

## Authors response to Anonymous Referee #1

### Anonymous Referee #1

Review of the manuscript: “Impact of aerosols and clouds on decadal trends in all-sky solar radiation over the Netherland (1966-2015)” by Boers et al. The authors made a good work in analyzing 50-year hourly dataset of global radiation, cloudiness and visibility over the Netherland in order to quantify the contribution of aerosols and clouds to trends in all-sky radiation. They show that all trends in fractional cloudiness, clear-sky and cloud-base radiation contribute significantly to the observed trend in all-sky radiation. I suggest to consider this paper for publication after the following issues are addressed:

Authors response: We thank the referee for the comments. Below follow the comments and our answers to them:

Specific comments: - Le length of the manuscript could be reduced (especially sections where the methods are described). In this way it will be easier to read the paper and to follow the discussion. –

Author’s response: This point was also brought up by Referee #2. The authors have decided to put the Method sections 2.1, 2.2, 2.3, and 2.4 in an appendix and only write down the end result (including a description of it) of the final equations, namely Eq. (17) and Eq. (21). This is a substantial reduction in the main text which improves the flow of the manuscript.

Line 121: the authors write that all-sky radiation is a function of three components: clear-sky radiation, cloud-base radiation and fractional cloudiness. How do you think that the results could change considering also the type of clouds and not only their extent?

Author’s response: Interesting point. If some cloud would have shifted from ice to liquid within those fifty year, the microphysics would have changed [but to an unknown extent]

which in turn could have impacted the radiation at the surface. However, then it needs to be quantified how such changes took place and perhaps more importantly how it would have impacted the radiation. This is not a feasible subtopic within this paper. Nevertheless, we decided to put in a statement alerting the reader to this potential issue.

*Long term changes in cloud type could perhaps affect cloud optical properties (liquid water versus ice water) but their influence on trends is unknown and not studied here.*

Line 262: the right hand side of the equation has four components. Only three of them are discussed (lines: 264-269).

Author's response: This was a remnant of a previous version of the paper. We corrected this as there are indeed four terms. All four are described now.

At line 269, the authors write that the fourth term is not shown. Clarify this point.

Author's response: This point is directly linked to the previous one. The correction to the text was made by removing '*not shown here*' in line 270.

Line 325: How are estimated the last two parameters used for model calculations? -

Author's response: They come from the analysis of the Boers et al., 2015 Environmental Research Letters paper. This is now referenced:

*The asymmetry parameter and the Ångström parameter are set to 0.69 and 1.5 respectively to reflect typical aerosol values derived for the Netherlands (Boers et al., 2015).*

Line 430: How does the present weather sensor work? Why does the change from human observations to automatic sensor introduce a break in cloudiness series and not in visibility series?

Author's response: A statement was put in described the working of this instrument:

*The PWS detects the forward scattering of light emitted by a Near Infrared Light Emitting Diode under an angle of 42°*

We suspect that the simplicity of the PWS instrument in comparison with the ceilometer has much to do with the ease of transition from human observer to instrument. In both cases an overlap period of two years was used to assess their performance. But for the PWS a simple adjustment will probably have sufficed. However, at an early stage it was noted that the transition to ceilometer posed serious problems mostly the result of the fact that the sky coverage of an individual ceilometer observation is a couple of square meters or less, while a human observer covers at least 25 km<sup>2</sup> if not more. How to manage such a transition for selected cloud cover is much more difficult than a simple PWS adjustment.

We decided not to amplify this point further in the text, except by stating for the PWS that

*No discontinuity was detected at the year 2002 indicating good adjustment procedures from Human Observer to instrument at the transition time.*

Lines 568-570: How do you explain this result?

Author's response: The increased in cloud cover together with a decrease in cloud optical thickness is an interesting result. The cause is unclear and contrary to [our] intuition. We could speculate on this issue but that would detract from the main results. However it is a valid point of attention so we included:

The implication is that clouds have become (optically thinner) but at the same time more frequent, the cause of which is unclear.

Technical corrections:

Check the reference at line 77;

Author's response: Yes, corrected in the references

Line 105: It is the first time that the abbreviation ACI is used in the text so it is necessary to define it (even if it is already defined in the abstract);

Author's response: yes, was done

Line 226: Define all the parameters in equation 16;

Author's response: yes, was done, but will be part of the newly formed appendix.

Some additional references are necessary, for example at lines:

298,

Author's response: this is standard definition of optical thickness, we believe that this does not need a reference.

303,

Author's response: this is the Mean Value Theorem, which we included in the text.

315,

Author's response: this is indeed an imprecise statement. We used the average value over the Netherlands based on the ERA data. So we changed in the text:

*...and a value of 1000 m was used to reflect conditions over the Netherlands.*

323,

Author's response: yes, this is Boers (1994), and included in the reference list

350;

Author's response: yes, this is Twomey (1977) and a huge number of others!

Check the reference at lines 584 and 676.

Author's response: yes it is Sanchez-Lorenzo, not the other way around. We corrected.