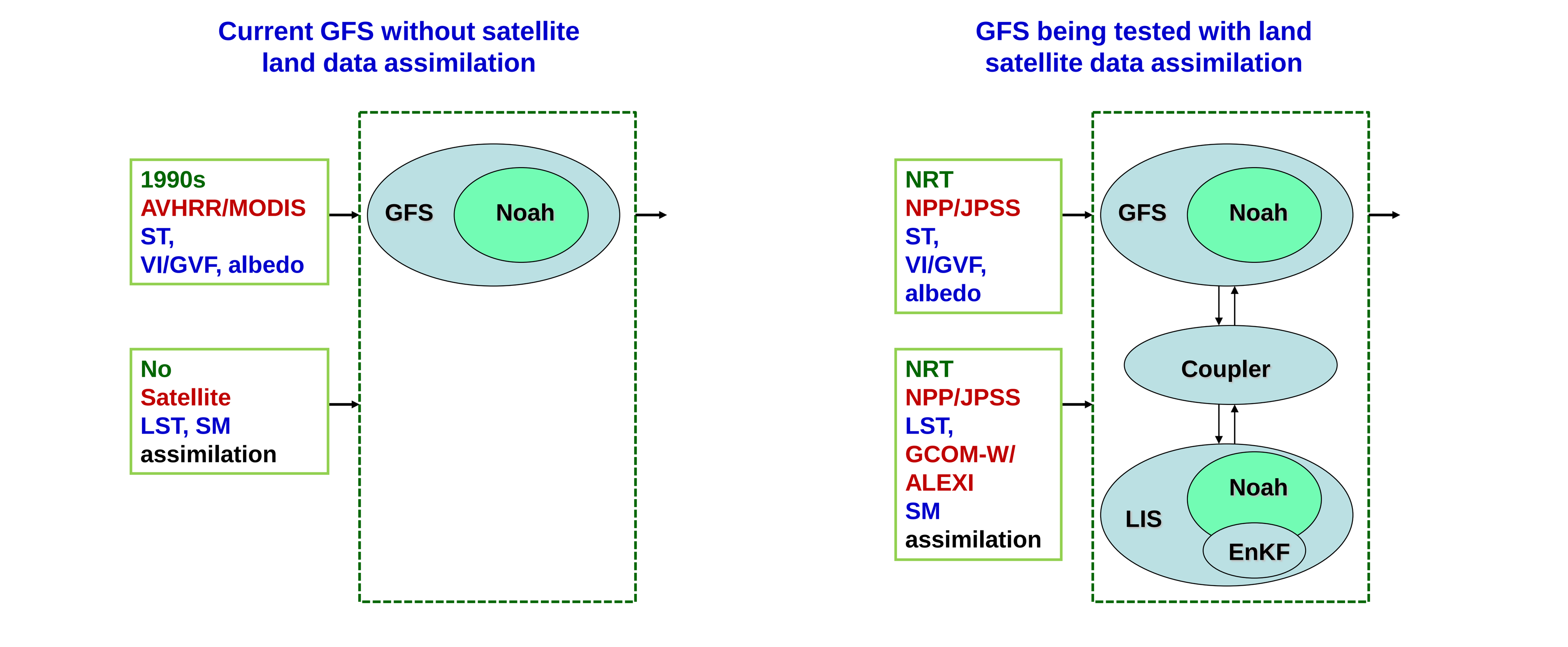

Figure 1. NCEP GFS with/without Assimilating Satellite Land Data Products

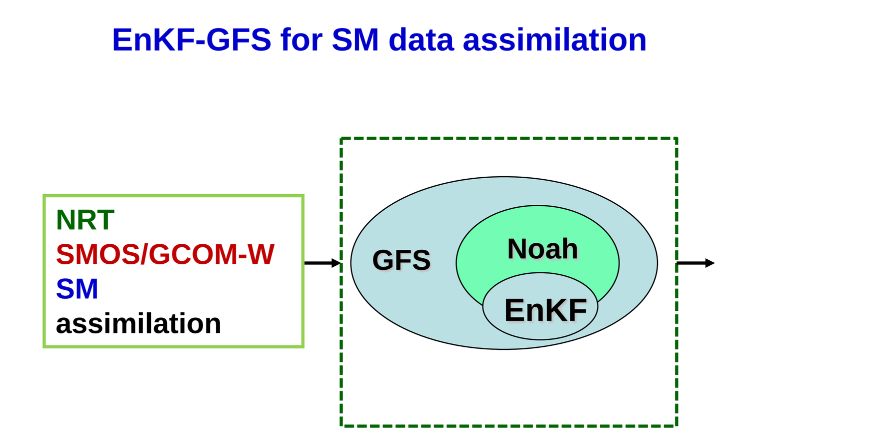

Figure 2. NCEP GFS Hard-wired EnKF for Satellite Soil Moisture Data Assimilation

Table 1. Assimilating SMOS SM Improves GFS Root-zone SM Estimates

Region	East CONUS (28 sites)			West CONUS (25 sites)		
Stats	*RMSE*	*Bias*	*Corr-Coef*	*RMSE*	*Bias*	*Corr-Coef*
CTL	0.149	0.015	0.458	0.122	0.049	0.488
EnKF	0.139	0.001	0.596	0.117	0.046	0.559

