Testimony before the U.S. Ocean Commission

Arctic Science and Investment

Robert C. Spindel

Director, Applied Physics Laboratory
University of Washington
Seattle, Washington 98105

June 14, 2002

Admiral Watkins and Commissioners, thank you for giving me the opportunity to speak to you this morning.

I am the Director of the Applied Physics Laboratory of the University of Washington. My testimony concerns scientific research and development related to the Arctic Ocean and its marginal and adjacent seas. My Laboratory and the University of Washington have a long and distinguished history of scientific research and technology development relevant to the marine environment of the Arctic.

First, I'd like to draw your attention to a polar projection chart of the Arctic. The Arctic Ocean is hardly visible on most common map projections, such as a Mercator projection, and sometimes not even shown at all, so I think it is helpful to be reminded of its geography. It is mostly ice-covered. It is dark for nearly six months of the year, and it is the least explored ocean in the world. It is a sensitive, poorly understood eco-system. Yet it is absolutely key to the delicate heat balance of the Earth, and is ringed by mighty nations who for decades used it as a base for strategic military and economic purposes.

Two profound changes have occurred in the Arctic in the last decade, and it is important for you to understand them in order to assess the kind of research that needs to be done, and to recommend what resources need to be invested.

First there are the well-publicized environmental changes---changes in ice cover, shifts in water masses, and movements of atmospheric patterns--- that have lead to speculation about much more consequential climate changes. This is the number one problem, the role of the Arctic marine environment in climate variability and climate change. The Arctic is recognized as both a link in global climate, and as a sensitive indicator of climate change. The short story is that we see changes, and we know they are important, but we do not fully understand their causes and consequences. They may only be part of an innocuous natural cycle with little long-term effect, or they may be the bell weather of processes that can upset the stability of the entire Earth system. Whichever it is, we can't afford leave the question unanswered.

Second, there are the geopolitical changes that came with the end of the Cold War. Navy underice operations have all but ceased, and Navy Arctic research has practically ended. The large investments made by the Navies of the United States and the Soviet Union to understand the Arctic Ocean have dwindled to zero. Soviet research that was once

motivated by economic interest in the Northern Sea Route and resource development has also ceased. Whatever the motivation, the U. S. and Soviet efforts constituted practically all the research done in the Arctic for the last fifty years. It was an investment in sustained, long-term observations, the kind we desperately need today to sort out the environmental changes we see. But with the military imperative gone, so are our long-term Arctic observations.

How has the Arctic Ocean changed, and why should we worry about it?

The influence of water from the Atlantic is becoming more widespread and intense. Data collected during several cruises in 1993–1995 indicate that in the upper ocean the boundary between the eastern, Atlantic-derived water-types and western, Pacific-derived water types has advanced westward towards Canada. The area occupied by the eastern water is nearly 20% greater than previously observed. This water also appears to be warmer than before. Historical data from the U.S.-Russian Arctic Oceanographic Atlas show a temperature over the Lomonosov Ridge (a bathymetric feature that nearly bisects the Arctic Ocean) almost 1°C lower than today. This change in temperature and salinity—the Atlantic is saltier than the Pacific--- appears to have begun in the late 1980s, just about when we and the Russians stopped our Arctic research.

In the last 20 years there has also been an alarming reduction in ice thickness, as much as 43%, and there has been a reduction in ice extent. We believe this is due to the change in ocean circulation mentioned above which, with changes in atmospheric pressure has produced changes in sea ice drift. Ice drift and pressure fields for the 1990's are shifted counterclockwise 40°–60° from the 1979–1992 pattern. More ice is carried directly from the Beaufort Sea region north of Alaska whereas the historical pattern draws ice primarily from the central Siberian quadrant leaving ice to circulate in the Beaufort Sea gyre. The decrease in sea ice extent may or may not be a fingerprint of greenhouse warming. One thing seems certain though. Less ice means less sunlight is reflected, and more solar radiation heats the Arctic waters and the atmosphere, which melts more ice, and so on.

