# Global Change Education in the Arctic

PAGES 158, 162–163

Bird species new to the Arctic call across ancient forests where the buzz is from the super sawmills, not the sound of elk hooves. Oil and gas wells plumb the tundra depths, and the pipelines scarify the surface, pumping fossil wealth south with a return flow measured in dollars and rubles. The eternal ice is going and tourist ships are coming, ironically to see the icy landscape that is disappearing. This is the Arctic today.

Global change has been a fact of life for many indigenous peoples in remote parts of the world for many decades. In Svalbard, Norway, which lies north of Europe in the Arctic Ocean, January 2006 was warmer than any previous April while April was five standard deviations warmer than average. Over the longer term, the Inuit in Nunavut, Canada, have found that hunting for seals—traditionally their major food supply—has become much more difficult as sea pup numbers have declined along with sea ice [*Arctic Climate Impact Assessment*, 2004]. About 20 Alaskan villages are candidates for relocation because of severe coastal erosion, exacerbated by loss of protective sea ice. For example, the U.S. Army Corps of Engineers estimates that it could cost from $100 million to $400 million to relocate Kivalina, which has only 385 inhabitants [*U.S. General Accounting Office*, 2003].

Ongoing climate change is accelerating and exacerbating the problems associated with change in the environment and traditional lifestyles of people. The Arctic is one of the locations where the effects of climate warming are being most keenly felt, and likely will be most dramatic in the future. This is in part because the landscape fabric itself is affected by permafrost degradation, reduction in sea ice, and increased coastline erosion. These changes have severe impacts on everyday life in the region.

In addition to experiencing rapid change, the Arctic region possesses rich resource areas, well-educated populations, and materially under-resourced people due to a lack of incoming high-quality goods and services, ranging from food to high culture. Many of the decision-makers in the Arctic, including those who relocate from other regions, receive some or all of their college-level education within the Arctic. Therefore, it is of interest to know how well the Arctic countries are preparing their university-level students to manage societal adaptation to global change.

By J. Moore, H. Kinnunen, and R. Boone

*University of the Arctic*

University of the Arctic (UArctic; http://www.uarctic.org) is a closely linked network of 102 member institutions across the Arctic that was established in 2001 to provide the tools for the inhabitants of the northern periphery to shape their own destiny. UArctic is a university without walls that draws on and promotes the educational and research resources in the circumpolar Arctic while being firmly focused on the people of the north. The majority of universities and colleges in the Arctic are small and cannot afford to support a comprehensive curriculum. UArctic facilitates the sharing of educational resources by providing online courses (including courses leading to a bachelor of circumpolar studies degree) that can be key to educating people living in small, dispersed communities that are typical of the northern circumpolar region.

University-level courses in global change generally are easy to distinguish from courses with a tighter disciplinary focus, because they often include the very words 'global change' in their titles. Differences in

