Report of the South Pole Prioritization Committee

February 2023

Contents

Preamble

The Director of the Office of Polar Programs (OPP) and the Chief Officer for Research Facilities (CORF) of the National Science Foundation (NSF) constituted a South Pole Prioritization Committee to recommend approaches to prioritizing projects using the South Pole Station with the goal of accommodating the diversity of disciplines, the capacity for world class science, and the range of scientific fields.

The Office assembled a committee of the following members. They are familiar with the needs of the major stakeholders and research communities, and they represent the Federal agencies who are the primary funders of research at the South Pole Station.

Jean Cottam Allen (Deputy Division Director, Physics Division, Mathematical and Physical Sciences Directorate, NSF)

Michelle Buchanan (Senior Technical Advisor to the Deputy Director for Science Programs, Office of Science, Department of Energy (DOE), formerly Deputy for Science and Technology at Oak Ridge National Laboratory (2017-20))

Fleming Crim, Chair (Emeritus Professor, University of Wisconsin, formerly Chief Operating Officer of NSF (2018-21) and Assistant Director for Mathematical and Physical Sciences (MPS) of NSF (2013-17))

Steve Iselin (OPP Advisory Committee and Senior Advisor at the Roosevelt Group and formerly Principal Deputy Assistant Secretary of the Navy for Energy, Installations & Environment)

Michael New (Deputy Associate Administrator for Research, NASA Science Mission Directorate)

Christine Smith (Field Operations Manager, Observatory Operations, Global Monitoring Laboratory, National Oceanic and Atmospheric Administration)

Alan Tomkins (Deputy Division Director, Social and Economic Science, Social, Behavioral, and Economic Science Directorate, NSF)

In addition, representatives of OPP including the Director of OPP, Roberta Marinelli, attended meetings and provided expert perspective. The Committee met seven times from August to December of 2022 to gather information and discuss options prior to preparing this report. **The goal of this report** is to provide recommendations that balance the powerful logistical constraints with the remarkable scientific opportunities at the South Pole Station.

1. Introduction

The essential constraint on the South Pole facility is analogous to that of a ship at sea or a space station in orbit. It has a finite capacity and limited access, and substantial expansion requires years of planning with stakeholders, including leaders in the Executive and Legislative branches of government. The National Science Foundation is the steward of this government-wide program serving a range of agencies, particularly the Department of Energy (DOE), National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF) along with the Department of Defense (DOD). Research projects from these agencies are notably varied, ranging from major efforts involving construction of elaborate and expensive facilities over many years to smaller projects and field work that have very different requirements.

The motivation for this report is a simple fact: the demand for resources to conduct important science through the South Pole Station substantially exceeds the capacity of the facility and associated logistics. The **purpose of this report** is to recommend transparent procedures for prioritizing projects competing for the limited resources of the South Pole Station. The charge to the Committee captures this goal by asking for

> …a framework, and decision rules, for determining how to prioritize projects that accommodates the diversity of disciplines, the capacity for world class science to be performed, and the scientific priorities in different fields.

The charge, which is in the Appendix, asks the Committee to focus on a set of criteria: science priorities, project urgency, available resources, and timescale of implementation and completion. The report first describes logistical constraints and follows with recommendations for processes that can facilitate assessment of projects, their prioritization and selection, and communication with stakeholders.

2. Logistical Considerations and Limits

There are logistical constraints that the Office of Polar Programs (OPP) understands well and described to the committee in clear detail. The presentation materials in the Appendix describe the facility and summarize the logistical situation succinctly. The essential constraints are

- *Transport and storage of fuel and cargo for South Pole Station.*
  (LC130 aircraft and traverses provide most of the transportation. Currently there are three traverses a season and a maximum number of flights determined by the available aircraft.)

- *Lodging at South Pole Station.*
  (There are 150 permanent beds available at the Station. Increasing the number of permanent beds would require new construction to expand the Station. Operation and maintenance of the station requires about half of these beds.)

- *Power at South Pole Station.*
  (Generation and fuel storage capacity constrain the available power to 600 kW.)

Except for the potential addition of one traverse, these are rigid near-term constraints because of both resources and time required to expand the South Pole capabilities.

An April 2022 Dear Colleague Letter about Antarctic resources called particular attention to the constraints on South Pole Station and the need for thoughtful responses from the community. (https://www.nsf.gov/pubs/2022/nsf22078/nsf22078.jsp)

> South Pole Station is saturated with already-funded projects, and required critical infrastructure and maintenance activities that can no longer be deferred, until late in the decade. South Pole Station will continue to host its current suite of large-scale science projects, such as the IceCube Neutrino Observatory; however, proposers seeking support for new projects at South Pole Station should consult the cognizant program officer to discuss alternative pathways to accomplish science goals.

There are important and critical projects, in a variety of scientific fields, that the present infrastructure cannot support. While its discussion is beyond the purview of this Committee, longer-term expansion of the South Pole Station would maximize the unique opportunities that the South Pole location provides. The capabilities of the South Pole Station and the compelling science they have enabled suggest that an expansion of the Station could pay great dividends in both research and international science leadership. As described above, potential expansion is an all-of-government decision.

These constraints lead us to address the allocation of available resources among proposed projects. One vital point is that basic operation and maintenance of the Station require a significant fraction of the resources available to OPP. The demands of research at the South Pole Station on aircraft and other field resources that are shared across the Continent can potentially overwhelm the rest of the Antarctic science program. Balancing those demands across the entire Antarctic program is a continuing challenge for OPP.

The Office of Polar Programs has proven capabilities for projecting the demands of existing projects, planned projects, and proposed projects. The Office's assessment and planning capabilities allow them to delineate clearly the requirements and consequences for a project of a defined scope. *The heart of the problem is that limits on resources force difficult choices.* The Office seeks to make those choices as transparently as possible, and several of our recommendations focus on transparency and consistency.

3. Review, Prioritization, and Selection Process

The review, prioritization, and selection process should be fair, transparent, and balanced. One essential point is that OPP must steward a portfolio of research at the South Pole Station that is feasible within its logistical constraints. The Committee divides its considerations into two aspects: One is **Review and Eligibility** and the other is **Prioritization and Selection**.

3.1 Review and Eligibility

3.1.1 Required Elements

Balance and transparency in part come from the consistency of information that OPP receives, and the Committee **recommends a set of common elements** for every proposal that comes to OPP. The submitting agency in concert with the proposers should provide this information to OPP.

- An explanation of why the proposed research is best done or only possible using the resources of the South Pole Station.
- A description of the expected science outcomes and contribution to the field of science from the proposed research.
- Discussion of the technical maturity and likelihood of accomplishing the proposed research.
- A description of both a "baseline level" of logistical resources that meets all of the goals and a "threshold (minimum) level" of logistical resources that meets enough of the goals to make the project worthwhile.
- A description of a science-driven operations timeline and project duration.
- A description of the full life cycle of the project, with particular attention to the end of operations and decommissioning plans. These plans include the means and funding source for removing equipment and associated infrastructure upon completion of the project.
- A management plan appropriate to the size and complexity of the project including strategies for meeting the challenges of the constrained and difficult South Pole environment.

3.1.2 Science, Technical, and Logistical Review

The funding organization conducts a scientific and technical review appropriate to the scale of the project and support levels. Because the agencies evaluate scientific and technical quality prior to requesting resources, OPP does not separately evaluate those aspects of the project. Agencies are best positioned to evaluate the degree to which a proposal fits into their programmatic goals and priorities. The Committee **recommends that agencies rank the proposals they send to OPP by priority**. Agencies may well balance criteria differently, and elements such as scientific quality, uniqueness for the South Pole, and urgency are essential. Ranking proposals by agency priority avoids the wasted effort of logistical assessment for lower ranked proposals. The Committee also **recommends a common deadline for submitting vetted proposals to OPP** to facilitate balanced consideration.

The Committee **recommends that OPP do a logistics and management readiness review for both the "baseline" and "threshold" versions of proposals** that the agencies have certified as scientifically and technically excellent. As is often the case now, constructing realistic plans at both scales will involve prior discussions with OPP. In appropriate cases for which the agency desires it, a representative of OPP might advise during the agency's technical review process. Even in the light of those discussions, OPP committing resources and scheduling projects requires this explicit OPP logistical review.

