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Interactive Comment

Interactive comment on "The impact of near-surface soil moisture assimilation at subseasonal, seasonal, and inter-annual time scales" *by* C. Draper and R. Reichle

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Anonymous Referee #1

- We appreciate the referee's comments on our manuscript, which have helped us to clarify several key points. These comments are reproduced below, with our response to each provided as a bullet point.

The paper investigates the benefits of data assimilation of remotely sensed soil moisture in the Catchment land model on three different time scales and therefore fits within the scope of the journal. The authors find that assimilation significantly reduces errors at every study site for all time scales, in particular also for long-term events. Further analysis on observation-bias correction parameters shows, that the estimation of rescaling parameters from only one year of data record will not considerably reduce the average benefit, but can increase local errors. The paper is well-written and in general well organized, but a more detailed description of the study approach would make the paper easier comprehensible:

1) It does not get clear in the Introduction and in the Methods if the decomposed soil moisture was assimilated into the model separately, or if the soil moisture time series were assimilated and the results decomposed afterwards for analysis.

- In response to Referee #1 & #2, Section 2.2, which introduces the data assimilation experiments has been expanded to more fully describe the assimilation experiments. This includes explicitly stating that the assimilation experiments use 'only the original AMSR-E time series data, and not the decomposed time series'.

2) It would greatly improve clarity to describe the two methods of rescaling (CDF and Interactive linear) in the Methods section as in the current draft the linear rescaling is first mentioned in section 3.4. Furthermore, a short explanation on the rescaling experiment with short data records in the Methods section would be useful.

- The details of the two rescaling methods, and the rescaling experiment with short data records, has been expanded and moved into the expanded Section 2.2.

3) It would be good to give the definition (for example the one of page 7985, lines 26-28) and an equation for the ubMSE in the methods section.

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- An equation for the ubMSE has been added to Section 3.5, together with a sentence pointing out that the ubMSE is also known as the variance of the error.

More information about the dealing with scaling differences between the soil moisture datasets would be interesting, as differences in the results might be influenced by differences in spatial scaling.

1) ARS sensors: Which and how many sensors were used for each study site? What is the size of the respective areas covered by the sensors?

- Section 2.1 has been expanded to provide more details of the in situ data used. This includes stating that there were between 8 and 15 sensors averaged at each site, covering an area roughly equivalent to the AMSR-E observations. The specific numbers of sensors and approximate area for each watershed have also been added to Table 1.

2) How many grid cells of AMSR-E and the Catchment model did you use /are surrounding each site? How did you deal with differences in the number of grid cells and their resolution (0.25° vs. 9km)?

- A single grid cell was used for each site. This has been made clearer in Section 2, by changing 'the grid cells surrounding each site' to the 'grid cells encompassing each site'. We do not explicitly deal with the difference between the 9 km model grid and the 25 km AMSR-E grid, beyond rescaling the observation time series prior to assimilation. While the difference in spatial support between the model and the AMSR-E observations could be better accounted for by averaging multiple model grid cells, in this example the resulting model time series would be very similar to the present time series for a single grid cell. This is because the model physics do not explicitly account for soil processes at multiple spatial

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scales, and likely do not represent the specified spatial support of the grid cells very well. Spatial variation present in the model soil moisture is derived from the atmospheric forcing or surface parameters (topography, vegetation, soil parameters). In these experiments, the forcing (from MERRA, at 0.5 degrees) is at much coarser resolution, and any sub-25 km variability will be contributed by the surface parameters, which do not have sharp gradients within the ARS Watershed sites.

3) If more than one grid cell was used for each site, how were the single time series for each site created?

- A single grid cell was used.

Specific and technical comments

Eq. 1: ak and bk are not defined

- ak and bk are the coefficients that will be selected to fit the function to the data. This has been clarified at the introduction of equation 1:
  'Formally, for some observed time series, y, the a_k and b_k coefficients in the decomposed form function, $\hat{y}$, are fit for some selection of integers k_i:'

P. 7987-7988, lines 28/1-2: '. . .differences that are addressed by the CDF-matching. . .'

You used linear rescaling for the Ayy results, is that right? Then this formulation might be confusing. The same applies for p. 7992, line 8

- CDF-matching was used for Ayy. This was not at all clear in the first submission, and has been made much clearer in the expanded Section 2.2.

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Page 7989, line 25: Delete one ‘significantly’

- Done.

References: Most references give the numbers of the pages on which they appear in the text after the year. However, this has not been done consistently.

- These numbers seem to have been added by the copy editors. We will coordinate with them to ensure a consistent approach.

Fig. 6: Which method of decomposition was used for these time series? Would there be a difference to the other decomposition method (even though Fig.2 did not show significant differences)?

- Harmonic decomposition was used. This is now specified in the caption.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 7971, 2015.

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