Comments from the Reviewer #3 and the corresponding revision

SM2RAIN-ASCAT (2007–2018): GLOBAL DAILY SATELLITE RAINFALL FROM ASCAT SOIL MOISTURE

by Luca Brocca, Paolo Filippucci, Sebastian Hahn, Luca Ciabatta, Christian Massari, Stefania Camici, Lothar Schüller, Bojan Bojkov, Wolfgang Wagner

Anonymous Referee #3

This study provides the descriptions and validation results of the 11-year (2007-2018) SM2RAIN-ASCAT global rainfall dataset. Overall, the study fits the scope of ESSD, the paper is well written and the presentation quality is very good. I think that the dataset has great potentials for different applications, as also stated by the authors, especially in specific regions of the world where it seems to outperform other products based on different approaches (e.g., GPM IMERG Early Run). However, there are several aspects that need to be addressed before the paper can be published.

We thank the reviewer for her/his appreciation of our study and for the valuable suggestions that helped us to clarify and improve the manuscript. A detailed answer to each comment is reported in the sequel.

As general reply to all the reviewers, we would like to underline that the paper goal is to present and describe the SM2RAIN-ASCAT global rainfall dataset and to perform a preliminary assessment of the product with respect to other state-of-the-art global rainfall products. We do not want to show a comprehensive assessment of the product. Indeed, we believe that the validation of the dataset should be performed by researchers other than the product developers (indeed the dataset is made freely available and a first paper was already published: Paredes-Trejo et al., 2019; doi:10.3390/rs11091113). Even better, we stress the importance of performing the validation by using the dataset in hydrological or agricultural applications (e.g., flood prediction and agricultural water management). The comparison with raingauges or any reference dataset could be misleading, mainly when the rainfall products include the ground observed information used for their derivation.

Line 34: What do the author mean by"operationally available in NRT"? This is not a crucial aspect for the dataset presented in this paper.

The reviewer is right; the sentence will be removed by the abstract in the revised manuscript. It is due to a parallel activity we are performing for producing a NRT SM2RAIN-ASCAT product.

Line 36: It is important to note that it is not global as it does not provide rainfall over water bodies, and it is limited to the avalability and quality of soil mosture data. This should be clearly stated also in the conclusions.

The reviewer is right; SM2RAIN-ASCAT product is not global and it will be clarified in the abstract and in the conclusions of the revised manuscript.

Line 42: Please, specify "the IMERG Global Precipitation Measurement (GPM) mission product

The text will be modified, accordingly.

Line 75: Rainfall is not "measured" from space. Precipitation retrieval based on "topdown" approaches is very complex due to interaction of the radiation emitted by the Earth's surface with gases, and liquid and solid hydrometeors within the clouds. For example, passive microwave retrieval techniques need to account for variability of all these elements (e.g., surf. emissivity and temperature, water vapour content, cloud water content, sizes, shapes, density, 3-D distribution of liquid, solid and mixed-phase hydrometeors).

The term "measured" will be removed from the revised manuscript, even though it's matter of terminology. Every measurement is affected by errors.

Line 76-78: Please, rephrase this sentence: "these methods are based on inversion techniques where the upwelling radiation (or backscattered signal for radars) is related to the surface precipitation rate".

The sentence will be revised.

Line 133 (and Line 176, and Line 327): Please, clarify what you mean by "1009 points". Are these 12.5km x1.2km grid boxes? What do you mean by "uniformly distributed? How have they been selected? How many "points" are selected in each region? How are the raingauge measurements treated to be associated to each "point"?

The 1009 points are uniformly distributed over a regular grid with spacing of 1.5°. Each point is considered representative of a 0.25° x 0.25° box; the selection is carried out for reducing the computational time for running the different SM2RAIN configurations. The numbers of points for each region is based on the size of the region (328 points in Australia, 163 in India, 55 in Italy, and 463 in the United States). Ground observations and GPM-ER data are regridded by spatial averaging measurements contained over each 0.25° x 0.25° box. All these details will be reported in the revised manuscript.

Line 203-205: it is not clear how the 12 hour sampling of the ASCAT soil moisture product is used to obtain the daily (24 hour) SM2RAIN rainfall prouct.

