

TOWARDS AN INTERNATIONAL SCIENTIFIC OBSERVATORY AT THE NORTH POLE

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AOS Themes: (1) International and national strategies for sustained support of long-term Arctic observing;
(5) Arctic Observations in the Context of Global Observing Initiatives

ABSTRACT: We advocate the establishment of a North Polar international station and observatory as a valuable scientific workspace and tool for studying the evolution of the Arctic environment and ecosystems, as well as a mechanism, entirely consistent with the United Nations Convention on the Law of the Sea (UNCLOS) and with the Ilulissat Declaration (Arctic Ocean Conference, 2008), for enhancing stability and peace through international collaboration in the Arctic.

1. The Arctic Climate

The past three decades are likely the warmest period of the last millennium in the Northern Hemisphere (Fig. 1). Global anthropogenic CO₂ and other greenhouse gas emissions have risen from less than 10 gigatonnes (Gt) per year in 1950, to almost 40 Gt annually in recent times, with atmospheric CO₂ levels unprecedented in the last 800,000 years (IPCC 2014). The impact of increased atmospheric CO₂ is most pronounced at high latitudes, with complex positive feedback effects that exacerbate and accelerate the changes in climate and environments locally and globally. The Arctic climate is changing most rapidly: the permafrost is thawing, releasing carbon and methane in the process, and snow and ice cover are shrinking on land and especially at sea, decreasing the albedo effect of these regions (solar radiation that is reflected back to space). The impact is felt on coastlines eroded by enhanced wave and storm activity, on animal populations depending on ice cover, and on the people who live in the region.

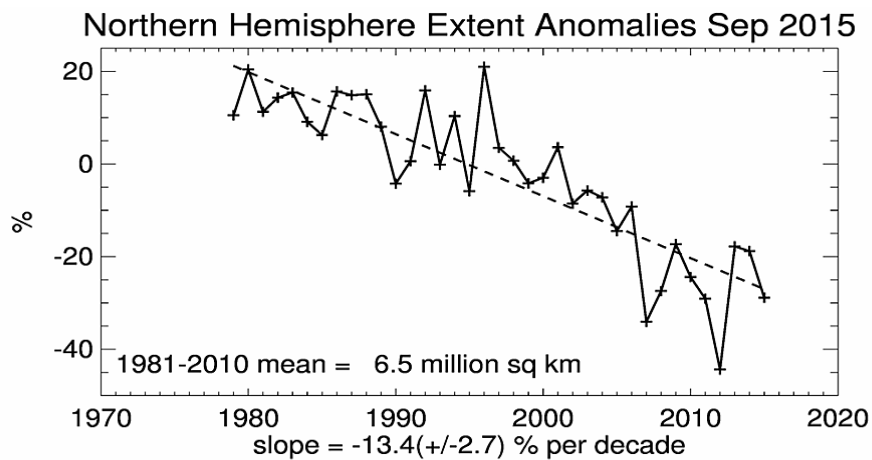


Figure 1. Monthly sea ice extent anomalies in the Northern Hemisphere from 1979 to 2015. Image courtesy of the National Snow and Ice Data Center, University of Colorado, Boulder (https://nsidc.org/data/seaice_index/).

Based on the rapid rate of decay of Arctic ice cover (e.g. Fig. 1), the Arctic would be expected to be ice free in September (the month of minimum coverage) by 2070, or even sooner, within the middle (IPCC 2014) or the early part of the 21st century (Overland and Wang, 2013). There would still remain considerable ice coverage in the central Arctic with a peak in March.

2. Opportunities

What is seen as a major ecological disruption by some is perceived as an opportunity by others, who hope to benefit from easier access to the Arctic basin's mineral and biological resources, on land and at sea. The reduced ice cover is already allowing easier passage through the Canadian archipelago and north of Siberia. Trans-arctic shipping routes linking Europe and Asia across the North Pole are already seriously contemplated (Smith and Stephenson, 2013).

