Response to the Referees

We would like to thank the two Referees for the comments and suggestions, which help to improve the quality of our work. We have made revisions and have replied to all comments and suggestions. Please find a detailed point-by-point response to each comment. Our responses are shown in "Blue" color and the changes in the manuscript are shown in "Red" color.

Response to the comments from Referee #1

Comment:

1. The study asserts a higher accuracy than that of satellite products but does not provide a comprehensive comparison with a broad range of such products. Moreover, the accuracy indicated by the data appears comparable to some recently developed satellite products (Li et al., 2021). It would be beneficial to acknowledge or ideally, compare with, notable satellite products like MCD18A1 (Wang et al., 2020), DSCOVER (Hao et al., 2020), and GeoNEX (Li et al., 2023). MCD18 is the official MODIS radiation dataset incorporating instantaneous direct and diffuse radiation estimations. DSCOVER provides daily scale estimates of the diffuse and direct components, while GeoNEX boasts the highest accuracy for estimating daily and monthly global radiation. Adding rRMSE as an extra matrix could further enhance intercomparison across studies.

Response:

According to the conclusion of Li et al. (2021), the CERES satellite radiation product generally performs better than those of CLARA, GLASS, BESS and MCD18, with relatively lower RMSE and rRMSE values, by validating against in situ measurements from 142 global sites. Meanwhile, Tang et al. (2019a) found that the accuracy of the ISCCP-HXG satellite radiation product is generally better than several global satellite radiation products, such as the CERES, GEWEX-SRB, and ISCCP-FD, by validating against in situ measurements from BSRN and CMA. In this study we found that the accuracy of our station-based estimates is significantly higher than that of the ISCCP-HXG satellite radiation product. Therefore, we will assume that our station-based estimates have a higher accuracy than the five global radiation products mentioned by Li et al. (2021). Of course, this speculation needs further verification with in-situ measurements collected in China, which would be our future work, since the main goal of this article is to establish a long-term station-based dataset of surface solar radiation in China, not to compare with as many satellite products as possible.

As for the other two satellite radiation products, DSCOVER and GeoNEX, we can't compare them with our station-based estimates because we only collected CMA

radiation observations during the time period from 1993 to 2010, but the two satellite radiation products are available after 2015. In the future, we will collect CMA radiation observations after 2015 to validate these two satellite radiation products after quality control of the original radiation observations.

The rRMSE is indeed a good indicator that could further improve the comparability between studies. Indeed, the metric rRMSE has been used in this paper (see Figure 3-8).

In fact, we have also found that the satellite products you mentioned above lack validation in China, which is worth doing in the future.

In response to your concerns, we have cited all the articles you mentioned, and have added some descriptions in the revised manuscript (L97-100, L101-103, and L149-153) as "Especially, Li et al. (2023) produced a high-spatiotemporal-resolution radiation product based on the new generation of geostationary satellites from the United States and Japan, with accuracy higher than other existing satellite products" , "In addition, Hao et al. (2020) developed a global radiation product based on the unique Deep Space Climate Observatory (DSCOVR) satellite, whose orbit is at the Lagrange point", and "Therefore, we would expect our station-based estimates to be more accurate than the five global radiation products mentioned by Li et al. (2021), as CERES generally performs best among them. Of course, this speculation needs to be further verified with in-situ measurements collected in China in the future.".

Reference:

1. Hao, D., Asrar, G. R., Zeng, Y., Zhu, Q., Wen, J., Xiao, Q., & Chen, M. (2020). DSCOVR/EPIC-derived global hourly and daily downward shortwave and photosynthetically active radiation data at 0.1°× 0.1° resolution. Earth System Science Data, 12(3), 2209-2221.

2. Li, R., Wang, D., & Liang, S. (2021). Comprehensive assessment of five global daily downward shortwave radiation satellite products. Science of Remote Sensing, 4, 100028.

3. Li, R., Wang, D., Wang, W., and Nemani, R.: A GeoNEX-based high-spatiotemporal-resolution product of land surface downward shortwave radiation and photosynthetically active radiation, Earth Syst. Sci. Data, 15, 1419–1436, https://doi.org/10.5194/essd-15-1419-2023, 2023.

4. Wang, D., Liang, S., Zhang, Y., Gao, X., Brown, M. G., & Jia, A. (2020). A new set of MODIS land products (MCD18): Downward shortwave radiation and photosynthetically active radiation. Remote Sensing, 12(1), 168.

Comment:

2. The products generated are site-based, implying discontinuity on a spatial scale. Figure 9 demonstrates numerous gaps in remote areas such as northwest China where active CSP are present. If there are minimal differences in accuracy and information between this station-based data and satellite products, the rationale for opting for station-based data needs to be more convincingly presented.

Response:

Good comment! Undoubtedly, station-based data have the advantage over satellite products of longer time series and higher accuracy, especially for direct radiation. It is true that our station-based products are spatially discontinuous, especially in northwestern China, which may introduce significant uncertainty when applied to the assessment of solar power system potential. However, the uncertainty caused by spatial discontinuity in flat areas would be relatively small, as the spatial representation of a station on flat ground is generally larger than 25 km (Hakuba et al., 2013). Fortunately, most solar power systems are built on land with slopes of less than 3%. In contrast, applications over complex terrain will introduce large uncertainties. Combining station-based data with satellite products will be a good solution in the future to improve the accuracy of solar energy potential assessment.
The above description has been added into in the revised manuscript (L451-459).

