

Modes of Variability in the Arctic System Online Forum February 4–6, 2002

Implementing SEARCH science

ARCSS Planning Discussion > Implementing SEARCH science > INTRODUCTION

Post Title: INTRODUCTION

Posted by: *jamie* at 2:07 PM 2/3/2002

Background

A complex suite of significant, interrelated changes has occurred in the Arctic system in recent decades. This event is affecting every part of the Arctic environment and is having repercussions on society. It is unclear what feedback processes on climate or ecosystems may be involved in the recent changes, or what the long-term impacts may be. However, observations suggest the impact at high latitudes is substantial and the impact at mid latitudes is significant. As a shorthand we have given the name Unaami (based on the Yup'ik word for "tomorrow") to the complex of intertwined, pan-Arctic changes.

[The Study of Environmental Arctic Change \(SEARCH\)](#) has grown out of efforts originating within the National Science Foundation Arctic System Science (ARCSS) program to develop a broad, interdisciplinary, multiscale, interagency program with a core aim of understanding Unaami. The SEARCH Science Plan has been developed by the SEARCH Science Steering Committee on the basis of several community workshops. The Interagency Working Group (IWG) for SEARCH has developed an FY 2003 Funding Implementation Framework which has been submitted to the Office of Management and Budget by the Interagency Research Policy Committee. The SSC and IWG are presently working on a bridge document that brings the funding strategy and science strategy together and lays the foundation for a detailed Science Implementation Plan. The bridge document includes a skeleton or outline for the ultimate science implementation plan. A clear need has developed in this outline, knowing the modes of variability of the Arctic system.

The SEARCH organizational strategy includes three fundamental elements: observations (detection of change), modeling/analysis (understanding change), and application (responding to change). Observations are needed to track Unaami many years into the future. Modeling is required not only to understand the relationship between the changes, but in many cases to evaluate critical variables that cannot be measured directly. The application of what we learn to explaining and predicting the impact of Unaami on society is the ultimate benefit of SEARCH. A fourth element, process studies, will grow out of the other three efforts as necessary. An Arctic System Reanalysis (ASR) has been proposed in the Science Plan as a leading component of SEARCH that combines both the observational and modeling/analysis components. It is an extension of the idea of atmospheric reanalysis in that key parameters would be estimated as an optimum combination of observations and model results. This is especially important for variables that are difficult or impossible to measure at requisite scales (e.g., precipitation-evaporation and ice thickness).

Importance of the Modes of Variability

The objective of many of the initial SEARCH activities will be to learn the full scope of Unaami and how to observe it with an observing system of practical size. To do this requires knowledge of the fundamental modes of variation of the Arctic system. This is true for several reasons. Knowledge of the fundamental modes of variability aids our understanding by reducing the number of variables to a countable few. This is critical to the long-term observations. Understanding the modes of variability will allow us to track change in the system with observations at relatively few key points. Also, in many cases the reanalysis requires having a model of how natural modes interact and respond to changing forcing. This is particularly true in parts of the system such as the ocean for which measurements are sparse. With such a model limited observations can be used in an optimum way to infer the actual behavior of the modes and from these the value of parameters that may be hard or impossible to measure directly.

Thus, we envision many initial activities of SEARCH will consist of observation and modeling-analysis efforts aimed at: (1) establishing the dominant modes of variation of the Arctic system especially as part of Unaami, (2) understanding the interaction of these modes, and (3) a prototype modeling and observation system based on (1) and (2) that will allow us to track and understand the behavior of Unaami far into the future.

Current Objectives

This online forum, a precursor to the working group discussions at the 2002 ARCSS All-Hands Workshop, offers opportunities for the ARCSS research community to integrate intersecting objectives of ARCSS and SEARCH. Over the last decade the ARCSS Program has focused on understanding the responses of physical, biological, and social systems within the Arctic to global changes, and how changes in the Arctic may affect the rest of the globe. Discussions at the Workshop and from this online forum will be advisory to the SEARCH SSC and IWG in developing the SEARCH science implementation skeleton and fleshing it out into the Science Implementation Plan. Scientists from all disciplines are welcome to participate in this discussion. However, the atmospheric and cryospheric communities have already gathered for the Atmospheric and Cryospheric Change in the Arctic (ACCA) workshop to advise in development of the SEARCH implementation plan. The oceanographic community involved in the Arctic and sub-arctic Ocean Flux (ASOF) study have also gathered to plan observations in the sub-Arctic seas and at the critical gateways to the Arctic Ocean. The areas still in most critical need of advice are arguably Modes of Variability of the Arctic Ocean, Modes of Variability of the Marine Ecosystem, Modes of Variability of the Terrestrial Ecosystem

James Morison
Polar Science Center
Applied Physics Lab, University of Washington
1013 NE 40th St.
Seattle, WA 98105 USA
Phone: 206 543 1394
Fax: 206 616 3142
morison@apl.washington.edu

Post Title: Re: INTRODUCTION (jamie)
Posted by: *codispot* at 8:00 AM 2/7/2002

Hi All,

I am not sure if the INTRO is the right place for this comment, but here are a few items that I would like SEARCH to keep in mind.

- 1) The need for paleo studies, particularly of times in the last few thousand years when the Arctic appeared to be significantly warmer than it is today.
- 2) The effect of warming of the Arctic on coastal erosion.
- 3) The possible releases of methane from Arctic clathrate deposits under warming scenarios.

ARCSS Planning Discussion > Implementing SEARCH science > What are the dominant modes of variability in the marine ecosystem?

Post Title: Implenting SEARCH science in the marine ecosystem
Posted by: *jamie* at 2:02 PM 2/3/2002

Many initial activities of SEARCH will consist of observation and modeling-analysis efforts aimed at: (1) establishing the dominant modes of variation of the Arctic system especially as part of Unaami, (2) understanding the interaction of these modes, and (3) a prototype modeling and observation system based on (1) and (2) that will allow us to track and understand the behavior of Unaami far into the future.

So, for the marine ecosystems:

- 1) What are the dominant modes of variability?
- 2) How might the dominant modes of variability be determined?
- 3) Given the dominant modes of variability, what are optimum observation points?
- 4) In what cases are variations in some other part of the Arctic system likely to drive variations of a mode so far or in such a nonlinear way as to constitute a regime shift? Understanding such cases is critical to extending our knowledge of the modes of variability to explaining possible future states.