3.2 Prioritization and Selection

The science priority from the agencies, including their assessment of time sensitivity or urgency, informs the prioritization and selection process by OPP. The proposed projects that reach this stage are scientifically excellent and have established logistical requirements, as defined by the set of common elements defined in the proposal that comes to OPP. OPP must then establish priorities for implementation and make selections that balance the following factors:

- agency priorities,
- science portfolio,
- project type and size,
- project urgency and time sensitivity,
- timescale of implementation and completion, and
- logistical and management readiness.

The Office must decide among projects from substantially different research areas and agencies, with a range of requirements, scopes, and timescales. In addition, the planning process must retain flexibility to accommodate urgent or time-sensitive projects on relatively short notice. The planning process cannot handcuff the science by committing all the limited resources for years in advance. Balancing long, medium, and short-term projects with unknown future demands is a daunting task facing OPP each year. Because a varied cohort of researchers propose compelling and important science using the capabilities of the South Pole Station, communication with those several groups is another essential aspect of balancing the demands on the resources of the Station, and the recommendations touch on that aspect as well.

This report does not propose a detailed process or suggest the weightings of the various criteria in selecting projects for the South Pole Station. The OPP team, which has the best understanding of the resources, constraints, and challenges associated with supporting South Pole research projects, is best equipped to make those decisions.

The committee stresses the importance transparency regarding the process and constraints around these decisions. As described below, two-way communication that both informs stakeholders and provides comments from them is critical in balancing the many competing interests and priorities. In the next section, we explicitly recommend establishing a mechanism for this communication.

The Committee **recommends that OPP formally review each possible project with respect to the factors listed above** in making selections**.** The Committee recognizes the challenge and delicacy of evaluation, selection, and scheduling. Communication with proposers, agency offices, and the larger stakeholder community is essential. These decisions are difficult as there are not resources to support all projects that come to OPP. A transparent evaluation process will be valuable to both agencies and OPP in looking to the future and assessing the timescales on which projects might move forward.

The discussion above implicitly describes the process for new projects. However, there are also currently long-term continuing projects ranging from relatively small efforts supporting field work to major installations. Using the South Pole Station resources most effectively requires inclusion of these continuing existing projects in assessment of balance and logistical constraints. Requiring the description of timescales for implementation and completion including the full lifecycle and decommissioning plans will help in the assessment of such projects.

The Committee **recommends that the Office establish a regular review of active projects against their planned timelines**. OPP should establish a cadence of review, such as annually, that serves both planning and communication. For existing projects without established plans, the projects should develop and submit those plans. The Office should also establish a means of considering projects that are nearing their planned conclusion and whose leaders want to continue the research or upgrade or add capacity. In such a case, proposing agencies will need to prioritize these existing projects along with new projects, and the Office will need to apply the assessment criteria and process described above. Thus, **the Committee recommends that OPP review requests for continuations beyond the original time horizon or for increases in existing capabilities as new proposals.** This process is in the spirit of established processes at agencies for assessing the continuation of active projects. In short, the constrained resources of the South Pole Station require a thoughtful and formal consideration of existing projects along with new ones.

3.3 Communication and Advising

Clearly articulated and carefully implemented processes such as those described above are critical for effective stewardship of the unique capabilities of the South Pole Station. As mentioned above, implementing these processes is a challenge for many reasons, including the variety of constituents drawn from different scientific communities and funded by different agencies. Communicating with those varied stakeholders and in turn receiving advice from them is critical to the continued success of the research at the South Pole Station. Thus, the Committee **recommends establishing an advisory group with representatives from funding agencies and scientific stakeholders.**

This group can provide periodic advice and suggestions to improve the proposal submission and review process and can also learn about the results of the annual prioritization and review. That latter briefing would inform stakeholders about the process and influence future submissions and agency prioritizations. One possible mechanism is creation of a subcommittee of the appropriate Advisory Committee (AC) with a member of the AC serving as liaison and with representatives from

the relevant constituencies. We suggest that the Advisory Committee request that OPP provide a response and a preliminary plan of implementation at the earliest opportunity.

Many of the recommendations in this report align with requirements laid out by OMB memorandum (M-21-27) from June 2021. In particular, the use of learning agendas and evaluation is important for assessing and measuring investments. Such an approach can inform the strategic decisions described above about concluding or continuing existing projects and initiating new ones.

4. Summary of Recommendations

(1) A set of required elements for each proposal to facilitate prioritization and selection.

(2) Agency ranking of the proposals sent to OPP by priority.

(3) A common annual deadline for vetted proposals to come to OPP to facilitate their balanced consideration.

(4) An OPP logistics review for both the "baseline" and "threshold" proposals that the agencies have certified to be scientifically and technically excellent.

(5) A formal OPP review of each possible project with respect to established criteria

- **agency priorities,**
- **science portfolio,**
- **project type and size,**
- **project urgency and time sensitivity,**
- **timescale of implementation and completion, and**
- **logistical and management readiness.**

(6) A regular review of active projects against their planned timelines.

(7) OPP review as new proposals any requests for continuations beyond the original time horizon or for increases in existing capabilities of active projects.

(8) An advisory group with representatives from funding agencies and scientific stakeholders.

Appendix: Charge and Presentation Materials

Charge

Committee to Develop a Framework for Establishing Research Priorities at South Pole Station

Introduction: Optimal use of field stations and remote research laboratories requires careful consideration of science priorities, project urgency, the availability of resources to support the project, and the time scale of project implementation and completion. At times, the demand for facilities and instruments available to support science at remote locations exceeds the capability of a facility and associated logistics, and difficult decisions arise. For example, does a new, short-term project take precedence over a long time series of measurements? Do the magnitude and duration of one project exclude other high priority projects for an extended period of time? Does station occupancy by long-term investigators preclude new investigators from entering a field? Are some projects simply not supportable?

South Pole Station exemplifies a facility in which the demand for research infrastructure exceeds the supply, and the cost of developing new facilities is great. South Pole Station supports a variety of disciplines that have different needs and different planning horizons. For example, there are large telescopes that serve the astrophysics community and take years to construct; geospatial interests that include long-term measurements of atmospheric and geomagnetic properties and space weather; and glaciology projects that require significant and frequent deep field support from the station to remote field locations. These diverse fields of inquiry have different space, power, facilities, and logistical requirements and inevitably compete for these assets.

At present, our approach to supporting the diversity of projects at South Pole is best described by 'waiting in line', recognizing that 'getting to the front of the line' does not have a well determined pathway that reflects scientific urgency and station capability. The range of potential scenarios is great, and so are the impacts on different fields of science.

Objectives: We seek a framework, and decision rules, for determining how to prioritize projects that accommodates the diversity of disciplines, the capacity for world class science to be performed, and the scientific priorities in different fields. While we must consider the station's assets as they currently stand (the station we have now), ideally this process will assist with prioritizing future assets (the station we'd like to have) that are critical to advancing NSF's mission. Finally, we note that the framework developed for South Pole may be relevant for other stations and facilities that have limited capacity and great need.

