Summary of NOAA Activities in Antarctica

(requests are in italics)

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NOAA has a long history of conducting research in Antarctica, dating back to the International Geophysical Year (IGY) in 1957. NOAA has maintained a permanent presence at South Pole, where it conducts long-term monitoring and research on atmospheric composition; has a committed research program on marine fisheries and ecosystems; and supports flight operations and other activities through its satellite and ground-based weather monitoring infrastructure. The agency has a research role for supporting policy relevant to marine conservation and management and a Congressional mandate to monitor the Antarctic stratospheric ozone layer. Four of NOAA's five Line Offices participate in Antarctic activtiies, the most prevalent being the National Marine Fisheries Service and the Office of Oceanic and Atmospheric Research. The agency is engaged in many interagency and several international efforts that are in or impinge upon the Antarctic.

National Marine Fisheries Service (NMFS)

NOAA's US AMLR Program was established with passage of the AMLR Convention Act in 1984. The Act establishes DOC's responsibility for conducting "directed research" to support US Antarctic policy, particularly with respect to the conservation and management of living marine resources in the Southern Ocean. The AMLR Convention Act also establishes NSF's responsibility for "basic research" in Antarctica. In general, therefore, NSF research and monitoring efforts in Antarctica are more broad-based (e.g., including geology, ecology, glaciology, etc.) and "academic" while research by NOAA's US AMLR Program is more narrowly focused (on ecological and oceanographic topics that relate directly to fisheries management) and "applied." Antarctic fisheries are managed by the consensus of Members, including the USA, to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). The vision for the US AMLR Program is to provide the scientific basis for US policy positions within CCAMLR by observing the ecosystem, interpreting observed changes within the context of fishing and climate change, and predicting the potential impacts of fishing and climate change in the future.

The US AMLR Program is implemented by the Antarctic Ecosystem Research Division (AERD) at the Southwest Fisheries Science Center (SWFSC). The Program supports 11 FTEs and 1 NOAA Corps officer, with over 130 years of cumulative expertise on krill, penguins, seals, fishes, and Antarctic fisheries. Up to 20 contractors may, during the conduct of field operations, be seasonally employed by the Program. Permanent staff from the Program play key leadership roles within the CCAMLR scientific community (e.g., chairs of various scientific committees and working groups), and the Director of the Program is the US Representative to the CCAMLR Scientific Committee. A representative from NSF

commonly attends CCAMLR scientific meetings and serves as an advisor to the US Representative (NOAA often pays for some of the travel costs associated with this collaboration). In reciprocal fashion, NOAA's US Representative to the CCAMLR Scientific Committee commonly attends Antarctic Treaty meetings to advise the US Representative to the Committee on Environmental Protection, where NSF plays the lead role.

The US AMLR Program's research effort is focused in the Antarctic Peninsula region and structures its work around two main themes: how fishing and climate change impact 1) the krill-centric ecosystem, and 2) communities of benthic invertebrates and demersal fishes. The US AMLR study area overlays a major krill fishing area and an area where finfish populations were severely overexploited before the existence of CCAMLR.

The Program's research involves analysis and modeling of time-series observations of the whole ecosystem. These series have demonstrated important changes in the Antarctic marine ecosystem and have been developed from annual research and monitoring efforts onboard a research vessel (e.g., physical oceanography, net and acoustics surveys of krill, other zooplankton, and fishes) and at two field camps (e.g., abundance and reproductive success of penguins and pinnipeds). The 2011 field season marked the 25th annual AMLR field season.

The US AMLR Program is NOAA's only ecosystem observing system in the Southern Ocean and is globally recognized as exemplifying how to support ecosystem-based fishery management, providing key data and scientific advice to meet the needs of CCAMLR, and understanding the impacts of climate change on the Antarctic marine ecosystem. Key research findings developed by the Program include the strong positive correlation between sea ice and krill recruitment, the regional decline (up to about 80%) in krill density from the mid-1970s to the early 2000s, the regional decline in abundances of Adélie and chinstrap penguins since the mid-1970s, that the historical distribution of krill fishing would cause undue risk to krill predator populations if the fishery continues to expand, and that fish stocks which were overexploited prior to the existence of CCAMLR have not yet recovered. Furthermore, about 30% of the Sea-viewing Wide Field-of-view Sensor (SeaWiFs) calibration data in the Southern Ocean was provided through collaboration between the US AMLR Program, NASA, and Scripps Institution of Oceanography. About 25% of the drifters deployed in the Southern Ocean since 2005 were provided in a collaboration between the US AMLR Program and NOAA's Global Drifter Program.

