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NSF Office of Polar Programs

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Office of Polar Programs, Directorate for Geosciences

**Board on Physics & Astronomy
November 8, 2023**

Outline



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- Budget Background
- Arctic Science
- Arctic Policy & Infrastructure
- Antarctic Perspective
- Antarctic Science
- Antarctic Policy & Infrastructure

FY 2024 NSF Budget Request



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\$565,600,000

OPP Funding (Dollars in Millions)

	FY 2022 Actual	FY 2023 Estimate Base	Disaster Relief Supplemental Base	FY 2023 Estimate Total	FY 2024 Request	Change over FY 2023 Base Total ¹ Amount	Percent
Total	\$544.68	\$545.16	-	\$545.16	\$565.60	\$20.44	3.7%
Research	110.78	115.61	-	115.61	106.82	-8.79	-7.6%
Education	3.71	3.92	-	3.92	3.93	0.01	0.3%
Infrastructure	430.19	425.63	-	425.63	454.85	29.22	6.9%
USALS	85.00	94.20	-	94.20	102.00	7.80	8.3%

- USALS = U.S. Antarctic Logistics Support, funds DoD Support Forces Antarctica (cargo, fuel, airlift)

¹ Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

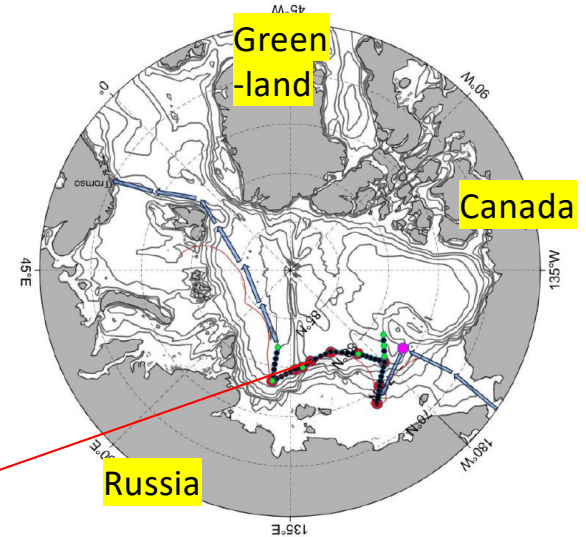
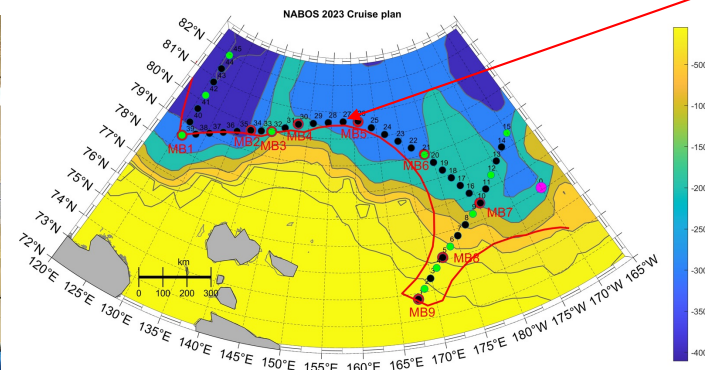
- Including \$60 million for Antarctic Infrastructure Recapitalization (AIR), FY24 request of \$515 million for infrastructure & logistics supports \$107 million in OPP science.
 - About \$400 million in Antarctic Infrastructure ops/re-cap and ~\$60-70 million in Antarctic science.

Nansen Amundsen Basins Observational Systems (NABOS)



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- The NSF-funded NABOS science mission's objective onboard USCGC Healy was to recover, service, and replace an array of nine long-term subsurface moorings that encircled the Siberian shelf from the Eurasian Basin to the East Siberian Sea. These moorings provide insight into how warm water from the Atlantic Ocean enters the Arctic and circulates along the shelf, impacting the deep basin interior, upper ocean, and sea ice.
- In addition to the mooring work, USCGC Healy supported 48 Conductivity, Temperature, and Depth (CTD) casts spread out over 45 different stations, which sampled the entire water column for subsequent analyses in areas normally inaccessible due to pack ice.
- NSF provided shipboard science equipment and technical support onboard USCGC Healy as part of the Ship-based Science Technical Support in the Arctic (STARC) Program through a Cooperative Agreement with UC-San Diego's Scripps Institution of Oceanography, in partnership with Oregon State University and the University of Washington.



