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How to obtain a quantitative record of Holocene Antarctic temperature variability

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Understanding the magnitude and causes of recent Antarctic climatic trends and variability is hampered by the short and sparse instrumental record. Stable water isotopes in firn and ice-cores allow us to infer past climate changes. However, existing reconstruction efforts on the East Antarctic Plateau are too uncertain to draw quantitative conclusions about climate variability and potential anthropogenic trends. The limited skill of the existing temperature reconstructions, as well as an improved understanding of the isotopic signal, suggests that single firn cores, or even small stacks of cores, are not enough to allow a quantitative climate reconstruction. Instead, extensive arrays of firn cores are required, combined with a statistical separation of signal and noise and supplemented by independent temperature proxies.
In this contribution, we present the state of the art in understanding the spatial and temporal variability of high-resolution firn isotope records, as derived from field studies, forward proxy modelling and theoretical considerations. We estimate the spatial and temporal structure of stratigraphic noise, precipitation intermittency and other non-temperature effects. As an application, we simulate virtual firn cores around the EPICA DML drilling site in order to estimate future coring positions optimised for retrieving interannual to centennial climate variability.