Atmospheric CO2 variability during the Plio-Pleistocene

Supervisors

Main supervisor: Dr Stephen Barker (Cardiff University)
Co-supervisor: Dr Carrie Lear (Cardiff University)

Project enquiries - Email: barkers3@cf.ac.uk **Contact number:** +44 (0) 2920 874328

Supervisory team:
Prof Daniela Schmidt (University of Bristol)

Host Institution: Cardiff University

Project description

The link between atmospheric CO_2 and climate is inextricable and the ongoing rise in atmospheric CO_2 will be the primary driver of climate change over the next few centuries. Yet the precise mechanisms linking climate change to CO_2 are uncertain to the point of speculation. For example, what role did CO_2 play in the great glacial cycles of the Late Pleistocene? We know that CO_2 was lower during glacial times and increased as climate warmed into interglacial conditions but whether CO_2 was a driver or responder to climate change is still under debate. The role of CO_2 on longer timescales is also uncertain; the transition from 41 kyr to ~100 kyr glacial cycles at ~1.2-0.9 Ma (the Mid Pleistocene Transition, MPT) and gradual cooling of Earth's climate over the last 5 Myr have both been proposed as a result of decreasing CO_2 but considerable uncertainty remains.

The keystone to improving our understanding of the links between CO_2 and climate variability is the reconstruction of past CO_2 variations over geologic timescales. Ice core records extend our knowledge of CO_2 variability back to ~0.8 Ma but for earlier intervals we rely on proxy reconstructions. One such proxy is the boron isotopic composition ($d^{11}B$) of planktonic foraminiferal shells (free-floating marine protozoa) (Hnisch et al., 2009). This proxy has been developed by several international groups over the last several years (Foster et al., 2008; Hnisch et al., 2009) and is gaining momentum as perhaps the best quantitative method for reconstructing atmospheric CO_2 during 'pre-ice core' times.

This project will produce reconstructions of atmospheric CO_2 variability during key intervals in the past. The Antarctic ice core demonstrates that CO_2 varied in concert with global climate during the 100 kyr glacial cycles of the Late Pleistocene but what was the relationship before the MPT? Was the observed relationship between millennial-scale climate variability and CO_2 similar during the Early Pleistocene and Pliocene? The student will use the B-isotope proxy in combination with other proxies for the global carbon cycle to provide a high-resolution framework in which to hang the more quantitative B-isotope based estimates. This approach will allow us to produce much longer records with higher resolution than would be possible using the B technique alone. These records will reveal how millennial-scale CO_2-climate interactions changed during the transition from the warmer "high CO_2 world of the Pliocene to the cooler "low CO_2 world of the late Pleistocene.

Foster, G. L. (2008), Seawater pH, pCO_2 and [CO_3^{2-}] variations in the Caribbean Sea over the last 130 kyr: A boron isotope and B/Ca study of planktic forminifera, *Earth and Planetary Science Letters*, *271*(1-4), 254-266.

Hnisch, B., N. G. Hemming, D. Archer, M. Siddall, and J. F. McManus (2009), Atmospheric Carbon Dioxide

Concentration Across the Mid-Pleistocene Transition, *Science*, *324*(5934), 1551-1554.