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Comment on hess-2022-342

Warrick Dawes (Referee)

Referee comment on "A comprehensive assessment of in situ and remote sensing soil moisture data assimilation in the APSIM model for improving agricultural forecasting across the US Midwest" by Marissa Kivi et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-342-RC1>, 2022

hess-2022-342 "A comprehensive assessment of in situ and remote sensing soil moisture data assimilation in the APSIM model for improving agricultural forecasting across the U.S. Midwest" M.Kivi, N.Vergopolan, H.Dokoohaki

Kivi et al (2022) is cited 25 times in the text! While this work is distinctly different to that work, perhaps a single mention at the start of each section, rather than every second and third level sub-section, would be adequate (such as the existing introductory paragraph in each major section). As far as I can tell, and I am no expert in data assimilation techniques or applications, the work presented is solid and thoroughly describes the proper use of the techniques. The authors honestly presented when the technique improved certain predictions, when it made little difference, and when the model performance degraded. While I can see why the extension was required in Figure 4b, as it's only 3 of the results and the big picture is shown well with the box-and-whiskers, the extension can be placed in the Appendices and mentioned in the text as with free-model results.

Was the "free run" calibrated against any data, or was it just an ensemble of model runs with the parameters randomly assigned from prior distributions? Were they a single run with an arbitrary (or literature) set of values assigned to parameters? How do the modelled results compare to the "final" set of parameters after the full SDA? I did not get the appendices so don't know if this is covered.

There are a number of questions that the work raises, that may be answered here (or later maybe).

- As the parameters are nudged successively with the SDA procedure, how much do they need to vary until the researcher considers that (a) their *a priori* range is incorrect, (b) that they cannot be considered a constant, or (c) that some process is too simplified or missing in the numerical model?
- Further to the case of a non-constant model parameter, is there a pattern in the parameter adjustments, e.g., always too high in winter and too low in summer, that indicates a systematic misrepresentation within the model?
- Is there a form of *a posteriori* distribution of parameter values, e.g., normal versus log-normal versus bi-modal versus uniform, that may indicate systematic model or data errors?
- Is there parameter bias (or trends?) associated with larger underlying groupings, such as soil texture, vertical layering (duplex, gradational, uniform), crop type, or management, that indicate model structure or data limitations?
- Given the use of numerical models is primarily predictive, i.e., what are future potential grain yields or nitrate loss or deep drainage under different management or climate conditions, which set of parameters (or reduced range) do researchers consider stable enough to make such computations?

The References and citations need a lot of purely technical corrections.

- Following reference not cited in text: Akhavizadegan et al (2021); Archontoulis et al (2014, 2020); Balboa et al (2019); Crane-Droesch (2018); Das et al (2020); Dietze et al (2013); Dietzel et al (2016); Flathers and Gessler (2018); Guerif and Duke (2000); Hoffman et al (2020); Jeong et al (2016); Kang et al (2020); van Klomperburg et al (2020); Leng and Hall (2020); Li et al (2014); Martinez-Feria et al (2019); Pasley et al (2021); Puntel et al (2016); Shahhosseini et al (2021); Spijker et al (2021); Wallach et al (2021).
- Following citations not in references: Lu et al (2019); Lu and Steele-Dunne (2019).
- The two articles of Vergopolan et al (2021) are cited with (a) and (b) in the text, but not indicated as such in the references.
- Citation for Chakrabarti et al (2014) is misspelled in the text line 83 and 605.