3. Territorial Claims

The opening of the Arctic Seas promises unprecedented access to natural resources and has attracted extensive territorial claims by circum-Arctic nations¹. Byers (2013) has presented a comprehensive discussion of claims within the framework of the United Nations Law of the Sea (UNCLOS), focusing mainly on the extensive Arctic continental shelf areas. Through the 2008 Ilulissat Declaration (Arctic Ocean Conference, 2008), the coastal Arctic states (Canada, Denmark, Norway, Russia, and the USA) declared that they saw “no need for a new comprehensive international legal regime to govern the Arctic Ocean,” but reaffirmed their commitment “to this legal [UNCLOS] framework and to the orderly settlement of any possible overlapping claims,” an attitude likely to bring the benefits of mutual cooperation (see Nowak and Highfield, 2011).

However, some unresolved claims remain sources of bilateral irritation (for example, Hans Island, between Canada and Denmark). There have also surfaced, more recently, aggressively competitive claims to the North Pole, seeds of further conflicts. In this paper, we examine more closely the meaning of a claim to the North Pole and suggest means of avoiding conflicts over its possession.

4. Where is the North Pole?

By definition, the North Pole is the intersection of the Earth's axis of rotation with the planet's surface: ideally, a fixed geometrical point, without area. In a pinch, national pride might be satisfied by sharing immediate proximity to that point. However, because of its oblateness, the Earth wobbles, a motion predicted by Leonard Euler in the 18th century and verified by Seth Carlo Chandler in the 19th. The Chandler wobble is complicated by seasonal variations in the Earth's moment of inertia related to atmospheric and oceanic motions, which are also thought to be responsible for the wobble's persistence against attenuation by internal friction. Gradual shrinking of the Greenland ice cap is also held to be responsible for a gradual drift in polar location. As a result, the pole describes a clockwise path with a radius of about 10 m over a period of about 433 days. The combined effect (polar motion), is estimated at 30 to 100 ft. per century (~ 9 to 35 m; Hutton and Eagle, 2004), but may vary (Fig. 2), and indeed, ice melting may have even expedited an abrupt eastward turn of the mean pole position since 2005 (Chen et al., 2013).

What ownership of the North Pole implies is possession of a rather small area -- under today's conditions, a radius of 100 m about the average pole position would suffice for centuries. Is possession of such a small area of sufficient economic importance and national prestige to engage in a conflict with neighbouring countries?

¹ Some recent claims by the Kingdom of Denmark include extensions to continental shelf areas off Greenland and the Faroe Islands, including the North Pole itself (e.g. see Continental Shelf Project of the Kingdom of Denmark, http://a76.dk/lng_uk/main.html). The recent December 2014 claim by Denmark overlaps with claims by Norway, USA, Canada and Russia (http://a76.dk/greenland_uk/north_uk/index.html).

We offer a solution that we believe will avoid conflict over the North Pole and prove of benefit to all Arctic nations and indeed the whole North Hemisphere: a North Pole International Observatory, established within an area left outside national claims or any new legal regime: the "high seas" on a very small scale.

