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The expanding record of rapid carbon-14 excursions in tree-rings - what do they tell us?

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Two 14C excursions apparently caused by an increase of incoming cosmic rays on a short time scale found in the Late Holocene generated widespread interest and have been reproduced in many different tree-ring records. These excursions at AD 774-775 and AD 993-994 are usually explained as due to extreme solar proton events (SPE). In addition, a larger event has also been reported at 5480 BC (Miyake et al. 2017), which is attributed to a special mode of a grand solar minimum, as well as another at 660 BC (Park et al. 2017). Other events have been reported such as at 3371-3371BC (Wang et al. 2017). Clearly, other events must exist, but could be the result of diverse processes affecting the cosmic-ray flux including solar events, gamma-ray bursts and geomagnetic phenomena. Searches for supernova effects have so far proved inconclusive (Dee et al. 2017). In order to detect more such possible events, we have identified periods when the 14C increase rate is rapid and large in the international radiocarbon calibration (IntCal) data. We identify a new possible excursion starting at 814BC,which may be connected to the beginning of a solar minimum associated with the beginning of the Hallstatt period, which is characterized by relatively constant 14C ages in the period from 800-400BC. We compare results of annual C14 measurements from tree rings of giant sequoia (California) and cedar (Japan), and compare these results to other identified excursions, as well as geomagnetic data. We note that the structure of the increase from 814 BC is similar to the increase at 5480 BC, suggesting a related origin. We also assess whether there are different kinds of events, which may be observed that are consistent with different types of solar phenomena, or other explanations. We also highlight the potential importance of these annual data to improve the international radiocarbon calibration, as it is increasingly clear that annual data provides additional information that needs to be included in IntCal.