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CORRECTION

Correction to: A Discussion of Implausible Total Solar Irradiance Variations Since 1700

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There was an omission which led to a discrepancy in the text about the scaling of the solar cycle component that was used.

Equation 4 in the originally published article was that suggested by Hoyt and Schatten (1993, HS93, hereafter) for scaling the solar cycle component. However, our analysis in Section 3.1 in the originally published article revealed that utilizing Equation 4 for scaling the solar cycle component resulted in amplifying the solar cycle variations compared to the original HS93 Total Solar Irradiance (TSI) series (see Figures 1 and 2). Consequently, we used an adjusted scaling factor by dividing it further by 1.5, resulting in a better reproduction of the original HS93 TSI series with their data as shown in Figure 7 of the originally published article. Thus, the actual scaling we used for the solar cycle component when reproducing the HS93 TSI series with their own data was

$$\Delta \mathrm{TSI} = 0.0067\,\mathrm{ISNv1}, \tag{1}$$

where ISNv1 is version 1 of the International Sunspot Number series.

To maintain consistency with the original HS93 TSI series, the same scaling for the solar cycle component was used in our update (taking into account the different reference level of ISNv1 and ISNv2 which requires a multiplication factor of 0.6, although potentially a factor of 0.7 would have been better to roughly account also for the Waldmeier discontinuity). Therefore, whenever we mention Equation 5 in Section 3 of the originally published article the actual equation that was used is

$$\Delta \mathrm{TSI} = 0.004\,\mathrm{ISNv2}. \tag{2}$$

Unfortunately, this was not explicitly stated in the originally published article.

Furthermore, Equation 5 in the originally published article mistakenly reflected the reduced scaling shown in Equation 1 here and not the actual scaling between ISNv2 and PMOD (named after Physikalisch-Meteorologisches Observatorium Davos) TSI series. The correct scalings between ISNv2 and PMOD, ACRIM (Active Cavity Radiometer Irradiance Monitor), ROB (named after Royal Observatory of Belgium), and Montillet et al. (2022)

The original article can be found online at https://doi.org/10.1007/s11207-024-02262-6

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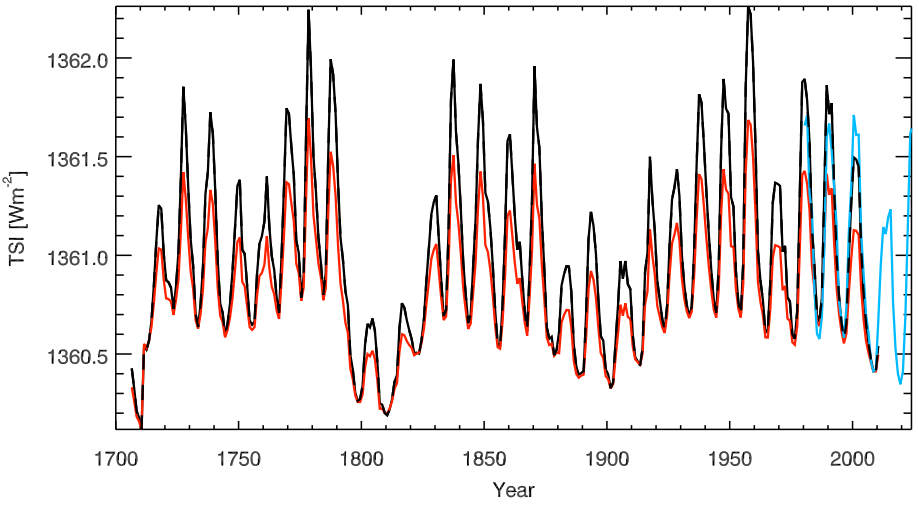

Figure 1 Comparison between our updated HS93 TSI series using Montillet et al. (2022, ciel) TSI to scale the five indices (see Section 3.3 of the originally published article), where the solar cycle component has been scaled using Equation 3 (black) and the reduced scaling to be consistent with the scaling used by HS93 (Equation 2, red). The red curve is the one shown in the originally published article, however, the black one is the one we consider as a more accurate update of the HS93 series. All series have been offset to match the value of the Montillet et al. (2022, ciel) TSI composite over the 2008 minimum.

