EXPERIMENTS OF SOIL MOISTURE RETRIEVAL BASED ON EXTENDED KALMAN FILTER

Ruofei Zhong[1] *,Qin Li*[2] *and Wenji Zhao*[3]

1: zrfgis@263.net

1,2,3: Capital Normal University Key Lab of 3D Information Acquisition and Application, MOE, Beijing 100037, China

1. ABSTRACT

This paper is intended to investigate the sensing of surface parameters by microwave radiometry. A Extended Kalman filter(EKF) is developed to manage the nonlinear relationship between surface parameters and radiometric signatures. Its performance of retrieving plant water content (PWC) and soil moisture content (SMC) from brightness temperatures is examined by using both predictions from model simulations and measurements from field experiments. It calculates background error covariance matrix using Monte Carlo method and is able to resolve the nonlinearity and discontinuity exist within model operator and observation operator.

We optimize the observing scheme for sensing surface soil moisture (SM) from simulated brightness temperatures by the EKF. The frequencies of interest include 6.9 and 10.7 GHz of the Advanced Microwave Scanning Radiometer (AMSR), and 1.4 GHz (L-band) of the Soil Moisture and Ocean Salinity (SMOS) sensor. The Land Surface Process/Radiobrightness (LSP/R) model is used to provide time series of both SM and brightness temperatures at 6.9 and 10.7 GHz for AMSR's viewing angle of 55 degrees, and at L-band for SMOS's multiple viewing angles of 0, 10, 20, 30, 40, and 50 degrees. These multiple frequencies and viewing angles allow us to design a variety of observation modes to examine their sensitivity to SM. For example, L-band brightness temperature at any single look angle is regarded as an L-band 1D observation mode. Meanwhile, it can be combined with either the observation at other angles to become an L-band 2D mode or a multiple dimensional observation mode, or with the observation at 6.9 or 10.7 GHz to become a multiple frequency/dimensional observation mode. In this study, it is shown that the L-band 1D radiometric observation is sensitive to SM. The sensitivity can be increased by incorporating radiometric observation either from a second angle, or from multiple look angles, or from any of the two lowest AMSR channels. In addition, the advantage of an L-band 2D mode or a multiple dimensional observation mode over an L-band 1D observation mode is demonstrated.

Moreover, we investigate the best observing configuration for sensing wheat plant water content (PWC) and soil moisture content (SMC) profiles from the measured H- and V-polarized brightness temperatures at 1.4 (L-band), and 10.65 (X-band) GHz by the EKF. The brightness temperatures were taken by the PORTOS radiometer over wheat fields through 3 months growth cycles in 1993 (PORTOS-93) and 1996 (PORTOS-96). During both field campaigns, the radiometer was used to measure brightness temperatures at incident angles from 0 to 50 degrees at L-band and at an incident angle of 50 degrees at X-band. The SMC profiles were measured to the depths of 10 cm in 1993 and 5 cm in 1996. The wheat was sampled approximately once a week in 1993 and 1996 to obtain its dry and wet biomass (i.e., PWC). The EKF was trained with observations randomly

chosen from the PORTOS-93 data, and evaluated by the remaining data from the same set. The results indicate that the EKF can significantly improve the soil moisture estimation in the surfaca Iayer． And we think that the Extended Kalman filter is both practical and effective for assimilating in situ observation into land surface models．

2. KEY WORDS

Soil Moisture Retrirvel，EKF,AMSR，SMOS