United States Antarctic Program Blue Ribbon Panel

A 12-member Blue Ribbon Panel (BRP) – formed at the request of the Assistant to the President for Science and Technology and Director, Office of Science and Technology Policy, Executive Office of the President, and the Director, National Science Foundation – met at the National Science Foundation, Arlington, Virginia 22230, 3-4 November 2011. The panel is assessing U.S. Antarctic Program operations, logistics, and management and is to recommend a long-term strategy regarding USAP support in Antarctica and the Southern Ocean.[1]

The meeting was open to the public. It was telecast to viewers in two remote rooms at the Foundation and connected via phone to USAP[2] participants at McMurdo Station, Antarctica.[3]

The BRP evaluation is the second of a two-phase review of the USAP. The first phase, coordinated by the National Research Council, identified science opportunities in Antarctica and in the Southern Ocean for the coming two decades.[4] The BRP will build on these findings and other input to accomplish its charge.

These minutes summarize presentations and discussions at the 3-4 November 2011meeting. Readers are encouraged to use it in conjunction with other documents on the BRP web site.[5]

Opening

The BRP chair, Norm Augustine, welcomed participants and the panelists each spent a few moments introducing themselves.[6]

Kelly Kenison Falkner, Deputy Director, Office of Polar Programs, NSF, identified herself as the acting conflicts officer (in the absence of Susanne M. LaFratta-Decker, Senior Advisor, OPP). She informed the panelists that during the meeting they are "special government employees" and reminded them that they are subject to Federal conflict-of-interest rules. She asked them to speak up in the event any question regarding conflicts arose and thanked them for turning in conflict-of-interest forms prior to their attendance.

Overview of the USAP

Karl A. Erb, Director, OPP, gave an overview of the USAP.[7] He described Presidential Memorandum 6646, which assigns responsibility for this National program to NSF while authorizing research participation by other Federal agencies and operational support from the

[1] A 15 July 2010 Request for Independent Review, a 7 April 2011 Charter, and a 3 November 2011 Charge define the BRP mission.
[2] Abbreviations are defined in the final section of this report.
[3] A *Federal Register* announcement states that the meeting is open (public) and is held in accordance with the Federal Advisory Committee Act.
[4] *Future Science Opportunities in Antarctica and the Southern Ocean*, National Academies Press, 2011, 230 p.
[5] Meeting agenda, documents, and images supplementing this report are on the BRP web site at www.nsf.gov.
[6] Résumés are on the panel's web site.
[7] Slides used during this talk are on the web site.

military. He noted that the Antarctic Treaty sets aside the early-20th-Century national territorial claims and reserves the region for peace and international collaboration. He referred to a White House statement that Antarctica is the only continent where science serves as the principal expression of National policy and interest.

The region – remote, extreme in climate, unpopulated, and without infrastructure other than that set up by government programs – makes research there more difficult than at other locations around the globe. Projects are approved only if they cannot reasonably be supported elsewhere and only if they show compelling scientific and societal need. While Federal agencies (as noted above) perform some work, most is carried out by U.S. university-based scientists whose research proposals have achieved approval following competitive review by research peers, operations specialists, and NSF program officers.[8]

International collaboration is extensive, extending geographic coverage for broad-based research needs such as weather measurements and, for more complex research questions, delivering strengths not held by any single nation.

The Antarctic ice sheet, which holds most of the world's ice and would raise sea level some 60 meters if melted completely, has lost mass (by evaporating or melting) since the last glacial maximum 20,000 years ago. Analysis of cores drilled from the ice sheet shows in unequalled detail the world climatic and atmospheric record of the last four glacial cycles, extending back 420,000 years (Vostok) and, in somewhat less detail, to about 800,000 years (EPICA). The ice is dynamic, both recording and responding to global change, and the tasks of analyzing its past and forecasting its future are too big for any one country. International projects are evaluating the relationship of the ice and climate. The work involves such complicating factors as postglacial rebound (PGR) of the underlying landmass as the ice overburden eases. Satellites and the global positioning system (GPS), are measuring the rebound. The West Antarctic Ice Sheet, though less than a tenth of Antarctica's ice mass, is of interest because, based below sea level, it likely is more responsive to change than the East Antarctic Ice Sheet. The large Pine Island Glacier has speeded considerably in recent years, and researchers are scrutinizing it for clues to what might happen there and throughout West Antarctica.

A high-altitude balloon project, Concordiasi, takes advantage of persistent wind patterns to circumnavigate the continent before returning on its own to somewhere near McMurdo Station, the starting point. The French-U.S. collaboration uses onboard infrared sensors to get precision measurements of atmospheric temperature and humidity, important for further understanding of climate change. A balloon campaign like this can get a payload aloft in 2 years and sample throughout the atmospheric column, whereas a project using satellites would take perhaps 10 years to plan and launch and would measure only total values as seen from the top.

The Swedish icebreaker *Oden*, contracted to NSF to help break the ship resupply channel through sea ice to McMurdo in recent years, also supported collaborative research involving researchers and educators from both countries.

[8] NSF awards the research funds to institutions in the United States. In fiscal 2010, these research institutions were located in 40 states. Most of the operations funding also is awarded to U.S. organizations. Exceptions are advance-headquarters costs in New Zealand and Chile, victuals such as fresh vegetables from these countries, a contract for airplane services with a company in Canada, and a contract with a company in Russia for icebreaker services.

Technological advances extend the reach of data acquisition having critical importance to Antarctic researchers. While satellites provide enormous reach and benefit, surface-based autonomous devices ranging from devices swum to depths by living seals to remote weather stations on the ice sheet remain essential. An example of a device that now can be bought commercially is a glider that acquires a range of oceanic data, including under floating ice shelves, previously difficult or impossible to reach.

Biota that have adapted to Antarctic extremes include ice fish that live and breed in 28°F water. Their mutations mimic human diseases and thus are of interest for human health.

The clear and dry air over the high interior of Antarctica provides astronomers and astrophysicists a window through Earth's atmosphere that is superior to most other places on Earth. In some wavelengths, the clarity rivals the view from space platforms; instruments on the Earth's surface are less costly and enable frequent access for repair and upgrade. Projects at the geographic South Pole, near the center of Antarctica and 9,200 feet above sea level, include instruments searching for Dark Matter and Dark Energy and testing cosmological models for the origin of the universe. Recent measurements by the 10-meter South Pole Telescope show that Dark Energy could not have accounted for more than 1.8 percent of the total density of the early universe, whereas today it accounts for 74 percent of all matter and energy.

Also at the South Pole, a cubic kilometer of the deep, clear ice beneath the surface has been instrumented with 5,160 optical sensors to detect high energy neutrinos arriving from some of the most distant locations in the universe. Only the interior of Antarctica has ice that is stable and deep enough for this experiment. The broadly international U.S.-led project, called IceCube, is intended to map early moments following the Big Bang. This is Antarctica's single largest research effort ever; the construction phase was completed in 2010 on schedule and under budget.

Amundsen-Scott South Pole, one of America's three year-round Antarctic research stations, was itself rebuilt to meet efficiency and safety standards and to support increased research requirements. The multiyear project, completed in 2009, employs an above-grade design to minimize snowdrift buildup; it replaces earlier, at-grade structures commissioned in 1975.

Challenges to America's continued effective presence in the Antarctic will be discussed throughout the meeting. Large-budget items include ship and icebreaker replacement. Further energy efficiencies will become critical. A number of other issues are present, and this panel is likely to identify more, as well as solutions we haven't thought of.

This BRP will steer America's science programs in Antarctica in the decades to come. Since the Second World War, only five other top-level reviews of the research program have been conducted, the last in 1996 and 1997 and the first in 1949.