Camp Century

1966: Camp Century
The Lost Core



2019: Copenhagen
The Core is Found



A Tale of Two Cores: Northwest Greenland

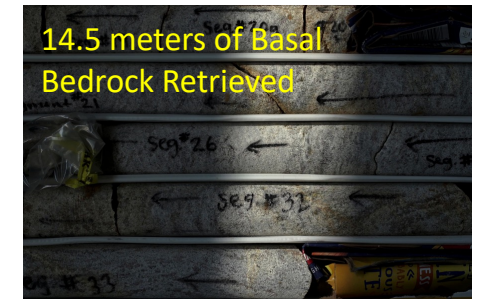


Camp Century International Collaborators: University of Copenhagen - Denmark, GEUS - Denmark, Université De Lorraine - France, Université Libre De Bruxelles - Brussels, CNRS - France

GreenDrill: Prudhoe Dome



14.5 meters of Basal
Bedrock Retrieved



Analysis Underway

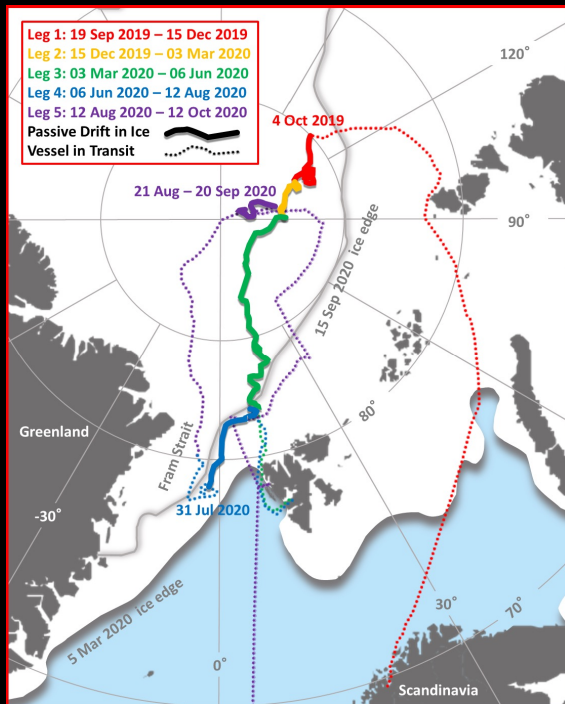
Sedimentology
Stratigraphy
3D imaging
CT Scanning
Grain size
Cosmogenic nuclide (^{10}Be , ^{14}C , ^{26}Al , ^{21}Ne)
Luminescence
Petrology/Mineralogy
Stable isotope measurement of porewater (ice)

