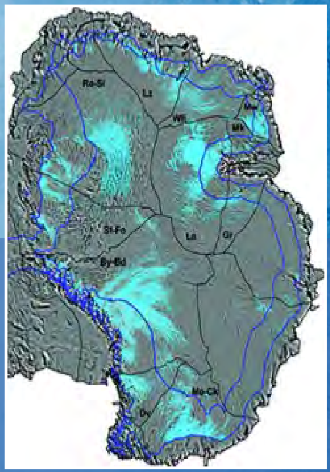
NSIDC

Advancing knowledge of the Earth's frozen regions

National Snow and Ice Data Center

2012 Annual Report






National Snow and Ice Data Center
2012 Annual Report

NSIDC
National Snow and Ice Data Center
University of Colorado Boulder

http://nsidc.org/pubs/annual/

Cover image captions

Top row, left to right

This image shows the distribution of glaze regions (cyan) in East Antarctica, for the major drainage basins for the ice sheet. The 1,500 to 2,500 meter elevation contours are shown in dark blue. Drainage basins are labeled with abbreviations of local major features or research bases. —Credit: Ted Scambos et al., *Journal of Glaciology*

Avalanches can be caused by a variety of factors, including terrain, slope steepness, weather, temperature, and snowpack conditions. —Credit: Richard Armstrong, NSIDC

Tingun Zhang and his colleagues spent several months in west China, drilling boreholes in permafrost. The temperature data from the boreholes will help them understand whether permafrost in the region is warming, and if so, how fast. —Credit: Cuicui Mu

Arctic animals such as these Bering Sea walruses depend on the ice edge as a platform for hunting and breeding. —Credit: Brad Benter, U.S. Fish and Wildlife Service.

Bottom row, left to right

An Arctic researcher removes a snow core sample. —Credit: Andrew Slater, NSIDC

NSIDC research scientist Ted Scambos checks on the GPS/GPR surveying system during the 2002-03 Megadunes expedition. —Credit: Ted Scambos and Rob Bauer, NSIDC

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Director's Overview

Our Mission

The mission of the National Snow and Ice Data Center (NSIDC) is to improve our understanding of the Earth's frozen realms. This includes our planet's floating sea ice cover, lake ice, glaciers, ice sheets, snow cover and frozen ground, collectively known as the cryosphere. NSIDC advances its mission through:

- Managing, distributing and stewarding cryospheric and related climate data collected from Earth orbiting satellites, aircraft missions and surface observations

- Facilitating the collection, preservation, exchange, and use of local observations and knowledge of the Arctic

- Conducting research addressing all major elements of the cryosphere; this research has increasingly focused on understanding how and why the cryosphere is changing and the implications of these changes

- Conducting informatics research aimed at finding better ways to discover, integrate and distill the vast and growing volume of cryospheric and climate data

- Educating the public about the cryosphere, the changes that are being observed, and their implications

The National Snow and Ice Data Center is part of the Cooperative Institute for Research in Environmental Sciences, at the University of Colorado Boulder.

NSIDC

National Snow and Ice Data Center

University of Colorado Boulder

NSIDC makes hundreds of scientific data sets accessible to researchers around the world, ranging from small text files to terabytes of remote sensing data from the National Aeronautics and Space Administration (NASA) Earth Observing System satellite program and other sources. Our data managers, technical writers and scientific programmers operate in teams to create or publish data sets, working closely with data providers and users to understand their needs and to offer documentation, tools, and formats that support scientific research. NSIDC also works to ensure that data and metadata (data describing the data) are continually preserved and will be accessible for the longer term, so that researchers can study climate change over long periods. Together, these practices ensure the physical and scientific integrity of the data we manage and disseminate. We manage data under sponsorship from NASA, the National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF).

> NSIDC is finding more efficient ways of conducting its work, including capitalizing on synergies between different projects and embracing a more flexible and responsive team-oriented approach to software development.

Major areas of research at NSIDC include:

- Processes driving the observed downward trend in Arctic sea ice extent and the environmental and societal consequences of this ice loss both within and beyond the Arctic

- The behavior of the Greenland and Antarctic ice sheets, Himalayan glaciers and their contributions to sea level rise

- Forecasting stream flow in the American West

- Changes in Earth's permafrost and their implications

- Alternative database structures to enable investigators to more efficiently search through vast data volumes to answer science questions
- Data casting services to making NSIDC data more visible to more researchers
- New directions in data stewardship involving the university library system
- Enhancing data discovery through semantic interoperability.

A continued strength of NSIDC is synergy between its environmental and informatics research and data management. Our in-house scientists consult in creating data products, answer questions from data users, and in some cases produce new data sets distributed by NSIDC. NSIDC's education and outreach efforts are wide ranging. NSIDC scientists are in high demand by the media to lend their expertise on environmental issues involving cryospheric change. Arctic Sea ice News and Analysis (http://nsidc.org/arcticseaicenews/), the most popular web page at NSIDC, provides daily updates of Arctic sea ice extent along with scientific analysis of evolving conditions that that is both accurate but accessible to a wide audience. Icelights (http://nsidc.org/icelights/) provides detailed information on ice and climate topics to complement Sea Ice News and Analysis. About the Cryosphere (http://nsidc.org/cryosphere/) provides a range of information about Earth's snow and ice, from comprehensive sections to quick facts on popular snow and ice topics.

Highlights of 2012

NSIDC Monthly Highlights (http://nsidc.org/monthlyhighlights/) serves to illustrate the breadth of work at the center, including how we are addressing challenges in data management, research on the cryosphere and the changes that are taking place, and how we are developing innovative ways to add value for our data and information users.

However, words and pictures are ineffective at conveying the pride, spirit of teamwork and willingness to adapt to change that characterizes the employees of NSIDC. In response to an increasingly challenging funding environment, NSIDC is finding more efficient ways of conducting its work, including capitalizing on synergies between different projects, embracing a more flexible and responsive team-oriented approach to software development, and reorganizing working space to promote better coordination and communication between the different functional groups of the center. While we have made great strides in the past year, as a living, evolving organization NSIDC is always learning and is constantly trying to improve itself to better serve the global community. ❄

As a living, evolving organization NSIDC is always learning and is constantly trying to improve itself to better serve the global community.

Monthly Highlights

A windy dilemma

On the world's most massive ice sheet, the bitter wind sculpts the surface snow into long, low dunes that are barely detectable while staring out into the horizon. Between the dunes, katabatic winds, caused by dense, cold air sinking and flowing off the continent, polish wind-swept areas to a high glaze. Much like waves on the ocean, megadunes form against the wind with scavenged snow rising only a few meters high but running tens of miles long and up to two miles wide.

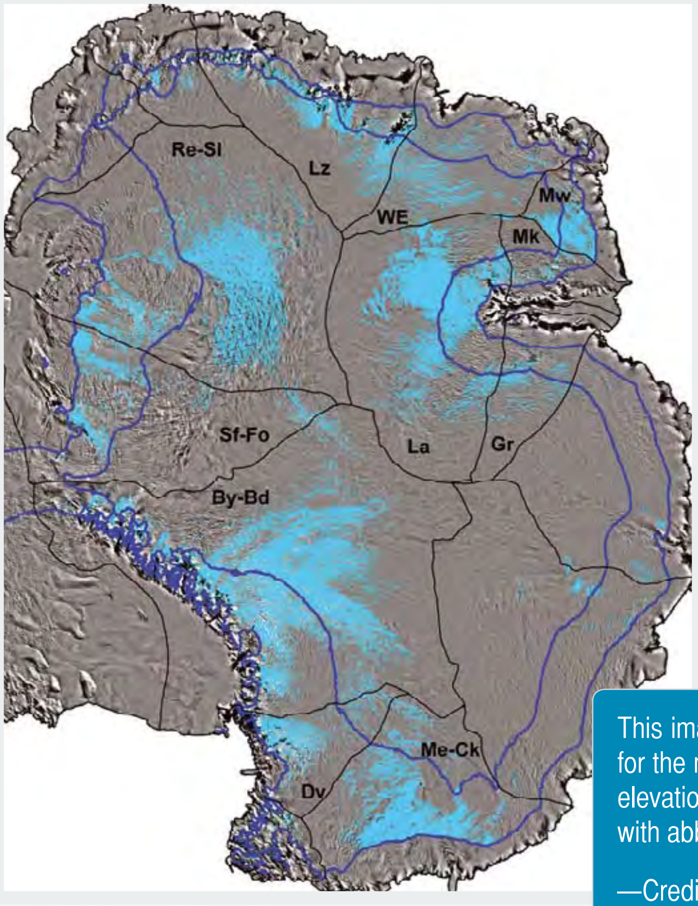
NSIDC lead scientist Ted Scambos has studied these formations for more than a decade. "Wind-glaze regions represent near-permanent bare patches in the snow layer—instead of a blanket layer, it's more like Swiss cheese," Scambos said. "Count the holes in the Swiss cheese and the overall accumulation of snow is much less than most modern scientists are saying." Knowledge of Antarctica's snow precipitation informs its contribution to seal level and is measured by the surface mass balance (SMB), or the difference between accumulation and ablation (sublimation and melting). A negative SMB implies a retreating ice sheet. So Scambos, along with a team of scientists from around the world, used a combination of satellite remote sensing and field-gathered datasets to map the extent of wind glaze in the East Antarctic Ice Sheet (EAIS) plateau.

Formation of wind glaze

The EAIS, much bigger than its western-hemisphere counterpart, features a distinctive topography of megadunes and wind-glaze surfaces, sculpted by the intense climate of the region. Low temperatures and low snow accumulation, coupled with near-continuous katabatic winds, create wind-glazed surfaces that can be 2 to 200 square kilometers (1 to 77 square miles) in area, usually above 1,500 meters (4,920 feet) on the leeward slopes of megadunes.

The wind-glaze surfaces result from strong winds, driven by the continent's temperature inversions. Typically the air closer to the Earth is warmer because the sun radiates warmth off the Earth's surface. Due to Antarctica's thick ice sheet, with an average thickness of 2,012 meters (6,600 feet), the coldest, most dense air hovers on the surface, providing the impetus for Antarctica's notoriously strong winds that sweep out toward its coastlines. With higher elevations, the gravity-driven drainage of cold inversion air accelerates the flow, removing any precipitated or wind-deposited snow within wind-glaze regions.

Wind gives a snowstorm personality. Under seemingly choreographed gusts, snow appears to merely resettle. Prior studies have assumed the same: wind distribution of snow is a mass-conservative process, meaning that mass lost from windswept areas is deposited in adjacent areas. But on the EAIS plateau, adjacent high-accumulation regions do not compensate for the surface loss. Since air must compress to descend, the snow it carries down a



This image shows distribution of glaze regions (cyan) in East Antarctica, for the major drainage basins for the ice sheet. The 1,500 to 2,500 meter elevation contours are shown in dark blue. Drainage basins are labeled with abbreviations of local major features or research bases.

—Credit: Ted Scambos et al., *Journal of Glaciology*

Ted Scambos checks on the GPS/GPR surveying system during the 2002-03 Megadunes expedition.

—Credit: Ted Scambos and Rob Bauer, NSIDC

mountainside gets progressively drier, smaller in particle size and more dissolvable.

An in-depth look

Beneath wind-glaze surfaces, a porous firn layer, 50 to 70 meters (164 to 230 feet) thick, preserves old snow with unique characteristics. Solar energy transmits more heat through a polished surface than an unmodified snow surface, warming the underlying firn and driving water vapor up. Condensation follows. Decades to centuries of repeated seasonal cycles have resulted in the formation of fingernail-sized crystals, which have been misrepresented in SMB measurements due to the intensity of their recrystallization. Where other studies have wrongly interpolated field measurements across glaze regions, Scambos and his colleagues used ground penetrating radar to properly image the subsurface and determine the extent of wind-glaze regions.

Earlier climate models have assumed the scope of wind glaze on the EAIS insignificant, but with about 11 percent identified, the regions can no longer be ignored. Results show that the overall SMB has been exaggerated anywhere between 46 to 82 gigatons, a large fraction to the net imbalance, meaning the actual SMB should be slightly negative. “If accounted for properly, this means there is less snow than we thought before,” Scambos said. “The implication is that Antarctica may be contributing more to sea level rising than we currently think.” ❄

References

Scambos, T. A., M. Frezzoti, T. Haran, J. Bohlander, J. T. M. Lenaerts, M. R. Van Den Broeke, K. Jezek, D. Long, S. Urbini, K. Farness, T. Neumann, M. Albert, J.-G. Winther (2012), Extent of low-accumulation ‘wind glaze’ areas on the East Antarctic plateau: implications for continental ice mass balance, Journal of Glaciology, Vol. 58, No. 210, doi: 10.3189/2012JoG11J232.

Ted Scambos’s Arctic Megadunes site: nsidc.org/cryosphere/antarctica/megadunes

All about snow

As winter approaches the Northern Hemisphere, millions of people unpack thick coats, hats, scarves, and gloves in anticipation, and sometimes dread, of the oncoming snowy weather. Snow affects many of us in some way. People must live and work in it, and cities must find ways to remove it. Animals and plants adapt to survive in snowy regions. Snowy weather can cause dangerous conditions, or create seasonal opportunities to get out and play.

NSIDC's recently updated educational Web site, All About Snow, can help satisfy your curiosity about snow. The site covers everything from snowflakes to snowstorms, explaining the various types of snow, both in the air and on the ground. Find out the difference between a flurry and a blizzard, how snow forms penitentes and rollers, or why snow looks white, blue, or sometimes pink or red. Learn about how people and animals cope with snow, and even use it to their advantage.

The expanded All About Snow also incorporates formerly separate educational pages from NSIDC's cryosphere section, "Avalanche awareness" and "Have snow shovel, will travel."

Snow and the globe

Many people are only interested how snow might affect the weekend's ski reports or the morning's commute. But snow plays

Once snow crystals form in the atmosphere, they grow by absorbing surrounding water droplets. The snowflakes we end up seeing on the ground are an accumulation of these ice crystals. This magnified image of snow crystals was captured by a low-temperature scanning electron microscope (SEM). The pseudo colors commonly found in SEM images are computer generated, and in this case highlight the different flake formations.

