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Atmospheric Measurement Techniques Discussions

Interactive comment on "Surface solar irradiance from SCIAMACHY measurements: algorithm and validation" *by* P. Wang et al.

P. Wang et al.

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Reply to referee #1

We would like to thank referee #1 for the comments and suggestions on the paper. We have answered all the questions and revised the paper.

Because we submitted the manuscript in word file format, the page and line numbers in the questions from referee #1 are corresponding to this word file but not the online AMTD paper. Therefore, for every question we added the page and line number in the AMTD paper. The answers start with 'A: The question refers to page XX, line XX in the AMTD paper.'

Interactive comment on "Surface solar irradiance from SCIAMACHY measurements:

algorithm and validation" by P. Wang et al.

Anonymous Referee #1

Received and published: 12 February 2011

General comments

The paper addresses a very interesting topic, and provides an assessment of a new product derived from SCIAMACKY satellite. The paper discusses new measurement techniques and as such falls within the scopes of AMT. Solar irradiance data at the surface are relevant for climate studies, and a validated dataset will be very useful for the scientific community. The paper presents and discusses a new algorithm to parameterize the cloud effects on incoming solar irradiance. The algorithm and the derived product are validated against measurements at the surface and against other satellite derived datasets. The methodology is adequately described and the statistical methods used to assess the data are valid. Both the abstract and the title reflect clearly the contents of the paper. The overall structure and presentation of the paper is clear. If the comparisons between datasets were shown as ratios, then the overall picture would have not been as good as appears in the paper. The scatter plots are dominated by the annual variation of the solar zenith angle and large part of the correlation coefficient is due to this variation. On the other hand, one cannot expect that satellite derived irradiance data can agree very well with ground based measurements a) because satellite estimates are based on modelling and b) because the two measurement techniques (from ground and space) are based on different principles. Because of this I would not insist in changing the type of the comparison plots.

Specific comments

11, 14: Use seasonally varying ozone? What happens over Antarctica during the ozone hole? Is fixed albedo appropriate for ice/snow covered areas? How about fixed Water vapor?

A: The question refers to page 882, line 11 in the AMTD paper.

Seasonally varying ozone is not used in this paper. Indeed during the ozone hole season, the ozone column is very low, the assumption of 345 DU O3 would cause too much O3 absorption and lower SSI value. We would like to correct the O3 variation in the new version of the SSI product.

In the basis SSI look-up-table the surface albedo is fixed. However, the effect of variation of surface albedo value with respect to the value used in the LUT is corrected. The actual surface albedo is taken from SARB/CERES surface albedo database. Therefore we do not use a fixed surface albedo to calculate SSI. The FRESCO SSI algorithm has not been applied to snow/ice covered area. This is clarified in the paper.

The water vapor column amount is fixed in the basis SSI LUT but it is corrected to the water vapor values for every SCIAMACHY pixel according to the ECMWF ERA interim water vapor climatological data which is provided at 0.1 degree resolution for every month. However, the water vapor climatological data are not changed for different years of SCIAMACHY measurements.

11, 19: What correction formulas and parameterizations were used? How large the correction factors are?

A: The question refers to page 882, line 16 in the AMTD paper.

The correction and parameterization formulas are provided in Mueller et al. (2009). We have added the reference after line 16 page 882 and some explanation about the corrections for the water vapor and surface albedo.

The correction for water vapor column is based on Eq. 5 in Mueller et al. (2009).

I_basis_h2o = I_basis + dI_h2o * cos(SZA)^a (5)

I_basis is the solar irradiance at the surface derived from the basis LUT for fixed water vapor amount of 15 mm, I_basis_h2o is the solar irradiance at the surface corrected

for the actual water vapor amount and the solar zenith angle (SZA). dI_h2o is the difference between the irradiance for the 15 kg/m2 water vapor and the irradiance for the actual amount of water vapor, for SZA=0 and a fixed standard atmosphere defined by rural aerosol type with an AOD of 0.2, a surface albedo of 0.2 and 345 DU ozone. dI_h2o depends on the amount of water vapor. It is pre-calculated for 18 water vapor amounts and the algorithm uses the appropriate dI_h2o value for the specific pixel and time.

The correction for surface albedo is based on Eq. 6 in Mueller et al. (2009).

I = I_basis_h2o * (0.98 + 0.1 * SAL) (6)

I_basis_h2o is the surface solar irradiance derived from the basis LUT for a surface albedo of 0.2 after Eq. (5) has been applied. SAL is the variable surface albedo and 'I' is the solar irradiance after the surface albedo correction has been applied.

The correction for the water vapor is quite large. As shown in Fig. 7 in Mueller et al. (2009), for the water vapor of 15 mm in the LUT, if the actual water vapor is 0 mm, the surface solar irradiance could be up to 150 W/m2 higher; if the actual water vapor is 70 mm, the surface solar irradiance could be up to -90 W/m2 lower. The surface solar irradiance shows a weak dependency of surface albedo for clear-sky situation as given by Equation 6 of Mueller et al..

