

Reviewer #1

This paper shows the assessment of surface solar irradiance estimated in real time from a multi-regression function (MRF) and a neural network (NN). In the case of NN the results for the integrated spectrum and for the spectral irradiance are considered. The output of MRF and NN are compared with Baseline Surface Radiation Network (BSRN) observations and with the training dataset, created by the libRadtran model. Nine stations with different climates are considered, giving to the discussion a general applicability. The verification against the BSRN shows that the uncertainty of the real-time estimations of GHI ranges from -100 W/m² to 40 W/m² for the 15-min GHI, while the error decreases for averages computed for longer time ranges (down to -20, 20 W/m² for monthly averages). The impact of the aerosols and cloud optical thickness on the GHI is also discussed in detail. The paper is well written and interesting and deserves publication on AMT. There are few points that I would remark to improve the quality of the paper.

- The paper well discusses the performance of the methods presented for the estimation of the GHI in real-time. The advantages and the usability of the method is clear for the estimation of the GHI, as well as other quantities useful for the exploitation of solar energy, at a site where observations are not available. Nevertheless, because of the importance given to the paper to the fact that a real-time estimation of the GHI is presented, a discussion on the potential of the method for the short-term forecast should be provided in this paper.

Author's reply: We thank the reviewer for this comment in order to provide additional information about the potential for short-term forecast. Since the proposed modelling techniques (MRF, NN and NNS) operate in real-time, the potential applicability for short-term forecasting purposes for the next few hours is feasible. To this direction, the CAMS AOD is already an operational forecast input (Benedetti et al., 2009) with accurate predictions every 1 hour even under high aerosol load conditions (Kosmopoulos et al., 2017). On the other hand, the MSG COT short-term forecasting requires the employment of a cloud motion vector analysis (e.g. Hammer et al., 1999) in high spatial and temporal resolution (5 x 5 km and 15 minutes, which is the MSG/SEVIRI resolution), in order to predict the impact of clouds on SSR for the next 2-3 hours, while under cloudless conditions the SZA and AOD are the main solar irradiance attenuators, and hence are available as input information to the models. The above description was added in the revised paper at the end of the sub-section 2.2.3.

- Also, a deeper discussion of the application fields of the methodology would be welcome.

Author's reply: We want to thank the reviewer for the opportunity given to us to describe the application fields of the methodology. Large scale, high temporal and spatial resolution EO-based assessment of the SSR seems to be an emerging market prospect (ITA, 2016). The potential application fields of the methodology proposed in this study include the production planning support on large scale solar farm projects and the efficient control of the electricity balancing and distribution (in support to the TSOs and DSOs), by incorporating

the produced energy of the solar farms into the electricity grid. At the same time, SSR in different spectral regions highlight spectrally-weighted outputs like the UV-index (linked with skin cancer, eye cataract, DNA damage etc), the Vitamin D efficiency (related with pregnancy) and a number of agricultural and oceanographical related processes (plant photosynthesis, crop production, phytoplankton growth etc). As a result, the developed real-time modelling techniques are able to assist Public Authorities in energy planning policies, support the work of various scientific communities dealing with health protection, energy production and consumption and solar energy exploitation, and finally are able to enable the solar industry to better plan clean energies, its transmission and distribution, which in turn will boost the relative contribution to national portfolios. The above deeper discussion of the application fields of our proposed methodology has been added in the Methodology section 2.2.

- At line 12 of page 7 it is written that NN is less computationally demanding than the interpolation. A quantification of this point should be given to better understand how the procedures work operationally.

Author's reply: Using a test set of 1,000 RTM simulations from the developed LUT, we applied an interpolating function to adjacent/nearest-value and was found that each interpolation calculation required a time in excess (in total ≈ 21 hours) of each single run of RTM used to generate the LUT in the first place (≈ 12 hours for 1,000 RTM simulation outputs with spectral resolution of 1 nm in the range 285-2700 nm), while for the same test set, the NN needed almost 0.144 seconds to generate the 1,000 output spectra. Takenaka et al. (2011) have pointed out that the inclusion of many parameters (we incorporated 6 for the clear and 4 for the cloudy sky simulations) and small step sizes (we produced more than 2.5 million RTM simulations in total) can dramatically increase the LUT volume, while Sauer and Xu (1995) and Gasca and Sauer (2000) noted that the multidimensional nature of the dataset requires interpolation/extrapolation procedures that impact strongly on calculation speed. The above quantification was included in sub-section 2.2.3 in order to clarify how the procedures work operationally and to explain the reason why the NN is less computationally demanding than the interpolation.

- Paragraph 3.2.1 Cloud effect: in the Figure 8, regression lines and determination coefficients should be included and discussed to give a quantitative estimation of the differences among the techniques.

Author's reply: In the revised paper we included the regression lines and determination coefficients in Fig. 8, while we incorporated and discussed them in the Cloud effect sub-section 3.2.1. We thank the reviewer for this comment, since now the revised paper gives a quantitative estimation of the differences among the techniques.

- Page 3 line 10: "coverege" -> "coverage".

Author's reply: Corrected.

- At the end of section 2.2 explain how the relative components of the errors are computed.

Author's reply: Concerning the relative components of MBE and RMSE error measures, the normalization is done with respect to the mean ground measurement irradiance in the considered station and period. This explanation was added in the revised paper.

- Figure 9: Add units to standard deviation.

Author's reply: Corrected.

Authors: Once again, we thank the reviewer #1 for the constructive comments and we believe that after the proposed revisions this paper was overall upgraded.