Post Title: Re: Implenting SEARCH science in the marine ecosystem (jamie)
Posted by: *jamie* at 12:29 PM 2/4/2002

Discussion Stimulus Package (Strawman)

Below, please find part of a draft skeleton for the SEARCH implementation plan dealing with observations. Hopefully, it will stimulate discussion in this thread, particularly on question 3. The term Early Phase is used to indicate that in the early portion of SEARCH these observation schemes will be instituted, modified, and made more efficient to make a system that will carry on long into the future. In terms of modes of variability, the idea is that in the early phase we take an educated guess at what the modes are, start measuring, and subsequently refine our understanding of the modes of variability so we can install a more efficient observing system as we go along. You might consider the questions in this thread in light of how you would modify this early phase observation plan. The atmospheric and cryospheric observations have already benefited from the ACCA Workshop deliberations. Hydrology is having an online forum for

CHAMP. Here we are hoping the ocean, marine ecosystem and terrestrial ecosystem threads will help develop this implementation skeleton or outline. Note that biological sampling is mentioned only once in each of terrestrial and marine observations. Is this enough? Can we explicitly include biological measurements in with the physical measurements? Or are the modes of variability too different? Or do the techniques not exist?

- Jamie Morison

2.1.1. Early Phase Observations

2.1.1.1. Examine historical data and perform paleo studies to determine the dominant modes of variability of the Arctic. These studies will examine whether the suite of dominant modes changes so as to produce fundamental regime shifts, and whether small changes in one part of the environment can produce a dramatic, non-linear change in another (e.g., ocean circulation affecting marine species composition)

2.1.1.1a. Modes of variability in the marine environment

2.1.1.1b. Modes of variability in the terrestrial environment

2.1.1.2. Early Phase field observations to track key modes of atmospheric variability

2.1.1.2a. Enhance the International Arctic Buoy Program to improve coverage of atmospheric pressure and temperature measurements, particularly for the Eurasian Basin.

2.1.1.2b. Working with the Global Climate Observing System (GCOS) program, establish quality controlled long time series available in near real time

2.1.1.2c. Establish or incorporate several complete weather stations on land (e.g., Barrow, Tiksi, Dickson, Svalbard, and Alert) and maintain two complete drifting automated weather stations in the Arctic Ocean (e.g., Beaufort Sea and North Pole regions).

2.1.1.2d. Recalibrate and update the satellite derived temperature sounding data set (TOVS Path-P) over the Arctic

2.1.1.3. Early Phase field observations to track key modes of ocean and sea ice variability

2.1.1.3a. Establish mooring arrays to monitor the Arctic Ocean exchanges (including sea ice) through Fram Strait, Barents Inflow Region, Bering Strait, and the Canadian Archipelago.

2.1.1.3b. Periodically conduct hydrographic surveys (including water sampling for nutrients, oxygen, tracers etc.) in the sub-Arctic sea regions adjacent to the critical straits.

2.1.1.3c. Establish mooring arrays to monitor key water and sea ice pathways in the Arctic Ocean (e.g., Eurasian continental slope, Lomonosov Ridge, Northwind Rise, Canada/Alaska continental slope).

2.1.1.3d. Periodically conduct hydrographic surveys (including water sampling for nutrients, oxygen, tracers etc.) across 3 or 4 key regions (e.g., Nansen-Amundsen Basins, Makarov Basin, Beaufort Sea, and Lincoln Sea-Pole).

2.1.1.3e. Maintain two complete drifting automated stations measuring upper ocean conditions, ocean heat flux, ice mass balance and atmospheric surface fluxes (2.1.1.2c) in the Arctic Ocean (e.g., Beaufort Sea and North Pole regions).

2.1.1.3f. Periodically conduct biological sampling (including water sampling for nutrients, oxygen, tracers etc.) at 3 or 4 representative sites (e.g., Nansen-Amundsen Basins, Makarov Basin, Beaufort Sea, and Lincoln Sea-Pole).

2.1.1.4. Early Phase field observations to track key modes of terrestrial variability

2.1.1.4a. Establish several snow and permafrost monitoring stations around the Arctic. Preferably a representative station will be chosen for each major drainage basin.

2.1.1.4b. Institute systematic gauging of the major rivers. This would continue past measurements, many of which have been discontinued.

2.1.1.4c. Periodically conduct biological sampling at representative land stations. These may incorporate existing observation sites such as LTER.

Post Title: Re: Implenting SEARCH science in the marine ecosystem (jamie)

Posted by: *George Hunt* at 12:12 PM 2/5/2002

Jumps in the marine ecosystem may come as a result of the timing or water temperature in which the spring bloom occurs. As the Arctic warms and more of the ice cover becomes seasonal, the system may change to allow the development of fish communities similar to those present in the northern Bering Sea, which in turn is looking more like what the SE Bering was like in the 1970s. thus, in anticipation of a more open and warmer arctic Ocean, it would be valuable to document the timing and fate of primary production. It would also be useful to develop a time series on zooplankton standing stocks in spring.

The cold polar seas are recognized as having a small biomass of fish- most of which are arctic cod. Is this because it is too cold for other species, the cold limits copepod production and thence fish production, or the season is too short for most fish species to grow to a size that gives them the energy necessary to survive the winter. Is the functional length of the growing season defined by the availability of sunlight, the amount of ice-free period, the period during which water temperature is above a threshold level or some combination of these?

The changes in the Arctic Oscillation, heat flux, and wind mixing that influence ice cover and water temperatures that are being examined are all relevant to these biological processes. If changes in the Arctic allow fish populations to grow or new species to invade, it may have interesting consequences for energy flow and elemental cycling.

Post Title: Re: Implenting SEARCH science in the marine ecosystem (jamie)

Posted by: *weingartner* at 12:40 PM 2/8/2002

SEARCH should consider how higher trophic levels respond to changes. Toward this end I'd recommend that some consideration be giving to understanding the role of arctic cod in the arctic marine ecosystem and their response to change. It is my understanding that cod play an important role in the food chain linking secondary producers to many marine mammals. They could be helpful in tracing contaminant pathways through the marine food chain, especially because the Arctic appears to be a sink for a variety of contaminants. They are endemic to the arctic and they are present throughout the arctic (as far as I know). However, very little is known about these animals. I think a cost-effective program could be established that begins to

address some of these issues. From talking to native subsistence fishermen I gather that cod are relatively easy to catch. One could imagine a pan-arctic sampling program that engages (i.e. pays for) the services of subsistence users to catch the fish, perform rudimentary but standardized measurements (size, weight, possibly other measures) and preservation for more sophisticated laboratory analyses (gut contents, contaminant analysis, body fat or other condition assessments, and genetic/molecular biological analyses). It seems to me that these fish could easily be caught throughout the arctic by coastal residents with the more sophisticated (but standardized) analyses performed at several labs distributed internationally.

