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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

Anonymous Referee #1

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This is a nice work, in which SunDu-derived surface solar radiation (Rs) data are merged with satellite-derived cloud fraction and AOD data to generate high spatial resolution (0.1°) Rs over China. Both direct Rs observations (pyranometer data) at ∼100 stations and sun duration records at 2400 stations are used in this study to demonstrate the reliable performances of the merging results. A striking result is that AOD plays a negligible role in the merging results, which indicates that the estimation method of Rs from sunshine measurements is robust and reliable. The result is valuable because long-term AOD retrievals are not accessible when building long-term Rs

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data. The paper is well organized. I suggest to accept this submission after following issues are addressed. Major concerns: 1. It is not clear how to calculate clear sky Rs although a simple equation is given. A detailed introduction to the method is required since the conclusion mainly relies on the method. I wonder whether aerosol effect on Rs is accounted for by Sunshine duration measurement or by the equation used for the calculation of clear sky Rs. Addition, pls introduce more clearly which data are used in the calculation of clear sky Rs. 2. It was said that site dependent parameters were used in the equation 1 (e.q., a0-a2). I'm not sure how to derive these parameters at each station. 3. Frankly speaking, I'm not comfortable with the statement that the CERES EBAF can be taken as the reference. This seems based on the result that the agreement between SunDu-derived Rs and EBAR is much better than that between SunDu-derived Rs and pyranometer measurements. My opinion is that there seems possibility that aerosol effects were not properly accounted for by both SunDu-derived and satellite Rs algorithm. I mean this possibility cannot be fully eliminated, so it is suggestive to discuss this issue in somewhere.

Minor issues

1) Lines 31, 'Based on the SunDu-derived Rs from 97 meteorological observation stations. . .', the authors should mention that these 97 stations are co-located with those that direct Rs measurements sites. 2) Lines 130-133, what about the quality of the datasets from (Tang et al. 2019) and (Stengel et al. 2020)? I suggest the authors add detailed descriptions of these datasets. 3) Lines 164 to 165, the authors show that interpolation results have uncertainties due to the lack of detailed high spatial resolution information. What about the performances of machine learning methods in simulation of Rs. I suggest add more references here. 4) Line 178, "0.1" changes to "0.1°". 5) Lines 177 to 179, the authors merge the SunDu-derived Rs data with satellite-derived cloud fraction (CF) and AOD data. Why not directly merging the SunDu-derived Rs data with current Rs products? 6) Line 183,"sunDu" changes to "SunDu". 7) Add spatial resolution of each dataset and the references of each dataset in table 2. 8) Line

291, why not use MODIS AOD as input data in this study. 9) Lines316 to 317, SunDu derived Rs also contain the information of clouds, what about merging SunDu-derived Rs data only with AOD data? 10) Lines 390 to 392, two validation sites are randomly selected to evaluate the seasonal and annual variations in Rs. I suggest two sites with high AOD values and low AOD values. 11) Line 474, “0.1” changes to “0.1°”. 12) Line 518, “0.1” changes to “0.1°”. 13) Lines 535 to 536, deleted “We also plan to expand our Rs dataset from 1983 to 2017 by using AVHRR based cloud retrievals.” Since this study focus the period from 2000 to 2016.

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