Applications of Satellite Soil Moisture in Drought Monitoring and Weather Forecast Improvements

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With satellite SM retrievals becoming widely and continuously available, it is desirable to use the remote sensing SM data to develop tools to improve agricultural drought monitoring and enhance accuracy of weather forecast. Based on SM data derived from thermal infrared (TIR) observations of land surface temperature, L/C/X-band microwave SM products, and land surface model simulations, drought estimations are assessed using the Triple Collocation Error Model (TCEM); and then we developed the blended drought index (BDI) framework that objectively integrates drought estimations with exhibiting the lowest TCEM-based root mean square errors (RMSEs). With respect to the official drought records and drought monitoring benchmarks including U.S. Drought Monitor, the Palmer Drought Severity Index and the standardized precipitation evapotranspiration index products, the BDI shows better performance and reasonably tracking drought development in terms of time evolution and spatial patterns of agricultural drought occurrences. These results suggest that model simulations and remotely sensed observations of SM can be objectively translated into useful information for drought monitoring and early warning, in turn reducing drought risk and impacts.

Additionally, based on the development of the coupled system of National Centers for Environmental Prediction (NCEP)-Global Forecast System (GFS)/National Aeronautics and Space Administration (NASA)-Land Information System (LIS), we also designed a synthetic experiment to demonstrate the impacts of assimilating the soil moisture data products from the Advanced Scatterometer (ASCAT) and the Soil Moisture Active and Passive (SMAP) on the weather forecasts of GFS. Validation results indicate that GFS model-base 2-meter air temperature and precipitation forecasts are significantly improved with benefits of remotely-sensed soil moisture assimilation. Assimilating satellite SM retrievals into the GFS with the EnKF algorithm using the monthly cumulative distribution function (CDF) matching method is suggested for enhancing accuracy of the weather forecasts. These results suggest that satellite soil moisture data assimilation could be beneficial for the GFS numerical weather forecasts of NOAA NCEP.