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Hydrology and Earth System Sciences Discussions

Interactive comment on "Assimilation of ASCAT near-surface soil moisture into the French SIM hydrological model" *by* C. Draper et al.

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This is an interesting study that has attempted to correct the SIM model random errors and biases by assimilating the surface soil moisture observations. Authors have substantially examined the effect of the assimilation experiments over the model performance; specifically over the water balance elements. However, there is still room to improve the manuscript further. These points include:

1) In the past, many studies have attempted to perform on-line and off-line corrections of biases during the assimilation of the observations. As Dee and Da Silva (1998; Data Assimilation in the Presence of Forecast Bias) have performed, bias corrections are generally done to correct "short-term forecast" biases. Furthermore, as Dee and Da

Silva (1998) says, "unless bias is explicitly accounted for, it can be reduced only at the expense of increasing the noisiness of the analysis" (shown in their fig. 1).

Hence, it is expectedly a better way to first correct the anticipated long-term bias in the system and then perform the assimilation of observations to reduce the random errors of the system.

However, in this study, the goal of the study is setup over the use of observations to reduce the long-term bias rather than the random errors of the system. Could authors elaborate the performance gain and loss of this assimilation system due to the setup selection in this study in the context of the bias and the random errors?

2) In general, in a forecasting system, every bit of information should be incorporated in the system to obtain the best model forecast. Given the awareness of the dry bias, can authors tell why a forcing bias correction before the assimilation was not performed?

There are so many precipitation observations obtained from rain gauges, radars, and satellites exist; a potential bias correction can be done in many different and much simpler ways, without performing complicated data assimilation techniques. Following the above comment, correcting the bias before the assimilation of observations could potentially further reduce the noisiness of the system too.

Without the bias correction, the question, would replacing the existing forcing with an unbiased forcing without the assimilation of the observations give better results than biased forcing simulations with assimilation, would always remain.

Hence, it is recommended that authors would also include some simulations (open loop and assimilation) that uses forcing that is corrected for bias.

3) In this study, observations added water into the system even though they were CDF matched and unbiased when compared to the forecasts. The results are intriguing that the observations effected the system in a particular direction (they increased the wetness). This implies that the observations were more correct than the forecast when

observations were wetter; and the reverse is also true that observations were less correct when they are drier than model forecast (=higher Kalman gain when observations are wetter and vice versa; so that on average observations would increase the moisture content of the system). This has to be the case, otherwise if the correctness of observations is equally distributed when the observations are wetter or drier than the forecasts, then the cumulative innovation would cancel each other; and eventually, on average, the assimilation system would not get drier or wetter (there wouldn't have been any bias).

Given a CDF match is already performed (observations are not biased in any direction), could authors tell why this mechanism exists? (observations are more correct when they are wetter than forecasts). Does it exist in other observation systems? Could this mechanism be a reliable mechanism to improve the assimilation studies in general?

Lastly, adding the innovation time-series in the same panel with the analysis increments (Figure 7f) could be very helpful in the interpretation of the effect of the observations.

4) The goal of the study can be clarified, specifically the definition of "benefit". Do authors mean "reducing the random errors of soil moisture analysis of SIM model", or "reducing the bias of the soil moisture analysis of SIM model", or both, "or including other water balance elements"?

5) It is not very easy to get the details of some plots in Figure 7 & 8. Using a scale consistent with the max/min values could help greatly.

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