Interactive comment on "SM2RAIN-ASCAT (2007–2018): global daily satellite rainfall from ASCAT soil moisture" *by* Luca Brocca et al.

Anonymous Referee #2

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An update of a satellite soil moisture-based rainfall dataset (SM2RAIN-ASCAT) is presented. The paper is fairly well written but paints an overly rosy picture of the dataset. Both the dataset and the validation exhibit a number of serious issues which must be addressed before the paper can be published.

(1) The peak underestimation issue has not been resolved in the current release of the dataset, as revealed by both the low STDRATIO values (Figure 3) and the time series comparison (Figure 4). This major issue has been highlighted in two large precipitation dataset evaluations that have been ignored in the present study (https://www.hydrol-earth-syst-sci.net/21/6201/2017/ and https://www.hydrol-earth-syst-sci.net/23/207/2019/). It is important that previously identified issues are addressed or at least discussed.

(2) The CDF correction is based on the REF data and is thus not independent, giving the dataset an unfair advantage compared to GPM-ER in Figure 3.

(3) The RMSE metric should not be used for the evaluation of precipitation datasets at daily time scales as it yields misleading results (makes it seem datasets with underestimated peaks such as SM2RAIN are better). This is due to the high skewness of the precipitation distribution and the prevalence of temporal mismatches between estimated and observed precipitation peaks. The problem is illustrated in the paper by Figure 3, which shows a higher RMSE value (i.e., "worse" performance) for the bias- and CDF-corrected SM2RAIN product (BC-CDF) than for any of the uncorrected SM2RAIN products.

(4) Only correlation and RMSE statistics are presented for the performance evaluation in Figure 6. Please remove the RMSE for the previously mentioned reason and add other metrics, such as variability ratio, bias, hit/miss ratio, frequency of wet days, peak magnitude, etc. for a more thorough performance evaluation.

(5) The TC evaluation only takes into account the monthly correlation – just one aspect of dataset performance (monthly temporal dynamics). Hence the TC evaluation alone cannot be used to conclude whether a particular dataset is better or worse (as is done in the last paragraph of the abstract: "SM2RAIN-ASCAT dataset provides better performance better than GPM and GPCC in the data scarce regions of the world"). Other aspects should also be considered.

(6) "The recent "bottom up" approach that uses satellite soil moisture observations for estimating rainfall through the SM2RAIN algorithm is suited to build long-term and consistent rainfall data record as a single polar orbiting satellite sensor is used." If this is true, why does the dataset span such a short period (2007-2018)? All datasets listed in Table 1 (excluding IMERG) span a longer period. This statement should be revised.

(7) On a related note, the evaluation of https://www.hydrol-earth-syst-sci.net/21/6201/2017/ (co-authored by the first author of the present study) shows that

SM2RAIN-ASCAT performs worst among all precipitation datasets in terms of trend, due to the combination of data from different ASCAT sensors. So are the different ASCAT sensors consistent with each other or not? Has this trend issue been resolved in this SM2RAIN-ASCAT release? If so, this should be shown. If not, this should be communicated to the reader.

(8) In the interest of transparency the abstract should mention that the presented SM2RAIN dataset i) is limited to liquid precipitation (snowfall is not present in the dataset), ii) exhibits spurious drizzle, iii) underestimates extremes (as demonstrated by Figures 3 and 4 of the paper), and iv) potentially suffers from intercalibration issues (see comment (7)). If any of these problems have been fixed in the current release of SM2RAIN-ASCAT, this should be shown in the paper.

(9) "The limitations of the bottom up approach are the possibility to estimate only terrestrial rainfall and its dependence on land characteristics (e.g., low accuracy for dense vegetation coverage and complex topography, Broccaet al., 2014)." The other limitations (spurious drizzle, underestimation of extremes, and intercalibration issues) should also be mentioned here.

(10) To my understanding the regional evaluation is performed using daily accumulations, while the triple collocation (TC) analysis is performed using monthly accumulations – correct? To avoid confusion, please state the time scale of each specific evaluation/analysis in both the abstract and the captions of all figures.

(11) Version numbers should be assigned to the different SM2RAIN-ASCAT releases, to avoid confusion. I know there have been at least two releases. Which one is this?

(12) Please add ERA5 to Figure 3 and make it easier to see the differences among the boxes, either by reducing the range of the y-axes or by exanding the size of the y-axes.

(13) The intro/methods part of the abstract is a bit too long, while the results/discussion part is a bit too short (just three sentences).

(14) "the surface runoff rate, i.e., the water that does not infiltrate into the soil and flows at the surface to the watercourses, is much lower than the rainfall rate, mainly if equation (1) is applied at coarse spatial resolution (20 km), i.e., with satellite soil moisture data." This statement does not make sense to me. Runoff can be equal to rainfall if the soil is saturated, at all scales – from hillslope to catchment.

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