

Carbon isotopes, the sun, and climate change over the last millennium

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The presentation will address results (i) from recent reconstructions of solar activity from the tree ring radiocarbon record (Muscheler et al., 2006), and (ii) of transient climate simulations with the NCAR atmosphere-ocean general circulation model for the period 850 to 2000 AD (Ammann et al., 2006).

Cosmogenic isotopes such as radiocarbon (^{14}C) are proxies of solar magnetic activity. The past production of ^{14}C by cosmic rays is estimated from the tree ring ^{14}C record over the late Holocene using three carbon cycle models. Radiocarbon production rates are then converted into estimates of solar magnetic activity by applying a production model for cosmogenic isotopes. The radiocarbon-based reconstruction of solar magnetic activity shows the well-known solar minima during the 15th, 17th, and early 19th century. Solar modulation was higher or equally high than today during three periods of the last millennium and the recent activity of the sun was not unusual in the context of the last millennium.

The magnitude of low-frequency solar irradiance changes is highly uncertain. Tentative correlations with records of cosmogenic nuclei (^{10}Be , ^{14}C), sunspots, aurora histories in combination with the behaviour of solar-like stars have been used to estimate past solar irradiance. The temporal evolution of different proxy series is in reasonable agreement for the past millennium. However, the scaling required to translate a proxy record into solar irradiance anomalies is highly uncertain and published estimates of multi-decadal solar irradiance changes vary by a factor of five.

The NCAR CSM1.4 coupled Atmosphere-Ocean General Circulation model was forced with different reconstructions of solar irradiance changes as well as with volcanic and anthropogenic forcing. It is found that large variations in solar irradiance are not compatible with the available range of NH temperature reconstructions in these transient simulations. Given the known low climate sensitivity of the NCAR model, smaller, possibly much smaller solar irradiance variations produce climate variations in better agreement with the temperature proxy records.

REFERENCES

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