14, 18: How ice/snow pixels are identified?

A: The question refers to page 885, line 1 in the AMTD paper.

In FRESCO algorithm, the snow/ice pixel is determined according to the TOMS monthly climatological surface albedo data at 340 nm. If the surface albedo value for a pixel is larger than 0.2, the pixel is flagged as snow/ice pixel. We have to admit that the snow/ice pixel detection is only valid for the surface with permanent snow/ice. The snow/ice identification in FRESCO algorithm has to be improved.

15, 9: Averages of daily SSI for local noon over 3 months would be affected by day-to-

day changes in the sza.

A: The question refers to page 885, line 13 in the AMTD paper.

We agree with the referee. We do not compare seasonally averaged SSI to other data source.

15, 18: The effect of the structure in the albedo is quite important. How the authors plan to cope with it? Same comment for the statement in 18, 19.

A: The question refers to page 885, line 21-22 in the AMTD paper.

Popp et al. (2011) have compiled a high resolution surface albedo database from MERIS surface albedo data. Since March 2011 the MERIS surface albedo database has been used in the FRESCO algorithm (version 6) and the SCIAMACHY FRESCO data have been reprocessed. We have seen some improvements of the FRESCO effective cloud fraction data over Sahara desert region and at the coastlines because of the high resolution of the MERIS surface albedo data. This is included in the discussion section in the revised paper.

16, 21: It would be important o show the validation results also for SBO site, because this would reveal the importance of the albedo problem in FRESCO.

A: The question refers to page 886, line 20 in the AMTD paper.

The comparison results for SBO are now included in Table 1 with some discussions. The large negative bias of SSI value at the SBO site is because of the larger effective cloud fraction which seems not realistic.

17, 17: I would prefer to see the figures as a function of day of year instead of case number. This way any seasonal features would be more evident.

A: The question refers to page 887, line 11 in the AMTD paper.

Thanks for the suggestion. The SSI values are now plotted as a function of day-of-year

(see Fig. 5). The figures have no big changes, because the SCIAMACHY overpass is at regular time interval, roughly every 6 days. For stations BAR, PAY and XIA, the missing data are quite clear in the new plots.

17, 18: Undoubtedly the comparison is good, but is dominated by the seasonal cycle of the sza which improves the correlation (as seen in Fig. 6). This should be mentioned in the text.

A: The question refers to page 887, line 11 in the AMTD paper

We agree with the referee. We have explained in the text that the seasonal cycle of the sza which improves the correlation (See Sect. 4.1, paragraph 3).

17, 22: Have these differences a preference in sign? I would expect that the ground stations measure less over islands because usually clouds are formed over land. Hence ground based measurements should be directly influenced, while the satellite measurements would not, as they take into account the average albedo of the corresponding pixel.

A: The question refers to page 887, line 15 in the AMTD paper

Thanks for the suggestions. We have checked the locations of MAN, KWA and COC on the Google map. The islands where the stations are located are smaller than 1 degree x 1 degree in lat/lon, therefore the surface albedo values for these islands are the surface albedo of ocean in the FRESCO surface albedo database. The islands COC and KWA are about 5 km2 in the middle of the ocean, so the effective cloud fraction may not be impacted by the island surface albedo. As shown in Fig. 6 the SSI values at COC and KWA have no large bias. For station MAN, the area of the island is about the pixel size of SCIAMACHY, thus the effective cloud fraction could be too high because the surface albedo of ocean is used in the cloud retrieval. This may explain that FRESCO SSI has a negative bias at MAN. This is included in the revised paper in Sect. 4.1, paragraph 3.

18, 21: I am not convinced that this statement is true when looking at Figure 7.

A: The question refers to page 888, line 9 in the AMTD paper

We agree with the referee. The statement, large difference observed at high values, is removed.

19, 11: Is the quoted large standard deviation (50%) the average std derived from all 60 minute intervals over a year?

A: The question refers to page 888, line 23 in the AMTD paper

Yes, it is.

22,1 : From Figure 8 it appears that the two datasets agree well with respect to the shape and broad details which mainly comes form the latitudinal variation of the solar zenith angle. This does not constitute a “very good” agreement. I would prefer a softer expression.

A: The question refers to page 890, line 15 in the AMTD paper

We agree with the referee. The statement “very good agreement” is changed. We have now also explained that the latitudinal variation of the solar zenith angle contributes to the linear correlation between the SCIAMACHY SSI and ISCCP-FD data in the revised paper (see Sect. 4.2, Paragraph 4).

43, 5: Is the color scale logarithmic (doesn’t look like) or the data are logarithms of the density?

A: The question refers to page 909, Fig.7 caption in the AMTD paper

The data are logarithms of the density. We have corrected it in the revised paper.

Technical corrections

10, 11: Shouldn’t it be -.02 (minus)

A: It was corrected in the AMTD paper already. Thanks for pointing out the error.

47: The first 3 columns in table 1 should be aligned vertically.

A: We have aligned the lat/lon vertically in Table 1.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 873, 2011.