Participants:

- Roberta Marinelli, Director, Office of Polar Programs, National Science Foundation
- Linnea Avallone, Chief Officer for Research Facilities, National Science Foundation
- NSF Senior Leaders
- Senior Representatives from partner agencies (NASA, NOAA, DOE)

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USAP and Amundsen-Scott South Pole Station

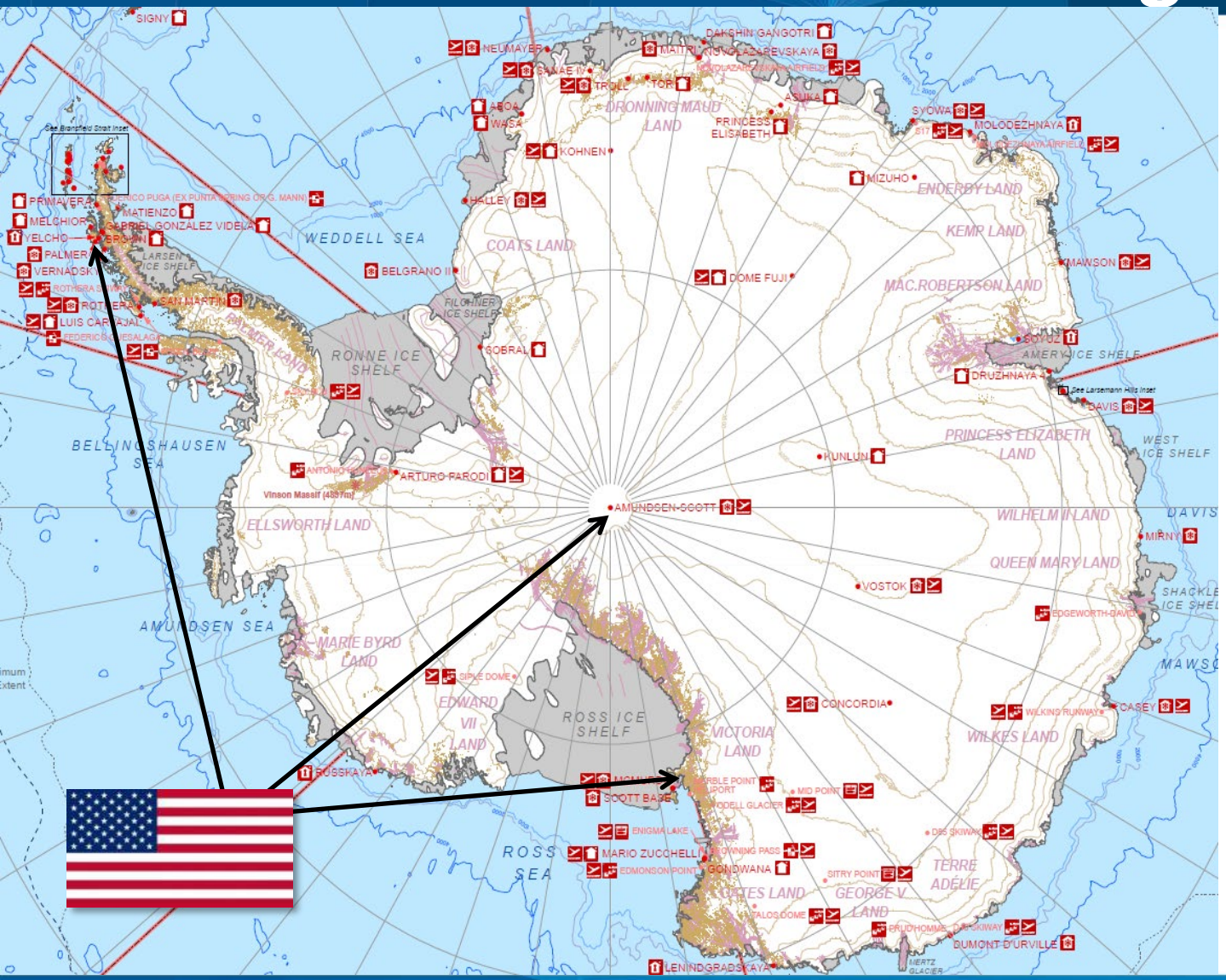
Dr. Roberta Marinelli, Director

Maggie Knuth, USAP Chief Program Manger

August 12, 2022

National Science Foundation
WHERE DISCOVERIES BEGIN

United States Antarctic Program (USAP)



- Established by Presidential Memorandum 6646 (1982)
  - An “active and influential presence” in Antarctica
  - Year-round occupation of three research stations
  - Directs NSF to budget for, and oversee, USAP
  - Provide logistical support to sustain presence

United States Antarctic Program (USAP)

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Credit: NSF

- U.S. Presence underpinned by Antarctic Treaty (1959)
  - Reserved for peaceful uses, environmental protection, and scientific research
- USAP is a national program that is operated by NSF in close collaboration with the NSB
- USAP supports research within NSF, across Federal agencies, internationally

U.S. Antarctic Program (USAP)

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Department of Defense Support

Science Support/ Infrastructure (AIL)

Funded Science Programs (NSF, Other Agency

Criteria for Antarctic Research Projects

Agency-specific:

DOE, NASA, NOAA, NSF

Singular requirement:

“Best or Only”

Credit: NSF

Funding Sources

Credit: NSF

- Science is funded by individual grants from NSF Directorate or agency budgets
- Campus operations are funded by the Office of Polar Programs (OPP)
- Military logistics are funded under a separate Defense budget line in the OPP account
- The Antarctic Infrastructure Recapitalization (AIR) program is funded through MREFC

Amundsen-Scott South Pole Station

Credit: NSF

South Pole Station:

- World leading astrophysics instruments and programs
- Unique atmospheric observatory
- Unparalleled hub for earth and climate science field work.

Antarctic Specially Managed Area (ASMA)

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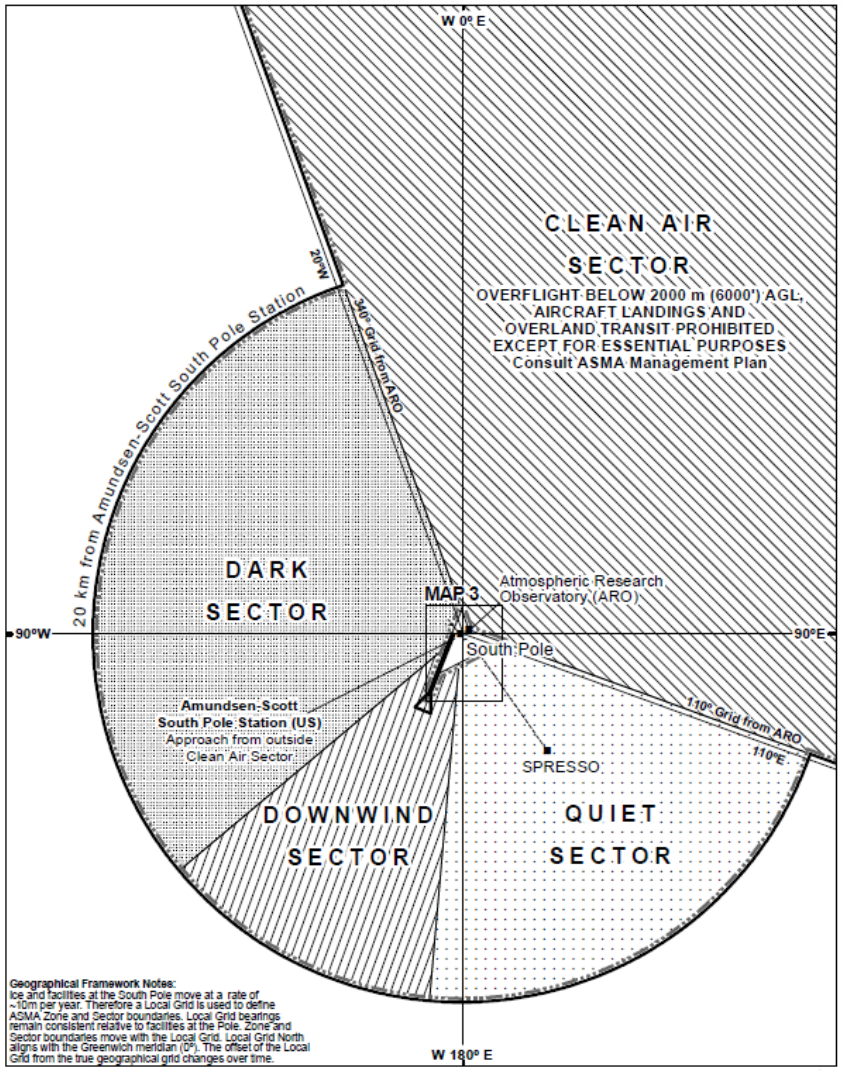
ASMA #5: Amundsen-Scott South Pole Station

