2009 ARCSS 8k project meeting

December 15, 4-8 PM

Pacific Room J, San Francisco Marriott

PART I: General Discussion

- Overview of project: goals and timeline
- Synthesis targets: what we need to produce and by when
- Modeling: progress and plans
- Integration with other on-going projects

BREAK (salad and sandwiches provided)

PART II: Project nitty gritty

- Lessons learned from the ARCSS 2k project
- ^{14}C procedures
- Website development; next steps; next meeting
- Individual PI plans, progress, remaining issues

Nonlinearities in the Arctic climate system during the Holocene

— ARCSS 8 ka project —

Principal Investigators

• Kaufman, Darrell - Northern Arizona University
• Abbott, Mark - University of Pittsburgh
• Axford, Yarrow - University of Colorado
• Bradley, Ray - University Massachusetts
• Briner, Jason - University of Buffalo
• Finney, Bruce - Idaho State University
• Hu, Feng Sheng - University of Illinois
• Lehman, Scott - University of Colorado
• Loso, Mike - Alaska Pacific University
• Miller, Giff - University of Colorado
• Wooller, Mat - University of Alaska
• Yu, Zecheng - Lehigh University

Postdocs, researchers, and students

• D'Andrea, Billy - University of Massachusetts
• Modeler during year 3 - to be named
• Chipman, Melissa - University of Illinois
• Schiff, Caleb - Northern Arizona University
• 10 Graduate students

Official Collaborators - Mostly international

• Anderson, Lesliegh - US Geological Survey
• Birks, John - University of Bergen
• Björck, Svante - Lund University
• Dahl, Sven Olaf - University of Bergen
• Francus, Pierre - Institut National de la Recherche Scientifique
• Froese, Duane - University of Alberta
• Geirsdóttir, Áslaug - University of Island
• Lamoureux, Scott - Queen's University
• Ojala, Antti - Geological Survey of Finland
• Thordarson, Thor - University of Edenburgh

Official Collaborators - Climate modelers

• Ammann, Caspar - National Center for Atmospheric Research
• Holland, Marika - National Center for Atmospheric Research
• Otto-Bliesner, Bette - National Center for Atmospheric Res

Other Collaborators

Lots!

Nonlinearities in the Arctic climate system during the Holocene

— ARCSS 8 ka project —

Funded by: Arctic System Science (Arctic section of OPP)

Element of U.S. Global Change Research Program

Timeline: 3 years (2010-2012)

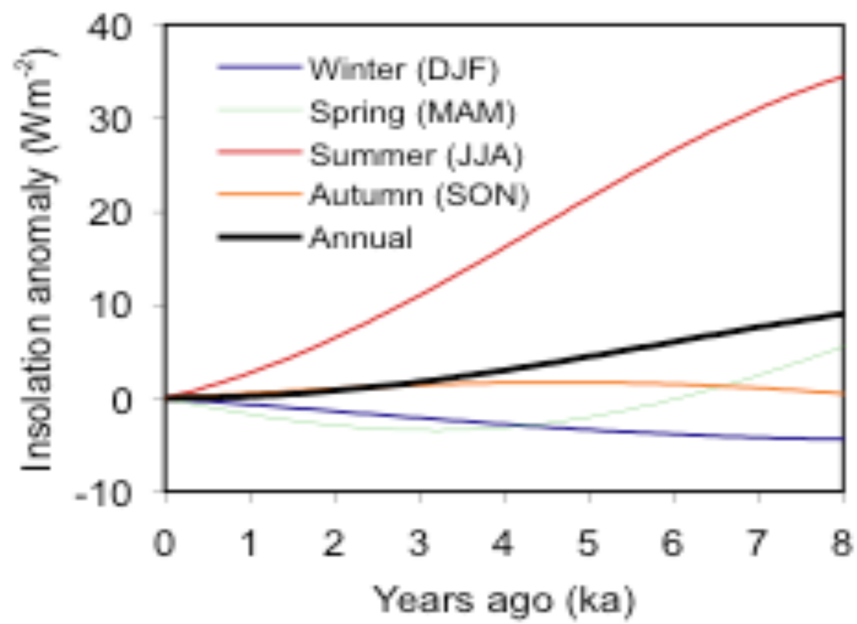
Amount: $2.2M (12 PIs)

Panel Summary: “The proposal is outstanding in every respect. The 12 PIs have been very productive and recent synthesis efforts by the PIs are especially impressive. The reviewers have not noted any problems with the research and neither has the panel.”

Hypotheses

- The steady decrease in summer sunlight during the past 8000 years led to the overall cooling of the Arctic.

- Sustained volcanism, possibly combined with low solar irradiance, and in concert with large-scale circulation changes over the Arctic, triggered the stepwise expansion of sea-ice cover and duration.