As with any sampling program, biases will clearly be introduced through this sampling procedure. However, I regard these as small trade-offs when compared against the important niche these species occupy in the arctic marine ecosystem, the relative ease (low-cost) by which the sampling could be conducted, and the potential pan-arctic (coastal) coverage that could be undertaken. I suspect that such a program could be readily initiated along coastal Alaska, Canada, Norway, and possibly parts of Russia. I understand that the North Slope Borough (Barrow, AK) has a successful working relationship with Chukotka communities with respect to assessing bowhead whales in the western Arctic. Conceivably this relationship could be expanded to incorporate the Siberian coast of the Chukchi Sea.

Understand that as a physical oceanographer, I have no expertise in this subject and much of what I've said is based on limited understanding. Consequently, many of these thoughts could be naive. However, I think that this issues is worthy of consideration by the fisheries biological community within the context of the SEARCH program.

ARCSS Planning Discussion > Implementing SEARCH science > What are the dominant modes of variability in the Arctic Ocean?

Post Title: Implementing SEARCH science in the Arctic Ocean
Posted by: *jamie* at 1:59 PM 2/3/2002

Many initial activities of SEARCH will consist of observation and modeling-analysis efforts aimed at: (1) establishing the dominant modes of variation of the Arctic system especially as part of Unaami, (2) understanding the interaction of these modes, and (3) a prototype modeling and observation system based on (1) and (2) that will allow us to track and understand the behavior of Unaami far into the future.

So, for the Arctic Ocean

- 1) What are the dominant modes of variability?
- 2) How might the dominant modes of variability be determined?
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Post Title: Re: Implementing SEARCH science in the Arctic Ocean (jamie)

Posted by: *jamie* at 12:28 PM 2/4/2002

Discussion Stimulus Package (Strawman)

NOTE: see identical post above, p. d-3

Post Title: Re: Implementing SEARCH science in the Arctic Ocean (jamie)

Posted by: *Mike Steele* at 4:51 PM 2/4/2002

In creating an observing system, we will probably look to models, etc to determine the "optimal" times/places to observe change. While this is a reasonable plan, I am concerned that in doing this, we might be too clever for our own good. If we narrow our focus too much, we can only observe what we already know! Observational coverage should be decent over the ENTIRE arctic, even if only with basic and relatively cheap instrumentation. After all, weather obs. were not originally taken in Iceland and Portugal in order to document the NAO.

Post Title: Re: Implementing SEARCH science in the Arctic Ocean (Mike Steele)

Posted by: *MilesMcPhee* at 9:20 AM 2/5/2002

Mike's point about using relying too heavily on models is well taken. Some of us argued (albeit unconvincingly) during SHEBA planning that our greatest ignorance was summer, and that we should concentrate resources there. The SHEBA summer was indeed interesting and taught us much, but by that time the drift was in a very complex region (oceanographically, at least), and perhaps more questions were posed than were answered (e.g. the big flush at the end of July-- was it a local or general phenomenon? how important is "summer ice growth" to the main feedback issues?). My concern regarding the SEARCH implementation is that it not exclude specific investigations (dare I say "process oriented studies?") based directly on what we have found are the main problems from programs like SHEBA and SBI. The models are not going to get it right until we get those physics right.

Post Title: Observational Bias

Posted by: *kfalkner* at 11:48 AM 2/6/2002

I'd like to echo the concerns regarding our present understanding of ocean circulation variability from another angle. From the chemical tracer point of view, much of what is considered to be "known" for all but the very local scale of the Arctic Ocean is the result of cobbling together multi-year, largely summer-early fall data sets and treating them as synoptic. The approach was not unreasonable given the difficulties of access to the Arctic and it generated a first order description of the system. However, as we attempt to move forward in the observational realm, we must remember that we have probably masked and aliased modes of variability. To the extent that tracers indicate that time-scales of change tend to increase with depth in the ocean, the bias problem is most exacerbated for the upper Arctic. So in accord with Mike's comments, I think we still have very basic questions to address regarding the nature of ocean circulation variability and we need to plan and integrate contemporaneous ocean, ice and atmospheric observations to tease out the modes of variability.

How do we address the issue? Again, from the chemical perspective, I'd like to see us push for hydrographic (including chemical and biological tracers) times series measurements at geographically distributed sections as suggested in Jamie's implementation outline. Let's attempt higher frequency tracer hydrographic sampling of the upper waters complemented with more complete sampling over the full water column at less frequent intervals. To accomplish this

effectively, can we take advantage of AUV technology coupled with moored instrumentation at these sections to develop records of both spatial and temporal variability that allow us to document variability? To address the points that Miles raised, we should select at least some of not all section locations to afford good process study potential.

How about making use of innovative sensor technologies on the drifting platforms (the new O2 sensors come to mind as one example) to get at the Lagrangian perspective for tracer hydrography of the upper water column?

As for setting these times series in the larger scale context, while we don't control the SCICEX operation, I think the SEARCH community should craft a broadly endorsed letter strongly urging the Navy to continue their full trans-Arctic XCTD sections. In addition, the community needs to develop a consensus regarding how frequently ship-based trans-Arctic full hydrographic tracer sections should be carried out. Obviously, making this discussion an international one offers the possibility of significantly leveraging efforts.

Post Title: water samples

Posted by: *wsmethie* at 7:02 PM 2/6/2002

I agree with all in that we need good observational coverage. I would like to follow up on Kelly's comments on tracers. For a number of important chemical and biological parameters, water samples are needed. Two areas of technology that would greatly enhance water sampling for SEARCH are 1) the development of a rosette system that could be used from aircraft to sample through a hole (12 " diameter) in the ice and 2) a moored water sampler to obtain time series of water samples. Both could be developed for a modest cost and would provide enough water for a suite of measurements such as tritium, CFCs, O-18, Ba, I-129, nutrients, oxygen, etc.

