

***Interactive comment on* “Operational assimilation of ASCAT surface soil wetness at the Met Office” by I. Dharssi et al.**

Anonymous Referee #2

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"Operational assimilation of ASCAT surface soil wetness at the Met Office" by Dharssi, Bovis, Macpherson and Jones is dealing with the benefit of satellite measured soil moisture for numerical weather prediction. ASCAT soil moisture measurements which are quality controlled and bias corrected are used to improve the distribution of water in the soil within their version of the UM of UK Met Office. The authors can show that due to this assimilation both the forecast for screen level parameters for different regions of the earth and the agreement between the modelled superficial soil moisture and in-situ measurements can be improved. The paper is well structured and the main aim of this study is quite well described. In addition, the topic of soil moisture assimilation is of high relevance nowadays. Nevertheless, there are some points which need to be clarified for the reader to make this paper worth being published. A detailed description

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can be found below. I am not quite sure about the severity of the bug in the model code reported in section 8.4: If it is a severe one affecting the results heavily, then the trials will have to be recalculated with the corrected model version. Otherwise (the authors should describe the influence of this error), I recommend accepting the paper with minor revision.

P4315, L3-4: Maybe it can be mentioned that there is an initiative to establish such a network (<http://www.ipf.tuwien.ac.at/insitu/>)

P4315, L19: “a more direct retrieval” compared to what?

P4315, L22: horizontal resolution of global NWP models

P4316, L11: ... soil moisture (Reichle

P4317, L2: “UM” is used before the shortcut is explained (see L20)

P4317, L4: “Most Met centres ...” Is soil moisture assimilation already widely used? If so, please give some citations.

P4317, L24: Are there any feedback mechanism between 4DVAR and MOSES2 or are they working totally independent (see also comment on P4326, L7-8)?

P4318, L1: ... surface scheme (Essery ...

P4319, L11 : ... ranging between 25° and 60° ...

P4319, L12: The gap is ~670km (see <http://oiswww.eumetsat.org/WEBOPS/eps-pg/ASCAT/ASCAT-PG-4ProdOverview.htm#TOC41>, Fig. 4.1)

P4319, L16: Is there any reason to use the data set with higher resolution (e.g. is it of better quality)? As far as I know, the ASCAT data set is improved permanently, so can you specify which version of the data set has been used for the experiments shown here?

P4320, L9-15: Is SWI used for your experiments? If not, I see no need to mention it

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here.

P4321, L1-10: It is mentioned that ASCAT is measuring the soil moisture of the uppermost ~ 1 stcm of the soil and that this layer is subjected to more rapid drying and wetting than layers below (e.g. 5cm). The uppermost layer of MOSES2 has a vertical extension of 10cm

(P4318, L2), which will lead to slower response to drying and wetting due to atmospheric influence. So I would like to read some arguments why ASCAT data can be used without any further processing to be assimilated to this model soil layer.

P4322, L4: What are a and b?

P4323, L6: Does that mean the parameter b is determined locally? If so, please specify the spatial and temporal resolution of this parameter.

P4323, L7: Which data base is used for the vegetation cover?

P4324,L23-P4325,L2: I do not understand this cross track cell number quality control. "3day period . . . re-gridded" means that averaged ASCAT values are calculated on a regular grid? How do you compare ASCAT data with re-gridded ASCAT data? I guess the quality controlled ASCAT data for each cross track cell will not fit spatial to the regular 25km grid. Is the effect a global one or have you tested for some regions of the earth separately (like for Fig. 1)? Besides this, has EUMETSAT given an explanation for this behaviour of the measurements?

P4325, L6: Which assumptions were made to use these values for observation and background errors?

P4325, L19: Are results of these early trials presented in this paper? If not, skip this footnote.

P4326, L15: Is this assumption proven by the results of this study? For the operational run, $K=0.2$ (P4331, L15) is used. How was this value determined?

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P4327, L1-6: Please specify more clearly the difference between the control experiment and the test experiment. Have you performed a control run without assimilation too? If no, why not – if yes, mention the results.

P4326, L7-8: I am not quite sure how the assimilation cycle is working. If only one forecast run is started for 12Z (P4327, L9 – trial 1), why do you calculated 4 analyses per day? How is MOSES 2 coupled to UM?

P4327, L10: UM NWP index: I am not familiar with this index, but following your argument, it seems to be not a very good index for soil wetness assimilation (L15-16). What are the absolute values of this index, as in table 2 only changes are mentioned (is the forecast better if the NWP index is increasing or decreasing?). Is there any other statistical measure that could be used instead of this one, showing the influence of ASCAT assimilation more pronounced?

P4327, L18: Figure 5 shows ...