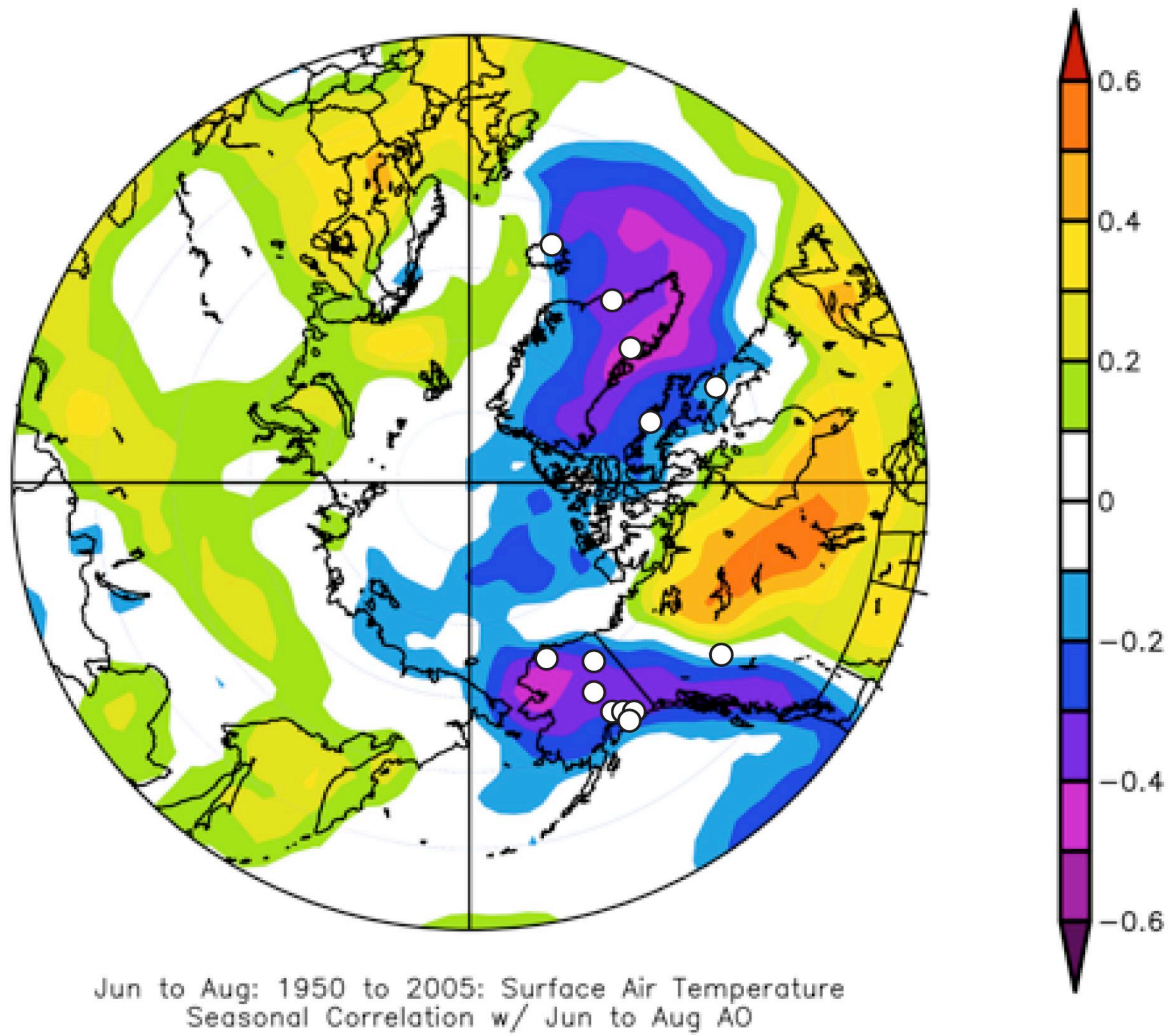
To test these hypotheses, we need to determine:

- Are step changes over the past 8 ka coherent with a “region” (climate driven), or spatially variable (catchment-specific threshold responses)?