Post Title: Re: Implementing SEARCH science in the Arctic Ocean (jamie)

Posted by: *codisport* at 7:54 AM 2/7/2002

Hi All,

In response to Bill Smethie's comment about water samplers, I can say that there are a couple of moorable water samplers on the market already, one of which is manufactured by W.S. Ocean Systems, I believe that the company that makes "Honjo" sediment trabs also makes such an instrument, and I Kelly Falkner's team had, I believe, a water sampler of their own design on Jamie's north pole instrument suite.

Also, we have also successfully deployed W.S. Ocean Systems nutrient analyers on buoys in Chesapeake Bay and have been able to telemeter these data. Terry Whitledge has had sucessful several month long deployments in the Gulf of Alaska and the Bering Sea with W.S. Ocean Systems autonomous nutrient samplers, and I am going to talk to the company to see if they have any interest in putting devices on Jamie's North Pole instrument suite. My chief tech, Vince Kelly works

part time for W.S. Ocean Systems, so I suppose you can say that I am biased towards their instruments, but the point is that we are finally getting some good technology for autonomous water sampling and for autonomous and telemetered nutrient data.

Cheers, Lou

ARCSS Planning Discussion > Implementing SEARCH science > What are the dominant modes of variability in the terrestrial ecosystem?

Post Title: Implementing SEARCH science in terrestrial ecosystems**Posted by:** *jamie* at 2:04 PM 2/3/2002

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So, for the terrestrial ecosystem:

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Post Title: Re: Implementing SEARCH science in terrestrial ecosystems (*jamie*)**Posted by:** *jamie* at 12:24 PM 2/4/2002

Discussion Stimulus Package (Strawman)

NOTE: see identical post above, p. d-3**Post Title:** Re: Implementing SEARCH science and PARCS**Posted by:** *MacDonald* at 12:46 PM 2/5/2002

Ok - sort of touting our own horn here - but as a PARCS person I am glad to see the paleo perspective front and center on your listing of Search tasks. It seems to me that in the Arctic in particular we need to supplement the observational record with paleoenvironmental and paleoclimatic data. I think the real trick is to make sure we are as closely coordinated as possible so that the efforts we expend looking into the past are directed at the most important indicators at the most appropriate temporal resolution. Paleoclimatology can be very labor (and money) intensive. Close cooperation at this points should pay big dividends later.

ARCSS and SEARCH

ARCSS Planning Discussion > ARCSS and SEARCH > ARCSS, SEARCH and modes of variability

Post Title: Intergrating the research

Posted by: *admin* at 1:43 PM 2/3/2002

ARCSS, SEARCH and Modes of Variability

Historically the ARCSS Program has focused on the response of the Arctic system to climate change. SEARCH seeks to understand environmental change in the Arctic, particularly with respect to a complex of seemingly related, decadal-scale, large spatial scale changes in the Arctic system that has been occurring recently. SEARCH has avoided setting hard boundaries on what may be considered part of this complex and will have to examine unrelated changes in the system to understand the complex. Thus boundaries between ARCSS and SEARCH are difficult to define. Briefly stated, though, ARCSS studies the system, and SEARCH is aimed at understanding a particular response of the system.

In general, SEARCH will be looking at larger-scale and longer-term modes of variability. A major issue for both programs is how variability at various scales interact to produce change at a given place and time. For example, the weather on a particular day at Barrow will be affected somewhat by the large-scale, longer-term modes of variability, but substantially by other smaller scale, higher frequency events. Ecosystem responses are likely to be even more complicated, due to coupling among modes of variability of different time and spatial scales. For example, a small magnitude but large-scale change in ocean circulation may change water conditions beyond a certain (as yet undefined) threshold, resulting in a major ecosystem change. If the air temperature changes, the treeline may advance, but probably at a slower rate than the isotherms move.

Some potential ARCSS-type questions related to modes of variability:

What are the modes of variability of the Arctic system that are not large-scale and low frequency?

How do the modes of variability of the system at the various scales interact?

What is their relative importance for a given region?

How can we distinguish the modes of variability at different scales from our measurements?

How can we know which modes of variability at which scales affect various parts of society?

Post Title: Re: Intergrating the research (admin)

Posted by: *JOverland* at 9:36 AM 2/4/2002

One feature that we do know, is that arctic change does not always have the same spatial pattern for different variables, even on the large scale. For example a map of long term winter temperature trends does not look the same over Alaska as the projection of the AO temperature

influence over Alaska. Springtime trends are different from winter trends. What would help is some organization of the data so that each example of change is seen in the context of other changes.

Post Title: Re: Intergrating the research (JOverland)
Posted by: *Ron Lindsay* at 11:42 AM 2/5/2002

Greetings all --

I'll throw in a couple of cents worth, maybe even a nickel.

I am confused by the term "modes of variability" which seems to imply a violin string out in the the northlands some place with just a few specific free modes (eigen functions) in which it will naturally oscillate. There could, of course, be forced modes as well, but these modes are as characteristic of the forcing as of the system. Free modes might possibly have some predictive value if sufficiently understood, but the forced modes would only be known if the forcing was known. Sorting out free and forced modes and gaining any predictive skill at all from the historic record is a daunting task (i.e. I don't know how to do it). For example, a trend is a kind of strange mode of variability and is often a rather lousy predictor (ask a few Enron stock holders). Also remember that the significance of a trend is not the same as its predictive value. In one sense a trend is a mode of variability for which we have only one representation. (How many representations are needed to make it a mode of variability?) I also have a question about detecting change. Clearly the system is always changing at many different temporal and spatial scales, so designing a system to detect change makes no sense. I think Greg Flato made this point that some definable signal must be sought with some level of confidence required, and then a system might be designed to find the signal. Clearly we are a long way from knowing even if there is a particular signal to look for, much less what it might be. So I am more comfortable with the idea of "monitoring the system" than of "detecting change", but this is probably an old argument.

Now that I have that off my chest, I will mention a some modes of variability seen in the annual mean MODELED ice thickness. This came out of work done after the Search implementation plan workshop. The model is the UW TED (Thickness and Enthalpy Distributions) model (Jinlun's model) and was forced with NCEP sea level pressure and air tmperature fields for 50 years. The region of the largest variability is along the Siberian coast. The eigen functions are a little different from what Greg Holloway found with his model. The first (34% of the variance) is a big bull's eye in the central basin and says that the annual mean for this mode goes up and down in synch over a broad region. The second mode (21%) is an oscillation between the Canadian side and the Siberian side. The third (11%) is orthogonal to that with the highs/lows in the Beaufort and the Fram Strait regions. The location that is best correlated with the over all mean ice thickness is between the Pole and Canada, not where the interannual variability is largest but where it is actually quite low. (The North Pole Observatory is in a pretty good spot if only one ice thickness measurement is to be made.)

