Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2017-95-AC2, 2018

Ocean Science
Discussions
Open Access
EGU

Interactive comment on "Estimating downwelling solar irradiance at the surface of the tropical Atlantic Ocean: A comparison of PIRATA measurements against several re-analyses and satellite-derived data sets" *by* Mélodie Trolliet et al.

Mélodie Trolliet et al.

melodie.trolliet@mines-paristech.fr

Received and published: 6 April 2018

Main comments: The discussions of the results for the satellite-based data sets are very similar, and the performances relative to PIRATA are also similar. I suggest putting the satellite-based data set results in one section and discussing them together in order to avoid repetition. The MERRA and ERA results could also be put into the same section and discussed together for the same reason. Making these changes would

Printer-friendly version

Discussion paper

improve the readability of the manuscript.

»» Thank you for this comment. We fully agree. Discussion and results sections have been restructured to improve the clarity and organization of the presentation and to avoid repetition in the description of the statistics for each data set. The three satellite-derived data sets are now present and discussed together, as the two re-analysis data sets. The layout of the figures can be improved. Currently they are structured so that a certain parameter is shown for all data sets in a given figure. However, in the text the results are discussed separately for each data set. It makes more sense to put all HelioClim plots (i.e. Fig. 2a,b, Fig. 3a,b, etc.) in the same figure, and the same for SARAH, CAMS, and the reanalyses.

»» The different figures have been moved and are now following the corresponding sections. The plots have been clustered in two sets of figures: one for the satellite-derived data sets and one for the re-analyses. As stated in the manuscript, potential biases in the PIRATA time series are an issue and complicate validation of the satellite-based data sets. These biases are discussed in section 1.1, but there's no summary or estimate of the overall uncertainty in the PIRATA hourly data. Can you provide an estimate?

»» You are right; these potential biases are an issue. According to the literature we have cited, the uncertainties are complex to model because of the large numbers influencing factors that occur with different time scales. For example, the wave effect and the aerosol effect do not influence the buoy at the same scale. These influencing factors are difficult to assess. Accordingly, we are not able to provide an estimate for the overall uncertainty in the PIRATA hourly data. The text has been modified and these difficulties have been underlined in the conclusion.

I would expect the buoy measurements may be biased low regardless of any aerosol buildup, based on the persistent low biases shown in Fig. 7 of Foltz et al. (2013), possibly due to fading of the radiometers' coatings with time. It might be helpful to plot the DSIS bias as a function of DSIS to help figure out if biases of buoy DSIS may be partially to blame. I would expect the bias may be larger for larger DSIS if the buoy data have biases, essentially due to a bias in the buoy radiometers' gain coefficients. I don't see any evidence of this dependence in your figures, but it's difficult to tell for sure.

»»The presented graphs in Section 3 may help to answer these concerns though it is difficult to tell for sure as written by the Reviewer. The 2D histograms as well as the comparison of monthly means may provide insight of the possible relationships between the errors and the DSIS. No clear relationship emerges, and it depends upon the data set. For example, one may see in the comparison of the monthly means for satellite-derived data sets that the bias is greater for medium DSIS occurring in November and December and not for the greatest ones. Other comments: It's unclear how repetitive buoy tilting/rocking from waves would introduce a mean bias for a daily average (p. 3, lines 21-24). A brief explanation here would help. For a systematic tilt (e.g. on the equator due to strong zonal currents) it's easier to imagine.

»» Katsaros and DeVault (1986) distinguished two main kinds of errors: the errors due to rocking motion caused by waves and the errors due to a mean tilt. As you mentioned, the last one is easier to imagine. The first one can be approached by the two following extreme cases: (i) the buoy motion is in the direction of the sun and (ii) the buoy motion is perpendicular to that direction. In the first situation, Katsaros and DeVault (1986) expressed the error in irradiance measurement as a combination of losses produced by a motion away from the sun and gains by the tilting of the buoy toward the sun. By means of an analytical model and gross assumptions, Katsaros and DeVault (1986) concluded that "the average error for a cycle of motion will not be zero but will not be large". In the second situation, the effect of a perpendicular movement is always a loss, due to the loss of the sky portion seen by the pyranometer. Katsaros and DeVault (1986) calculated that the loss is of the order of 10% in hourly mean of irradiance for 10° tilt and solar zenithal angle greater than 30°. For daily averaging periods, the influence of the buoy movement is a combination of the two cases. As a consequence, compensating errors would often lead to smaller errors in measurement of daily means of irradiance. The text has been modified to bring this explanation as requested. p. 4, line 19: I would expect equatorial moorings to be influenced the most by tilt due to currents. North of about 8N currents should be much weaker in the mean.

