The features of the great minima in solar activity during the last 1000 years

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Abstract

Although the historical data such as sunspot and auroral records are fragmentary and strongly depend on the frequency of observations, those offer important information on the real behavior of solar activity in the past with the proxy data produced by the cosmic rays. Recently, it is reported that there are correlations between the solar activity and the climate variation, and the great minima of greatly depressed activity corresponding to unusual cold weather on the Earth intervened in the regular time evolution of the solar activity. Moreover, it is indicated that the land-surface temperatures have been correlated with the length of solar cycle. Therefore, using the sunspot and auroral records of ancient Korea and China, and the proxy data as ^{10}Be in polar ice and ^{14}C in tree rings, we have examined the features of the great minima in solar activity during the last 1000 years.

The results are as follows: (1) in spite of the non-linear auroral data, the existence of the great minima is clearly seen in the time distributions of historical records, which it is nearly coincident with the variations of the cosmogenic data; (2) auroral observations were much more frequent than sunspots, and auroral records appeared in the years when no sunspots were observed; (3) the solar cycles derived from the auroral records of Korea for 992-1379 and 1391-1799 respectively are coincident with the Schwabe cycle and the Gleissberg cycle, but we could not derived any solar cycle during the great minima; (4) high-intensive auroral activity showing the just before Maunder minimum was the one of evidence that the transition from the normal high activity to deep minimum was sudden without any apparent precursor; (5) during the last millennium, the Spörer minimum was the longest period of solar inactivity, and both of sunspot and auroral records were more scare than any other great minima.