Hydrology and Earth System Sciences Discussions

Interactive comment on "Cross-evaluation of modelled and remotely sensed surface soil moisture with in situ data in Southwestern France" *by* C. Albergel et al.

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The authors thank the anonymous reviewer #1 for his review of the manuscript and for the fruitful comments. For an easier comprehension, general comments of the referee are also reported (1.XX).

1.1 [It is a bit confusing which stations are omitted from the comparison. It might be helpful to include station MTM in Tables 2 and 4 and list the metrics as "n/a". Similarly, Tables 5 and 6 could list SMX with "n/a".]

1.2 [Tables 1, 2, and 4 should include a final row that tabulates average values across

the stations (for ease of interpretation and cross-referencing with the text, where most numbers are mentioned).]

1.3 [Tables 2 and 4 should be merged. This would make it easier to see that ASCAT compares better to SIM than to in situ obs, and it would cut down on the number of different tables. It is a bit confusing at first to keep track of what is evaluated against what.]

Response 1.1, 1.2, 1.3

We agree with reviewer #1.

1.4 [Are the black lines in Figure 3 identical to the lines shown in Figure 1? From the text I understand that in both cases the black lines show the 5 cm in situ time series. However, the lines in Figure 1 show more pronounced peaks. It is not clear whether the two figures show different things or not. If they are different, please explain clearly. If not, Figure 1 should be deleted (because it would be repetitive).]

Response 1.4

In Fig.1, all the in situ data are presented (i.e. with a 12 minute time step) whereas they are daily averaged in Fig.3. This is a mistake, and Fig.1 will be modified with daily averaged data.

1.5 [Figure 2 should include a marker for the SMOSREX site.]

Response 1.5

In response to reviewers #1&#2, a new figure will replace Fig. 2, with a more detailed framework of the studied area (digital elevation model, SMOSMANIA and SMOSREX stations).

1.6 [Figure 4 is hard to read and discussed in the text in only one sentence. It should be deleted or improved with additional discussion.]

Response 1.6

This study uses three types of SSM estimates. It is important to show the individual SSM values used in this study, including the ASCAT ones. Figure 4 shows the comparison between ASCAT and SIM SSM. Over this two year period, it is possible to appreciate the seasonal cycles of SSM, i.e. with dry (summer) and wet (winter) periods for both SSM data sets and for all the considered stations. However, the seasonal cycle seems to be more marked for the SIM SSM.

1.7 [I am guessing that the bias and RMSE values in Tables 2-4 are in non-dimensional units obtained after rescaling the ASCAT retrieval according to equation 3 and also rescaling the in situ obs (as discussed on page 12). Please emphasize in the discussion and captions of Tables 2-4 that the units are different from the m3/m3 units that are used in the other Tables. As it stands the discussion is confusing, in particular since you convert the non-dimensional units back to m3/m3 for the ASCAT RMSE v. in situ(page 15, line 6).]

Response 1.7

We agree with reviewer #1. The units issue will be emphasized in both text and captions of Tables 2-4, as it can lead to misunderstandings.

1.8 [I am surprised about the use of the word "synthetic" for soil moisture estimates from a land surface model (SIM). These "synthetic" estimates are no more synthetic than the "operational" products. In both cases, estimates of precipitation and radiation forcing (along screen-level obs for the operational products) are converted into soil moisture based on physical models. Considering this, the ASCAT retrievals can also be considered "synthetic" because they are based on converting backscatter observations into soil moisture. I would recommend to replace "synthetic soil moisture" with "soil moisture from a land model".]

Response 1.8

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We agree with reviewer #1 that the use of "synthetic" could be applied to both SIM and NWP analyses, therefore, as suggested, "synthetic soil moisture" will be replaced by "soil moisture from a land model" in the next version of the manuscript.

1.9 [Page 16: Figure 5 is discussed in just 2.5 lines. Such a short discussion does not warrant a figure. Please expand the discussion or delete the figure. It is not clear, for example, whether the situation is similar at the other stations.]

Response 1.9

Fig. 5 completes Figs. 3 and 4 by presenting the probability density function of the three SSM data sets (in situ, ASCAT, SIM) over the LHS station. A bi-modal shape, characteristic of long SSM time series, is observed for the three data sets. Similar bi-modal pdfs are observed for the other stations (not shown).

1.10 [Page 16, section 3.2.3 first sentence: The linear transformation of the ASCAT into the downscaled ASCAT product may not affect the correlation coefficient, but it should affect the bias and RMSE. It is thus not clear why these metrics are not further discussed in the paper for the downscaled product. I think they should be.]