»» Yes you are right, the mooring located in the equatorial band are subjected to tilt due to current. Foltz et al. (2013) wrote: "Errors due to buoy tilt are difficult to quantify (MacWhorter and Weller 1991), but are likely to be significant only at locations with strong mean currents (i.e., in the strong westward flow along the equator and eastward flow between 4 and 8N in the tropical Atlantic)." Hence, these stations were excluded in the study. North of 8 °N, "tilt biases are not expected to be significant in the 12–21N latitude band, where monthly-mean current speeds are ,20 cm s-1" (Foltz et al., 2013). The stations in this latitude band were excluded because of the contamination by African dust (Foltz et al., 2013). The text has been modified to make it clearer. p. 5, lines 21-22: Why not use the same EO as is used for PIRATA? That would ensure that differences in DSIS are the only thing contributing to differences in KT. Or if the EO values from different data sets are basically the same, that should be stated.

»» Each data set uses its own EO, which is provided by external astronomical models. The innovation of satellite-derived model and re-analyses is in the modelling of the clearness index KT, and not in E0. If we use the same E0 for all data sets, including PIRATA, this would create artificial distortions. This is why we use E0 of each data set. In any case, the E0 differs slightly from a data set to another by a few W m-2, excepted for MERRA-2 as shown in the study (mean and true solar time). The text has been modified to make it clearer. p. 6, lines 4-5: It's not clear how 30-min values were converted to hourly. Do you add anomalies from the TOA irradiance to 1-min TAO irradiance, then average this to an hourly average?

»» Regarding SARAH-2, the instantaneous values every 30 min were converted into instantaneous clearness index every 30 min. Assuming that KT is constant over 30 min, each instantaneous KT is multiplied by the corresponding E0 integrated over 30 min, yielding 30 min irradiation. These 30 min irradiations are summed two by two to yield hourly irradiations, and then hourly means of irradiance. The text has been modified in order to add this information. The portion of section 2 on p. 7-8 describes methodology more than results, so could be moved to section 1.

»» The section “Results” has been split and this part of the manuscript is now in the Section 1.

Why do you show only the 6S, 10W location in the figures? Please explain.

»» The station 6s10w has been chosen as an illustrative example. This precision has been added in the text. The plots for the others locations have been added in appendix in order to guarantee the ability to the reader to compare the different results.

In Fig. 2 the font within the figure (Mean, bias, st-dev, corr_coeff) is too small to read.

»» This has been corrected taking into account this comment.

p. 10, lines 15-20: Are you saying here that HelioClim does not have enough cloud radiative forcing? It seems like it, but not sure.

»» You are right, these sentences were unclear. We have rewritten this part.

p. 10, line 23: Are the results for 0n0e and 0n10w shown in a figure or table?

»» The different plots for the five buoys are now provided in Appendix.

p. 10, lines 25-26: Why the underestimation and overestimation? Low cloudiness?

»» answer

p. 11, line 1: Are you referring to the bias for KT=0.7?

»» This comment has been taken into account during the rewriting of the section.

p. 11, line 13: Please explain why it is important that spatial gradients are reproduced.

»» answer

p. 11, line 19: I don't see this underestimation ion Fig. 2c.

»» Indeed, the underestimation is only visible on the frequency histogram. This comment has been taken into account in the rewriting of the analysis of the frequency distribution of PIRATA measurements and satellite-derived data sets.

p. 12, line 27: What is special about KT=0.6-0.7 that results in large biases in the satellite analyses? Because it appears so consistently, it would be worthwhile to know.

»» A sentence suggesting explanations of the large over-estimation in the satellite-derived data sets has been added in the description of the frequency distribution of PIRATA measurements and satellite-derived data sets. TO DO

p. 13, line 5: "do not correlate" might be too strong of a statement, since some correlations are 0.82-0.91.

»» Thank you for the comment, it was a mistake. The text has been corrected from "do not correlate" to "correlate".

p. 13, line 9: What is the difference between true solar time and mean solar time?

»» answer The mean solar time corresponds to the time defined through the time duration for one earth rotation divided into 24 h as an average. The sun is approximately at its zenith when the mean solar time is equal to 12 h. Consequently, the mean solar time is not the same everywhere on the earth. It depends upon the longitude. The true solar time takes into account that the earth's angular speed varies slightly throughout the year because of the elliptic orbit of the earth. Combined with the rotation of the earth on itself, which is very regular, it results that the sun does not reach its highest position in the sky at 12 h mean solar time every day. In other words, the true solar time corresponds to the time determined every day by the actual position of the sun in the sky. The true solar time is that needed for computing the solar zenithal angle accurately enough. This angle intervenes twice: firstly to compute the irradiance impinging on the horizontal plane at the top of atmosphere and secondly as a major input to the radiative transfer model. Hence, an error in this angle yields an error in the estimated DSIS. The mean solar time can differ up to 17 min from the true solar time. These precisions have been added in Section “Discussion and results”.

p. 13, line 17: MERRA results are in Fig. 5c,d according to figure caption, not Fig. 5a.

»» You are right, the figures has been mixed. It has been corrected.

p. 14, line 20: This statement is very confusing.

»» The paragraph has been rewritten in order to avoid confusion. The observations are now in the Section “Daily analyses of the re-analysis data sets”.

Interactive comment on Ocean Sci. Discuss., https://doi.org/10.5194/os-2017-95, 2017.