Long-term periodicities in solar activity between 170 and 200 kyr ago reconstructed from ^{10}Be in ice-core and sediment archives

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Centennial to millennial periodicities of past solar activity in the Holocene epoch have been well investigated by using cosmogenic-nuclides records from tree-ring (^{14}C) and ice-core (^{10}Be) archives. However, those of the older ages are quite unclear because high-resolution records of cosmogenic nuclides are scarce. We obtained multiple high-resolution ^{10}Be records (atmospheric ^{10}Be flux and authigenic ^{10}Be/^{9}Be ratio) of 170–200 kyr ago, the period that includes the Iceland Basin geomagnetic excursion interval (Horiuchi et al., in press). Strong consistency among the records enables us to construct a robust ^{10}Be stack of this interval. A wavelet analysis of the stacked record reveals 4-kyr and 8-kyr periodicities, both of which can be interpreted as intrinsic geomagnetic cycles. We also found a cycle of 1.7 kyr in the ^{10}Be stack record, but it is significant only near the ^{10}Be maximum (the minimum of the geomagnetic paleointensity). A relative enhancement of solar modulation in ^{10}Be production is predicted with reduced paleointensity (Masarik and Beer, 1999; Beer et al., 2012). Therefore, it is possible to attribute this cosmogenic 1.7-kyr cycle to the long-term solar cycle that is identified in this period. The wavelet spectrum of the highest-resolution ^{10}Be record (obtained from the Dome Fuji ice core) shows more a detailed structure than the stacked record. The 4- and 1.7-kyr cycles show similar tendencies to, and are clearer than, those of the stack. The spectrum also shows somewhat intermingled multi-centennial (0.3, 0.5 and 0.7 kyr) cycles around the maxima of ^{10}Be, which likely represent solar cycles in this period (note: 200-yr Suess/de Vries cycle is under the detection limit of our record). On the other hand, the 2.2–2.4-kyr Hallstatt cycle and 1-kyr Eddy cycle, which are frequently documented in Holocene cosmogenic records, are not dominant in our records.