Discussion:

1. Modeling is a key need, and the big challenge is at the regional scale. In turn, the modelers need more data. Panelist Hugh Ducklow commented that, among scientists,

modeling is a top priority. Research is needed into the relative strengths and weaknesses of models.

2. The need for access to remote locations, including in all three dimensions.

3. Energy, fuel storage, lighter-than-air craft, direct flights New Zealand to South Pole.

4. Other countries are building new polar ships, but not the USA. For international collaboration, you have to bring something to the game.

5. Lcdr. Michael Krause, U.S. Coast Guard, stated that the icebreaker USCGC *Polar Star* is expected to be mission-ready in October 2013 following completion of repairs. Karl Erb noted that The Murmansk Shipping Company icebreaker charter extends until then.

6. Potential for private sector participation.

7. Using existing U.S. Antarctic strengths to leverage our effectiveness in working with other nations.

8. International collaboration potential to increase access to satellite based bandwidth.

Panel welcome and tasking

John Holdren, Assistant to the President for Science and Technology and Director, Office of Science and Technology Policy, The White House, thanked Norm Augustine and the panel on behalf of OSTP and the President, noting that President Obama is strongly committed to science, knows its importance to society, and understands why Antarctic science is important. NSF has run the program excellently for over 50 years, but the demands are getting bigger. The first (NRC) phase of the work has laid out the science picture. He looks to the BRP to evaluate infrastructure, collaborations, and future requirements. Management options include business and economic matters: getting more bang for the buck through use of new technologies, best practices, and efficiencies.

Subra Suresh, Director, National Science Foundation, attesting to the importance of panels in the conduct of NSF business, noted that three advisory panels were in the building on that day. He referred to OMB's assignment of NSF's leadership role for the overall Antarctic program since 1971 and President Reagan's confirmation of it in 1982. He called attention to an External Panel that Norm Augustine chaired in 1997 to evaluate the importance to the Nation of rebuilding the research station at the geographic South Pole and stated that the project the External Panel recommended was completed on time and within 7 percent of the forecast cost despite the difficult site and the rise in the cost of fuel. He read a sentence from chapter 5 of the NRC phase-1 report, "The United States is well positioned to continue as the preeminent research presence in Antarctica and the Southern Ocean by virtue of having a large National logistical support program and an exceptional pool of scientific talent upon which to draw," then commented that with other nations showing increased prominence in the region and future financial constraints facing all of us, our Nation perhaps can hope to accomplish much through even more international collaboration than is going on now.

David A. Balton, Deputy Assistant Secretary, Bureau of Oceans and International Environmental and Scientific Affairs, Department of State, summarized a written document that he provided.[9] He said that our Nation has a critical interest in the Antarctic. The U.S. Antarctic Program, focused on science, supports our foreign policies by continuing the active and influential presence in the region mandated in the 1982 Presidential memorandum referred to by Subra Suresh.[10] A 1994 Presidential directive states U.S. policy for the region is to protect the environment, protect opportunities for scientific research, maintain Antarctica as an area of international cooperation for peaceful purposes, and conserve living resources in the adjacent oceans.[11] These objectives are components of America's adherence to the Antarctic Treaty, for which the United States was a chief proponent. Signed by representatives of 12 nations in 1959 in Washington, D.C., the treaty is one of the greatest examples of international diplomacy, and it now also encompasses an environmental protocol and conventions for conservation of marine living resources. It features freezing of territorial claims; a key element of U.S. diplomacy is to act as a bulwark against any reassertion of those claims. The treaty now has 49 member nations, Malaysia having acceded most recently, in October 2011. The USAP directly asserts our foreign policy, and the South Pole research station is a critical component. We have more than a science presence, though, and exercise on-site inspections of other nations' facilities under the treaty's article VII. In December 2011the USAP will support a visit to the South Pole by Norway's Prime Minister, who will commemorate the 100th anniversary of the first humans to arrive there, Norwegian Roald Amundsen and party on 14 December 1911.

Paul Shawcross, Branch Chief, Science and Space, Office of Management and Budget, The White House, stated that he initially was confident that NSF would have robust funding growth, but now in the current budget climate smaller increases, if any, are expected and that recommendations for larger expenditures are unlikely to gain traction.[12] Thus the need is for more science per dollar, perhaps involving incremental improvements and different approaches – for example, not resupplying McMurdo every year.

Discussion:

Panelist Craig Dorman stated the budget concern about the NRC phase 1 report recommending continuing basic program research along with establishing a long-term observing system. John Holdren did not discourage the group from saying what resources the recommended activities will require, and he said that he does not recommend preemptive concession. The panel may wish to express what will be lost in the event that the government cannot spend a certain amount. Paul Shawcross added that the panel should be sure to state what the program can do with the resources it has. Karl Erb noted that to be circum-Antarctic the long-term observing system would have to be international, bringing non-U.S. resources into play.

The U.S. icebreaking capability was stated to be insufficient for foreign policy.

[9] U.S. Strategic Interests in Antarctica, Statement by David A. Balton, Deputy Assistant Secretary for Oceans and Fisheries, U.S. Department of State.
[10] U.S. Antarctic Policy and Programs. White House Memorandum 6646, 5 February 1982.
[11] United States Policy in the Arctic and Antarctic Regions, Presidential Decision Directive NSC-26, 9 June 1994.
[12] On 18 November 2011 the President signed into law NSF's fiscal 2012 appropriation (up 2.5 percent over 2011).

Panelist Thad Allen brought up New Zealand's refusal of nuclear powered ships at its ports in the context of Antarctic icebreakers. David Balton suggested that New Zealand is considered to appreciate cooperating with the USA and perhaps might be open to discussing a more flexible arrangement.

Karl Erb stated the schedule for completing the panel's report to be March or April 2012 so that it can inform the President's fiscal year 2014 budget proposal to the Congress.

Subra Suresh said that it would be enormously helpful to NSF for the panel to provide its sentiment regarding the level (with budget implications) of international engagement that is reasonable while maintaining U.S. leadership. He said also that with technology we have great opportunities for Antarctic-based STEM education: new and innovative methods will be welcome, including opportunities to partner with other Federal agencies.

In response to a query from panelist Thad Allen, David Balton said that changes in USAP that might result from the panel's recommendations were considered not to require addenda to the Antarctic Treaty. However, the Department of State could be helpful in codifying the U.S. stance regarding other nations' requests for search and rescue. Another area of international interest could be international intermodal transportation.

Panelist Gérard Jugie commented on the need for universal (international) data standards in the context of the envisioned long term observing system.

USAP research support overview

Brian Stone, Division Director, Antarctic Infrastructure and Logistics, OPP, summarized the support system, noting that other staff would provide further detail in presentations later.[13] The science support concept is that anyone can be a polar explorer: a scientist not familiar with Antarctic field work can step into the program's infrastructure and adapt it, with the help of staff field experts, to the need.

McMurdo, on the coast, initially (1955) was expeditionary, set up to establish a year-round research station at the geographic South Pole, 730 nautical miles inland. Because of its useful natural features, high latitude location, and nearness to areas of research interest, McMurdo evolved into a long-term investment with laboratories, dormitories, fuel storage, warehouses, a waste management complex, a helicopter port, a year-round runway, and a satellite ground station that together support not just South Pole station but dozens of encampments and unattended automatic data gatherers distributed throughout much of the Antarctic continent.

Amundsen-Scott South Pole Station, its most recent rebuild completed in 2009, evolved into a facility supporting a range of disciplines with astronomy and astrophysics dominant. Palmer, along the Antarctic Peninsula and the third year-round U.S. Antarctic station, operates separately from the others via sea support from South America; it focuses on ocean sciences and biology, among other things.

[13] For Brian Stone's slides click on the third bullet in the Documents section of the BRP web site.

