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Monthly and annual variations of 10Be fallout in the early 21st century recorded in a Greenland ice core

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Cosmogenic 10Be is produced by spallation reactions between galactic cosmic rays and nitrogen and oxygen atoms, mainly in the lower stratosphere and upper troposphere. Since the intensity of galactic cosmic rays is modulated by solar/geomagnetic fields, 10Be serves as a proxy for solar activity and the paleointensity of the Earth's magnetic field (Beer et al., 2012).

The 10Be produced is immediately oxidized and then falls to the surface, usually attached to aerosols. Approximately 65 % of 10Be is estimate to be produced in the stratosphere and 35% in the troposphere (Beer et al., 2012). Stratospheric 10Be is thought to have an average residence time of one to two years, to be well mixed in the latitudinal direction by the Brewer-Dobson circulation, and to enter the troposphere mainly at mid-latitudes. It is then transported to higher latitudes by atmospheric circulation in the troposphere and is removed within several days to weeks along with the 10Be produced in the upper troposphere (e.g. Heikkilä et al., 2009). These atmospheric behaviors may allow 10Be variations recorded in high resolution ice cores to serve as unique chemical tracers associated with specific stratospheric/tropospheric processes (e.g. Pedro et al., 2011; Zheng et al., 2020).

In this study, we present a quasi-monthly 10Be record from 2000 to 2020 CE obtained from an ice core drilled in 2021 from the southeastern dome (67°11'30" N, 36°28'13" W) of the Greenland ice sheet (hereafter as SE-Dome II). An accurate age model was constructed based mainly on annual layer counting using the seasonality of H2O2 concentration in SE-Dome II (Kawakami et al., 2023). The 10Be concentrations ranged from 0.27×10^4 to 1.74×10^4 atoms/g. Seasonal variations characterized by an increase from late spring to early summer were evident in the 10Be profile throughout the period. On the other hand, the annually averaged 10Be concentration correlates well with the 10Be production rate in the atmosphere estimated from neutron monitor observations and a production model (Poluianov et al., 2016), but with a lag of one to two years. In contrast to the 10Be concentration, the annually averaged 10Be flux does not correlate well with the 10Be production, suggesting that solar activity reconstructions from the SE-Dome II 10Be record should use concentrations rather than fluxes. Recently, an advanced chronology of SE-Dome II has been proposed based on an oxygen isotope correlation with the output of an oxygen isotope GCM, a similar approach to that had already been used for an ice core from a nearby site (Furukawa et al., 2017). Based on this new chronology as well, both seasonal and annual variations of 10Be recorded in the SE-Dome II ice core will be further discussed.

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