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# 10Be in ice at high resolution: Solar activity and climate signals observed and GCM-modeled in Law Dome ice cores

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Changes in solar activity modulate the galactic cosmic ray flux, and in turn, the production rate of 10Be in the earth's atmosphere. The best archives of past changes in 10Be production rate are the polar ice cores. Key challenges in interpreting these archives as proxies for past solar activity lie in separating the useful solar activity (or production) signal from the interfering meteorological (or climate) signal, and furthermore, in determining the atmospheric source regions of 10Be deposited to the ice core site. In this study we use a new monthly resolution composite 10Be record, which spans the past decade, and a general circulation model (ECHAM5-HAM), to constrain both the production and climate signals in 10Be concentrations at the Law Dome ice core site, East Antarctica. This study differs from most previous work on 10Be in Antarctica due to the very high sample resolution achieved. This high resolution, through a time period where accurate instrumental measurements of solar activity and climate are available, allows us to examine the response of 10Be concentrations in ice to short-term (monthly to annual) variations in solar activity, and to short-term variations in climate, including seasonality. We find a significant correlation ($r2 = 0.56$, $P < 0.005$, $n = 92$) between observed 10Be concentrations and solar activity (represented by the neutron counting rate). The most pervasive climate influence is a seasonal cycle, which shows maximum concentrations in mid-to-late-summer and minimum concentrations in winter. Model results show reasonable agreement with observations; both a solar activity signal and seasonal cycle in 10Be are captured. However, the modeled snow accumulation rate is too high by approximately 60%. According to the model, the main atmospheric source region of 10Be deposited to Law Dome is the 30-90°S stratosphere (∼50%), followed by the 30-90°S troposphere (∼30%). An enhancement in the fraction of 10Be arriving to Law Dome from the stratosphere is found by the model during the mid-to-late summer, we suggest this pattern is implicated in the seasonality of observed 10Be concentrations in ice. Our results have implications for interpretation of longer term records of 10Be from ice cores. Firstly, the strong production signal supports the use of 10Be as a solar proxy. Secondly, the short term climate processes operating here, may provide clues to how longer term shifts in climate impact on ice core 10Be.