Review of manuscript: validation of satellite OPEMW precipitation product with ground-based weather radar and rain gauge networks.

The paper verifies the satellite based QPE against a) radar rainfall and b) rain gauges over a 1 year period over Italy.

General

1. Several language errors are made. Some will be listed in my review, but not all. In general a good English editor is required for this paper.
2. Several sentences lose their meaning due to being too long.

We are grateful to the reviewer for the constructive comments. We have revised the manuscript accordingly, checking for language errors and partitioning long sentences. Our replies are shown hereafter in red, while modifications to the text are highlighted in yellow within the revised manuscript.

ABSTRACT

Page1: line 20
..has been running… for two years…

Agreed.

Page 1: line 21
..products as input to operational…

Agreed.

Page1: line 23
…observations consisting of 20 weather radar systems …

Agreed. We have changed this sentence into "observations from a network of 20 weather radar systems"

Page 1: line 25
… a data set covering one year…

Agreed.

Page 1: lines 24-27 and Page 2 lines 1-3 are all one sentence. Rephrase, too long.

Agreed.

Page 2 line 6-10 – all one sentence, rephrase, too long.

Agreed.

Page 2: line 8

Omit “a sort of”

Agreed. We removed “a sort of hinge point roughly around 6-7 mm/h” from the abstract. We also removed “a sort of” in Sections 4.2 and 5.

Perhaps too much detail is given in the abstract and a more general overview would be good enough, without the detailed values.

Agreed. We have shortened the abstract, giving a bit less detail. However, we prefer to keep some of the quantitative results within the abstract, as these are often required.

INTRODUCTION

Page 2: line 26
Low Earth Orbit (all caps)

Agreed.

Page 3: lines 3-7 sentence too long. Rephrase.

Agreed.

Page 3: line 13
… by comparing the satellite estimation against…

Agreed.

DATA SET

Page 4: line 7
Language use not clear “rather technical then functional”

Agreed. We have changed into “more technical rather than functional”

Page 4: line 10
At Nadir, the footprint of the instrument…

Agreed.

Page 4: line 12
FOVs have an ellipsoidal shape..

Agreed.

Page 4: line 13
Start new sentence with: The first axis refers to..

Agreed.

Page 5: line 21
More information is needed on how the radar rainfall is calculated (which algorithm is used, which ZR relationship, is dBZ or CAPPI used for calculation, etc.)

Agreed. We have added the following information in Section 2.2.
"The sri product is computed applying the reflectivity-rainfall (Z-R) relationship proposed by Marshall and Palmer (1948) to the Lowest Beam Map (LBM) product. The latter is the near-ground reflectivity map obtained from the corrected radars volume data using the lowest height reflectivity value in each vertical column."

Page 5: line 26
Techniques are being tested…

Agreed.

Page 6: line 3
Which belong to independent…
DPC was recently appointed…

Agreed.

Page 6: line 8
Omit “some”

Agreed.

Are point values of the gauges used or an interpolated field?

The point values of rain gauges are upscaled into the satellite FOVs, as discusse in Section 3.1. We have added this information in Section 2.3 as well.

METHODOLOGY

Page 6: line 20
“was processed for searching space-time colocation”… language use not clear

Agreed. We modified the sentence to make it more clear.

Page 7: line 2-3
Unless the system failed…

We removed this statement since it did not bring useful information.

Page 7: lines 4-7
Long sentence, without clear meaning. Rephrase.

Agreed. We completely rephrased the sentence to make it more clear.

Page 7: lines 10 and 11
Omit “some”

Agreed.

Lines 11-13 – meaning not clear, the smoothing procedure should be described better.

Agreed. We modified the sentence to improve clarity.

Page 7: lines 15-30
Different possible errors are listed for satellite rainfall, radar rainfall as well as gauges, but it is not clear how these were dealt with in order to ensure a good quality rainfall data. Attenuation is mentioned in the summary and conclusions, so can the assumption be made that this is not taken care of in the radar rainfall field?
Maximum thresholds are mentioned, but that does not take care of all the possible errors.
This paragraph needs a lot more detail since all the statistical evaluation which is done can be contaminated if the "truth" fields (radar rainfall and rain gauges) are not properly quality controlled.

Section 3.2 (Data quality) points out three sources of errors, namely (i) geolocation errors, (ii) beam filling errors, and (iii) instrument errors. Measures to mitigate these three sources are given. However, we agree with the reviewer that little detail was given concerning the measures adopted to mitigate the instrument error. Therefore, we have added the following information:

"Instrument errors may affect all the instruments considered here, i.e. satellite microwave radiometers and ground-based radars and rain gauges. A first quality control (QC) is performed by the data providers, which shall ensure proper functioning and calibration. The QC flags provided are used to screen out potentially erroneous data. In addition, we discarded RGN data that resulted suspicious due to telecommunication problems (wrong coordinates or time/date, redundant data, etcetera). Measuring errors related to weather conditions (such as wind, frozen precipitation) are not taken into account. In order to prevent unrealistic sri values entering in the statistical analysis, the procedure discards RGN sri values higher than 150 mm/h, assumed to be the upper limit for 1-h accumulated precipitation. The same upper limitation is adopted for the instantaneous RNC sri values. In addition, the radar echoes generated by non-meteorological targets are discriminated from weather returns by combining the static clutter map, the Doppler velocity, and the texture of the reflectivity field (Vulpiani et al., 2012). Additionally, a median filter is applied to remove residual clutter echoes. Partial beam blocking sectors are identified through an Empirical Visibility Map (EVM), which is derived directly from the radar observations. Measures to mitigate the effects of attenuation are not applied to RNC at the current stage. Radar attenuation likely causes a systematic underestimation of sri. The other instrument errors mentioned above are likely to produce random effects depending upon time, location, and weather conditions; therefore we believe their effects are mitigated by the temporal and spatial averaging of the analysis described below."