Deglaciation of northwestern Greenland during Marine Isotope Stage 11

Christ et al., *Science* 381, 330–335 (2023) 21 July 2023

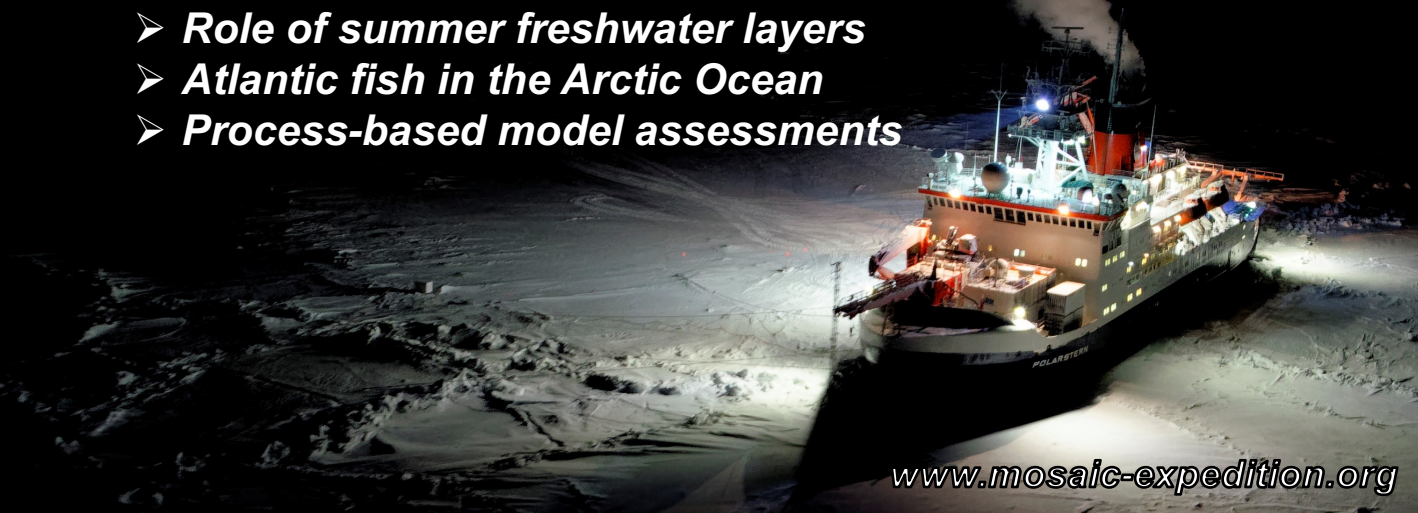
➔ Subglacial sediment from the Camp Century ice core preserves direct evidence that northwestern Greenland was ice free 416Kyr ago when global air temperatures were +1 – 2 deg. C greater than pre-industrial temperatures.

MOSAIC – Multidisciplinary drifting Observatory for the Study of Arctic Climate



- **Most comprehensive Central Arctic observations ever**
- **Covered all seasons, including cold-dark winter**
- **>150 Publications and growing quickly**
- **Data is publicly available**
- **New Scientific Insights (among many others):**
 - **First annual cycles of C. Arctic aerosols**
 - **Cloud impacts on surface energy budget**
 - **Multi-scale dynamics of thin sea ice**
 - **Microbial predictors of water column oxygen**
 - **Role of summer freshwater layers**
 - **Atlantic fish in the Arctic Ocean**
 - **Process-based model assessments**

Drift Expedition
Sept 2019 – Oct 2020



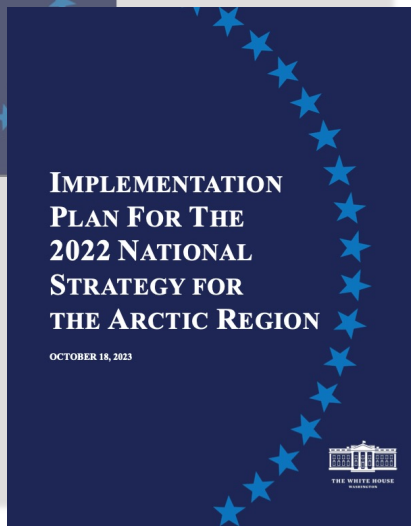
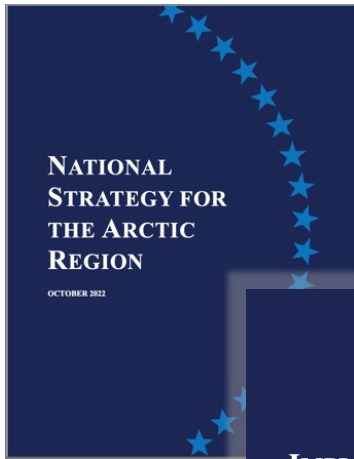
www.mosaic-expedition.org

National Strategy for the Arctic Region

First Released: 2013

Update: Nov 2022

Implementation Plan: Oct 2023



NSAR PILLARS:

