

Review of:**“Understanding the variation of Reflected Solar Radiation: A Latitude- and month-based Perspective“, Li et al.**

The authors conduct a statistical analysis of the evolution of the hemispheric albedo symmetry in the observational record through looking at the components that comprise it, the annual cycle, and where in the world/which component of albedo/when in the year trends are occurring. The analysis aids in studies of the hemispheric albedo symmetry by breaking down trends in components of the albedo symmetry into regions, latitudes, and months, which would point the community towards details around its changing nature. Comparisons between data sets and reanalyses would help advise the community in using the right tools to understand the hemispheric albedo symmetry. The description of the data sets and methods is well-written and thorough.

I would recommend the manuscript to be accepted after some minor revisions. My two major comments below address things that I feel need to be addressed in order for the analysis to be more robust, especially with using albedo as fractional terms in addition to the energetic terms presented. The rest of my comments are aimed at smaller errors or points of confusion.

More generally: although I understood and the paper is generally structured well, I had difficulty with the language and grammar, and I suggest that a language service be used in revising the manuscript. I would caution the authors to use the word “significant” carefully as it is generally used to mean statistical significance, but I have difficulty understanding which is meant throughout the manuscript.

Sincerely,

Aiden Jönsson

Major Comments

Since CERES is itself an observational data set assimilating multiple sources of satellite-based observations with its own weaknesses, it should not be considered truth. I recognize that the albedo symmetry is primarily a feature able to be studied through CERES, but statements of it being more real/true than other data sets by nature could be relaxed throughout the manuscript.

L389 and the following paragraph: There is a reduction from spring to winter in both hemispheres, but since these are in energetic units, it could be good to show Figure 2 using albedo as fractional terms in order to remove the seasonal insolation cycle. Please consider replacing Figure 2 with that, or including it in the supplement. I’m not sure how these will affect the results, but I think a stronger decreasing trend in energetic terms during summer can be expected.

L945-957: The authors calculate a trend in CERES Earth energy imbalance (EEI) and introduce the result in the Discussion and Conclusions section. Accurately observing and calculating the EEI is not an easy task and should probably not be done in this way; it would probably be best to refer to previous studies on this, and if the authors wish to include it in the results, they should do so before this section.

Minor comments

Title: This paper has more to do with trends than it does variation/variability; would it be more fitting to call it "Understanding trends in Reflected Solar Radiation: ..."?

L8: It is unclear what "hemispheric variations" may mean for signals in the hemispheric symmetry's development or trends.

L11: It is unclear what is being reproduced: reproducing the hemispheric symmetry would indicate a modeling study, but I believe the authors intend to reproduce analyses of the hemispheric symmetry in other observational records. It would help to clarify what is being done here.

L13: Here and elsewhere: when saying "decreasing trends" or so, please specify what is decreasing, such as explicitly stating "trends in decreasing RSR".

L21-22 and elsewhere (e.g. L26): "Reproducing hemispheric symmetry": This makes it seem as if the symmetry primarily studied in CERES is an absolute truth, and other data sets would "fail" if they do not have symmetry. If I am understanding correctly that this sentence means that AVHRR *exhibits* hemispheric symmetry, then perhaps it would help to phrase it so.

L32-33: It would help the flow to use percentage or fractional terms consistently (e.g. 5% and 1%, or 0.05 and 0.01).

L53: Please introduce CMIP/its full name before defining it as an abbreviation.

L89: Could you please clarify what "longer storm tracks" implies – are they longer in the temporal dimension, for example?

L92: Specify that forest fires occur during summer and autumn, not volcanic eruptions.

L100: Please expand or clarify "aerosol effects"; long-range aerosol transport can affect both AOD at range, but may also affect clouds.

L102: The deep convective region and the storm track are quite remote to one another, and it isn't obvious how one affects the other. Please expand and clarify what is meant by this effect, and how it occurs.

L117: They did find that model projections would suggest a symmetry breaking with warming, but I think a more open interpretation of the results – that "will be disrupted" can be relaxed to "may be disrupted" – could better reflect their conclusions.

L117: Connecting word ("... *because* the CERES record ...") missing.

