The 8.2kyr event

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The PAGES/CLIVAR Intersection panel has highlighted climate events around 8200 years ago (Rohling and Pälike, 2005; Morrill and Jacobsen, 2005) as a key period that may allow paleoclimate data and analysis to influence model development and understanding of future projections for the North Atlantic. In order to further that goal the panel recently organized a workshop on the 8.2kyr event to better synthesize our understanding of the event. The workshop brought together specialists in the ice core record, ocean sediments, terrestrial proxies and modelers from both the EMIC and GCM communities. The existence of a unique event at around 8200 yr BP around the North Atlantic is no longer in question, but there remain uncertainties about how widespread the anomalies were and how well the length, duration and character of the event can be characterized. The currently favored hypothesis is that these anomalies were related to a transient change in the North Atlantic overturning circulation, possibly triggered by the final drainage of Lake Agassiz (Barber et al., 1999; von Grafenstein et al., 1998), so direct evidence from oceanic proxies for such an event are particularly sought after. Unfortunately, the abruptness of the event, poor age control, and the potential for opposing influences on the carbonate isotope record have made extracting oceanic counterparts to the terrestrial anomalies particularly challenging. The workshop agenda reflected these questions and was designed to :

a) Highlight what is known from the least ambiguous proxies.
b) Assess what it is meaningful to conclude from other evidence.
c) Look for potential problems in the Lake Agassiz hypothesis.
d) Agree on key questions that need to be addressed in the future.

The best evidence for a widespread and unique event at this time comes for the Greenland ice cores. New, extremely high-resolution ice core records were presented and clearly demonstrated that there was a coherent event whose peak lasted a few decades, that was distinct from all other events in the Greenland records for the Holocene (Fig. 1) . Layer counting indicates that while the whole event seems to have lasted around 160 years, the peak anomalies lasted only 60 to 70 years—underlining the challenge of finding this event in coarser resolution proxies. Evidence for a distinct event that was similarly unique in the Holocene in regions far from the Central and North Atlantic was more ambiguous. With a strict definition, and only using high-resolution and exceptionally well-dated records, clear evidence is restricted to the circum-North Atlantic region. New records from the British Isles, Newfoundland and Norway, for instance, were presented that have clear 8.2kyr event signatures. However, while there are hints of possibly synchronous excursions in lower resolution, less well-dated records, it is necessary to be extremely conservative in attributing them to the same event, to guard against 'false positives' arising simply from noise or longer term unrelated variations.

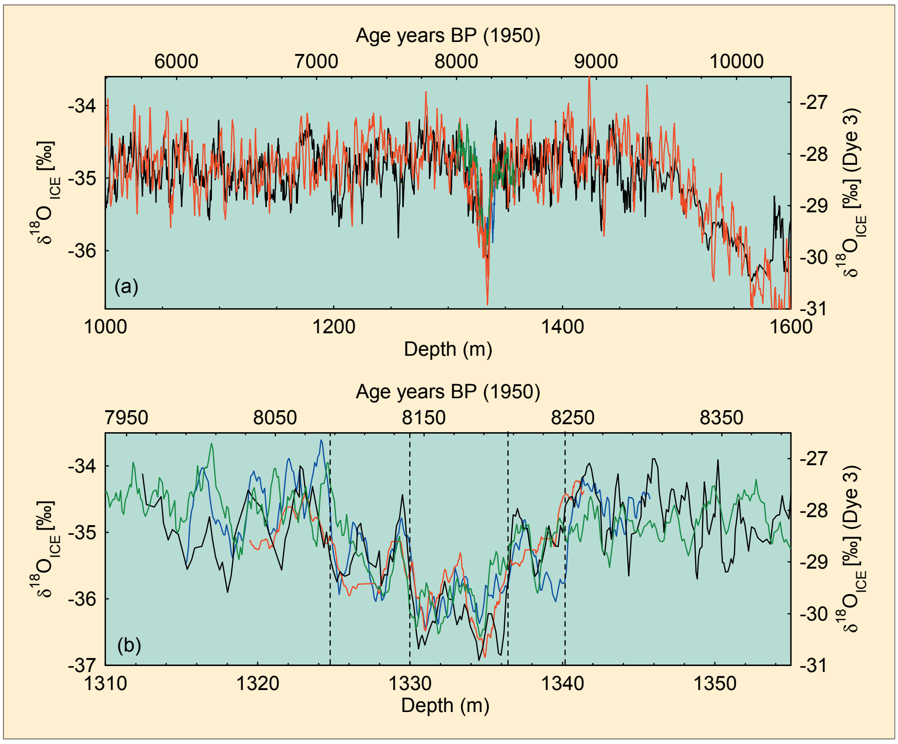

Figure 1: Four Greenland ice cores (Dye3, GISP2, GRIP and North GRIP) show a unique signature of an event at 8.2kyr BP. Each ice core record (on a common time/depth scale and scaled to the Dye3 isotope ratios) contains many common features found in all, however, at the timescale of individual years they do show differences that cannot be easily interpreted. The dashed lines denote where the records persistently depart from (and return to) one sigma and two sigma deviations from the preceeding period, usefully encapsulating the length of the detectable event (around 160 years) and its peak period (60-70 years) (figure courtesy of Liz Thomas and Eric Wolff).