1. Security

2. Climate Change and Environmental Protection

3. Sustainable Economic Development

4. International Cooperation and Governance

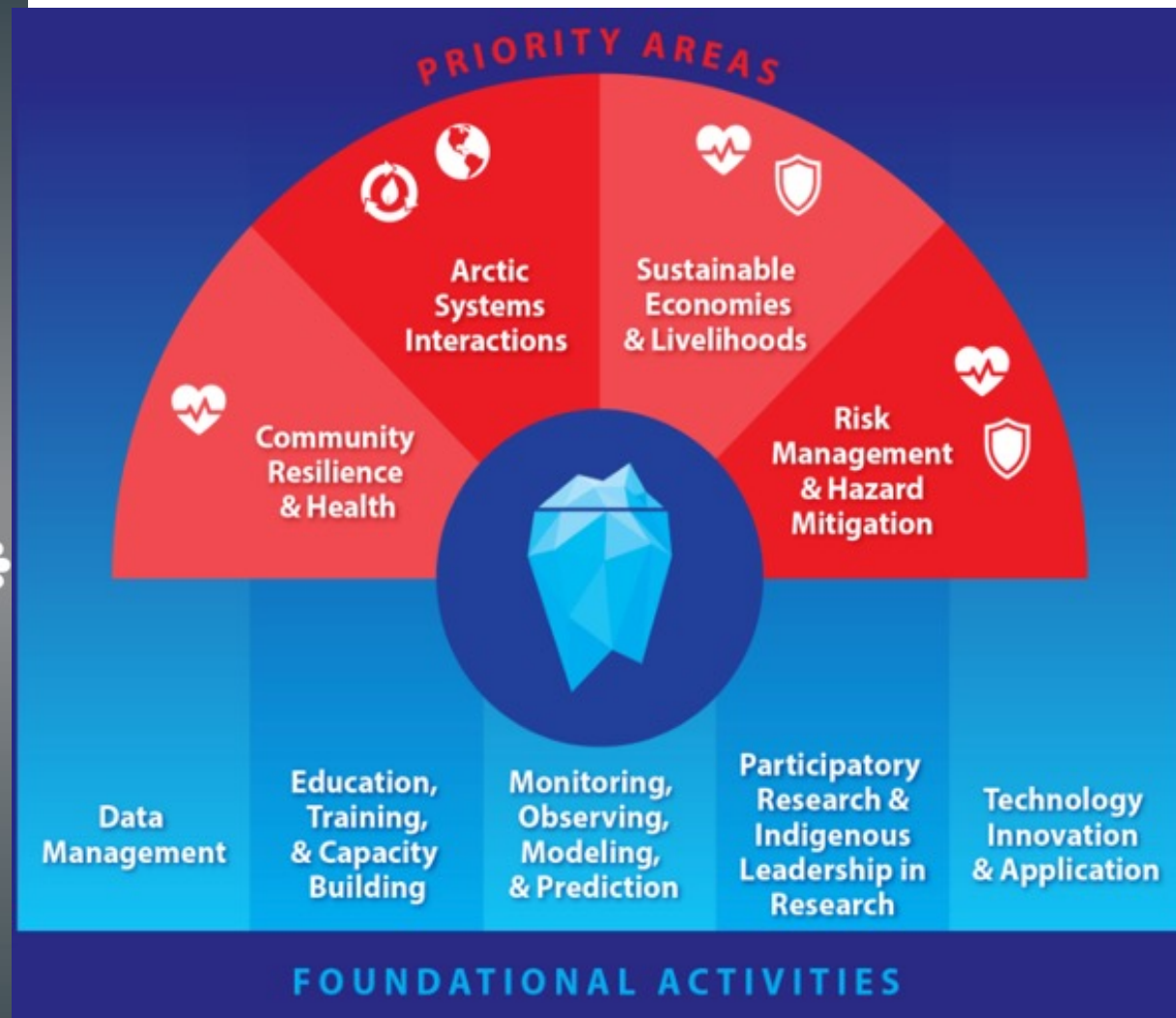
ARCTIC RESEARCH PLAN

2022-2026



Product of the Interagency Arctic Research Policy Committee
of the National Science and Technology Council

DECEMBER 2021



Summit Station-Greenland



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- A preeminent polar research site, integrated into a network of arctic observatories, supporting cutting edge atmospheric, cryospheric, astrophysics, and engineering research.
- Only high-altitude (3200 meters), high-latitude (72.6 deg North), year-round inland research platform in the Arctic.
- Getting by with aging infrastructure dating back to setup as a “temporary” camp in 1989.