The Antarctic Treaty Parties designated the region around the South Pole as Antarctic Specially Managed Area (ASMA) No. 5 in 2007 in order to maximize the valuable scientific opportunities at the Pole, protect the near-pristine environment, and ensure that all activities can be conducted safely, environmentally responsibly and without disruption to scientific programs. The Management Plan was comprehensively revised in 2017.

www.southpole.aq



Map 2: ASMA No. 5 - South Pole - Management Zones and Sectors

Aerial View

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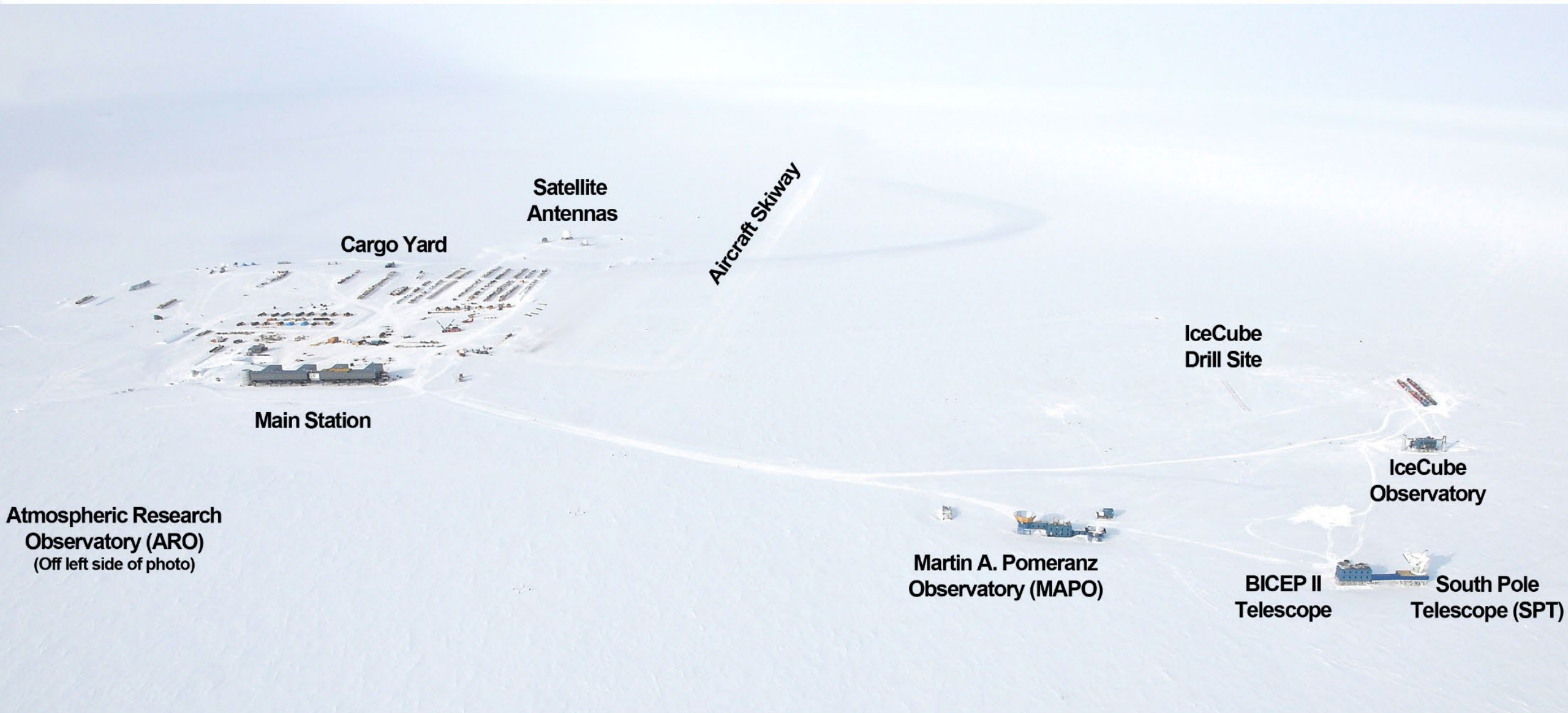
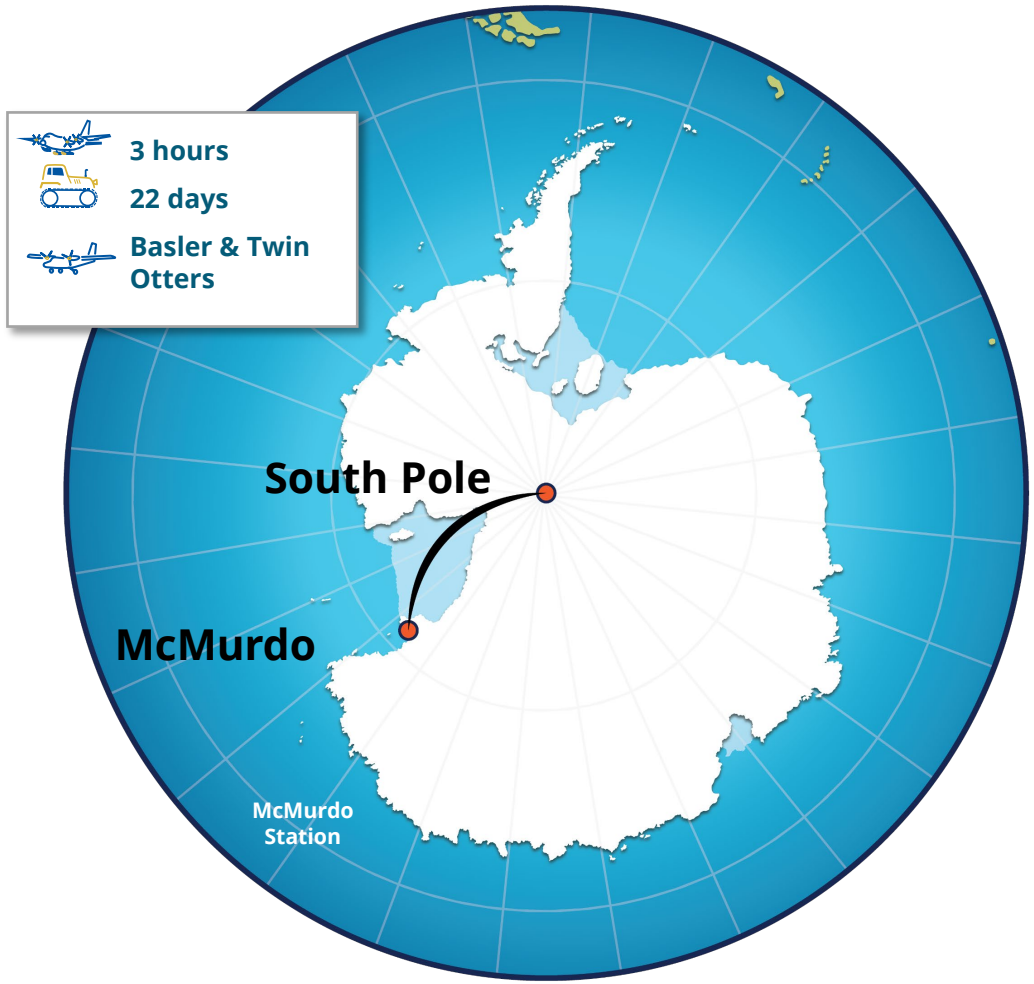