Two ice-rated ships support research throughout the Southern Ocean and resupply Palmer Station. Two icebreaker-escorted freight ships (one cargo, one a tanker) deliver all McMurdo's fuel and over 90 percent of its cargo. Wheeled USAF C-17s fly personnel and some priority cargo between New Zealand and McMurdo. Ski-equipped C-130s (LC-130s), Baslers (refurbished DC-3s), and Twin Otters fly throughout the Antarctic, and the LC-130s routinely make the McMurdo-N.Z. run. Heavy-duty over snow traverse equipment, a mainstay of the program in earlier years, has been reintroduced in almost off-the-shelf modern versions to help resupply South Pole Station and for direct support of research.

Discussion:

1. Energy efficiencies including solar and wind at the camps, along with innovations in material and equipment to reduce energy demand, discussion initiated by panelist Louis Lanzerotti.

2. Communication and transportation methods to camps, discussion initiated by panelists Robert Spearing and Duncan McNabb.

3. Traverse opportunities.

4. Collaborative work with the French Antarctic Program on traverse techniques, discussion initiated by Gérard Jugie.

Future scientific frontiers

Three members – Warren Zapol (chair), Robin Bell, and John King – of the NRC Committee on Future Science Opportunities in the Antarctic and the Southern Ocean described their backgrounds and summarized the prepublication copy of their report, which is phase 1 of the USAP BRP evaluation.[14]

Discussion:

1. The appropriate level of interactions between scientists and the contractor, scientists and NSF, and the contractor and NSF

2. The continuing need for an integrated international science mission.

3. A briefing to the panel on NSF's new (forthcoming) Antarctic support contractor

4. Universal access to data from large projects such as NASA satellites and from small projects conducted by individual scientists or small teams

5. A sustainable education program to keep the momentum from IPY

[14] The report, *Future Science Opportunities in Antarctica and the Southern Ocean*, is available from the National Academies Press. A summary of it is on the BRP web site. The slides for this presentation also are on the panel's web site.

6. Panelist Craig Dorman asked for more detail about the recommended observing system. Panelist Hugh Ducklow said that while many components are in place, careful design is critical and international collaboration is essential.

7. Panelist Gérard Jugie emphasized the need to correlate among monitoring locations and sensors and to standardize observations.

More future scientific frontiers

Mahlon (Chuck) Kennicutt, Texas A&M, presented a plan for Antarctic science over the next 20 years derived from his presidency of the nongovernmental Scientific Committee on Antarctic Research. SCAR membership consists of national scientific academies or research councils from 31 nations conducting science in Antarctica and another 5 nations planning Antarctic research, along with 9 members from other committees of SCAR's parent body the International Council of Science, or ICSU. He stated that research in Antarctica and the Southern Ocean is uniquely positioned to lead in ICSU's five Grand Challenges (forecasting, observing, confining, responding, and innovating) to deliver knowledge for sustainability in an era of rapid global environmental change. SCAR's strategic plan for 2011-2016 includes the need for expanded access to field locations over extended periods beyond summer and for intellectual access across disciplines and national borders. U.S. leadership essentials include support of innovative science, further investment in infrastructure, promotion of international partnerships, fostering of linkages to global programs, and serving as an example in Antarctic policy making.[15]

Round table

1. NSF's responsibility is to the research portfolio (mainly university based) and to other agencies' mission needs. The envisioned observing system needs to integrate the requirements of both groups.

2. What is the scale of the observing system and the level or amount of needed infrastructure? Robin Bell answered that the real goal is to cross disciplines. She gave an example of glaciologists becoming interested in the oceans. Another goal is to be truly international since no nation has the resources to see what is going on over the entire continent, but continental change has global consequences.

3. John King noted that "one almost always goes bigger than you thought you were going to go over the long run" because you find things that are interesting and necessary to follow. Learning by doing is an aspect of an observation network.

4. Craig Dorman said there may be advantages in coupling to Arctic work – technology, icebreakers, planning. Robin Bell said that the Arctic is ahead in term of planning, although that has to do with the geographic difference between the Arctic and the Antarctic, especially the continental Antarctic. Hugh Ducklow stated that bipolar aspects of cooperation are important.

[15] Slides are on the web site. ICSU and SCAR web sites reference relevant publications.

5. The Academy's 24-25 August 2010 workshop on the role of polar ecosystems in climate change was discussed. Several workshop participants had noted the need for a vastly enhanced, expanded, and better-integrated system of sustained observations to support polar research. Besides weather (the workshop report states), observing systems are needed to document and quantify sea ice, glacier, and ice sheet dynamics; fluxes of greenhouse gases; and distributions and activities of organisms and biogeochemical cycles.[16]

6. Robin Bell stressed that the observing system envisioned in *Future Opportunities . . .* should not shut down other science. Warren Zapol said observing is essential: we need answers to straightforward questions such as mass balance of the ice sheet; getting down on the ground and measuring things is necessary before you can have answers. Thad Allen commented that following the Deep Horizon spill the lack of baseline data on pre-spill deep hydrocarbons hampered damage assessment.

7. Karl Erb suggested looking at what all the countries have in place and then building a more effective observing system. Chuck Kennicut said SOOS[17] is an alternative means to bring together existing assets rather than setting up a new system. Hugh Ducklow said NEON[18] is a network of infrastructure to make observations, but it is left to the scientists to decide what to do with it, just as astronomers decide what to do with a telescope. Louis Lanzerotti observed that NEON is still grappling with what to measure.

8. Panelists discussed the interrelated difficulties of finding out or at least presupposing specific future research questions needing answers, developing a hierarchy of priorities among disciplines in a geographic area such as Antarctica, figuring out how priorities influence the need for infrastructure, matching priorities to logistics means, and linking the funding of infrastructure to those performing the research.

9. Operators ideally want scientists to provide complete and specific requirements for infrastructure. John King noted that investigators sometimes don't know what they want until they know what they can get; the list of new technologies driving new discoveries is long. Norm Augustine noted that setting priorities is important. Louis Lanzerotti noted that science at a given moment can be murky in terms of knowing now what you need to measure for later science.

Current USAP supply chain

George Blaisdell, Operations Manager, Antarctic Infrastructure & Logistics, OPP, discussed the supply system.[19] On the surface, he said, it is like any supply system. But it is a hundred to a thousand times the size of Antarctic programs of other nations. It typically delivers, for example, 14 million pounds of cargo and 37 million pounds of fuel each year to McMurdo during the 5-month summer season. Of that amount, more than 90 percent arrives on two ships escorted in

[16] *Frontiers in Understanding Climate Change and Polar Ecosystems*, National Academies Press, 2011
[17] Southern Ocean Observing System, a nascent effort to develop an integrated multidisciplinary observing system. See also Rintoul et al., 2010, *Southern Ocean Observing System (SOOS): Rationale and Strategy for Sustained Observations of the Southern Ocean*.
[18] National Ecological Observatory Network, which has NSF funding.

and out by icebreaker in a tightly interwoven sequence coinciding with the 18-day window when the southern Ross Sea statistically is expected to have the least amount of sea ice. The cargo ship typically retrogrades more tonnage than it delivers, ranging from wastes not allowed to stay in Antarctica to scientific samples that are irreplaceable. Among complexities peculiar to Antarctica, some cargo must be kept frozen, and some must not be allowed to freeze.

Innovations include increasing McMurdo's stored fuel to a 2-year supply, but the cargo ship still is needed every year. McMurdo's legacy infrastructure includes warehouses built over the years for each function or trade rather than a more efficient central one. The dormitories impose a nominal population cap of 1,100, while during some periods more people might be needed there, and the 2011 New Zealand earthquakes reduced the number of hotel rooms in Christchurch, removing a population buffer that the Antarctic program formerly had for enroute participants. Buildings still in use have had to be condemned. NSF is at a point of needing to make serious decisions.