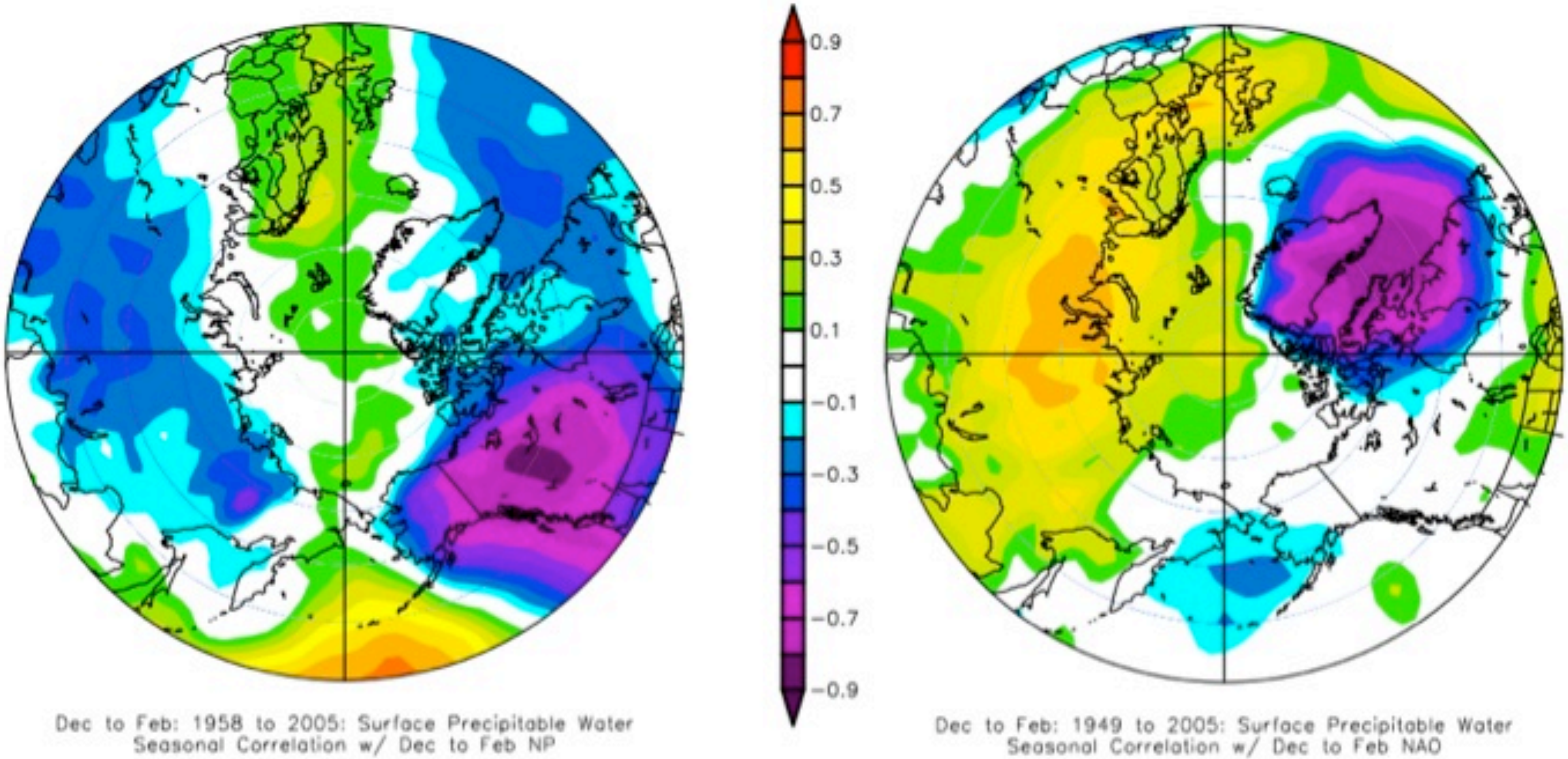
- If regionally coherent, are step changes similar in sign and magnitude between different regions of the Arctic?
    - Same sign and magnitude = possible shift in mean state
    - Different sign/magnitude = dynamical redistribution of temperature by ocean-atmosphere circulation

Correlation between the Arctic Oscillation and summer temperature

White dots = study sites



NCEP/NCAR reanalysis (1958-2003)



Winter North Pacific Index vs. Precipitation

Winter North Atlantic Oscillation vs. Precipitation

To address these questions, we will:

• Produce continuous 8000-year-long, *sub-centennially-resolved*, well-dated records of environmental change from a network of lacustrine archives.

• Derive quantitative estimates of summer temperature or hydroclimate variables across the most prominent and regionally coherent step-transitions at *decadal resolution*.

• Combine the results from the two focus regions of this project with similar time-series from the NE Atlantic (by European collaborators) to map the spatial patterns of climate transitions across the Arctic.

These results will lead to syntheses and data-model comparisons to:

- Test whether the regional pattern of Arctic system change observed in the paleo records can be simulated using plausible boundary conditions and climate forcings.

- Indentify the climate conditions, including the state of the Arctic Oscillation and extent of sea ice, that are associated with nonlinear responses in the Arctic system, and that might elicit nonlinear changes in the future.

Proxies and their temporal resolutions

Annual to sub-annual resolution

- Laminae (5)

Near-annual resolution over instrumental period
Sub-decadal over climate transitions
Sub-centennial over last 8000 years

- BSi (9)
- OM, C:N, $\delta^{13}C$ (9)
- $\delta^{18}O$: carbonate (4)
- δD: *n*-alkanoic acids (2)

Multi-decadal resolution over climate transitions
Centennial over last 8000 years

- $\delta^{18}O$: diatoms, midges (2)
- Chironomid taxa (3)
- Alkenones (?)