Credit: NSF / Andrew Williams

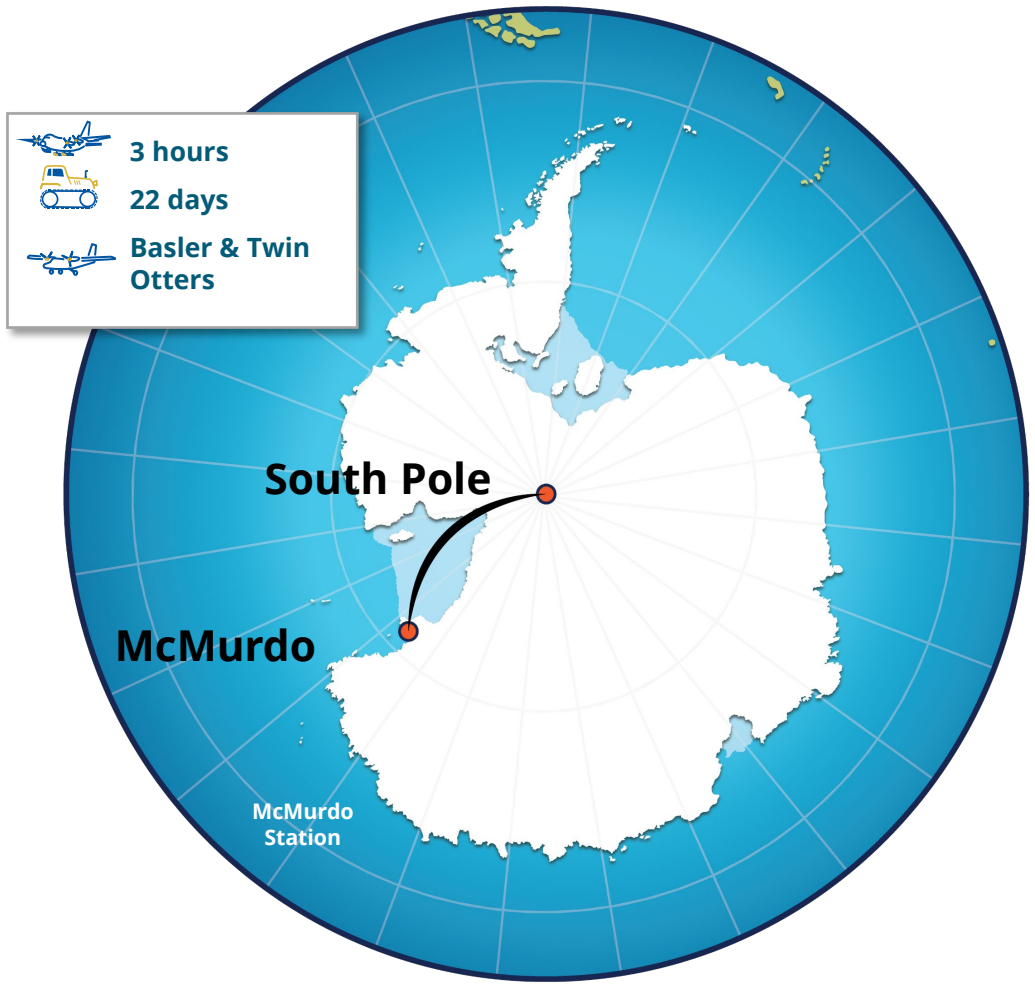
Infrastructure and Logistics

- Logistics Network
- Primary Constraints
- Multi-year outlook
- Example of science and logistics integration

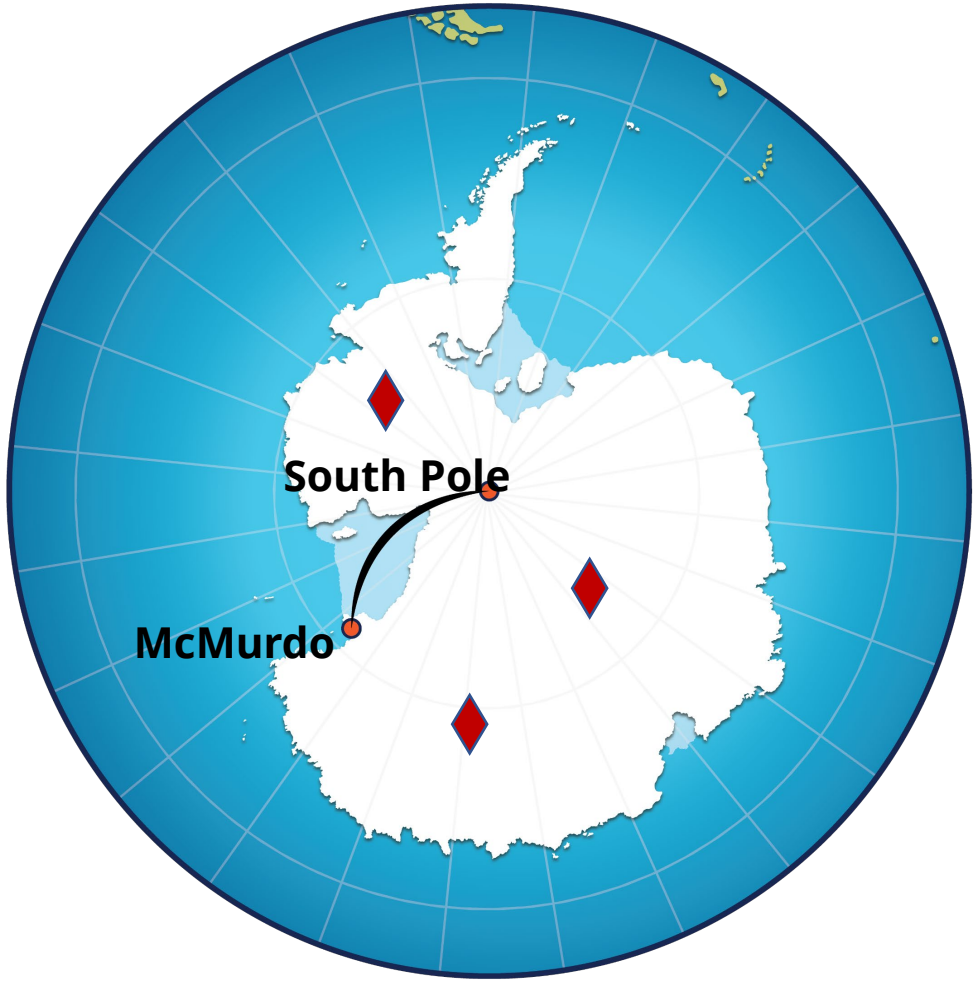
Logistics Network: McMurdo to South Pole



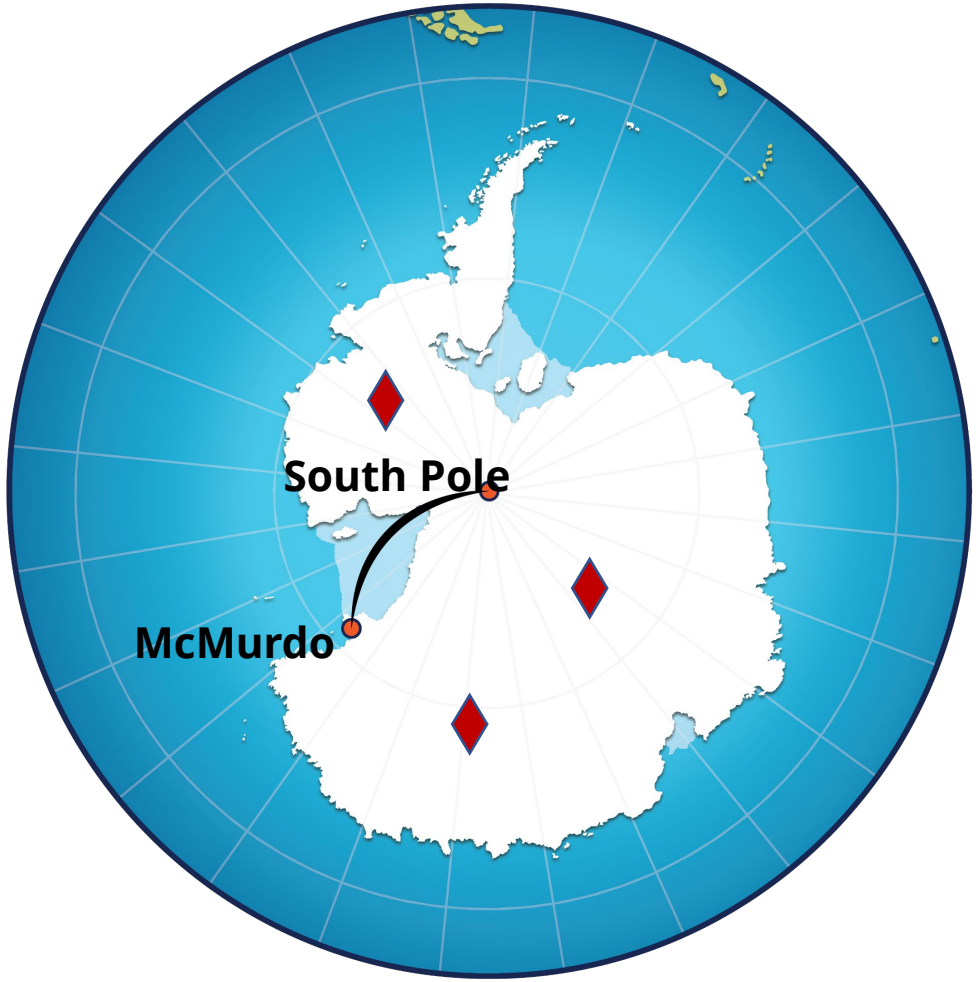
Logistics Network: McMurdo to South Pole



Logistics Network – Field Camps



Logistics Network – Field Camps



South Pole Constraints

Credit: NSF

- Amount of fuel and cargo that can be moved by the traverse and aircraft fleet
- Beds available in the Station's living quarters
- Power that can be produced on-site

South Pole Constraints (cont.)

