Replies to comments from Reviewer #2

Suggestions:

Line 63. Please expand with a half-sentence on how the concept of seeder-feeder is related to under- or over-estimation of surface rain fall amount, or how the seeder-feeder process causes a lag of surface precipitation relative to the radar observing enhanced precipitation aloft. This reviewer is not familiar with how the seeder-feeder ice cloud process impacts surface rain accumulations. Thus, I believe an AMT reader would be interested in what information the authors want to share.

> We have added an explanation:
>
> "the seeder–feeder effect" → "the seeder–feeder effect **(when precipitation from an upper-level cloud falls through a lower-level orographic stratus cloud capping a small mountain)**".

Line 112-124. Make these three paragraphs one paragraph because the phrase "The latter approach…" should refer to an approach that is in the same paragraph. Also, the first two paragraphs are one sentence each.

> Thank you for your suggestion - we have put these paragraphs together.

Line 137. Does the phrase "lower-level" refer to lower-altitude stations, or lower-quality (less reliable) stations? Please clarify.

> They are stations of a lower category ("order", not "level" - we named them incorrectly), i.e. mainly "precipitation stations" (https://glossary.ametsoc.org/wiki/Precipitation_station). We improved the terminology and changed this sentence as suggested:
>
> "…devices are installed, whereas lower-level stations use mainly…"
> → "…devices are installed, whereas **precipitation** stations use mainly…"

Lines 150-151. The sentence starting with "Both gauges…" is confusing. Should the sentence read: "Both stations are equipped with heated and unheated sensors"? Please clarify.

> We have changed this sentence as follows to be consistent with the surrounding sentences:
>
> "Both gauges are equipped with tipping bucket devices"
> → "Both **stations** are equipped with **two** tipping bucket **sensors**"

Line 156. The first sentence is confusing to me. Should the sentence be something like, "...corresponds to well-functioning rain gauges, and the right graph corresponds to one or both rain gauges not functioning correctly." Please clarify.

> We agree with the Reviewer that this fragment was unclear. We have changed these two sentences as follows:

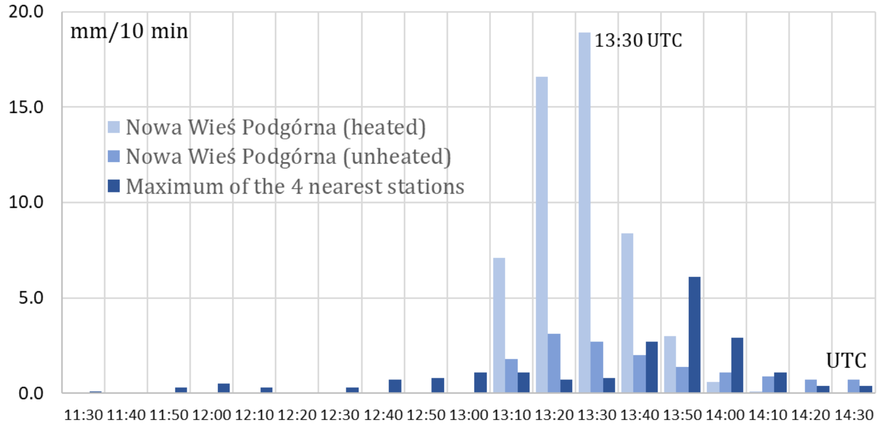
"Generally, the left graph of Fig. 2 corresponds to a well-functioning rain gauge, and the right graph to a rain gauge providing data with large errors. For the latter, one or both sensors recorded erroneous precipitation values, and they therefore require effective quality control."
→ "Generally, the left graph of Fig. 2 corresponds to well-functioning rain **station**, and the right graph **corresponds** to rain **station with** one or both sensors **not functioning correctly**, and they therefore require effective quality control."

Line 220. Can you calculate the corresponding radar reflectivity factor needed with the MP Z-R relationship to get 56 mm/10 min rain rate? That would be an interesting comparison for radar-centric AMT readers.

We counted it and added the result:
"above 56 mm/10 min" → "above 56 mm/10 min **(i.e. 51 dBZ)**"

Section 4.3. This is a good example of how the proposed method identifies a large rain gauge data value and lowers the QI score. As a visual of how the algorithms identify this outlier and reduces the QI score, can a time-series plot be included in Fig. 8 of rain rates from neighboring gauges and radar estimates over the Nowa Wies Podgorna site for the 12 samples before and a few samples after the outlier event? Also, this timeseries plot can be used to remind the AMT reader that the time-series analysis is only looking backward in time to produce a real-time QC'd product.

We have inserted the graph that the reviewer expects along with the relevant paragraph into line 380.