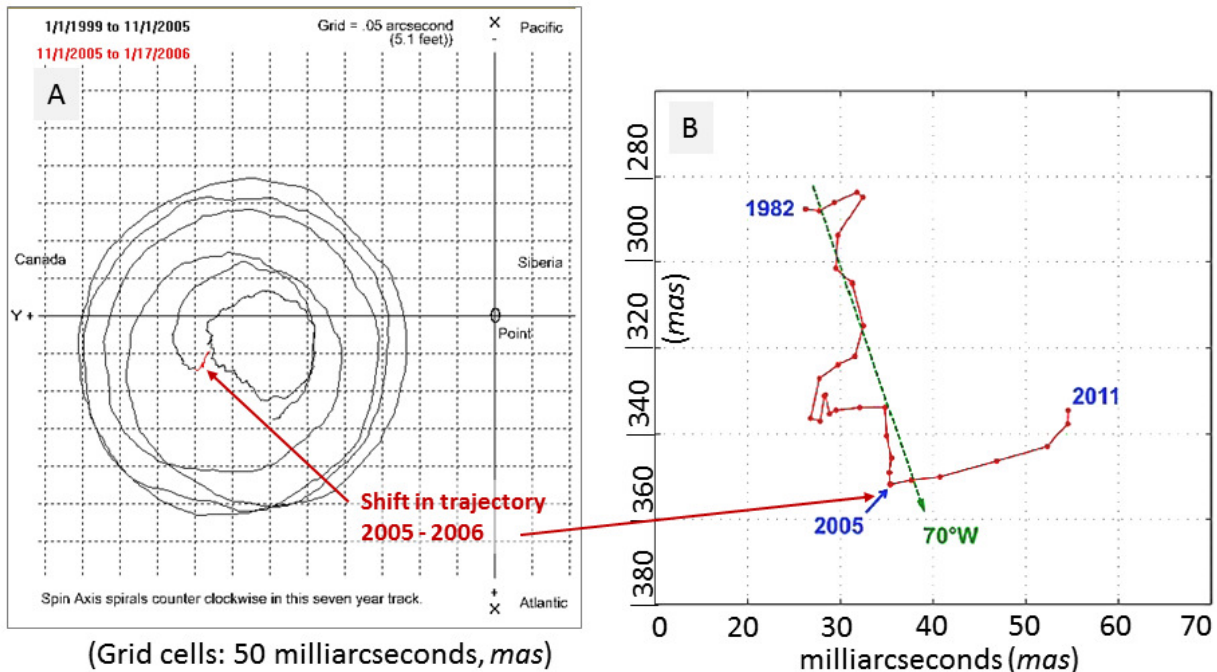


Figure 2. Recent path of the North Pole as noted by Michael Mandeville (Mandeville, 2006; panel A), including the initial shift in trajectory starting in late 2005, and average annual pole position by year as calculated by Chen and colleagues from 1982 to 2011 (Chen et al., 2013; panel B). Figures modified from Mandeville (2006) and Chen et al. (2013). (One milliarcsecond is equivalent to approx. 3 cm of motion on the Earth's surface near the pole; 50 mas, the length of a grid cell in panel A, measures approx. 5.1 feet).

5. POLARIS Station

The POLAR International Science Station and Observatory (POLARIS, for now, Fig. 3) would be an observatory of polar areas and of much of the northern hemisphere. It would provide direct atmospheric and oceanic information from a data-poor part of the world, data that would contribute to a better understanding of the Arctic and the whole Northern Hemisphere circulation and improve weather predictions in the north. Enhanced ocean observations would help to better understand flows in and out of the Arctic and the contribution to the climate that they make in transferring heat between the Atlantic to the Pacific.

Situated at the pole, **POLARIS** would be ideally located for astronomical observations and observations of auroras, and would contribute to a better understanding of upper atmospheric conditions over the North Hemisphere, with benefits to ground and satellite radio communications. Because of its equidistance from equatorial areas, the poles are privileged observations points for Schumann resonances, another indicator of global ionospheric conditions.

Besides observing the impact of climate change on species of special concern and of particular interest to Arctic communities, such as polar bears, marine mammals and fish, biological monitoring at the North Pole would document the evolution of deep ocean primary productivity as the ice cover shrinks and thus form a basis

for understanding a new ice-free Arctic marine ecosystem and food webs, from invertebrates to migratory species. The potential location of **POLARIS** would be ideal also for studying the physical, chemical and biological components of the environments spanning from sea level to ~4000 m depth adjacent to the Lomonosov Ridge, and the slow-spreading Gakkel Ridge (Fig. 3), including novel hydrothermal vent ecosystems (Edmonds et al., 2003; German et al. 2011).