—Credit: Agricultural Research Service, United States Department of Agriculture a much bigger role in Earth's climate. So scientists also try to see how snow fits into the global picture: how much snow covers the globe each winter, and how long does it last? Each year, snow covers almost 18 million square miles of Earth's surface, with 98 percent falling during the Northern Hemisphere winter. Because it is such a large component of the cryosphere, snow influences the Earth's energy balance, regulating heat exchange between Earth's surface and the atmosphere.

Likewise, as climate shifts and regions warm, changes in the amount of snowfall and the extent of snow cover produce ripple effects throughout entire ecosystems. Snow that falls later in autumn and melts sooner in spring can extend growing seasons, or cause temperate plant species to creep northward into new territory. In turn, animals accustomed to snowy environments may increasingly find themselves drier and warmer for longer periods each year.

To find out more, explore the updated and expanded All About Snow site. Find out why snow matters to people, plants, and animals all over the world, or browse the list of resources about snow, blizzards, avalanches, and other related topics.

Visit All About Snow in the All About the Cryosphere section of our site, or go to the Web site directly at http://nsidc.org/cryosphere/snow. ❄

Avalanches can be caused by a variety of factors, including terrain, slope steepness, weather, temperature, and snowpack conditions.

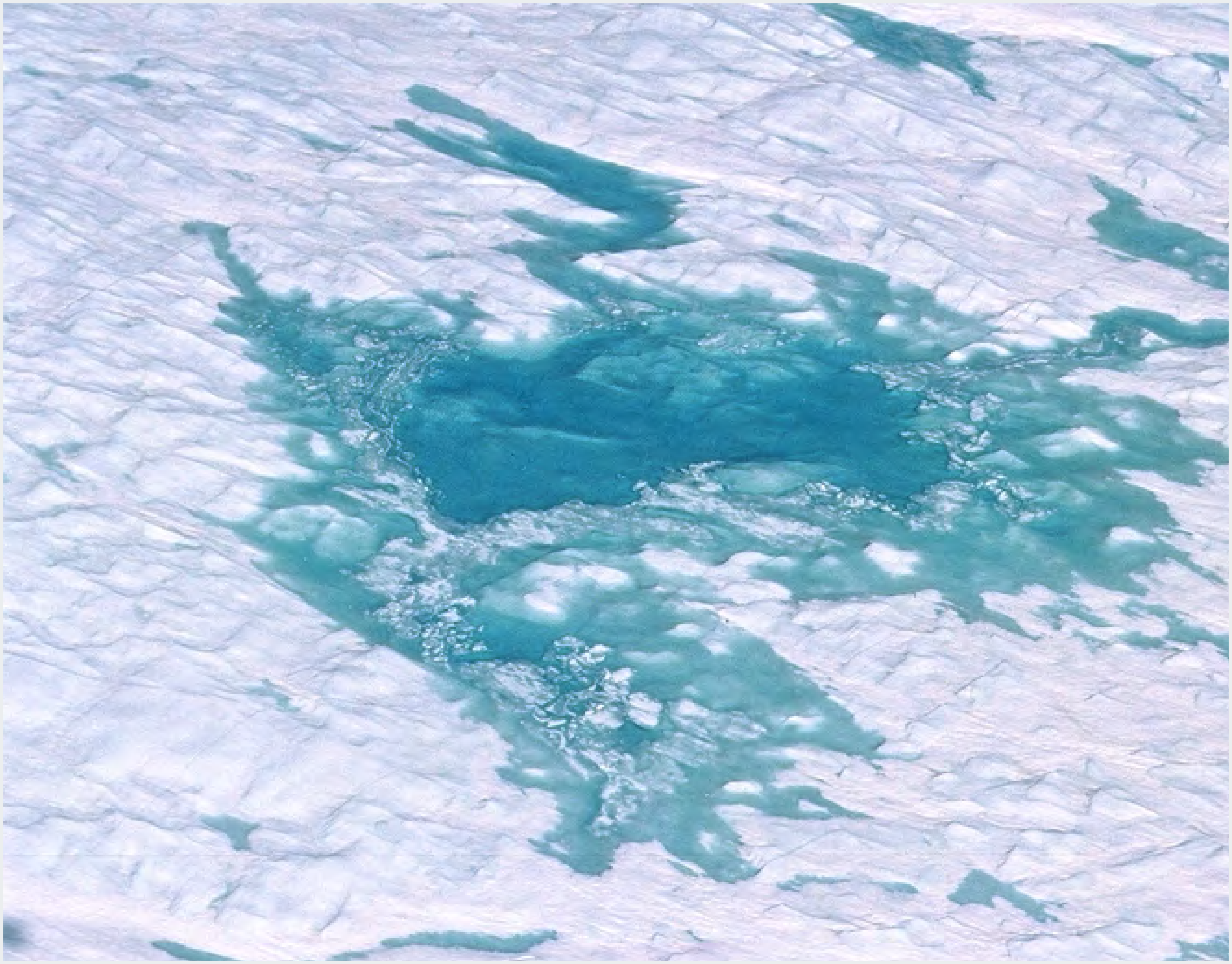
—Credit: Richard Armstrong, NSIDC

Newest eye on the cryosphere

Once Earth's frozen features were mostly solid and holding still, or at least moving very slowly and predictably, like the patient creep of a glacier towards its outlet. But now summer's thaw is beginning to outpace winter's freeze up, most strongly observed in the waning of Greenland's ice sheet and of summer Arctic sea ice cover. Around the Antarctic Peninsula and West Antarctica, ice shelves are collapsing, the ice sheet is thinning, and glaciers are speeding up. The cryosphere is on the move.

This aerial photograph shows a melt lake forming on the Greenland ice sheet during summer. In recent years, these melt lakes have become more extensive, providing visual evidence of higher-than-average surface melt during summer that is contributing to the thinning of this massive ice sheet.

—Credit: J. Maurer



These changes are too slow for a video camera to capture, but satellites can capture that time lapse of long-term changes seen in Earth's coldest regions. Perhaps the longest and most consistent series of satellites is Landsat, and early next year a new Landsat will fly. This new eye in the sky promises not just to keep the record going, but to provide more detail on Earth's forests, oceans, croplands, savannahs, snow, ice, and more.

A bluer vision

NSIDC scientist Ted Scambos was recently named to the Landsat Science Team, which advises NASA and the USGS on Landsat operations. "Landsat has been a great mapping tool," he said. "But it has now emerged as the best climate change detection system we've got as well." The newest Landsat, launched in February 2013, is the eighth in the series. Scambos and his Landsat team colleagues in other Earth science fields will help check that data from the new instrument aligns with past data, so that researchers have an uninterrupted record of the planet. They also provide guidance to the Landsat mission that will help Landsat reach its full potential for science. Landsat has always been powerful for its high resolution, and for its range of spectral channels. It can see in the visible light spectrum, like a photograph, and it can also see in the infrared to detect thermal information, invisible to the eye but valuable for studying features of oceans and forests in greater detail. The upcoming satellite also has two extra bands, giving it higher sensitivity.

With Landsat data, scientists like Scambos were able to map ice flow on Antarctica, helping to show that glaciers were accelerating the flow of ice to the ocean after the floating ice shelves in front of them broke up. Landsat 8 will be even better for studying changes in the ice sheets, Scambos said. "The new bands, and the new precision of the sensor, are going to help in a lot of areas," Scambos said, "especially the new blue channel. We'll be able to map melt water lakes on the ice sheets and ice shelves in fantastic detail." Other uses include snow and ice surface mapping, ice melt detection and melt pond measurement, and thermal mapping of debris-covered glaciers and the ocean surface near large floating glaciers.

Scientists used this Landsat image to study changes to the ice flow of Crane Glacier in Antarctica. The image was overlaid with information gathered by aircraft during NASA Operation IceBridge, which flew altimetry and other instruments over Antarctica to monitor Antarctica's changing ice sheet and glaciers.

—Credit: C. A. Schuman

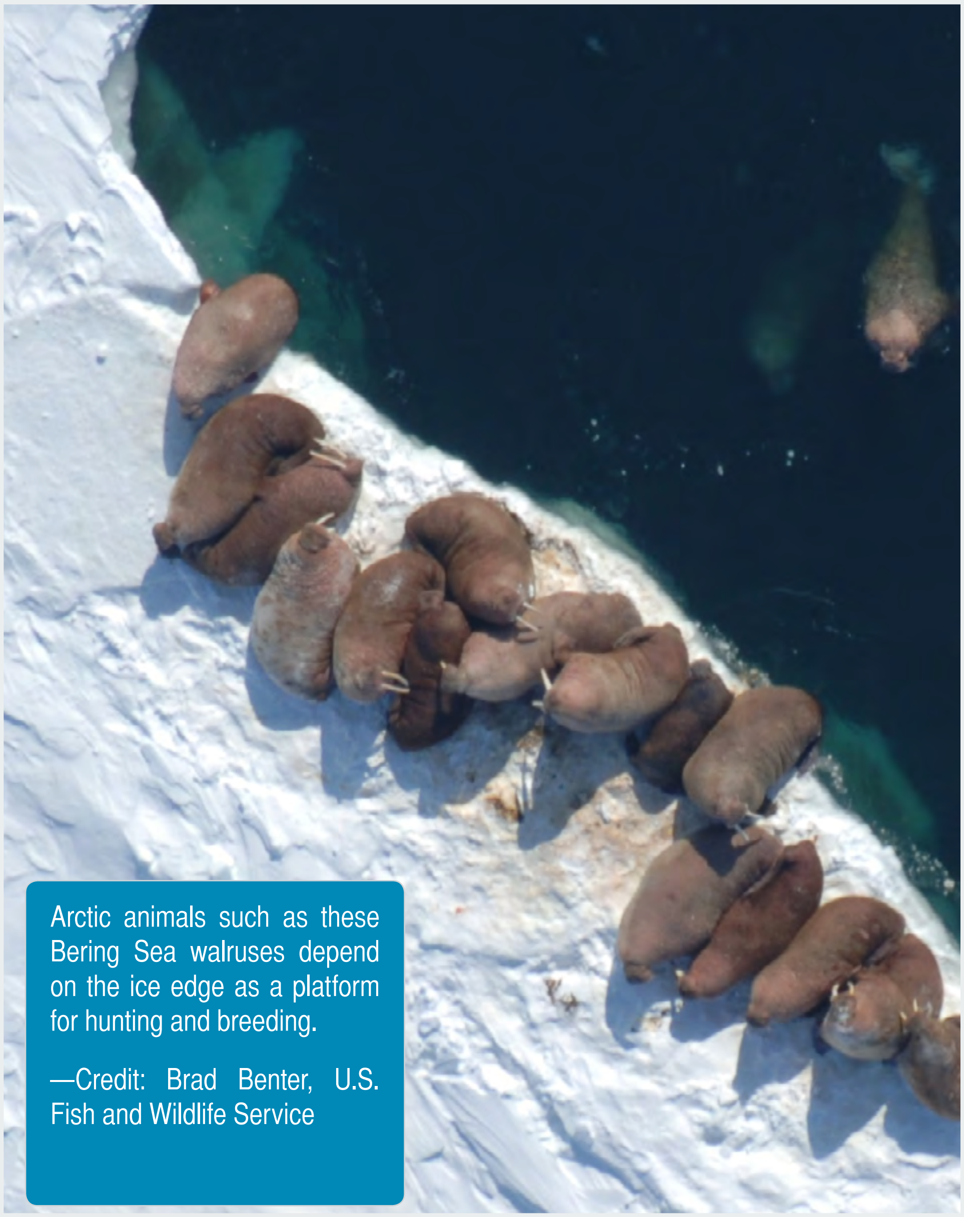
For more information on the Landsat Program, visit their Web page at landsat.gsfc.nasa.gov.

For more information on Ted Scambos's research, see nsidc.org/research/bios/scambos.html.

An Arctic without sea ice

The rapid retreat and thinning of the Arctic sea ice cover over the past several decades is one of the most striking manifestations of global climate change. As the ice left at the end of each summer continues its sharp downward trend, setting a new record low in 2012, scientists want to understand exactly what this means for the Arctic and for Earth's climate as a whole.

One of the grand challenges in understanding summer sea ice decline is the question of how soon the Arctic Ocean could become virtually ice-free by summer's end. An Arctic Ocean with only discontinuous patches of ice floes is thought of as a marker of fundamental change in the Arctic climate system. More of the darker ocean surface would be exposed for a longer time, absorbing the Sun's heat and then transmitting that heat back to the air and land. A warmer Arctic also portends warmer lower latitudes, as the Arctic weakens in its role as Earth's air conditioner.



Arctic animals such as these Bering Sea walruses depend on the ice edge as a platform for hunting and breeding.

—Credit: Brad Benter, U.S. Fish and Wildlife Service

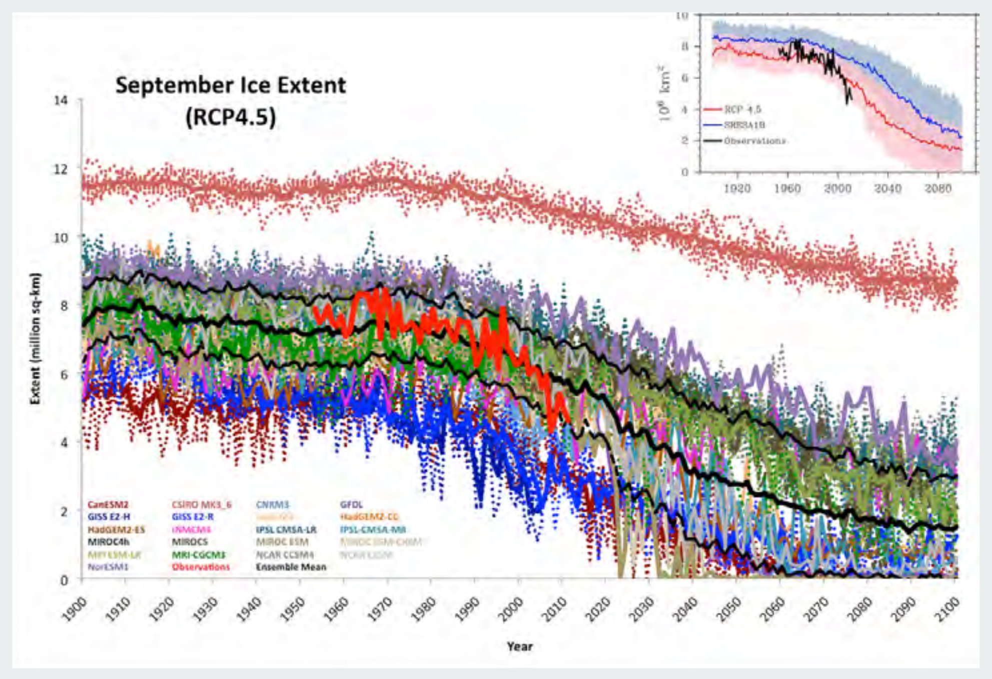
Modeling the decline

Computer climate models help strengthen researchers' understanding of how Arctic sea ice loss feeds back warming into the Earth system. The models are built on current understanding of the system and past observations. Researchers can use the models to run scenarios with less sea ice cover, increased greenhouse gases in the atmosphere, and other inputs that could affect climate. When the Arctic may become ice free is but one of the important questions that they may use the models to study.

