

Authors' Responses to Reviewer 1:

The authors provide an extensive overview about the CM-SAF CAL approach for retrieving the SSI from satellite measurements. In the introduction, the authors also mentioned other methods to derive the SSI and referred to many publications. Then the authors mainly explained the CM-SAF SSI algorithm with new development and ideas. It is amazing that the authors could include so many topics in one paper. The structure of the paper could be improved. Some subsections seem not at the right place. I think the paper fits the scopes of AMT and can be published after some corrections.

Specific comments

Line 57,

'500 nm' should be '500 m'

→ Thanks, corrected.

line 75

'The value of satellite data is further increased due to the automation of ground based networks. '

Could you add an explanation for this [sentence](#)?

→ Thanks: The following sentence is added to the manuscript. „E.g. at DWD the satellite-based direct irradiance is used to derive raster data of sunshine duration as a replacement of the former [Campbell–Stokes recorders](#) .

Paragraph from line 114.

The authors reviewed some SSI data sources. The KNMI CPP -SICCS data set is also available online. Actually the CM- SAF cloud properties are retrieved using the CPP algorithm and SICCS SSI products derived from the cloud properties. <https://msgcpp.knmi.nl/>.

→ Thanks, we added the following information to the manuscript: „*Solar radiation data are also available online from KNMI ([\it msgcpp.knmi.nl](https://msgcpp.knmi.nl/))*. The data is based on the Cloud Physical Properties (CPP) algorithm, which is being developed at KNMI to derive cloud, precipitation and radiation products from satellite instruments (e.g. SEVIRI). The development was partly funded

by Eumetsat within the scope of the CM SAF activities. Open Geospatial Consortium (OGC) services are used to offer the near real time products.“

todo

In the end of section 1, I think it is better to include a few sentences to present an outline of the rest of the paper.

→ Thanks: A few sentences for the outline were added to the manuscript.
Line 131-136

Line 145 please correct the typo 'emmitted'

→ Thanks, done.

line 184 'many RTMs must be performed ...'

Do you mean 'many RTM calculations must be performed ...'?

→ Yes, thanks, corrected.

line 186 , '... recalcuation , whiis necessary from time ...'

please correct the typo.

→ Thanks, corrected

Line 196 '... using the DISORT solver (Stammes et al., 1988) ...'

Please correct the author name, it should be 'Stamnes'.

→ Thanks, corrected.

Line 197 ' ... resulting from a adaptation of the Skartveit et al. (1998) ...'

change 'a' to 'an'

→ Thanks, done.

#Eq. 5 looks the same as Eq. 3, Is it needed here?

→ Thanks, indeed, they are identical, thus we replaced the equation by a reference to eqzuation 2

line 210 , ' ... hence almost all of the UV-A radiation reaching the top of ...'

I think 'UV-A' should be changed to 'UV-B' according to the content of the sentence.

→ Thanks we rephrased the sentence: „Almost all UV-B radiation that enters the atmosphere is absorbed“

line 218 ' In contrast, cloud droplets and aerosols are leading to Mie scattering, ...'

It is not accurate to include aerosols here. Because some aerosols particles are not spherical, Mie scattering is not a good approximation for aerosol scattering.

Please rewrite the sentence.

→ Thanks, we agree, aerosols is too general and misleading in this context. We rephrased the sentence as follows: „*In contrast, cloud droplets and spherical aerosols are leading to Mie scattering, ...*“

Line 223 ' The great majority of air molecules (N₂ , O₂ , CO₂ , methane, noble and inert gases) are well mixed and uniformly distributed and do not affect the spatial and temporal distribution of solar surface irradiance. '

Please rewrite this sentence. CO₂ and methane could be well mixed vertically in the atmosphere but there are spatial and temporal variations. Of course the variations are small but they are not in the same category as O₂ and N₂. The sentence in line 223 could be misleading.

→ Thanks: We rephrased it to: „*The great majority of air molecules (N₂, O₂, noble and inert gases) are well mixed and uniformly distributed and do not affect the spatial and temporal variation of solar surface irradiance. Even the rather small fluctuations of methane and CO₂ have no significant effect on SSI variation.*“

#Line 258 ' Is the change in the fluxes induced by a different viewing geometry for the same SAL or by the change in SAL induced by SZA, change in vegetation, different pixel size, calibration issues (ageing of channels, change of spectral response function), change of satellite instruments, and others. '

This sentence is not easy to read. Please rewrite it.