In the North Atlantic ocean, new and varied sediment data seem to indicate concurrent changes in the circulation, particularly in transport-related proxies such as the sortable-silt fraction, but with varied timing and duration that still requires analysis (Ellison et al., 2006). Indeed, dating problems due to potential reservoir age uncertainty and bioturbation still limit our ability to easily interpret the ocean records. Overall, the ocean data provide a complex and not easily interpretable picture and in that sense are analogous to the similarly complex picture of the North Atlantic circulation variability provided by direct observations over recent decades.

Modelers have started to use the 8.2kyr event as a test case for examining the models' response to freshwater forcing, and are now using freshwater amounts and input locations that are much more relevant to this event than had been done previously with idealized 'hosing' experiments. Workshop participants discussed results from intermediate models as well as from GCM groups (The Hadley Centre, NCAR and GISS). These relate to the somewhat stochastic nature of the response to Agassiz-sized forcings, the impact of ocean changes on relevant proxies (water isotopes, methane emissions, aerosols) and the importance of preventing Labrador Sea deep water production (which is not thought to have been initiated prior to about 7 kyr BP).

Despite these initially encouraging results, significant problems remain. The most important and one that was repeatedly raised was that of chronology. The offset (around 200 years) in the terrestrial dates for the Agassiz drainage and the ice core chronologies, while within error bars, is still quite significant. Other carbon-dated records in the ocean sediment or on land are affected by a carbon-dating plateau around this time, which suggests the need for more work on alternate dating techniques, such as tephrology, for cross-correlating the different records. Other questions are more subtle. The North Atlantic has a very complex and dynamic circulation on decadal to multi-decadal timescales, and modern observations do not support the notion that all of this variability can be associated with a single quantity (such as the overturning streamfunction). Fitting the disparate ocean records into a wider and more complex picture is not easy and work is clearly required to improve that. And finally, improved and higher resolution data from the tropics and sub-tropics—particularly in Asia—are going to be needed to resolve the amplitude of any far-field response. The latest results and initial modeling work strengthen the panel's initial view that this event is a key target for Holocene paleoclimatology and that it may prove helpful in providing tests of climate models and influencing their development. That potential has yet to be fully realized.

Acknowledgements

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IGBP-SCOR Workshop: Ocean acidification — modern observations and past experiences

GLOBAL IGBP CHANGE
International Council for Science
Scientific Committee on Oceanic Research

Lamont-Doherty Earth Observatory of Columbia University, USA, 28-30 September 2006

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This workshop was the centerpiece of the Fast-Track Initiative (FTI) on Ocean Acidification of the International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR). The FTI is about exploring how we can learn from past changes in the Earth system to better understand the consequences of ongoing ocean acidification, and involves several projects with a marine focus (GLOBEC, IMBER, LOICZ, SOLAS, PAGES and IMAGES).

The workshop was attended by 65 international participants (Fig. 1). It was co-sponsored by IGBP, SCOR, and PAGES, and organized by the PAGES IPO and local hosts at Lamont. The goals of the workshop were to:

1) bring together researchers on modern ocean acidification with researchers investigating relevant events in Earth history and

(2) explore how paleo-studies can shed light on the consequences of fossil-fuel CO_2 release into our environment.

A series of overview talks, posters, and breakout-group discussions stimulated cross-disciplinary thinking between paleo and modern perspectives, and among chemical, geological, and biological researchers, as summarized below:

Modern observations ...

The rates and amounts of CO_2 currently being emitted exceed those inferred for at least the past 50 million years, and possibly much longer. Much of this CO_2 is being absorbed by the ocean, where it is causing changes in the carbonate chemistry of seawater. Today, the surface oceans are supersaturated with respect to aragonite and calcite. However, the degree of supersaturation is declining, and the saturation horizons are migrating toward the ocean surface. The fundamental chemistry of human-induced ocean acidification is well understood but we are unable to predict how marine organisms will be able to adapt to ocean chemistry changes. The most optimistic view is that for organisms with short generation times, micro-evolutionary adaptation could be rapid and that species adversely affected by high CO_2 could be replaced by more CO_2-tolerant strains or species, with minimal ecological impacts. The most pessimistic view is that CO_2-sensitive groups (e.g., marine calcifiers) will be unable to compete ecologically with profound ramifications up the food chain, including widespread extinctions.

The consequences of ocean acidification appear to be clearest for corals, with most studies suggesting a linear relationship between coral calcification rate and aragonite saturation state. Coccolithophores and foraminifera generally exhibit

Figure 1: Group photo of the participants at the IGBP-SCOR Workshop on "ocean acidification" in front of "Lamont Hall".