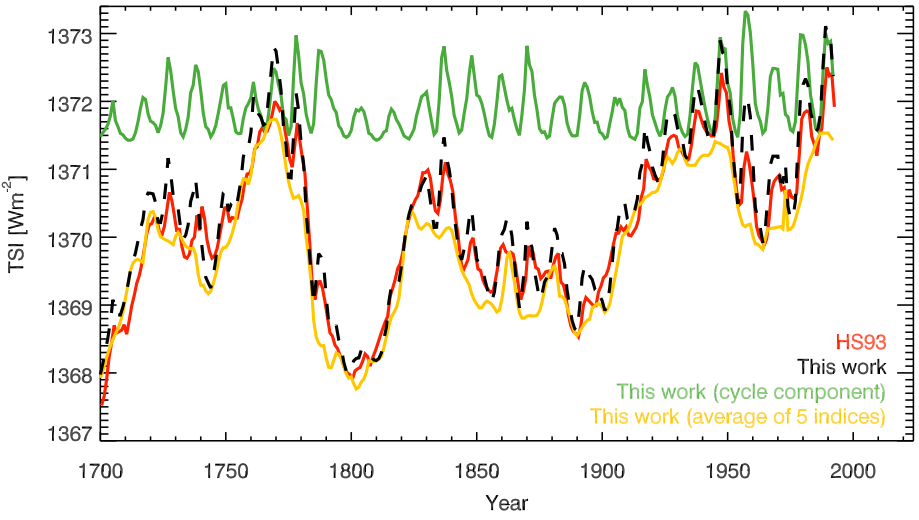

Figure 2 Same as Figure 7 bottom panel from the originally published article, but now using Equation 4 as is presented in the originally published article to scale the solar cycle component. This value leads to a significant overestimation of solar cycle variations, which is why in the originally published article a lower value was used (Equation 1).

TSI composites are 0.0056, 0.0064, 0.007, and 0.0062, respectively. The scalings are calculated based on annual means, which are derived from monthly means computed only for the overlapping days between each set of two series. Our suggested scaling is that determined

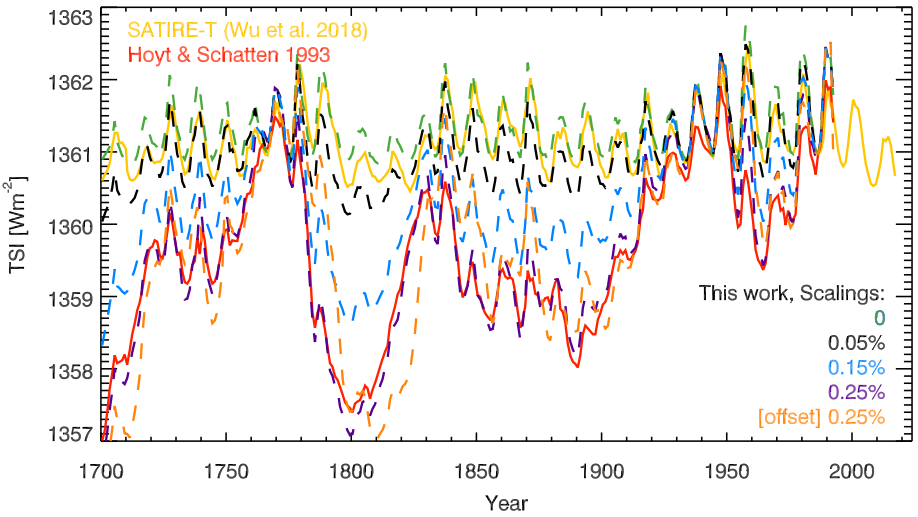

Figure 3 Same as Figure 8 from the originally published article, but now using Equation 4 as is presented in the originally published article to scale the solar cycle component.

Table 1 Same as Table 3 in the originally published article, but now using Equation 3 to scale the solar cycle component. SATIRE-T stands for Spectral And Total Irradiance REconstruction model over the Telescopic era (Wu et al., 2018).