→ Thanks, we rephrased it to „*The relation between observed radiances and simulated fluxes depends not only on the viewing geometry but also on landuse (SAL SZA dependency), pixel size, calibration issues (ageing of channels, change of spectral response function) and other effects.*“

#Line 293

'In brief, using the indirect approach means to be further away from the observations, to introduce further error sources by weak assumptions and to use simulations instead of observations directly.'

I think this statement is too negative about the indirect approach. I would write it differently.

-> Thanks, we agree. We deleted the word weak and the ill-posed phrase rephrased the paragraph to *„In brief, using the indirect approach means to be further away from the observations, as additional assumptions and simulations are needed in contrast to the direct path, which is discussed in the next section.“*

line 367

‘ ... cloud transmission ist quite ...’ correct the typo

→ Thanks, done.

section 6 ‘Forecasting and seamless prediction’

I do not see the authors mentioned anything about the seamless prediction. Could the authors add a short paragraph?

→ Thanks: A detailed discussion of seamless prediction would be out of the scope of the manuscript and seamless prediction was therefore deleted from the section title, but for completeness we added the following sentence to the manuscript: *„However, cloud motion vector methods have the disadvantage that they can not capture convection or dissipation (change in intensity). Although NWP has also great difficulties in this area they include at least physical parameterisations to deal with the phenomena. That is the reason why after a couple of hours NWP models outperform NWC and a combination of both methods is needed in order to gain the optimal accuracy for every time step.“*

A more detailed discussion of seamless prediction would be out of the scope of the manuscript

line 541.

Please add some comments about the ECMWF snow/ice forecast product.

→ Please apologize, but we did not capture what is meant here. In the manuscript NIC IMS snow mask is mentioned and referred. We think a discussion of the ECMWF snow/ice forecast product might be out of the scope.

Section 7.2.1 around line 600. The authors commented that the the error reduction by implementing the parallax correction is marginal. I think the authors look at the monthly mean or in a large area.

For a specific location having some small clouds, the parallax correction is important. Perhaps the authors could add some discussions on this case. Perhaps there are not much corrections for the SSI values but the SSI values have to be assigned at the right pixels.

→ The comment is based on the communication with Reto Stöckli from MeteoSwiss. The error reduction was marginal compared to the other „mountain“ specific sources. Of course, the parallax correction could be more significant in homogenous terrain. We added a sentence to clarify this. *„Especially since the parallax correction could be more significant in homogeneous terrain.“*

7.2.3 Deep learning - ...

I think this deep learning section does not belong to 7.2. It could be a new subsection, 7.3 or 7.4.

→ Thanks, section 7.2 was incorrectly a section but should be a subsection. Has been modified accordingly.

7.3.1 Ozone

The discussion of impact of ozone is only on the broadband SSI. Since the authors also discussed the spectral resolved irradiance, the readers may want to know the impact of ozone on the SSI in the UV wavelengths.

→ Thanks: We added the following sentence to the manuscript: *“However, the absorption effect of ozone in the UV is very strong and therefore accurate information about the ozone concentration is required for this spectral range.”*

7.3.4. Aerosols

Could you comment on the CAMS aerosol forecast product?

→ Thanks: We added the following text to the manuscript. *„The research and developments of the MACC projects went into the Copernicus Atmosphere Monitoring Service (CAMS) \cite{Innes_19}, which was implemented by ECMWF as part of the Copernicus Programme. Thus, CAMS is some kind of successor of MACC and a very valuable source for aerosol information. CAMS provides reanalysis as well as forecast data.*

Line 774 ‘The effective cloud albedo CAL, also referred to as cloud index or effective cloud fraction ...’

I think the OMI SSI product using the effective cloud fraction and its references can be referred to . (<https://www.temis.nl/ssi/>).

→ Thanks, this is now mentioned and cited at the end of section 4

Please correct the typos.

→ Done