The 2012 field season has been substantially altered. Difficulties during contract negotiations caused the Program to lose its charter research vessel, and, in the FY12 Conference Report, Congress cut a key budget line supporting the Program by over $1M. Program funding in FY11 was $4.75M and has dropped to at least $3.57M in FY12. It is estimated that the Program would need $6M to re-establish its "full presence", which includes independent support for an ice-strengthened research vessel and the two field camps, contracting and grants to support data collection and analysis, and participation in

CCAMLR meetings. As a result, staff members from the AERD and leadership at the SWFSC are currently considering how to redesign the field component of the US AMLR Program.

NSF has provided excellent logistical support to the US AMLR Program over the past two and a half decades. Among other things, this support has included the transfer of personnel and cargo between southern Chile and field stations in Antarctica, the use of NSF shore services and field equipment, communications infrastructure, and carpentry expertise. When possible, the US AMLR Program has reciprocated by providing in-kind opportunities for NSF researchers to participate in field research.

Over the coming years, NOAA hopes to further strengthen its partnership with NSF. *In particular, NOAA hopes to investigate the possibility of using NSF research vessels for scientific work at sea.*

National Weather Service (NWS) and National Satellite Data and Information Service (NESDIS)

The NWS Telecommunications Operations Center (TOC) processes all the Antarctic meteorological data coming through the WMO Gateway.

International Programme for Antarctic Buoys (http://www.ipab.aq/) -This is not a NOAA program, but NOAA is involved via the National Ice Center (Pablo Clemete-Colón).

Satellite product generation at McMurdo -NESDIS generates satellite products, particularly polar winds, with satellite data acquired at McMurdo Station and at Rothera (operated by the British Antarctic Survey). All processing is done on site. The winds are used by numerical weather prediction centers worldwide. This is a low budget operation, but very important. The acquisition systems are owned and operated by NSF and other countries, not by NOAA. *Satellite data acquisition in Antarctica should continue*.

Jeff Key (NWS) is co-leading the development and implementation of the WMO Global Cryosphere Watch (GCW). GCW was approved by the WMO Congress last May, and is entering the implementation phase now. Surface-based observations and satellite products for Antarctica will be an important part of GCW. NOAA will play a role, though I can't say exactly what it will be (beyond a single individual's participation) at this point. NSF funds the US part of the automated weather station (AWS) network. NOAA hopes NSF will be involved in GCW.

Internationally, NOAA's National Weather Service works with the EUMETSAT Polar System (EPS) Metop mission, which has the goal of provide continuous, long-term data sets, in support of operational meteorological and environmental forecasting and global climate monitoring. The EPS programme consists of a series of three polar orbiting Metop

satellites, to be flown successively for more than 14 years, from 2006, together with the relevant ground facilities. Metop carries a set of 'heritage' instruments provided by the United States and a new generation of European instruments that offer improved remote sensing capabilities to both meteorologists and climatologists. The new instruments will augment the accuracy of temperature humidity measurements, readings of wind speed and direction, and atmospheric ozone profiles.

Additionally, there are some satellite products that provide products only for the high latitudes. However, they do not depend upon Antarctic infrastructure or major programs.

NOAA would like to see one or two satellites in a highly-elliptical orbit (HEO) over the Antarctic. We believe NSF has some interest for communications purposes. The Canadians are developing such a system for the Arctic now, called the Polar Communications and Weather (PCW) satellite mission. NOAA will play a role, though more on the product development side rather than hardware. A similar system over the Antarctic is desirable.