But tuning these climate models is a work in progress, given that scientists are modeling a moving target. One test of the models is how well they simulate current climate conditions. Previous studies revealed that the actual downward trend in September ice extent exceeded simulated trends from most models participating in the World Climate Research Programme Coupled Model Intercomparison Project Phase 3 (CMIP3). Since then, researchers have worked to refine the models.

This graph comparing results from climate models shows that the actual downward trend of Arctic sea ice decline continues to exceed what most models predicted.

—Credit: Stroeve et al., *Geophysical Research Letters*



A new study led by NSIDC scientist Julienne Stroeve shows that as a group, simulated trends from the next generation of models, CMIP5, are more consistent with observations over the satellite era (1979 to 2011). So researchers may be closer to an accurate picture of sea ice decline, yet that picture remains elusive.

Exceeding expectations

While closer, the trends from most models nevertheless remain smaller than the observed rate of decline. As of September 2012, satellite data indicated that September Arctic sea ice is currently declining at a rate of -13% per decade, compared to the 1979 to 2000 average. Modeling sea ice thickness continues to be a challenge. Thinning sea ice impacts its ability to survive the melt season, and ice thickness depends on complex factors such as rates of ice transport by winds and ocean currents, and ice melt and growth. As well, natural variability remains a factor in sea ice decline, and by its nature is hard for models to account for. This means that a prolonged series of warmer or colder years could considerably accelerate or delay ice-free summers.

Still, it is clear that if greenhouse gas concentrations continue to rise, the Arctic Ocean will eventually become seasonally ice free. While the models still do not provide a certain date, the CMIP5 models are presently suggesting that the Arctic will be seasonally ice-free Arctic sooner than 2035, what the previous model ensemble version CMIP3 suggested. ❄

Reference

Stroeve, J. C., V. Kattsov, A. Barrett, M. Serreze, T. Pavlova, M. Holland, and W. N. Meier (2012), Trends in Arctic sea ice extent from CMIP5, CMIP3 and observations, Geophys. Res. Lett., 39, L16502, doi:10.1029/2012GL052676.

Libre frees polar data

Knowledge is the common wealth of humanity.

–Adama Samassekou, Convener of the UN World Summit on the Information Society

Science is increasingly based on data, yet the systems and tools for sharing data lag the immediacy and variety of data being produced. The rapid changes being observed in Earth's frozen regions—thawing ground, retreating glaciers, melting ice sheets, and waning summer sea ice extent–are a case in point. Scientists who collaborated during the recent International Polar Year identified ease of data sharing as key to help pace scientific understanding with the speed of climate-induced changes being observed. A project at NSIDC called Libre puts data sharing tools in the hands of researchers—tools that are free and easy to use, and address some of the common sticking points that prevent open sharing.

Simplifying data sharing

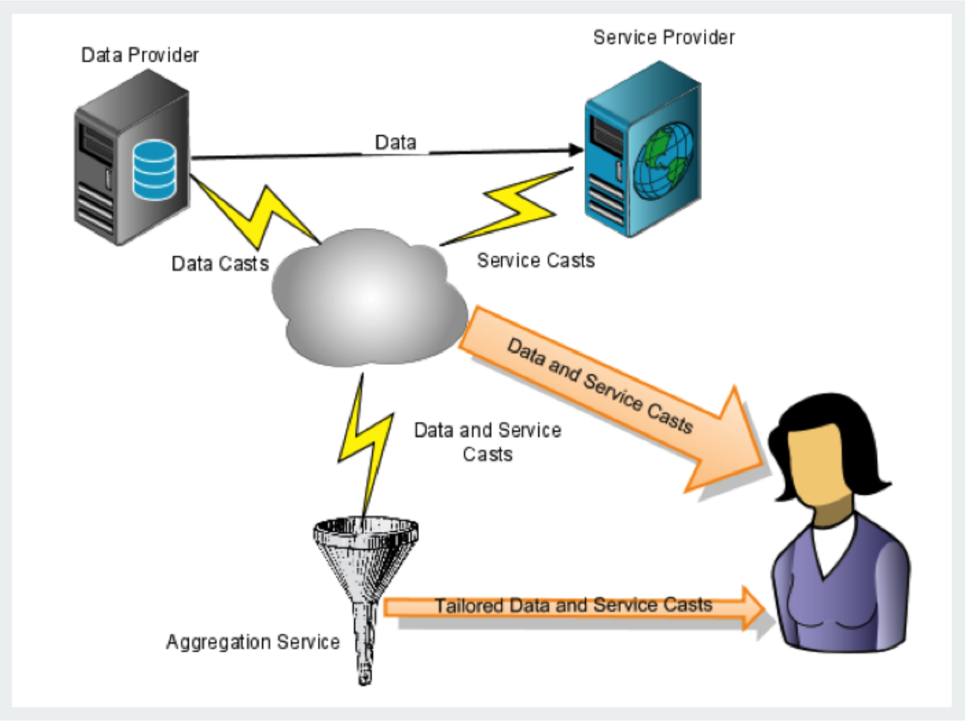
Libre is a project devoted to liberating science data from traditional constraints of publication, location, and findability. Leveraging open-source technology and data management standards, Libre's Web-based tools and services make it easy for scientists to publish and advertise their data and share it with the world.

An Arctic researcher removes a snow core sample.

—Credit: Andrew Slater, NSIDC

A major challenge recognized throughout the Earth science data community is the problem of uniform discovery of all data relevant to a particular user's needs. The problem is that in most cases, relevant data may be found in any number of discipline-specific repositories, national data centers, organizational repositories, and libraries. Or the data may not reside in any repository at all. Instead, the data may reside with an individual researcher, laboratory, or work group. In this case, it can be difficult for an investigator to find or obtain the data.

Libre allows data providers, whether an individual investigator with a single data set to share or a data repository with potentially hundreds of data sets to share, to advertise their holdings in a Web-discoverable way, and for registries to find those advertisements wherever they are located, and to aggregate those that are relevant to their particular user communities.



Tools and services

Libre offers several tools to these ends. First, the Libre Collection Caster is a Web-based tool that creates Atom feeds so data providers can advertise their data sets, and users and computers on the internet can discover the data quickly and more efficiently. The Collection Caster uses Atom technology, which means that the Collection Cast or feed can be viewed with any desktop or browser-based feed reader.

Once data are exposed to the Web, Libre's OpenSearch Application Programming Interface (API) provides a simple way to discover and access data holdings that have been found by Libre's web crawling and aggregation services. The API can be tailored for queries specific to a user's research, and return ATOM feeds listing the search results.

For example, the Libre OpenSearch API underlies the NASA DAAC IceBridge Portal developed by NSIDC. From the Portal, users can subscribe to a feed listing all the related data sets that match their data query and that are known to the NSIDC system. Once subscribed, whenever a new data set matching the query criteria becomes available, or one of the existing data sets on their personal feed is updated, users are notified.

> Libre provides simple tools for data sharing that can be used by individual investigators and research projects of any size.

And finally, Libre makes it easy for data providers to clearly communicate to others about appropriate reuse of their data. Libre's badging tool makes it simple to declare your data open for broad use, while asserting that such data should be used according to the Ethical Norms of Data Sharing developed by the polar science community. This tool provides the data provider with a Creative Commons badge to display on their Web pages and in their data documentation that conveys their wishes in a way readily understood by both people and data systems.

For more information, visit the Libre Web page at NSIDC.

Taking the temperature of permafrost

Last summer, Tingjun Zhang spent two months in China, drilling boreholes and taking temperatures. Zhang, a senior research scientist at NSIDC, is part of a team studying permafrost in the upper reaches of the Heihe River Basin in the Qilian Mountains, which form the north-eastern escarpment between the Tibetan Plateau and the Gobi Desert. Zhang's research is part of a larger study of Heihe River basin along the north slope of the Qilian Mountains, funded by the Natural Science Foundation of China. His research team, along with nearly forty others, is hoping to gather enough data over the course of the study to form a clearer picture of how a changing climate may affect the plants, wildlife, and the people of the area.

Frozen layers

"We are looking at how changes in permafrost are affecting the region's hydrology," Zhang said. "We also want to understand how permafrost affects the ecosystem, because the area has grazing for sheep, cattle, and other livestock." The permafrost underlying the study area is already considered warm, remaining only two degrees Celsius below freezing. Only a very slight warming would be disastrous

Tingun Zhang and his colleagues spent several months in west China, drilling boreholes in permafrost. The temperature data from the boreholes will help them understand whether permafrost in the region is warming, and if so, how fast.

—Credit: Cuicui Mu

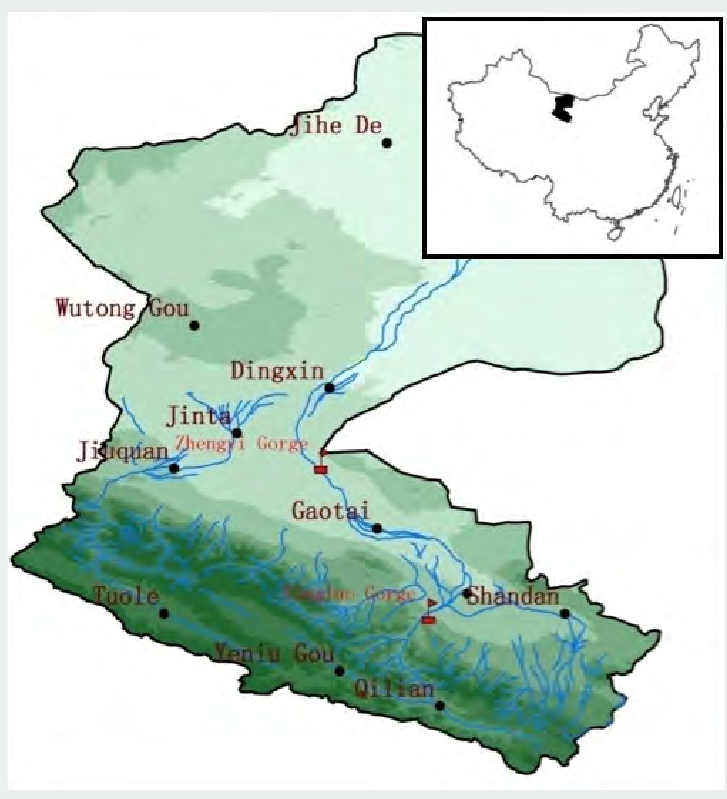
for the region. "Air temperatures have increased by one degree Celsius over the past 30 years," he said.

Permafrost is soil that remains frozen year-round. In many places, however, permafrost is topped by a shallow layer that scientists call an active layer, because it freezes and thaws seasonally. Over the study area that Zhang is investigating, this layer is 2 to 4 meters (6.5 to 13 feet) deep. Plants grow when an active layer is present, because the seasonal thawing releases water. The underlying permafrost acts like a barrier, locking moisture in and preventing it from draining through the soil. If this reserve of water does not remain near the surface, it could have serious consequences for grazing along the plateau. Zhang said, "As temperatures increase, the active layer gets deeper, meaning ground water levels get deeper and there is less water available near the surface to grow the vegetation animals need for grazing."

The current temperature records rely on sparse measurements, so one of Zhang's projects is to install instruments that will take regular temperature readings in the area and develop a long-term record. He will return to China over the next few summers to continue his research and learn how permafrost in the region is responding to this gradual warming. He and his team will map the distribution of permafrost as well as the development of the active layer that irrigates the grasslands.

Considering carbon

Changes in permafrost could have more wide ranging affects, as well, because thawing permafrost releases carbon into the atmosphere. "There is a lot of carbon stored in permafrost, and it could really contribute to global warming," Zhang said. He and his team will start investigating how much carbon might be released, should the area continue to warm. Carbon is a potent greenhouse gas, so thawing permafrost could fuel a global feedback loop that further warms the atmosphere. ❄



Tingjun Zhang and his team are researching permafrost in the Qilian Mountains of north central China. The area has been slowly warming, and thawing permafrost could change the area's vegetation and make it more difficult for herders to find good grazing for their livestock.

