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Solar forcing based on Be-10 in Antarctica ice over the past millennium and beyond

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Over the past millennium, variations of the total solar irradiance (TSI) have been recognized as a primary forcing. Volcanic eruptions have had a strong climatic impact but limited in time. The solar variations are reconstructed from proxies of the solar activity, mainly cosmogenic isotope (carbon-14, beryllium-10) concentration and sunspot number, each proxy having its own limitation. We have averaged 10Be records from Central Antarctica ice cores (South Pole by Raisbeck et al. 1990, Bard et al. 1997 and Dome Fuji by Horiuchi et al. 2008) in order to provide a new reconstruction of the solar activity covering the last ca. 1300 years (modulation parameter PHI). Stacking together these records offers the possibility to smooth out the short variability related to deposition and snow accumulation processes rather than to solar activity. Central Antarctica offers at least three fundamental interests: (1) there is no long term trend in the snow accumulation over the last millennium, (2) the conditions of 10Be deposition are very stable, and (3) the 10Be flux is more sensitive to the solar activity than to the geomagnetic field. We then use this 10Be stack as a proxy of 14C production in different carbon cycle models. This allows us to simulate past atmospheric 14C variations, which compare quite well with reconstructed ones. Such a good correlation supports the solar origin of the 10Be stack. This curve is calibrated on measurements to be converted into solar modulation parameter PHI. An important uncertainty in this conversion is the sensitivity of the 10Be flux to the solar variability. For this reason we propose two different estimations of the solar modulation parameter, based on two contrasted sensitivity values. The minima of the solar modulation parameter are found much more variable than the maxima. The reconstructed solar modulation parameter shows two interesting features: the lowest values are found during the so-called Spörer Minimum (around year 1450); and high solar activity is found at approximately the same level over the last decades as during the 8th century. A tentative conversion into TSI is also proposed. A comparison with the recent reconstruction of the Asian Monsoon by Zhang et al. (2008) shows a broad agreement at the centennial timescale, but some divergence at the decadal one. This further supports the solar origin of our stack. We will also discuss prospects for extending this record to the entire Holocene.