So there are a couple of examples of modes of variability from one who doesn't know quite what they mean.

Cheers,

-- Ron Lindsay

How can we integrate various types of paleo data into studies of variability in the arctic system?

ARCSS Planning Discussion > Integrating paleo data into studies of variability in the arctic system > How can we integrate various types of paleo data?

Post Title: How can we increase and integrate various types of paleo data?

Posted by: *ajensen* at 3:25 PM 2/2/2002

1. How can the pool of paleoclimate data be increased, and better integrated with data from contemporary observations?
2. Can paleo data be used to help differentiate anthropogenically-driven changes from those driven by various natural processes, cyclical or otherwise?
3. How can archaeological studies be integrated with other types of paleo- (botanical, bio-geographic, climatic, etc.) research?
4. What can we learn about human responses to climate change, sustainable or otherwise, and how can we best use this information for public education and policy purposes?

Post Title: Re: How can we increase and integrate various types of paleo data? (*ajensen*)

Posted by: *Darrell Kaufman* at 6:33 AM 2/4/2002

Of the major research imperatives set forth in the PARCS Science Plan (1999), the PARCS community has recently identified two priorities for research during the next three to five years. The PARCS Steering Committee is presently developing plans for implementing a coordinated effort to address these topics and is looking for input from both the PARCS community and from other ARCSS researchers. We are seeking input on how to most effectively integrate paleoscience into the research of other ARCSS components and new initiatives. The two focused priorities for PARCS research are:

(1) High-frequency climatic variability

PARCS intends to contribute to an understanding the temporal modes of natural climatic variability in the Arctic by recovering and synthesizing a network of high-resolution (annual to decadal) paleoenvironmental records. This network will include ice cores, tree rings, and lake and marine sediment cores that span at least 1000 years and extend through the 20th century. It will be used to address questions such as the impact, periodicity and persistence of oscillations inherent to the Arctic and global climate system. Patterns of climatic change will be reconstructed at a variety of temporal scales and will be compared to the known patterns of historically documented oscillations (e.g., AO, NAO, ENSO) to elucidate possible driving mechanisms and longer-term behavior of the arctic climate system. PARCS intends to improve the spatial resolution of high-quality and high-resolution paleoclimate records over areas where data are sparse or where a denser network of sites is needed to capture sub-regional-scale heterogeneity. PARCS will facilitate the compilation of this information into arctic-wide synthesis that illustrates the spatial variability of climatic change. The spatial reconstructions will use the PARCS paleoenvironmental Atlas as a vehicle for uniform data synthesis. The goal is to document and understand the major controls on spatial heterogeneity of decadal to centennial climatic change in the Arctic at scales ranging from circum-arctic (in conjunction with the

international effort of the Circumarctic Paleoenvironments (CAPE) consortium) to sub-regional (with emphasis on Beringia and the northwestern North Atlantic regions).

(2) Warm climates and their consequences

PARCS intends to contribute to an understanding of a warmer Arctic by describing the state of marine, terrestrial, and biological systems during periods when the Arctic shifted toward and experienced warmer conditions in the past. PARCS will focus on three well-known periods of warmer-than-present conditions: (a) intervals during the last two millennia; (b) other warm intervals of the current interglacial period, and (c) the last interglaciation. Not only is the arctic system sensitive to climatic change, it can instigate strong feedbacks to other parts of the Earth system. Important, non-linear feedbacks driven by changes in oceanic circulation, seasonal snow, sea ice, and vegetation cover are known to amplify warming on a hemispheric scale, and, in some instances, may have led to climatic surprises of global consequences. During the last interglaciation, for example, the extent of the Greenland ice sheet and Arctic Ocean sea ice is postulated to have been considerably reduced; the role that the reduced albedo played in the 2-3° C global warming during the last interglaciation (similar to that predicted for anthropogenic warming) is not known. Paleoclimate proxy data for key intervals of arctic warmth will be compared with model simulations with the goal of understanding the sensitivity of the arctic system to global warming and its feedback to the Earth system.

Post Title: Re: How can we increase and integrate various types of paleo data? (ajensen)

Posted by: rbradley at 7:21 AM 2/4/2002

Within the framework of current NSF funding structures, there is an unnecessary dichotomy between "paleo" research and contemporary research. Paleo-research can provide an essential perspective on variability of modern systems--hydrological, glaciological, biological, geomorphological and oceanographic; this is especially important in the Arctic, where instrumental observations are so short. However, to meaningfully interpret paleo data, instrumental data are needed to properly calibrate and interpret the paleo-record. Studies of modern processes, in order to better understand the paleo-record, are therefore needed. This provides a great opportunity to interface contemporary studies with paleo-studies. I think this should be a major focus of Arctic research in the future, perhaps within the framework of SEARCH.

Post Title: Re: How can we increase and integrate various types of paleo data? (ajensen)

Posted by: JBischof at 9:36 AM 2/4/2002

Anne, your first question can be easily answered: The pool of paleo-information can be increased if such science is receiving funding. It's that simple.

In my opinion, we must first have a profound understanding of the naturally occurring climate variability before we can assess any human impact. But unfortunately, any such attempts are not receiving the attention they deserve at the NSF level, and PARCS at the moment is nothing more than a declaration of intent without financial backing. So, in my opinion it really comes down to money and the will to invest in creative research.

Another problem is that the science community seems to be hell-bent on measuring all sorts of things in the Arctic, like feeling its pulse close-up and in very much detail, but to some extent ignores the information on past climate changes already available. Consider, for example, the outcry over apparently thinning Arctic sea ice. Everyone who ever bothered to read Fritjof Nansen's "Farthest North" would know that he made very detailed measurements of ice

thickness, and that the ice at that time (1894 - 1897, long before any human impact would be felt) was not thick at all. In fact, his thickest measurement was 2.8 m. But almost 100 years later, when Global Warming could have been underway, we measured routinely 4 meters or more in the exact same region of the Arctic travelled by Nansen earlier.