There are other changes. In the North Atlantic, the Greenland Sea and the Laborador Sea are where waters flowing from the equator cool, become salty and dense, and sink, driving the so-called global ocean circulation "conveyor belt". But the flow of fresh surface water and sea ice to the sub-Arctic seas has decreased and and this lowers surface salinity making the water less dense, and less apt to sink, thus inhibiting the general global ocean circulation and the transport of heat (about 10^{15} W) from the equator to high northern latitudes. Certainly if the global circulation were to be stopped entirely the consequences would be enormous. There is speculation that this could happen, and there is speculation that such circulation change is a driver for abrupt climate changes. Indeed, paleoclimate records and computer models suggest that changes in the strength of the circulation may occur rapidly, in a few decades. So if we think these changes take centuries and can be addressed leisurely, or by future generations, we could be dead wrong.

The physical changes are producing changes in the ecosystem and living resources and affecting the human population. Inhabitants of the Arctic live close to their environment and the recent changes in the marine environment are affecting their transportation,

safety, infrastructure, food gathering, and cultural practices. On a broader scale the changes are affecting economic activities such as shipping and fisheries worth billions of dollars.

The pattern of change we see in the Arctic marine environment has become apparent in the context of historical data collected prior to 1990, during the Cold War. Now, many of the operational observing programs that produced those data are gone. The extensive Russian hydrographic programs of the Cold War era have stopped. Many Russian and Canadian meteorological stations are being closed or automated. The Russian drifting ice stations which were manned continuously for decades, have been discontinued. No long-term manned U. S. ice stations are planned. The Navy has closed its Arctic Research Laboratory in Barrow. And the successful Navy submarine science cruises of the 1990s—which were highly instrumental in discovering the changes I have mentioned--have been sharply reduced. Just when we most need the data, we are no longer collecting it.

If changes in the Arctic marine environment are to be tracked and understood, we must rededicate effort to fundamental observations that continue on a regular basis, perhaps for decades into the future.

We cannot afford to continue to under sample the Arctic.

With the Navy gone, now NSF funds a large fraction of today's Arctic research. Unfortunately , the proposal-driven, project-oriented approach of NSF is not ideally suited to the long-term, sustained observation we need to track and understand the decade long changes that are occurring. Without sustained operations, dependable access disappears. Every trip is a whole new enterprise, and has to be spun up from scratch. It takes special equipment and unique expertise to work successfully and safely in the Arctic. When you deposit people on the polar icecap, you don't just drop them off. But the way things have evolved, logistics has become catch as catch can. The trend in government is towards hiring commercial support, but of course commercial support for science tends to be on a short-term contract-by-contract basis with a changing cast of characters. Just a few months ago we mounted an expedition to the pole and wound up having to rent a Russian runway from a French tour operator to land an aircraft we leased from Canadian operators. The lack of stable long-term support arrangements is a serious obstacle to programs of coherent long-term observation.

Ocean scientists have long understood that their needs are poorly met by commercial entities. As a result they have established and operated their own system of research ships, the University National Oceanographic Laboratory System, UNOLS. For Arctic research we used to have a less formal, but similar university-based system. But it is almost extinct. We're losing expertise. We're losing capability. And we're short-changing our scientists.

The Arctic is difficult to access, and expensive, and there are few Arctic-ocean capable resources available. Contrast this with the tens of thousands of ships that ply the other oceans, or satellites, which even though they only see the top millimeter of the ocean, at

least see the ocean itself, not its ice cover. With access so difficult, planning and coordination requirements take on an even more important role than they do elsewhere.

A commitment to sustained, long-term observations would begin to correct these problems. It would acquire the needed data. It would ensure the development and support of a solid logistics infrastructure. And it would spur the development of measurement and observational techniques, and platforms, for Arctic research which are now woefully less developed than those used in the temperate oceans.

There are a few other issues I would like to bring to your attention.