"Fig. 9 shows the recorded precipitation time series from 12 time steps (i.e. two hours) before the analysis date (13:30 UTC), and 6 time steps after this date, at Nowa Wieś Podgórna station (two sensors) and maximum values of the four neighbouring stations. These stations are located between 19 and 35 km from the analysed Nowa Wieś Podgórna station. Until the analysis date, precipitation measured by the sensors of these stations was not high, as it was up to about 1 mm/10 min, but 20 min later a significant increase in precipitation of about 6 mm/10 min was observed on both sensors of one of the nearby stations. At the analysed time-step only Nowa Wieś Podgórna station recorded a slightly higher precipitation on the heated sensor, while it was drastically higher on the unheated sensor (Table 2)."

Lines 375 and 395. The rainRGS and NWC-SAF datasets need to introduced in Section 2, which describes the datasets that are used in the study.

We have added a new section 2.3:

2.3. Other data

In addition, the fields of the following precipitation estimates were used for the case studies:

- satellite precipitation fields determined from various NWC-SAF (Satellite Application Facilities on Support to Nowcasting and Very Short Range Forecasting) products based on Meteosat data (Jurczyk et al., 2020),
- QPE fields produced by the RainGRS system, which operationally combines precipitation data from rain gauges, weather radar and meteorological satellites, based on conditional merging and additionally taking quality information into account (Jurczyk et al., 2020).

In the text, we have shortened the explanations and added references to the new section 2.3. Line 375:

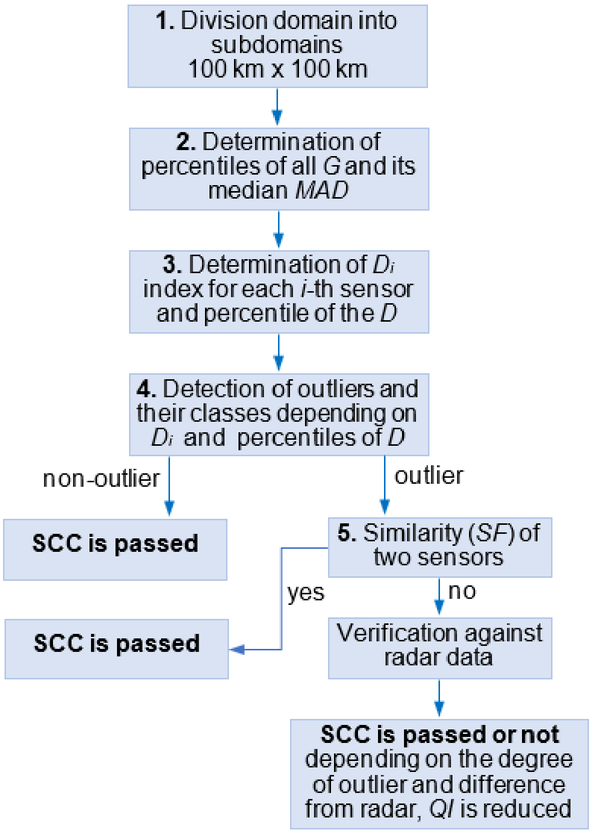
“Satellite rainfall, determined from various NWC-SAF products based on Meteosat data (Jurczyk et al., 2020) …”
→ “Satellite rainfall, determined from various NWC-SAF products based on Meteosat data (**see Section 2.3**) …”

Lines 395-397:
“This is shown by the example of the QPE fields produced by the RainGRS system, which operationally combines precipitation data from rain gauges, weather radar and meteorological satellites, based on conditional merging and additionally taking quality information into account (Jurczyk et al., 2020).”
→ “This is shown by the example of the QPE fields produced by the RainGRS system, which operationally combines precipitation data from rain gauges, weather radar and meteorological satellites (**see Section 2.3**).”