Step 1: Generate new records

- Need batch of new records with common targets
- Compile into an edited volume
- Deadline: Aug 31, 2011 (6-8 months review = spring 2012)
- Papers focus on proxies and geochronology
- No room for regional compilations and lengthy introductions
- Must be an original record
- Need not be the record that was originally proposed
- Datasets must be archived (publisher and WDC)

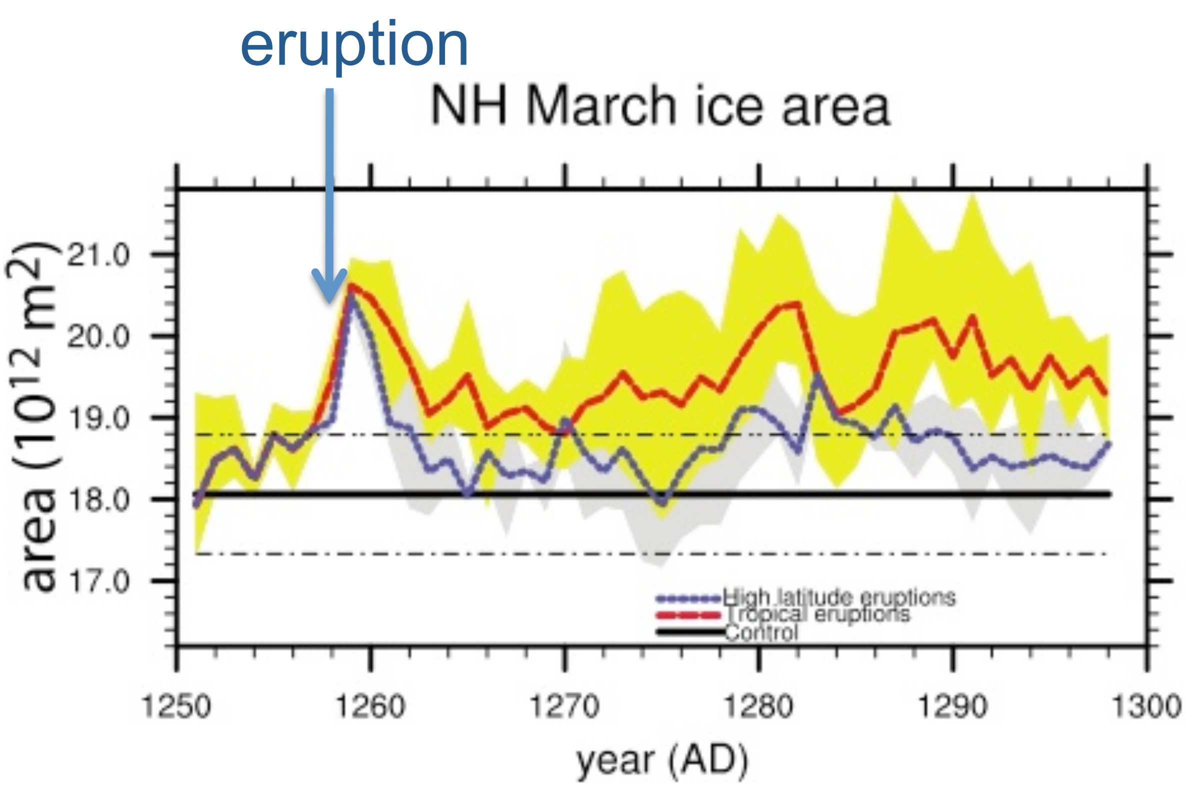
Step 2: Syntheses and model comparisons

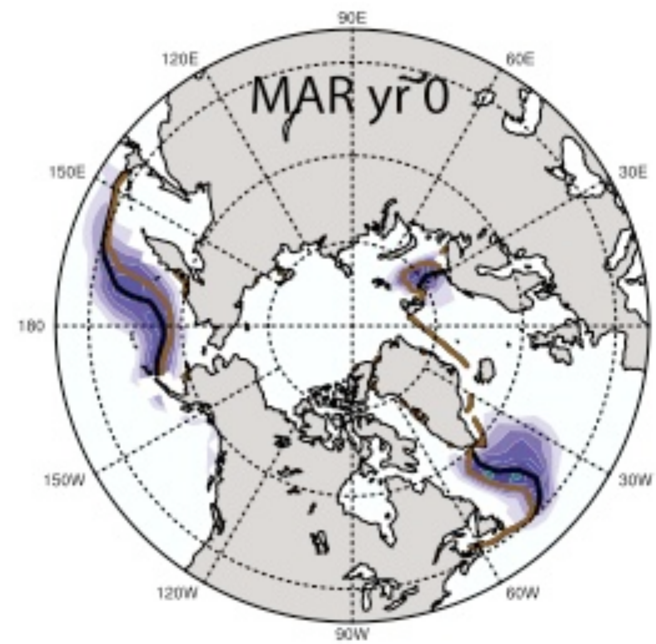
Common threads from new and existing records

- Regional summaries, including glaciers, ice & marine cores
- Proxy inter-comparisons and development
- Quantitative temperature reconstructions for target intervals
    - Holocene thermal maximum —
      warmer than last decade?
    - Onset of Neoglaciation —
      what does it take to freeze the arctic?
    - Last 2000 years —
      spatial patterns and modes of variability

Modeling: progress

• ARCSS 2k & Volcanism in the Arctic System (VAST) — Climate response to large volcanic eruptions in Community Climate System Model





