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Earth System Science Data Discussions

Interactive comment on "Merging ground-based sunshine duration with satellite cloud and aerosol data to produce high resolution long-term surface solar radiation over China" *by* Fei Feng and Kaicun Wang

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Reviewer #2 OVERALL 1) Comment: This study attempts to generate a high resolution surface solar radiation (Rs) dataset. The idea is to construct a linear model between station based Rs, cloud fraction and AOD, and applies the model to the full study domain (China). While this dataset can be potentially useful, I don't understand how this approach could achieve a better accuracy than CERES 1 degree Rs product. This is because: (1) although the SunDu Rs can represent a much smaller area than the CERES 1 degree grid, SunDu Rs is validated using CERES Rs, which means that

SunDu Rs cannot have a higher accuracy than CERES Rs, even at the 1 degree scale; (2) the AOD data used is still at 1 degree resolution. This does not add much finer information and may be the reason why AOD has little impact on the prediction results. Overall, I don't see much value in this study unless the above question is addressed. Please see the specific comments below: Reply: We realize that we have not clearly explained the significance of our work to generate high spatial resolution Rs data and the comparison results. We carefully think about all comments from anonymous referee #2. Below are our point by point responses to his comments.

MAJOR COMMENTS 2) Comment: The authors used SunDu Rs to train the model and to generate the high resolution Rs dataset. However, SunDu Rs is validated against CERES Rs, assuming that the latter has higher accuracy. On one hand, using grid based data to validate station based data is not appropriate. There can be a lot of variability within this 1 degree box. The authors did compare SunDu Rs with observed Rs but argued that their agreement is not as good as that between SunDu Rs and CERES Rs, and that the agreement between the latter two proofs the reliability of SunDu Rs. I don't agree with this argument. SunDu Rs should be directly validated against surface observed Rs. On the other hand, if CERES Rs is better than SunDu Rs, what's the point of using SunDu Rs to generate the 0.1 degree dataset? I guess using CERES Rs with 0.1 cloud and AOD would achieve at least the same accuracy, if not better. Yet, it has the advantage of full spatial coverage than SunDu Rs. Reply: We realize that we have not clearly explained the significance of our work and comparison results. In this study, we aim to build a reliable high resolution grid Rs data by establishing the physical spatial relationship between ground based SunDu derived Rs data with high resolution cloud satellite data with AOD to avoid the disadvantage of CERES for capturing the variability of Rs within a 1 degree box. The CERES and SunDu derived Rs are two completely different ways of measurements. Their correlation should be wake, but the high agreements of these two datasets from results indicate that CERES and SunDu-derived Rs can reflect the truth distribution of Rs to some extent. Similar results are also reported by (Wang et al., 2015) that SunDu-derived Rs have the best agreement

with model-based Rs estimates, whereas satellite Rs retrievals, such as CERES, show best agreement with SunDu derived Rs and poor agreement with direct Rs observation due to the impact of thermal offset and directional response errors in direct observed Rs data. We know that direct comparison between grid based data and station based data is not perfect. But direct comparison are widely used as a tradeoff way for validation in many studies due to lack of reliable high resolution grid Rs data. In this study, we aim to build this reliable high resolution grid Rs data. One may argue that using CERES Rs with 0.1 cloud and AOD can also produce high resolution Rs data. However, there are large amount of input data are require to ensure the accuracy of CERES. Most of these input data in CERES have low spatial resolution and limited spatial coverage and are only available after 2000. SunDu Rs have long time records with large spatial coverage. The merged SunDu derived Rs data can overcome these disadvantages of CERES and have the possibilities to build long term Rs by using AVHRR data.

3) Comment: To proof the effect of fine resolution processing, a direct comparison with CERES should be provided. The authors can interpolate the CERES Rs to 0.1 degree and compare with their results. How difference are they? Are the differences physically explainable (i.e., related to cloud variability?). Reply: Thanks for your suggestion. By using spatial interpolation method, CERES Rs can also be downscaled to 1km or 30m. These interpolated CERES Rs data cannot represent the detailed Rs distributions at spatial resolution of 1km or 30m. Without additional high spatial resolution data, interpolated cannot capture more detail variability of Rs. High spatial resolution cloud data can provide more detail information of cloud variability.

MINOR COMMENTS 4) Comment: What is the reason of the lower agreement between SunDu Rs and observed Rs? Reply: We realize that we have not clearly explained this issue. According to previous studies (Wang, 2014; Wang et al., 2015; Yang et al., 2018), the possible reasons of discrepancies between SunDu Rs and observed Rs are the changes in instrument and observation schedule of the observed Rs. (Wang, 2014; Wang et al., 2015; Yang et al., 2018) show that nearly half of observed

Rs (60 out of the 119 Rs observed stations) have inhomogeneity issues. These artificial changes points in observed Rs are mainly caused by instrument change (42 shifts), stations relocation (34 shifts), observation schedule change (20 shifts) and remaining 64 changepoints which could not be identified.

5) Comment: Why using CERES 1dgree AOD? If spatial resolution matters, there are much finer products, such as the MODIS 1km and MODIS 3km products. Reply: MODIS AOD conation missing values and can't meet the requirements of spatiotemporal continuity of AOD input in this study.

6) Comment: There are remote locations with very few SunDu stations, such as the Tibet plateau, are the relationships applicable? Reply: As shown in figure 9, the regional mean of the annual anomaly of the surface solar radiation (Rs) for zone II and zone VIII which are the regions such as the Tibet plateau. We notice that the merged Rs (GWR-CF-AOD) can produce consistent variation of Rs compared with observed data, indicating the relationships are applicable.

7) Comment: It would be interesting to look at the spatial distribution of the coefficients. This can tell us some information about where clouds make a bigger impact and where aerosols are important. Reply: According to the figure 6 in our previous study (Feng and Wang, 2019), cloud fraction shows strong negative correlation with Rs in most parts of China, while slight weak correlation coefficient near the north border of China. While clear sky Rs, which are primarily impact by the atmospheric aerosol loading, generally have small the correlation coefficient with Rs in most parts China.

8) Comment: What's the unit of Figure 2? Reply: The unit of Figure 2 is W/m2. We will add this information in the revised paper.

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