The 24-hour accumulated rainfall is obtained by summing the two 12-hour accumulated rainfall data obtained for each day, it will be specified in the revised manuscript.

Line 282-284: correction of the overall bias can be very effective for mitigating errors in all products. It should be pointed out by the authors if SM2RAIN-ASCAT dataset presented in this paper is the same product that would be obtained operationally in NRT (see also Line 34). If this is not the case, in my opinion, for a fair comparison, the IMERG GPM Final Run should be used instead of the Early Run in this study. Otherwise, the authors should explain clearly why the GPM Early Run is used in this study. Although I understand that IMERG Final Run can not be used for TC, I recommend to show the results of SM2RAIN-ASCAT compared to IMERG Final Run.

The SM2RAIN-ASCAT dataset presented in the paper is the same product that would be obtained operationally in NRT. The climatological correction is performed with constant parameter values and,

hence, it can be implemented in NRT. We note that a climatological correction is performed in several satellite rainfall datasets delivered in NRT (e.g., 3B42RT, IMERG ER, PERSIANN CCS, CMORPH CRT).

Line 314: Optimal value for FAR is 0, not 1. Please, correct.

The reviewer is right; we will correct the error in the revised manuscript, thanks for spotting the mistake.

Line 316: Please, motivate the choice of 0.5 mm/day (and not a lower value > 0 mm/day) as rainfall/no rainfall threshold.

As mentioned in the manuscript, the threshold is selected in order to exclude spurious events that might be due to rainfall interpolation\regridding in the reference datasets.

Line 379-380: How many points are used to compute these averages in each region? Are "problematic" areas for soil moisture retrieval (complex orography, highly vegetated, ecc.) included among the 1009 points used here?

All points in each region are used, i.e., 328 points in Australia, 163 in India, 55 in Italy, and 463 in the United States. The "problematic" areas are included as 1009 points are randomly selected; no masking has been carried out in this analysis.

Line 389: Why R and RMSE are considered "more important"? Please, justify this choice.

We believe that R and RMSE are the two most important statistics for evaluating precipitation datasets after performing several assessment studies of different datasets. However, we acknowledge that the selection of the statistics could be arbitrary and in the revised manuscript we will add multiple statistics at Figure 6 (similarly to Figure 3) to provide a more comprehensive assessment of the products.

Line 400-401: It is not clear what periods is used for the calibration in the two separate time frames. I assume that the calibration is not carried out for the whole periods.

In the development of the global SM2RAIN-ASCAT dataset the calibration is performed for the whole periods. Indeed, we do not want to perform calibration and validation against ERA5. As mentioned above, the validation should be performed with independent datasets, and even better by using the product for applications.

Line 404-408: it is not clear what the authors mean by distinguishing "in space" and "in time".

In space, we mean a fixed spatial mask over which we are aware of the lower performance of the ASCAT soil moisture product, and consequently of SM2RAIN-ASCAT rainfall product. In time, we have considered a temporally variable mask that flags observations with soil temperature, obtained from ERA5, lower than 3°C. It will be specified better in the revised manuscript.

Line 411-413: ERA-5 is used for calibration. It is not fair to use this dataset to create this map, and show R and RMSE.

The reviewer is right; Figure 5 shows the consistency of ERA5 and SM2RAIN-ASCAT and not the

"accuracy" or the "performance" of the product, these terms will be removed from this section of the revised manuscript. Of course, we expect better performance in the areas in which the consistency is higher, but the preliminary assessment of SM2RAIN-ASCAT is performed in section 4.3.

Line 468: Please, specify what is the committed area for ASCAT products (not ASCAT).

The reviewer is right; the committed area refers to the ASCAT soil moisture product; it will be specified in the revised manuscript.

Minor corrections:

Line 46: correct: "provides better performance better"

The text will be modified, accordingly.

Line 100: correct "has the advantage of requiring"

The text will be modified, accordingly.

Line 138-139: please specify which datasets have been used for the TC, what for the regional assessment, and what for global assessement.

The datasets used for the three analyses will be specified in the revised manuscript.

Line 190: Please, correct: "spatially averaging"

The text will be modified, accordingly.

Line 392-393: please correct this sentence. Something is missing, or maybe remove "," after "filtering".

The sentence will be revised, accordingly.

Line 402-403: Please, correct this sentence.

The sentence will be corrected.