AN ACTIVE-PASSIVE COMBINED ALGORITHM FOR HIGH SPATIAL RESOLUTION RETRIEVAL OF SOIL MOISTURE FROM SATELLITE SENSORS

Venkat Lakshmi

USC Department of Earth and Ocean Sciences, 701 Sumter St., Columbia, SC 29208, USA; email: vlakshmi@geol.sc.edu.

Introduction and motivation

Soil moisture is known to be an essential factor in controlling the partitioning of rainfall into surface runoff and infiltration and solar energy into latent and sensible heat fluxes. Remote sensing has long proven its capability to obtain soil moisture in near real-time. However, at the present time we have the Advanced Scanning Microwave Radiometer (AMSR-E) on board NASA's AQUA platform is the only satellite sensor that supplies a soil moisture product. AMSR-E coarse spatial resolution (~ 50 km at 6.9 GHz) strongly limits its applicability for small scale studies.

A very promising technique for spatial disaggregation by combining radar and radiometer observations has been demonstrated by the authors using a methodology is based on the assumption that any change in measured brightness temperature and backscatter from one to the next time step is due primarily to change in soil wetness. The approach uses radiometric estimates of soil moisture at a lower resolution to compute the sensitivity of radar to soil moisture at the lower resolution. This estimate of sensitivity is then disaggregated using vegetation water content, vegetation type and soil texture information, which are the variables on which determine the radar sensitivity to soil moisture and are generally available at a scale of radar observation.

Methodology

This change detection algorithm is applied to several locations. We have used aircraft observed active and passive data over Walnut Creek watershed in Central Iowa in 2002; the Little Washita Watershed in Oklahoma in 2003 and the Murrumbidgee Catchment in southeastern Australia for 2006. All of these locations have different soils and land cover conditions which leads to a rigorous test of the disaggregation algorithm. Furthermore, we compare the derived high spatial resolution soil moisture to in-situ sampling and ground observation networks. We will use data from a variety of sources. In-situ data for soil moisture comes from permanent stations and opportunity-based sampling during field experiments. Aircraft data are from the JPL AirSAR sensor collected in SMEX02. The satellite data comes from the ASAR (Advanced Synthetic Aperture Radar) and the TRMM – PR (Precipitation Radar) sensors. The disaggregation algorithm is based on change detection, viz. if we have two close overpasses for the active sensor with one or two days, we can take the backscatter difference and this will give us a measure of the change in the soil moisture as no other variable has changed (Narayan et al. 2006).

Central Conclusions

Application of the algorithm to data obtained from the SMEX02 experiments resulted gave excellent results with root mean square error of prediction of 0.03 and 0.02 (error for estimated versus measured volumetric soil moisture, both at 100 m resolution) for two periods - July 5th to July 7th and July 7th to July 8th. The R^2 value for both cases was 0.85. Use of the TRMM-PR with the AMSR-E data provided a good estimation of 5km soil moisture from the 50km AMSR-E estimates (Narayan et al. 2008). The ASAR Global Monitoring soil moisture product was shown to capture the soil moisture variability reasonably well when evaluated with the point measured *in situ* data obtained from the permanent soil moisture stations in the domain (R = 0.69 and $RMSE$ = 0.099 m^3/m^3). Comparisons with field collected and PLMR derived SM at 1 km soil moisture showed similar correlation and root mean square error (Mladenova, 2009).

Bibliography

1) Narayan, U., Lakshmi, V., and T. Jackson, A Simple Algorithm for Spatial Disaggregation of Radiometer Derived Soil Moisture Using Higher Resolution Radar Observations, Vol. 44, No. 6, pp 1545-1554, *IEEE Transactions on Geoscience and Remote Sensing*, 2006

2) Narayan, U. and V. Lakshmi, High resolution change detection using TMI-PR and AMSR-E soil moisture data, *Water Resources Research*, 44(6), June 2008

3) Mladenova, Lakshmi, Walker, Panciera, Wagner and Doubkova, Validation of ASAR Global Monitoring mode soil moisture using the NAFE05 data set, Under review Transactions of Geoscience and Remote Sensing, 2009