

Dual Assimilation of Microwave and Thermal-Infrared Satellite Observations of Soil Moisture into NLDAS for Improved Drought Monitoring

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The utility and reliability of standard meteorological drought indices based on measurements of precipitation is limited by the spatial distribution and quality of currently available rainfall data. Furthermore, precipitation-based indices only reflect one component of the surface hydrologic cycle, and cannot readily capture non-precipitation based moisture inputs to the land-surface system (e.g., irrigation, shallow groundwater tables) that may temper drought impacts or variable rates of water consumption across a landscape. The Evaporative Stress Index (ESI), used here as a proxy for soil moisture, quantifies anomalies in the ratio of actual to potential ET (PET) mapped using signals of diurnal land-surface temperature (LST) change obtained from geostationary satellites. Because LST is a fast-response variable, and ESI quantifies anomalous water-use, the ESI has value in monitoring “flash drought” signals that may be missed or delayed in other drought indices based on precipitation or vegetation index.

The presentation will address the development of an operational system for optimal assimilation of thermal infrared (TIR) and microwave (MW) soil moisture (SM) and insertion of near real-time vegetation fraction (GVF) into the NLDAS Noah LSM towards the improvement of LSM-based drought monitoring. It has been demonstrated that diagnostic information about SM and evapotranspiration (ET) from MW and TIR remote sensing can reduce SM drifts in LSMs such as Noah. The two retrievals have been shown to be quite complementary: TIR provides relatively high spatial (down to 100 m) and low temporal resolution (due to cloud cover) retrievals over a wide range of GVF, while MW provides relatively low spatial (25-60 km) and high temporal resolution (can retrieve through cloud cover), but only over areas with low GVF. Furthermore, MW retrievals are sensitive to SM only in the first few centimeters of the soil profile, while TIR provides information about SM conditions integrated over the full root-zone, reflected in the observed canopy temperature. Outputs from the operational DA system will include near real-time (updated each night) maps of surface and root-zone SM, ET and runoff. Finally, an evaluation of SM moisture anomalies from the DA simulations will be compared to ALEXI ESI and standard drought metrics, including operational NLDAS output.