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Identification and synchronization of the common cosmic-ray signal in the IntCal13 14C calibration and the Greenland ice-core 10Be records

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The production rates of cosmogenic radionuclides (such as 10Be and 14C) are modulated by the solar and geomagnetic shielding of galactic cosmic rays. In addition, 14C and 10Be are influenced by the carbon cycle and the atmospheric transport and deposition, respectively. Isolating and identifying the common production signal allows us to synchronize ice core 10Be and tree ring 14C records during the Holocene (Adolphi and Muscheler, 2016), thereby connecting ice core climate records with 14C-dated records.

Extending this comparison further back in time is challenging due to deteriorating quality of the 14C calibration record, IntCal13, (Reimer et al., 2013) and possible unidentified climate influences on the ice-core 10Be records. Nevertheless, by focusing on the most prominent production-rate features this comparison can be extended far back into the last glacial where, for example, the linkage of tree-ring based Kauri 14C data and the Greenland ice-core time scale (GICC05) suggested unresolved data and/or time scale differences around the period of the Laschamp geomagnetic field minimum at about 42000 yrs BP (Muscheler et al., 2014).

Here we show that the data underlying the IntCal13 14C record and the ice-core 10Be records exhibit common variability that allows us to tentatively link the ice core GICC05 time scale to the radiocarbon time scale for almost the complete radiocarbon dating range. The observed time scale differences could be related to uncertainties in both the U/Th-based dating of the IntCal13 calibration data set and the GICC05 time scale, and we show that the two can be reconciled within the uncertainties of the ice-core layer counting. This direct comparison between IntCal13 and 10Be also suggests that the 14C differences shown in (Muscheler et al., 2014) around the Laschamp geomagnetic field minimum can be reduced by moderate adjustments to the GICC05 time scale.

References:

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