Within the U.S., we are presently completely dependent on the U.S. Coast Guard for ice-breaker support. There are problems with this, easily appreciated by a community accustomed to UNOLS support. There are several steps we might take to broaden the logistical base, including prioritizing the construction of the new ice-capable UNOLS vessel.

In terms of organized Arctic research, there hardly is any. While many agencies other than NSF do things in the Arctic, like NASA and NOAA, each has its own agenda, and rarely is there coordination, especially in the case of long term observations. An exception that illustrates the problem is the SEARCH program (Study of Environmental Arctic Change). In response to the perceived inadequacy of long-term observations in the Arctic, the Arctic science community is presently engaged with an interagency group (NSF, NOAA, NASA, DOD, DOE, DOI, and EPA) to develop SEARCH, a long-term program of observations, analysis and modeling to understand the changing Arctic and its impact on the ecosystem and society. Getting SEARCH going faces one anticipated challenge, obtaining funding. But it also faces the unanticipated challenge of finding a vehicle for an interagency group to pool their funding for a truly common effort. Structural features of the various funding processes at institutions and in the federal government make this difficult. The mandate of the Commission suggests it may be able to help with these kinds of interagency funding issues.

Finally, there is the issue of research access to an ocean that is subject to a bewildering set of jurisdictional claims by countries, native peoples, and other claimants. A larger fraction of the Arctic Ocean is within the 200 mile EEZ of its bordering nations than any other ocean, and this adds political complications to already complex science problems, which range from the survival of the stellar sea lion to global heating. Any future plan for Arctic Ocean research has to include a diplomatic element at an appropriately high level to ensure scientific research access.

I have tried to make several points.

> 1) The Arctic is changing. There has been an observed decrease in ice thickness and ice cover. Whether this is a harbinger of serious planetary warming, or simply a natural, cyclic variation is unknown, and disputed, although the evidence at the moment points to serious warming. **WE NEED TO UNDERSTAND WHAT IS HAPPENING IN THE ARCTIC, AND WHY.**

2) The end of the Cold War and under ice submarine operations has set our Arctic Ocean research program back a decade or more, and unless something is done about it, it will only get worse. **WE NEED TO REINVIGORATE OUR ARCTIC OCEAN RESEARCH PROGRAM.**

