

Lengths of Schwabe cycles in the 7th and 8th centuries indicated by precise measurement of carbon-14 content in tree ring

Fusa Miyake^{1*}, Kimiaki Masuda¹, Toshio Nakamura²

¹Solar-Terrestrial Environment Laboratory, Nagoya University, ²Center for Chronological Research, Nagoya University

Radiocarbon (¹⁴C) is produced in the upper atmosphere by galactic cosmic rays, which are modulated by solar magnetic activity. Its content in tree rings is retained and provides a record of past cosmic ray intensity and solar activity. We have measured the ¹⁴C content in Japanese cedar tree rings from AD 600 to 760, a time interval including a small grand solar minimum in the 7-8th centuries, with a resolution of 2 year.

Periodicity analysis of the ¹⁴C data exhibits a component in the frequency band of the Schwabe cycle with a period of 12-13 years continuing throughout the minimum. This is the fourth case of increase in the length of the Schwabe cycle observed in grand solar minima, after the Maunder Minimum, the Sporer Minimum, and the 4th century BC Minimum. A finding of the fourth of these cases strengthens the evidence that the length of the Schwabe cycle increases during grand solar minima.

Also a difference between the Maunder type and the Sporer type minima was found, i.e. the length of the Schwabe cycle of the Maunder type minima increase during the most period of the minima, while that of the Sporer type minima increase during only the preceding or the beginning of the minima. There is a correlation between the cycle length and the amplitude of the Maunder type minimum.

In addition to the increase in the cycle length, it was also found that short frequency components appear preceding and at the beginning of the minimum. These short frequency components are due to solar magnetic activity which is predicted by the flux-transport dynamo model (Choudhuri and Karak, 2009).