In the same vein, I have written a book on climate change in the Arctic (Ice Drift, Ocean Circulation, and Climate Change, Springer-Praxis), in which you can find climate changes described back to about 1.6 million years ago. One of my conclusions is that a natural mode of cold - warm cycles in the polar regions exists, and that the cyclicity is at a period of perhaps 30 - 80 years, each time plunging Europe into a deep freeze. Of course, if no one takes note of this existing information on natural climate change and incorporates it into climate models, these models run under erroneous conditions.

I think I let this be it for the moment and come back later. This communication may sound a bit harsh, but I really think it boils down to this:

1. Rather than producing one nicely illustrated brochure after another, we have to get funding, actual dollars, to do the research
2. All Arctic researchers are kindly encouraged to study the existing literature, they may be surprised by what they can find!
3. It has never killed anybody to show an interest into other people's work
4. It also does not help to conduct Arctic research under pre-conceived ideas such as Global Warming being underway.

Hope this helps

Cheers

Jens

Post Title: Re: How can we increase and integrate various types of paleo data? (rbradley)

Posted by: *jamie* at 12:51 PM 2/4/2002

This discussion appears to be off to a hot start and very relevant to the SEARCH implementation thread, so I wonder if it would be OK to crash the party? Relevant to this thread, SEARCH considers paleo/archeological observations right along with present/future observations. The Strawman below was written to stimulate discussion of observations in the terrestrial and marine ecosystems, but you will note the paleo/slash historical observations are also in the SEARCH Implementation Skeleton (outline) as things we want right up front. As with the ecologists and physical oceanographers, we would love to hear your thoughts on the SEARCH outline relative toPaleo/Historical/Archeological Observations.

- Jamie

ps If you are unfamiliar with SEARCH, and you would like to know more, please visit our Web site: <http://psc.apl.washington.edu/search/>

Discussion Stimulus Package (Strawman)

NOTE: See identical post above, p. d-3

Post Title: Re: How can we increase and integrate various types of paleo data? (JBischof)
Posted by: *ajensen* at 12:55 PM 2/4/2002

One of the themes which seem to be emerging here, mentioned by both Jens and R. Bradley, is the lack of funding for paleo- data gathering, particularly the sort of high-res data that is needed to understand past variations in biogeography, for example. It is encouraging to see from Darrell's post that PARCS is planning to focus on this sort of data, as well as to focus on the more recent past. One great frustration to me (and many of my colleagues) as archaeologists interested in paleoeconomic questions has been the focus on time periods well before most of human occupation of the Americas, as well as a focus on lower res data and phenomena with longer periods. One or two "bad" years can make a huge difference for small populations in tough areas, and if you can't see them, you can't incorporate them in models or explanations. Jens points out that PARCS doesn't really have any money.

It would seem that one task of the upcoming meetings should be to attempt to change that. After all, it will take a very long time to get a handle on the range of climatic variation, and decadal to century scale oscillations if we only look at data for 1970 or so and forward! Not to mention, if there is some kind of anthropogenic forcing occurring now, teasing the causes and effects out will be that much more complicated.

Post Title: Re: How can we increase and integrate various types of paleo data? (jamie)
Posted by: *ajensen* at 2:13 PM 2/4/2002

Feel free to hop right in.

It seems to me that biological monitoring needs to include explicit attention to larger species of animals (the sorts that may not be captured by marine or terrestrial sampling programs.) This does not mean that NSF needs to fund lots of marine mammal surveys or what have you, since a great deal of that sort of data is collected by various government agencies with management responsibilities, but that ways to put that data into a format useful for paleoclimatic/climatic research, and possibly a few supplemental programs for species or areas that fall through cracks, would need to be supported in order for people to make use of this mass of publically-funded data for research purposes.

The explicit inclusion of archaeology (and paleo research in general) in SEARCH is very promising. As Jens mentioned above, it needs to be funded to really get anywhere. Funding for Arctic archaeology through the general NSF Social and Behavioral Sciences directorate has always been very difficult, due to the enormous logistic costs of working the Arctic versus say, Arizona. OPP and Arctic Social Sciences is better, but still pretty limited, since they have a relatively small pot of money, and other disciplines with lower field costs tend to feel they aren't getting their share of the pie. In either case, though, projects are often cut to the bare bones (\$10/day/person food budgets and housing in Barrow under Dave Nortons' dining room table versus Ilisagvik meal cards (\$43/day) and rooms at the NARL hotel for people funded under other programs), and what might be called "ancillary studies" - e.g. palynology, coastal geomorphology, paleobotanical, C14 for anything but dating, paleobiogeographical - are hard to justify within a social science framework and tight budgets, so they often wind up being cut or postponed indefinitely.

Post Title: Re: How can we increase and integrate various types of paleo data? (ajensen)
Posted by: *jamie* at 4:57 PM 2/4/2002

Yes, Jim Overland has been uncovering a great deal of large animal and fisheries time series data gathered by the mission oriented agencies. Because they are time series for huntable/fishable size critters, it seems like they would mesh nicely with archeological and local historical records.

Post Title: Re: How can we increase and integrate various types of paleo data? (ajensen)
Posted by: *ddarby* at 9:19 AM 2/5/2002

Both Ray and Jens have hit upon the lack of funding for paleoclimate studies in the Arctic and I would like to add that the one area that is critical to paleoclimatology in the marine realm is the availability of high resolution (high sedimentation rates) cores in the Arctic Ocean where 1cm per kyr is the norm. Now that the Germans and more recently, our SBI group has shown that high resolution sediment cores can be obtained - mainly from the upper continental slopes and parts of the shelves - a major effort is needed to obtain many new high resolution cores from all parts of the Arctic Ocean.

Post Title: Re: How can we increase and integrate various types of paleo data? (ddarby)
Posted by: *ajensen* at 11:59 AM 2/5/2002

There seems to be a pretty general consensus that more funding would be good, and that paleo-data should be intergrated with current observations. So, the next step is to figure out how to get there. There seem to be several questions related to that.

1) What is the scientific justification for the increase funding and inclusion of paleo-data? We seem to be in general agreement, but not everyone in the Arctic research community is. (Check some of the other threads in this forum if you aren't convinced.) It seems to us that an alteration in the status quo (paleo-data relatively poorly funded within ARCSS, archaeology excluded from HARC, etc.) to something else would result in better science. Why and how?

