Title: ASSIMILATION OF MICROWAVE BRIGHTNESS AT L-BAND TO ESTIMATE ROOT ZONE SOIL MOISTURE IN A GROWING SEASON OF CORN.

Authors: Alejandro Monsivais-Huertero[1], Jasmeet Judge[2], and Karthik Nagarajan[2]

[1]Escuela Superior de Ingenieria Mecanica y Electrica-Ticoman. Instituto Politecnico Nacional. Mexico City, Mexico.
[2]Center for Remote Sensing. Agricultural and Biological Engineering Department. University of Florida, Gainesville, FL.

Abstract

Accurate knowledge of root zone soil moisture (RZSM) is crucial in hydrology, micrometeorology, and agriculture for estimating energy and moisture fluxes at the land surface. Soil Vegetation Atmosphere Transfer (SVAT) models are typically used to simulate energy and moisture transport in soil and vegetation [1]. Coupled SVAT and vegetation models capture the biophysics of dynamic vegetation fairly well, RZSM estimates still diverge from reality due to errors in computation, and however uncertainties in model parameters, forcings, and initial conditions should be considered. The model estimates of RZSM can be significantly improved by assimilating remotely sensed observations that are sensitive to soil moisture changes, such as microwave brightness at frequencies < 10 Ghz [2]. For soil moisture studies, observations at L-band frequencies of 1.2 – 1.4 GHz are desirable due to larger penetration depth and system feasibility. The near-future NASA Soil Moisture Active/Passive (SMAP) mission will include active and passive microwave sensors at L-band (1.2 – 1.4 GHz) to provide global observations, with a repeat coverage of every 2-3 days [3].

In this study, an Ensemble Kalman Filter (EnKF)-based assimilation algorithm was implemented to simultaneously update states and parameters every 3 days, matching the interval of satellite revisit, by assimilating soil moisture (SM), soil temperature (ST) and L-band microwave brightness temperature (T_b) into the SVAT-vegetation growth model linked with a forward microwave model. Fig. 1 shows the framework of the assimilation algorithm implemented. We use a coupled Land Surface Process (LSP)/vegetation growth model [4] to estimate the SM profile and ST profile and a microwave brightness (MB) model [5] to estimate T_b during a growing season of sweet corn in North Florida.