Office of Oceanic and Atmospheric Research (OAR)

Background. NOAA's Global Monitoring Division (GMD) and its predecessor organizations have maintained manned atmospheric monitoring and research presence at the South Pole since 1957. Since 1974, NOAA has had a presence on the Antarctic continent 365 days per year and has fostered virtually continuous records of atmospheric composition at South Pole since 1957. The effort involves over 100 personnel in Boulder, permanent staffing at South Pole to oversee measurements, and maintain instruments (2 FTE), and summer visits by 5-10 staff for installing, upgrading, and testing specific instruments. Over 150 atmospheric constituents and properties are measured continuously by NOAA at the South Pole Atmospheric Research Observatory (ARO) and are broadly used by scientists working in Antarctica and by the international community in general. Results of these measurements are used for initiating and validating satellite retrievals, for numerous scientific publications, and for international scientific assessments (e.g., Scientific Assessments of Ozone Depletion, IPCC Climate Assessments, etc.). Finally, OAR staff serves as the "caretaker" of the South Pole Clean Air Sector (CAS) in accordance with NSF's Antarctic Specially Managed Area (ASMA) for current & future clean air and snow research.

Some Noteworthy Scientific Contributions from NOAA research and monitoring at the South Pole.

- The South Pole carbon dioxide record (begun in 1956 in partnership with Scripps Institution of Oceanography) is the longest on Earth and pre-dates the more famous Mauna Loa record. These data show man's effect on changing the composition of the global atmosphere. Together with data from NOAA's other Atmospheric Baseline observatories, they provide a robust record of the trends and distributions of this most important greenhouse gas and a backbone for other regional monitoring systems.

- The long-term, continuous monitoring of formerly increasing, and now decreasing, concentrations of ozone-depleting gases in the Antarctic atmosphere is also done in concert with the other Atmospheric Baseline Observatories to provide unambiguous trends and distributions of ozone-depleting gases. This is a requirement under the US Clean Air Act of 1990, which directed NOAA and NASA to globally monitor stratospheric ozone and the substances that cause its depletion.
- Similarly, monitoring of the Antarctic stratospheric ozone layer, with both balloon-borne, in-situ instruments and with a calibrated, Dobson Spectrometer operated from ground level, has provided a clear record of the extreme depletion of stratospheric ozone over Antarctica during the Austral spring, its worsening between the early 1960s and late 1990s, and its lack of change since 2000, indicating recovery may soon be on its way. These measurements are indispensable for initiation and validation of satellite retrievals.
- NOAA, with its NASA and NSF partners, has also conducted additional research at McMurdo and South Pole in association with these long-term records to elucidate the causes of the ozone hole and the roles of chemistry and circulation in its reappearance each year.
- NSF recently transitioned to NOAA its 22 year program for monitoring UV levels in relation to stratospheric ozone in the Antarctic. These measurements continue at all three US Antarctic sites with support from NOAA. They are still seen as a necessary and vital component for monitoring stratospheric ozone recovery over the next several decades.
- NOAA aerosol data have been used to show there is an annual cycle of black carbon at the South Pole resulting from interhemispheric transport.
- In the late 1990s and early 2000s, NOAA and its NSF partners conducted measurements of over 20 extremely low-concentration, anthropogenic gases in Antarctic firn air, extending their records from the early 1970s back to the late 1800s, and showing when they first arrived in detectable concentrations in Antarctica. These measurements were the first to demonstrate the entirely anthropogenic origin of chlorofluorcarbons (CFCs), halons, and other industrial compounds, putting to rest various assertions that these compounds emanate partly from volcanoes or other natural sources.

Needs and concerns

NOAA heavily relies upon and is grateful for all aspects of NSF operational support, including supply ships, research vessels, aircraft, facilities, communications, and personnel accommodations. NOAA's vital activities on the continent would not be possible without this operational support and the reliable interaction we've had with NSF science programs. It is hoped that this can continue, allowing NOAA to provide on-going, unique data records and enhance other efforts with its data.

Our concerns are few, in that there has always been good communication between the two agencies. However, we are concerned about integrity of the clean air sector at South Pole. While it is understood that research and operational activities are not to take place in the clean air sector, there are violations virtually every year and some of them are significant. It is vital that the NOAA personnel on site be fully informed of activities that have potential to

impinge on the clean air sector long before they begin to take place if we are to protect long-term records from periodic or even extended local contamination. This includes activities on site and any form of transportation to and from the site. *We would recommend that contractors at South Pole be informed on their obligation to engage NOAA staff on site for such activities.*

Other concerns of NOAA are mainly related to the supply chain, which NSF handles very well. However, we hope that that the issue with the ice-breaker this past year will not repeat in the future, as it is a threat to our ability to function year-round at South Pole and McMurdo. Overall, however, operational support by NSF has been exemplary over the past decades and we look forward to a continued mutually beneficial relationship in coming decades.