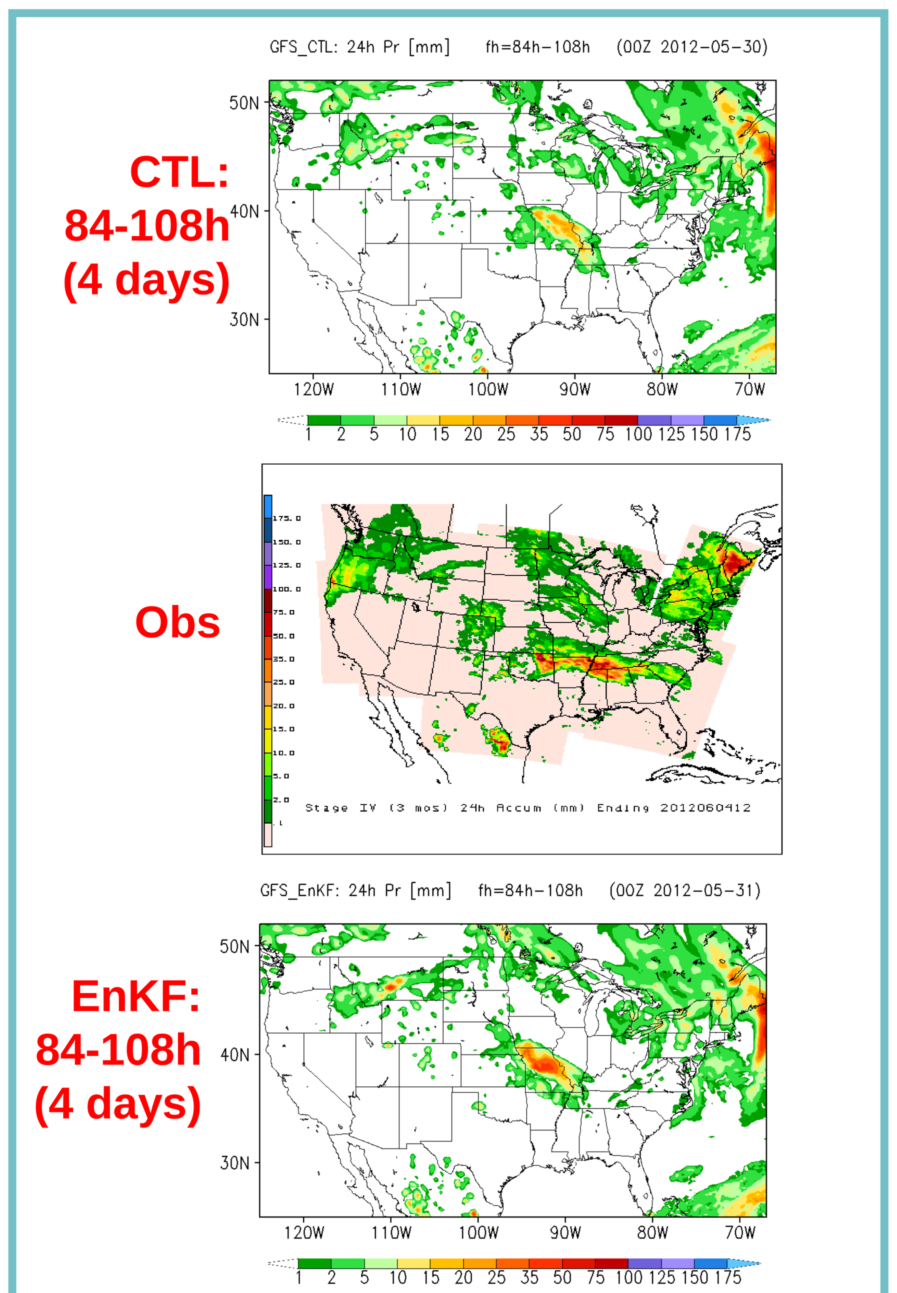

Figure 3. Impact of Assimilating SMOS SM on GFS Rainfall Forecasts

Dual Assimilation of Soil Moisture Data from Both GOES/GOES-R Thermal Based ALEXI Model and Microwave Retrievals

Simultaneously assimilating GOES/ GOES-R thermal-based ALEXI model estimates and AMSR-E microwave retrievals of soil moisture may have different impact on Noah LSM simulations. The dual assimilation