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The Holocene climatic optimum temperature signal from the NGRIP record. A study based on the water isotope diffusion rates as estimated from discrete high-resolution $\delta^{18}\mathrm{O}$ data.

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The water isotope signal has been traditionally used in ice core studies as a proxy for past temperature. The validity of this signal has been extensively debated. Effects related to the location of the vapor source region, the seasonality of the precipitation and ice sheet elevation changes have been shown to cause isotopic artifacts. Consequently, the sensitivity of the isotopic thermometer to past temperature changes, commonly expressed by the isotope slope, should be considered as a variable parameter. A period of particular interest is the Holocene climatic optimum, where due to apparent ice sheet elevation changes, the $\delta^{18}\mathrm{O}$ record from the Greenland summit ice cores does not present a clear maximum. This is in contradiction to borehole temperatures and other paleoclimate records from northern latitudes.

Water isotope diffusion is a process that occurs after deposition and takes place in the porous space of the firn until the close off depth. Assuming a diffusivity parameterization and based on a densification and strain rate history, it is possible to investigate the effects of temperature and accumulation on the diffusion length.

Here we present reconstructions of the isotope slope through the last 11 ka based on the study of the diffusion rates of $\delta^{18}\mathrm{O}$, as estimated from high resolution (5 cm) samples from the NGRIP ice core. We demonstrate how the precision and the resolution of the isotopic ratio measurements affect the estimation of the diffusion length from the ice core data. We generate different scenarios of diffusion length profiles by coupling a physical model for water isotope diffusion to an empirical densification model and by using various combinations of temperature, accumulation and ice sheet elevation histories as inputs. Based on these scenarios we can infer a temperature and an ice sheet elevation history for this part of the NGRIP core. These calculations refer to firn temperatures and as a result should not be affected by the isotopic artifacts mentioned above. Our findings indicate the presence of a climatic optimum in the record at approximately 9.5 ka b2k. We discuss the validity of our reconstruction and its potential application on other ice core records and climatic periods.