

^{14}C during the ~660 BCE solar proton event from Japanese tree rings

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Annual rings record the intensity of cosmic rays that had entered into the Earth's atmosphere. Several rapid ^{14}C increases in the past, such as the 775 CE and 994CE ^{14}C spikes, have been reported to originate from extreme solar proton events (SPEs). Another rapid ^{14}C increase, also known as the ca. 660 BCE event in German oak tree rings as well as increases of ^{10}Be and ^{36}Cl in ice cores, was presumed similar to the 775 CE event; however, as the ^{14}C increase of approximately 10‰ in 660 BCE had taken a rather longer rise time of 3–4 years as compared to that of the 775 CE event, the occurrence could not be simply associated to an extreme SPE. In this study, to elucidate the rapid increase in ^{14}C concentrations in tree rings around 660 BCE, we have precisely measured the ^{14}C concentrations of earlywoods and latewoods inside the annual rings of Japanese cedar for the period 669–633 BCE. Based on the feature of ^{14}C production rate calculated from the fine measured profile of the ^{14}C concentrations using an 11-Box model of carbon cycle, we found that the ^{14}C rapid increase occurred within 665–663.5 BCE, and that duration of ^{14}C production describing the event is distributed from one month to 3.4 years. The possibility of occurrence of consecutive SPEs over up to three years is offered.

Keywords: ^{14}C , ~660 BCE event, SPE