EGU2020-5377
https://doi.org/10.5194/egusphere-egu2020-5377
EGU General Assembly 2020

Evidence for solar-flare and other cosmic-ray events in the 14C record in tree rings: New information and a cautionary tale.

Anthony Jull[1,2], Irina Panyushkina[3], Fusa Miyake[4], Matthew Salzer[3], Chris Baisan[3], Mihaly Molnar[2], Tamas Varga[2], Lukas Wacker[5], Nicholas Brehm[5], and Willy Tegel[6]

[1]University of Arizona, Geosciences, Tucson, United States of America (jull@email.arizona.edu)
[2]Isotope Climatology and Environmental Research Centre, Institute for Nuclear Research, Debrecen, Hungary
[3]Laboratory for Tree-Ring Research, University of Arizona, Tucson, AZ, USA
[4]Institute for Space-Earth Environment Research, University of Nagoya, Japan
[5]Laboratory for Ion Beam Physics, ETH-Zürich, Switzerland
[6]Chair of Forest Growth and Dendrochronology, University of Freiburg, Germany

Excursions in the radiocarbon (^{14}C) record, which are rapid changes on a scale of a few years are presumed to be caused by an increase of incoming cosmic rays. The excursions at AD 774-775AD and 993-994AD have generated widespread interest and have been reproduced in many different tree-ring records (Miyake et al. 2012, 2013, 2017; Büntgen et al. 2018). Similar structures have also been detailed, such as at 660BC (Park et al. 2017; O'Hare et al. 2019). Other types of change in ^{14}C production may be due to a mix of SPE and different phenomena, such as around 5480BC (Miyake et al. 2017) and 815BC (Jull et al. 2018). We note that a proposed SPE event about 3371BC (Wang et al. 2018) is currently unconfirmed and this emphasizes the need for an anchored dendro-record to determine possible events. Timing of these events is important to understand the underlying recurrence intervals. A considerable number of processes can affect the cosmic-ray flux, including solar events, gamma-ray bursts, geomagnetic shifts and relatively close supernovae. Such studies are providing a wealth of new information through which to characterize new 'events' in ^{14}C structure and to begin to understand the processes behind them. These effects also have introduced more complexity to the international radiocarbon calibration curve.

This research was supported in part by the European Union and the State of Hungary, co-financed by the European Regional Development Fund in the project of GINOP-2.3.2-15-2016-00009 'ICER'.

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