MERGING THERMAL AND MICROWAVE SATELLITE OBSERVATIONS FOR A HIGH-RESOLUTION SOIL MOISTURE DATA PRODUCT

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1. INTRODUCTION

Many societal applications of soil moisture data products require high spatial resolution and numerical accuracy. Current thermal geostationary satellite sensors (GOES Imager and GOES-R ABI) could produce 2-16km resolution soil moisture proxy data. Passive microwave satellite radiometers (e.g. AMSR-E, WindSat, SMOS, SMAP & NPOESS MIS) soil moisture observations could be more accurate but with coarser spatial resolution. In this paper we explore the feasibility for merging these two types of satellite soil moisture observations to generate a soil moisture data product with higher spatial resolution and better numerical accuracy.

2. MICROWAVE SATELLITE SOIL MOISTURE OBSERVATIONS

NASA has been generating a 25km resolution soil moisture data product from AMSR-E since June 2002 [1]. To improve soil moisture data accuracy, NOAA-NESDIS are generating an alternative AMSR-E soil moisture data product with better spatial and temporal variations than the NASA product [2], comparing with *in situ* soil moisture measurements in Little Washita in OK and Walnut Gultch in AZ as shown in Figure 1.

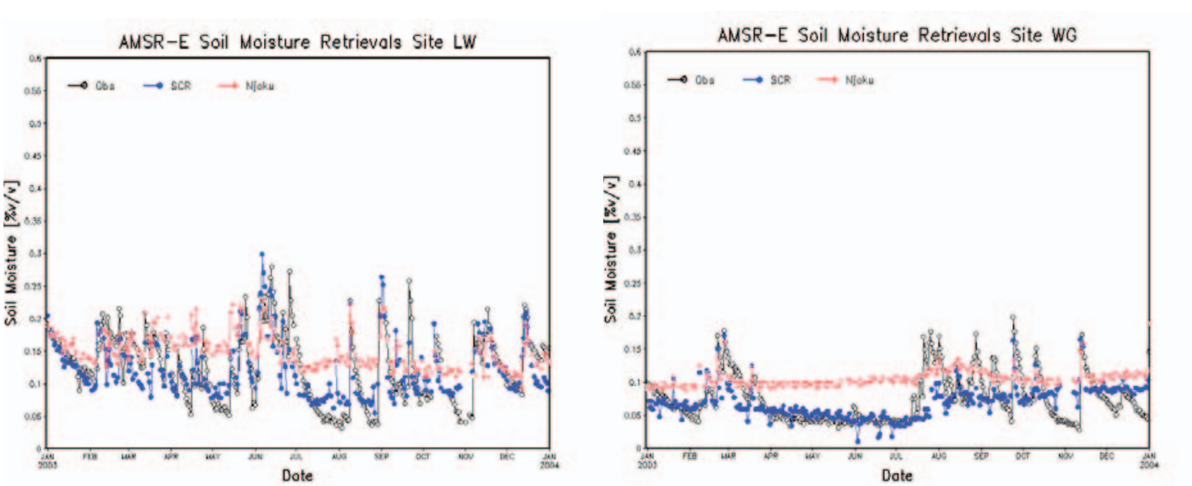

Figure 1. AMSR-E Soil Moisture Data Accuracy Evaluation

Other potentially more accurate microwave satellite soil moisture data products will be generated from the SMOS mission of ESA, the SMAP mission of NASA and the future operational NPOESS Microwave Imager/Sounder (MIS). Except SMAP products that may have up to 10km spatial resolution, all other products from these future microwave sensors will have a spatial resolution larger than or equal to 40km. This spatial resolution limits the data product applications in agricultural water management, drought monitoring, crop production forecasts, flash flood and river flow forecasts, regional water quality monitoring, military mobility, and regional vector disease forecasts. Thus, improving the spatial resolution of these data products will be useful for their wider applications.

3. GOES THERMAL-BASED SOIL MOISTURE PROXY FROM ALEXI MODEL

GOES Imagers and future GOES-R Advanced Baseline Imager (ABI) have thermal bands observations at up to 2km spatial resolution [3]. The Atmosphere-Land Exchange Inversion (ALEXI) model can use these observations to compute a soil moisture estimates for each of these higher resolution pixels [4]. Since these ALEXI model estimates are indirect observation of soil moisture, they may be less accurate than the microwave direct observations. Thus, combining both the thermal and microwave soil moisture observations may produce a soil moisture data product with microwave observation accuracy and thermal sensor spatial resolution.

4. METHODOLOGY FOR MERGING SOIL MOISTURE PRODUCTS

A Bayesian method has been tested for merging Hydros (former name of the NASA SMAP mission) radiometer and radar observations toward a high resolution high accuracy soil moisture data product [5]. It is also used to merge microwave radiometer and red, near-infrared and thermal sensor observations [6]. Another robust algorithm has been developed to disaggregate microwave soil moisture observations based on red, near-infrared and thermal satellite data [7]. Simultaneously assimilating thermal and microwave data into a high resolution comprehensive land surface model (LSM) could also generate high resolution high accuracy soil moisture data .products, but the large number of forcing data required by the LSM and the data assimilation algorithm may add more uncertainties to the resulting soil moisture data product. In this study, we further examine the Bayesian method in [5] and the disaggregating method [7] for the AMSR-E soil moisture retrievals and GOES-ALEXI soil moisture estimates.

5. VALIDATION DATA SETS

The in situ soil moisture measurements used to validate the AMSR-E soil moisture retrievals in Figure 1 and the continuous observations of selected USDA Soil Climate Analysis Network (SCAN) stations for the years from 2002-2004 are used to validate the soil moisture retrieval results from AMSR-E, GOES-ALEXI and their combinations.

6. RESULTS AND DISCUSSION

Preliminary result of merging the AMSR-E soil moisture retrievals and the GOES-ALEXI soil moisture estimates demonstrate advantages of the merged product over each of the individual products comparing with the in situ soil moisture measurements. These comparison results will be presented in the full paper. Conditions to obtain the advantageous merged products will be discussed.

7. CONCLUSION

Based on Bayesian theory, the merged soil moisture data product should have smaller errors than the errors of each of the individual soil moisture products to be merged. From the application point of view, if the accurate coarser resolution microwave soil moisture observations can constrain the errors of the less accurate high resolution thermal soil moisture estimates using the merging approach, then the merged product will broaden the applications of the satellite soil moisture products. This study have examined how the selected merging approaches realize the advantages of the merged soil moisture data products.

11. REFERENCES

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