Discussion:

The new contractor inherits the infrastructure because the government owns it, but is there an opportunity for a fresh start? The new contractor will bring new strengths, but the money comes out of the same NSF pocket. Some buildings are inefficient. We have evaluated them: in the private sector you would get a loan, replace the structure, and reduce the life cycle cost.

Norm Augustine said the panel needs to understand the procurement structure: operating capital, multiyear funding, and so forth. Response: During the building of the new South Pole station, we worked with the Congress and planned ahead, buying steel all at once and stockpiling it, for example. The Congress also asked us to try to better handle changes in the cost of fuel, but after study the options did not look good. OMB will consider a business plan that says if we invest $A now we can save $B later.

What's the contract with the Murmansk Shipping Company icebreaker? Response: 1 year with two 1-year add-ons depending upon performance. Conditions this coming season – more first-year sea ice than usual – are in our favor.

The panel requested a summary of U.S. Antarctic Program cash flow.

Support services integration

George Blaisdell. [20] Antarctica has no native infrastructure, and its "environmental services" for the sustenance of humans are minimal to nonexistent. It is a work site (unemployment: 0%), and it is home: program participants are in the Antarctic for weeks, months, or a year. We have some duty of care over them, and all functional areas of the program are involved (slides 1-14).

The delivered costs of fuel, water, and electricity vary considerably among the U.S. Antarctic stations, but are higher than in the United States. The newer buildings, especially at South Pole

[19] The twenty-six slides used with this presentation are on the BRP web site. Click the 6th bullet.
[20] For the slides accompanying this presentation, click on the 7th bullet in the Documents section of the BRP web site.

Station, are well insulated, but at McMurdo the average age of structures exceeds 25 years, and the overall R (insulative) value of the buildings is less than 10 ft^2 ˚F hr/BTU. Energy efficiency is pursued in ways ranging from use of efficient machinery to wind and solar sources. Fossil fuel remains necessary at all three year-round stations; efficiencies are achieved using modern diesel engines and capturing waste heat at the power plants. McMurdo and New Zealand's nearby Scott Base are partnering in developing a wind turbine farm that currently runs Scott Base and reduces McMurdo's fossil fuel need by about 15 percent. Our reviews of science proposals require researchers to collaborate with USAP specialists in finding ways to reduce their need for fuel and power in the field.

Transport uses a lot of fuel. We can't change the burn rate in the airplanes and ships, but state-of-the-art tractor trains have replaced some air transport, delivering a gallon of fuel from McMurdo to South Pole for just 0.3 gallon of fuel instead of 1.3 gallons using an LC-130. At McMurdo, we have introduced electric trucks in a demonstration project with the Department of Energy.

The Antarctic Treaty designates the region as a conservation area; U.S. law specifies USAP compliance. A facility at McMurdo consolidates regulated waste generated at U.S. stations and camps throughout the Antarctic (except Palmer Station, which does this separately), certifies it for Stateside acceptance, and puts it on the annual cargo ship for disposal at waste management facilities in the United States. The amounts are substantial; food waste alone totals some 750,000 pounds a year.

The services pyramid (slides 15-18) is flatter than we'd like. We aim to increase the pyramid's angle of repose so that more of the Program's funds go into the performance of scientific research.

Discussion:

What is the agreed level of service for a science project? Response: We have not defined that in an overall sense; projects typically have specific needs that we address on a case-by-case basis. The goal is to get the researchers in and out of Antarctica on their schedules and to assign support personnel to non-science tasks if efficiencies can be achieved doing that.

Craig Dorman: Are other efficiencies in the works? Response: The wind farm at McMurdo and Scott Base appears successful; a phase 2 could come. The Williams Field skiway at McMurdo is likely to be closed. An extension of the summer field season has been considered. Review of research projects has led to efficiencies; delivery of liquid helium needed to cool the South Pole telescopes is likely to be replaced with local generation, for example.

Norm Augustine: What is the policy for recovery from the loss of icebreaker service needed to get the annual ship resupply in to McMurdo? Response: The McMurdo fuel farm can hold 1.8 years worth, getting us through the winter. South Pole stores a winter's worth plus 2 months. We would have to cut back some of the more ambitious projects. Duncan McNabb commented that a C-17 can drop fuel – for 10 times the cost of regular delivery. George Blaisdell: Systems are in place such that the risk of life is extremely unlikely; we know how to shrink operations to maintain the asset and avoid a life-threatening situation.

Hugh Ducklow said the pie chart (slide 20 in the supply chain set) suggests that cutting back doesn't save you much. Response: We're finding efficiencies in various ways. The 10-meter telescope at South Pole has power spikes, and we've found a way to flatten them. Saving fuel at South Pole cascades quickly. We have gone to Energy Star appliances. Non-flush toilets are saving a million gallons of water a year. We buy more expensive gas chromatographs that draw less power and would like to do the same for a more efficient magnetometer, which would cost $200,000. There's the ever-present tradeoff between capital investment now and savings later.

Current USAP business systems, information technology, and communications

Patrick D. Smith, Technology Development Manager, Antarctic Infrastructure & Logistics, OPP, presented this topic. [21] The presentation and its slides covered major challenges, including complexity of this system beyond a typical white collar IT system. Special security needs and other concerns are posed by the physical isolation, an aging infrastructure, the long supply chain, and the transient work force.

The USAP community depends on information and communication technology (ICT) both within the Antarctic and between the Antarctic and home institutions. The enterprise network developed to service this community is centrally supported from Centennial, Colorado. For a size comparison to something perhaps more familiar, the number of desktops in it (1,600) is about the same as at National Science Foundation headquarters in Virginia, but it is more complex with ten globally dispersed operating locations versus NSF's one, a wide area network, and its own telecom service while NSF is able to use a commercial one.

Providing high bandwidth to Earth's high latitudes is problematic. Most communication satellites are geostationary. An Earth location south (or, in the Arctic, north) of about 81° latitude is below the horizon for these satellites – out of reach. Of the three U.S. year-round Antarctic stations, Palmer at 64° 46'S is not problematic, McMurdo at 77° 51'S is on the edge, and Amundsen-Scott South Pole at 90°S is out of reach. Many USAP field camps are south of 81°. Of the well-known satellite networks servicing all latitudes, Iridium Communications Inc. is low bandwidth, and the GPS satellites do not provide communications.

The USAP solution so far has had two approaches. One is to establish commercial agreements with the owners of polar-orbiting satellites such as Iridium. Another is to negotiate arrangements with owners of aging geostationary satellites getting past original mission requirements and beginning to oscillate every day several degrees north and south of the equator; this approach can be said to have an aura of "dumpster diving" for services, but when successful it yields several hours a day of good bandwidth.

The trend in science worldwide, as in the Antarctic, is toward the need for more bandwidth. At the South Pole the growth in demand since the mid 1990s has been exponential. The first-generation TDRSS satellite on which South Pole now depends critically will fail by around 2017. Candidate replacements, all expensive, range from a dedicated polar satellite or satellites to an Antarctic ground station north of 81°S connected to South Pole Station and other locations by

[21] For the 30 slides accompanying this presentation, click on the 8th bullet in the Documents section of the BRP web site.

over-ice cable. International collaboration likely would be involved, and for some solutions high-latitude Arctic communities might participate, further distributing costs.

The expectation of many new USAP participants is that they will get fat-pipe internet service in Antarctica as if they were home in the States, where the average household spends $38 a month for an average connection speed of 5.8 Mbps. The soda-straw reality of McMurdo is that the total inbound bandwidth for a thousand people is 18 Mbps, and the monthly cost to NSF is $83,333.