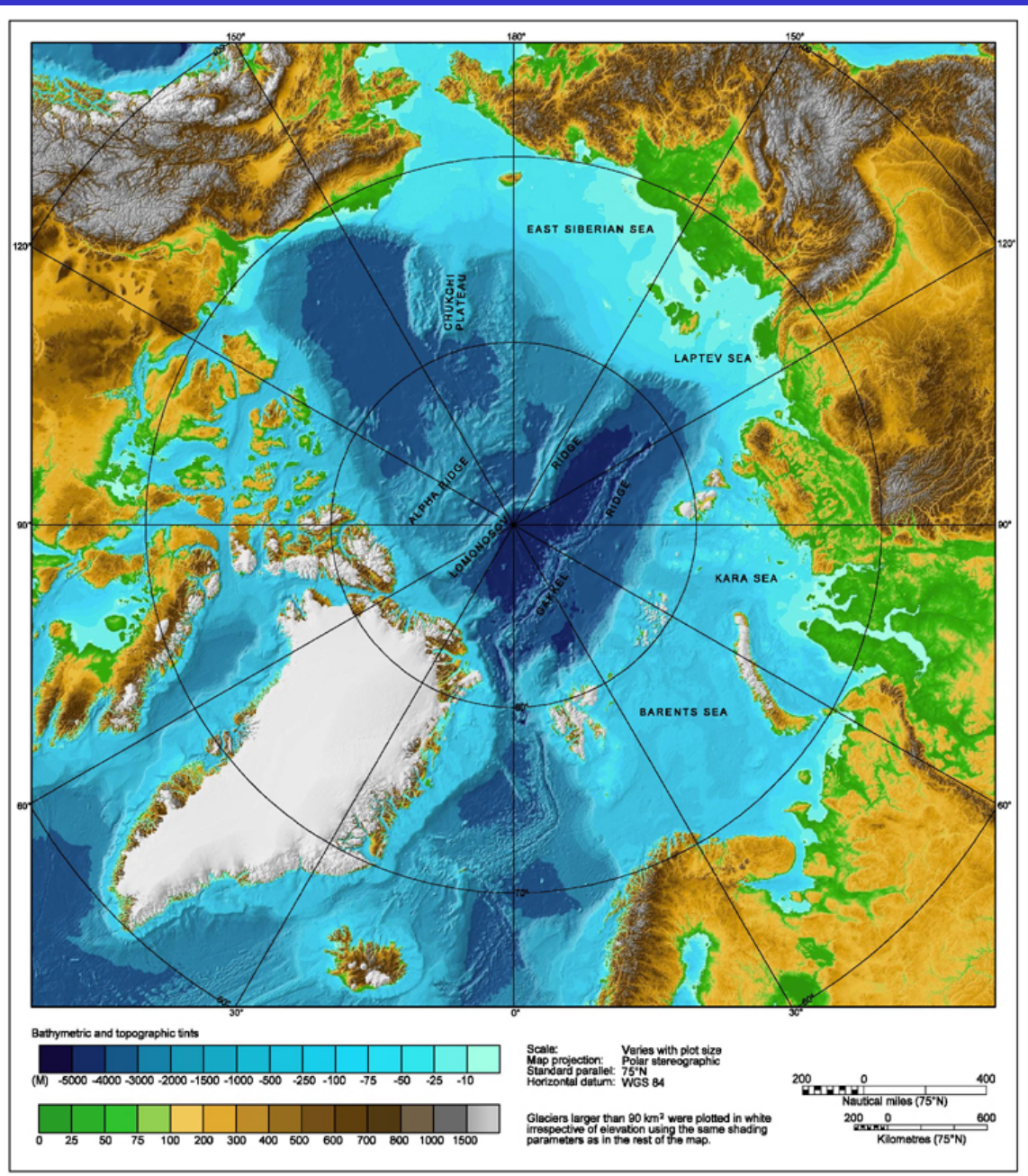
3) We can't answer the most basic questions about why the Arctic has changed without sustained, continuous observations, and we have stopped making them. **WE NEED TO DEVELOP AND EXECUTE A PLAN FOR SUSTAINED, LONG-TERM OBSERVATION.**

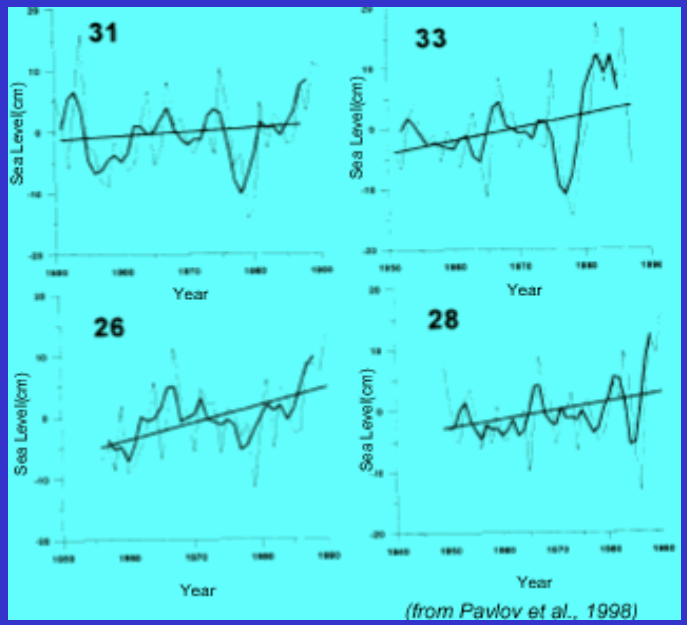
4) Whatever research is now being done by U.S. agencies – NSF, NOAA, NASA—is not coordinated, and is not part of an integrated observation plan. **WE NEED TO ESTABLISH AN INTERAGENCY AUTHORITY FOR ARCTIC OCEAN RESEARCH.** The National Ocean Research Leadership Council might be the right vehicle.