Capability	Current	Future
Traverse	3 deliveries per summer	Expansion planned under AIR
Aircraft	10 planes, declining capabilities	No budget for replacement
Beds	150 in Station, 36 modular	No plans for expansion
Power	600 kW	No plans for expansion

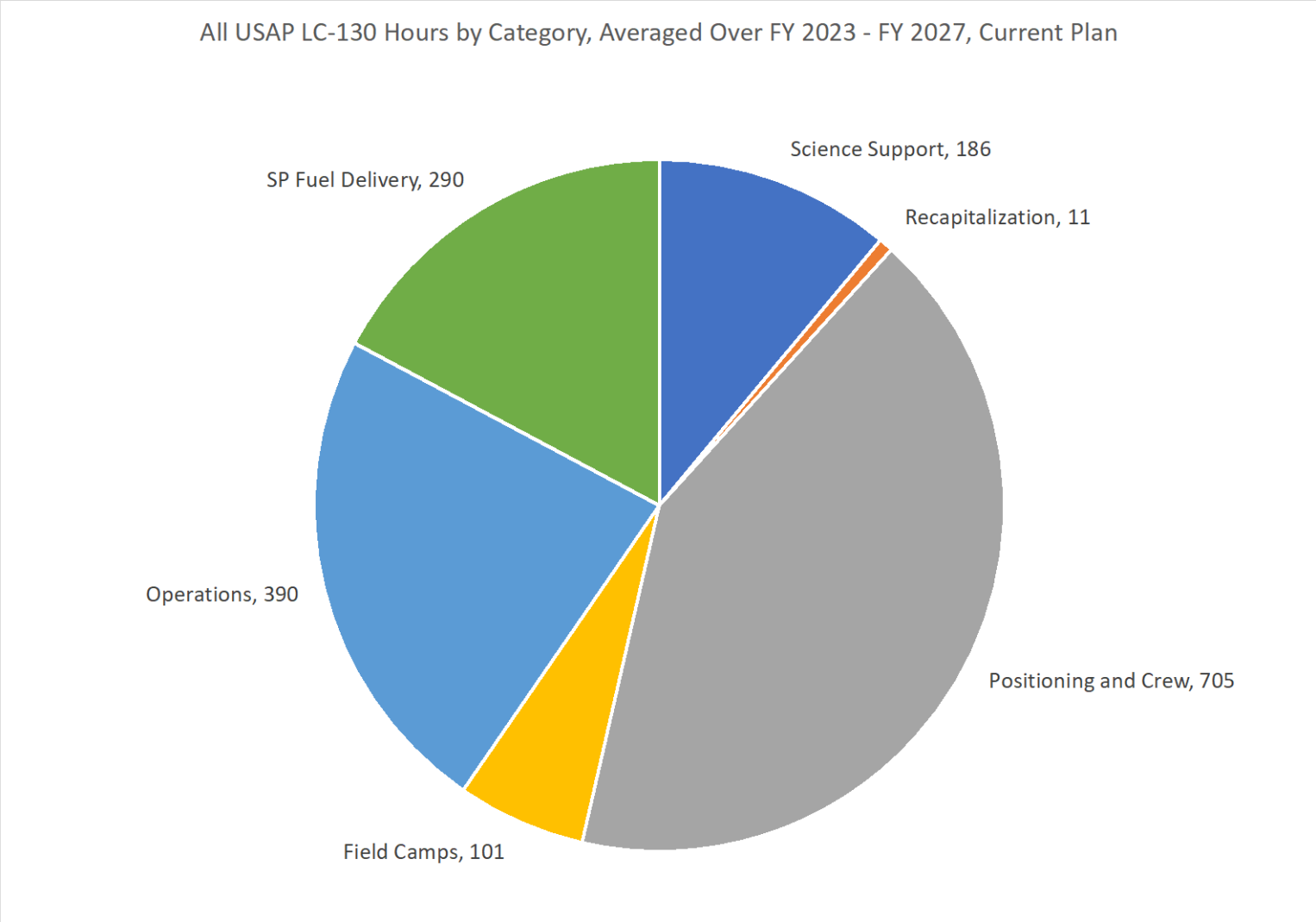
Operational Fuel Demand

Delivery

- Traverse Capacity
  300,000 gallons
- Air Delivery
  + 145,000 gallons (290 LC flight hours)
- Total Station Need
  445,000 gallons

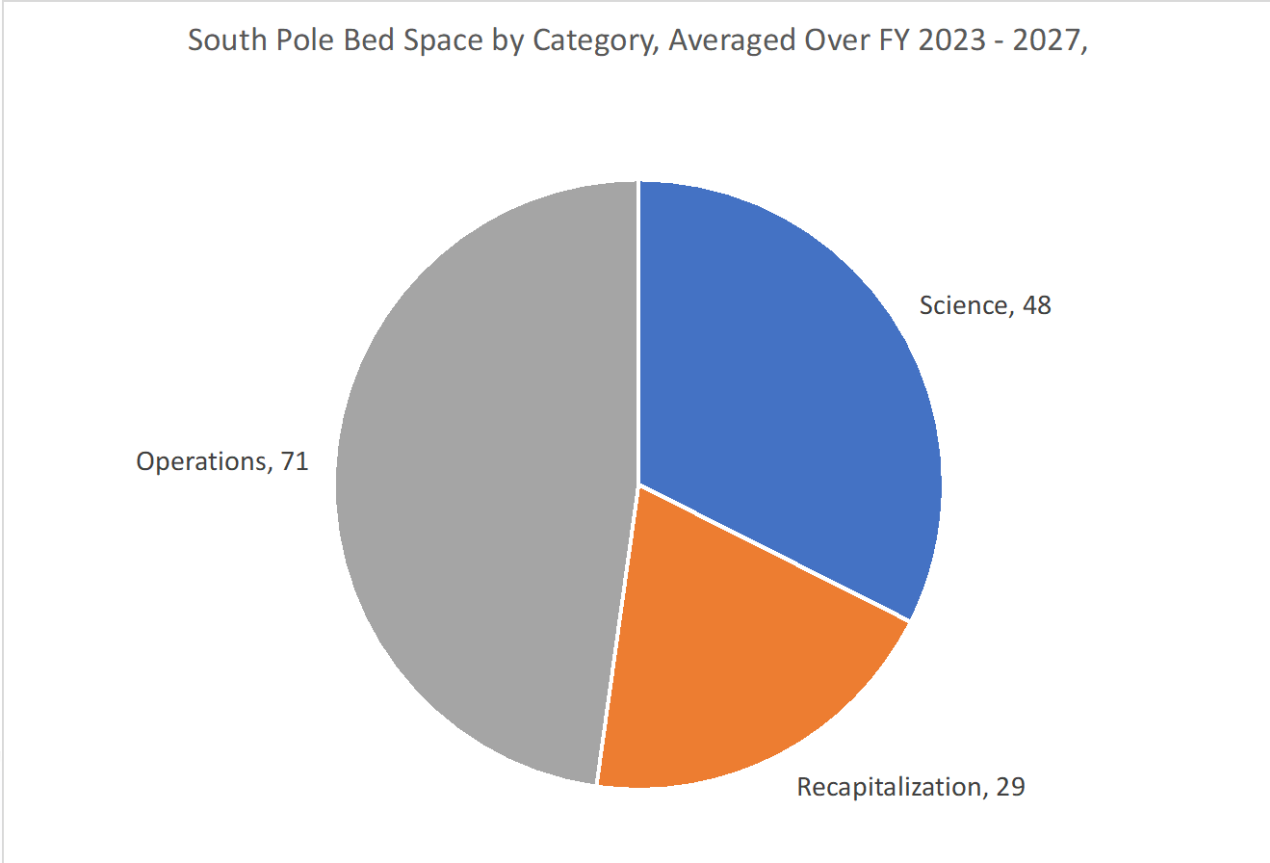
Storage

- Total Arch Capacity = 450,000 gallons
- Current Station Requirement =
  445,000 gallons