	0%	0.02%	0.05%	0.15%	0.25%	Regression
Montillet et al. (2022)	0.13 (0.96)	0.31 (0.86)	0.20 (0.92)	0.48 (0.76)	0.77 (0.63)	0.13 (0.96)
ACRIM	0.31 (0.84)	0.50 (0.64)	0.41 (0.73)	0.65 (0.52)	0.92 (0.38)	0.35 (0.87)
PMOD	0.15 (0.94)	0.36 (0.80)	0.25 (0.88)	0.52 (0.70)	0.81 (0.56)	0.15 (0.94)
ROB	0.12 (0.96)	0.30 (0.83)	0.18 (0.91)	0.47 (0.69)	0.76 (0.52)	0.13 (0.95)
SATIRE-T	0.19 (0.91)	0.42 (0.83)	0.27 (0.89)	0.67 (0.75)	1.11 (0.67)	0.19 (0.90)

Table 2 Correlation coefficients between Earth's temperature measurements and TSI reconstructions with the HS93 model as replicated by us here using Equation 3 for scaling the solar cycle component. HadCRUT5 stands for Hadley Centre/Climatic Research Unit Temperature and GISTEMP4 stands for NASA Goddard Institute for Space Studies Surface Temperature Analysis.

	HS93 (Ours) 1700 – 2010	HS93 (Ours) 1700 – 1992
HadCRUT5 global	0.14	0.38
HadCRUT5 north	0.12	0.38
GISTEMP4 global	0.14	0.41
GISTEMP4 north	0.15	0.46
Berkeley Earth global	0.11	0.34
Neukom et al. (2019)	0.22	0.26