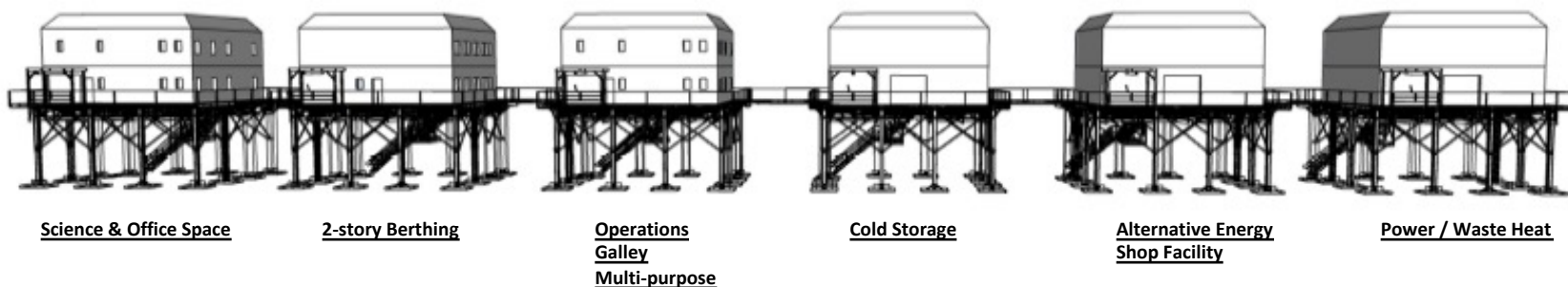
Summit Modernization and Recapitalization (SuMR)

Project Scope & purpose



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View from south of station looking north



- Elevated structures above snow accumulation and drifting
- Efficient and easier to maintain
- Configurable for different populations and science uses
- Automated for potentially unstaffed operation

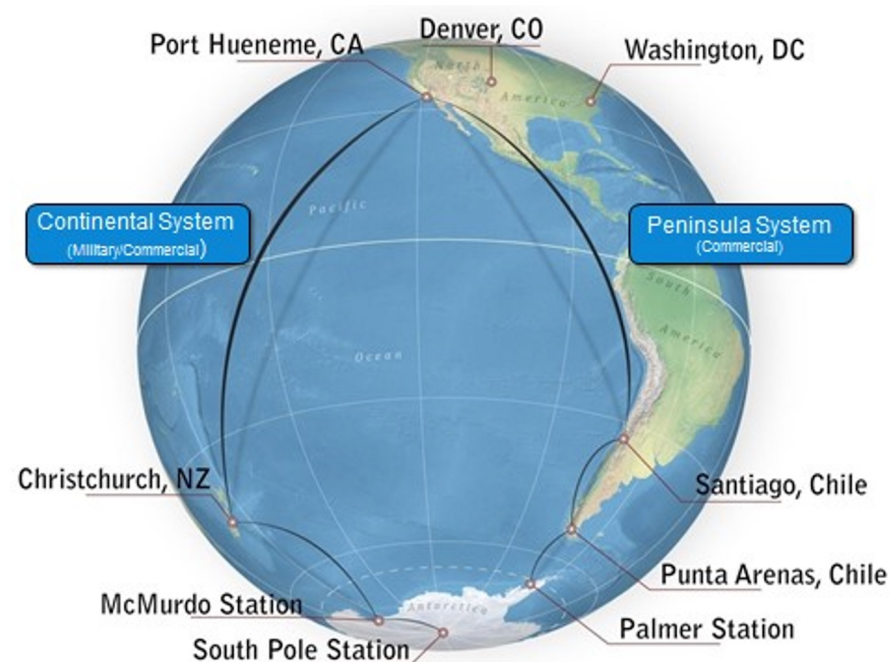


Global Antarctic Perspective



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- Peninsula System
 - Punta Arenas, Chile is embarkation point.
 - Punta Arenas is jump-off point for research vessels.
 - Transport people and cargo by sea to Palmer Station.
- Continental System
 - Christchurch, New Zealand is embarkation point.
 - Airlift people and cargo to McMurdo and to South Pole (NZ and US military).
 - Overland traverse of cargo and fuel from McMurdo to South Pole
 - U.S. Coast Guard icebreaker enables 1-2 cargo ships/yr and 1 fuel tanker every other year (~January).