South Pole Bed Space

- Total Station Capacity = 150 beds
- Average Allocation to Science Teams = 50 beds



South Pole Bed Space

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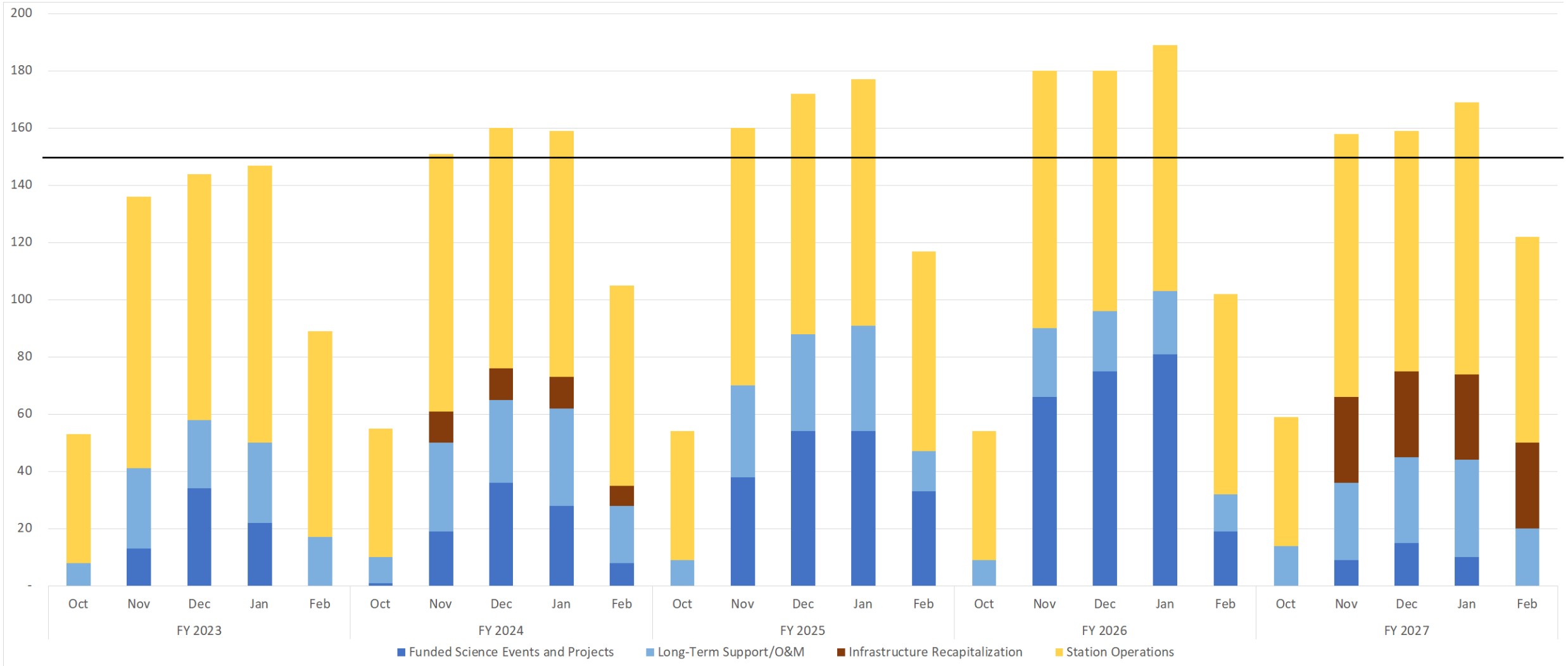

Continental Heavy Airlift Calendar

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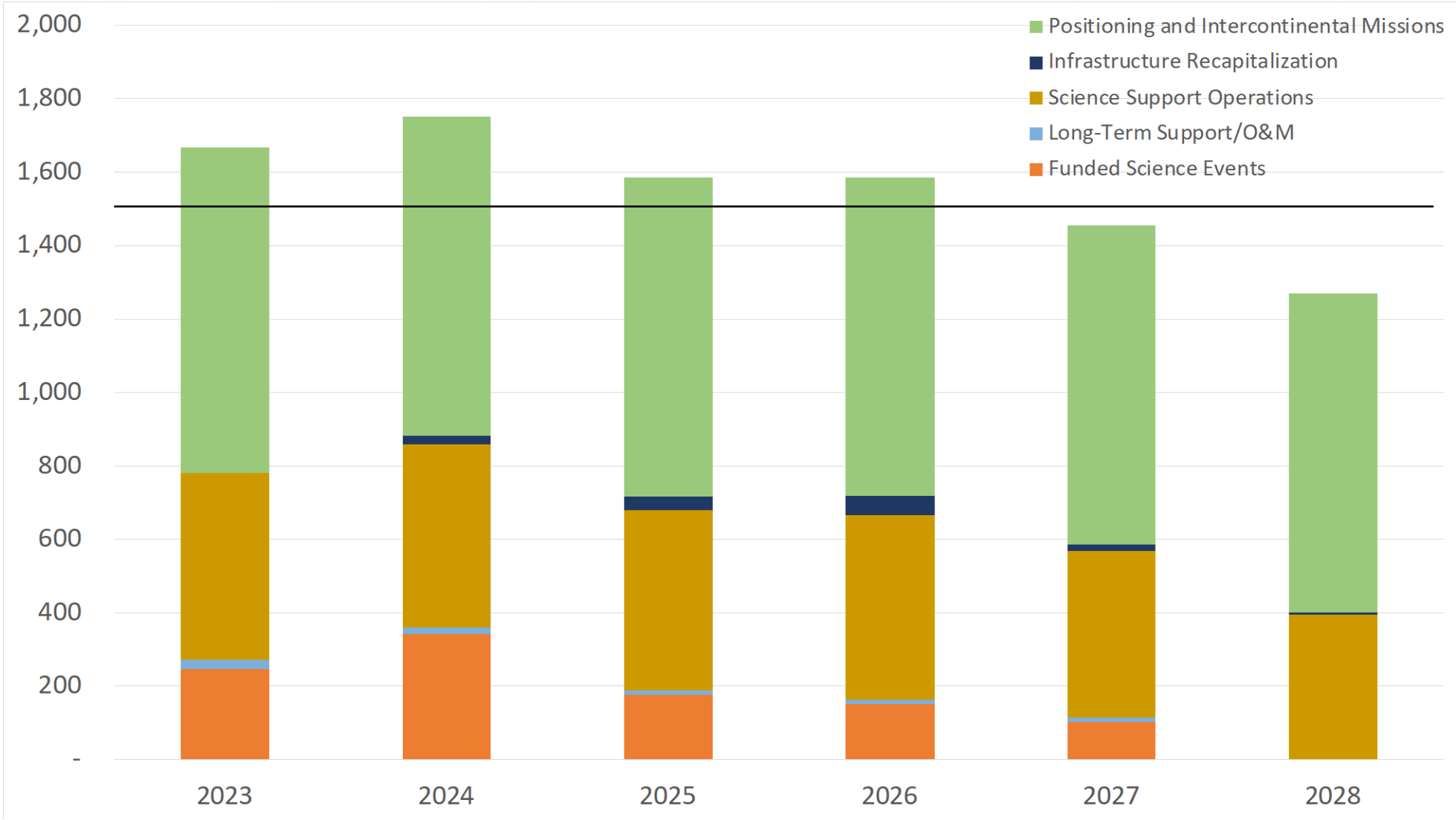