5) We are losing logistic capability**. WE NEED TO PRIORITIZE CONSTRUCTION OF A UNOLS ICE-CAPABLE VESSEL, AND WE NEED TO SUPPORT REGULAR, CONTINUOUS OPERATIONS RATHER THAN SPORADIC FORAYS.**

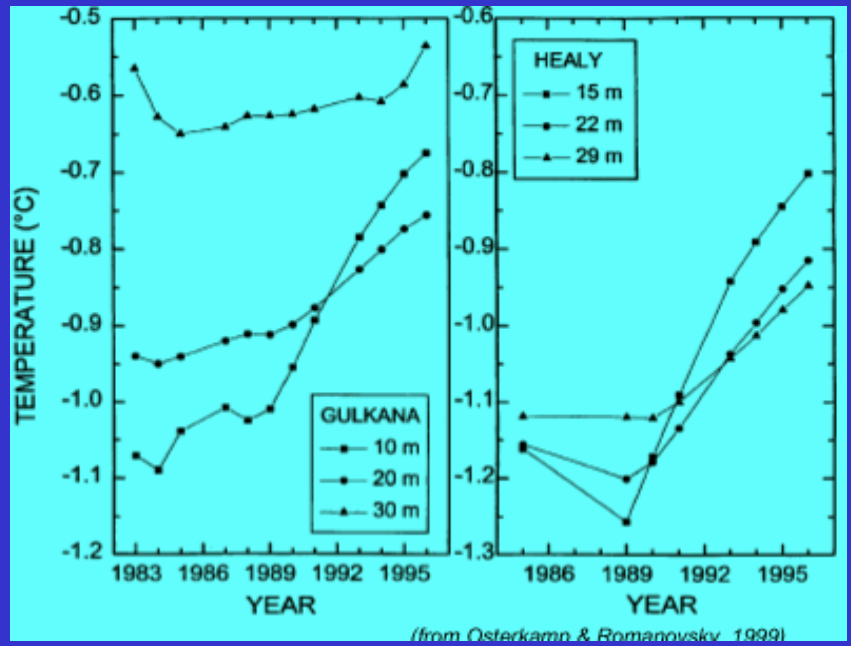
6) The Arctic Ocean is split by national jurisdictional claims, making research access difficult, and the trend is towards even more claimants **WE NEED TO INCLUDE A HIGH LEVEL DIPLOMATIC COMPONENT IN OUR PLANS FOR FUTURE ARCTIC RESEARCH TO ASSURE RESEARCH ACCESS**.

Mr. Chairman and Commissioners, I am grateful for your attention. Thank you for listening to me this morning.

