Reply to report of reviewer #1
"Validating global horizontal irradiance retrievals from Meteosat SEVIRI at increased spatial resolution against a dense network of ground-based observations by Wiltink et. al."

bold italic font = reviewer's comment
regular font = authors' reply
red regular font = adjustments in manuscript

The authors present a methodology to downscale GHI retrievals from MSG imagery which is validated againts the HOPE field campaign (a set os 99 solar radiation sensors distributed along 10 × 12 km2). The paper is rather good and the results also are. I think that it has enough quality to be accepted for publication and also interest in the community. I have only a few minor comments and/or doubts.

We thank the reviewer for the comments and suggestions aimed at improving the quality of the manuscript. Please find a response to the review below to see how the reviewer's concerns were handled.

1) ***It is not quite clear to me what is the time scale of the GHI retrievals, since Meteosat Second Generation imagery is disseminated in 15-minutes how the authors estimate 5-minute GHI?***

   The primary service of MSG SEVIRI indeed has a repeat cycle of 15 minutes. However, here, the Rapid Scan Service (RSS) is used instead of the primary service. In 2013, the RSS was mainly performed by Meteosat-9. With the RSS, only the part of the SEVIRI disk covering Northern Africa and Europe is scanned, which enables a 5-minute repeat cycle instead of the 15-minute repeat cycle of the primary service. In the manuscript, we rearranged the following sentence to make it clear to readers less familiar with the RSS how a 5-minute temporal resolution can be achieved.

   page 6, lines 115-116: ~~Using the rapid scan service of SEVIRI (RSS), a single scan covering Europe is completed every five minutes.~~ → Using the Rapid scan service (RSS), only part of the SEVIRI disk covering Northern Africa and Europe is scanned, enabling a 5-minute repeat cycle.

2) ***would need a clearer explanation, I don't see why the use of residuals istead of reflectance and it is not completeley clear (at least to me) how this method is used or affect to the GHI retrieval. How afect the reflectance?***

   The high frequency residuals are used in the retrieval to update the SR reflectances of the 0.6 μm channel that do not include HR information to reflectances where the HR information is included. This is done by adding the high frequency residuals to the original (SR) reflectances. This was not explicitly mentioned in the manuscript. We have included the following line in the updated manuscript to clarify this aspect.

   page 7, Line 180: "... first estimation of δr_{06}. The high-frequency residuals of the 0.6 μm channel are then added to the original 0.6 μm reflectances, providing updated values of reflectances for the 0.6 μm channel that include HRV information. Using CPP LUTs and the bi-spectral retrieval method ..."

   We have also extended the explanation on how the conservation of retrieval accuracy of CER at HR is perfomred.

   page 7, line 182-183: ~~Therefore, the adjustment of $\delta r_{1.6}$ is iteratively determined from the LUT to conserve the SR value of CER (Werner and Deneke 2020).~~ → To restore the accuracy of the retrieved CER at HR,