L126: The term AVHRR is not introduced before using it.

L129: MERRA-2 and ERA5 should also be introduced and cited.

L276: Decomposing into cloudy and clear-sky atmospheric flux contributions was already done in Stephens et al (2015).

L372: Citing Diamond et al (2022) would be helpful here, since the topic is the clear-sky asymmetry.

L419: Suggest: reduce → reducing

L422: Suggest: link → relate/be related

L429: "This might be attributed to decreasing cloud cover": I am not sure what is meant by this statement.

L435: "where is" → "where it is"

L452: Compensate for RSR in what way?

L461: "where has" → "where there is"

L465: The citation George and Bjorn, 2021 needs to be fixed (Datseris and Stevens, 2021).

L473: Suggest "more radiation" → "more reflected radiation"

L475: Missing a connecting word or phrase between "the NH as a whole" and "slightly higher"

L481-485: These repeat L471-473, suggest combining to shorten.

L486: The citation should be Bender et al., 2017; the author order needs to be fixed.

L490-492: It is not clear what this sentence offers in terms of conclusions; it needs to be reformulated more specifically regarding hemispheric differences by latitude to be a helpful summarizing statement.

L493-503: This paragraph would address an essential part of the analysis and provide some good insights, but I find it hard to understand. The annual cycle could be removed to aid this, and I suggest the use of albedo as fractional terms rather than reflected radiation in $W m^{-2}$ here to help.

L504: Is it supposed to be "decadal/secular" trend rather than "interannual trend"?

L509: Not sure if "disparate" is used correctly.

L537-541: There is also the effect of cloud reductions, which "unmasks" some of the clear-sky component. Thus the masking effect may explain at least some of the clear-sky increasing trends over the SH midlatitudes. This may also help the following two paragraphs' analysis in contribution rates' trends.

L583-584: This reflects previous results as well, such as [Sledd and L'ecuyer \(2021a\)](#) and [Sledd and L'ecuyer \(2021b\)](#).

Figure 5a: It may be good to label the "OBS" origin in the plot as "CERES" instead, since there are multiple observational data sets here, and it could be good to not regard CERES as absolute truth.

L608-609: These sentences should be written in complete form.

L609: It could help to make the figure stand alone better if DISO is defined in the caption.

L621: Suggest "Note that the good performance of dataset" → "Note that a data set may perform well because ..."

L654-655: I understand what this sentence is saying, but the grammar makes it difficult to read.

L681: What is it that it exhibits the poorest of?

L774: "Length of year" is an odd choice of words as it sounds like the year length is varying. It would be better to say "Length of time series [years]" instead.

L782: Citation needs to be fixed as in L465.

L794: The quantification of the symmetry has been discussed in various ways throughout the literature; please clarify what it is that has not been shown before.

L806: "More than two years" is a very imprecise description, please be specific.

L812: What does "regional average" mean here? Across which spatial scale?

Figure 8d: There is a clear meridionally dependent bias with too much clear-sky atmospheric component in the tropics and too little at the poles in AVHRR. Is there an explanation for this, or can the authors comment on this? Perhaps water vapor affecting transmissivity can play a role here, since the t term in the transfer model can be reduced by increasing absorption of water vapor.

L875: "Unreal" is a loaded word to be used in scientific writing. Here and elsewhere I would suggest using phrases such as "not seen in CERES" rather than unreal or spurious.

L877: Clouds are not parameterized in observational data sets or radiative transfer models, or at least not in the same way that they are in reanalysis forecast models. I would suggest clarifying this earlier in the manuscript.

L889: What is meant by "powerful"? Perhaps "robust"?

L891-893: There have not been many compensation mechanisms suggested as of yet.

L908-910: This sentence makes it sound like the connection between the PDO and the North Atlantic clouds is trivial and well-documented, although I do not think this is what the authors meant to convey.

L917-919: What is meant by the “the contribution rate from 30-40° N to the hemisphere”?

L921: The term “outstanding” is a bit too extreme here.

L955: There is a more recent IPCC Assessment Report that can be cited to better reflect the current state of understanding.