Geosci. Model Dev. Discuss., 8, C3377–C3381, 2015
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Geoscientific Model Development Discussions
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# *Interactive comment on* "TerrSysMP-PDAF (version 1.0): a modular high-performance data assimilation framework for an integrated land surface–subsurface model" *by* W. Kurtz et al.

**Anonymous Referee #2**

Received and published: 16 December 2015

## General comments

This paper by Kurtz *et al.* introduces a modular high performance data assimilation framework for a coupled land surface groundwater model (part of the TerrSysMP model). This paper introduces the technical implementation in great detail, analyzed the computational efficiency of the parallel framework, and provides an illustrative example. The paper is generally well written. Both data assimilation and coupled modeling systems have become increasingly popular in the hydrometeorology community in recent years. The coupling technique and the implementation of data assimilation technique introduced in this paper could be expanded to other data assimilation method



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and other coupled modeling systems.

**Specific comments**

1. P9622, L12 “However, while such integrated modelling approaches provide a better description of model physics which effectively reduces model structural errors that often occur in single compartment models through the parameterization of lower or upper boundary conditions. . .”

   I don’t quite agree. Sometimes coupled models could introduce model structural errors. However, this is minor.

2. P9627, L24 “For example, local filter variants like LETKF need special routines to infer the position of each element of the state vector in the model domain in order to perform the localization which is not needed by global filter algorithms like EnKF.”

   I understand that localization is not needed by EnKF. However, covariance localization could be important for a large-scale multi-watershed application. Is there a way to account for localization in the data assimilation system?

3. P9633, L6 “In this case, pressure values in ParFlow are indirectly corrected with the incoming soil moisture measurements through the correlations between soil moisture and pressure. This is necessary, because the prognostic variable in ParFlow is pressure and soil moisture (or saturation) is a derived quantity which is not directly used as a state variable for the next time step.”

   I understand that soil moisture is a derived variable but not a prognostic variable in ParFlow. But the pressure values could easily be converted into soil moisture using the van Genuchten equation. So why not convert the pressure values into



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soil moisture values, update the soil moisture values, and convert them back into pressure values?

4. The system can be used to estimate parameter values. Is there a way to constrain the parameter values (and state variables) in their physically plausible ranges? This could be important as some "bad" parameter values could break the model.

5. P9643, L18 "The improvements made by assimilating soil moisture content are relatively limited for land surface fluxes which is related to the shallow ground water table in the simulations guaranteeing that actual evapotranspiration is equal to potential evapotranspiration."

   I don't think the actual evapotranspiration is equal to potential evapotranspiration in this case. The plant stomatal conductance is affected by visible solar radiation ($S$), air temperature ($T_{\mathrm{air}}$), air humidity (RH), and soil moisture ($\Theta$). In this case, although soil moisture is close to saturation, $S$, $T_{\mathrm{air}}$ and RH still limit the actual ET which may not reach the potential ET. The reason that the AAE is small for $H$ and LE is because (1) $S$, $T_{\mathrm{air}}$, and RH are the same in the ensemble as in the reference run; (2) in both the ensemble and the reference run, soil moisture is close to saturation, and (3) the other parameters affecting ET are not perturbed (e.g., the minimum stomatal conductance).

**Technical corrections**

1. P9619 L1 "20 Mio. unknows"

   Should be "unknowns".

2. P9619 L10 "precipitation, hydraulic properties"

   Could be more clear if change this to "soil hydraulic properties".



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3. P9620, L4 “. . . and to a lesser extend also concentration”
   Not clear concentration of what.
4. L9622, L7 “like, e.g., . . .”
   “Like” is redundant.
5. P9623, L22 “Finally, 6 provides. . .”
   Change this to “Section 6”.
6. P9624, L10 “i.e., the is no lateral exchange. . .”
   Change this to “there is no lateral exchange”.
7. P9625, L21 “recharge values”
   Do you mean infiltration values? Are they the same?
8. P9627, L21 “for e.g.”
   “For” is redundant.
9. P9635, L6 “The porosity is set to a value of 0.4 and . . .”
   Unit is missing for porosity.
10. P9641, L11 “A more detailed information . . .”
    “A” is redundant.
11. P9642, L13 “. . . stays above $> 0.8$”
    The greater than symbol is redundant.
12. P9644, L15 “Therefore, it was also tested whether the . . . framework is also applicable . . .”
    “Also” appear twice in this sentence.



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13. Figure 9

    Legend is missing. The ensemble mean is not shown in the figure.

14. Figure 10 There is a phantom line at $y = 1500$ m. Not sure if this is a pdf rendering problem.

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Interactive comment on Geosci. Model Dev. Discuss., 8, 9617, 2015.