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Hydrology and Earth System Sciences Discussions

Interactive comment on "A global analysis of satellite derived and DGVM surface soil moisture products" *by* K. T. Rebel et al.

Anonymous Referee #1

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A global analysis of satellite derived and DGVM surface soil moisture products

General comments

An interesting study that compares the soil moisture simulations of a process-based vegetation model with soil moisture measured in-situ and derived from the AMSR-E radiometer. The study is original as, apart from classical metrics such as pearson's R it also considers autocorrelation to compare the dynamics of the various data sets. The manuscript is well structured and written in fluent English. I would like to recommend it for publication in HESS after carefully addressing the issues raised in this review.

My major concern is the application of a 5 day moving average to the satellite-based

soil moisture product prior to starting the analysis. Your motivation for doing this seems unjustified. In many cases the random noise of the signal is on average much smaller than the natural fluctuations of soil moisture. This means that you take out a lot of the soil moisture dynamics. First, the radiometric accuracy of AMSR-E is believed to be rather good, second, the revisit time of the satellite is far higher than every 16 days, so a global coverage is attained within $\sim$2 days (You even contradict yourself in the next paragraph where you discuss the coverage...). I recommend to either repeating the analysis for non-convoluted data or to providing much stronger justification. Alternatively, you could use remote sensing-based profile soil moisture, such as the soil water index (Wagner et al., 1999).

Related to this, I find your results difficult to interpret, as in most analyses you compare the surface soil moisture measured by AMSR-E with ROOT_SM (2m column?) of ORCHIDEE. Also in this context, using a remote sensing-based profile soil moisture instead of surface soil moisture would significantly increase the value of the similarities and differences observed in this study.

My second concern is the use of in-situ data. On the one hand, a clear description of the measurements is missing, even as a clear description of the measurement depths that were used for the comparison. In Section 2.3 you write that you selected sites with a reliable record of top-soil moisture record, whereas in Section 3.2.2 it seems that you used deeper in-situ measurements for the comparison. Or did you use surface measurements for the comparison with AMSR-E and deeper measurements for comparison with ROOT_SM? Otherwise I could not explain the differences in availability between AMSR-E and ORCHIDEE in Table 3. On the other hand, the sites selected do not seem to be very representative on a global level, especially not if half of the sites falls out in the in the analysis. They cover mainly grassland sites at mid-latitudes.

Specific comments

P4282.l5:"...to evaluate the results..." Please be more precise. What results? What do

you mean with “evaluate”? Reading this the first time I expected a more comprehensive validation than the one presented in the manuscript.

P4282.l6: why is only the period 2003-2004 considered? Including more years, e.g. until 2009 would make the observed findings more robust. For example, are the structural differences between 2003 and 2004 still present (or reversed) between 2004 and 2005?

P4283.l15: “...difficult to observe...” Add “with in-situ measurements”

P4283.l15: “Microwave remote sensing provides the capability for direct observation of soil moisture.” This is wrong, remote sensing of soil moisture is an indirect measurement (radiation is measured) and a model is needed to convert measured radiation into soil moisture units.

P4284.l4: “working at the same temporal and spatial resolution. This is not always true: several land surface models work at higher or lower temporal (e.g. 6h) and spatial (e.g. 0.5°) resolutions. Based on section 2.2 (p4287.L1) I even assume that the soil moisture state in ORCHIDEE is updated every 0.5 h.

P4284.l4: “... spatial correlation is lost at around 25 km...”. This cannot be considered a general statement as it depends very much on the region and principle weather systems. In many areas spatial correlation may extend for 100s of kilometres whereas in others the correlation may get lost within a few kms. Anyway, this statement is not really needed to justify the use of satellite-based retrievals for LSM validation.

P4284.l9: Spend a few more words on ORCHIDEE, e.g., the input and output variables.

P4284.l23: Explain “comparison analysis”. In this form it is too vague.

P4286.l3: see my comment on the 5 –day low-pass filter in general comments section

P4286.l16: define “sparse”, “moderate”, and “dense” vegetation cover. Please check and cite also (Parinussa et al., 2011) for uncertainty of LPRM product.

P4286.l17: “This is relatively small number...” This statement does not hold: an error of 0.04 m3m-3 still leads to a very high relative error in dry conditions.

P4287. L15: What is the lower boundary of SHALLOW_SM?

P4287.l17-l23: too little information is give on the way how SHALLOW_SM fills up and looses water. At what speed? What mathematical description is used to percolate water to the deeper layer? How is “very dry” defined? How “wet”?

P?4287.l24: 300 mm: is this for the 2 m profile or per meter?

P4288.l4: To me it is not clear how ROOT_SM is related to SHALLOW_SM and DEEP_SM. Is this a different layer?

P4288.L15; how is increasing CO2 accounted for? Using what scenario? How do you incorporate the increase in CO2?

P4288.L21: aren’t there more than 500 FLUXNET sites?

P4288.L27: Information should be provided about the measurement depths (this can be done in Table 1) as this will determine to a large extent the results in Section 3.2.2. How are in-situ data processed? Do you average over all depths to obtain a value for the root zone which in Section 3.2.2. you use for comparison with ROOT_SM?