Hakuba, M.Z., Folini, D., Sanchez-Lorenzo, A., & Wild, M. (2013). Spatial representativeness of ground-based solar radiation measurements. Journal of Geophysical Research: Atmospheres, 118, 8585-8597, https://doi.org/10.1002/2017JD027261.

Comment:

3. The long term availability is the highlight of this datasets, but the potential applications of the long term solar radiation data is not explained in detail. The authors should elaborate on this point in the introduction and consider incorporating a more extended analysis of the three radiation variables within the manuscript.

Response:

Good comment! Some explanations of the potential applications of our developed long-term solar radiation data have been added into the revised manuscript (L149-153) as "This long-term dataset will contribute to the analysis of long-term variations in surface process simulations and solar energy applications, such as the assessment of solar energy potential, the determination of the optimal angle for solar PV panels and their long-term variation analysis, as well as the assessment of historical extreme events on solar energy systems."

Based on the three radiation variables, extended analyses, and potential applications, such as long-term simulations of land surface-related processes, climate change analysis and related solar energy applications, can be carried out, but this is beyond the aim and scope of this article, since the main aim of this article is to establish a long-term station-based dataset of surface solar radiation in China.

Comment:

4. Tables and equations should be improved aesthetically, possibly through the use of a LaTeX package.

Response:

Accepted！ Tables and equations have been improved in the revised manuscript.

Comment:

5. Please consider adopting color schemes that are accessible to readers with color vision deficiencies.

Response:

Accepted！We have revised all Figures in the revised manuscript, and also adopted color schemes that are accessible to readers with color vision deficiencies.

Response to the comments from Referee #2

Comment:

This manuscript produced a dense station-based long-term dataset of daily surface solar radiation in China at the 2473 CMA meteorological stations during 1950s -2021, and the dataset consists of estimates of global, direct and diffuse radiation. Surface solar radiation is crucial in research of agriculture, hydrology, ecology, climate change, and simulations of land surface processes. Validation against in-situ observations and comparisons with two satellite-based radiation products show that the station-based radiation dataset clearly outperforms the satellite-based radiation products at both daily and monthly scales. The dataset produced in this study was available for more than 60 years and includes three radiation components, which is not possible with satellite products. This dataset will contribute to the climate change research and solar energy engineering applications in the future. The topic is highly interesting and appropriated for ESSD. The paper is clear and well written. Therefore, I recommend its publishing on the ESSD after answering the following several minor issues.

Response:

We thank Referee #2 for the encouraging comments. All comments and suggestions have been considered carefully and well addressed.

Comment:

1. Line 77-78, the sentence of "Among the GEBA, there are only about 100 radiation stations (Jiang et al. 2020a), which are provided by the China Meteorological

Administration (CMA).” is repeated with the sentence of “For example, there are only about 100 radiation stations maintained by CMA,” in Line 111-112.

Response:
Accepted! We have changed the sentence in Line 111-112 in the original manuscript to “For example, the number of radiation stations maintained by the CMA is only about 100, but the number of routine weather stations with long-term observations is much denser, exceeding 2400 stations” in the revised manuscript (L116-118).

Comment:
2. Line 116, “sunshine-duration-based models” should be “sunshine duration-based models”.

Response:
Accepted!

Comment:
3. Line 143-144, the sentence of “, including three elements of global radiation, direct radiation and diffuse radiation” should be polished.

Response:
Accepted! We have changed the sentence to “which includes three elements: global radiation, direct radiation, and diffuse radiation.” in the revised manuscript (L148-149).

Comment:
4. Equations (2) and (5), it should be better to use $\tau_{c,b}$ (but not $\tau_{c,dir}$) to denote cloud transmittance for the daily direct radiation.

Response:
Accepted!

Comment:
5. Line 226, “period 1961-2021” should be “period of 1961-2021”.

Response:
Accepted!

Comment:
6. Line 242, “that of the global and diffuse radiation” should be “those of the global and diffuse radiation”.

Response:
Accepted!

Comment:
7. Line 270, “the period 1983.7-2018.12” should be “the period of 1983.7-2018.12”.

Response:
Accepted!

Comment:
8. Line 323, “a R” should be “an R”.

Response:
Accepted!

Comment:
9. Line 359, “direct and global radiation” should be “direct and diffuse radiation”.

Response:
Accepted!

Comment:
10. Line 385-386, the word “from 2000 to 2010” is redundant.

Response:
Accepted! We have deleted the word.

Comment:
11. Line 394, “W m-2” should be “W m^{-2}”.

Response:
Accepted!

Comment:
12. Line 397, “Jiang et al. (2020a)’s” should be “Jiang et al. (2020a)”.

Response:
Accepted!

Comment:
13. The format of Tables 1 and 2 should be a “three line table”.
Response:
Accepted! We have improved the Tables in the revised manuscript.

Comment:
14. Line 414, “that of the two satellite products” should be “those of the two satellite

products".

Response:

Accepted!

Comment:

15. Line 410-413, the sentence should be polished.

Response:

Accepted! We have changed the sentence to "The MBE and RMSE of our estimate are 2.6 W m^{-2} and 13.4 W m^{-2}, respectively, which are lower than those of the two satellite products, with MBE and RMSE values of 4.6 W m^{-2} and 18.5 W m^{-2} for the Jiang et al. (2020a) product and 6.7 W m^{-2} and 16.3 W m^{-2} for the Tang et al. (2019a) product." in the revised manuscript (L422-426).

Comment:

16. Line 448, "northwester" should be "northwestern".

Response:

Accepted!