USAP support integration

Brian Stone discussed international logistics collatorations.[22] One of the best examples of integrating Antarctic research and operations is the AGAP project studying Antarctica's Gamburtsev Province, a range of mountains the size of the Alps under the East Antarctic Ice Sheet. These mountains were discovered in 1958, but were not well surveyed until the 2007-2009 International Polar Year. For AGAP, seven nations assembled research and operations strengths that none could have produced on its own. For example, a USAF C-17 starting from New Zealand with a payload of fuel in drums refueled at McMurdo then went on to an air drop zone in East Antarctica where members of the Chinese Antarctic program recovered the drums and eventually sent the parachutes back to the USAF. USAP LC-130s transported people and cargo. The British Antarctic Survey provided Twin Otter flights equipped with ice-penetrating radars, laser ranging systems, gravity meters, and magnetometers.

The slides illustrate some of the other operational collaborations. More than 120,000 km of new aerogeophysical data were collected, providing the most comprehensive geophysical perspective so far of crustal architecture and mountain-building processes in interior East Antarctica.[23]

In the USAP, each of us is a portfolio manager with responsibility for managing contractor activities. Much of the program operates on the principle that good and dedicated people are professionally committed to project completion – a trait that you will see when you visit Antarctica.

Planning future actions of the panel

Norm Augustine laid out future plans for the panel, including a working visit or visits to U.S. activities in the Antarctic later this month for at least some members, one or two meetings after that, visits to sites in the United States by some panel members, and developing the initial report draft. Perhaps three meetings will be needed to shape that first effort into a good draft, followed by cleanup by e-mail and completion in the Spring. During this process, panelists receiving media inquiries might wish to pass them along to Karl Erb and to me so that we can present a coordinated sense of progress.

[22] For slides, click on the bottom Thursday bullet in the Documents section of the BRP web site.
[23] Ferraccioli, F., et al., 2011. East Antarctic rifting triggers uplift of the Gamburtsev Mountains, *Nature* 479, 388-392, 17 November 2011. See Acknowledgements for national contributions.

International partnerships: general considerations

Karl Erb noted that phase 1 of this effort, the NRC report, demonstrates that the overlapping scientific priorities of the United States and those of other nations present numerous opportunities for collaboration.[24]

The Foundation's most recent statistical analysis of world science, *Science and Engineering Indicators 2010*, points out that international collaboration has become the norm. A separate study shows that international collaboration in polar research has moved along at an even more vigorous pace, with the international coauthorship of Arctic and Antarctic papers rising from around 6 percent in 1981 to more than 40 percent in 2007.

The International Polar Year began just after this period. NSF was the designated lead U.S. agency. Congress provided funds enabling that leadership; we were in partnership projects with scientists in 28 other countries.

Another recent study of citation patterns in the polar research literature – this one concerning just Antarctica – found a rise in international coauthorship similar to the above polar study. It showed the United States as the most networked country in Antarctic science, followed by Germany, the U.K., France, and Australia.

The research literature and IPY demonstrate that we have a good base on which to build. A question might be: Are we using it effectively?

International partnerships: specific examples

Brian Stone provided examples of international partnerships.[25] Many of the examples were initiated or refined during the once a year meeting of representatives of the national operating programs, the Council of Managers of National Antarctic.[26]

The U.S./N.Z. collaboration is extensive and mature, having begun in 1957. The two nations' flights between Christchurch and McMurdo operate essentially as one airline, with the number of flights by each equivalent to program size. In the Antarctic, New Zealand contributes one helicopter to the two nations' fleet, stevedores for ship unloading and loading, divers, and, lately, construction personnel. We negotiate a support plan annually and try to leave a little flexibility for surprises that come up during the season.

An Australian Airbus flies eight missions from Christchurch to McMurdo; in exchange, U.S. LC-130s fly Australian personnel to their Casey Station to give them a longer operating season than if they had gone straight to Casey aboard their ship.

Italy has a similar arrangement. An Italian C-130 brings U.S. and Italian personnel to McMurdo, and we give the Italians a lift to their station at Terra Nova Bay (they use their helicopters for this, too).

[24] Slides at first bullet, Documents, Friday.
[25] Slides at second bullet, Documents, Friday.
[26] COMNAP, founded 1988, 28 member nations, meets in Portland, Oregon, 15-16 July 2012.

The Twin Otters and Baslers that we lease don't have the range for the Christchurch-McMurdo run, so each season they come to Antarctica from North America by way of South America. Rothera, a U.K. research station along the Antarctic Peninsula, refuels them enroute.

Characteristics common to the international arrangements (slide 2) are that the cooperative operations must be based on science collaboration or a negotiated cooperative relationship, all contact is via the national Antarctic programs, and our logistics are not for sale.

Discussion:

Duncan McNabb observed that payment in kind is great if it is equal and asked if the logistics-not-for-sale arrangement is working. Brian Stone and Karl Erb noted that we work hard on that and audit the results, and Congress asks the question, too. Some situations are hard to price. What's the value of a gallon of fuel when you need it in the middle of West Antarctica, and there it is? A robust audit example is the McMurdo-Scott Base power grid: New Zealand had seen that it needed to raise its share and built the wind turbine farm you've heard about. U.S. resources are fully engaged, so having excess to sell would be a rare situation. Sometimes, though, we've had to buy abroad, as when we chartered the Swedish icebreaker *Oden* to break the sea ice channel to McMurdo. Another level of collaboration is technology exchange as was done with the French program regarding traverse expertise.

Duncan McNabb: Your supply chain has great value. Opportunities are there to save everybody money. In response Karl Erb noted that engaging with others would also extend the USAP's range.

Hugh Ducklow: Has the United States approached another country and it did not work out? Karl Erb explained that Korean colleagues have approached the USAP for collaboration, but have not yet identified what they can bring to the table.

Norm Augustine: You don't trade logistics for science, but are the data available anyway? Brian Stone and Karl Erb explained that we do exchange logistics for science in the field. Antarctica Treaty article III requires that data be available. This usually happens within 2 years. The British Antarctic Survey could help to support Palmer Station, but we don't know the business case yet. The researchers' need for an extended small boating range around Palmer could be a candidate, although no discussion is taking place about this. The BAS ship *Shackleton* could free up our *L.M. Gould*. Chile wants to beef up its facility at King George Island so that cruise ships could offer fly-cruise-fly packages – a government-commercial arrangement – enabling tourists to skip crossing Drake Passage in a ship.

Bart Gordon: Because a flat USAP budget may be the new definition of success, we should look at all alternatives, with the United States taking the initiative. Karl Erb and Brian Stone noted that the private sector represents an opportunity; the tour industry wants to collaborate with us, although we have not yet worked out a way, and the treaty parties are concerned about their environmental impact. Should we engage the tour operators to bring our cargo? Provide increased access to research stations? Chileans have thought about beefing up their air installations near the tip of the Antarctic Peninsula to support cruise ship passengers, and this has

potential to open up possibilities for other nation's science programs. Perhaps the tourist industry can help with cargo to Palmer, perhaps in exchange for science outreach to the ships.

Research platforms: agility, sustainability, relevance

Brian Stone described some of the research platforms in use. Looking forward 10 or 20 years, how do we assure availability of the technology needed to meet research requirements?

Here's an example from the last decade. We had no Basler airplane (old DC-3 airframe, new engines, skis, avionics).[27] A Twin Otter is not big enough to carry snowmobiles, and an LC-130 is much more capacity than needed. We were the first to work with the Basler company, deploying one plane to Antarctica as an experiment. The scientists told us it was a very effective platform. Now we can't get enough of them (airframes are available; skis are the limiter). It took 6 years, but we created a market. For some situations we *are* the market. The question arises: How can we stimulate competition?

Traverse equipment used now is different from the older equipment. Ten years ago agricultural needs stimulated development of Caterpillar Challenger 65 tractors. The French pioneered their use in Antarctica. The USAP joined in. Now vendors know how to set up Challenger tractors for polar use. The Chinese and the Australians buy Challengers for use in Antarctica.

