Review of "Estimation of the state and parameters in ice sheet model using an ensemble Kalman filter and Observing System Simulation Experiments"

August 27, 2025

The revised version of the manuscript greatly improved the presentation of the methodology and experimental design. It has a more logical flow, and, with the exception of some minor issues outlined in the specific comments below, the key aspects of the results are now adequately addressed and discussed. The additional experiments presented in the Appendix provide further value.

Specific comments

[Now, we use consistent terminology (model state) throughout the manuscript.]
There are still instances in which you do not use *model state* (e.g., L12).

[L26-27]
I suggest adding a sentence that better links the two paragraphs by describing how DA methods can reduce the uncertainty in key model parameters and model initialisation.

[L52-54: As new observations are incorporated within the assimilation period, the ensemble mean presents an increasingly more accurate estimate of the model state.]
This seems to contradict your statement in L14-15: *additional observations do not improve and may even degrade long-term estimates of model parameters and state*

[We revised it to "true values".]
I suggest adding "*synthetic* twin experiment" in L95.

[We used an adaptive mesh based on ice velocity and included a new figure (Fig. 1(d)) in the revised manuscript.]
Add a reference to Fig. 1d to the end of L127. Is the mesh adjusted as the grounding line retreats? Note that the rainbow colour scheme in panel d is not in line with the journal guidelines.

[$z_{\mathrm{b,deep}}$ = Depth of the bedrock topography in Table 1]
This is confusing, as your bedrock topography in Fig. 2 varies spatially. Consider *Maximum depth of the initial bedrock topography.*

[L156: these surface and basal forcings]
Since the lines directly above are discussing the melt rate, consider re-stating what these forcings are or refer to them as *perturbed surface and basal forcings.*

[L169: we choose the EAKF due to its reduced sensitivity to ensemble size]
This is somewhat confusing, as in L179, you state *a common challenge with [...] EAKFs [...] arises when the size of the ensemble is significantly smaller than the independently observed degrees of freedom.*

[L282: EnKF]
Should this be EAKF?

[L297: continues to decrease steadily]
It does not continue to decrease steadily.

[L301-302: the benefits saturate as the ensemble size increases from 50 to 100]
Be more precise here. For bed elevation and ice thickness, an ensemble size of 100 has a larger RMSE at t=30a than for a size of 50.

[L302: illustrative purposes]
What do you mean by that?

[Fig. 7: What causes the sharp grounding line extent towards higher x values at y=10 km in the no assimilation panel?]
You did not provide an answer to this question.

[We chose to show the difference in ice thickness in Fig. 8 because changes in thickness are difficult to detect visually from the similar figure as Fig. 6 and 7.]
Yes, but wouldn't it also be easier to detect the changes if you plotted the differences in Figs 6 and 7?

[L362: although RMSE values continue to decrease until the end of the assimilation window]
At 15 km across-track spacing, not all RMSE values continue to decrease.

[We added the reference to Fig. 13 and described the increase in RMSE for the 20 km grid data.]
Fig. is missing for some of these references.

[L437: observations years]
Change to *observation years*.

I hope the authors find my comments helpful.

Sincerely, Kevin Hank