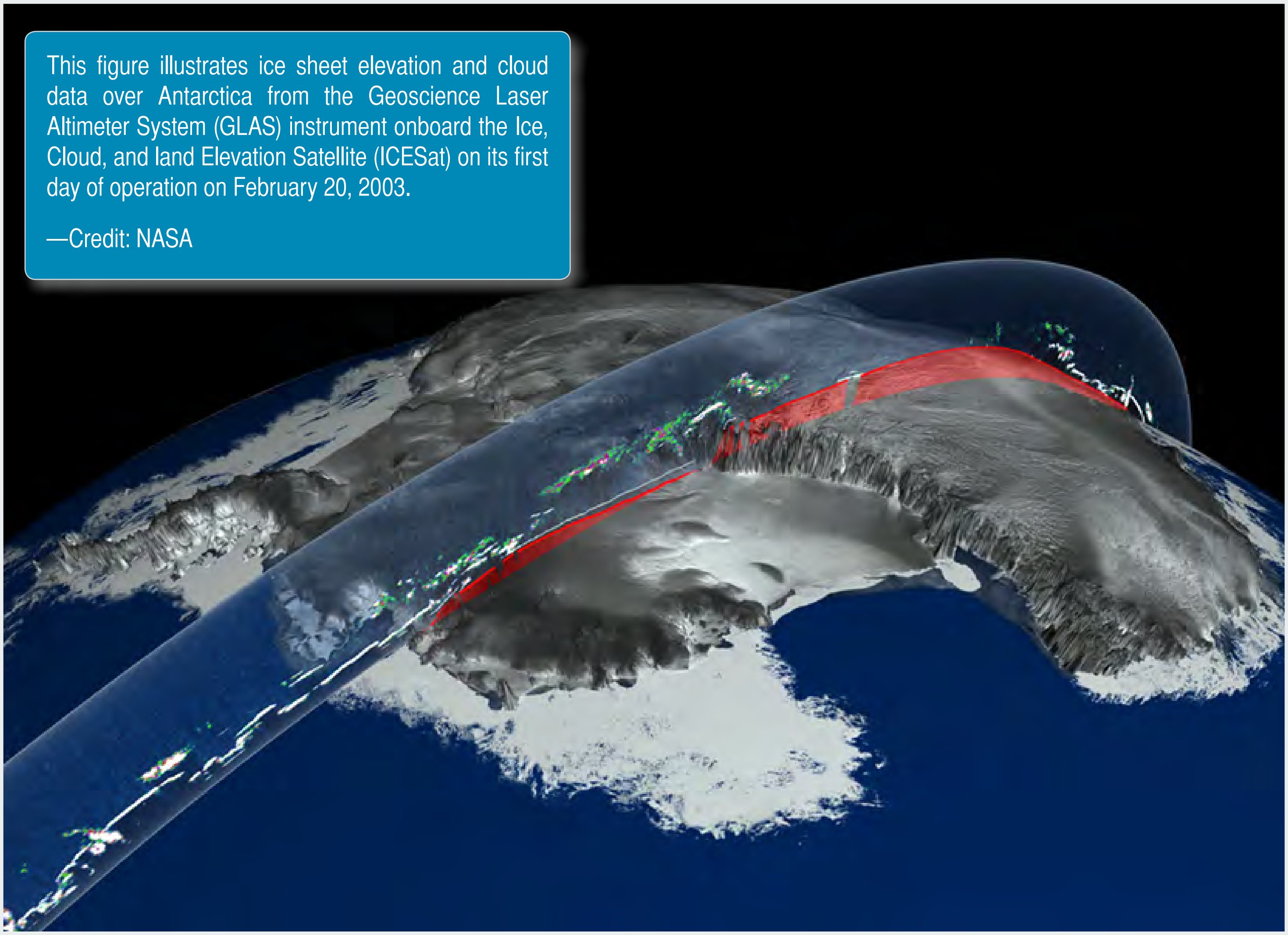
—Credit: Tingjun Zhang, NSIDC

A permanent home for ice sheet data

Data wranglers will agree that the worst thing that can happen to a data set is for it to become orphaned. Even before NASA decommissioned the Ice, Cloud, and land Elevation Satellite (ICESat) in 2010, the space agency chose the National Snow and Ice Data Center (NSIDC) as the permanent home for the satellite's data. NSIDC is steadily preparing data from the satellite's sole instrument—the Geoscience Laser Altimeter System (GLAS)—for the long haul.

"There have been missions in the past when researchers stop using the data after these became difficult to access or the documentation had gone away," said Doug Fowler, who leads the product team for GLAS. NASA is making sure that GLAS data will remain available to Earth science researchers by permanently archiving the data, software, and user documentation at NSIDC. Program and mission documentation on ICESat will reside on the NASA Technical Reports Server.

"GLAS was the first space-borne laser altimeter and it collected elevation data over ice sheets and sea ice better than any previous satellite instrument, so it is impor-



This figure illustrates ice sheet elevation and cloud data over Antarctica from the Geoscience Laser Altimeter System (GLAS) instrument onboard the Ice, Cloud, and land Elevation Satellite (ICESat) on its first day of operation on February 20, 2003.

—Credit: NASA

tant to keep its data available and compatible with missions that follow it," Fowler said.

Beyond binary

ICESat circled Earth for seven years, collecting data that are crucial for understanding ice sheet mass balance and sea level change. It measured cloud and aerosol profiles for studies of atmospheric processes. The satellite also collected elevation data over land and vegetation. Data collected over forests are especially important for studying how much carbon is stored in the world's trees. ICESat was decommissioned in August 2010 and its successor, ICESat-2, is expected to launch in late 2016.

This photo shows green laser pulses from the Ice, Cloud, and land Elevation Satellite (ICESat) reflected on clouds of the night sky, as seen from the ground soon after the laser was first turned on in 2003.

—Credit: Ball Aerospace

"We are archiving a copy of all ICESat data in the format that ICESat-2 data will be in to preserve the time series of available data," Fowler said. ICESat data have been offered in binary format, but storing and offering the data in HDF5 format will make the extremely large and complex data collection easier to manage. NSIDC will continue to offer ICESat data in binary format and will start offering the data in HDF5 format in September 2012.

From GLAS to MABEL to ATLAS

NASA has also been working on GLAS's successor. ICESat-2 will use a new type of laser altimeter instrument for measuring elevation, and will acquire far more data. To test the instrument concept, and develop accurate software to process the data, NASA has been flying an instrument called Multiple Altimeter Beam Experimental Lidar (MABEL) on high-altitude aircrafts to simulate measurements that the Advanced Topographic Laser Altimeter System (ATLAS)—GLAS's successor–will be making from space.

MABEL and ATLAS are photon-counting laser altimeters, meaning they measure distance by detecting just a few photons from each laser pulse and timing their round-trip travel from satellite to earth and back extremely accurately. While GLAS used millions of photons to make a single distance measurement, MABEL and ATLAS gather a data set of just a few dozen photons at most, and produce a cloud of points describing the snow or land or vegetation surface structure. Sophisticated software will determine the location of the surface track, the tops of the tree canopy, or the amount of dust or fog in the air.

In the meantime, NASA's Operation IceBridge began in 2009 with the goal of using airborne lasers and other sensors to bridge the gap in polar observations between ICESat and ICESat-2. The surveys will collect data in selected areas of the Arctic and Antarctica until the launch of ICESat-2.

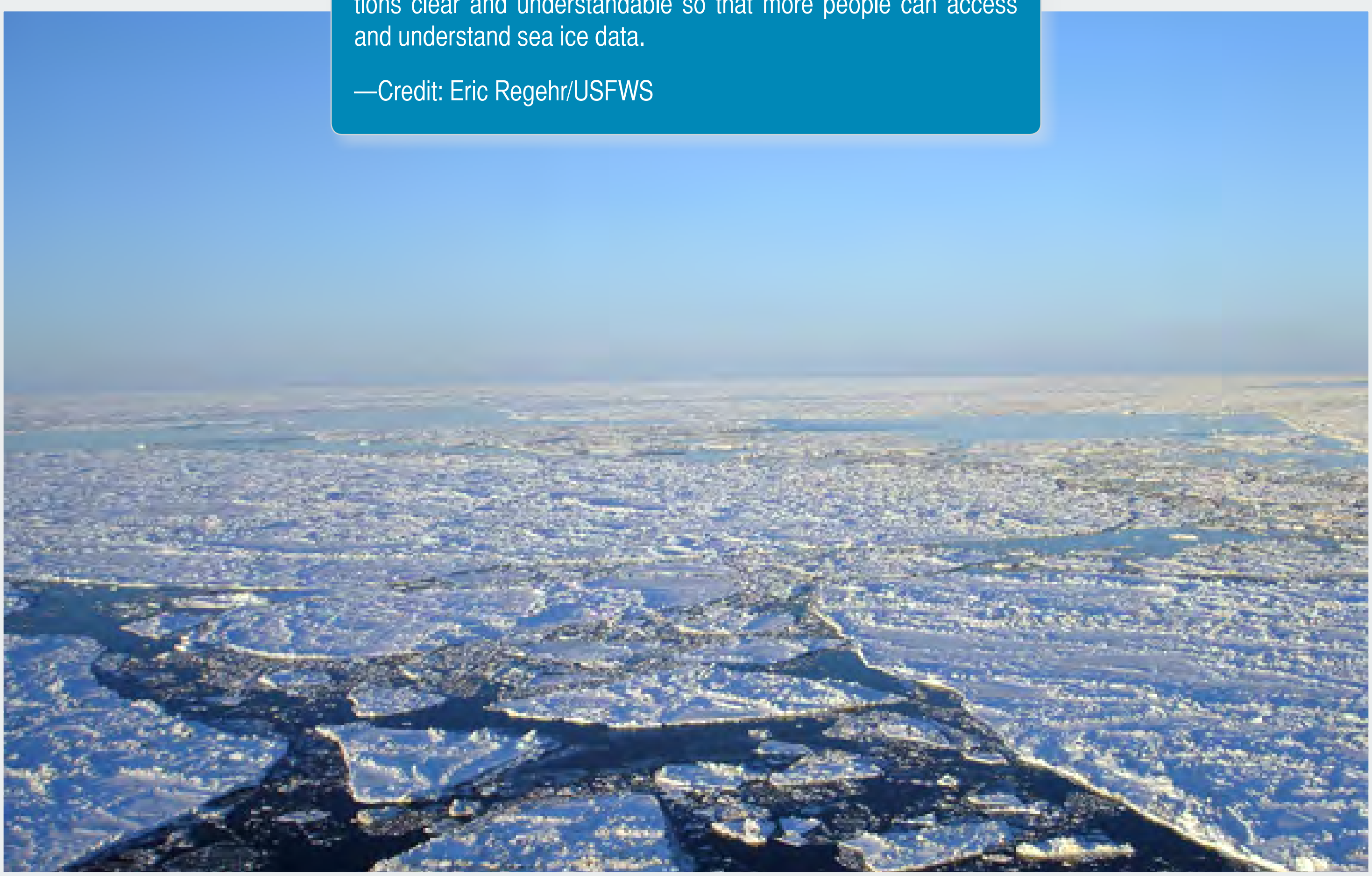
To learn more about GLAS data at NSIDC, visit the ICESat/GLAS Web page. To learn more about ICESat progam and mission documentation, visit the NASA Technical Reports Server. For more information about IceBridge, visit the NSIDC Distributed Active Archive Center's IceBridge Data Web page.

Data across disciplines

At NSIDC, researchers study Arctic sea ice using data from satellites. But those data just provide one view of the ice cover. Arctic biologists, climate scientists, hunters, and ship captains all use data on sea ice to inform their work. NSIDC data expert Mark Parsons said, “Think about just a simple term like ‘ice edge.’ Different communities define that in different ways.” Researchers who use satellite data define the edge of the sea ice pack as where less than fifteen percent of the surface is covered in ice. Parsons said, “But if you are a ship captain, that's not going to cut it. You need to know where the ice edge is in terms of risk to your ship.”

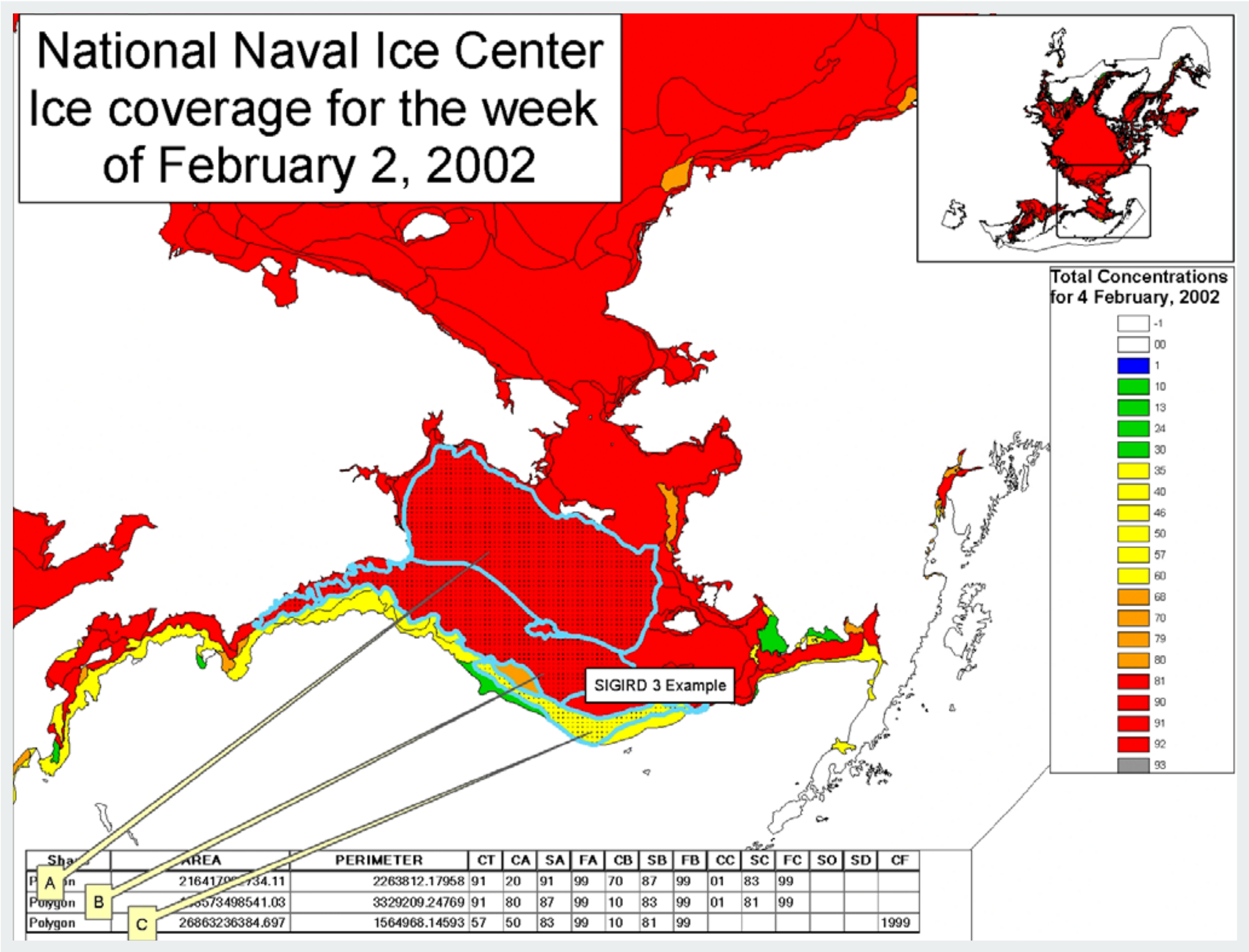
How can sea ice data from different disciplines be made accessible and usable by a broader audience? Parsons and a team of researchers from NSIDC and Rensselaer Polytechnic Institute are working to solve that problem with a new project called the Semantic Sea Ice Interoperability Initiative (SSIII). “The whole goal in Arctic science is to try to understand the Arctic as a system,” said Parsons. ”So we need data from very diverse sources.” The SSIII aims to bridge the gaps between those different data types, establishing clear definitions of terms and linking them to other terms in a way that computers can understand and communicate.