Schneider et al., 2009, JGR

Modeling: in progress

• NCAR (Otto-Bliesner) — Synchronously coupled atmosphere-ocean transient simulation of climate evolution of the past 21 ka (SynTraCE-21)

Modeling: Plans

• Select a model year when the state of the AO, and the extent of sea-ice cover are most prone to nonlinear response, as indentified by the on-going modeling

• Perturb the modeled climate by specifying a change in solar irradiance and by injecting volcanic aerosols

• Compare the spatial pattern of climate change simulated by the model to the pattern reconstructed by the network of proxy records

Integration with other projects

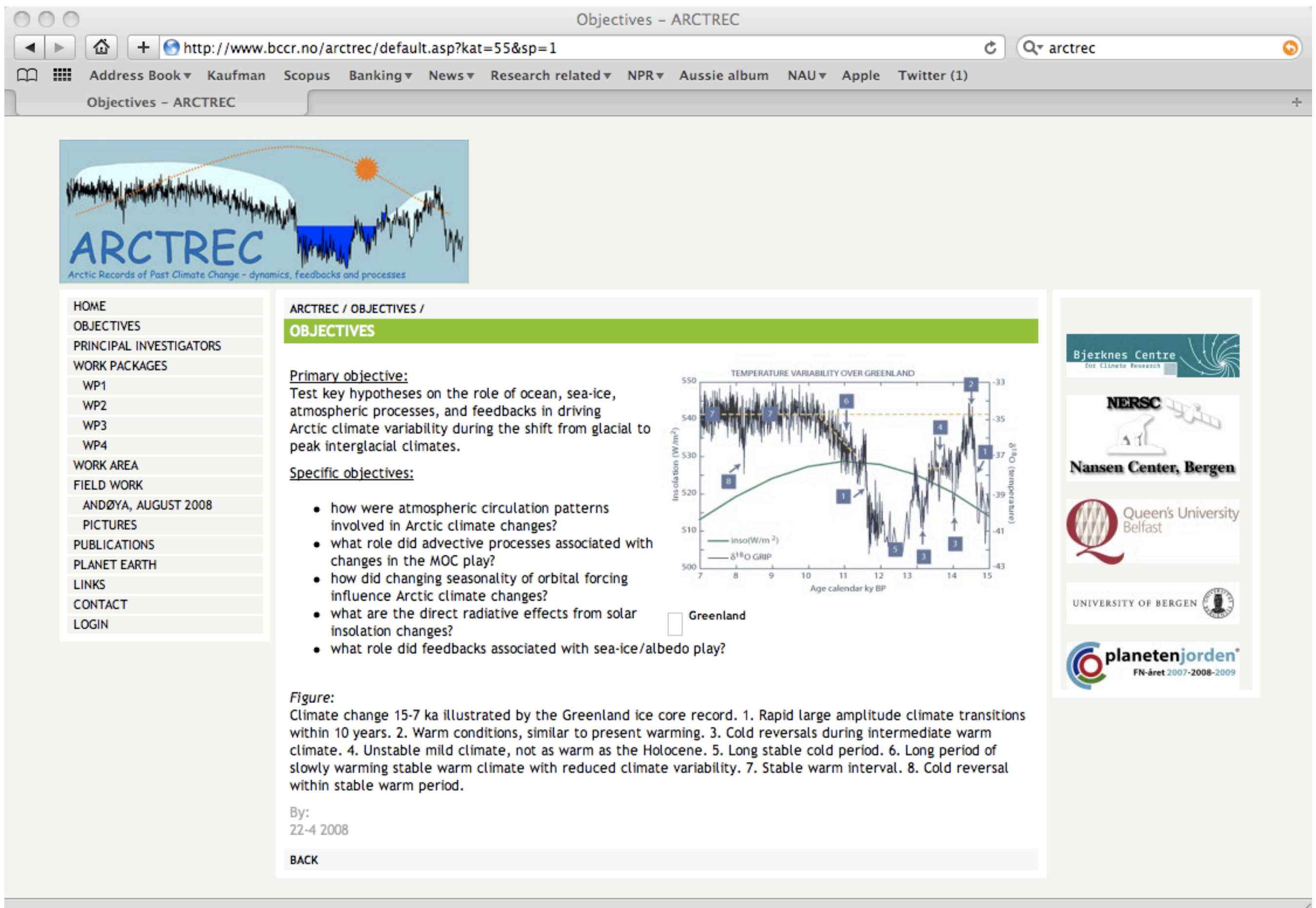
- Other NSF Arctic System Science Projects
  - Changing Seasonality in the Arctic System —
    aimed at understanding changes in the seasonal timing of events that are critical to the functioning of the system

  - Synthesis of Arctic System Science —
    focused on integrating existing data to advance our understanding of linkages, interactions, and feedbacks among components of the arctic system

  - Robock's Polar Weather Research & Forecasting (WRF) — high-resolution model for detailed evaluation of volcanic impacts on Arctic climate

