Response to Reviewer #2's Comments:

Ruixue Li et al. (Author)

We are very grateful for the Reviewer #2' constructive comments and suggestions, which help us improve this paper significantly. Based on the comments from reviewers, we reorganize the abstract, introduction, datasets and methods, results and conclusion sections, and add some interpretations in each section in order to enhance the manuscript's continuity and depth of analysis. In addition, some superfluous information in each section is deleted. Based on the comments and suggestions, we also correct inappropriate or unclear descriptions in the manuscript.

Important revision includes:

(1) Section 1, Introduction, is rewritten to enhance clarity regarding the significance and innovations of the manuscript. Superfluous information is removed, and specifically, we highlight the reasons for studying the changes in reflected solar radiation (RSR) at finer spatiotemporal scales and the importance of assessing the applicability of different radiation datasets with longer record in hemispheric symmetry studies. More details are described in Line 65-138. The abstract is also further reorganized to summarize the main findings of this paper.

(2) In Section 2, Datasets and Methodology, we update the CERES data to the latest version (CERES-EBAF 4.2) and correct some bugs in the data processing, and revise the corresponding descriptions.

(3) We agree the reviewer's comments. In Section 3.1, we acknowledge that there is a little bit overlap between Fig. 1 and previous studies. However, the focus of this section is on analyzing changes in RSR and its components at the latitude and monthly scales. We have reorganized Section 3.1 and added an expanded discussion on hemispheric RSR trends, highlighting the contributions of finer spatiotemporal scales to these trends. Additionally, we have analyzed the changes in the contribution rates of different components to the RSR.

(4) The content discussing the contribution of different factors to latitudinal zones in extreme years (Section 3.2) is removed. The adjustment allows us to maintain a more focused and streamlined discussion, centering on the primary objectives and findings of the study.

(5) We substantially expand the original Section 3.3 (now revised as Section 3.2) to systematically quantify the performance of four radiation datasets in reproducing hemispheric differences and symmetry

of RSR observed by CERES at hemispheric and finer temporal-spatial scales. This expansion ensures a smoother and tighter connection with Section 3.1.

(6) In the Section 4, Discussion and Summary, we revise the main conclusions of this study and delete some superfluous information.

(7) In each section, we also add some interpretations about the comments from reviewers

Please see our point-by-point reply to comments. All revisions are shown in revised manuscript by using track changes.

General responses:

1. In Section 3.3, rather than simply comparing with CERES for the asymmetry issue in modeled PA, the analysis should be integrated more cohesively with key findings from previous sections. This integration is essential for establishing a stronger motivation and relevance for the comparison. For instance, it would be valuable to assess whether the model data captures the interannual anomaly of the contribution rate of different components to total reflected radiation, thus linking the analysis with earlier sections and enhancing the manuscript's continuity and depth of analysis.

   Response: We very thank reviewer for providing detailed and constructive comments and suggestions. Based on the comments and suggestions from two Reviewers, in the revised manuscript, we delete the Section 3.2 and substantially expanded the original Section 3.3 (now revised as Section 3.2) to systematically quantify the performance of four radiation datasets in reproducing hemispheric differences and symmetry of reflected solar radiation observed by CERES at hemispheric and finer temporal-spatial scales. Please see Section 3.2.

2. Simulated Snow uncertainty has been suggested to introduce substantial bias of surface albedo among reanalysis data, especially at mid and high latitudes [1]. Are there any influences for the TOA asymmetry issue in simulations?

   Response: Thanks for your comments. Surface snow cover significantly affects surface albedo, especially at middle and high latitudes. In the process of calculating reflected solar radiation, surface parameters, including snow products, are introduced into the radiative transfer model, which may introduce bias. The inaccuracy in snow cover products can introduce some bias in the top-of-atmosphere radiative fluxes and potentially influence hemispheric differences of reflected solar radiation to some extent. The relevant reference and discussion are added in the revised manuscript: "Moreover, MERRA-2 significantly underestimates surface components in Antarctica during melting season (November to January), which could be due to biases in the input snow products that introduce significant uncertainties in surface albedo (Jia et al., 2022)."

Please see the Line: 755-757.

3. Line 546: despite including various driving factors (e.g., NDVI, snow cover) for anomaly attribution, their corresponding radiative forcings differ significantly. Consequently, even if two factors exhibit similar anomaly magnitudes in a given year, the importance of NDVI may not be comparable to snow cover changes, rendering the anomaly analysis less meaningful. Therefore, I recommend converting the anomaly analysis to a corresponding radiative forcing analysis to better capture the relative importance of different factors in driving changes in radiative forcing over time.

Response: We very thank reviewer for providing detailed comments and suggestions. We agree with the reviewer. Indeed, even if two factors exhibit similar magnitudes of anomalies in a given year, their relative importance may not be comparable. As stated in original manuscript: "the radiation contributions from different latitudinal zones exhibit varying sensitivities to changes in different factors, resulting in different magnitudes of response." Therefore, in previous analyses, the relative anomalies of factors serve merely as a reference for identifying and analyzing anomaly events. Based on the comments and suggestions from two Reviewers, we reorganize the manuscript and only focus on two key issues: (1) analyze the characteristics of the variations in hemispheric reflected solar radiation at a latitude- and month-based perspective; and (2) systematically quantify the performance of four radiation datasets in reproducing hemispheric differences and symmetry of reflected solar radiation observed by CERES. In the revised manuscript, we reorganize the section of results in order to make the manuscript clearer. Thus, the content discussing the contribution of different factors to latitudinal zones in extreme years (Section 3.2) is already removed and some ambiguous descriptions are also corrected in the revised manuscript.