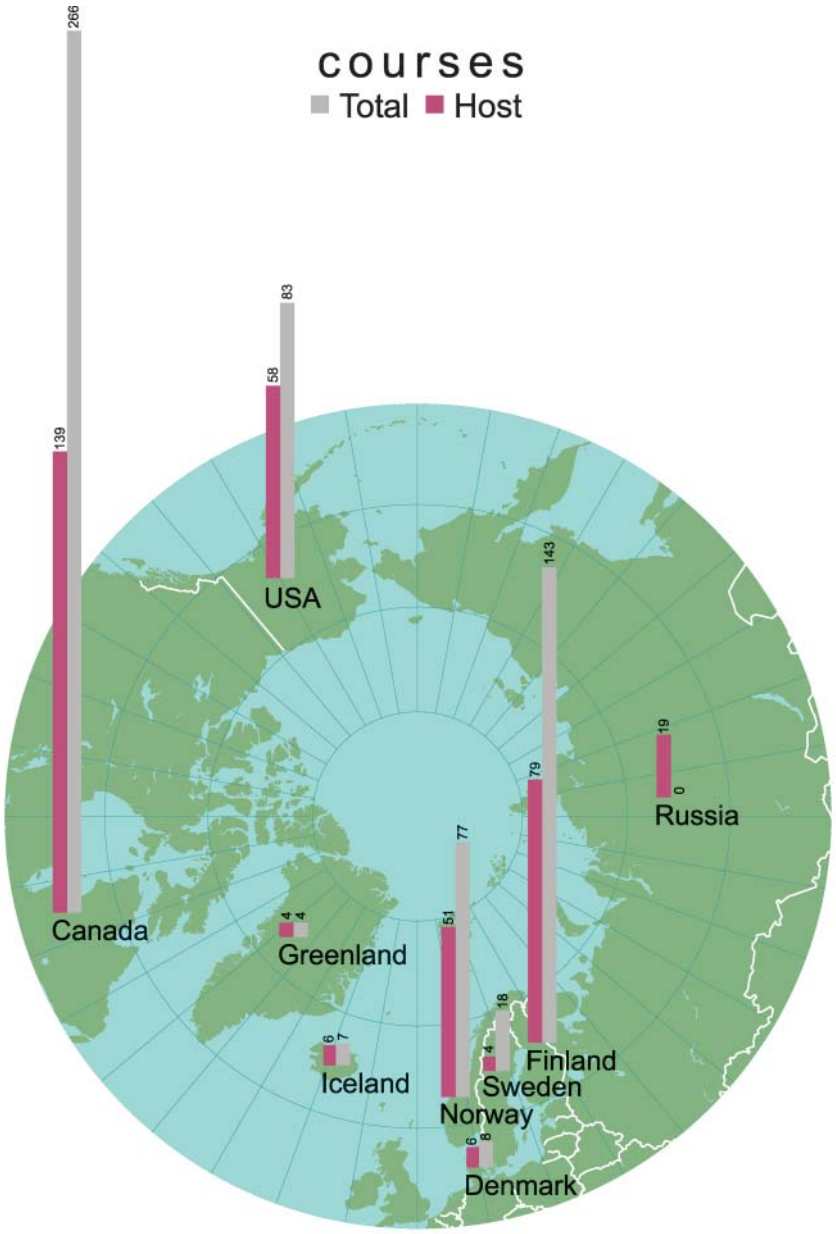



*Fig. 1. Number of courses found in each Arctic country. The purple bar is the number of courses listed by the UArctic institutions on their own Web sites. The grey bar represents the total number of courses found through this survey as well as those courses listed in UArctic member institution Web sites.*

course focuses also are readily apparent. A traditional biology course, for instance, may include discussion of the nuts and bolts of anatomy or behavior, whereas in a global change biology course the discussion may concern how the landscape, ecotones, and ecology evolve rapidly on human timescales. This article defines a global change course as one in which the underlying philosophy is the transient nature of the present, and the course emphasis is not on the fundamentals of a discipline but on how that discipline is applied to, or reacts with, the changing planet.

Over a period of 3 months in 2006, the UArctic Thematic Network on Global Change in the Arctic, which is hosted by Thule Institute of Oulu University, Finland, conducted an inventory of global change courses listed by UArctic member institutions on their Web sites. To supplement those data, researchers sent a questionnaire, in both English and Russian, to all UArctic members, including 61 higher-education institutions in the circumpolar Arctic. The survey had two goals: (1) create a directory of course curriculums and identify gaps, and (2) make the directory available on the Internet for the benefit of teachers and students. This directory will allow students to make knowledgeable choices between institutions, allow institutions to find the most mutually beneficial student and teacher exchanges, and indicate areas of weakness in the current curriculum.

The questionnaire, which simply required yes or no answers to a series of questions, was sent to the deans of each faculty. Twenty-eight of the institutions had no course listings in any subject on their Web sites, and no Russian courses were found on the Internet.

### *Responses to the Survey*

In all, 66% of institutions responded to the questionnaire. Informal communication suggests it is likely that many of the institutions that did not return the questionnaire do not offer global change courses.

Figure 1 shows the number of courses found. Altogether, UArctic institutions offer 609 global change courses (now listed on the UArctic Web site). These courses include some, such as the 19 Russian courses, that were not found on the Web in initial investigations.

A striking feature of Figure 1 is the large difference in course numbers among neighboring countries. For example, when compared with Finland and Norway, Sweden and Denmark have few global change courses, which is surprising considering the similar sizes and shared histories of these countries. However, Sweden has little Arctic territory and few northern institutions. Denmark, though not within the Arctic traditionally, has strong involvement through its responsibilities in Greenland. Norway's interest is due to its historical exploration and exploitation of the Arctic, as well as its Svalbard territory. Large numbers of courses from Finnish institutions reflect Finnish Lapland's relatively well populated and institution-rich province. Canada, with its vast Arctic territory, has many courses compared with the United States, which has only five UArctic institutional members. The low number of courses in Russia probably reflects current political priorities, despite the importance of current and potential Arctic resources.