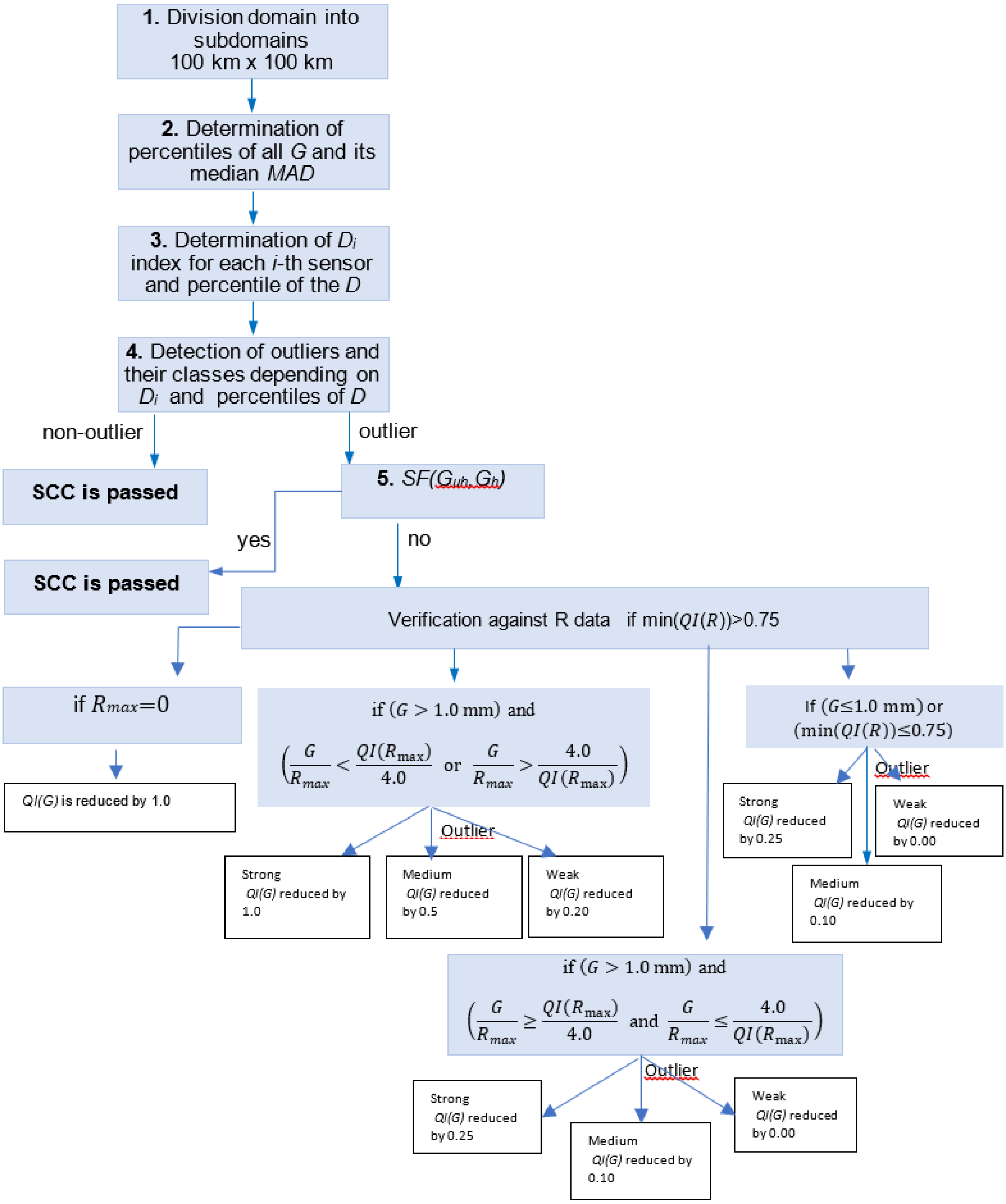
The appendices are well written and describe the algorithms with sufficient detail that I think this reviewer and AMT readers could repeat the algorithm with their own rain gauge network. The conclusions properly state that every network needs to be calibrated to determine their own thresholds. To help promote the algorithm, can flow diagrams be provided showing the if-then-else flow of the algorithms? I am thinking big-picture diagrams with the text providing the details. (I assume the authors already have these diagrams for their conference slide-deck oral presentations.)

With these diagrams we have a problem. We have made attempts, but in our opinion it is not possible to diagram these algorithms in such a way that it is both complete and clearer than a step-by-step description in bullet points. We attach below two working versions of the diagram for the SCC algorithm: a shorter one and a longer one. In our opinion, neither of these meets expectations, even though both are somewhat simplified relative to the full description. In summary, we therefore propose not to add these diagrams.

Shorter version:



Longer version:


1. Division domain into subdomains 100 km x 100 km
2. Determination of percentiles of all G and its median MAD
3. Determination of D_i index for each i-th sensor and percentile of the D
4. Detection of outliers and their classes depending on D_i and percentiles of D
non-outlier
outlier
SCC is passed
5. $SF(G_{ub}, G_b)$
yes
no
SCC is passed
Verification against R data if $\min(QI(R))>0.75$
if $R_{max}=0$
$QI(G)$ is reduced by 1.0
if $(G > 1.0\text{ mm})$ and
$\left(\frac{G}{R_{max}} < \frac{QI(R_{\max})}{4.0} \text{ or } \frac{G}{R_{max}} > \frac{4.0}{QI(R_{\max})}\right)$
Outlier
Strong $QI(G)$ reduced by 1.0
Medium $QI(G)$ reduced by 0.5
Weak $QI(G)$ reduced by 0.20
If $(G\leq 1.0\text{ mm})$ or $(\min(QI(R))\leq 0.75)$
Outlier
Strong $QI(G)$ reduced by 0.25
Weak $QI(G)$ reduced by 0.00
Medium $QI(G)$ reduced by 0.10
if $(G > 1.0\text{ mm})$ and
$\left(\frac{G}{R_{max}} \geq \frac{QI(R_{\max})}{4.0} \text{ and } \frac{G}{R_{max}} \leq \frac{4.0}{QI(R_{\max})}\right)$
Outlier
Strong $QI(G)$ reduced by 0.25
Medium $QI(G)$ reduced by 0.10
Weak $QI(G)$ reduced by 0.00