How does the buy-American requirement affect your acquisitions? Response: Some flexibility exists. We buy Cat (U.S. company) dump trucks made in England. A unique offshore product can be reachable.

Is bridging crevasses a limiting factor for the traverses? The expertise has advanced, and improvements in both Greenland and Antarctica have moved capabilities forward enough that bridging is not a critical path limiter. The real limit is the 12-hour day for operators. We are working on automating functions to enable a 20-hour day; this will both speed delivery and reduce the cost of labor.

Can other agencies help? The Defense Advanced Research Projects Agency, the U.S. Army Cold Regions Research and Engineering Laboratory, and others are partners.

Turning to sustainability, Brian Stone explained solutions for small-scale energy use, 10 kilowatts and down, at field camps. Intermediate scale and up is more difficult, with fuel a constraining commodity. At the stations we're doing the expected things from light bulbs on up, and our partnership with the Department of Energy is yielding gains, including innovative approaches at McMurdo's satellite ground station Black Island. We are increasing tankage at McMurdo, as mentioned, toward a 2-year supply.

With regard to relevance, we are working at better anticipating the direct needs of science, mindful that 24 to 36 months of advance knowledge is helpful. We are working to have scientists' research proposals include innovative solutions, and we increasingly are shifting our time and resources past things like fuel to the direct needs of science. South Pole Station uses a lot of solar power in summer, for example.

[27] Basler Turbo-67.

Thad Allen asked who owns what in Antarctica, and who is responsible for life cycle costs. NSF owns the fixed USAP infrastructure; McMurdo represents about $400-million worth. NSF owns eight LC-130s, of which four are stored at Davis-Monthan Air Force Base in the desert. The Air Force owns six LC-130s. The LC-130s operate in both Antarctica and Greenland. These are the world's only LC-130s. Replacement of some will become an issue within 20 years. The Coast Guard owns its icebreakers.

A contractor, PHI, owns the helicopters; we buy the service. The helicopters are a standard make, and availability is not an issue. We contract for the Twin Otters. The ice-strengthened ships are chartered from a U.S. company, Edison-Chouest Offshore. We re-compete all the contracts periodically, going for the longest term plus options so the owner can amortize the asset. The Military Sealift Command tanker and cargo ship contracts for McMurdo resupply were just re-competed.

Acquiring a Southern Ocean ice capable deep sea vessel responsive to research needs is a major issue, and discussions are under way. A preliminary UNOLS report refreshing science mission requirements for a polar research vessel is out, said Hugh Ducklow, and the final will be ready in Spring 2012. We specified breaking 1- to 1.5-meter ice at 5 knots (about the same as USCGC *Healy*).

Will the Arctic Regional Research Vessel *Sikuliaq* (under construction for the UNOLS fleet) be able to go South? Tim McGovern, Ocean Projects Manager, Division of Antarctic Infrastructure & Logistics, OPP, noted it is about as capable as the USAP RV *L.M. Gould*, less capable than needed for Southern Ocean circum-Antarctic work. A spreadsheet describing characteristics of polar research ships is in the UNOLS report referred to for the polar research vessel.

The panel requested information on capabilities held by the other nations, both ships and planes.

George Blaisdell explained that wheeled intercontinental airplanes can land at McMurdo year-round. Recent types in summer have been C-130, LC-130 (wheeled landing), 757, Airbus 319, C-17, P-3. For winter we don't have in place some navigational aids.

Range to McMurdo is a factor, and not many airplanes have it. Christchurch (2,400 miles, 10,800 ft runway) is the usual starting airport.[28] Between New Zealand and McMurdo are no alternate landing fields. If, en route, the destination weather fouls, you turn around at a fuel-imposed PSR (point of safe return). Past PSR, you're committed. For some plane types, loads, and winds, PSR can be overhead McMurdo.

Local warming around McMurdo has our attention. The Pegasus hard runway on prepared glacier ice gets a snow cap during the warmest part of the year to keep it cool. With experience we've learned to use the runway then, but for 1 to 2 weeks in December-January it's right on the edge of the temperature range. We land at local midnight then, when it's cooler, not around noon. Diane Wall said that the Dry Valleys have had three warming events since 2000, and Brian Stone added that we had to move camps back from the water's edge.

[28] The Christchurch-McMurdo distance, for a familiar comparison, is same as IAD-LAX. Hobart, Tasmania, with a 7,400 ft runway, is 2,480 miles from McMurdo. McMurdo's closest non-Antarctic runway (2,000 miles) is Invercargill, New Zealand, with a 7,200 ft runway.

Norm Augustine asked if OPP has an example of investing now for payback later. In response, OPP noted that Recovery Act funding was used to improve the heat tape on utility lines at McMurdo, enabling closer control of the heating, and this is saving a huge amount of energy.

Bart Gordon asked how the program gets feedback from users. Workshops, international sharing of information, an incentive program for Raytheon employees, user committees for each station and vessel, direct feedback from grantees, outbriefs of departing science teams, Office of Polar Programs Advisory Committee.

Louis Lanzerotti recommended a suggestion box. Norm Augustine added that the space program implemented a suggested box and received 1,700 responses.

For a new ship, Louis Lanzerotti asked if OPP goes through MREFC (Major Research Equipment and Facilities Construction program). Karl Erb explained that construction estimated to cost more than $15- to $20-million uses that funding mechanism.

Would communications procurements be different? A new satellite would use the MREFC process, but the purchase of services would not.

Craig Dorman asked if other agencies' needs are expected to change in the future. Karl Erb suggested that the panel could inquire at the OSTP level. More specifically, NOAA and NASA have ground stations at McMurdo, and a new polar satellite is soon to be launched. The southern location is valuable for these agencies. For Antarctic test ban participation, real time data are required. Hugh Ducklow noted that NOAA has a living resources program in the Southern Ocean.[29]

Brian Stone discussed high-level challenges such as airlift. Over a 20-year horizon we need to consider the LC-130 fleet. Should NSF lead? DOD? The C-17 is an excellent platform, but too big for some parts of the year. We want a regular schedule in summer, but the transpacific run from the USA (to position the airplane) is expensive. Inventory management perhaps should include more just-in-time delivery, but that needs just-in-time transport. Palmer Station originally (1965) was to have air access; should we consider this?

Norm Augustine asked for a comparison with operations at Prudhoe Bay. Sam Feola, Director, Raytheon Polar Services Company, explained that Alaska Airlines flies there from Anchorage (630 miles, compared to 2,400 miles Christchurch-McMurdo): mainly personnel, a little cargo. BP and another company own and share a 737. Ordinary trucks use the 414-mile paved or graveled haul road from Fairbanks. Barges go up through the Bering Strait, and the sea is free of ice part of the year. Weather is not much of a concern. So Prudhoe Bay has options. The employee base is two people for every job with fixed rotations. The situation is radically different from McMurdo.

Duncan McNabb asked about options for keeping the footprint down, like airdrops to South Pole from Christchurch with refueling at McMurdo; low-altitude, low-cost 'chutes as in Afghanistan; precision-guided approach. Brian Stone noted there is precision approach at McMurdo; the Baslers and the Twin Otters use GPS and thus use it. The Air Force may consider a GPS

[29] Antarctic Marine Living Resources Program; 2011-2012 was its 26th season.

decision for the LC-130s. We have the technology and the tools to ready the South Pole skiway for C-17s; it would take an annual effort, but not huge. Regarding air drops, South Pole uses 700,000 gallons of fuel a year; at 12,000 gallons that would be nearly 60 C-17missions. For comparison, we now fly 60 missions a year between Christchurch and McMurdo. Landing as opposed to dropping makes more efficient use of the airframe, but the C-17 would be on the ground at South Pole close to an hour, and the cold-soak question arises. Dropping would reduce crew time and possibly ground infrastructure.