with the Montillet et al. (2022) TSI composite, namely

$$\Delta \mathrm{TSI} = 0.0062\,\mathrm{ISNv2}. \tag{3}$$

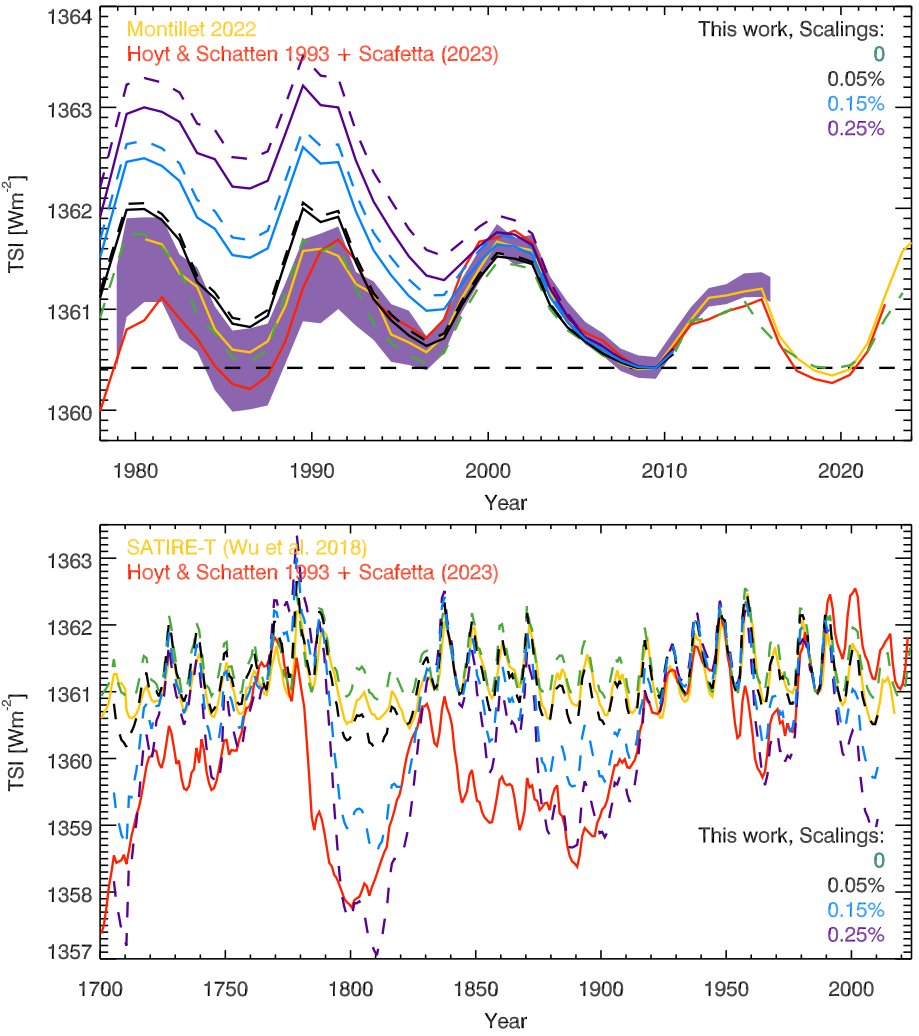

Figure 4 Same as Figure 10 from the originally published article, but now using Equation 3 to scale the solar cycle component.

We also stress that since this is just a scaling of the solar cycle component, it only affects the overall amplitude of solar cycles, while it does not affect the long-term trend of the reconstructions and, thus, any of the arguments made in the originally published article (see Figure 1). However, such greater solar cycle variations lead to a slightly worse agreement between our updated TSI series with the HS93 model and Earth's temperatures (Table 2) further strengthening our conclusions. We do not change the figures and tables in the article since what is presented there is consistent with HS93. However, we consider as a more accurate update of the HS93 TSI series the one using Equation 3 to scale the solar cycle component.

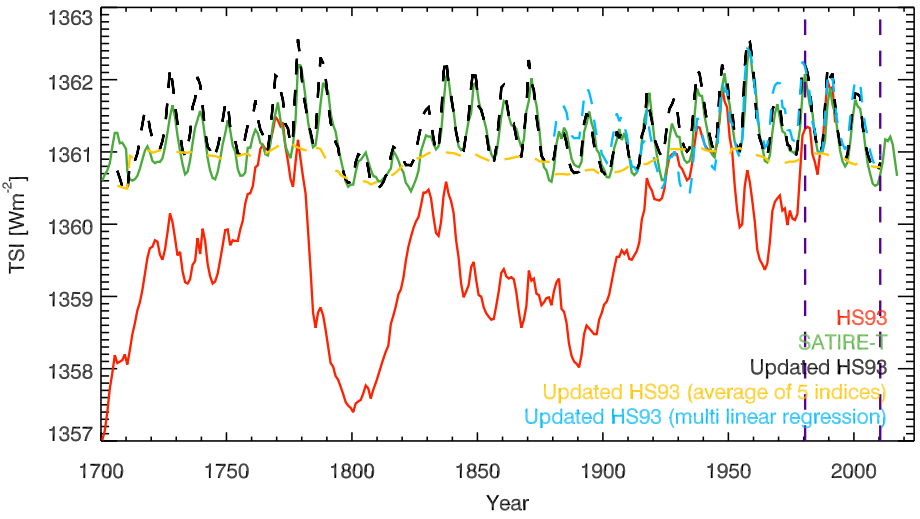

Figure 5 Same as Figure 11 bottom panel from the originally published article, but now using Equation 3 to scale the solar cycle component.

