

Interactive comment on “Kalman filters for assimilating near-surface observations in the Richards equation – Part 1: Retrieving state profiles with linear and nonlinear numerical schemes” by G. B. Chirico et al.

Anonymous Referee #1

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In this paper, a number of different approaches are evaluated to improve a Richards equation model through the assimilation of surface soil moisture or pressure head measurements. Generally, the paper is well written and interesting.

My major remarks are:

- Equation 4: This is not the expression for the gain that I have seen in many papers on data assimilation, for example De Lannoy et al., Reichle et al., etc. Please further

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explain or correct. I hope the formula has been applied correctly.

- Equation 5: Again, this equation is different from the equation in other papers on EKF. Same remark regarding the application.
- Beginning of section 2.1. Looking at literature I would argue that the ensemble Kalman filter is the most widely used version of the KF for nonlinear settings. Please either prove the statement or correct.
- Equation 18 is unclear. \hat{x}_{k-1}^a is multiplied to itself. Please explain or correct.
- The explanation between equations 33 and 36 is unclear. This needs more explanation.
- We need more explanation on how the principal components are calculated in section 4.5.

Minor remarks:

- Please change "assimilation in" into "assimilation into" throughout the paper.
- Abstract line 13: remove "instead"
- Page 13294 Line 14: variance of the error of the state variable
- Equation 1 and explanation thereafter: in the equation u_{k-1} is used, in the explanation u_k . Please make consistent.
- Immediately after equation 6: F is now in boldface but before and after
- Provide units for all variables after equation 28. this it isn't.
- Page 13308 line 13: please name some operational applications of this kind of model.
- Same page line 25: sensible -> sensitive
- Page 13309 line 6: has then been compared.

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- Page 13313 line 8: Jacobians -> Jacobian
- Same page line 13: retrieving -> retrieval
- Page 13315 line 6-12: This sentence is way too long and incomprehensible. Please rewrite.
- Page 13317 line 4: unavoidable -> inevitable
- Figure 6: What do you mean by "explained variance" ?

Overall, I think that if these comments are taken into account, that the paper can be published.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 13291, 2012.

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