



## **Progress in the search for rapid carbon-14 excursions in the tree-ring record**

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Two  $^{14}\text{C}$  excursions are caused by an increase of incoming cosmic rays on a short time scale found in the Late Holocene (AD 774-775 and AD 993-994). The most plausible cause of these events is considered to be extreme Solar Proton Events (SPE). It is possible that there are other annual  $^{14}\text{C}$  excursions in the past. In order to detect more such events, we measured the  $^{14}\text{C}$  contents in bristlecone pine tree rings during the periods when the  $^{14}\text{C}$  increase rate is rapid and large in the IntCal data. We have analyzed four periods every other year for the Mid Holocene (BC2479-BC2455, BC4055-BC4031, BC4465-BC4441, and BC4689-BC4681), where no significant events were discovered. Dee et al. (2017) have also studied a number of events potentially associated with supernovae, but found no measurable effect. It is important to do continuous measurements to find annual cosmic ray events at other locations in the tree-ring record. We have also extended our survey to other time periods where we expect there may be such events. We also assess whether there are other events which may be observed that are consistent with the solar-flare hypothesis, or other explanations. We also highlight the potential importance of these annual data to add to the IntCal record.