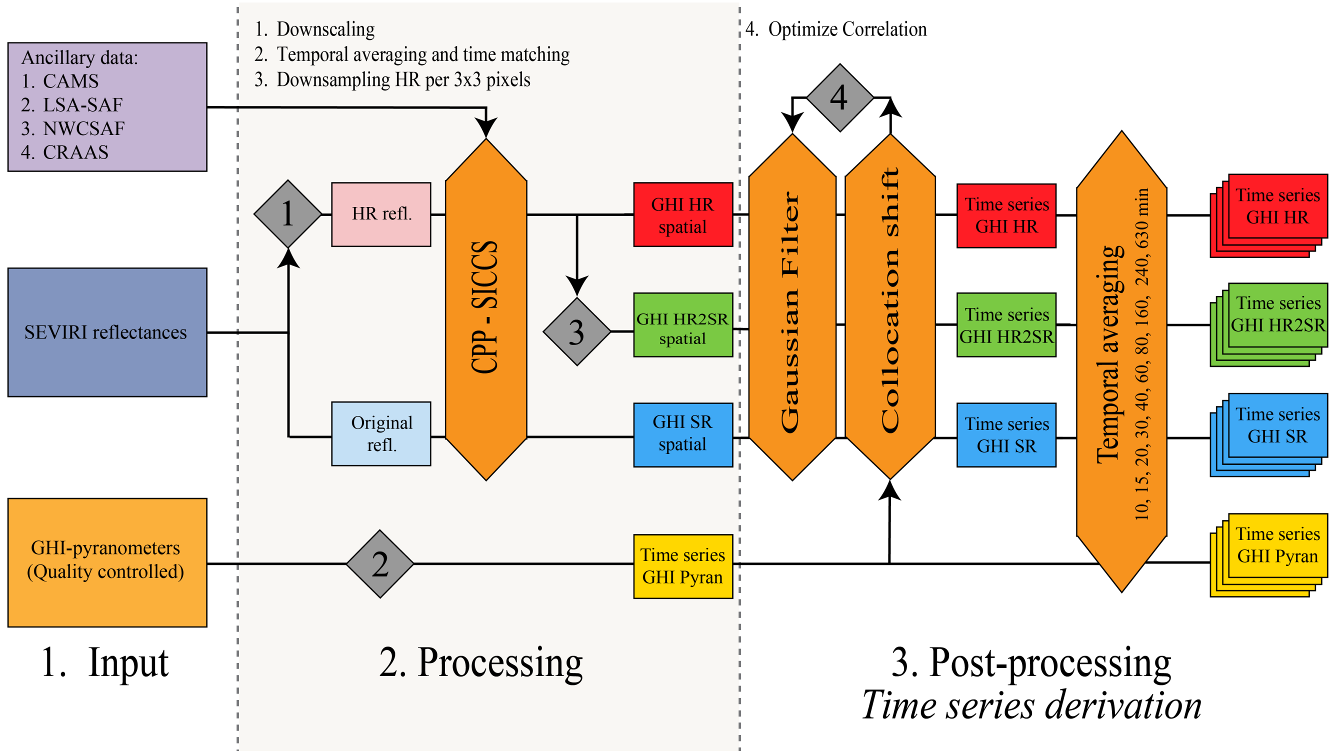

Figure 2: Flow diagram illustrating the required steps to derive time series of GHI from SEVIRI reflectances. The input data and processing are explained in Section 2 while the post-processing is explained in Section 3.

a local slope adjustment is performed. The slope adjustment determines where the high-frequency residual of $r_{1.6}$ equals zero, meaning the SR value of CER is restored. However, since the slope adjustment is based on the tangent of the COT contour at the location of the SR reflectances in the LUT, the HR CER retrieval does not precisely have to match the SR value (Werner and Deneke, 2020).

More details on the downscaling algorithm and the high-frequency residuals are presented in Werner and Deneke (2020). Their Figure 4c graphically shows how residuals are used to derive HR cloud optical thickness and effective radius from the 0.6/1.6 μm bispectral reflectance, which are then used to calculate GHI.

3) ***I think that it would be eneficial a scheme or flow diagrama explaining or indicating the different steps and products used in the methodology in order to get easier for the reader the understanding.***

We have added a flow diagram (Fig. 2) to Section 2.2 of the manuscript, graphically illustrating the steps required to go from input data to satellite-derived time series. The figure is introduced as follows:

page 5, line 124 '... is presented in Deneke et al. (2021), and shown in a more compact form in the left hand side of Figure 2.

Note that a detailed flow diagram for the CPP-SICCS algorithm is presented in Deneke et al. (2021).

References

Deneke, H., Barrientos-Velasco, C., Bley, S., Hunerbein, A., Lenk, S., Macke, A., Meirink, J. F., Schroedter-Homscheidt, M., Senf, F., Wang, P., Werner, F., and Witthuhn, J.: Increasing the spatial resolution of cloud property retrievals from Meteosat SEVIRI by use of its high-resolution visible channel: Implementation and examples, Atmospheric Measurement Techniques, 14, 5107–5126, https://doi.org/10.5194/amt-14-5107-2021, 2021.

Werner, F. and Deneke, H.: Increasing the spatial resolution of cloud property retrievals from Meteosat SEVIRI by use of its high-resolution visible channel: Evaluation of candidate approaches with MODIS observations, Atmospheric Measurement Techniques, 13, 1089–1111, https://doi.org/10.5194/amt-13-1089-2020, 2020.