Large solar proton event explains 774-775 CE carbon-14 increase

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Tree ring records indicate that in 774-775 CE, atmospheric carbon-14 levels increased substantially. Researchers suggest that a solar proton event may have been the cause. In solar proton events, large numbers of high-energy protons are emitted from the Sun, along with other particles. If these particles reach Earth's atmosphere, they ionize the atmosphere and induce nuclear reactions that produce higher levels of carbon-14; the particles also cause chemical reactions that result in depletion of ozone in the ozone layer, allowing harmful ultraviolet radiation to reach the ground.

A previous group of researchers suggested that to cause the observed eighth century carbon-14 increase, a solar proton event would have had to be thousands of times larger than any that has been observed from the Sun. However, Thomas et al. believe that group's calculations were incorrect. They modeled the atmospheric and biologic effects of three solar proton events with different energy spectra and fluences (number of protons per area). They find that an event with about 7 or more times greater fluence (depending on the spectrum) than an observed October 1989 solar flare event could explain the 774-775 CE carbon-14 enhancement. With a hard (high-energy) spectrum, an event with this fluence would result in moderately damaging effects on life but would not cause a mass extinction. They rule out an event with a softer spectrum because such an event would cause severe ozone depletion and mass extinction, which were not observed in the eighth century.

The authors estimate that solar proton events of this magnitude occur on

average once in a thousand years, and more often if the estimate is based on astronomical observations of flares on Sun-like stars. They note that although that may seem low, such an event would have severely damaging effects on the technology on which society relies.

More information: Terrestrial effects of possible astrophysical sources of an AD 774-775 increase in carbon-14 production, *Geophysical Research Letters*, doi:10.1002/grl.50222, 2013 onlinelibrary.wiley.com/doi/10 … 2/grl.50222/abstract

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