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Modeling cosmogenic radionuclides ^{10}Be and ^{7}Be during the Maunder Minimum using the ECHAM5-HAM General Circulation Model

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Abstract. All existing ^{10}Be records from Greenland and Antarctica show increasing concentrations during the Maunder Minimum period (MM), 1645–1715, when solar activity was very low and the climate was colder (little ice age). In detail, however, the ^{10}Be records deviate from each other. We investigate to what extent climatic changes influence the ^{10}Be measured in ice by modeling this period using the ECHAM5-HAM general circulation model. Production calculations show that during the MM the mean global ^{10}Be production was higher by 32% than at present due to lower solar activity. Our modeling shows that the zonally averaged modeled ^{10}Be deposition flux deviates by only ~8% from the average increase of 32%, indicating that climatic effects are much smaller than the production change. Due to increased stratospheric production, the ^{10}Be content in the downward fluxes is larger during MM, leading to larger ^{10}Be deposition fluxes in the subtropics, where stratosphere-troposphere exchange (STE) is strongest. In polar regions the effect is small. In Greenland the deposition change depends on latitude and altitude. In Antarctica the change is larger in the east than in the west. We use the ^{10}Be/^{7}Be ratio to study changes in STE. We find larger change between 20° N–40° N during spring, pointing to a stronger STE in the Northern Hemisphere during MM. In the Southern Hemisphere the change is small. These findings indicate that climate changes do influence the ^{10}Be deposition fluxes, but not enough to significantly disturb the production signal. Climate-induced changes remain small, especially in polar regions.

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