Precise interpolar phasing of Younger Dryas climate change using isotopes of nitrogen and argon in air from the WAIS Divide ice core

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Ice core gas records provide a multitude of paleoclimatic proxies for both global and local processes. We present measurements of the isotopic composition of molecular nitrogen (N_2) and argon (Ar) in the West Antarctic Ice Sheet (WAIS) Divide Ice Core that constrain temporal changes of the firn column temperature gradient in response to local surface temperature change. We focus on the structure and timing of West Antarctic temperature change during the Younger Dryas, a period of abrupt global climate change during the last glacial termination. The unprecedented resolution of the WAIS Divide Core allows us to make measurements at a resolution of 20-50 years.

Our approach has two advantages over using delta-^{18}O of ice, the traditional ice core temperature proxy. Firstly, it is based on the well-understood physics of gas-phase thermal diffusion so is not hampered by some of the complicated assumptions that underly delta-^{18}O. Secondly, by using a gas-phase temperature proxy we can quantify, with uncertainties at the level of tens of years, the lag between northern hemisphere and southern hemisphere temperature changes by taking advantage of the precisely synchronized gas age models in Greenlandic and Antarctic ice cores. Our proxy does not require modelling of the ice-age–gas-age difference, a major source of uncertainty in a previous estimate of the lag [1]. Our high-resolution data will improve our understanding of the nature and timescales of the teleconnections that communicate climatic changes between the tropics and the two poles, improving predictions of how polar regions are likely to respond to future abrupt climate change.

[1] Buizert, C. et al. Precise interpolar phasing of abrupt climate change during the last ice age. Nature 520, 661–665 (2015).