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Atmospheric Measurement Techniques Discussions

Interactive comment on "Shortwave surface radiation budget network for observing small-scale cloud inhomogeneity fields" *by* B. L. Madhavan et al.

Anonymous Referee #1

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Summary: This paper describes a unique high-resolution array of radiometers that was deployed in Germany during the spring and summer of 2013, the QC methods applied to the resulting irradiance data, and some preliminary results of its analysis. Presentation of this data set to the community is important, as it could make possible studies of the inhomogeneity of cloud and radiation fields at unusually small scales. However, this paper has several scientific weaknesses. English expression could also be significantly improved.

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Scientific comments:

a) I have a lot of questions about the QC methods. In this regard, the data provider must demonstrate that the data are of sufficient quality for the analysis that is performed or intended. For the present preliminary work, the standard of proof is not as high as it would be for more explicit study of the effects of cloud structure on the surface SW irradiance field. Even so, a number of questions remain unaddressed.

p. 2561, 20-25 – How were the cleanliness and level flags assigned? If contaminants or tilt in the instrument were found, were these situations corrected?

p. 2563, 18-20 – The presence of birds, droplets, and shadows are physically observable. Do you just mean that you didn't observe them? Some of these can be (at least partly) accounted for. For example, observations that occur during periods when precipitation was falling can be eliminated; shadowing can be detected by looking for low irradiance values that occur for the same sun positions every day or by taking hemispheric photos at the station locations to determine the position of obstacles. A visit to or photograph of the site should allow one to make a rough estimate of where and when shading might occur, making the process of identifying shading in the data easier. In order for this data to be used in serious cloud research, at least the shading should be treated explicitly.

p. 2563, 21-23 – Could bad data not also be characterized as good by these procedures?

p. 2564, 18-22 – "... the possibility of small-scale cloud induced fields from a few stations being classified as outliers is high. So, the pyranometer stations with more than 50% measurements classified as outliers or minima or maxima on a given day were ignored completely considering the chance of sensor malfunctioning." In other words, you eliminated data points because they might be correct?

Overall – A clearer presentation of how the operational and statistical flags were applied

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should be given. For that matter, it would be helpful to have the full procedure described on the same page instead of the operational checks two pages before the statistical methods.

p. 2566, ll. 12-15 – It's unclear where the estimate of 10% error came from. Previously, error was specified only in terms of the values in Table 1, not as a combined value. This possible error is then ignored. Is it not possible that this level of error could affect the measured "small-scale spatial and temporal variability"?

Fig. 7 – Why are there so many more missing or malfunctioning stations on the overcast day?

b) The purpose of the thermopile radiometers in this study is unclear.

– If it is as a check of the measurements from the silicon detectors, differences should be computed in terms of irradiance or derived transmittance. Correlation is a very weak indicator of agreement. For one thing, it depends highly on meteorological conditions: if the sky is reasonably uniform (clear or overcast), both signals will be highly correlated because the main feature of the day is the sun rising and setting; if broken clouds are present, correlation depends on factors such as the separation of the instruments and the size of the clouds. For another, bias does not affect correlation and, when signals are large, noise doesn't have much effect either.

– In the array configuration that is described, it is not possible to use the thermopile radiometers to assess the accuracy of more than a few of the silicon detectors, because of the spacing. I'm wondering why the typical procedure of setting out all of the instruments over a small area and comparing their measurements over a couple of weeks before deploying them wasn't undertaken. This would at least help in estimating how much the range of estimated transmittances at any given time is affected by instrument biases.

– At several points, it looks like the thermopile radiometer measurements are being

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used to corroborate the range of transmittance values derived for the silicon detector array: “transmittance from thermopile pyranometers always lie within the limits of spatial variability from pyranometer network. This indicates that our pyranometer network is well capturing the cloud inhomogeneity fields at the surface.” I don’t see how the fact that the transmittance values from the thermopile detectors fall within the range of those from the silicon detectors indicates that the network is capturing the variability accurately. Transmittance from the thermopile detectors could range from 0.5 to 0.52 and would fall within the range from the array whether that range was 0.49-0.52 or 0.1-0.9.

c) Other

Title. The title is overstated, since only one component of the radiation budget is considered.

Section 2.1.ii and Appendix A. Please state whether the accuracy specifications given here are operational values or manufacturer’s specifications. These can differ significantly. It is the operational accuracy that we are interested in.

p. 2562, l. 4. How far apart were the thermopile pyranometers from each other? Based on this, is there any reason to expect the variability of estimated transmittance among these radiometers to be similar to that from the more extensive array of silicon-based instruments?

p. 2563, 11-12. GHI is not equal to DNI unless the sun is directly overhead.

p. 2569, ll. 2-6. The fact that something is difficult to model doesn’t mean that it’s significant.

p. 2570, l. 10-12. This is backwards. See, for example, Chow et al., Solar Energy, 2011. This statement, as given, is superfluous because it’s not discussed in the context of the experiment. However, it is relevant to the measurements because of the limited spectral response of the silicon detectors.

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p. 2571, ll. 10-15. Please brush up on the principles of 3D radiative transfer. Side exit of scattered photons from clouds is an important component of increased irradiance in the areas between the clouds. Also, multiple scattering is not required to produce the observed effect. These phenomena have been known for some time, so an older reference should be cited.

p. 2573, ll. 16-21. It is unclear how the measurements from the array can be used in a 3D radiative transfer model or how radiative transfer through cloud fields from an LES model can be used to explain the measurements.

Figures: 2: The red boxes are difficult to see. It would be nice to have a scale in m or km. 4-7: What do the grey areas in the time series represent?

Writing:

There are a few grammatical errors in this paper, however, poor phrasing and incorrect word usage are a greater problem because they create confusing or misleading statements. A native English speaker should read through and correct the text so that the authors' meanings are clear. While there are many instances of poor phrasing in the paper, I have listed some of the most egregious examples below.

p. 2556, l. 17 - What are "indirect interactions" between radiation and clouds?

p. 2560, l. 25 – "Serial" and "analog" do not represent conflicting properties. Aren't the meteorological values also reported as a function of time?

p. 2563, l. 21 – "Nullified" is a rather strong word for this screening procedure.

p. 2565, l. 6 – What does "the time-series between the minimum and maximum values" mean?

p. 2567, l. 20 – What is meant by "background shadowing" (vs. "foreground shadowing")?

p. 2567, l. 21 – Should say "spatial distribution," not "spatial variability."

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p. 2567, l. 24 – How would you recognize “perfect” clear-sky conditions?

p. 2570, l. 5 – Do you see statistical significance? If not, avoid the word “significance.”

p. 2570, l. 16 – What does “the loss in significant digits” mean?

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