Hydrology and Earth System Sciences Discussions

Interactive
Comment

Interactive comment on "Inverse modeling of soil characteristics from surface soil moisture observations: potential and limitations" *by* A. Loew and W. Mauser

Anonymous Referee #2

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The paper addresses the estimation of soil parameters in the Process Oriented Multiscale EvapoTranspiration (PROMET) land surface model, which is representative of many land surface models that simulate water and energy fluxes. The goal of the paper is to understand the efficiency of using soil moisture measurement to estimate the model soil parameters. In general this problem has been fairly well presented in the past by a number of authors. Nonetheless, the results to date are not comprehensive and further work is required to provide guidance to modelers.

The introduction suggests that satellite remote sensing could be used to estimate model parameters, but this direction is not followed since only field measurements

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from the AgriSAR 2006 campaign. Given the well documented differences between the statistical characteristics of satellite-retrieved soil moisture and ground (or model) observations, and the rather low RMS measurement error (RMS = 1 to 2% vsm) used in the study. The authors need to comment on whether the results are relevant for the situations related to using satellite-retrieved soil moisture for soil parameter estimation. (Their own conclusions state: "It is therefore expected that much worse performance of the inversion algorithm can be expected in case of observation errors >4 vol.%";.

The paper restricts the estimation procedure to the infiltration component of the model (eqn 3 - 5), but eqn (3) (Richards eqn for one-dimensional water movement in a partially saturated rigid porous medium, is incomplete in a land surface model in that eqn (3) should have a sink term that represents the moisture extracted by roots for plant transpiration. Because the parameters from this component (a Penman-Moneith in their particular LSM) can be in error along with the soil parameters, it is unclear what portion of the model RMS can be attributed to soil parameters and what to other parts of the model. The reviewer recognizes that the authors assume that the model is without error (w=0 in eqn 1), but that does not remove the problem from their simulations. The authors need more discussion on this issue.

Which raises the major difficulty with the study, as presented: the need for an idealized estimation exercise to demonstrate under what conditions they can actually recover the parameters, given noisy measurements. They may want to consider correlation among the parameter errors, and test whether ignoring it raises problems. They do not cite any of the body of literature (by Keith Beven among others) that show that estimating 4 or 5 parameters from noisy samples is almost impossible, and that many combinations of parameters can give the same RMS model predictions errors. Before this is done, it is really hard to argue that the study is sound. In this study they had 14 samples taken over 2 months – not very much for the number of parameters being estimated.

The authors present an analysis framework in section 3 that due to the assumption of w=0 is almost like carrying out a non-linear regression and estimating the parameters

through a search procedure. There are many assumptions that need justification: Is there evidence in the literature that a Gaussian distribution is reasonable? How will negative values be treated if they arise? Given the range if K from soils, I find the Gaussian assumption problematic, and can an additive noise model be justified? – ditto with no covariance terms among the parameters or measurements. At a minimum, these need to be more fully discussed.

Overall, the paper is well written and presented. Unfortunately, there are some deeper issues that they haven't considered: an idealized experiment, parameter error assumptions, connectivity between the soil module and other modules of a LSM, the level of assumed soil moisture measurement errors etc. that raise critical issues that the authors need to address.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 95, 2008.