

# Long-Term Solar Activity Throughout Holocene

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The sunspot number record is 400-years long, but longer series are needed, e.g., for an improved knowledge of the solar dynamo, solar-terrestrial relation, etc. On the longer time scales, indirect proxy data like cosmogenic nuclides should be used to evaluate the solar activity level in the past. A 11, 000-year long series of sunspot numbers has been recently reconstructed (Solanki et al., *Nature*, 431, 1084, 2004) using <sup>14</sup>C measurements in tree rings and a physics-based models. The reconstructed activity depicts great variability, from grand minima with almost vanishing sunspot activity to grand maxima, when the activity was comparable or even higher than the contemporary high activity level. We analyze this series with particular attention to grand minima and maxima of solar activity. The extremes of solar activity tend to cluster during periods, which show distinct quasi-periodicities at around 2200-2400 and 6000 years. Within the clusters, shorter periodicities, 100-120 and about 250 years, can be identified. The Sun spent about 10-12% of the time within grand minima but only a few % of the time at a very high level similar to the modern magnetic activity. This implies that the contemporary high level of solar activity is exceptional, but not unique, on the multi-millennial time scale. We discuss also implications of the solar variability for the solar dynamo theory.