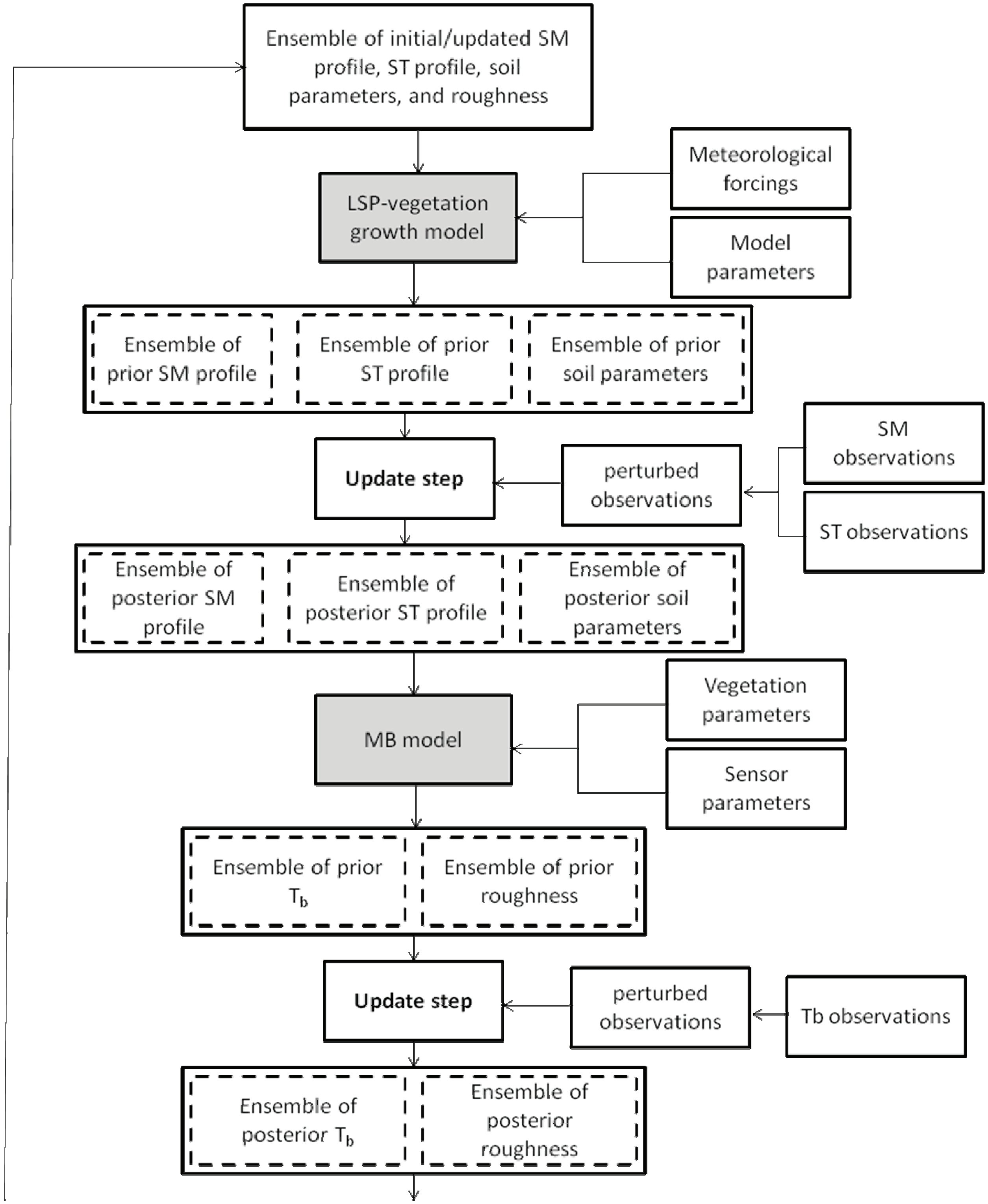

Fig. 1. Framework of the EnKF algorithm.

Field observations were obtained from the Fifth Microwave Water and Energy Balance (MicroWEX-5) experiment which was conducted during the growing season of sweet-corn from Day of Year (DoY) 68 (March 9) to DoY 150 (May 30) in 2006 [6]. In situ soil moisture observations were obtained every fifteen minutes at depths of 2, 4, 8, 16, 32, 64, and 120 cm and L-band brightness temperature observations at H-polarization and 50^o incidence angle were measured every fifteen minutes. The radiometer was calibrated at least every week with a microwave absorber as warm load and measurements of sky at several angles as cold load. Comparisons of RZSM estimates using both synthetic and field observations during the MicroWEX-5 experiment were conducted to understand the improvement in RZSM estimation using both in situ and remotely sensed measurements.

The simultaneous of state-parameter estimates resulted in the lowest uncertainty in RZSM estimation when the observations describing the VSM soil profile were assimilated. For both synthetic and MicroWEX-5 observations, the assimilation of observations improved the RZSM estimates in comparison with open-loop simulations. The assimilation of in situ soil moisture observations linked to the assimilation of brightness-temperature observations showed lower differences with observations than the assimilation of brightness temperature observations only. When assimilation MicroWEX-5 observations, it was found that the differences between RZSM estimates and observations increased in comparison with the difference between RZSM estimates and synthetic observations. This points out the possibility of accounted for model error due to vegetation conditions in the actual field.

[1] J. J. Casanova and J. Judge, "Estimation of energy and moisture fluxes for dynamic vegetation using coupled SVAT and crop-growth models", *Water Res. Research,* vol. 44 (W07415), doi:10.1029/2007WR006503, 2008.

[2] Dunne, S. C., Entekahbi, D., and Njoku, E. G, "Impact of multiresolution active and passive microwave measurements on soil moisture estimation using the Ensemble Kalman Smoother", *IEEE Trans. on Geosc. and Rem. Sens*, vol. 45 (4), pp. 1016-1028, 2007.

[3] D. Entekhabi, E. Njoku, P. O'Neill, M. Spencer, T. Jackson, J. Entin, E. Im, and K. Kellogg, "The Soil Moisture Active/Passive Mission (SMAP)", *IEEE Int. Geosc. and Rem. Sens. Symposium*, vol. 3, Proc. IGARSS 2008, pp. III-1 – III-4.

[4] J. Judge, L. Abriola, and A. England, "Numerical validation of the land surface process component of an LSP/R model", *Adv. in Water Res.*, vol. 26 (7), pp. 733-746, 2003.

[5] J. Judge, A. W. England, J. R. Metcalfe, D. McNichol, and B. E. Goodison, "Calibration of an integrated land surface process and radiobrightness (LSP/R) model during summertime", *Adv. in Water Res.*, vol. 31 (1), pp. 189-202, 2008.

[6] J. Casanova, F. Yan, M. Jang, J. Fernandez, J. Judge, C. Slatton, K. Calvin, T. Lin, O. Lanni, and L. W. Miller, "Field observations during the Fifth Microwave, Water, and Energy Balance Experiment

(MicroWEX-5): from March 9 through May, 2006. Circular No. 1514", http://edis.ifas.ufl.edu/AE407, Center for Remote Sensing, University of Florida, Tech. Rep., 2006.