Page 8: line 2
The elimination system described is not clear.

Agreed. Last paragraph of Section 3.2 has been rewritten to improve clarity.

Page 8 lines 12 and further
The terminology "rainy and not rainy" is not correct.
The threshold is not clear – is it >=1 mm/h or > 0mm/h for pixels with rain?

Agreed. We modified the whole sentence to improve clarity.

The threshold is 0 mm/h. This is now reported in Section 3.3.

Line 14: “These include” – what is these?

Agreed. Now it reads “The dichotomous scores include…”

Line 17: remind not the correct English

Agreed. We removed the sentence.

Line 21: omit “even more stringent”

Agreed.

Page 9: line 4-5 Meaning not clear.

Agreed. We modified the whole sentence to improve clarity.

RESULTS

Page 9: Line 11
The 15 and/or 16 mm/h bins are not clear, a better motivation is needed.

Agreed. We modified the whole sentence to improve clarity.

Figure 4 needs more detail on the Y-axis. The interpretation is not clear.

Agreed. More detail is now given to the Y- as well as X-axis in Figure 4. Thanks for pointing this out.

Page 9: line 25
Accuracy of 98% for both..

Agreed.

Accuracy is not a reliable score to use due to statistical reasons, but also due to the QC approach which was described in paragraph 3.2.

We agree with the reviewer that the dichotomous score accuracy could be misleading, as it tends to be optimistic by considering the few interesting events (sri>0) at the same level as thousands of less interesting ones (sri=0). However, since this paper builds upon the results of Di Tomaso et al. (2009), we decided to evaluate it.
Concerning the QC approach in Section 3.2, we do not see it in conflict with the accuracy definition. Since our explanation of the QC was found unclear, it may have caused misunderstandings. Hopefully the revised Section 3.2 clarifies this concern.

Page 9: line 28-29 HHS is incorrect, assume HSS is meant.

Correct. Thanks for spotting these typos.

..HSS ranging from 0.42 to 0.45 and ETS ranging from 0.27 to 0.29…

Agreed. We replaced "-" within the text to avoid the impression of a range of variability.

Page 9 lines 27-30 and Page 10 lines 1. Sentence too long.

Agreed. Sentence has been rewritten.

Page 10: line 1 "FB is fairly close to unity"? – I don't see that.

Agreed. This statement has been removed.

Page 10 line 13:
Figure 5 – Captions are not clear on which line is presenting which variable.

The text has been modified for improved clarity.

Page 10: line 18
…As the rainfall intensity becomes more significant…

Agreed.

Page 10: 21-31
Motivate why 1mm/h bins were chosen and not perhaps 2 or 5 mm/h. 1 mm/h is a very fine distinction to make for remotely sensed "observations" (radar) or estimates (satellites).

The 1mm/h bins were chosen to be consistent with Di Tomaso et al. (2009) and Ferraro and Marks (1995), so that the results are directly comparable. As the reviewer points out, larger bins or even classes (light, moderate, heavy rainfall) could have been chosen. We do not expect the main conclusions to change greatly. We have added this information in the revised manuscript (Section 4.2). Incidentally, we realized that figures 7-8-9 of the original manuscript display results for a test with narrower bins (0.5mm/h); the correct figures are now displayed in the revised manuscript.

Page 11: lines 12-14 Sentence too long.

Agreed.

Page 12: line 15 Indicate Sicily on the map in Figure 10.

Agreed. A black arrow now indicates Sicily in one of the panels of Figure 10.

Page 12: line 31 "std" should be written out

Agreed.

I would suggest that the titles of the different subsections also mention what is evaluated (i.e. … to evaluate area/intensity) and not just how (i.e. dichotomous statistical assessment)

We thank the reviewer for this suggestion, although we feel the titles would become rather long and thus prefer to keep as they are.

SUMMARY AND CONCLUSIONS

Page 13: line 7-10 Sentence too long

Agreed.

Page 13: line 15 FB score is “a bit” larger than unity – omit “a bit”

Agreed.

Page 13: line 21 Start new paragraph here.

Agreed.

Page 14: line 1 Omit “sort of”

Agreed.

Page 14: line 2 While the scatter plot..

We changed “scatter” with “dispersion” to avoid confusion.

Page 14: line 3 Due to the low number of cases with rainfall higher than 10mm/h…

Agreed.

Page 14: line 4 “std” – write out

Agreed.

Page 13-14
The summary and conclusions paragraph is confusing to me and not well written. Clearer distinction should be made on what was evaluated (intensity, area etc.) by which methodology, together with the outcome. Sometimes the results seem to be contradicting… due to small difference not clearly identified. A clear conclusion is lacking. A stronger statement needs to be made and then also exactly what will/can be addressed in “future”/ongoing work.

Agreed. We have rewritten Section 5 to improve efficiency. We have also improved the conclusions and future work discussion.