Discovery of 11-year and 22-year cylces of solar activity in an Antarctic ice core of one thousand years ago

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Our knowledge of sunspot cycle is limited for the last 400 years. The first observation of sunspots was carried out in 1610 AD soon after the invention of a telescope. Galellio Galilei is one of the first observers and found that the sunspots are on the solar surface. The sunspots have been continuously monitored especially since the beginning of the eighteenth century after the Maunder Minimum, the period in the seventeenth century in which almost no sunspots were observed. The continuous observations led to the finding of solar periodicities of 11 years and 22 years. However, an accurate knowledge of the solar variability before the first telescope observation is crucially demanded both in the fields of astronomy and climatology.

Here we report the discovery of solar modulation about 1,000 years ago, which clearly shows prominent periods of 11 years and 22 years. The result was obtained from a direct spectral analysis of the depth profile of nitrate ion concentration in a shallow ice core drilled at Dome Fuji, Antarctica, in 2001. We anticipate that this discovery and the extended studies on this line will provide a useful clue to understand solar dynamo process and also a possible solar influence on the climate on the Earth.