The SSIII takes vague terms like “ice edge” and encodes all the different definitions, in a way that computers can comprehend them, to create a framework that organizes



In studying sea ice, even seemingly simple terms like “ice edge” have different meanings in different communities. The Semantic Sea Ice Interoperability Initiative (SSIII) aims to make these definitions clear and understandable so that more people can access and understand sea ice data.

—Credit: Eric Regehr/USFWS



This ice chart from the National Ice Center encodes sea ice data in a way that makes sense to ships and boats. The SSIII takes data like these and provides additional information that make the data more understandable to a broad audience.

—Credit: NSIDC/NIC

concepts and their relationships, called an ontology. The ontology for ice edge would include the ship captain's definition, the remote sensing definition, as well as any definitions provided by other groups like Inuit hunters, who rely on the ice pack for travel and hunting.

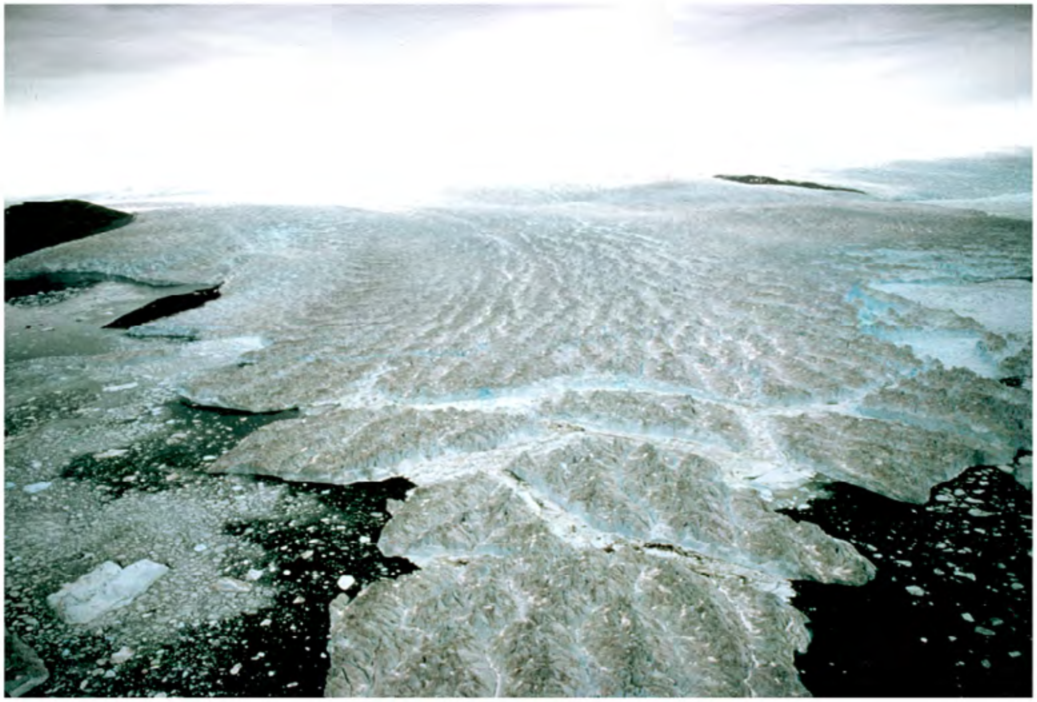
Towards interoperability

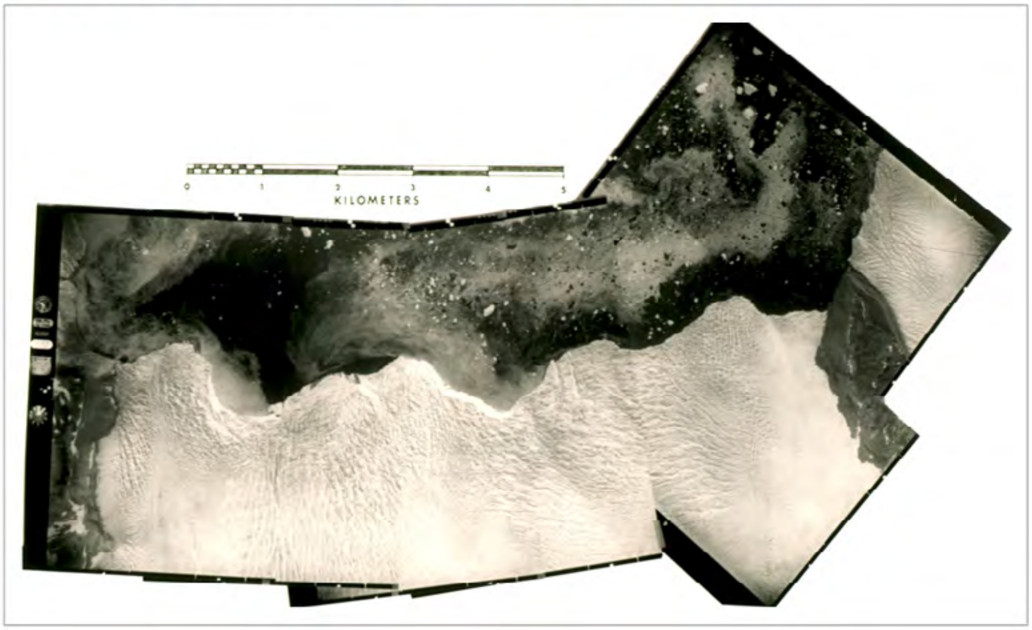
Organizing the vocabularies of sea ice into a framework provides a foundation for sharing not just data, but the meaning of the data "This is a baby step towards the greater vision," said Parsons. "You have precise meanings that are understood by machines, to enable people to use data from different sources." While the SSIII focuses on sea ice as a model system, Parsons and his colleagues at NSIDC and Rensselaer are part of a growing community of data experts who are working to make data more accessible and useable, as science becomes increasingly interdisciplinary and data sets become larger and more complicated. The ontologies are available at http://nsidc.org/ssiii and the team welcomes feedback. The project, funded by a grant from the National Science Foundation, has just completed its first of four years. ❄

A census of moving ice

Researchers in Boulder and Zurich are gaining ground in compiling the most extensive record of Earth's constantly changing glaciers. Using data from aerial photographs and maps, the National Snow and Ice Data Center (NSIDC) and the World Glacier Monitoring Service (WGMS) have added 25,000 more glaciers to World Glacier Inventory (WGI), bringing the total to 132,890. The inventory now describes 85 percent of Earth's estimated 160,000 glaciers, or 70 percent (470,000 square kilometers) of the total estimated area covered by glaciers and ice caps (680,000 square kilometers).

Glaciers are slowly moving rivers of ice made up of fallen snow that, over the years, compressed into large, thickened ice masses. Some





Two views of the Nansen Gletscher terminus in aerial photos taken by the U.S. Coast Guard in 1980 (top) and 1970 (bottom). This Greenland glacier is one of 25,000 that have been added to the World Glacier Inventory.

—From the Glacier Photograph Collection. Boulder, Colorado, USA: National Snow and Ice Data Center/World Data Center for Glaciology. Digital Media.

are the size of football fields while others grow to be over a hundred kilometers long. Scientists study glaciers because these are a large source of fresh water and are among the most sensitive indicators of climate change.

How much ice

"How many glaciers are there on Earth? That's a good question, but a very hard one to answer," said NSIDC glaciologist Bruce Raup. When glaciers grow or retreat over time, they can either merge into a bigger one or get divided into smaller ones. Estimates of the total number of glaciers vary hugely, from 160,000 to 300,000.

"It's easier and more important to keep track of how many square kilometers are covered by glaciers," Raup said. "Say a glacier retreats up a valley and its tributaries get separated. Where you once had one glacier, you now have three. But then you also have less ice."

How much ice a glacier contains or has lost interests scientists the most. Each glacier in the inventory is described by geographic location, area, length, width, elevation, glacier classification and form, orientation, and ablation (how much snow or ice the glacier has lost) and accumulation area. Using these, scientists can derive information on how climate is changing and how much glacial melt is contributing to rising sea levels.

Ambitious effort

The inventory has been valuable in helping build other glacier databases. The Global Land Ice Measurements from Space (GLIMS), a database of glacier outlines from satellite data, draws on and extends information from the inventory and is monitoring changes in 93,000 glaciers. The Randolph Glacier Inventory, in turn, expands on GLIMS to produce a complete map of where all glaciers are on Earth, in preparation for the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

"The World Glacier Inventory is the oldest of modern glacier inventories," Raup said. "It's a global, collaborative effort and is rooted in work that began in the 1890s as an ambitious attempt to measure and classify all perennial ice masses on Earth." Glaciers recently added to the inventory are located in the Antarctic Peninsula, the Antarctic Islands, South Patagonia, the Central Andes, Iceland, Greenland, and Baffin Island and Yukon in Canada. NSIDC and the WGMS will continue to update and improve the inventory as more data becomes available.

For more information and to access the data, see the World Glacier Inventory page. ❄

References

Dyurgerov, M. B. and M. F. Meier. 2005. Glaciers and the changing Earth system: a 2004 snapshot. Institute of Arctic and Alpine Research, Occasional Paper 58.

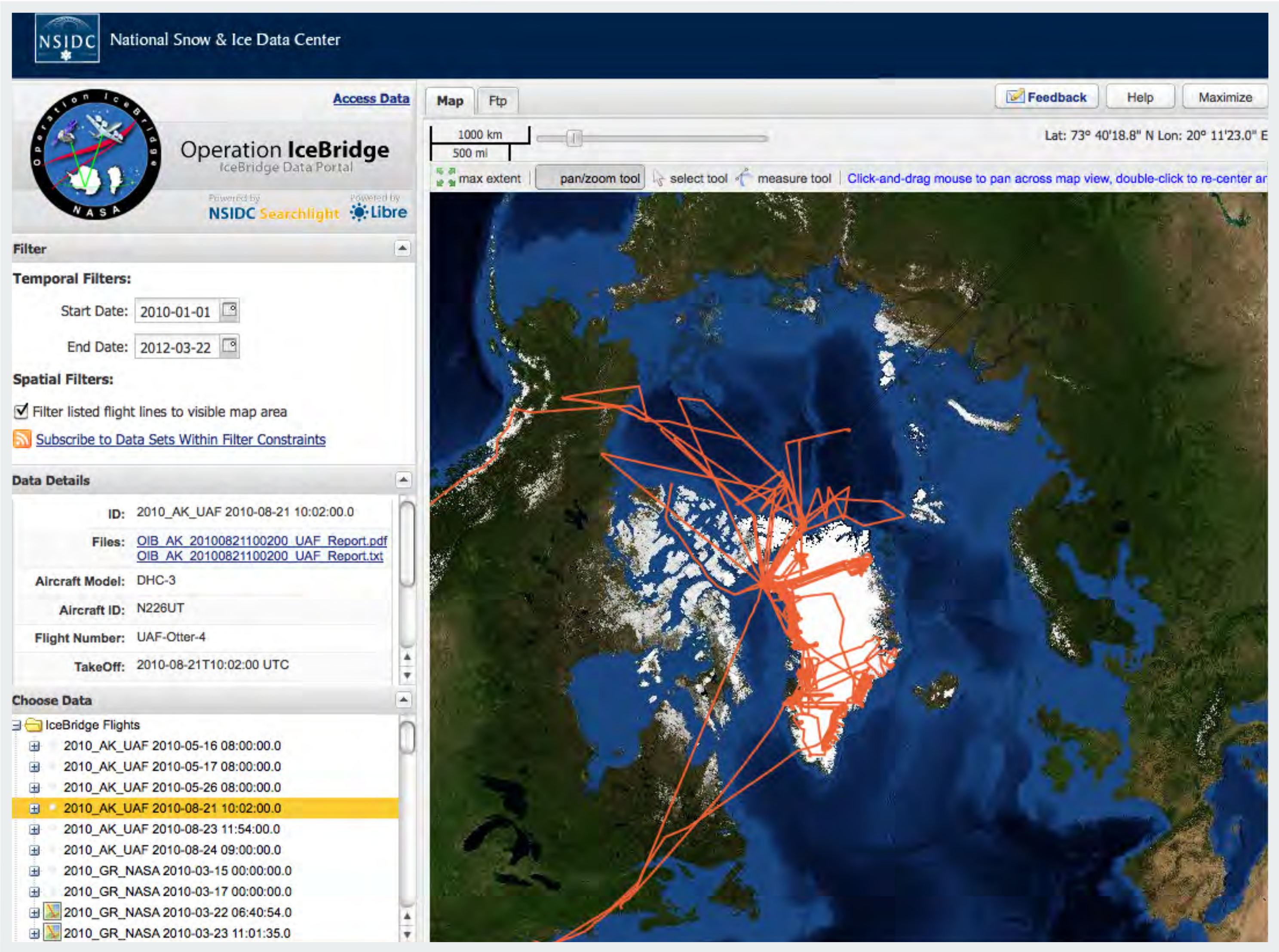
Meier, M. F. and D. B. Bahr. 1996. Counting glaciers: Use of scaling methods to estimate the number and size distribution of the glaciers of the world. CRREL Spec. Rep., 96, 89–94.

Mapping IceBridge

The NASA Operation IceBridge mission ensures continuous scientific observations over Earth's polar regions during a period of unprecedented change. The mission collects airborne remote sensing measurements to bridge the gap between the NASA Ice, Cloud and Land Elevation Satellite (ICESat), which stopped collecting data in 2009, and the upcoming ICESat-2 mission planned for 2016. ICESat carried the Geoscience Laser Altimeter System (GLAS) instrument, which was unique in its ability to measure the elevation of ice sheets, ice shelves, and glaciers, compared to other satellites that only detect surface extent. These elevation measurements help researchers assess mass changes in the ice, an indicator of climate change as well as of the potential for sea level rise as water is unlocked from glaciers and ice sheets and added to the oceans.

> The IceBridge data portal helps researchers locate and access data through a map-based interface.

The data produced by IceBridge are just as complex as they are critical. As the data



archive and distribution point for IceBridge, NSIDC is addressing the unique challenges of managing data for an extended airborne campaign and getting these data into the hands of researchers studying the polar regions. The recent update of the IceBridge Data Portal at NSIDC is designed to speed that access.