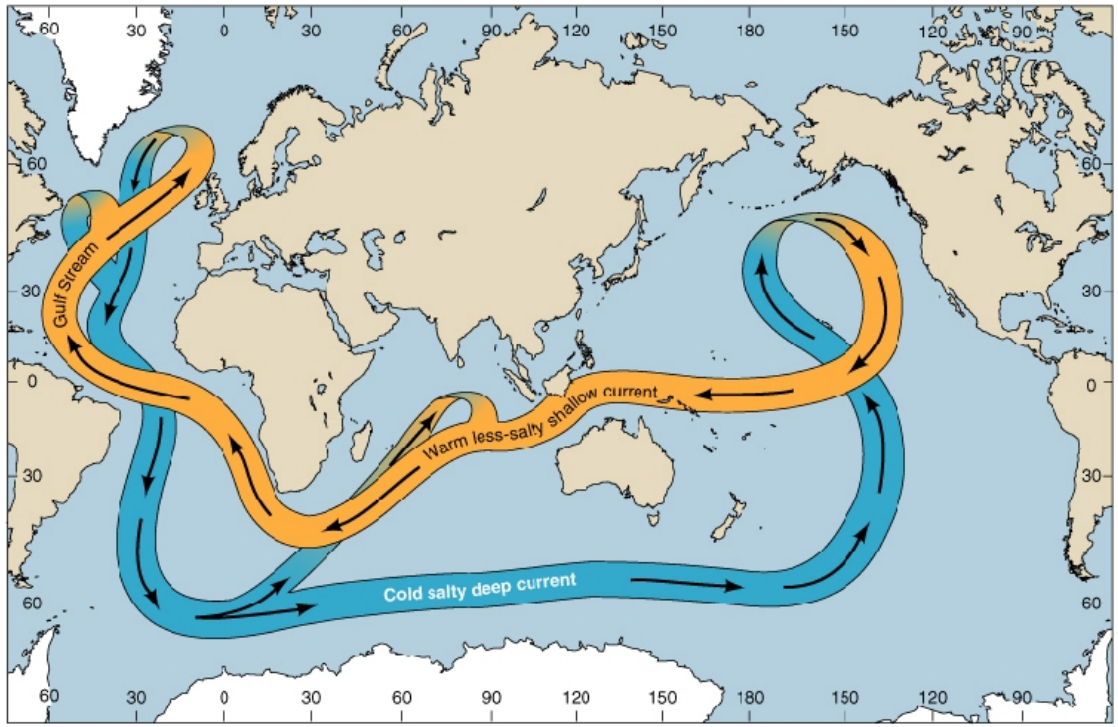

150°
180°
150°
120°
120°
90°
90°
60°
60°
30°
0°
30°
EAST SIBERIAN SEA
CHUKCHI PLATEAU
LAPTEV SEA
ALPHA RIDGE
LOMONOSOV RIDGE
GAKKEL RIDGE
KARA SEA
BARENTS SEA
Bathymetric and topographic tints
(M) -5000 -4000 -3000 -2000 -1500 -1000 -500 -250 -100 -75 -50 -25 -10
0 25 50 75 100 200 300 400 500 600 700 800 1000 1500
Scale: Varies with plot size
Map projection: Polar stereographic
Standard parallel: 75°N
Horizontal datum: WGS 84
Glaciers larger than 90 km² were plotted in white irrespective of elevation using the same shading parameters as in the rest of the map.
200 0 400
Nautical miles (75°N)
200 0 600
Kilometres (75°N)



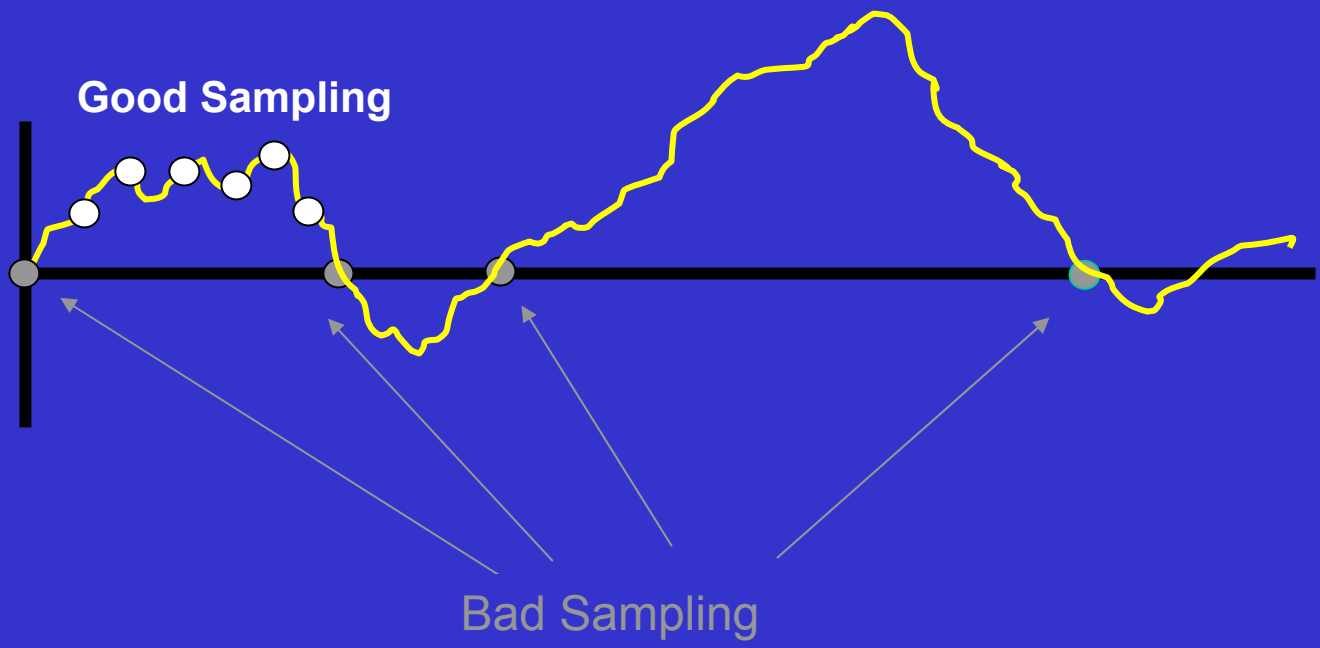
Sea level has been rising in the Russian Arctic for 50 years