Integration with other projects

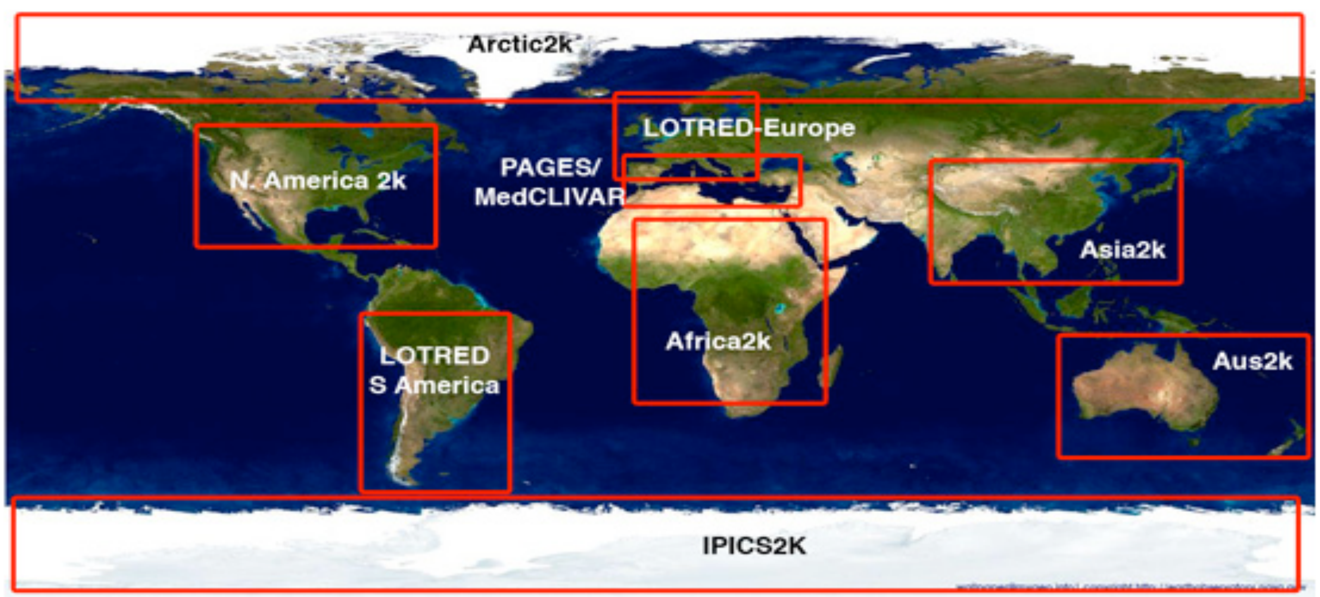
- Arctic Records of Past Climate Change (ARCTREC) — Investigate past warm and cold periods with different forcing to determine key feedbacks on Arctic climate variability



Integration with other projects

Past Global Changes (PAGES) Arctic2k

- What were the main patterns and modes of climate variability on sub-decadal to orbital timescales?
- How does climate variability relate to primary forcing factors, namely orbital, solar and volcanic?
- What feedbacks operated to modulate the climate response?



The PAGES 2k Network of regional Working Groups

Integration with other projects

- PAGES — Should we propose an “Arctic Holocene” WG?

PAGES
PAST GLOBAL CHANGES

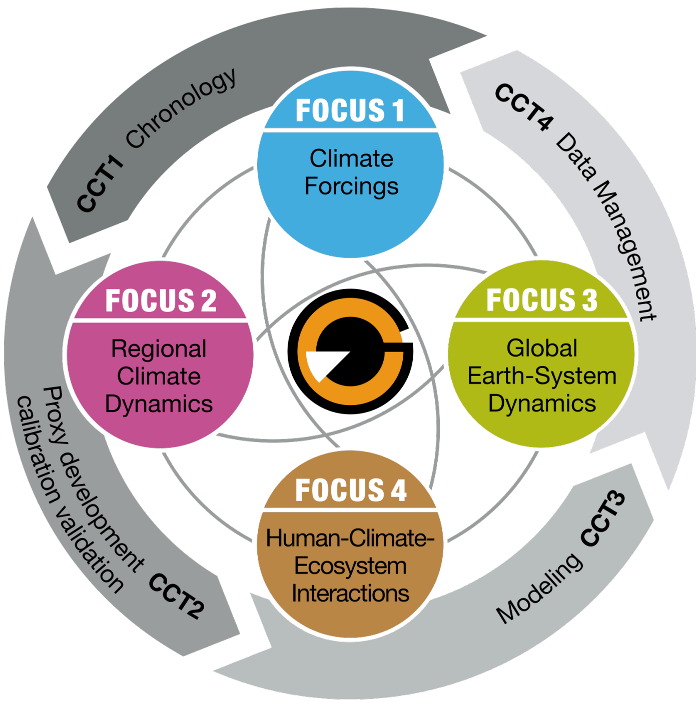
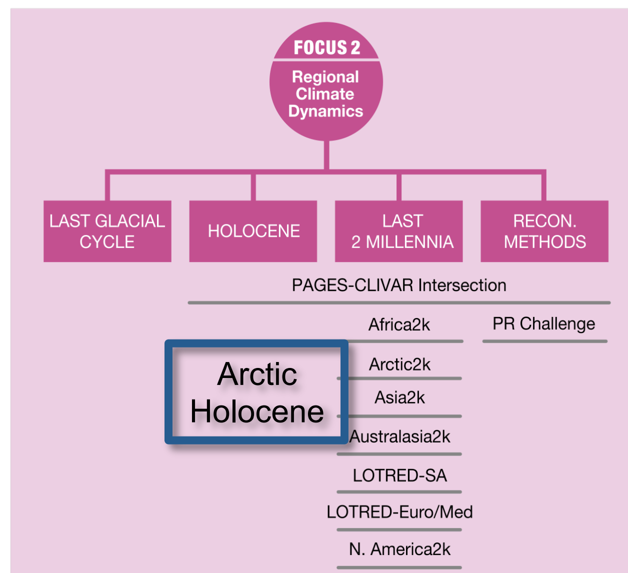