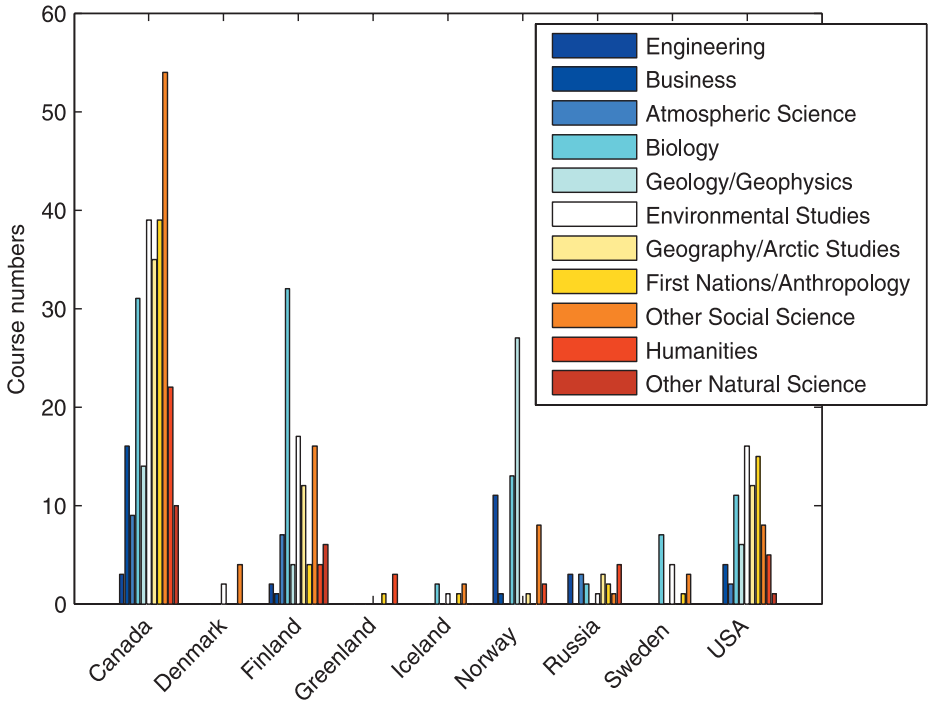



*Fig. 2. Course categories in each country.*

The types of courses vary considerably among countries. The Scandinavian system is based around the master's degree, so most of the courses are at that level. In North America, most courses are at the bachelor's level.

There was considerable diversity in the types of global change courses offered by discipline among countries (Figure 2). Biology courses are the most common, but Earth science courses, such as atmospheric sciences and geology, also are well represented. In addition, there are many regionally focused geography and Arctic studies courses. The largest number of courses in a broader disciplinary grouping is within social sciences. Within that grouping, first nations and anthropology studies are the largest subcategory, reflecting the importance of Arctic indigenous peoples in managing and adapting to global change.

Additionally, traditional knowledge is becoming more widely recognized as an important contributor to global change data sets, based on findings from interviews with Inuit, for instance, that species of birds now commonly seen in the Arctic have no name in the Inuit language of Inuktitut. Similarly, the Nenets who are reindeer herders living in western Siberia know from their oral histories that severe icing that prevents pasture grazing now occurs more frequently than it had in the past.

The effects of global change already are changing the lives of Arctic inhabitants, who already have shorter life spans and are less healthy than their southern counterparts [*Arctic Human Development Report*, 2004]. Therefore, one of the most striking results from the survey is that many UArctic institutions lack courses in the health and economic issues related to global change, as can be seen by the relatively few courses (22) in business, which are mostly located in the United States. There are even fewer global change courses in tourism (12), architecture (3), law (7), and agriculture, forestry, and fisheries (6).

Perhaps the most worrying finding is the nearly complete lack of global change courses for university students in primary and secondary education. Only a single course for the entire UArctic network was found in the education category. Presumably nearly all the students who will become primary- and secondary-school teachers in UArctic nations are receiving no training in global change science and how it affects society.

As a response to the survey, UArctic is trying to fill gaps in the curriculum. Examples of planned courses include Human Rights and Global Change, which concerns laws and policies that typically fail to recognize the aspirations and rights of indigenous peoples. Environmental degradation often is worse in countries where human rights abuses are rampant. A planned course, Institutional Dimensions of Global Change,

examines issues such as transnational comanagement regimes/wildlife management and land claims, and the control of resources.