using LIS has demonstrated that thermal satellite SM may improve deeper soil moisture than microwave SM (Fig. 4). Semi-coupling of LIS with GFS will tell how they improve GFS forecasts of rainfall, temperature and other weather elements.

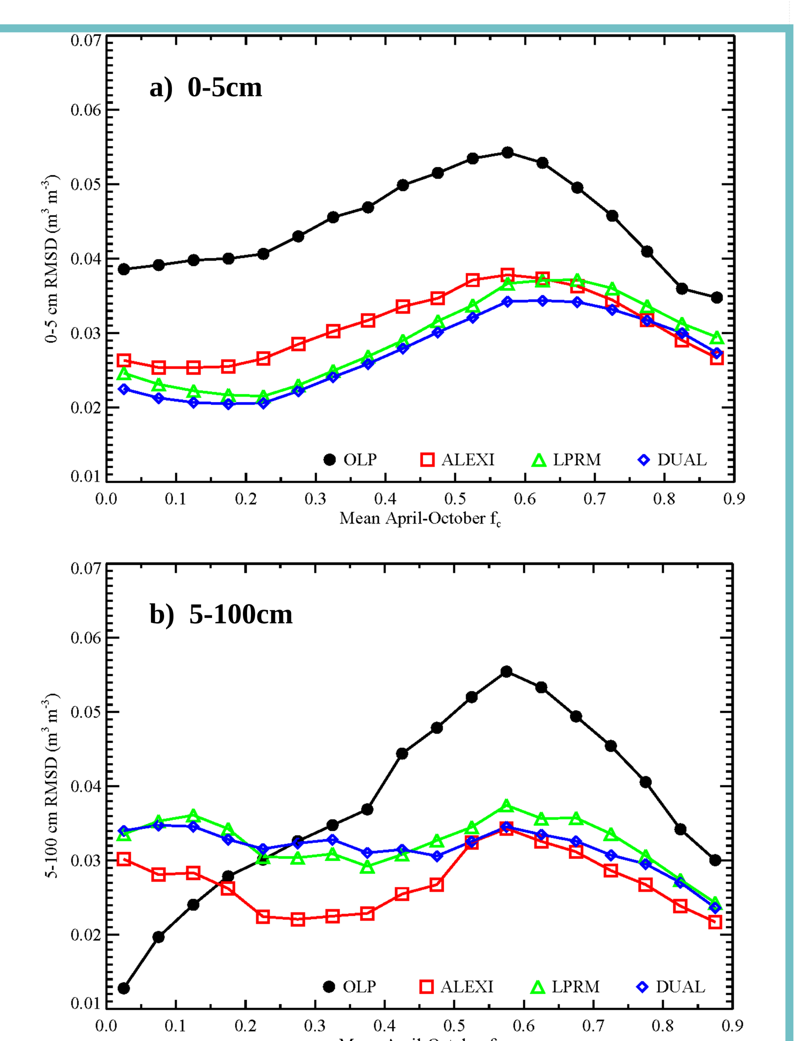

Figure 4. Different Impact of Assimilating Thermal ALEXI and Microwave SM Data

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