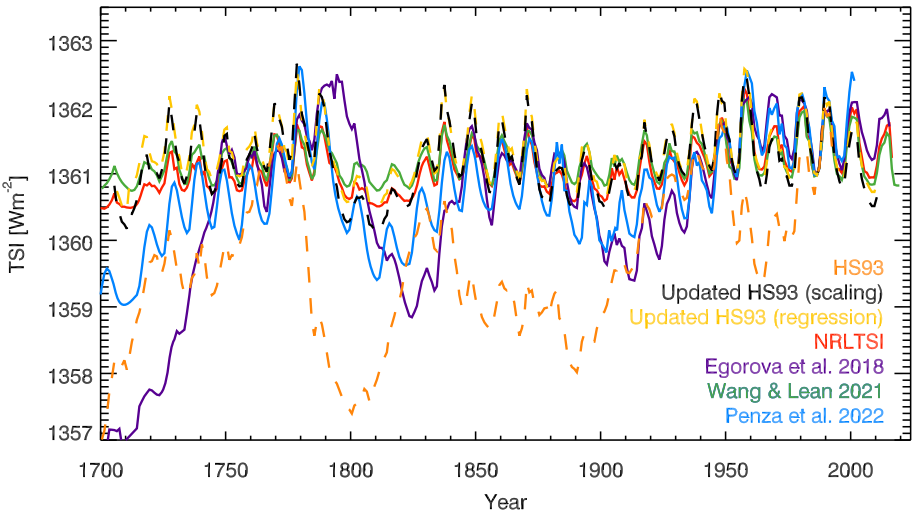

Figure 6 Same as Figure 12 from the originally published article, but now using Equation 3 to scale the solar cycle component. NRLTSI stands for Naval Research Laboratory TSI.

For completeness, we add here the figures (Figures 2 – 7) and tables (Tables 1 – 2) that change if the solar cycle component was derived from Equation 4 (that suggested by HS93) as presented in the originally published article and Equation 3 when replicating the original HS93 series and creating our update, respectively. Figures from the originally published article that are not included here are not affected at all by this inconsistency.

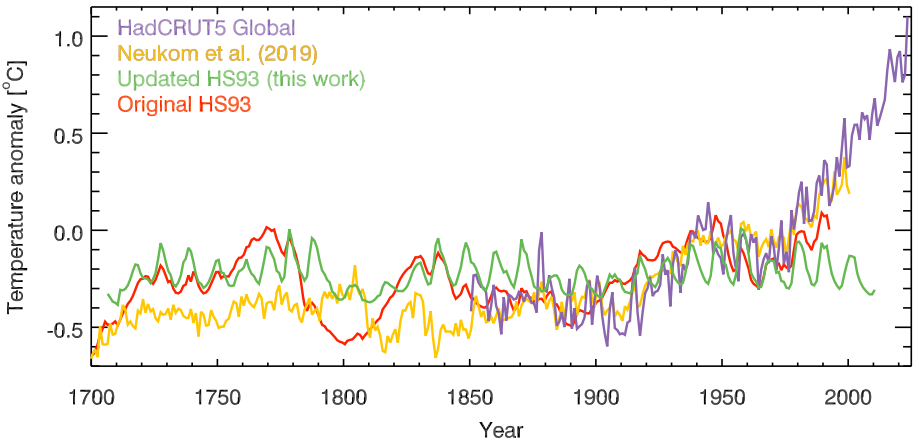

Figure 7 Same as Figure 13 from the originally published article, but now using Equation 3 to scale the solar cycle component. Due to the additional scaling of our updated HS93 TSI series to the HadCRUT5 global temperature series, hardly any difference is seen between this figure and Figure 13 from the original article.

Declarations

Competing Interests The author declares no competing interests.

References

Hoyt, D.V., Schatten, K.H.: 1993, A discussion of plausible solar irradiance variations, 1700 – 1992. *J. Geophys. Res.* **98**, 18. DOI. ADS

Montillet, J.-P., Finsterle, W., Kermarrec, G., Sikonja, R., Haberreiter, M., Schmutz, W., Dudok de Wit, T.: 2022, Data fusion of total solar irradiance composite time series using 41 years of satellite measurements. *J. Geophys. Res., Atmos.* **127**, e2021JD036146. DOI.

Neukom, R., Barboza, L.A., Erb, M.P., Shi, F., Emile-Geay, J., Evans, M.N., Franke, J., Kaufman, D.S., Lücke, L., Rehfeld, K., Schurer, A., Zhu, F., Brönnimann, S., Hakim, G.J., Henley, B.J., Ljungqvist, F.C., McKay, N., Valler, V.: von Gunten, L., PAGES 2k Consortium: 2019, PAGES 2k consortium: 2019, consistent multidecadal variability in global temperature reconstructions and simulations over the common era. *Nat. Geosci.* **12**, 643. DOI. https://www.nature.com/articles/s41561-019-0400-0.

Wu, C.-J., Krivova, N.A., Solanki, S.K., Usoskin, I.G.: 2018, Solar total and spectral irradiance reconstruction over the last 9000 years. *Astron. Astrophys.* **620**, A120. DOI. https://www.aanda.org/articles/aa/full_html/2018/12/aa32956-18/aa32956-18.html.