Are you confident in the McMurdo-South Pole traverse operation? The geography is in our favor in one way. We climb the hill from the Ross Ice Shelf to the polar plateau at the 2/3 point so we've burned off a lot of fuel, and we cache more at the bottom. The transits have been routine and safe, with a better accident/incident rate than flying. Duncan McNabb commented that going by surface whenever you can saves money; it's been a success in Afghanistan.

Duncan McNabb asked about airdropping fuel to the traverse. George Blaisdell noted that it has been 10 years since we examined that possibility, and that was before C-17s. A blue ice site is 300 miles from South Pole.

Bart Gordon asked about any other climate change effects on the program. George Blaisdell noted that besides the Pegasus runway, the McMurdo ice pier possibly could be affected. We had 12 years of increased sea ice, and the pier was robust. The sea ice seems to be getting back to normal and could require a different solution. Surface transport between the runway and McMurdo could be affected. The traverse operations seem to face no tipping point, and warmer weather has the advantage of reducing surface friction. A regional climate projection does not exist for the McMurdo area; the Antarctic Peninsula region is documented as warming as much as anywhere on the planet. Over Antarctica generally, the ozone hole and its eventual recovery introduce differences and confound climate models.

Louis Lanzerotti asked about an alternative site to McMurdo. The program has done such studies,[30] and we could study alternatives – such as traverse, hovercraft, and lighter-than-air-craft – to breaking a sea ice channel to McMurdo. We refuel Marble Point (across McMurdo Sound from McMurdo) by surface now instead of by hose across sea ice from the icebreaker. Alternatives for Palmer Station include resupply using other ships, including cost-sharing with other nations, and introducing ice-strengthened work boats to increase the local range of research.

Thad Allen commented that the panel could ask the U.S. Coast Guard about its funding for icebreaking in fiscal 2012 and 2013, giving this information more visibility and elevating the issue above budget-driven choices. Regarding Palmer, he noted the Coast Guard uses ice-strengthened workboats on the Great Lakes.

Brian Stone noted that a new challenge for vessels is the ban on heavy fuel use in the Antarctic.[31] Back to infrastructure, it has built up over time and could be shrunk or redeveloped to raise

[30] *Hard-surface runways in Antarctica*, by Malcolm Mellor, 1988 (CRREL Special Report 88-13), reviews studies since 1957 of the potential for a land-based runway at Marble Point, on the mainland west of McMurdo Station.

[31] Antarctic fuel oil ban and North American ECA MARPOL amendments enter into force on 1 August 2011

efficiency. For example, an arriving plane offloads cargo, which is transported to McMurdo and then back to the airfield for eventual onward shipment; an investment in infrastructure could change that. Applying renewable energy to an inefficient system is not an optimal idea. Centralizing into one warehouse would improve the business process. We are proud of our 67 percent recycle rate, as good as the best cities in the USA, but is it cost effective?

Don Hartill asked if the Antarctic stations incinerate. Not on site, although thought has been given to wood gasification equipment to reduce the need to retrograde crating and so forth, and we do mix used oil into the furnace fuel. NREL (National Renewable Energy Laboratory) has been consulting with us for three to four years, including electric trucks and building rehabilitation decisions. The challenge always is finding capital now for savings later. Don Hartill said Fermilab improved its energy use by having a contractor capitalize the upfront cost and sharing in the savings.

George Blaisdell brought up two areas for attention: the level of service provided to science (with researchers desiring at least what they get at the home institution) and what services to provide outside of Antarctica. For example, basic training is required of anyone before leaving McMurdo for the field, and we typically do it on site, but we shifted some to Christchurch last season and got only positive comments. This year, with the effect of the New Zealand earthquakes, we don't have the Christchurch option.

Brian Stone explained that some of the weather forecasting has been moved off site and could do others. There always is the concern about communications and how exactly to do it. The infrastructure is the life support system as well as home. Services like the old bowling alley at McMurdo, now condemned and removed, raise the question of what level to provide. Rotating personnel more could reduce the onsite need, but there is the balance between productivity and recruiting success.

Diana Wall commented that having experienced people onsite who understand the Antarctic and how to work in it is a huge benefit to scientists.

Scott Borg, Division Director, Antarctic Sciences, OPP; and Karl Erb noted the irony of lengthening the season to reduce cost. There's currently no research proposal pressure to lengthen the season, but the notion is build it and they will come. If we announced that we'll lengthen the season, we'd get proposals: ecosystems don't go away in winter. A preferable approach might be workshops say every 4 years to develop a more agile system. Jim Swift has joined OPP to help enable that. Twenty-five years ago much of the support a scientist obtained came forth after arriving in Antarctica. The process is more rigorous and planned now, and the system itself is more responsive. For example, the helicopter contract pays for flying, not just sitting there. We have a plethora of good research proposals motivating us to plan for working at the edge of what's possible and having the occasional failure.

Craig Dorman asked about the balance between proposal-driven and long-term observations. Scott Borg indicated that there is a need to explore the opportunities with NOAA and other agencies.

Several panelist commented that setting up long-term observations means you are warning the community that you will be doing this for years. Then, with budget pressure, there's reluctance to cut back the investment, and proposal-driven science suffers. The panel commented on the need to involve other agencies and the other communities, too. The NRC phase 1 report includes both discovery and long-term observations, but many of the research questions are embedded in "long term observations."

Scott Borg noted that several continuous projects in Antarctica have universities as strong players, e.g., the automatic weather stations and seismology. The Antarctic Science Division easily devotes 10 percent of the budget to long-term observations.

Antarctic site visit planning

This item was discussed earlier than shown on the agenda because some panelists had to leave early. It involved detailed travel planning, what to bring, what to do. One decision was that the panelists who make the trip will develop checklists along the way for discussion on return to New Zealand. The trip is scheduled for 28 November to 8 December 2011.

Panel discussion

Think about information needed from NSF and how USAP can get more bang for the buck.

We need an inventory of the science that has produced economic or other benefits.

The introductory section of the report will get us going, and we might include the President's 1970 quote in that section.

We need a financial analyst – someone familiar with the OMB approach.

Climate change and budget might be topics needing further evaluation.

In the Arctic, minerals exploration is under way, and we should consider Antarctica (the Southern Ocean, really) in this context, including consequences of spills, etc. Department of State and CCAMLR could be involved.

Are lessons from Arctic Observing Network applicable to the Antarctic?

Supply chain management

Brian Stone discussed some challenges. For example, a government-furnished supply software system, MAPCON, that is old and unsustainable. Regarding storage, at South Pole Station inventory goes where inventory fits – under stairs and so forth – and for safety reasons (fire, etc.) we don't want to lock it up. Any future system should provide the ability to track these locations. Work center personnel have a lot of autonomy, but the work force rotates typically annually, so the next employee has to be able to use it. A better system for stocking and reordering is needed.

Port Hueneme, California, is the receiving location for onward shipment to Antarctica. With the once a year ship, the end user typically gets a faulty or mis-shipped item too late to return it for credit. Accuracy in ordering is particularly important for us, and the government procurement idiosyncrasy of specifying characteristics rather than brands can work against us. If an item misses the boat, then it waits a year or it has to be flown.

The fiscal year starts 1 October, and items must be in Port Hueneme in December. This is a tight procurement line, and an extra year of procurement funding to get ahead would be helpful.

Items headed for the Antarctic get repacked at Port Hueneme to remove material such as plastic peanuts and bark that the Antarctic Conservation Act prohibits and to pack them robustly for export shipment standards and for storage outside in Antarctica. This process could be streamlined.

Expiration dates are an issue. A drink box arrives in Antarctica almost out of date. It's an economic issue and a morale issue, not to mention safety. We buy lots of food out of New Zealand and some out of southern South America: things like eggs and potatoes with short shelf lives.