Recent Case Study

IceCube Upgrade (ICU) Rebaseline

- ICU team provided needs (people, cargo, fuel)
- AIL assessed known commitments and provided capacities by year

ICU Planning Capacities
OPP-AIL, 1/31/2022

Year	FY23	FY24	FY25	FY26	FY27
Vessel South (TEUs)	18*	as needed	as needed	n/a	n/a
Vessel North (TEUs)	n/a	17	50	17	50
LC-130: Hours/Flights^	12/2	114/19	60/10	42/7	36/6
SPoT-1 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
SPoT-2 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
SPoT-3 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
Pole Population (Nov-Jan)	0	11	21	46~	4

- ICU team updated schedule for rebaseline review to fit these constraints

Charge to Committee

Credit: NSF

Develop a framework and decision rules for prioritizing projects given:

- Diversity of disciplines
- Capacity for world class science
- Scientific priorities established in different fields

Consider:

- Current assets at SPS
- Potential future investments

Questions?

Backup slides

NSF Criteria for Antarctic Research Projects

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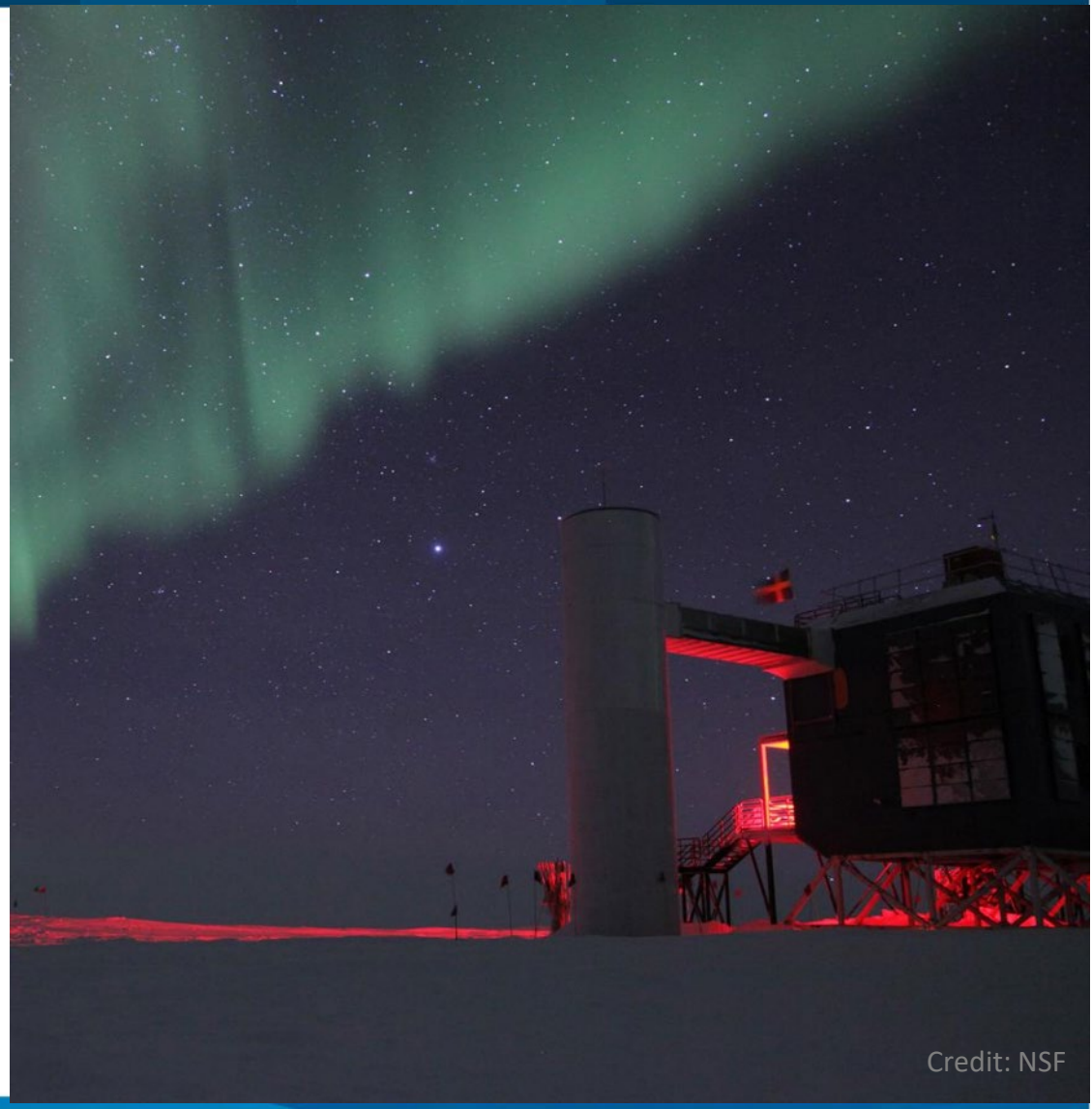
- Improve understanding of interactions between the Antarctic region and global earth systems
- Expand fundamental knowledge of Antarctic systems, biota, and processes
- Utilize unique characteristics of the Antarctic region as an observing platform

Best or only place to do the research



Credit: NSF

Determining Current Antarctic Research Priorities

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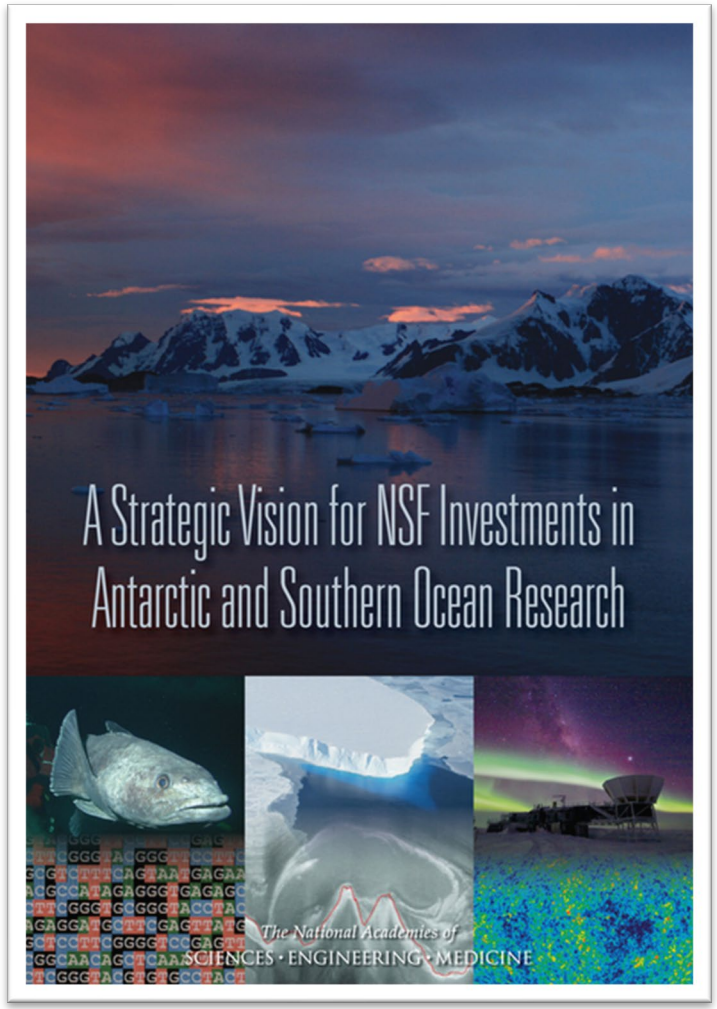

Priority 1 Changing ice sheets

Priority 2 Biological adaptation and response

Priority 3 Next generation cosmic microwave background research