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Hydrology and Earth System Sciences Discussions

Interactive comment on "Assimilation of space-based passive microwave soil moisture retrievals and the correction for a dynamic open water fraction" *by* B. T. Gouweleeuw et al.

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Anonymous Referee #2

The authors would like to express sincere thanks to anonymous referee #2 for submitting a review and for his helpful comments.

General Comments

Referee #2 makes mention of some issues earlier addressed by referee #1, such as the scaling of the various soil moisture products, the use of actual satellite microwave data (as opposed to synthesized data), the overestimation of the VUA soil moisture

product in the South-Central area and the different sampling depths. In addition to the response given (see reply to referee # 1) with regard to the scaling issue, the following text has been added to the manuscript:

p6, L17: To assess the impact of (re)scaling on the LPRM soil moisture product, both the absolute and relative retrieval are analysed for the year 2003.

P8, L21: Unsurprisingly, the AMSR-E VUA rel retrieval shows a larger range than the AMSR-E VUA abs product for these areas. The seasonal pattern, however, is virtually identical. This seems to indicate the (re)scaling of the VUA product does not significantly affect the observed pattern.

Further, the use of real AMSR-E data, as opposed to synthesised satellite data is emphasized, as suggested by the referee.

P2, L9-11: We analysed the influence of such small open water bodies on near-surface soil moisture products derived from actual (non-synthetic) data from the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) for three areas in Oklahoma, USA.

Finally, the authors believe the sampling depth issue is discussed in detail under the section 4: Results, Comparison of on-ground, modeled and satellite-derived soil moisture, concluding the satellite-derived soil moisture products generally agree best with the CLM2 simulations in the absence of positive bias, due to comparable top soil sampling depths:

P9,L11: In the Western area, the AMSR-E products plot closest to the CLM2 simulation, in agreement with the comparable sampling depth. Specific Comments/ Technical Corrections (P: page, L: line or lines)

p2 (1015), L25: It seems Davenport et al (2008)and Loew (2008) probably uses absolute error and this study does relative error? Is it possible to have a few sentences towards the end in the discussion section that compare the error between this and the

synthetic studies? Reply: The Root Mean Square Error (m3m-3) computed is absolute, although the 30 vol. % refers to the current LPRM relative soil moisture products, which may exceed the 0.5 vol. % threshold, and, as such, may be considered an index. The maximum RMSE with the earlier LPRM absolute soil moisture product, scaled between 0-0.5 vol. %, is a little over 20 vol. %. The text has been adjusted to include the latter RSME (see below). This, however, is still in excess of the maximum RMSE values (0.10-0.15 vol. %) reported in the papers mentioned above. This may be explained by the use of observed satellite microwave data, as opposed to synthesized data. In the synthetic studies, the various factors that a cause positive bias in the soil moisture retrieval (open water, vegetation, urban area) are analysed individually. The current study is based on actual satellite observations. As a result, a number of factors may aggregate or interact to cause larger errors.

The text has been adjusted as follows:

P2, L25: The comparison demonstrates the presence of relatively small areas (<0.05) of open water in or near the sensor footprint, possibly in combination with increased, below-critical vegetation density (optical density < 0.8), contribute to seasonally varying biases in excess of 0.2 (m3m-3) soil water content.

P12, L23-25:Previous synthetic studies (e.g. Davenport et al., 2008; Loew, 2008) suggest that ignoring 0.05 open water fraction in the retrieval can lead to a bias of about 0.05-0.1 (m3 m-3).The larger bias in proportion to the open water fraction in the longer time series observed here, therefore, may represent an integrated error, caused by (an interaction of) open water, increased vegetation density, and/or other. However, as mentioned earlier, the times series in Figure 7 show VOD (and hence the associated soil moisture retrieval error) in reverse phase with the observed positive soil moisture bias.

p4 (1020), L13: Both images do show a distinct gradient. Reply: Agreed and acknowledged, although the summer image (28 July) does not reflect the higher extremes of

the early spring image (2 April) in the East.

p5 (1021), L1: Why should it be "Despite these differences": maybe remove the phrase? If I understand correct, AMSR-E VUA in Fig. 3 has an assumed static open water fraction, and it is shows pronounced seasonality. So for AMSR-E UoM with the dynamic open water fraction can show even more pronounced seasonality, or maybe some reduction of the seasonality which is what the figures seem to be showing. I think this "Despite these differences" phrase should be used only after the VOD-based discussion on p.1023.