Figure 1.2: Overall structure and key elements of PAGES scientific emphasis. The four Foci are complemented by four Cross-Cutting Themes that are of relevance to all Foci.

Focus 2: Regional Climate Dynamics

This Focus seeks to achieve a better understanding of past regional climatic and environmental dynamics through comparison of reconstructions and model simulations. Activities contribute towards a global coverage of high-resolution, well-dated palaeoclimatic data, reconstructions of past climate-state parameters (e.g., temperature, precipitation, atmospheric pressure fields), a better understanding of past modes of climate variability and their teleconnections, and of rapid and extreme climate events at the regional scale. The Focus hosts activities that promote data-model comparisons and collaborates closely with Cross-Cutting Theme 2 on proxy development and calibration. The timescales covered by this Focus encompass the last 130 ka, in particular the time streams of the last glacial-interglacial cycle, the Holocene and the last 2 ka.



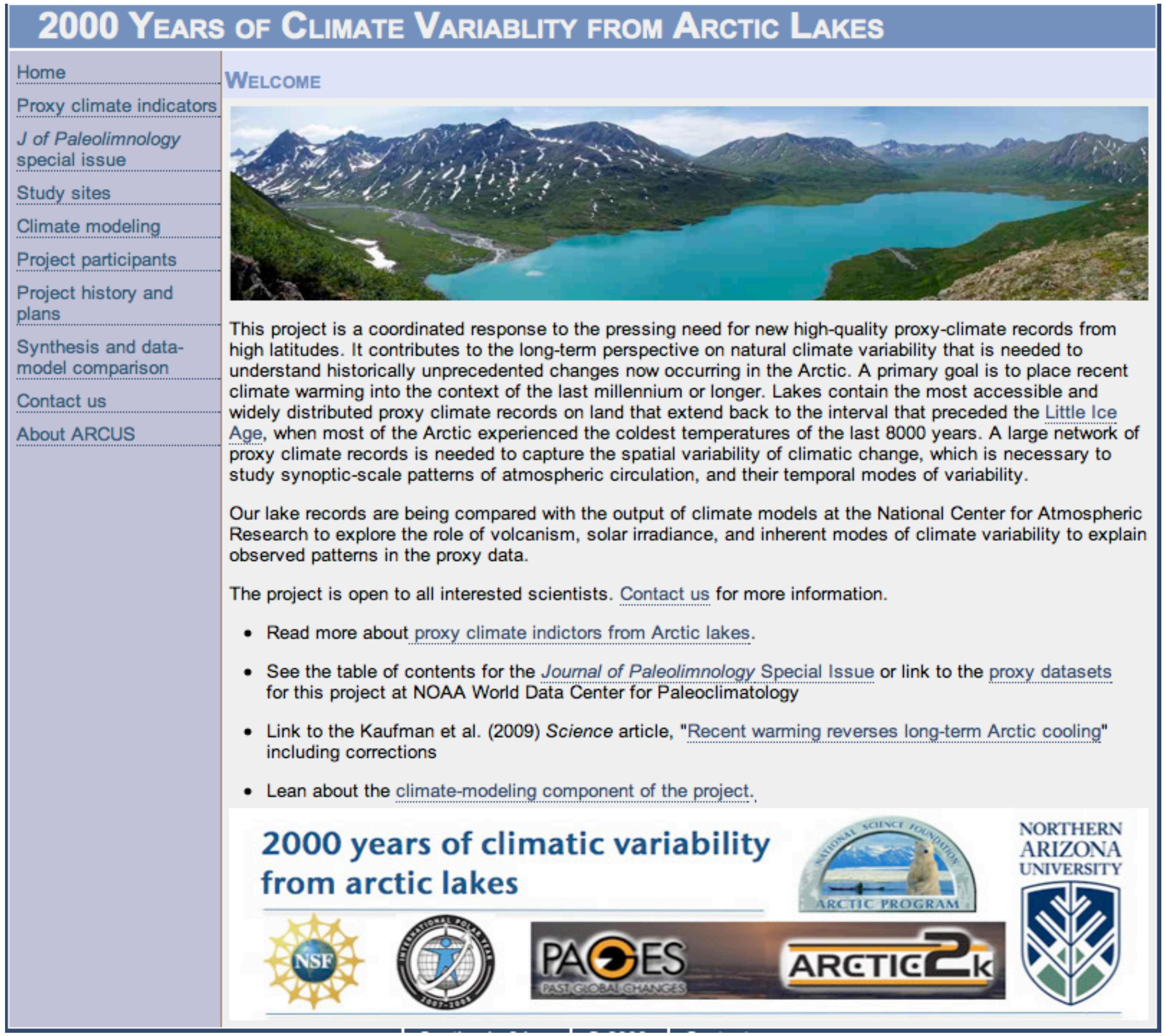
Products due by 2013

Lessons learned from ARCSS 2k Project

- 8k = 4 x 2k
- Need larger network of sites to assess spatial patterns
- Involve collaborators throughout
- Timing is everything
    - 2010: developing proxy time series
    - 2011: publish results (manuscript deadline is firm)
    - 2012: participate in syntheses; write the next proposal

Website

Need a public face — what should it be?



2000 Years of Climate Variablity from Arctic Lakes

- Home
- Proxy climate indicators
- *J of Paleolimnology* special issue
- Study sites
- Climate modeling
- Project participants
- Project history and plans
- Synthesis and data-model comparison
- Contact us
- About ARCUS

Welcome

This project is a coordinated response to the pressing need for new high-quality proxy-climate records from high latitudes. It contributes to the long-term perspective on natural climate variability that is needed to understand historically unprecedented changes now occurring in the Arctic. A primary goal is to place recent climate warming into the context of the last millennium or longer. Lakes contain the most accessible and widely distributed proxy climate records on land that extend back to the interval that preceded the Little Ice Age, when most of the Arctic experienced the coldest temperatures of the last 8000 years. A large network of proxy climate records is needed to capture the spatial variability of climatic change, which is necessary to study synoptic-scale patterns of atmospheric circulation, and their temporal modes of variability.

