Enhancing NCEP-NAM Model Forecasts via Assimilating Real-time GOES-R Observations of Land Surface Temperature and Vegetation Dynamics

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Abstract

Building on our previously GOES-R3 funded project (ended in 2013) pertinent to the generation of evapotranspiration (ET) and drought monitoring products using proxy GOES-R observations through the Atmosphere-Land Exchange Inversion model (ALEXI), we propose a follow-up project to assimilate real-time GOES-R observations of land surface temperature (LST), a GOES-R based thermal infrared soil moisture proxy retrieved using ALEXI, and GOES-R vegetation dynamics (using green vegetation fraction as representative) into the NCEP North American Mesoscale Forecast System (NAM) in order to improve NAM weather forecasts. This proposal addresses the research priorities A1 and A2 of this GOES-R3 solicitation.

Several studies have shown the unique value of satellite-based LST and vegetation cover information and the feasibility of assimilating LST and vegetation dynamics products into the land surface models (LSMs) to improve the land-atmosphere water and energy exchange simulations. However, there are significant obstacles to methodology that seeks to directly assimilate LST because of its short memory. For LST assimilation, one unique and novel methodology is to use ALEXI as a "forward model" that converts LST information into soil moisture (SM) proxy, based on the ratio of actual to potential evapotranspiration (f_{PET}). Hain et al. (2012) assimilated an ALEXI f_{PET} product into an uncoupled Noah LSM simulation and demonstrated significant improvements in SM estimates while avoiding the issues caused by the direct assimilation of LST data. On another aspect, the current NCEP Noah LSM within NAM uses only a multiyear climatology of green vegetation fraction (GVF) although land-atmosphere interactions are well known to be sensitive to realistic vegetation status. Fang et al. (2014) compared Noah LSM SM estimates using either the multiyear climatology or real time GVF and found the later could improve Noah LSM performance. Based on these analyses and with the enhanced spatio-temporal resolution, radiometric accuracy and cloud-clearing capabilities, assimilating the GOES-R vegetation GVF, GOES-R LST and/or LST-based ALEXI SM proxy into the Noah LSM of NCEP NAM is expected to enhance NAM weather forecasts.

Proposing this GOES-R3 project, we aim at assessing the impact on NCEP-NAM weather forecasts by assimilating real time GOES/GOES-R GVF, LST, and GOES/GOES-R LST based ALEXI SM retrievals. Specifically, we will: 1) Prepare GOES/GOES-R proxy data sets for assimilation use, including GVF, LST observations, and LST-based soil moisture proxy from ALEXI; 2) Ingest real time GOES/GOES-R proxy GVF in NCEP-NAM and assess the impact on NCEP-NAM weather forecasts; 3) Assimilate the GOES/GOES-R LST-based ALEXI soil moisture retrievals and the GOES/GOES-R LST observations into NCEP-NAM using the Ensemble Kalman filter data assimilation utilities; 4) Evaluate the effectiveness and efficiency of the two assimilation approaches using in situ soil moisture observations and the standard NWS-NCEP NWP evaluation metrics; and 5) Document and publish findings of the above investigations.