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Mean Ocean Temperature during MIS6-5 Based on Noble Gas Ratios in the EDC Ice Core

Content

Deglaciations are the largest natural global warming events across the Quaternary. These transitions of the global climate from its cold glacial into the warmer interglacial state are the consequence of changes in the latitudinal distribution of insolation, amplified by major positive feedbacks such as the ice-albedo feedback and the greenhouse gas feedback. During this large-scale reorganization of the climate system, the planet takes up vast amounts of energy. This energy is largely partitioned between Earth's two dominant energy reservoirs on glacial-interglacial time scale: the ocean and the latent heat stored in glacial ice sheets. Thus, global ocean heat content (OHC), in combination with global sea level, are the two key metrics for the determination of Earth's energy imbalance during the last transitions.

Ratios of noble gases and molecular nitrogen trapped in polar ice cores can be used as a proxy for past mean ocean temperature (MOT), which is directly linked to OHC. Since noble gases are inert, their past atmospheric abundances on glacial-interglacial time scale are solely dependent on their well understood temperature-dependent physical solubilities in ocean water. As the atmosphere is well-mixed, a single ice core sample is sufficient to obtain a snapshot of the global ocean's noble gas content, and, thus, through the temperature-dependent solubilities, its heat content. Thanks to high precision mass spectrometry measurements, the 1σ uncertainty of recent MOT reconstructions is on the order of 0.4℃. As a consequence, MOT has proven to be a novel powerful proxy for the past climate.

The Last Interglacial (LIG) is one of the warmest climatic periods of the past 800 kyr, which featured global sea level on the order of meters above modern. Although substantial differences in greenhouse gas concentrations and orbital parameters exist, the LIG is considered a potential analogue for certain aspects of near-future anthropogenic warming. Here we present a new MOT dataset for the MIS6-5 period based on noble gas ratios in the EDC ice core. Our record spans from 163 kyr-116 kyr and thus encompasses the more recent half of the penultimate glacial, Transition II, the overshoot at the onset of the Last Interglacial (LIG), as well as the last warm period itself. We thereby complement and largely expand on a recently published dataset from Shackleton et al. 2020, who used Taylor glacier ice to obtain a highly resolved MOT record for the LIG. In accordance with Shackleton et al. 2020, we find an overshoot in MOT at the onset of the LIG, which is believed to be a consequence of the sustained reduction in AMOC during Heinrich Stadial 11. Having available a complete picture of the MOT evolution throughout Transition II and the following LIG, we can furthermore compare the MOT changes of this time period with those of other glacial-interglacial transitions, which we are currently in the process of measuring.

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