**Extreme solar and other cosmic events recorded in 14C in tree rings**

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Solar flares are intense bursts of radiation from the Sun, that particularly occur during solar maximum. These flares can cause changes in the ionization of the atmosphere and geomagnetic effects. This can disrupt electronic communications and cause aurora much further south than normal. However, these are small events compared to some very large events recorded in past tree-ring records. There are historical reports of an intense event associated with solar activity, for example, a historical event recorded in 1859 called the “Carrington event” caused massive disruption to telegraph communications and caused aurora to be observed as far south as Cuba and Panama. One can only imagine the effect of such an extreme event on our society, which depends so much on GPS and electronic communications.

Large and rapid changes on the scale of 1-2 years in the radiocarbon concentration in tree rings have been linked to solar flare events in the past. The best documented is the 774-775 AD event, recorded in over 34 different locations around the world, in both the northern and southern hemispheres. This even caused an increase in the annual radiocarbon signal by about a factor of 5, meaning a much larger flux of solar cosmic rays, perhaps up to 100 times the largest measured ~~observed~~ solar-flare event in 1956. This 774-775 AD event has been confirmed independently in cosmogenic isotopes measured in ice-core records. Ancient chronicles from European and Asian civilizations describe strange atmospheric phenomena in the past as well at about this time. Surprisingly, the Carrington Event is not easily apparent in the 14C record.

There are 6 confirmed events in the last 14,500 years, at 993-994 AD, 774-775 AD, 664-663 BC, 5259 BC, 7176 BC and 12,450 BC in the literature. These are mainly independently confirmed from other radionuclide records, such as 10Be in ice cores. That seems like a small number, and there are other events that aren’t independently confirmed at about 5410 BC, 810 BC, and 1261-1262, 1268-1269 and 1279-1280 AD, although some may be caused by other astronomical processes. We expect there are more that remain to be found, especially the big gap between 664 BC and 5259 BC. For precise timing of these events and effects from the carbon cycle and plant growth also need to be taken into account. In additional to these events, we have investigated whether there are possible rapid increases in 14C production due to other phenomena, such as supernovae. We will discuss the possible ramifications of these very large events and their possible climatic and other effects.

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