Variational Data Assimilation Method for Soil Moisture Estimation Using Active Microwave Data

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Abstract. Microwave remote sensing systems are used to measure soil moisture on the basis of a large contrast that exists between the dielectric constant values for dry and wet soils. This work focuses on development of a variational data assimilation method for soil moisture estimation because of its general flexibility to treating any type of observation in conjunction with complex models. An inherent feature of the variational method is that it requires the availability of adjoint models, which is used within the variational data assimilation approach. In this study, a microwave observational operator and its adjoint will be developed and tested (i.e., designed to work in concert with a suitable soil and land model). The active microwave observational operator is an extension of the Integral Equation Model (IEM) to make it more suitable to land surface model data assimilation use. In this study, the adjoint model is developed, and the information content of active microwave measurements sensitive to the land surface and soil parameters is analyzed. This study focuses on the use of active satellite microwave observations (ASCAT, RADARSAT-1/2, ERS-1/2, and JERS-1). In constructing the adjoint of the forward model, all input variables and parameters were treated as candidate control variables. The base states were selected to be representative of nominal conditions. In addition, two linear perturbation model variants are also defined for better physical insight: a polarization (VV, HH, VH) difference perturbation operator and a frequency (1.8 GHz and 5.3 GHz) difference perturbation operator. The perturbation analysis of all input variables allows a relative variable response ranking to be performed. A comprehensive linear perturbation analysis is used to select five control variables (surface roughness, surface height, soil moisture, soil temperature, soil composition). The perturbation analysis is completed in stages and preliminary results will be presented. The relative component strength analysis is used to deducing dominant control variable. The analysis indicates that the sensitivity ranking of the control variables is sensitive to the linear operator measure (e.g., frequency differences, and polarization difference).