Reply: The authors agree this comment is made prior to the discussion and have adjusted the sentence to remove the part “Despite these differences”: Some seasonality is also present in the UoM retrievals in the South-Central and Eastern area, albeit less pronounced and at a lower level than in the VUA retrievals.

p5 (1021), L3-5: South-Central Mesonet also seems higher (though statistically insignificant). I think the sentence should be elaborated upon more in terms of higher vs. lower soil moisture areas as seen from the Figure 2 map.

Reply: The authors agree and have adjusted the text to elaborate on the differences between the different areas with regard to the UoM retrieval. The Figure 2 map (now Figure 1), shows the VUA soil moisture product: Table 1 and 2 indicate RMSE for the UoM retrievals vs. ground-observed and modeled soil moisture is consistently higher in the Western area, while it is alternately higher and lower in the other two areas. The UoM compares best to the CLM2 simulations, which reproduce relatively dry time series of soil moisture with a high dynamic range (Fig. 2).

p5 (1021), L5-7: But then the CLM series does not match the AMSR-Es. Can you speculate why in terms of any known forcing, radiative model, open water sensitivity etc. biases?

Reply: In the Western area, where no seasonal bias is observed, both the VUA and

the UoM soil moisture product compare best with the CLM2 simulations, as expected, due to the relatively shallow top soil moisture depth. This holds in the other two areas too for the UoM product, but not for the VUA product, due to the observed seasonal bias.

p5 (1021), L9-11: Now this seems to imply an absence of average forcing bias, something that seems contrary to implied as referenced in comments above for p5 (1021), L5-7. Please reconcile and/or speculate about this apparent discrepancy.

Reply: After further examination, the authors agree this statement is not entirely correct and have adjusted the sentence as follows: The Mesonet observations taken at a 5 cm depth mostly plot close to the Noah simulations, although they differ more in the Eastern area.

p5 (1021), L11-13: So this means a static open water fraction is better (i.e., if I understand correct that AMSR-E VUA has a static open water fraction)?

Reply: This is correct, in case no open water is present in the satellite footprint, as in the Western area. It should be noted, however, the UoM product does not return an open water fraction in this area. The authors have added: “In the Western area” to the sentence. In the Western area ,the AMSR-E products plot closest to the CLM2 simulation, in agreement with the comparable sampling depth.

Figure 4: Is there supposed to be a colorbar here?

Reply: Apart from the open water pixels (blue), the colours do not represent any (classified) information, apart from being false colour representation of bands 7, 2, and 1. The three colours mix according to the band ratio in each pixel. A colour bar is therefore not considered applicable here.

Technical Comments

Title: Remove the phrase "Assimilation of" from the title, there is not assimilation here.

Reply: “Assimilation of” has been removed from the title.

p1 (1014), L13: maybe "to those based on dynamic estimates of open water fraction" instead of "to dynamic estimates of open water fraction"?

Reply: The authors have replaced “compared” with “related”, as a more accurate description of the presented analysis.

p3 (1017), L27: maybe replace "dynamic variable" by "dynamic model state"?

Reply: The authors are unsure (all) the atmospheric forcing variables would classify as model states.

p3 (1018), L19-23: Perhaps explain the 2 sentences more clearly for the benefit of readers. e.g., what resampling method? how/why 37 km?

Reply: The diameter of the largest (6.9 GHz) oval satellite footprint = 74 km. If the centroid of the satellite footprint plots close to the border of a grid cell (and its value is subsequently assigned to that grid cell), it represents an area outside of the grid cell equal to the radius of the satellite footprint = diameter/2 = 74/2 = 37 km. The sentence is rephrased as follows: It is noted that this extends the nominal footprint area considered to a zone by up to 37 km beyond the grid cell, in case the centroid happens to plot close to the grid cell borderline.

p5 (1021), L8: Why cannot it be changed? Please provide an appropriate citation.

Reply: The authors believe a soil profile with fixed depths is inherent to the Noah model structure. The text has been adjusted and an appropriate reference has been added: The Noah model structure stipulates a soil profile with fixed depths of its 10 layers (Ek et al., 2003). The depth of the top soil layer is fixed at a 10 cm, prompting higher average moisture content with a lower dynamic range.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/9/C796/2012/hessd-9-C796-2012-

supplement.pdf

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