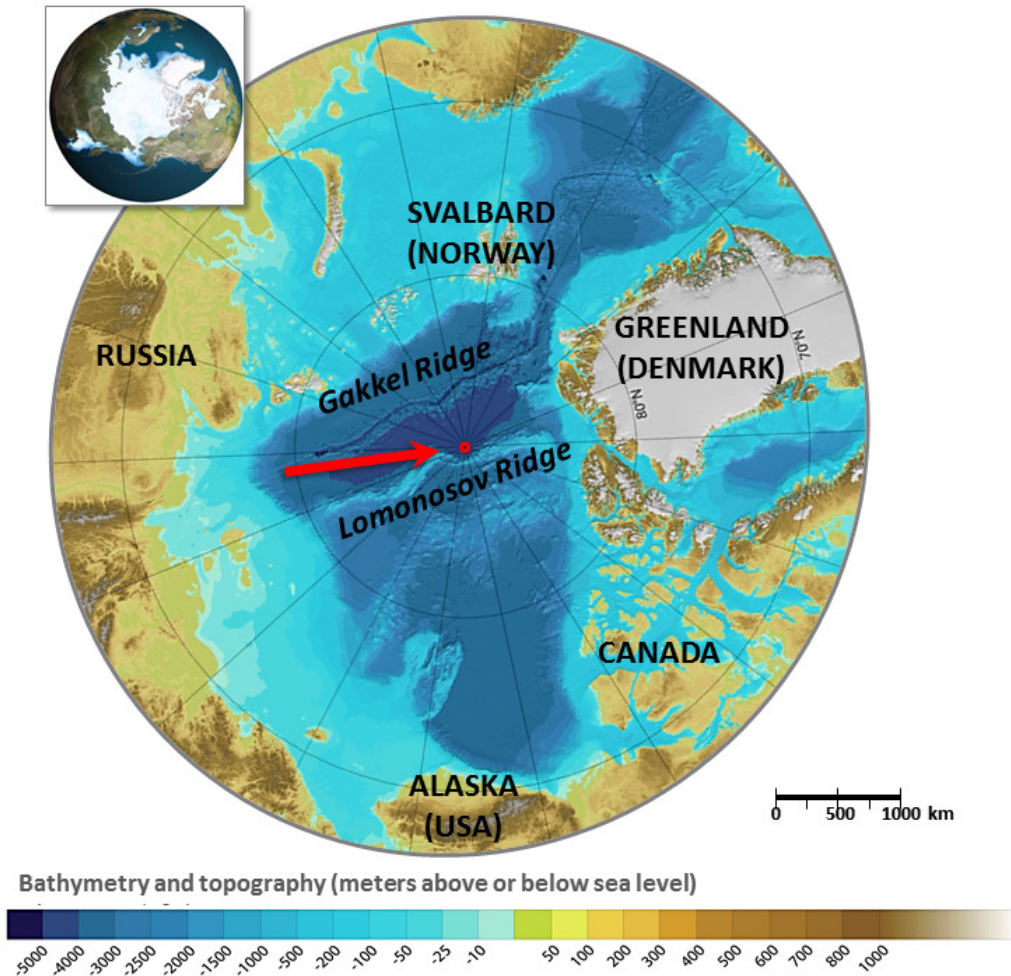


Figure 3. Bathymetry under Arctic ice at 90° N and approximate location of the Geographic North Pole (red point and arrow). The POLARIS International Station and Observatory could be located at or near the Geographic North Pole and could serve as an invaluable site to investigate the atmosphere and the heterogeneous marine physical, chemical and ecological environment within 50 to 100 km from the Lomonosov Ridge, from sea ice to depths over 4000 m, and the ultraslow-spreading Gakkel Ridge. (Image data sources and information: Johnson et al. 2009; Jakobsson et al. 2012; Edmonds et al. 2003).

Along with other existing drifting, ship-based and land-based stations, and those that already participate in international collaborative networks such as INTERACT (INTERACT - International Network for Terrestrial Research and Monitoring in the Arctic; <http://www.eu-interact.org/en/>), CNNRO (Canadian Network of Northern Research Operators, <http://new.cnnro.org/about-cnnro/>), and others, POLARIS would complement research and monitoring as part of such station networks, and be ideally situated to serve as a hub for basic emergency response and as a communications relay site.

POLARIS would eventually pay for itself through the broad, long-term benefits that it would bring to the nations of the North Hemisphere, and especially of the Arctic. It would also pay for more than itself by eliminating onerous expenses associated with the management of international disputes, bringing substantial budgetary savings to Arctic states. Peace pays! For some research activities, the cost of ship-based surveys may be reduced and survey time could be complemented where **POLARIS** could serve as a hub for shorter, more focused surveys. Costs of operation for **POLARIS** could be supported in part from occasional tourism activities and for use by the private sector with a review system for the approval and oversight of such activities, with the goal of setting high standards for environmental stewardship and sustainability in Arctic environments.

The role of scientific collaboration in ensuring stability and peace in the Arctic has been stressed by others, namely by Berkman (2012, 2014) and most prominently in the words of Mikhail Gorbachev (as quoted by Berkman): “**Let the North Pole be a Pole of Peace.**”

6. Obstacles

Perhaps the **POLARIS** concept may elicit skepticism and objections initially: ‘*A research station at the pole doesn't make any sense! It's a deep ocean, heavily ice-covered area, which is likely to continue to have some ice for quite a few years!*’, or, ‘*Too expensive, and technologically idealistic!*’.