2) In practical terms, how do we bring about more intergrated/interdisciplinary work? Certainly getting the funding barriers removed will help. However, from my vantage point in Barrow, where there is a good bit of research of various sorts going on, there is a definite problem in communication across disciplinary boundaries. Researchers are often completely unaware of research with a direct bearing on their own project being carried out by people in another discipline (not to mention the academic/agency/industry divides). This is coupled with the very limited use of traditional knowledge which can be invaluable in research design and practical execution. Taken together, it seems to result in a lot of reinventing the wheel and collection of similar data over and over again. Given limited science dollars & human resources, this would seem to be a bad thing. What mechanisms might be useful in changing this situation? How can interdisciplinary groups be fostered?

Post Title: Re: How can we increase and integrate various types of paleo data? (ajensen)
Posted by: *Henry Huntington* at 12:28 PM 2/5/2002

Getting more funding for whatever branch of research is one way to get more activity, but a critical question is how that money is spent. There is a tendency to be conservative--to fund what is known and familiar, the results of which can thus be anticipated with some degree of confidence. Far more difficult is to get funding for projects that try new things, that take the risk

of producing nothing in the hopes of making a breakthrough, etc. This seems to be a real problem with interdisciplinary work, where new approaches are required for which there is not a track record to establish the likelihood of success. Furthermore, there is an emphasis on "more research" rather than synthesis and analysis. We go through planning exercises, develop prospectuses for various initiatives, and spend time at all-hands meetings looking to the future, but not reviewing what we've learned and trying to make links between various projects, initiatives, and fields. It's hard to break out of your own area if you don't have the time and freedom to explore new areas and to spend time with those in other disciplines bouncing ideas around, etc. The successful interdisciplinary projects seem to have invested the time to learn from each other, and the lessons from these experiences should be applied elsewhere (as Anne says, why invent the wheel each time we try this?).

I'm not sure what mechanism would work best, but a forum in which we could learn from one another instead of jockeying for position in the next funding cycle would be very useful. One of the most interesting meetings I've been to was the "cross-fertilization" meeting held by the Arctic Monitoring and Assessment Program in Winnipeg in April 1996. The various chapter teams (POPs, heavy metals, radioactivity, human health, etc.) met individually, and then sequentially with every other team to share ideas, conclusions, etc. It sounded hokey beforehand, but turned out to be hugely informative, stimulating, and worthwhile. It's not easy, it takes time, it's costly, you have to talk with a bunch of people who don't know much about your field, but in the end the investment can be highly worthwhile.

Post Title: Re: How can we increase and integrate various types of paleo data? (ajensen)
Posted by: *Robie Macdonald* at 11:58 AM 2/8/2002

I'd like to hop in on the biological monitoring question. As noted, marine mammals and other components of the biological system have been collected for contaminant surveys for quite some time. However, it's pretty clear that biological systems are not just a collection of components. In fact, they are structures that can be altered in many ways such that a single observation of a component selected out of the system might provide information easily misinterpreted. Specifically, we could envision change in the arctic ocean being organized by altered stratification (runoff/ice melt redistribution) or altered coastal upwelling (cyclonic or anticyclonic wind set based on the Arctic Oscillation), or change in ice climate. Change could be witnessed in such cases as altered trophism low down in the food web (so-called bottom up FX) or altered trophism at the top of the food web (top down FX). We've got recent examples of both kinds of FX- eg diatoms vs flagellates or pelagic vs benthic coupling in Bering and Beaufort Seas, and polar bears in Hudson Bay or seals in the Beaufort Sea. The point is, we need to monitor the biological system as a structure and not a loose collection of components valued for their economic or aesthetic benefits.

High priority research for society

ARCSS Planning Discussion > High priority research for society > Modes research priorities

Post Title: Modes research priorities

Posted by: *Jack Kruse* at 1:26 PM 2/4/2002

What research about variability in the arctic system is of the highest priority for policy and decision makers who must cope with the impacts of future arctic/global climate change?

How can we best apply our current understanding of the various modes of variability to help society?

Post Title: Re: Modes research priorities (Jack Kruse)

Posted by: *Jim Maslanik* at 7:54 PM 2/5/2002

I wonder how common it is that there is a fairly sharp distinction between the information needs of the "western society" elements of Arctic communities, versus the types of information that indigenous residents might find most valuable. For example, local government agencies may be most concerned with issues such as floodplain development or wetland impacts, while other groups may have more interest in effects of climate variability on subsistence hunting. This complicates the process of determining how best to contribute to a community's information needs and can lead to some misconceptions depending on who is providing the community feedback.

Post Title: Re: Modes research priorities (Jim Maslanik)

Posted by: *ajensen* at 11:45 AM 2/6/2002

There is certainly a distinction, which makes it vitally important to involve not only local government reps but also Elders in research design and implementation. In most cases, though, the local government people are also involved in subsistence themselves, even if only on weekends. Villages tend to consider both aspects of importance.

For example, Shismaref is on an eroding barrier island. Many houses have already had to be moved, and the community is resigned to the fact that the whole thing will need to move. Given this, infrastructure improvements (water/sewer, new school, etc.) have been postponed and the funds held until a new site is selected. However, no suitable site has been found. The sites which aren't in danger of erosion and meet engineering criteria for stability of ground, etc. so far have all had real problems with subsistence access, and have therefore been rejected on that basis. All the alternate sites which have reasonable subsistence access have been rejected on engineering grounds. There are one or two of them which are technically feasible, but the cost per resident would be astronomical and even Ted Stevens doesn't think he can get Congress to swallow it.

Post Title: Re: Modes research priorities (ajensen)

Posted by: *Matt Berman* at 6:00 PM 2/6/2002

Jack Kruse's introduction and this ensuing discussion makes me wonder whether the Arctic system as defined in ARCSS planning includes an Arctic human system? Human institutions

(including culture here as a type of institution) mediate the effects of climate and associated ecosystem variability on people. These institutions are not constant over time and adapt to change. If there is an Arctic human system, then what is it, and can we describe the way it responds to natural variability to cause impacts on people?

The Arctic human system surely includes the resident indigenous people of the Arctic. But these indigenous people make their living in mixed economies that are dependent on world markets for resources, visitors to the Arctic, national government programs, etc. One could perhaps describe the Arctic human system as a neo-colonial, or post-colonial system with variations across North America and Eurasia. However we define it, this human system is what determines the effects on people of natural variability. The human dimensions of any given climate-driven geophysical or ecological effect may be large or trivial depending on how the human system responds.

