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Greenhouse gas record from the Allan Hills Blue Ice Area for the penultimate deglaciation and last interglacial period

Content

The discovery of very old ice in Antarctic ablation zones such as the Allan Hills Blue Ice Area marks a significant step toward understanding the greenhouse gas history of the early Pleistocene/late Pliocene. However, collecting an ice core from a different location than the site of original deposition leaves questions of gas preservation and stratigraphy. Here, we verify gas preservation at Allan Hills using the CMC3 ice core spanning Marine Isotope Stage 6-5. This termination is a useful span of Earth's history to validate the greenhouse gas record, as it encompasses a major climatic shift which was potentially accompanied by changes in the glaciological setting at Allan Hills. Furthermore, the CMC3 core provides an excellent opportunity to study the sequence of events during MIS6-5e, a period not well represented in the US ice core archive. The CMC3 core has been analyzed for concentrations of carbon dioxide, methane, and nitrous oxide, as well as total air content, and stable carbon isotope ratios ($\delta^{13}\text{C-CO}_2$). Results from the gas phase of the core indicate a well-preserved climatic signature across the penultimate deglaciation. The methane record has been used to construct a gas-phase chronology for the core. Though a limited number of CO_2 and $\delta^{13}\text{C-CO}_2$ measurements have been made so far, they seem to agree with published data (CO_2 concentrations plot within 3 ppm of a previously compiled record from Antarctic cores and the corresponding $\delta^{13}\text{C-CO}_2$ within $\sim 0.12\%$ of measurements made from Talos Dome (Schneider et al. 2013)). Total air content ranges from 0.089 to 0.1 cm^3g^{-1} – values that are typical of other East Antarctic ice cores – and shows the expected inverse relationship to integrated summer insolation. Results from this study are encouraging for the continued analysis of these ice cores, including a high-resolution record of $\delta^{13}\text{C-CO}_2$ across Termination II. Furthermore, this study adds confidence to the greenhouse gas concentrations measured in older ice from the Allan Hills.

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