

Causal Link between Solar Magnetic Variability and Japanese Climate Anomalies during the Maunder Minimum

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Causal link between solar variations and climate has been actively discussed for a various time scales. There is one major problem on this issue. It is difficult to distinguish each of the effects of solar parameters (total solar irradiance (TSI), solar ultraviolet (UV) radiation, and galactic cosmic rays (GCRs)) on climate changes as their variations are more or less synchronized. The characteristics of GCR variations associated with solar magnetic activity, however, are slightly different from other solar related parameters, such as TSI and UV. Especially, previous study has suggested that the cosmic ray variation was unique during the Maunder Minimum (A. D. 1645-1715), a period of prolonged sunspot absence. Comparison of annually measured tree-ring D14C and ice-core 10Be records revealed that GCRs had significant amplification associated with the magnetic polarity reversals of the Sun during the Maunder Minimum. This phenomenon enables us to estimate the GCR effect on climate.

In this study, we utilize tree rings that contain both climate and cosmic ray proxies (d18O, D14C) that can directly compare these reconstructions without any dating error. Our tree-ring d18O records from both high and middle latitude Japan show distinct negative spikes indicating cold and wet climate at every other 28 years at which anomalous GCR flux was detected in 10Be record.

Keywords: Solar Magnetic Activity, Galactic Cosmic Ray, The Maunder Minimum, Tree-ring isotope