Replies to Reviewer Comments (RC2)

General Comment: The authors made significant efforts to integrate observational data of sunshine duration in China, including for the first time to address a sharp drop in zero-value frequency after 2019 caused by the instrument upgrade and to adjust inhomogeneities of its long-term series. This produces the first homogenized daily observational dataset of sunshine duration over China from 1961 to 2022. This effectively addresses critical gaps in data availability and homogeneity of sunshine duration observation providing a crucial dataset to accurately assess the dimming and brightening and to support other practical applications. The manuscript is well-structured, clearly presenting the research goals, statistical methods, dataset description, and results.

The manuscript is recommended for publication with minor revisions as specified below:

Response: Thank you for your high recommendation and providing constructive suggestions. Following your suggestions, we have revised a figure, added a new figure, and provided more details on methods and additional explanations, which makes clearer the revised manuscript. Below please find our point-by-point responses to your comments.

Specific Comments:

1) Comment: It's not clear if the presentation of spatial patterns of regression slopes (α, β, γ in Section 2.3.2) aids to understand the use of reference series during the homogenization. Could you plot them and assess their necessity in the main text?

Response: Following your suggestion, we have plotted a new Figure 6 in the main text to show spatial patterns of regression slopes (α, β, γ in Section 2.3.2), which is copied here. Correspondingly, we have added some explanations in Section 2.3.2.

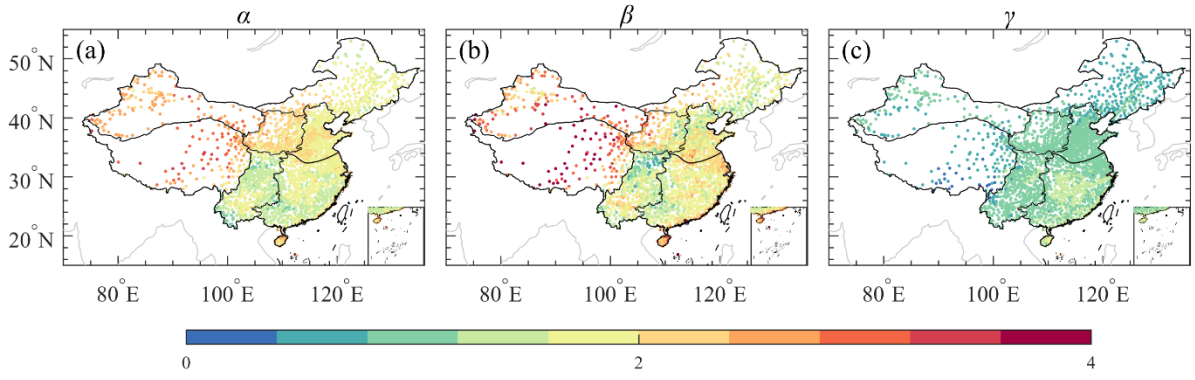

Figure 6 (a) Map of the linear regression coefficient (α) of the daily anomalies of $SSDd_{obs}$ against $SSDd_{ERA5}$. (b-c) Same as (a), but showing β for $SSDm_{obs}$ against $SSDm_{ERA5}$, and γ for $SSDd_{obs}$ against $SSDd_{ERA5}$, respectively. For more details, refer to Equations 1, 4, and 5.

2) Comment: Even though the methods used in the homogenization are widely recognized, a concise description of PMF and PMT test algorithms should be included to help understand the detected breakpoints in Section 2.3. Additionally, more details of the improved K-S test should be added in Section 2.3.1 to enhance its readability.

Response: As suggested, we have added more descriptions of the PMF and PMT test algorithms as well as the improved K-S test in Section 2.3. These brief descriptions actually enhance the readability of these methods to some extent.

Added details in Section 2.3: … The PMT test searches for the most likely location of mean shifts in segments of the difference between the candidate and reference series using a recursive testing algorithm (Wang et al., 2007). The PMF test, on the other hand, detects undocumented mean shifts in the difference series with a linear trend by employing a common-trend two-phase regression model (Wang, 2008a). Both test algorithms account for the lag-1 autocorrelation of the series. … For variance shifts in the series, an improved Kolmogorov–Smirnov (K-S) test has been widely used to assess whether two samples follow similar or different distributions (Press et al. 1992). To account for the effects of the lag-1 autocorrelation and sample size, Dai et al. (2011) and Zhou et al. (2021a) developed critical values for given significance levels through a series of Monte Carlo simulations.

3) Comment: Provide additional details on daily cloud cover fraction and aerosol optical depth at 500nm (AOD) from MODIS in Section 2.1 to help understand their relationships with sunshine duration in the following text.

Response: As suggested, we have provided additional details on cloud cover fraction and aerosol optical depth of MODIS in Section 2.1: Cloud cover fraction is calculated as the percentage of a grid cell that is covered by clouds, with values ranging from 0 (no clouds) to 1 (completely overcast). AOD at 550nm is a measure of the total aerosol content in the atmosphere, quantifying how much sunlight is absorbed and scattered by aerosols, with values ranging from 0 (no aerosol) to values greater than 1 (high aerosol loading).

4) Comment: Line 298: Please clarify how to calculate the hit probability of 65%.

Response: This information has been clarified in Lines xxx: Since the date of a station relocation does not always align with the date of a statistically detected breakpoint, this value is calculated as the ratio of the number of breakpoints that have one or more relocations within one year of the breakpoint to the total number of breakpoints.

5) Comment: The subfigure in Figure 6 is too small to be easily readable. Please revise it.

Response: Corrected as suggested.