The dilemma the residents of Shishmaref face, for example, is one brought about at least in part by federal and state money and governance. It will be resolved by asking federal and state taxpayers to pay to relocate the community relocate, after public funds for erosion control are no longer sufficient. The fact that the Arctic National Wildlife Refuge is an area of international environmental concern has little to do with the aspirations local residents. In both these cases, the effects of climate variation on people depend on how the complex local, regional, and national institutions and cultures of the Arctic human system respond to uncertainty and change. We know relatively little about how these institutions are likely to respond to the specific types of changes that might be predicted by climate-driven hydrological, and ecosystem models. This should be a high priority for research that aspires to include human dimensions of Arctic environmental change.

Post Title: Re: Modes research priorities (Matt Berman)

Posted by: *ajensen* at 10:54 AM 2/7/2002

The question as to how humans fit into the Arctic system as seen by ARCSS is a good one. Currently, there is a component of ARCSS, HARC, which is concerned with the human dimensions of change, but only in a current and future sense. There is no room to look at those issues in the past. Since the existing Arctic system, in an ecological sense, developed with a human component, this would seem to be a significant gap. SEARCH does plan to include the human dimension through time.

As far as prediction, I am a little dubious. Even short-term weather prediction doesn't work all that well, and the system is far simpler. But exploration of possible scenarios of change, in a context of knowledge of past changes and their outcomes, might be a very helpful thing for people when significant changes come.

Post Title: Re: Modes research priorities (ajensen)

Posted by: *Henry Huntington* at 4:35 PM 2/8/2002

I'm intrigued by Matt's question. Although I share Anne's skepticism about prediction, I wonder if we've given enough attention to the role of institutions and their response to environmental inputs and changes. It might be instructive to do so--either we'll find out that there isn't much connection (or that it doesn't readily conform to any kind of useful pattern), or that in fact there are patterns and lessons we can make use of. In other words, how large is the human dimension of the Arctic system (i.e., how strong is the environmental-human connection), and how can we go about characterizing and studying it? There is more to it than institutions, of

course, but they're an important element. I'm sure the answer to the question varies greatly by time, place, and aspect of human society, but I think we could do more to understand this empirically rather than by gut instinct, which is how it seems to me it's often done with regard to the human component of the Arctic system.

As for HARC, it's a great place to do this kind of thing. And HARC doesn't necessarily exclude the past--I think we need to explore the ways in which HARC can benefit from using the past as part of our comparative case study pool. The problem is how to apply results from a time that was in some respects very different from the present--perhaps another HARC on-line workshop exploring this topic???

Post Title: Re: Modes research priorities (Henry Huntington)

Posted by: *ajensen* at 4:45 PM 2/10/2002

I agree that more attention needs to be paid to the role of institutions as they have assumed more importance as the North becomes more integrated into the modern world-system. However, this seems to have been driven largely by the desires of people from the south to exploit resources found in the North. One frequently expressed concern of Elders on the North Slope is the urgency for young people to learn the old ways of surviving, so that they will be ready when the oil is gone and the Inupiat are left to their own resources. It is important not to succumb to a sense of historical inevitability of ever-increasing integration of remote parts of the world. Just look at the current situation in Chukotka.

As to HARC and the past, while archaeology certainly is not precluded in the science plan, as a practical matter, it is very low priority for funding as far as we can see. Two quotes from the 1999 program announcement: "HARC research will focus exclusively on current and potential impacts on human activity that may be expected to occur in response to global change" and "Research projects that (1) illuminate the present and future role of humans in the arctic system; (2) focus on the development of predictive capabilities; and (3) build upon the existing body of ARCSS research will be considered high priority." The phrases "focus exclusively on current and potential" and "present and futurewill be considered high priority" don't encourage anyone to spend time writing a proposal that doesn't look like it fits the program's priorities well enough to get funded. Perhaps this just needs to be rewritten so it doesn't discourage archaeologists, since many other funding sources are less suited for interdisciplinary work due to their own priorities.

Post Title: Re: Arctic ozone hole

Posted by: *codisport* at 1:50 PM 2/11/2002

In going over some recent literature in preparation for our AHM, I came across a comment in Science suggesting that recent decreases in halogenated gas emissions to the atmosphere may be overwhelmed by a cooling stratosphere arising from greenhouse gases and by increases in stratospheric water vapor.

"Over the next few decades, changes in stratospheric temperature and water vapor could overwhelm reductions in chlorine and bromine".

This article goes on to say:

"To follow how stratospheric ozone is coping with all its stresses, keep your eye on the Arctic. Each spring the mix of chemicals, water vapor and temperature has been depleting ozone until a full-fledged ozone hole, approaching the one that forms over the Antarctic now threatens to emerge.

The Arctic is sitting right on this cusp. The next decade should tell."

This snippet is by Kerr who quotes a paper by Anderson, and it appears in Science, Vol. 291, 19 January 2001.

To date ARCSS programs do not appear to have put much focus on the "ozone hole" issue.

What's missing in this discussion?

ARCSS Planning Discussion > What important questions haven't been posed here? > What's missing?

Post Title: What's missing?

Posted by: *Wendy Warnick* at 1:40 PM 2/4/2002

What pressing questions about modes of variability in the Arctic system are not being discussed here?

Post Title: Re: What's missing? (Wendy Warnick)

Posted by: *Robie Macdonald* at 11:06 AM 2/8/2002

We've all focussed on the Arctic Oscillation or its sister the NAO in the attempt to sort out recent change in the Arctic and what forces it. It has been pointed out that the AO carries only about 20% of the variance of the system. That seems to me to be a very small amount - so, what else is going on that the AO does not organize?

Post Title: Re: What's missing? (Wendy Warnick)

Posted by: *tomdelworth* at 4:40 AM 2/13/2002

One issue missing from the discussion is the influence of lower latitudes on high latitude modes of variability. Recent work has suggested that long term changes in tropical sea surface temperature may be a very important driving force in long term trends in mid to high latitude atmospheric circulation. Therefore, while the focus of much of the discussion is on Arctic issues, the connections with lower latitudes are essential (both atmospheric and oceanic).

To the extent that tropical sea surface temperatures may impact Arctic modes of variability, an intriguing question is what are the feedbacks from the Arctic to the tropics.