IceBridge data at NSIDC

As of March 2012, NSIDC has published 47 unique data sets. Many more data sets are expected as annual campaigns wrap up and submit their data. IceBridge mission observations and measurements include coastal Greenland, coastal Antarctica, the Antarctic Peninsula, interior Antarctica, the southeast Alaskan glaciers, and Antarctic and Arctic sea ice.

These data were acquired by 30 separate instruments during 12 flight campaigns, which is one reason that IceBridge data are more complex to manage and access than satellite data. IceBridge combines multiple instruments to map ice surface topography, bedrock topography beneath the ice sheets, grounding line position, ice and snow thickness, and sea ice distribution and freeboard. Data from laser altimeters and radar sounders are paired with gravimeter, magnetometer, digital camera, and other data to provide dynamic, high-value, repeat measurements of rapidly changing portions of land and sea ice.

Because these measurements follow a complex web of flight lines rather than the large, consistent swaths of satellite-borne instruments, researchers need a way to discover what data exist for a study region. NSIDC is building the IceBridge Data Portal to help researchers more quickly locate and access data, using a map-based interface.

The IceBridge Data Portal

The IceBridge Data Portal is a Web-based tool for quickly and easily finding flight reports and science data for a selected flight. A map display helps users visualize where the actual flights took place. The interface provides three panels with information and controls to display flight reports, instrument data, and related data sets.

In the Filter panel, users can filter flight reports by temporal coverage using a calendar, and filter flight reports by spatial coverage by drawing a bounding box on the map display. Flight lines appear on the map, showing researchers which flights covered a particular study area. Users can click on a flight line to get more detailed information.

The Data Details panel displays metadata about the selected flight report, and a link to either a text file, or a Portable Document Format (PDF) of the flight report. The text file contains a subset of the content in the PDF. The PDF contains more detailed information logged by the flight manager after the flight.

Users can also click on a flight report in the Choose Data panel, and that flight line will change to yellow on the map display. They can click on the data set link in the Choose Data panel to access the flight data via FTP. They can also access related NSIDC data sets.

In addition, NSIDC is currently preparing to put datasets into permanent archive, where they will have full spatial metadata and more related services. This move will make the data accessible via the NASA Reverb data interface and the NSIDC Data Pool drill down interface, in addition to direct FTP download. Future portal releases will include more sophisticated search and visualization functions necessary to fully exploit the data. These steps are part of the long-term plan to increase visibility and access for IceBridge data.

To learn more about IceBridge data sets, visit the NSIDC IceBridge Data site. To learn more about the IceBridge project, visit the NASA Operation IceBridge home page. ❄

A case of the vapors

When it comes to climate change in the Arctic, melting sea ice and warming oceans often get the most attention. Yet in the atmosphere, another watery component is changing as well: water vapor. As sea ice extent and duration decrease and air temperatures rise, the increasingly open Arctic Ocean is subject to even more evaporation, pumping more water vapor into the atmosphere, making it more humid. In addition, warmer air is capable of holding more water, so increasing humidity over the Arctic may be yet another signal that air temperatures in the region are rising, producing yet another feedback mechanism throwing the Arctic climate off-kilter.

Looking backward to look forward

To understand how an increase in water vapor might play into the changing Arctic climate, NSIDC scientists Mark Serreze, Julienne Stroeve, and Andrew Barrett looked at data from radiosondes, instruments attached to weather balloons that are released into the atmosphere to measure things like temperature, air pressure, and relative humidity. The readings, collected between 1979 and 2010, provided evidence that not only were seasonal air temperatures increasing, but so was the humidity, or the amount of water vapor in the air.

Meteorological data from the radiosondes could only provide part of the picture. To place the findings in the larger context of Arctic climate, the team combined the radiosonde data with six different atmospheric reanalyses.

Radiosondes are instruments designed to collect meteorological measurements, and are launched on weather balloons. Launches like this one in Barrow, Alaska, continue several decades of radiosonde measurements that help reveal trends in the Arctic climate.

—Credit: Atmospheric Radiation Measurement (ARM) Climate Research Facility

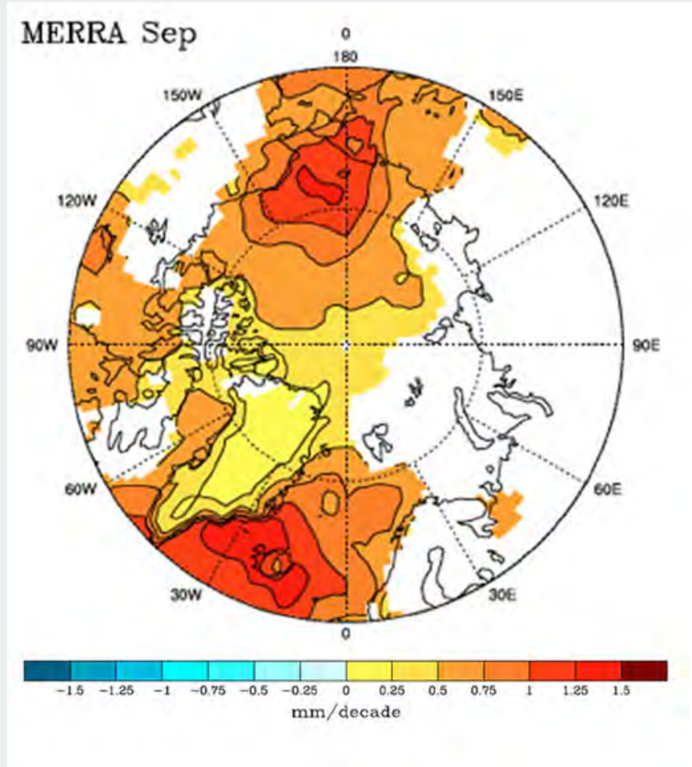
Reanalyses assimilate historic climate data, such as from radiosondes or satellites, in a consistent fashion. This consistency minimizes anomalies and differences caused by things like changes in data collection methods, sensors, or parameters that may have occurred over time, making it easier to accurately compare data from different sources. Poring through several different reanalyses permitted the scientists to better identify long-term trends over the entire Arctic region.

Feeding the feedbacks

Between the radiosonde data and the reanalysis efforts, Serreze and his colleagues found consistent matches that often coincided with other signals of climate change. For instance, an increase in water vapor over the North Atlantic corresponded with regions of higher sea surface temperatures, particularly over the North Atlantic. Similarly, a rise in water vapor also occurred over the Beaufort and Chukchi Seas, areas where annual end-of-season sea ice loss during August and September has been most dramatic.

Increasing the amount of water vapor in the atmosphere is a feedback mechanism. Decreased sea ice extent is leaving larger areas of open water, leading to more evaporation into a slightly warmer atmosphere. Because water vapor is a greenhouse gas that traps heat in the atmosphere, higher humidity may cause further warming in the Arctic.

Of course, climate scientists expect some degree of seasonal and interannual variations in Arctic climate, but the amount of change they have observed is more noticeable and more rapid than elsewhere in the Northern Hemisphere. And the change is still underway: how this increase in humidity affects Arctic climate remains to be seen. Will more water vapor lead to increased rain or snowfall among Earth's higher latitudes? Or is the Arctic destined to remain a more humid, and perhaps more temperate, environment? ❄



The NASA-based Modern Era Retrospective-analysis for Research And Applications (MERRA) reanalysis model is one of the reanalysis projects that NSIDC scientists relied on to observe increased humidity over the Arctic. The data revealed a spike in atmospheric water vapor over portions of the Arctic that coincide with decreasing sea ice, particularly over the North Atlantic east of Greenland and in the Beaufort and Chukchi Seas north and west of Alaska.

—Credit: NSIDC

References

Serreze, M. C., A. P. Barrett, and J. Stroeve. Submitted. Recent changes in tropospheric water vapor over the Arctic as assessed from radiosondes and atmospheric reanalysis. Journal of Geophysical Research.

European Centre for Medium-Range Weather Forecasts Re-analysis Interim (ERA-I)

European Centre for Medium-Range Weather Forecasts 40 Year Re-analysis (ERA-40)

Japanese 25-year Reanalysis Project (JRA-25)

NASA Modern Era Retrospective-Analysis for Research and Applications (MERRA)

National Centers for Environmental Prediction/National Center for Atmospheric Research NCEP/NCAR Reanalysis 1

National Oceanic and Atmospheric Administration Climate Forecast System Reanalysis

National Oceanic and Atmospheric Administration Integrated Global Radiosonde Archive

NSIDC Grants & Contracts

In 2012, NSIDC had 43 active contracts and grants, with a total value (over the anticipated lifetime of each award) of $63,109,823. New awards received totaled $4,522,359.

Approximately 56% of NSIDC's funding is from a NASA contract for operation of the Snow and Ice Distributed Active Archive Center (DAAC). Remaining funding is in the form of grants from NASA, NSF and NOAA. NSIDC had 14 active data management grants and contracts in 2012 and 29 active research grants. Current major data management projects follow below:

Distributed Active Archive Center (NASA)

The NSIDC DAAC is one of NASA's Earth Observing System Data and Information System (EOSDIS) data centers. The NASA data centers process, archive, document, and distribute data from NASA's past and current Earth Observing System (EOS) satellites and field measurement programs. Each data center serves one or more specific Earth science disciplines and provides its user community with data products, data information, user services, and tools unique to its particular science. Each data center is also guided by a User Working Group in identifying and generating these needed data products. The NASA data centers serve as the operational data management and user services arm of EOSDIS, performing such tasks as data ingest and storage, filling user orders, answering inquiries, monitoring user comments, and providing referrals to other data centers. (http://nsidc.org/daac/index.html)

Advanced Cooperative Arctic Data and Information Service (ACADIS PI M. Serreze and J. Moore, UCAR)

ACADIS is designed to manage the diverse data needs of the Arctic research community supported by the NSF Office of Polar Programs (OPP) Division of Arctic Sciences (ARC). ACADIS is a collaborative effort between the National Snow and Ice Data Center (NSIDC), the University Corporation for Atmospheric Research (UCAR), and the National Center for Atmospheric Research (NCAR). It represents an expansion of the Cooperative Arctic Data and Information System (CADIS) system originally developed by NCAR, NSIDC and UCAR, which provided data management support and archival services for the Arctic Observing Network (AON) for nearly four years. ACADIS, by contrast, is serving needs of the broader Arctic NSF-funded community, including, but not limited, to projects funded by OPP under AON, Arctic System Sciences (ARCSS), Arctic Natural Sciences (ANS) and the Arctic Social Sciences Program (ASSP).

ACADIS is designed to allow scientists an easier path to archive, access, integrate and work with data spanning multiple disciplines. ACADIS is providing data ingest and access services to scientists, decision-makers and other Arctic stakeholders, as well as archival services to ensure data accessibility through the coming years and decades.

NSIDC is focused on improving the discoverability, accessibility, and usability of NSF data in conjunction with broader Arctic data holdings from other agencies and countries. NSIDC also works with UCAR/NCAR on data stewardship, integration and (as is necessary), customized services, and activities for a broad user community. For each potential value-added product or activity, NSIDC scopes the level of effort required and meets the need based on recommendations by the ACADIS Data Advisory Committee (ADAC) and NSF management.

Antarctic Glaciological Data Center (NSF)

The AGDC archives and distributes Antarctic glaciological and cryospheric system data collected by the U.S. Antarctic Program. It contains data sets collected by individual investigators and products assembled from many different PI data sets, published literature, and other sources. The catalog provides useful compilations of important geophysical parameters, such as accumulation rate or ice velocity (http://nsidc.org/agdc/).

Exchange for Local Observations and Knowledge of the Arctic, Phase III (NSF)

ELOKA facilitates the collection, preservation, exchange, and use of local observations and knowledge of the Arctic. ELOKA provides data management and user support, and fosters collaboration between resident Arctic experts and visiting researchers. By working together, Arctic residents and researchers can make significant contributions to understanding the Arctic and recent changes. (http://eloka-arctic.org/)

Operation Icebridge (NASA)

NASA's Operation IceBridge, initiated in 2009, collects airborne remote sensing measurements to bridge the gap between NASA's Ice, Cloud and Land Elevation Satellite (ICESat) mission and the upcoming ICESat-2 mission. IceBridge mission observations and measurements include coastal Greenland, coastal Antarctica, the Antarctic Peninsula, interior Antarctica, the southeast Alaskan glaciers, and Antarctic and Arctic sea ice. The IceBridge mission combines multiple instruments to map ice surface topography, bedrock topography beneath the ice sheets, grounding line position, ice and snow thickness, and sea ice distribution and freeboard. Data from laser altimeters and radar sounders are paired with gravitometer, magnetometer, mapping camera, and other data to provide dynamic, high-value, repeat measurements of rapidly-changing portions of land and sea ice (http://nsidc.org/data/icebridge/index.html).

NOAA@NSIDC

The National Oceanic and Atmospheric Administration team at NSIDC manages, archives, and publishes data sets with an emphasis on in situ data, data sets from operational communities such as the U.S. Navy, and digitizing old and sometimes forgotten but valuable analog data. We also help develop educational pages, contribute to larger center-wide projects, and support the Roger G. Barry Archives and Resource Center (ARC) at NSIDC (http://nsidc.org/noaa/). ❄

New Funding

Cryospheric Application of the LANDSAT Data Continuity Mission

LANDSAT 8, PI Ted Scambos

The Landsat 8 satellite, now launched and collecting data, promises to extend Landsat's digital satellite data record of the Earth's surface well into a fifth decade, with greatly improved sensor technology for mapping surface reflectance and surface temperatures. This grant is funded by the Geological Survey for the exploration of new snow and ice applications using Landsat 8 data, and continued mapping of cryospheric changes by comparison with Landsat series legacy data.

Korean KOPRI Antarctic Expedition Support

PI Ted Scambos

South Korea is building a new Antarctic research base near Terra Nova Bay, Antarctica, and is installing a number of new instruments on the glaciers and mountains in the area. This grant from Korea Polar Research Institute provides support for Mr. Robert Bauer of NSIDC to join a KOPRI field group. Rob provides field mountaineering expertise and assists in the installation of the sensors.