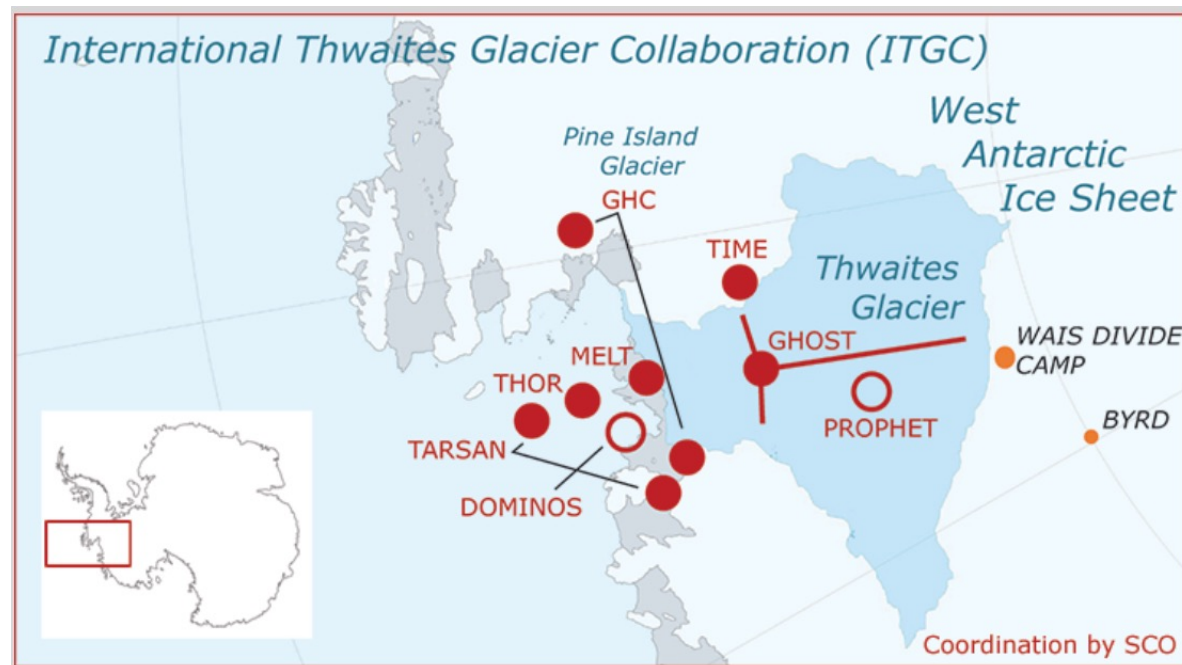


International Thwaites Glacier Collaboration- 1



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- ITGC is a 5-yr joint project of US (NSF) and UK (NERC).
- Thwaites Glacier has ~65 cm of sea-level rise contained in its ice.
- West Antarctic Ice Sheet has ~5 m of sea-level rise.
- Projects include:
 - Modeling
 - Advance/retreat of glacial boundary
 - Ice-ocean interaction
 - Ice/bedrock at core