Given the rapidly changing face of the Arctic, the gaps in global change education highlighted here are important, and they likely are the key results on which UArctic and the circumpolar authorities need to work.

The full survey results may be found on the University of the Arctic Web site at http://www.uarctic.org.

*Acknowledgments*

Three anonymous referees and Kirsi Latola, Outi Snellman, and Olga Haurinen gave valuable comments on the manuscript and survey. We thank all who filled out the questionnaire.

*References*

Arctic Climate Impact Assessment (2004), Impacts of a Warming Arctic: Arctic Climate Impact Assessment, 140 pp., Cambridge Univ. Press, New York.

Arctic Human Development Report (2004), Steffansson Arct. Inst., Akureyri, Iceland.

U.S. General Accounting Office (2003), Alaska native villages: Most are affected by flooding and erosion, but few qualify for federal assistance, Rep. GAO-04-142, 91 pp., Washington, D.C., 12 Dec.

*Author Information*

John Moore, Arctic Centre, University of Lapland, Rovaniemi, Finland; E-mail: john.moore@ulapland.fi; Heli Kinnunen, Thule Institute, University of Oulu, Finland; and Richard Boone, University of Alaska Fairbanks

# NEWS

## New Detailed Images of the Sun

PAGE 159

Newly released images of small-scale solar structures indicate that the Sun is much more turbulent that previously known. The images, produced by the satellite Hinode (formerly known as Solar-B), were released by NASA and the Japan Aerospace Exploration Agency (JAXA) on 21 March.

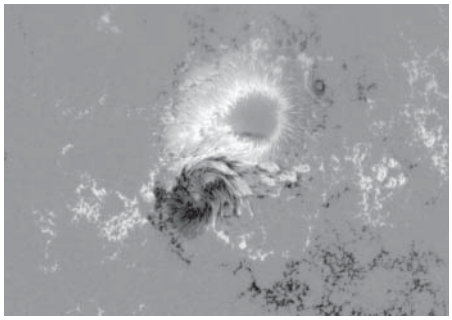
Many of the recently released images focused on a large sunspot identified by scientists in December 2006. The sunspot, which was anomalous because it occurred in the declining phase of the 11-year sunspot cycle, ejected a flare of white light and protons.

With Hinode instrumentation, scientists viewed the detailed evolution of the sunspot area without interruption for more than four days and witnessed the emergence of a rotating smaller sunspot described as "a kind of magnetic hurricane," according to Alan Title, a senior fellow at Lockheed Martin's Advanced Technology Center, the agency that built Hinode's Solar Optical Telescope (SOT). At a diameter of 50 centimeters, the SOT is the largest telescope ever to be in orbit, allowing for the recovery of images at resolutions that have never been viewed before.

A quick comparison between SOT images and pictures of the same area from the Solar and Heliophysics Observatory (SOHO) satellite revealed that Hinode has about 15 times better resolution. "We can see all of the [Sun's] fine-structure," said Title. "With Hinode, we have new eyes."

The improvement in image quality is "equivalent to going from ground-based astronomy at night with Earth telescopes to [looking through] the Hubble space telescope," said Richard Fisher, the director of NASA's Heliophysics Division.

In addition to the SOT, new data was also released from the X-ray Telescope (XRT), and the Extreme Ultraviolet Imaging Spectrometer. Comparisons of SOT and XRT data show "complicated intermingling of hot and cold material" in the Sun's turbulent structures, explained Leon Golub, a senior astrophysicist at the Harvard-Smithsonian Center for Astrophysics. Further, images reveal magnetic loops collapsing during flares, phenomena not predicted by theory.



*An image from Hinode's Solar Optical Telescope shows two sunspots colliding, revealing their hurricane-like structure. Courtesy of JAXA/NASA.*

"There are many things in the data… that are going to change our views once we figure out what's going on," Golub said.

Hinode, an international collaboration between JAXA, the European Space Agency, NASA, and other partners, was launched on 23 September 2006 from Japan's Uchinoura Space Station to study the Sun's magnetic field and how its explosive energy propagates from the Sun's surface through the solar atmosphere. The satellite circles the Earth at a polar orbit along the dawn/dusk line, allowing it to continuously view the Sun for nine months of the year.

—MOHI KUMAR, Staff Writer