

and-effect explanation is not sufficient to tune or wiggle-match records. Scientists should first use independent chronologies to demonstrate that the records behave synchronously and there must be reason to believe the records are driven by the same mechanisms. Once such a comparison has been made, it is then permissible to tune or wiggle-match. It is recommended to

use a reasonable number of tie-points but not more than two per distinct lithological unit, as too many tie-points would cause unnatural breaks in accumulation rates.

This Spring School was a great opportunity for senior and younger scientists to meet and discuss different chronological issues. The 17 lectures and the 40 participant presentations covered a wide range

of dating techniques available for Late Quaternary archives, as well as various geographic areas. It is hoped that participants will use and circulate the information regarding best practices for constructing Late Quaternary chronologies—from sample selection in the field to publication of the results.



## A new PAGES Working Group: Arctic2k - Arctic climate during the last 2 millennia

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Climate change in the Arctic is amplified, mostly due to ice- and snow-albedo feedback effects. Warming in the Arctic has occurred at about twice the rate of the global mean, both from the 19<sup>th</sup> to 21<sup>st</sup> centuries and from the late 1960s to present (Arctic Climate Impact Assessment, 2004). This trend has further accelerated during the past decade, as evidenced both by the dramatic decrease of summer sea ice cover and increased melt rates of glaciers (e.g., Kohler et al., 2007; Comiso et al., 2008). Observed increases in Arctic river discharge and freshening of Arctic water masses are consistent with human-induced Arctic moistening (Min et al., 2008). The effects of anthropogenic warming will continue to be superimposed on natural climate variability. Unfortunately, Arctic instrumental measurements only extend back to the mid-20<sup>th</sup> century, which limits our understanding of multi-decadal and -centennial spatial and temporal natural variability in this region.



Figure 1: Drilling site at Lomonosovfonna, Svalbard.

In recent years, some high-resolution Arctic paleoclimate data have been obtained from ice cores (Figs. 1 and 2), and lake and ocean sediments. PAGES Working Group (WG) on Arctic climate during the last two millennia (Arctic2k) is a new initiative that will generate additional records and synthesize these high-resolution paleoclimate data to assess and elucidate both the tim-

ing and variability of Arctic climate change during this period. In particular, the group will contribute to regional reconstructions of the last 2 kyr, under the new PAGES Focus 2 "Regional Climate Dynamics". Forty paleoclimatologists from both the data and modeling communities, gathered for the first Arctic2k workshop at NCAR, Boulder, USA on 8 March 2008, following the 38<sup>th</sup> International Arctic Workshop at INSTAAR (5-7 March 2008).

During this one-day kick-off, workshop participants gave a preliminary overview of national and regional activities from the different paleocommunities. The future research issues for the Arctic 2k WG were discussed extensively. These included emphasizing the need to assess sensitivities and thresholds in the Arctic system, spatial and temporal modes of climate signals, persistence of anomalies, frequencies of extreme events, rates of change, and irreversibility and feedback mechanisms. Some central questions emerged:

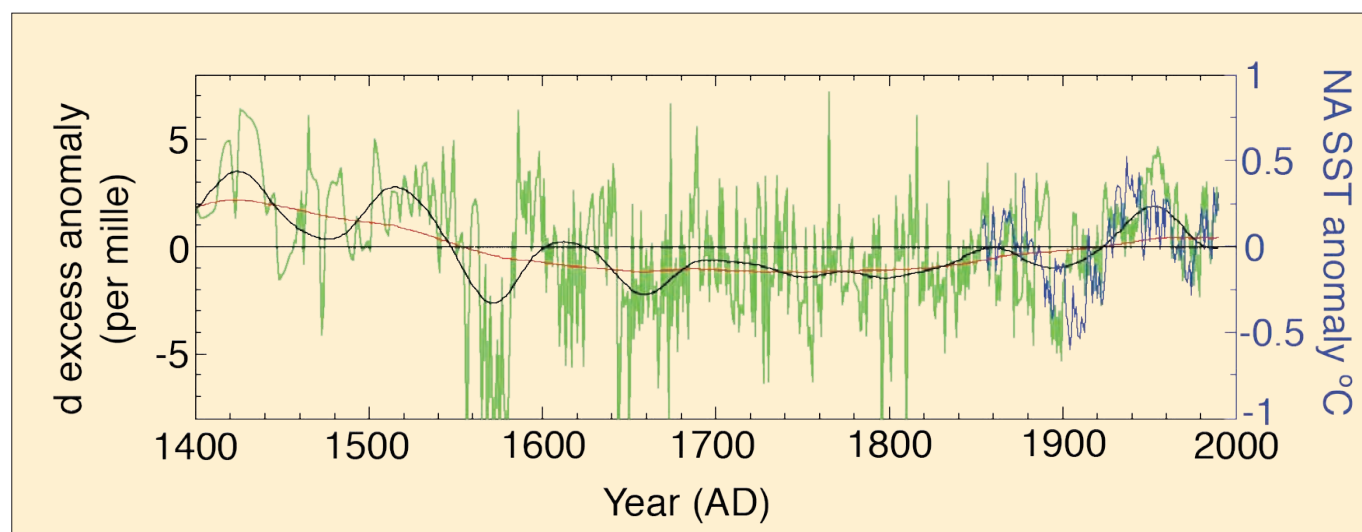


Figure 2: **Left axis:** Annual mean deuterium excess anomalies for the Lomonosovfonna ice core (green); non-linear trend (red) and non-linear trend with superimposed centennial component (black), both retrieved using Singular Spectrum Analysis. Deuterium excess ( $d = \delta D - 8 \cdot \delta^{18}O$ ) is a sensitive indicator of sea surface temperature (SST) of the area where the precipitated moisture originally evaporated. **Right axis:** Annual mean SST anomalies in mid-latitude North Atlantic between 20°-45°N (blue) (Divine et al., submitted).

a) Is the 20<sup>th</sup> century warming of the Arctic unprecedented in the last 2 kyr? b) What is the multi-decadal- to century-scale variability in Arctic climate? c) What portion of the Arctic-wide and regional temperature changes during the last 2 kyr can be explained by changes in solar irradiance and volcanic activity, and what portion is related to internal adjustments of the climate system? In addition, improvement of our confidence in the interpretation of the proxies and the geochronology were identified as important underlying goals.

The group decided to limit the study area to north of 60°N latitude, which in-

cludes Greenland, Iceland and Alaska. A website for the WG has been launched, which lists the researchers and sub-projects involved ([www.pages-igbp.org/science/arctic2k/](http://www.pages-igbp.org/science/arctic2k/)). Furthermore, a metadata-base is being developed there to assist the compilation of Arctic records. An immediate task is to map the available data and to assess regions with data gaps. The Arctic2k WG will be organizing three regional reconstruction workshops in 2009 (Scandinavia-Nordic Seas-Svalbard; Baffin Bay-Greenland-Iceland; Northern Pacific-Alaska). All paleoclimate scientists working in the Arctic with high-resolution data

and/or modeling are welcome to join and contribute to the PAGES Arctic2k WG.

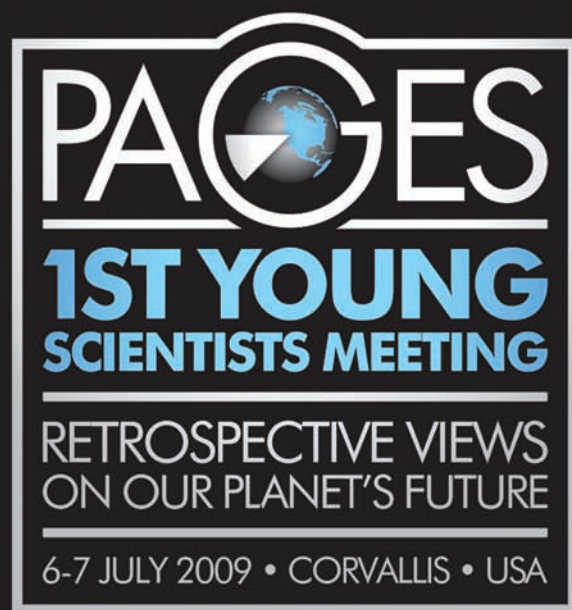
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## Oral and poster session themes:

### Climate Forcings

- Climate-Biogeochemistry Interactions
- Stability of Polar Ice Sheets & Sea Level

### Regional Climate Dynamics

- Reconstructing Climate Modes
- Regional Climate Reconstructions: Filling the Gaps

### Global-Scale Earth System Dynamics

- Origin of Interglacial Climate Variability
- The Global Hydrological Cycle & Abrupt Changes

### Past Human-Climate-Ecosystem Interactions

- Past Perspectives on Modern Human-Environment Interactions
- Land Cover, Water & Sediment: Regional & Global Synthesis

### Chronology in Paleoscience

### Proxy Development, Calibration & Validation Modeling in Paleoscience Data Management

## Hot topic discussions:

- The Role of Paleoscience in IPCC
- Past Ocean Acidification: Biogenic Impacts & Climate Feedbacks
- Transient vs. Rapid Change in the Sahara
- How Abrupt can Sea Level Rise?
- Future Directions for Paleoscience & PAGES