P4327, LL19-20: “Within a few weeks, the ... soil moisture adjusts towards the ASCAT values...”. According to Fig.5, I would say it needs 2-3 weeks until the model soil relaxed towards the ASCAT data. Most of the trials (table 2) are 4-5 weeks, is this time period including the adjusting phase? Is this adjusting phase included in the verification results or have you skipped these 2-3 weeks at the beginning of each trial?

P4328, L4: “Apart from snow, there is no significant change ...”? For wetland and mountain points, values are changing by a factor of two, for the ASCAT estimated error even for a factor of three – although all three quality checks together are quite the same percentage throughout the trial. Was there maybe some change in the treatment of ASCAT estimate errors?

P4328, L7: What is the reference data set to calculate the RMS?

P4328, L23-P4330, L3: Does that mean the results shown here are including this bug? If the UM T/q soil moisture nudging scheme is including the bug, it should be also

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affecting the ASCAT nudging, isn't it (according to P4327, L1-6)? Can you also provide results from the bug-free version? I don't understand the reference to Fig. 7 here. I thought Fig.7 is showing the difference between test and control experiment, so the drying displayed there for northern Africa is a relative one (although I cannot say which run is the drier one as it is not mentioned if the difference is test –control or control-test). Does this difference disappear (or change significant) for the bug-free version?

P4329, L26: zig-zag pattern: What is the reason for this pattern?

P4330, L2: According to table 2, the NWP index vs. ANAL is quite different for trial 3, compared to trial 2 and 4.

P4330, L22-24: Why are stations rejected if there is a low correlation/high RMS?

P4331, L23-24: Are there any ideas why there is a positive benefit for the regions mentioned, but not for other ones (according to Fig. 8-10, I am not quite sure if your statement is true for North America for all trials)?

P4332, L7: "... may be slightly too moist": I would like to see more of the verification results for this argument. In Fig 13, 5 out of 6 stations show this behaviour, is it also true for the other 86 stations? Is it possible to include ASCAT measurements in these plots? Is the dark blue curve (with ASCAT assimilation) closer to the red curve than the light blue one for all stations?

P4332, L19: Maybe you can include a statement about the ASCAT data quality, usability of the data set and improvements on the data set which could further increase its usability for data assimilation.

P4332, L19: As the operational assimilation of ASCAT data started more than a half year ago, I am curious if there are any evaluations of the forecasts which would be worth being mentioned in this paper.

Table1: What is the meaning of these variables?

Table2: Please describe the difference between trial 3 and 4 (why is the K value only affecting the NWP index vs. ANAL and not vs. OBS?). Is + or – indicating an improvement of the forecast?

Table3: See comment on P4328, L4.

Table 4: The effect of the improvement stays the same no matter if stations are excluded from the comparison or not.

Fig. 1: The annotation of the axes is too small. Which time period was investigated for these plots? Is one dot in the plot referring to one measurement or is it the average for the whole domain for one month or something else? If these plots are valid for a longer time period, is there a yearly cycle (especially for regions with pronounced seasons and changes in vegetation like UK region)?

Fig. 2: The annotation of the axes is too small.

Fig. 3: The annotation of the axes is too small.

Fig. 5: The annotation of the axes is too small. What is the unit of the x-axis, I cannot figure out a time period which is separating one month into 9 parts?

Fig. 6: These plots are really small. What are the soil moisture nudges compared to for calculating the RMS?

Fig. 7: These plots are really small. Please specify in the legend if you calculated test-control or control-test. ASCAT assimilation is only affecting level 1 of MOSES2 directly; differences in level 2 are only due to propagation of soil moisture between the different levels in MOSES2?

Fig. 8: The annotation of the axes is too small. The different scales on the y-axis are confusing when trying to compare the results for different regions. Why is the zig-zag pattern not occurring for all regions? How many stations have been used for verification? I am wondering about the fact that for Australia, the forecasts with ASCAT

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assimilation are even getting better for long time forecasts (hours 96+). I thought it would be the other way round: assimilation is improving the analysis, giving a positive impact on the short range forecasts.

Fig. 9: see Fig.8

Fig. 10: The annotation of the axes is too small. The different scales on the y-axis are confusing when trying to compare the results for different regions. What is the main reason for the differences (e.g. improvement for North America in trial 4, improvement for Tropics in trial 3) between Fig. 9 and Fig. 10 (e.g. different number of levels, different season)?

Fig.11: Is there any coherence for the stations that are increasing the random error in UM?

Fig.13: The annotation of the axes and the legend is too small. What is the unit of the x-axis? I would also like to see the ASCAT measurements in these plots. Can you mark the stations shown in Fig. 13 in Fig. 11 or 12 (for those who are not familiar with US federal states)? Are these stations chosen randomly or is there a special reason for choosing them? What is the unit of Elev?

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