Assessing the link between abrupt climate variability and global ice volume

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Project description: Rationale: It is well known that the occurrence and magnitude of abrupt climate change is somehow linked to the size of continental ice sheets but the precise link is unknown. For example, the ~60m drop in global sea level (SL) between 70-80kyr ago witnessed several abrupt climate shifts that involved large changes in Atlantic Ocean circulation. However, it is not known whether the change in SL affected climate stability or vice versa, in part because of the poor constraints on the timing of ice sheet growth. This project will address this fundamental uncertainty in climate dynamics by placing critical constraints on the timing of SL fall during this major climate transition and during earlier times of ice growth.

Methodology: Benthic foraminiferal Mg/Ca ratios provide a well established means of reconstructing calcification temperatures and, in combination with $\delta^{18}O$ measurements, provide an unparalleled approach for reconstructing changes in the oxygen isotope composition of seawater ($\delta^{18}O_{sw}$), a function of global ice volume. Here we will use this technique across major intervals of ice growth in multiple locations (necessary because the response at any individual site will be influenced by regional hydrographic changes as well as the effects of ocean mixing). We will also use state-of-the-art climate model results to investigate the possibility that the reconstructed history of $\delta^{18}O_{sw}$ at any one site might simply be a function of internal ocean dynamics and regional variations in evaporation and precipitation.

Wider Implications: The fifth assessment report of the IPCC (AR5) states, “It is very unlikely that the AMOC will undergo an abrupt transition or collapse in the 21stcentury for the scenarios considered.” It also states, “However, a collapse beyond the 21st century for large sustained warming cannot beexcluded.” The possibility of future abrupt change is important because such a change would have dramatic implications for humankind. Uncertainty as to whether such a change may or may not occur is compounded by our lack of understanding of the precise mechanisms (forcings and feedbacks) of the processes involved. This project will address this lack of understanding.

Cutler, K. B., et al. (2003), Rapid sea-level fall and deep-ocean temperature change since the last interglacial period, *Earth Planet. Sci. Lett*., 206, 253-271.

Sanchez Goni, M. F., E. Bard, A. Landais, L. Rossignol, and F. d'Errico (2013), Air-sea temperature decoupling in western Europe during the last interglacial-glacial transition, *Nature Geoscience*, 6, 837-841.

Training opportunities: The student will be offered a wide range of training opportunities. They will be given full training in benthic foraminiferal identification and trace metal and isotopic preparation (including clean lab protocols) and analytical techniques (e.g. IR-MS and HR-ICP-MS techniques), and will gain crucial experience in age modelling. Training in COSHH is mandatory. Depending on suitability and progress the student will also have the opportunity to receive training in post-processing of complex climate model output which will be provided by Dr Gregor Knorr of the Alfred Wegener Institute in Bremerhaven, Germany. It is envisaged that the student will gain sea-going experience.