# Improving Satellite Soil Moisture Data for Assimilation into NCEP Global Forecast System

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## ABSTRACT

*The JSDI-funded project on improving satellite soil moisture data products for assimilation into GFS of NCEP has used a single channel retrieval (SCR) algorithm to retrieve global soil moisture from AMSR-E observations. The output of SCR demonstrated smaller biases and root-mean-square differences than the NASA baseline global soil moisture AMSR-E data products comparing with the field measurements of land surface soil moisture from several ground networks. Using SCR, a NOAA version of AMSR-E global soil moisture data product has been generated from AMSR-E observations since June 2002 and has been delivered to NCEP EMC land group for assimilation in to the Noah land surface model (LSM) which is the land components of its global forecast system (GFS). Preliminary results of assimilating both NASA and NOAA AMSR-E soil moisture data products into Noah LSM indicated that the satellite soil moisture data products improves Noah LSM land state variable simulations in some areas while the improvements for other areas are marginal. Further soil moisture data assimilation experiments are carried out for improving drought area mapping using the Noah LSM driven by the Global Land Data Assimilation System (GDAS) forcing data. The NOAA version of AMSR-E soil moisture data product demonstrated better capability of mapping drought areas.*

## INTRODUCTION

The advanced microwave scanning radiometer on Aqua satellite (AMSR-E) have been providing soil moisture sensitive brightness observations since June 2002. The baseline global soil moisture data product from AMSR-E has been made available for many years. However, the data product has not been used in any operational numerical weather prediction models because of the smaller than realistic spatial and temporal variations of the soil moisture values in the product. Funded by the Joint Center, we have tested an alternative soil moisture retrieval algorithm, namely the Single-Channel Retrieval (SCR) algorithm (Jackson, 1993), to generate a NOAA-NESDIS version of global soil moisture data product from AMSR-E (Zhan et al, 2008; Liu et al, 2008). This poster presents how the NOAA AMSR-E soil moisture data product is compared with NASA's AMSR-E soil moisture product and how the NOAA product contributes potential to the GFS numerical weather prediction and drought area monitoring.

## RETRIEVAL ALGORITHMS

The retrieval algorithm used in NASA's baseline AMSR-E soil moisture product and the SCR are both based on the $\tau$-$\omega$ land low-frequency-microwave transfer model:

$$T_{B,i} = T_{skin}\{e_{r,p}\exp(-\tau_i/\cos\theta) + (1-\omega)[1-\exp(-\tau_i/\cos\theta)][1+R_{r,i}\exp(-\tau_i/\cos\theta)]\}$$

The NASA AMSR-E soil moisture baseline algorithm inverses multi-channel brightness temperatures (TBs) to solve for soil moisture, vegetation water content, and land surface temperature (Njoku et al, 2003) while NOAA Single-Channel algorithm uses the most sensitive soil moisture channel TB, optical observation of vegetation water content and the on-board land surface temperature estimate from the 37GHz v-pol TB to retrieve soil moisture (Zhan et al, 2008; Liu et al, 2008). Comparing to field soil moisture measurements at Little Washita, OK and Walnut Gulch, AZ, the time series of soil moisture retrievals from the Njoku algorithm of NASA product and the SCR algorithm of NOAA product are plotted in Figure 1. The NOAA product demonstrated variations closer to the field measurements.

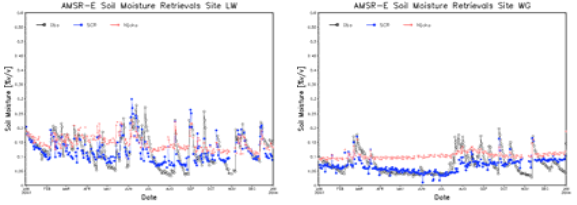


*Figure 1. NASA and NOAA AMSR-E Soil Moisture Compared with In Situ Measurements*

## SOIL MOISTURE DATA ASSIMILATION & DROUGHT MONITORING

Drought is the dry anomaly of soil moisture. Figure 2 illustrates the NASA and NOAA AMSR-E soil moisture anomalies, the MODIS NDVI anomaly compared with the published U. S. Drought Monitor. It's shown than the NOAA product depicts the drought areas better than the NASA product and the NDVI anomaly maps. Using the Ensemble Kalman Filter implemented in NASA's Land Information System (LIS), we assimilated both NASA and NOAA AMSR-E soil moisture data product into the Noah land surface model (LSM) over the NLDAS domain using the operational GDAS forcing data (Figure 3). The root-zone soil moisture dry anomaly areas after assimilating the NOAA soil moisture product seems better matching the drought map. NLDAS runs using analysis forcing were used in the drought maps. More complete data assimilation comparison will be presented in a paper by Kumar et al, (2009).

## CONCLUSION

From all these results, it can be concluded that the NOAA AMSR-E sol moisture data product demonstrate certain improvements over NASA product.

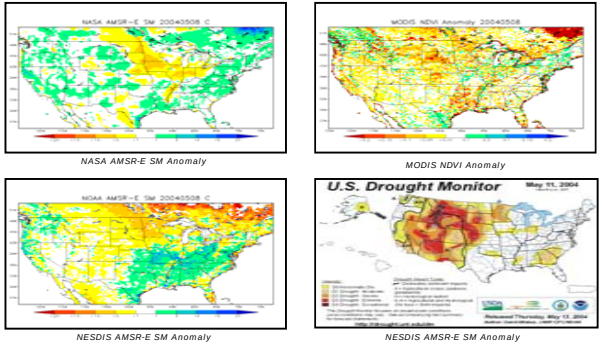


*Figure 2. NASA and NOAA AMSR-E Soil Moisture and MODIS NDVI anomalies Compared with Published U.S. Drought Monitor*

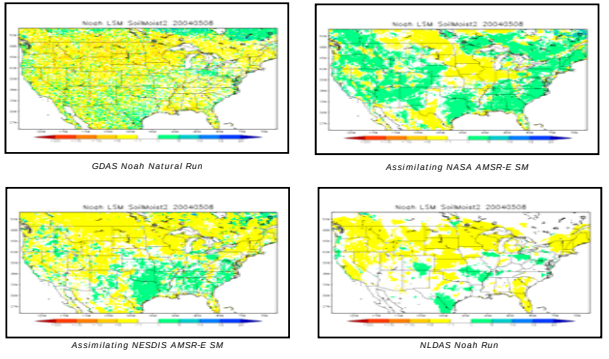


*Figure 3. Assimilating NASA and NOAA AMSR-E Soil Moisture may improve the drought area monitoring using the root-zone soil moisture anomaly of Noah LSM estimates*