As a first step, there would be a need to develop international agreements. For the small area proposed directly around North Pole, establishing a cooperation agreement may be feasible, at least compared to the complex Arctic claims that are currently under review. Cooperation will be needed to allow access via international waters and national jurisdictions. However, an agreement could be modelled in part following the *Antarctic Treaty* (<http://www.ats.ag/e/ats.htm>), implemented in 1961, and ratified by 53 countries at present, outlining scientific research, cooperation and knowledge exchange, and limiting activities to peaceful purposes only. In 1991, the Protocol on Environmental Protection to the Antarctic Treaty further strengthened the establishment of Antarctica for peaceful scientific purposes only and identifying Antarctica as a reserve. An agreement among collaborators in the **POLARIS** observatory could be designed to satisfy the requirements of the Ilulissat declaration.

Aside from cost, logistic and design challenges, establishing a scientific presence at the North Pole will certainly encounter other potentially serious problems. However, one may reflect on what early polar explorers like Robert F. Scott, Roald E. G. Amundsen, or Ernest H. Shackleton would have thought of a research station at the South Pole one hundred years ago. Within half a century the international community has collaborated extensively to overcome extreme challenges and participated in co-development and co-design of advanced bases capable of adapting to the most extreme Antarctic conditions, such as the Amundsen–Scott South Pole Scientific Station, Halley VI, and Princess Elisabeth Antarctica, a zero-emissions building. What might become possible over the next hundred years?

7. Robust Design and Advanced Engineering

If **POLARIS** is to be the focus of scientific presence at the North Pole, what kind of structure will it be? Most likely a structure which will evolve from simple beginnings, as has the South Pole station. It may start as did the many former Ocean Weather Stations, on a ship -- an ice breaker, of course --keeping position at the pole.

A more advanced structure would have to maintain its position against wind, current and ice, either dynamically like a modern drill-ship, or through an anchoring system. Currently, the deepest drilling platform, Perdido, operated by Shell Oil in the Gulf of Mexico, works in a depth of 2,450 m, still well-short of the 4,000 m depth at the pole. Perdido is of course not equipped to handle ice pressures. The Hibernia platform, located on

the Grand Banks of Newfoundland, was built to resist the impact of icebergs and sits on a massive anchoring base, but sits in relatively shallow water (80 m). There is obviously no existing platform that would fit the bill. We hope that the idea will soon challenge the imagination of the cleverest of engineers.

8. Recommendation

We bring the concept of a North Pole international scientific observatory to the attention of the Arctic Observing Summit in the hope that it will germinate in the minds of some of the participants. We recommend to the participants and Thematic Working Groups of the Summit that a Study Group be considered to explore international interest and input for such an observatory, including discussion of a potential agreement to support international cooperation and to pave the way for peaceful resolution of ownership of the Geographic North Pole. The Study Group would act as a forum for international discussion of the idea and engage in detailed assessments of the challenges and benefits of such an observatory.

In addition to an important role as a symbol of peace and international collaboration, *POLARIS* would be ideally located where a vast polar area remains largely unexplored and where travel and research are still limited by logistic and environmental challenges. As outlined above (Section 5. *POLARIS Station*), from a scientific perspective, exploration, monitoring, and experimental approaches build our fundamental knowledge base about polar ecosystems that remain understudied. Ultimately, the potential benefits of such knowledge can include applications such as filling gaps in coverage and scope, and improving our ability to detect or even predict extreme events, understand circulation patterns, improve ecosystem and environmental monitoring for better management, and for detecting shifting species distributions. Such knowledge may even help refine indicators and sustainability limits to guide emerging economies with eyes on the Arctic, such as the large number of bioprospecting companies searching for the next generation of pharmaceuticals in polar regions (Hoag 2009). From a geographic perspective, *POLARIS* can potentially serve as a communications relay center or to serve as an important satellite site for emergency response in the future. This northernmost observatory could bring benefits to diverse sectors, communities, and nations within and beyond the Arctic. As part of existing station and observatory networks, *POLARIS* could contribute to global observing initiatives by expanding the geographic reach and focus towards more comprehensive Earth observation efforts.

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