P4289.L1: is optical depth <0.8 considered as “low” vegetation density?

P4290.L1: equation requires appropriate formatting, using variable names instead of numbers. And where does 2003/2004 stand for? Average soil moisture content for the year 2003/4?

P4291.L2: What is the time unit of k? Days?

P4291.l17: You write that you masked cells with less than 100 data points per year. For me it is difficult to believe that for large parts of the Sahara and the entire Arabian Peninsula the top layer bucket is filled more than 100 days / year. Please check if this

is correct.

P4291.l21: “the correlation coefficient is difficult to calculate at dry times of the year”. But you don’t do this: You calculate R for the entire year, not for parts of the year

P4291.L21: I miss a discussion on the differences we see in Fig. 1 between SHALLOW_SM and DEEP_SM. They almost perfectly behave like each other’s negative (See e.g., northern America, SE and SW Australia). Where does this behaviour come from? Why are correlations for SHALLOW_SM higher for many dry areas than for other areas?

P4192.L3: frozen soils should be masked out entirely for the AMSR-E product. The analysis should be redone using a snow and frozen soil mask.

P4292.l7: I’d suggest to also have a look at Fig.4 in (Liu et al., 2011) where correlations are shown between AMSR-E and the Noah model. This would provide you a more direct comparison.

P4292.l10: “. . . results in low r-values, comprised between 0 and 1.” Remove “low”, 1 is not really a low r-value... Or do you mean the globally averaged r-value?

P4292.l17: “correlation between AMSR-E and ORCHIDEE”: which soil moisture layer are you referring to? Same for caption table 2.

P4292.l20; “Figure 3c shows. . .”: how significant are these differences? Or is it just a “>=”?

P4293.l10: In Table 3 half of the comparisons are missing for ORCHIDEE, which really is a pity and bases the evaluations made in this section only on 8 stations. I would suggest that you look for some more sites where also ROOT_SM is available for 2003-2004. Apart from the FLUXNET sites you could have a look at the International Soil Moisture network (http://www.ipf.tuwien.ac.at/insitu) to see if you find something suitable (e.g. OzNet). To me it is not clear what in-situ measurements (which depths) you use for the comparison with ROOT_SM (see my comment above).

P4293.l15: What do you mean by “correlation coefficient rank”?

P4293.l17: “The correlation coefficients for ORCHIDEE are generally higher than for AMSR-E”. I am not entirely satisfied with the explanation you give in the following line s. Are you sure that you compare the same things? Can the explanation also between sought in the fact that AMSR-E represents surface soil moisture and ROOT_SM root zone soil moisture?

P4294.l9: Why do you use this cut-off value? Is there any physical meaning for this? A reference or plausible explanation should be provided for this.

P4294.l17: “ORCHIDEE always overestimates the auto-correlation”. Two things: 1) avoid the use of “overestimates” as you are not sure if the other ones are correct (notice that this also depends on the threshold rk that you use).2) Can you convince me that you are not comparing apples with oranges as you compare the time lags of surface SM with the time lags of root-zone SM? I therefore think that reason number 3 (p4294.l25) is THE reason for the differences encountered between AMSR-E and ROOT_SM.

P4295.l12: “ . . . showing a too slow temporal dynamics. . .” Based on your analysis you can only conclude that they are different, but not which one is correct, as you correct surface soil moisture with root-zone soil moisture. Unless you want to use ROOT_SM to describe your surface soil moisture characteristics, but I don’t think that this is the case.

P4295.l17: “...overestimates...” see remark above.

P4295.l21: provide support for choosing “1/e” as threshold for being significant.

P4295.l23ff:Fig.6 This comparison would be even more interesting if you would include a soil map. Fig6c suggests that high differences correspond to areas with relatively impermeable soils (clay) and peat land (Siberia).

Technical corrections

Title: the term DGVM is not explained in the text: spell out entirely in title and explain somewhere in manuscript

P4284.l11: "...point locations, and in..." remove ", and"

P4285.l11: "swatted" is used incorrectly here.

P4286.l16: "0.1" what unit?

P4292.l6-9: this part should move to previous paragraph. New paragraph should start with: "Correlating the precipitation..."

P4292.l29: I would not use the term "climate" for yearly variations

P4295.l18: "this may suggests" Remove "s"

Fig.4.: legend cannot be read entirely: Root_SM falls off. Use same formatting of variables as in text, i.e. "ROOT_SM" instead of "Root_SM". Does rk have a unit? You only show grassland sites. I would suggest to show at least one other land cover type. ". . . calculated foUr different sites: remove "u"

Fig.5.:Use different symbols for AMSR-E and ROOT_SM which makes the distinction easier in a black and white print. What do labels indicate? The plot numbers? Some labels overlap.

References

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Parinussa, R., Meesters, A. G. C. A., Liu, Y. Y., Dorigo, W., Wagner, W., and De Jeu, R. A. M.: An analytical solution to estimate the error structure of a global soil moisture data set, IEEE Geosci. Remote S., 8, 779-783, 2011.

Wagner, W., Lemoine, G., and Rott, H.: A method for estimating soil moisture from ERS scatterometer and soil data, Remote Sensing Envir., 70, 191-207, 1999.

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