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A new approach to long-term reconstruction of the solar spectral irradiance suggests large historical solar forcing

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Analysis of historical data suggests a strong correlation between solar activity and terrestrial climate variations on centennial time-scales, such as the colder climate during the Maunder (about 1650–1700 AD) and Dalton (about 1800–1820 AD) minima, and climate warming during increasing solar activity from about 1900–1950 AD. Numerous attempts to confirm these correlations with different climate models have shown that it is only possible with an imposed large forcing, consistent with a direct solar radiative forcing from the present to the Maunder minimum of $\Delta F_{P-M} \sim 0.6 - 0.8$ W/m^2. At the same time the majority of recent estimates suggest significantly lower values of $\Delta F_{P-M} \sim 0.1 - 0.2$ W/m^2. The importance of solar irradiance variability on climate therefore remains highly controversial.

Here we present a new approach to determine centennial variations of the quiet Sun and show that it leads to a significant increase in the solar forcing value. We assume that the minimum state of the quiet Sun in time corresponds to the observed quietest area on the present Sun. Then we use available long-term proxies of the solar activity, which are ^{10}Be isotope concentrations in ice cores and 22-year smoothed neutron monitor data, to interpolate between the present quiet Sun and the minimum state of the quiet Sun. This determines the long-term trend in the solar variability which is then superposed with the 11-year activity cycle calculated from the sunspot number. The time-dependent solar spectral irradiance from about 7000 BC to the present is then derived using a state-of-the-art radiation code. Our approach gives us $\Delta F_{P-M} \sim 1.0 \pm 0.5$ W/m^2 which is significantly larger than the present consensus. The solar UV variability, which indirectly affects climate, is also found to exceed previous estimates. Our findings suggest that solar variability may play an active role in natural climate change.