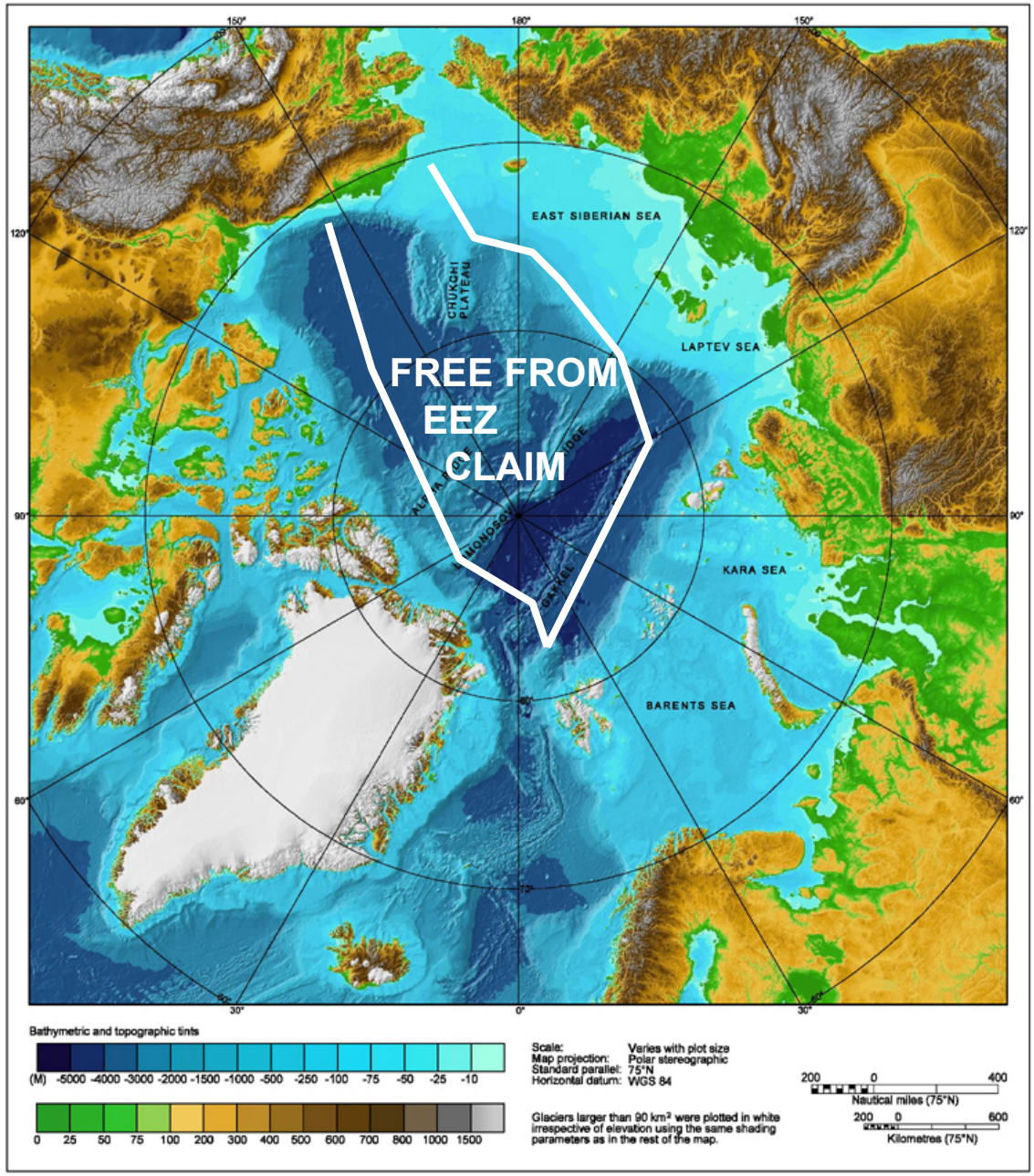


Permafrost temperatures in Alaska have been rising for 20 years



The Broecker “Conveyor Belt”.


Good Sampling
Bad Sampling


150°
180°
150°
120°
120°
90°
90°
60°
60°
30°
0°
30°
EAST SIBERIAN SEA
CHUKCHI PLATEAU
LAPTEV SEA
FREE FROM
EEZ
CLAIM
LOMONOSOV RIDGE
ALPHA RIDGE
KARA SEA
BARENTS SEA
Bathymetric and topographic tints
(M) -5000 -4000 -3000 -2000 -1500 -1000 -500 -250 -100 -75 -50 -25 -10
0 25 50 75 100 200 300 400 500 600 700 800 1000 1500
Scale: Varies with plot size
Map projection: Polar stereographic
Standard parallel: 75°N
Horizontal datum: WGS 84
Glaciers larger than 90 km² were plotted in white irrespective of elevation using the same shading parameters as in the rest of the map.
200 0 400
Nautical miles (75°N)
200 0 600
Kilometres (75°N)

Summary

- The Arctic is changing. There has been an observed decrease in ice thickness and ice cover. Whether this is a harbinger of serious planetary warming, or simply a natural, cyclic variation is unknown, and disputed, although the evidence at the moment points to serious warming.

WE NEED TO UNDERSTAND WHAT IS HAPPENING IN THE ARCTIC, AND WHY.