Response 1.10

If we consider this group of 10 stations (9 SMOSMANIA, and SMOSREX), the following scores are obtain with the standard ASCAT product (averaged for all stations), bias = -0.078 and RMSE = 0.243. With the downscaled product, rather similar scores are obtained: bias = -0.071 and RMSE = 0.257.

1.11 [Page 16, section 3.2.3, and Figure 6: Are the "spatial correlation" R values plotted in Figure 6 really based on just 10 data points in each case (9 SMOSMANIA stations and the SMOSREX station)?? The confidence interval associated with each of these R estimates would be huge. What are the average of the R values over all 150 images (separately for ASCAT and downscaled ASCAT)? While Figure 6 motivates that the average R values (over 150 images) is greater for the downscaled ASCAT product

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than that of the ASCAT product, the difference might not be statistically significant. This must be investigated further.]

Response 1.11

A suggested by reviewers #1&#2, spatial correlations were further investigated. While (from Figure 6) it is possible to appreciate that R values are generally greater for the downscaled ASCAT product than for the original ASCAT product, average R values are quite similar.

1.12 [Page 16, line 5 from bottom: "For each date at nine stations, ASCAT data at one km scale are spatially averaged and compared with the in situ observations." I do not understand why/how the "ASCAT data ... are spatially averaged" in this context. Please clarify.]

Response 1.12

We agree with reviewer #1 that this sentence is not clear. This analysis is done through different steps:

- step 1: Over the considered 2-year period, the ASCAT swaths covering the 10 considered stations (9 SMOSMANIA + SMOSREX) are isolated and analyzed separately,

- step 2: For each of these swaths (a total of 150), spatial correlations are calculated between the available in situ data (always 10 stations) and either ASCAT coarse resolution or downscaled estimates, resulting in 150 correlations values in both cases.

- step 3: the 150 correlations values obtained from the comparison between in situ and coarse resolution ASCAT estimates are compared to the 150 correlations values obtained from the comparison between in situ and downscaled ASCAT estimates. It permits to appreciate the added value of the downscaled product.

1.13 [Page 18, Figure 8: If the ECMWF IFS_F6ui estimates are better than the SIM estimates, why is the IFS_F6ui product not considered the "alternative truth" against

which the ASCAT obs are evaluated (section 3.2.2)??? See also page 19, lines 4-5.]

Response 1.13

In this part of the study, an advanced surface data assimilation system, based on a simplified extended Kalman filter (SEKF), screen-level parameters (T2m, RH2m) and ASCAT estimates is evaluated (i.e. the IFS_F6ui). We would like to show the added value of this new system (ingesting ASCAT estimates) compared to the operational one, i.e. optimal interpolation and screen-level parameters (T2m, RH2m). The IFS_F6ui product cannot be considered as an independent "alternative truth" against which the ASCAT observations are evaluated, as these estimates are used in the IFS_F6ui analysis.

1.14 [Page 19, lines 3-4: "Regarding ASCAT estimates, it was confirmed..." I do not see how this was in fact confirmed. You did evaluate ASCAT against in situ obs, but as far as I can tell the study does not prove that you can do so – except if you assume that the in situ validation yields results that are consistent with the validation against SIM. At some point you have to *assume* a "truth". Because that "truth" will always contain errors (measurement errors and representative errors in the case of the in situ obs; forcing and modelling errors in the case of SIM), it is really an assumption. At best you can conjecture that the errors in the "truth" that is used to validate a given dataset are much smaller than the errors in the dataset that is being validated.]

Response 1.14

What we mean here is that this study confirms that even if local in situ observations of surface soil moisture do not measure the same quantity than coarse resolution remotely sensed products, significant correlations are observed between the two measures. These correlations can be used to monitor the quality of satellite SSM estimates.

1.15 [Page 19, final sentence: "While the assimilation of ASCAT data ..." I am confused. Did you not just evaluate the IFS_F6ui (with assim of screen-level obs and ASCAT) ver-

sus the operational ECWMF (with assim of screen-level obs only), thereby separating the contribution of the ASCAT assimilation? I think what you are trying to say is that the operational ECMWF uses a different assim technique (OI) than IFS_F6ui (SEKF), but this is not at all clear from the sentence as it stands.]

Response 1.15

What is meant here is that while the IFS_F6ui prototype seems to perform better than the operational ECMWF IFS in 2008 and 2009, this added value of IFS_F6ui might be attributed to either the enhanced assimilation technique or to the use of the ASCAT SSM product.

1.16 [Caption of Figure 5: Change "Probability density function of the three datasets..." to "Probability density function of SSM for the three datasets..."]

Response 1.16

We agree with reviewer #1.

1.17 [Table 3: There are many commas left in this Table that should be changed into decimal points.]

Response to 1.17

It will be corrected in the next version of the manuscript.