Thad Allen asked who owns the warehouse in Port Hueneme. Response (Sam Feola): The Navy owns it, NSF leases it, Raytheon staffs it. It is a warehouse dedicated to USAP.

We buy through DOD/DOA, so can Raytheon.

Duncan McNabb: DOA is benchmarked to industry and is highly effective and has some of your issues. An annual conference is held, and USAP might attend the next one.

Gérard Jugie said France has the same issue, but smaller, and adds the complication of working with Italy on a joint station. USAP has the biggest organization, and several smaller countries rely on the USAP's logistics. When we discuss in-kind we need to be extremely careful. USAP cannot be responsible for everything happening in Antarctica: you need a fair collaboration, and not just when we need you in a tight situation. Some countries may be going too far.

Information technology and communications

Brian Stone explained that every part of the USAP system, including personal communications to family back home, depends on ITC. The system has limits, so we prioritize the uses – critical and other. In Antarctica, cloud computing, to name one Stateside development, is not easy: the

needed bandwidth does not exist. More demands are on the horizon, and in the next 20 years we see telecommunications as a big issue for the USAP. We've developed workarounds – for example, caching a download likely to have more than one user so that bandwidth demand is reduced and it is there immediately for the second user. Infrastructure investments are needed, for example, to discern official and other traffic.

Robert Speering asked whether a company such as Verizon has reviewed the operation. Pat Smith indicated it had not, but that this could be useful. Missing in Antarctica, for example, is 4G: the piece Verizon supplies in the States.

Brian Stone noted that USAP information is compartmentalized, so it is cumbersome to pull together what's going on and respond to an urgent need. For example, when a fire alarm sounds, that information needs to be available at once to certain people. Business intelligence and data mining could capture the data that we do generate. Dialog with the scientists is useful, and the IceCube project at South Pole is notable for a tenfold reduction in the volume of data being transmitted to the USA with no loss of scientific content. Operations personnel will want to automate processes. We track the location of aircraft, but not vehicles or people. People leaving the station must check out, then check back in on return or we send out a SAR team; a technological solution would be more effective and less susceptible to human error. Capabilities available in the USA – your iPhone telling you where your grandchildren are – will be useful for improving safety and mission effectiveness in the Antarctic.

A panel member commented that AIS (Automatic Identification System) is an IMO requirement for ship tracking.[32] LRIT (Long Range Identification and Tracking) collects and disseminates vessel position information received from IMO member-state ships that are subject to the International Convention for the Safety of Life at Sea (SOLAS).[33] Other potentially useful services exist.[34]

Patrick Smith noted that NSF's Geosciences Directorate is providing fleet broadband access to the UNOLS ships through a grant to Woods Hole Oceanographic Institution. The USAP participates for its ships, but buy the service by the byte and so cost is an issue.

For aviation command and control we would like to use Iridium more; flight management is not optimum. We have a legacy investment in HF. DOD may be able to collaborate on this need.

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[32] International Maritime Organization requires all vessels over 299GT to carry an AIS transponder, which transmits position, speed, course, and static information such as vessel name, dimensions, and voyage details. A free service online tracks ships worldwide.

[33] Long Range Identification and Tracking

[34] MSSIS (Maritime Safety and Security Information System), managed by the Department of Transportation, Volpe Center, collects AIS data Nationwide and provides Internet access for authorized users. MSSIS, via the U.S. Coast Guard, is working with Orbcomm for satellite-based AIS data recovery to enable global monitoring. A Canadian company, ExactEarth, provides this service using only polar-orbiting satellites. Ship tracking in the Arctic is a national priority for Canada; the Arctic will be the market driver, but the Antarctic will benefit. Sites:
https://mssis.volpe.dot.gov/Main/home/
https://mssis.volpe.dot.gov/Main/AIS/
http://www.orbcomm.com/services-ais.htm
http://www.exactearth.com/
http://www.asc-csa.gc.ca/eng/satellites/radarsat/components.asp

Blue Force Tracking could have applicability in Antarctica. For South Pole broadband, NASA is a strategic partner, but not many satellites meet the need; TDRSS helps with our telemedicine and other critical requirements. We are looking in to possible use no earlier than 2014 of one of three Air Force satellites being phased out that would meet USAP's South Pole need.

The panel commented that the USAP should keep some HF for disaster recovery. Panelists Allen and Dorman will confer on Blue Force Tracking. What would it cost to put up your own satellite? Response: NSF issued an RFI in April. Russia may be able to offer an option. Our Australian counterpart is looking at a collaboration of the Antarctic countries but it is not certain that they can close the business case.

What is the status of your bulk fuel storage at McMurdo? We are close to 2 years worth, and this year if successful we will have it. At South Pole we now have tanks only, no bladders: 550,000 gallons capacity for an annual usage rate of 700,000 gallons.

Brian Stone explained the fuel spill containment control plan. At McMurdo, the tankage is consolidating at a central bermed farm, off the hillsides. The single-fuel notion is being thought through: we use JP-5 and AN-8, but JP-5 is less expensive. George Blaisdell added that bladders line the steel tanks at Palmer Station. The ships use the same fuel. For the station engines we mix ship fuel and jet fuel. The two urgent issues at Palmer are fuel storage and sewage treatment.

Meeting wrapup

Norm Augustine and Karl Erb will outline approaches to issues and assign issues to experts on the panel. Those deploying to Antarctica will meet in Christchurch to review lists for cost savings or better services. The intent is to leave New Zealand with extensive and better lists. We've raised requests for information throughout the meeting that we hope NSF will be able to help with.

Suggested list topics from panelists:

1. Shipping
2. RV *Sikuliaq*
3. Icebreaker
4. Dual use??
5. Long-term plan for observing, with insights from the Arctic and from SCAR
6. Arctic technologies applicability
7. Argos floats
8. Interplay of technologies

9. Stations near each other – potential for international collaborations
10. Concern about losing sight of forefront science in other areas than the ground-based sciences (example: space weather studies)
11. Small autonomous stations
12. UNOLS report on PRV
13. Panel or part of it visit Palmer Station
14. Collaboration with cruise ships and the cruise industry
15. International logistics, synergy and economy of working together
16. Remotely operated vehicles, water, air, and ground
17. Assuring long term observations meet research needs
18. Need for European polar nations to collaborate further
19. Further leveraging U.S. Antarctic capabilities in the international setting

Adjourn: end of meeting 1

Abbreviations

Abbreviation	Definition
AGAP	Antarctica's Gamburtsev Province
AIS	Automatic Identification System
BAS	British Antarctic Survey
BRP	[United States Antarctic Program] Blue Ribbon Panel
DOD	Department of Defense
DOD/DOA	Department of Defense/Department of the Army [?]
GPS	Global Positioning System
HF	High frequency (radio)
ICSU	International Council for Science
ICT	Information and Communications Technology
IPY	International Polar Year
IT	Information Technology
LRAD	Long Range Acoustic Device
MAPCON	Mapcon Technologies, Inc.
MREFC	Major Research Equipment and Facilities Construction (NSF program)
N.Z.	New Zealand

NASA	National Aeronautics and Space Administration
NEON	National Ecological Observing Network
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSF	National Science Foundation
OPP	Office of Polar Programs (NSF)
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
PGR	Postglacial Rebound
PHI	Petroleum Helicopters International, Inc.
PRV	Polar Research Vessel
PSR	Point of Safe Return
RFI	Request for Information
RPSC	Raytheon Polar Services Company
RV	Research Vessel
SCAR	Scientific Committee on Antarctic Research
SOOS	Southern Ocean Observing System
STEM	Science, Technology, Engineering, and Mathematics
TDRSS	Tracking and Data Relay Satellite System
U.K.	United Kingdom
UNOLS	University-National Oceanographic Laboratory System
USAF	United States Air Force
USAP	United States Antarctic Program
USCG	United States Coast Guard
USCGC	United States Coast Guard Cutter