Forecasting future sea ice conditions in the marginal ice zone: A Lagrangian approach

PI Bruno Trembley, COPI: S. Pfirman, R. Newton, and W. Meier

Changes in sea are occurring rapidly and the marginal ice zone is expanding. This ONR funded project will track parcels of sea ice using ice motion algorithms to determine source and sink areas of sea ice in the marginal ice zone. These observed trajectories will be compared with trajectories from IPCC GCM model estimates to help determine the potential future sea ice state.

Development and validation of an operational sea ice environmental data record for GCOM-W1 AMSR2. (PI Walter Meier)

The GCOM-W1 AMSR2 sensor was launched in May 2012 by the Japanese Aerospace Exploration Agency (JAXA). It is a passive microwave sensor continuing the record started by the NASA AMSR-E sensor launched in 2002. This NOAA NESDIS project will develop an operational sea ice concentration algorithm for NOAA NESDIS, to be used in NOAA's forecasting and analysis systems. Concentration will determined from established algorithms and will be updated several times per day as new data is collected.

Strengthening our Audience Connection with ICELIGHTS: Questions of the Moment (Phase II)

PI Jane Beitler

The NSF Icelights project responds to questions from the public, new developments in climate and cryospheric science, buzz in the media about the cryosphere, and scientific misinformation by posting short articles explaining background science, answering specific questions, or highlighting new studies. It fills a natural demand from the public for accurate scientific information about the changing cryosphere.

Science Writing for the NOAA Climate Watch Site

PI Jane Beitler

This contract from Harmonic International provides science writing services to the NOAA Climate Watch site, developing feature articles as requested on current topics in cryospheric science for a broad public audience.

Managing the SCICEX Data Collection in 2012

PI Florence Fetterer

The SCience ICe EXcercise (SCICEX) program is a collaboration between the U.S. Navy and the marine research community to utilize nuclear-powered submarines for the study of the Arctic Ocean. Support to NSIDC is to locate, make accessible, and begin to collect documentation on data from past SCICEX cruises; to guide data handling procedures on future cruises; and to document the continuing history of the program so that its relevance is clear to the agencies that fund it and to the public.

Toward Cyber-infrastructure 2025: Addressing Critical Milestones for Earth Cube

PI Siri Jodha Singh Khalsa

The goal of this project was to explore brokering technologies that can address the challenges stemming from the vast data volumes, diverse data types, semantic differences between communities, and siloed access to information. Brokering enables data repositories to meet the needs of diverse communities by providing data in ways that make sense to those communities, without requiring significant changes in the repository's current practices. A key output of the project was a roadmap giving guidance on developing a longer-term strategy for building and deploying the capabilities that are needed to help realize NSF's EarthCube cyber-infrastructure vision.

Furthering Earth Cube: A Road Map Coordination Workshop

PI Siri Jodha Singh Khalsa

This workshop provided a forum in which all the Principle Investigators currently funded under NSF's EarthCube program could address the critical issues for furthering NSF's cyberinfrastructure vision. The goals include refining the roadmaps that had been developed by each team, convergence on a timeline and key infrastructure attributes. The workshop addressed cutting-edge issues in cyberinfrastructure development, including technical, sociological and governance aspects. The report generated by the workshop sought to significantly advance EarthCube by assisting NSF in planning for the next stage of development.

Exploring the Dynamics of the Active Layer and Near-Surface Permafrost Across the North Slope of Alaska

PI Tingjun Zhang

This collaborative research project funded by NSF will investigate changes in the dynamics of the active layer and the top layers of ice-rich permafrost on the North Slope of Alaska using InSAR technique. We will include both C-band and, especially, L-band data (the latter mostly from the ALOS PALSAR instrument), acquired during the last two decades and over the next few years. The project will be accomplished through satellite remote sensing, field measurements and sampling, and data analysis. The expected results of the proposed research will provide (i) a validated InSAR FGA useful for regional-scale active layer and permafrost studies; (ii) time series of ALT and their change over the study period, (iii) long-term (1991-2011) mean of ALT across the North Slope of Alaska, and (iv) potential ground-ice melting in the top layers of ice-rich permafrost across the North Slope of Alaska with a resolution of from tens of meters to hundreds of meters.

Development and Innovation of the Barrow Area Information Database (BAID)

PI Mark Parsons

This collaborative NSF project will support the continued maintenance, development and innovation of the Barrow Area Information Database (BAID). BAID is a cyberinfrastructure (CI) that details much of the historic and extant research effort in the Barrow area through a suite of interactive web-based applications. This effort supports Arctic science, outreach and education.

NSIDC's contribution will focus on improving the interoperability between BAID and other pan-Arctic data systems via Web service mechanisms, with the goal of tying the logistical research information managed by BAID to the data produced by those research efforts and presenting those connections seamlessly to the user.

2012 citations

Journal Articles

Berthier, E., **T. A. Scambos** and C. A. Shuman. 2012. Mass loss of Larsen B tributary glaciers (Antarctic Peninsula) unabated since 2002*. Geophys. Res. Lett.*, 39(L13): Art. No. L13501. doi: 10.1029/2012GL051755.

Brodzik, M. J., B. Billingsley, T. Haran, B. Raup and **M. H. Savoie**. 2012. EASE-Grid 2.0: Incremental but Significant Improvements for Earth-Gridded Data Sets. *ISPRS International Journal of Geo-Information*, 1(1): 32-45.

Brodzik, M. J., T. H. Painter, A. Racoviteanu and **R. Armstrong**. 2012. Automated mapping of Earth's annual minimum exposed snow and ice with MODIS. *Geophysical Research Letters*, 39(L20): Art. No. L20501. doi:10.1029/2012GL053340.

Catania, G., C. Hulbe, H. Conway, **T. A. Scambos** and C. F. Raymond. 2012. Variability in the mass flux of the Ross ice streams, West Antarctica, over the last millennium. *Journal of Glaciology*, 58(210): 741-752. doi: 10.3189/2012JoG11J219.

Fogt, R. A. and **T. A. Scambos**, eds. Antarctica [in *State of the Climate in 2011*]. *Bull. Amer. Meteor. Soc*., 93(7): 149-162.

Jenouvrier, S., M. Holland, **J. Stroeve**, C. Barbraud, H. Weimerskirch, **M. Serreze** and H. Caswell. 2012. Effects of climate change on an emperor penguin population: analysis of coupled demographic and climate models. *Global Change Biology*, 18: 2756-2770. doi:10.1111/j.1365-2486.2012.02744.

Kargel, J. S., A. P. Ahlstrom, R. B. Alley, J. L. Bamber, T. J. Benham, J. E. Box, C. Chen, P. Christoffersen, M. Citterio, J. G. Cogley, H. Jiskoot, G. J. Leonard, P. Morin, **T. Scambos**, T. Sheldon and I. Willis. 2012. Greenland's shrinking ice cover: "fast times" but not that fast. *Cryosphere*, 6(3): 533-537. doi: 10.5194/tc-6-533-2012.

Lawrence, D. M., **A. G. Slater** and S. C. Swenson. 2012. Simulation of Present-Day and Future Permafrost and Seasonally Frozen Ground Conditions in CCSM4. J. Clim., 25(7): 2207-2225. doi: 10.1175/JCLI-D-11-00334.1.

Lee, C. K., K. W. Seo, S. C. Han, J. Yu and **T. A. Scambos**. 2012. Ice velocity mapping of Ross Ice Shelf, Antarctica by matching surface undulations measured by ICESat laser altimetry. *Remote Sens. Environ*., 124: 251-258. doi: 10.1016/j.rse.2012.05.017.

Liang Y., W. Colgan, Q. Lv, K. Steffen, W. Abdalati, **J. Stroeve**, **D. Gallaher** and N. Bayou. 2012. A decadal investigation of supraglacial lakes in West Greenland using a fully automatic detection and tracking algorithm. *Remote Sensing of Environment*, 123: 127–138.

McCann, H. 2012. Qaluyaarminui Nunamtenek Qanemciput/Our Nelson Island stories: meanings of place on the Bering Sea coast. *Oral History Review*, 39(2): 364-365. doi: 10.1093/ohr/ohs053.

McGrath, D., K. Steffen, **T. Scambos**, H. Rajaram, G. Casassa and J. L. R. Lagos. 2012. Basal crevasses and associated surface crevassing on the Larsen C ice shelf, Antarctica, and their role in ice-shelf instability. *Ann. Glaciol*., 53(60): 10-18. doi: 10.3189/2012AoG60A005.

Meier, W. N., J. Stroeve, A. Barrett and F. Fetterer. 2012. A simple approach to providing a more consistent Arctic sea ice extent time series from the 1950s to present. *Cryosphere*, 6(6): 1359-1368. doi: 10.5194/tc-6-1359-2012.

Padman, L., D. P. Costa, M. S. Dinniman, H. A. Fricker, M. E. Goebel, L. A. Huckstadt, A. Humbert, I. Joughin, J. T. M. Lenaerts, S. R. M. Ligtenberg, **T. Scambos** and M. R. van den Broeke. 2012. Oceanic controls on the mass balance of Wilkins Ice Shelf, Antarctica. *J. Geophys. Res.-Oceans*, 117(C01): Art. No. C01010. doi: 10.1029/2011JC007301.

Porter, D.F., J. J. Cassano and **M.C. Serreze**. 2012. Local and large-scale atmospheric responses to reduced Arctic sea ice and ocean warming in the WRF model. *Journal of Geophysical Research*, 117(D11): Art. No. D11115. doi:10.1029/2011JD016969.

Pulsifer, P., S. Gearheard, H. P. Huntington, M. A. Parsons**, C. McNeave** and **H. S. McCann**. 2012. The role of data management in engaging communities in Arctic research: overview of the Exchange for Local Observations and Knowledge of the Arctic (ELOKA). *Polar Geography*, 35(3-4): 271-290. doi: 10.1080/1088937X.2012.708364.

Scambos, T. A., M. Frezzotti, **T. Haran**, **J. Bohlander**, J. T. M. Lenaerts, M. R. van den Broeke, K. Jezek, D. Long, S. Urbini, K. Farness, T. Neumann, M. Albert and J. G. Winther. 2012. Extent of low-accumulation 'wind glaze' areas on the East Antarctic plateau: implications for continental ice mass balance. *J. Glaciol.*, 58(210): 633-647. doi: 10.3189/2012JoG11J232

Serreze, M.C., **A. P. Barrett** and **J. Stroeve**. 2012. Recent changes in tropospheric water vapor over the Arctic as assessed from radiosondes and atmospheric reanalyses. *Journal of Geophysical Research*, 117(D10): Art. No. D10104. doi: 10.1029/2011JD017421.

Shepherd, A., E. R. Ivins, A. Geruo, V. R. Barletta, M. J. Bentley, S. Bettadpur, K. H. Briggs, D. H. Bromwich, R. Forsberg, N. Galin, M. Horwath, S. Jacobs, I. Joughin, M. A. King, J. T. M. Lenaerts, J. L. Li, S. R. M. Ligtenberg, A. Luckman, S. B. Luthcke, M. McMillan, R. Meister, G. Milne, J. Mouginot, A. Muir, J. P. Nicolas, J. Paden, A. J. Payne, H. Pritchard, E. Rignot, H. Rott, L. S. Sorensen, **T. A. Scambos**, B. Scheuchl, E. J. O. Schrama, B. Smith, A. V. Sundal, J. H. van Angelen, W. J. van de Berg, M. R. van den Broeke, D. G. Vaughan, I. Velicogna, J. Wahr, P. L. Whitehouse, D. J. Wingham, D. H. Yi, D. Young and H. J. Zwally (2012), A Reconciled Estimate of Ice-Sheet Mass Balance. *Science*, 338(6111): 1183-1189. doi: 10.1126/science.1228102.

Stroeve, J. C., V. Kattsov, **A. Barrett**, **M. Serreze**, T. Pavlova, M. Holland and **W. N. Meier**. 2012. Trends in Arctic sea ice extent from CMIP5, CMIP3 and observations. *Geophys. Res. Lett.*, 39(L16): Art. No. L16502. doi: 10.1029/2012GL052676.

Vernet, M., W. A. Kozlowski, **L. R. Yarmey**, A. T. Lowe, R. M. Ross, L. B. Quetin and C. H. Fritsen. 2012. Primary production throughout austral fall, during a time of decreasing daylength in the western Antarctic Peninsula. *Marine Ecology Progress Series*, 452: 45-61. doi:10.3354/meps09704.

Zagorodnov, V., O. Nagornov, **T. A. Scambos**, A. Muto, E. Mosley-Thompson, E. C. Pettit and S. Tyuflin. 2012. Borehole temperatures reveal details of 20th century warming at Bruce Plateau, Antarctic Peninsula. *Cryosphere*, 6(3): 675-686. doi: 10.5194/tc-6-675-2012.

Books

Weyapuk, Jr. W. and I. Krupnik, comps. H. Anungazuk, I. Krupnik, and **M.L. Druckenmiller**, eds./contributors. 2012. Kifikmi Sigum Qanuq Ilitaavut – Wales Inupiaq Sea-Ice Dictionary. Washington, DC: Arctic Studies Center, Smithsonian Institution, 112 p.

Book Chapter

Barry, R. G. and **M. C. Serreze**. 2012. The changing climate. In: *Canada's Changing Cold Environments* edited by H. French and O. Slaymaker. Hoboken, NJ: Wiley-Blackwell, 89-104.

Overland, J. A. and **M. C, Serreze**. 2012. Advances in Arctic atmospheric research. IN: *Arctic Climate Change – The ACSYS Decade and Beyond* edited by Peter Lemke and Hans-Werner Jacobi. New York: Springer, 11-26. doi:10.1007/978-94-007-2027-5_2.

Stroeve, J. C. and **W. Meier**. 2012. Arctic sea ice decline. In: *Greenhouse Gases - Emission, Measurement and Management* edited by Guoxiang Liu. InTech, 441-462.

Data Sets

Underhill, V. and **F. Fetterer**. 2012. Arctic Sea Ice Charts from Danish Meteorological Institute, 1893 - 1956. Danish Meteorological Institute and National Snow and Ice Data Center. Boulder, Colorado USA: National Snow and Ice Data Center.

Other Publications

Beitler, J. A., ed. 2012. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 52 p.

Beitler, J. A. 2012. Leaking lakes. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 22-27.

Beitler, J. A. 2012. Where on Earth. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 10-13.