4. The difference of r in Eqs. 4 and 5: r in Eq.4 represents blue-sky reflectance, where the solar beam reflects from the surface, whereas the r in eq5 is black-sky reflectance and the incoming radiation is from space. Does this difference in physics have any impact, particularly at high latitudes where the SZA is large?

Response: We very thank reviewer for providing detailed comments and suggestions. We fully understand the reviewer's concerns and apologize for any confusion caused by our unclear expression. Black-sky albedo is the intrinsic albedo of the surface when atmospheric diffuse is ignored. Blue sky albedo is the actual surface albedo. However, r in Eq. 4 and Eq. 5 represents atmospheric intrinsic reflectivity, which is independent of the surface albedo. We correct the inappropriate statements in the revised manuscript: "Here, r and t represent atmospheric intrinsic reflectivity (that is, PA purely contributed by the atmosphere) and atmospheric transmittance, respectively."

Please see the Line: 260-261.

Specific Responses:

1. Suggest introducing parameters with 0 in Eq. 20

Response: Thanks for your suggestions. We have added the introduction for parameters with 0 in Eq. 21 (same as the Eq. 20 in the original manuscript) in the revised manuscript:

$$DISO_i^{xj} = \sqrt{(CC_i - CC_0)^2 + (NAE_i - NAE_0)^2 + (NRMSE_i - NRMSE_0)^2} \qquad (21)$$

Where i and xj represent the ith model and jth variable. The subscript "0" in Eq. 21 represents statistical parameters of variable xj from observation data (here refers to CERES EBAF).

Please see Line: 340-341.

2. Figure 2a: I suggest changing the color bar because the conventional association of 'blue & red' typically implies negative and positive directions, whereas the result here is uni-directional.

Response: We very thank reviewer for providing detailed comments and suggestions. We have modified the inappropriate color bar of figures in the revised manuscript. Additionally, based on the comments and suggestions from two Reviewers, we reorganize the Section 3.1 to only focus on analyzing the characteristics of the variations in hemispheric reflected solar radiation at a latitude- and month-based perspective, rather than on the contribution of different latitudinal zones to hemispheric total reflected radiation at TOA. As a result, we replace the related content regarding the "contribution of different latitudinal zones to hemispheric total reflected radiation at TOA from 2001 to 2021 and the corresponding components (Figure 2a-d in the original manuscript)" with "reflected solar radiation of different latitudinal zones at TOA from 2001 to 2021 and the corresponding components (Figure 3a-d in the revised manuscript, please see the Figure R1)". Although the variables shown here are different, they essentially reflect the same information.

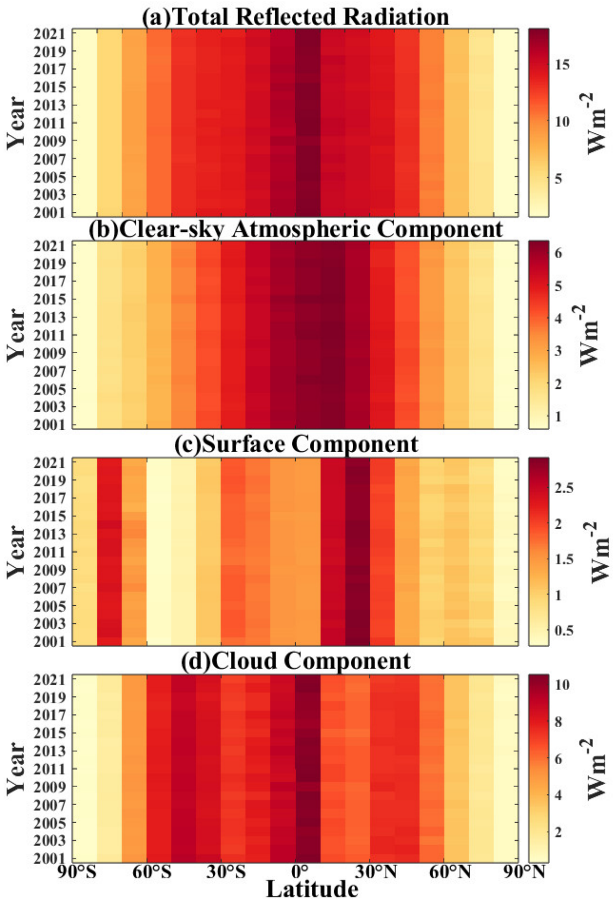

Figure R1 (same as the Fig. 3a-d in the revised manuscript): Annual averages from 2001 to 2021 of (a)total reflected solar radiation flux and its (b) clear-sky atmospheric component, (c) surface component, and (d) cloud component at different latitudinal zones.

3. Line 437: The dominant component in the NH?

Response: It is corrected in the revised manuscript: "The higher RSR from the 0°-40° latitude zones in the NH stems from the higher cloud component from the equator to 10° and the combined effect of clear-sky atmospheric and surface components in the 10°-40°."

Please see the Line: 469-471.

4. Line 438: 0°-70°? Why does it have some overlaps with the following ones?

   Response: Thanks for your comments. We correct the inappropriate statements in the revised manuscript: "The higher RSR from the 0°-40° latitude zones in the NH stems from the higher cloud component from the equator to 10° and the combined effect of clear-sky atmospheric and surface components in the 10°-40°."

   Please see the Line: 469-471.

5. The figures should be enlarged.

   Response: Thanks for your comments. We have enlarged the text in all figures in the revised manuscript.

Reference:

Jia, A., Wang, D., Liang, S., Peng, J., and Yu, Y.: Global daily actual and snow-free blue-sky land surface albedo climatology from 20-year MODIS products, Journal of Geophysical Research: Atmospheres, 127, e2021JD035987, https://doi.org/10.1029/2021JD035987, 2022.