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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Do surface lateral flows matter for data assimilation of soil moisture observations into hyperresolution land models?" *by* Yohei Sawada

Anonymous Referee #2

Received and published: 6 January 2020

Journal: HESS Title: Do surface lateral flows matter for data assimilation of soil moisture observations into hyperresolution land models?

Author(s): Yohei Sawada MS No.: hess-2019-324 MS Type: Research Article

General Comments:

The author discusses the effects of inclusion of lateral transfer on propagation of soil moisture and its assimilation in a land surface model.

The importance of lateral transfers for land surface modeling is an important and open questions in the field, and hence worth performing diagnostic experiments. In my

view, studying the Data Assimilation (DA) results when lateral transfers are included or ignored in a land surface model (as it is done in this paper) will highlight more the efficiency of the DA technique rather than the impacts of lateral flow representation. Therefore, I find it more informative to discuss how soil moisture updates in a DA scheme differ when lateral transfers are switched on and off in a land surface model. Because this will highlight the importance of the processes that we know they occur but are overlooked in land surface models.

Moreover, the author claims that the focus of the study is "How and when surface water flows driven by local topography matter for data assimilation of soil moisture observations- line 19-20" but he fails to answer these questions shortly in the abstract or throughout the manuscript.

In line 24-26, the author indicate that the non-gaussianity of the background error disturbs the DA technique. Then why the author pursue this method while the very assumption needed for the DA technique presented here is violated?

The abstract doesn't state clearly what are the point by point messages that the manuscript intend to deliver.

In general, the arguments in interpreting the results are weak.

Major concerns:

Line 24, state variable and parameter variable are two technical terms that need to be explained for none-DA-community.

Line 37, what are examples of conventional land surface models, at what spatial resolution do they operate? Doesn't it make more sense to design the synthetic experiments at the same spatial resolution of typical land surface models that you are referring to?

Line 39-44, the author report the existing hyper-resolution land surface models that include lateral transfer. Given that such set ups already exist, what is the need to set up a synthetic experiment with synthetic observations, etc?

Line 50-52: you mean the challenge of land data assimilation is to “improve” the unobservable variables “using” observations by propagating. . .. ? Moreover, explain state and parameter space and their differences.

Line 44-47, be more specific about the outcome of the studies rather than sticking to “play an important role in terrestrial water and energy fluxes”.

Line 66, for people outside the DA-community you need to explain what state variable, forcing variable and output variable are.

Line 87-89, what was the main outcome?

Line 87-91: Do these model set up include lateral transfers between the grid-cells? (if they have solved 3D Richards equation). In that case, what is new in synthetic experimental design of your study that have not been tested before?

Line 133, describe the van Gnuchten relationships you are refereeing to.

Line 146, this is an uncommon way of representing an equation. You may separate the two equations for x and Y as presented in Eq. 3 of Kollet and Maxwell 2006.

Line 149-150: summarize what are those methodology and numerical methods that are used to solve the equations. You are asking the readers to read 6 other papers to get the basic information about your simulations.

Section 2. Method, line 109-150: the description of the model that is used is not informative and comprehensive. Consider restructuring and adding more details in such way that it covers the following: 1) how the unsaturated zone is modelled? 2) How surface flows are modeled? 3) How the coupling of the two is being done? 4) What is the numerical approach taken for solving the equations?

Section 2.2. Data Assimilation, line 153-206: Please explain the topic of DA in a plain language and for audiences larger than merely DA-community. What is the general philosophy there? Why Kalman filter? Why Ensemble Transfer Kalman Filter? Is it

more accurate? is it faster? Please justify the choices you made.

Line 193-194: what do you mean? Please explain what an “ensemble inflation method” is. Explain how this method correct for this?

Line 195: again you are throwing a term and you are asking your audience to read an entire paper to understand what “relaxation to prior perturbation method (RTPP)” is!

Line 199: where does this number come from? Report the literature or justify your choice.

Line 201-206: Badly written. It is not clear which observations are assimilated in the system. It is not clear what are the state variables that are updated in every modeling time step.

Line 210-217: Please better explain what kind of measure “KLD” is, what it measures and why you used this measure to quantify the non-gaussianity of the background error? What do you do with the asymmetry of KLD? Is P Gaussian distribution or q?

Line 235: where did you get these estimates? Provide references or justify your choice.

Section 3.1.1 experimental design: what do you want to achieve with these two synthetic experimental design? Please explain why you made your choices of experimental design more clearly. e.g., Why dividing your domain to rain and no-rain regions?

Line 268-269: most land surface models use satellite observations of surface soil moisture for DA. Observations are usually not available to the depth of 1m! Please explain more clearly what you want to gain by assimilating SM at several depth?

How reference runs are different from no-assimilation runs?

Line 292: What is LDAS?

Line 322: What do you mean by Ks,surface is accurate?

Line 322: the increase of RSME or IR index?

Line 324-326: check the structure of the sentence.

Line 325: RMSE of what variable?

Line 329-330: this statement is not correct!

Line 332: where does this optimized value for K_sat come from? How do you infer its accuracy?

Line 335-336: Please elaborate what this difference indicates.

Line 342: How do you explain figure 2a then? The valley bottom in figure 2a (left corner) should theoretically improve when lateral transfers are included (when the uphill is raining). This figure shows that the observations of SM (also in depth) didn't improve the predictions downhill although lateral transfer processes are included in your model!

Line 356-363: I am confused! How did you conclude this? Didn't you assimilate SM observations across all areas (where it rains and where it does not rain)? The DA results are not sufficiently and clearly explained.

Line 365-366: what do you mean?

Line 370-371: yes, because of higher Hydraulic conductivity!

Line 395: nonlinear dynamics of what?

Line 409: you don't show that the errors are correlated.

Line 412-413: This is what most land surface models do when they assimilate SM and they still show improvements!

Line 435: why is this constant number added? Please justify the choices you made.

Line 467: what is "OF"?

Line 488-492: weak justification. What is over fitting? what is wrong with that? why does it have a negative impact? elaborate.. also in lines 505-507.

Line 522-525: what variable are you talking about?

Line 533-535: then this assimilation technique is not suitable for topographically driven systems.

Line 553, add a reference to this argument.

Line 564-566: knowing that Gaussian distribution of background error is a pre-requisite, why this method then?

Line 594: what is localization method?

Bottom line: I don't understand the choice of experimental set up, the data assimilation technique chosen given the non-gaussianity of the background error, and the justification of the simulation results.

Minor comments:

Consider breaking long sentences into multiple sentences. Examples of this include: Line 26-30, 55-61, 69-74

Line 111, what do you mean by "parallel simulation platform"?

Line 113, provide examples of such land models.

Line 160-171: what is Pa? In general, what do "a" and "f" stand for?

Line 647: space after error

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