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Solar and climate signal revealed by seasonal ^{10}Be data from the NEEM ice core project for neutron monitor period

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Studying sub-annual ^{10}Be records is vital for the understanding of the isotope distribution in ice cores and related interpretations of the changes in solar activity and climate. However, such high-resolution data from Greenland are scarce and cover less than one full solar cycle (11yr). Here we present a seasonally resolved ^{10}Be data set covering the neutron monitor period (1951-2002) from a firn core connected to the NEEM (North Greenland Eemian Ice Drilling) project. The result suggests that both summer and winter ^{10}Be reflect the production signal induced by solar modulation of galactic cosmic rays, although some mismatch to the solar signal partly disturbs full agreement between the records. We found that the NEEM summer and winter ^{10}Be is influenced by different climate conditions and, therefore, consideration of the annual ^{10}Be deposition minimizes the seasonal noise. We also found that the varying tropopause height over 30˚N represents a main factor controlling the NEEM ^{10}Be data on a seasonal and annual scales. Exceptionally low tropopause height may have contributed to a peak in winter ^{10}Be deposition in 1983 which is not directly associated with the ^{10}Be production rate. Summer ^{10}Be data also correlates significantly with the tropopause height over the Greenland suggesting a direct contribution of summer stratospheric ^{10}Be intrusion to the ^{10}Be deposition in Greenland. The result suggests that summer ^{10}Be deposition may be more influenced by stratospheric ^{10}Be intrusions than winter ^{10}Be. To adjust for these climate biases, we apply a first-order correction to ^{10}Be data using a multi-linear regression model. The climate-corrected ^{10}Be data indicate better correlations with the production rate than the original ^{10}Be data. Furthermore, a ^{10}Be composite record from 5 ice cores in Greenland including the NEEM ice core data also shows the exceptional ^{10}Be deposition during the early 1980s. This feature suggests a regional climate influence on Greenland ^{10}Be that can be difficult to correct for by construction of a composite record using Greenland ice core data only. This study shows that long term seasonally resolved ^{10}Be records may provide a better understanding of climate factors influencing the ^{10}Be deposition in ice cores and improve reconstructions of past changes in solar activity.