Beitler, J. A. 2012. How low is low? *Icelights.* http://nsidc.org/icelights/2012/08/30/how-low-is-low/

Haran, T. 2012. On thin ice: expedition to a crumbling Antarctic ice shelf. http://iceshelf.wordpress.com/

LeFevre, K. 2012. New angles. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 18-21.

LeFevre, K. 2012. Biomes in the balance. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 40-43.

McCann, H., C. McNeave, **J. Collins**, **P. Pulsifer**, M. Parsons, S. Gearheard and H. Huntington. 2012. Archiving local and traditional knowledge of the Arctic: Managing data and information in partnership with indigenous communities and earth scientists. IN: *Cold Regions: Pivot Points, Focal Points - Proceedings of the 24th Polar Libraries Colloquy*, 79-88. http://nsidc.org/pubs/gd/gd-34/PLC-24-proceedings-GD-34.pdf.

Meier, W. N., M. Granskog, S. Gerland and J. Key. 2012. Sea ice. IN: *Snow, Water, Ice, and Permafrost in the Arctic (SWIPA): Climate Change and the Cryosphere*. AMAP Assessment Report, 87 p.

Naranjo, L. 2012. Fleeting phytoplankton. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 2-5.

Naranjo, L. 2012. Winter's water. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 32-35.

Naranjo, L. 2012. Shadowing the tuna boats. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 36-39.

Perovich, D., **W. N. Meier**, M. Tschudi, S. Gerland, and J. Richter-Menge. 2012. Arctic Report Card. Sea Ice, NOAA.

Schlagel, E. 2012. Putting DAHLI to Bed: Preservation tactics for managing collections with limited means. In: *Cold Regions: Pivot Points, Focal Points - Proceedings of the 24th Polar Libraries Colloquy*, 135-155. http://nsidc.org/pubs/gd/gd-34/PLC-24-proceedings-GD-34.pdf.

Vizcarra, N. 2012. A kink in the jet stream. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 6-9.

Vizcarra, N. 2012. Orbiting watchtowers. *Sensing Our Planet: NASA Earth Science Research Features 2012*. Boulder, CO: National Snow and Ice Data Center, 48-51.

Presentations

Armstrong, R. L., **A. P. Barrett**, **M. J. Brodzik**, **F. Fetterer**, U. Horodyskyj, **S. J. S. Khalsa**, A. Khan, A. Racoviteanu, A. Rasmussen, **B. H. Raup**, M. W. Williams and A. M. Wilson. 2012. Establishing a collaborative effort to assess the role of glaciers and seasonal snow cover in the hydrology of the mountains of High Asia. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec., CG11A-0956.

Barrett, A. P., **R. L. Armstrong**, **M. Brodzik**, **F. M. Fetterer**, **S. S. Khalsa**, A. Racoviteanu, **B. H. Raup** and M. W. Williams. Variability of snow cover extent and snow melt runoff in the Himalaya-Karakoram. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Beitler, J., **M. C. Serreze**, **W. N. Meier**, **T. Scambos** and **K. M. Schaefer**. 2012. Just Answer the Question: The Cryosphere in the Public Consciousness. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Brodzik, M. J., T. H. Painter, A. Racoviteanu and **R. L. Armstrong**. 2012. Using MODIS to map changes in Earth's annual minimum exposed snow and ice. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec., C21C-0624.

Campbell, G. G., **D. W. Gallaher** and **W. N. Meier**. 2012. Massive variability in 1960's maximum Antarctic Sea ice extent from Nimbus

satellite data. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Collins, J., D. Harper, M. McNulty, J. Lacy, **L. Lopez**, S. Lewis, **M. Liu**, **J. Oldenburg**, **S. Reed**, **D. Scott**, **I. Truslove** and **H. Wilcox**. 2012.The Human Side of Agile in Earth Sciences Application Development. UCAR SEA Software Engineering Conference, Boulder, CO, USA, Feb. 21-24.

Fetterer, F., **A. Windnagel**, **K. Gergely**, **W. Meier** and **D. Scott**, 2012. Monitoring Arctic Sea Ice: Product Development Considerations. 92nd American Meteorological Society Annual Meeting, New Orleans, LA, January 22-26.

Fetterer, F., J. A. Moore, M. A. Parsons, **M. C. Serreze** and S. Williams. 2012. Arctic to Archive: End-to-End Data Support Services for the NSF Arctic Program . 92nd American Meteorological Society Annual Meeting, New Orleans, LA, January 22-26.

Gallaher, D., **G. Campbell** and G. Grant. 2012. Using an Object Database to Examine Properties of Ice in the Arctic. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Gallaher, D., A. Gasiewski, **R. Weaver** and S. Sanders. 2012. PolarCube: Building an Arctic Observing, Passive Microwave CubeSat. International Symposium on Small Satellites for Arctic and Maritime Operations and Research. Washington, DC, Nov. 9.

Gallaher. D., G. Grant and **G. Campbell**. 2012. Data Rods: High Speed, Time-Series Analysis of Massive Cryospheric Data Sets Using Pure Object Databases. IGARRS 2012, Munich, Germany, Jul. 22-27.

Grant, G., **G. Campbell**, **D. Gallaher**, **J. Stroeve** and J. Key. 2012. A New Look at the AVHRR Polar Pathfinder Data and Why Good Data Sometimes Goes Bad. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Kaminski, M., **M. J. Brodzik** and **J. Deems**. 2012. IceBridge airborne mission data and services at the National Snow and Ice Data Center. ESA-CliC-EGU Earth Observation and Cryosphere Science Meeting, Frascati, Italy, 13-15 Nov.

Jackson, B., S. R. Helfrich, P. Clemente-Colon, **M. Savoie** and **F. Fetterer**. 2012. Variability of the MASIE Product Versus Automated Retrieval Algorithms . 92nd American Meteorological Society Annual Meeting, New Orleans, LA, January 22-26.

Liu, M., **J. A. Collins**, **S. Lewis**, **J. Oldenburg**, **M. J. Brodzik** and **J. Braucher**. 2012. Caching strategies for improving performance of web-based geographic applications. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec., IN13A-1502.

McCann, H., **C. McNeave**, **J. Collins**, **P. Pulsifer**, **M. Parsons**, S. Gearheard and H. Hunting. 2012. Archiving Local and Traditional Knowledge of the Arctic – Managing Data and Information in Partnership with Indigenous Communities and Earth Scientists. 24th Polar Libraries Colloquy, Jun. 11-14.

McCann, H., C. McNeave, J. Collins, P. Pulsifer, M. Parsons, S. Gearheard and H. Hunting. 2012. The stewardship of Local and Traditional Knowledge of the Arctic. The American Indian Science and Engineering Society National Conference, Anchorage, AK, USA, Nov. 1-3.

Meier, W. N., S. Mallory, **M. Savoie**, **D. J. Scott**, **R. Duerr** and **F. Fetterer**. 2012. Continuity and enhancement of NSIDC cryosphere products using AMSR2 data. JAXA GCOM-W1 Science Team Meeting, Tokyo, Japan, Jan. 19.

Meier, W. N, 2012. The state of Arctic sea ice and Arctic sea ice data. WCRP Climate and Cryosphere Science Steering Group Meeting, Innsbruck, Austria, Mar. 12-16.

Meier, W. N. 2012. Arctic sea ice: Climate change on the fast track. National Science Teachers Association National Conference, Indianapolis, IN, USA, Mar. 29-Apr.1.

Meier, W. N. 2012. The Arctic: Global climate's canary in a coal mine. National Science Teachers Association National Conference, Indianapolis, IN, USA, Mar. 29-Apr.1.

Meier, W. N. and E. Hunke. 2012. Ice at the interface: Atmosphere-ice-ocean boundary layer processes and their role in polar change. Arctic Science Summit Week, Montreal, Canada, Apr. 19-22.

Meier, W. N., **F. Fetterer**, S. Mallory, **M. Savoie** and **D. J. Scott**. 2012. A new sea ice concentration climate data record for monitoring Arctic and Antarctic change and variability. International Polar Year Conference, Montreal, Canada, Apr. 22-27.

Meier, W. N. 2012. Changes in Arctic sea ice. NASA Hyperwall, International Polar Year Conference, Montreal, Canada, Apr. 22-27.

Meier, W. N. 2012. Observations and implications of changes in Arctic sea ice cover. University of Lanzhou, Lanzhou, China, Jul. 19.

Meier, W. N. 2012. Passive microwave remote sensing of sea ice. U.S.-Chile Satellites and Ice Workshop, Valparaiso, Chile, Jul. 24.

Meier, W. N., D. Hall and J. Key. 2012. A product development team for snow and ice climate data records. NOAA Climate Data Record Program PI Meeting, Asheville, NC, USA, Jul. 31.

Meier, W.N. 2012. Arctic sea ice in summer 2012: An exclamation point on a long-term declining trend. Arctic Futures Symposium, Brussels, Belgium, Oct. 4-5.

Meier, W. N. 2012. Recent observed sea ice conditions extent, thickness, multi-year fraction. Arctic Monitoring and Assessment Programme Sea Ice Forecasting Workshop, Seattle, WA, USA, Oct. 16.

Meier, W. N. and B. Else. 2012. The dynamics of Arctic sea ice decline and consequences for heat and carbon fluxes. Arctic in Rapid Transition Workshop, Sopot, Poland, Oct. 23-26.

Meier, W. N., G. Peng and **D. J. Scott**. 2012. Evaluation of a passive microwave sea ice concentration climate data record. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Meier, W. N., **J. C. Stroeve**, **A. P. Barrett** and **F. Fetterer**. 2012. Extending passive microwave Arctic sea ice extents to the early 1950s through a consistent integration of pre-satellite estimates. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Persson, O., M. Shupe, M. Tjernstrom, K. Dethloff, D. Perovich and **W. N. Meier**. 2012. Multidisciplinary drifting observatory for studies of Arctic climate (MOSAiC). Arctic Science Summit Week, Montreal, Canada, Apr. 19-22.

Raup , B. , **R. Armstrong**, **F. Fetterer** , I. Gartner-Roer, W. Haeberli, M. Hoelzle, **S. J. S Khalsa** , S. Nussbaumer, **R. Weaver** and M. Zemp. 2012. Global Terrestrial Network for Glaciers: Databases and Web interfaces. European Geosciences Union General Assembly 2012, Vienna, Austria, Apr. 22 – 27.

Scambos, T., C. Shuman, M. Truffer, E. Pettit, **J. Bohlander** and **T. Haran**. 2012. Stability Assessment of Antarctic Ice Shelves with respect to Melt-induced Disintegration. International Glaciological Society Symposium on Glaciers and Ice Sheets in a Warming Climate, Fairbanks, AK, USA, Jun. 24-29.

Scambos, T., C. Shuman, M. Truffer, E. Pettit, **J. Bohlander** and **T. Haran**. 2012. Recent changes in the remnant ice shelf of Larsen B - an imminent break-up?. International Glaciological Society Symposium on Glaciers in a Changing Climate, Seattle, WA, USA, Sep. 25.

Scambos, T., E. Berthier, C. Shuman, M. Truffer, E. Pettit, **J. Bohlander** and **T. Haran**. 2012. Recent changes in the remnant ice shelf of Larsen B - an imminent break-up? International Glaciological Society Symposium on Glaciers in a Changing Climate, Portland, OR, USA, Jul. 20.

Scambos, T., M. Truffer and E. Pettit. 2012. LARISSA Glaciology: Science and Field Plans for the 2013 Araon cruise. KOPRI 18th International International Symposium on Polar Sciences, Jeju City, Republic of Korea, May 22-24.

Scambos, T., E. Berthier, C. Shuman, **T. Haran**, A. Cook and **J. Bohlander**, 2012. Mass balance of the northern Antarctic Peninsula using Satellite Altimetry and stereo-image DEMs. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Schlagel, E. 2012. Putting DAHLI to Bed: Preservation tactics for managing collections with limited means. 24th Polar Libraries Colloquy, Jun. 11-14.

Scott, D. J., **K. Gergely** and **W. N. Meier**. 2012. NSIDC sea ice data: Making it easier for users to choose the data they need. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Slater, A.G. 2012. Permafrost in Climate Models. Tenth International Conference on Permafrost, Salekhard, Russian Federation, Jun. 25-29.

Slater, A.G. and D. M. Lawrence. 2012. Diagnosing Present and Future Permafrost in Climate Models. NCAR Land Model Working Group Meeting, Boulder, CO, USA, Feb. 27-Mar. 2.

Slater, A.G. and D. M. Lawrence. 2012. Diagnosing Present and Future Permafrost in Climate Models. Canadian and American Meteorological Society Meeting Joint Meeting, Montreal, Canada, May 29.

Slater, A. G. and D. M. Lawrence. 2012. Diagnosing Present and Future Permafrost in Climate Models. Tenth International Conference on Permafrost, Salekhard, Russian Federation, Jun. 25-29.

Tressel, S. S., **M. L. Kaminski**, **M. J. Brodzik**. 2012. The NASA IceBridge project quickly delivers snow and ice elevation measurements of dynamic polar landscapes. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec., C21B-0594.

Weaver, R., A. Gasiewski, **D. Gallaher**, B. Sanders, L. Periasamy, **T. Scambos**. 2012. PolarCube – A CubeSat to Monitor the Sea Ice and Atmosphere Temperature Structures. 2012 Fall Meeting, American Geophysical Union, San Francisco, CA, 3-7 Dec.

Yarmey, L. 2012. Finding our way through the data lifecycle. Data-Day! University of Colorado Boulder Library, Boulder, CO, USA, Dec. 11.

Yarmey, L. 2012. Data Citation as a Service. Bridging Data Lifecycles: Tracking Data Use via Data Citations/UCAR, Boulder, CO, USA, Apr. 5.

Yarmey, L. and **L. Schlagel**. 2012. Data Literacy for the Arctic and Below: Help your data help you. Bridging the Gap between Science and Society through Scientific Data Literacy/Colorado State University NREL, Ft. Collins, CO, USA, Feb. 2.

Zemp, M., **R. Armstrong**, **F. Fetterer**, H. Frey, I. Gärtner-Roer, W. Haeberli, M. Hoelzle, A. Kääb, J. S. Kargel, K. Naegeli, S. U. Nussbaumer, F. Paul and **B. H. Raup**. 2012. Latest findings and recent news from the internationally coordinated glacier monitoring. 16th Alpine Glaciology Meeting, Zurich, CH, Feb. 2-3.