- The end of the Cold War and under ice submarine operations has set our Arctic Ocean research program back a decade or more, and unless something is done about it, it will only get worse.

WE NEED TO REINVIGORATE OUR ARCTIC OCEAN RESEARCH PROGRAM.

- We can't answer the most basic questions about why the Arctic has changed without sustained, continuous observations, and we have stopped making them.

WE NEED TO DEVELOP AND EXECUTE A PLAN FOR SUSTAINED, LONG-TERM OBSERVATION.

- Whatever research is now being done by U.S. agencies – NSF, NOAA, NASA—is not coordinated, and is not part of an integrated observation plan.

WE NEED TO ESTABLISH AN INTERAGENCY AUTHORITY FOR ARCTIC OCEAN RESEARCH. (The National Ocean Research Leadership Council might be the right vehicle.)

- We are losing logistic capability.

WE NEED TO PRIORITIZE CONSTRUCTION OF A UNOLS) ICE-CAPABLE VESSEL, AND WE NEED TO SUPPORT REGULAR, CONTINUOUS OPERATIONS RATHER THAN SPORADIC FORAYS.

- The Arctic Ocean is split by national jurisdictional claims, making research access difficult, and the trend is towards even more claimants.

WE NEED TO INCLUDE A HIGH LEVEL DIPLOMATIC COMPONENT IN OUR PLANS FOR FUTURE ARCTIC RESEARCH TO ASSURE RESEARCH ACCESS.