Università Ca'Foscari Venezia

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BUSTA 1

- Il/la candidato/a descriva la/le tecnica/tecniche di analisi che utilizzerebbe per la determinazione della composizione isotopica di acqua in neve, firn e carote di ghiaccio.
- Il/la candidato/a illustri le metodologie di campionamento e processamento utilizzate per i campioni di neve e ghiaccio per la successiva analisi chimico-isotopica.
- Il/la candidato/a esponga brevemente tipologia ed utilizzo dei DPI (dispositivi di protezione individuali) di un laboratorio di ricerca chimico-fisico.
- Il/la candidato/a descriva la tipologia di software e le modalità che utilizzerebbe per la calibrazione di dati isotopici.

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BUSTA 2

- Il/la candidato/a descriva la/le tecnica/tecniche di analisi che utilizzerebbe per la determinazione della composizione isotopica in campioni estratti da suoli, linfa xilematica, pozzi, sorgenti e acque superficiali.
- Il/la candidato/a illustri le principali caratteristiche di uno standard di laboratorio per analisi isotopiche descrivendone le varie tipologie, conservazione ed utilizzo.
- Il candidato/a descriva come procede per l'acquisizione di uno strumento scientifico da collocare in un laboratorio di ricerca.
- Il/la candidato/a descriva la tipologia di software e le modalità che utilizzerebbe per rappresentare graficamente dati isotopici.

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Climate of the Past
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Improving temperature reconstructions from ice-core water-isotope records

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Abstract. Oxygen and hydrogen isotope ratios in polar precipitation are widely used as proxies for local temperature. In combination, oxygen and hydrogen isotope ratios also provide information on sea surface temperature at the oceanic moisture source locations where polar precipitation originates. Temperature reconstructions obtained from ice-core records generally rely on linear approximations of the relationships among local temperature, source temperature, and water-isotope values. However, there are important nonlinearities that significantly affect such reconstructions, particularly for source region temperatures. Here, we describe a relatively simple water-isotope distillation model and a novel temperature reconstruction method that accounts for these nonlinearities. Further, we examine in detail many of the parameters, assumptions, and uncertainties that underlie water-isotope distillation models and their influence on these temperature reconstructions. We provide new reconstructions of absolute surface temperature, condensation temperature, and source region evaporation temperature for all long Antarctic ice-core records for which the necessary data are available. These reconstructions differ from previous estimates due to both our new model and reconstruction technique, the influence of which is investigated directly. We also provide thorough uncertainty estimates for all temperature histories. Our reconstructions constrain the pattern and magnitude of polar amplification in the past and reveal asymmetries in the temperature histories of East and West Antarctica.

1 Introduction

Stable-isotope ratios of water have been the foundational proxy for polar paleoclimate research for more than a half-century (Langway, 1958; Gonfiantini, 1959; Dansgaard, 1964). Primarily used as a temperature proxy, stratigraphic records of water-isotope ratios in ice sheets provide detailed histories of Earth's climate over hundreds of thousands of years (Dansgaard et al., 1969; Petit et al., 1999), providing insight into the past magnitudes, spatial patterns, and phasing of climate change across the globe (Masson-Delmotte et al., 2006; EPICA Community Members, 2006; WAIS Divide Project Members, 2013, 2015). Both oxygen and hydrogen have stable isotopes whose ratios ($^{18}O/^{16}O$ and $^{2}H/^{1}H$) are commonly expressed as deviations, $\delta^{18}O$ and δD, from Vienna Standard Mean Ocean Water (VSMOW) in per mill (‰):

$$\delta = \frac{R_x - R_{std}}{R_{std}}, \qquad (1)$$

where R_x is the ratio in the sample and R_{std} is the ratio in VSMOW.

Poleward transport of moisture by the climate system, the progressive removal of moisture from the atmosphere by condensation and precipitation, and the fractionation of water-isotope ratios during phase changes are all processes inherently linked to temperature and together underpin the use of water-isotope ratios in polar precipitation as a temperature proxy (Craig, 1961; Epstein et al., 1963; Dansgaard, 1964; Gonfiantini, 1965). The strong empirical correlation between the water-isotope ratios in precipitation and surface temperature supports this interpretation (Petit et al.,

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Climate of the Past
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Climatic information archived in ice cores: impact of intermittency and diffusion on the recorded isotopic signal in Antarctica

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Abstract. The isotopic signal ($\delta^{18}O$ and δD) imprinted in ice cores from Antarctica is not solely generated by the temperature sensitivity of the isotopic composition of precipitation, but it also contains the signature of the intermittency of the precipitation patterns, as well as of post-deposition processes occurring at the surface and in the firn. This leads to a proxy signal recorded by the ice cores that may not be representative of the local climate variations. Due to precipitation intermittency, the ice cores only record brief snapshots of the climatic conditions, resulting in aliasing of the climatic signal and thus a large amount of noise which reduces the minimum temporal resolution at which a meaningful signal can be retrieved. The analyses are further complicated by isotopic diffusion, which acts as a low-pass filter that dampens any high-frequency changes. Here, we use reanalysis data (ERA-Interim) combined with satellite products of accumulation to evaluate the spatial distribution of the numerical estimates of the transfer function that describes the formation of the isotopic signal across Antarctica. As a result, the minimum timescales at which the signal-to-noise ratio exceeds unity range from less than 1 year at the coast to about 1000 years further inland. Based on solely physical processes, we are thus able to define a lower bound for the timescales at which climate variability can be reconstructed from the isotopic composition in ice cores.

1 Introduction

Ice cores are key archives of past climatic conditions (Jouzel and Masson-Delmotte, 2010, and references therein) as a wide range of climatic parameters are recorded in the physical and chemical composition of the ice itself and of the air bubbles trapped within. Water isotopes are commonly used as a past temperature proxy due to the sensitivity of the isotopic composition to atmospheric temperature variations over the course of the water cycle (Dansgaard, 1964; Lorius et al., 1969). Antarctic ice cores have been used to reconstruct continuous high-resolution temperature time series dating back 800 000 years (Petit et al., 1999; EPICA Community Members, 2004; Kawamura et al., 2017). Ice core water isotope data have also been used to compare rapid (e.g. Dansgaard–Oeschger) events between the Arctic and Antarctica (EPICA Community Members, 2006; Markle et al., 2017) or to provide a context for recent climate change (Stenni et al., 2017). Even though the amount of water needed to analyse water isotopes is very small (Jones et al., 2017a), inhomogeneous deposition and diffusion together with the annual layer thickness limit the temporal resolution of the climatic signal that can be retrieved from isotopes. As a result, ice cores from high accumulation areas such as coastal Antarctica (Morgan, 1985; Masson-Delmotte et al., 2003; Küttel et al., 2012; Vega et al., 2016; Caiazzo et al., 2017; Goursaud et al., 2018) and West Antarctica (Markle et al., 2017) could be used to achieve up to seasonal resolution in temperature reconstructions, while ice cores from low

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