Our lake records are being compared with the output of climate models at the National Center for Atmospheric Research to explore the role of volcanism, solar irradiance, and inherent modes of climate variability to explain observed patterns in the proxy data.

The project is open to all interested scientists. Contact us for more information.

- Read more about proxy climate indictors from Arctic lakes.
- See the table of contents for the *Journal of Paleolimnology* Special Issue or link to the proxy datasets for this project at NOAA World Data Center for Paleoclimatology
- Link to the Kaufman et al. (2009) *Science* article, "Recent warming reverses long-term Arctic cooling" including corrections
- Lean about the climate-modeling component of the project.

2000 years of climatic variability from arctic lakes

NORTHERN ARIZONA UNIVERSITY

Next steps

Identify focus (transition) intervals

- HTM
- onset of Neoglacial: 4.2 or 3.5 ka
- last 2k

Future project meetings

- EGU 2010 (May 2-7) – Jan 18th abstract deadline
  Arctic Holocene warmth session
- AGU 2010
- INQUA 2011 (July 20-27, Bern Switzerland)
- ? 2012 for a wrap-up/synthesis meeting

^{14}C procedures

- PIs e-mail Kaufman
    - Number of samples
    - Lake name
    - AMS lab name

- Enough $ for at least 15 samples per PI
- Remaining $ distributed as needs and priorities develop
- PIs sending samples to other labs arrange billing through INSTAAR budget administrator
- Cost > $320 per sample is the responsibility of the PI
- INSTAAR Lab: samples < 0.3 mg C may take longer

PI plans, progress, and remaining issues

Lakes selected for this study, listed from west to east

Sub-region	Lake	Proxies	PI (collaborator)
Alaska	Qalluuraq	$\delta^{18}O$ in chironomids, C:N, OM	MW
Alaska	Kepler	$\delta^{18}O$ in $CaCO_3$, BSi, OM	ZY
Alaska	Mica	$\delta^{18}O$ in diatoms, δD in n-alkanoic acids	
		chironomid assemblages, BSi, OM	DK, RB, YA
Alaska	Keche	$\delta^{18}O$ in $CaCO_3$, C:N, BSi, OM	FSH
Alaska	Little Harding	$\delta^{18}O$ in $CaCO_3$, laminae, BSi	MA, BF
Alaska	Tonsina	Laminae	DK (SL)
Alaska	Iceberg	Laminae	ML
Yukon	Rantin	$\delta^{18}O$ in $CaCO_3$, laminae, BSi	MA, BF
Baffin	Foxtrap	Laminae, BSi, OM	JB, GM
Baffin	Iqaluit	Chironomid assemblages, BSi, OM	GM, YA
Greenland	Airport	Chironomid assemblages, BSi, OM	JB, YA
Greenland	Angmagssalik	δD in specific compounds, OM	RB
Iceland	Gislholtsvatn	Chironomid assemblages, BSi, OM	GM, YA (AG)