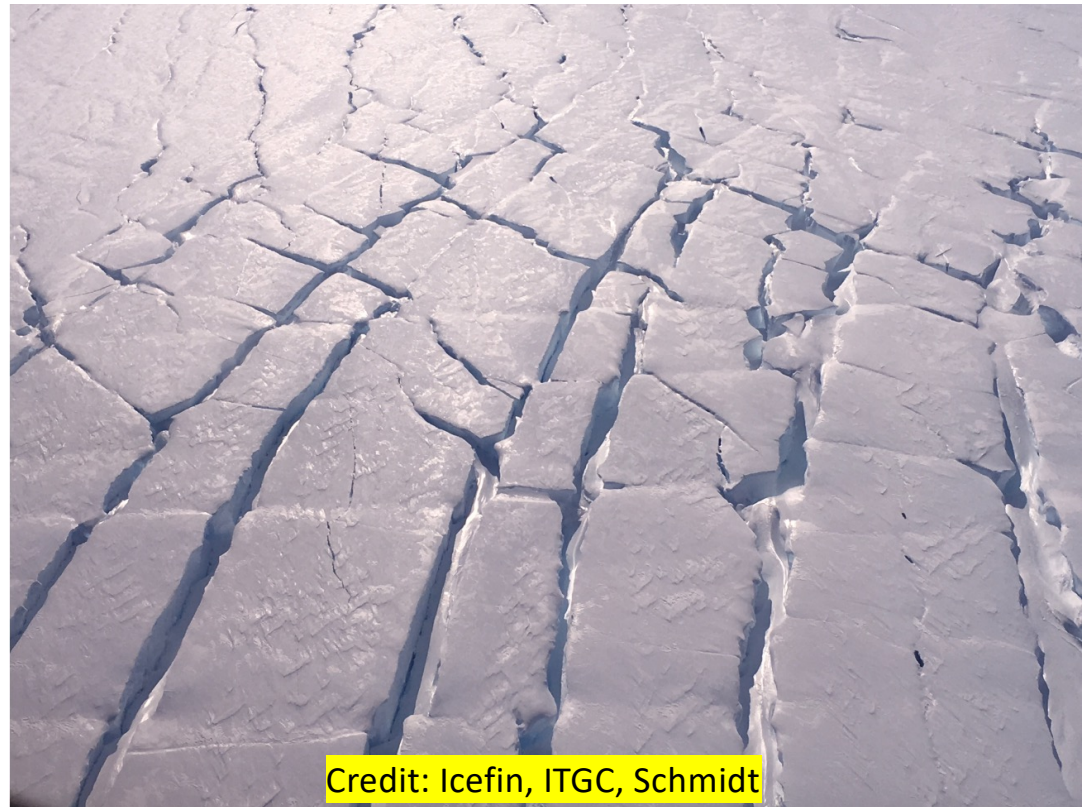


International Thwaites Glacier Collaboration- 2



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- Study of glacial retreat.
- Melting beneath ice shelf is weaker than expected.
- Rapid melting in cracks and crevasses, as well as in staircase-like topography at bottom of ice shelf.
- <https://thwaitesglacier.org/index.php/news/results-provide-close-view-melting-underneath-thwaites-glacier>



Credit: Icefin, ITGC, Schmidt

IceCube Neutrino Observatory



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- See earlier talk by Jean Cottam.

Science Priorities for 2023/24 Antarctic Season



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- International Thwaites Glacier Collaboration
 - <https://thwaitesglacier.org/>
- NASA Long-Duration Balloon (LDB) program
 - Includes GUSTO from NASA Explorer program (GUSTO = Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory).
- IceCube Upgrade
 - More detector strings, providing (among other things) improved energy resolution and event localization.
 - Must be accomplished in next 3 seasons before needed South Pole infrastructure refurbishment.

OPP DCL NSF 23-117: 2023 Update on Science Support and Infrastructure in Antarctica



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- Due to compounding constraints, the upcoming 2023-2024 Antarctic season will be significantly curtailed.
- For the next three field seasons (August 2023 through March 2026), already-funded science projects will be prioritized to the greatest extent possible.
- While OPP will continue to accept proposals involving fieldwork, USAP will not be able to support science exceeding Logistics Support Level 2.
 - Level 2: fieldwork that can easily be accommodated & does not require heavy airlift on continent or South Pole deployments

NSF 23-117: South Pole Details



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“*South Pole Station* is saturated with already-funded projects and required critical infrastructure and maintenance activities that cannot be deferred until late in the decade. South Pole Station will continue to host the current suite of large-scale science projects; however, proposers seeking support for new projects at South Pole Station should consult the cognizant program officer to discuss alternative locations to accomplish science goals.”

South Pole Limitations 101

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- **What are the limitations at Amundsen-Scott South Pole Station?**

1. Beds—150 people maximum
2. Cargo—air re-supply and traverse capabilities
3. Fuel/station power
4. Need to refurbish infrastructure



McMurdo Lodging Construction



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Upper Case Dorms



Location

Bldg 202 (NSF Lodging)



New Dorm Floor Plan



Antarctic Infrastructure Recapitalization (AIR)



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- Early AIR projects:



South Pole Blue Building Raise



South Pole Critical Infrastructure Remediation



Traverse Fleet Refresh

South Pole Master Plan



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- NSF considered several options for the baseline. Power and bed space are key parameters; many characteristics would scale with number of people in residence.
 - Future SPS with ~10% increase in bed space and ~ current power.
 - Future SPS with ~10% increase in bed space, but considerably more power (~30-50% increase).
 - **Future South Pole Station (SPS) with capabilities similar to today.**

Why choose “Status Quo” in Master Plan for South Pole Station?



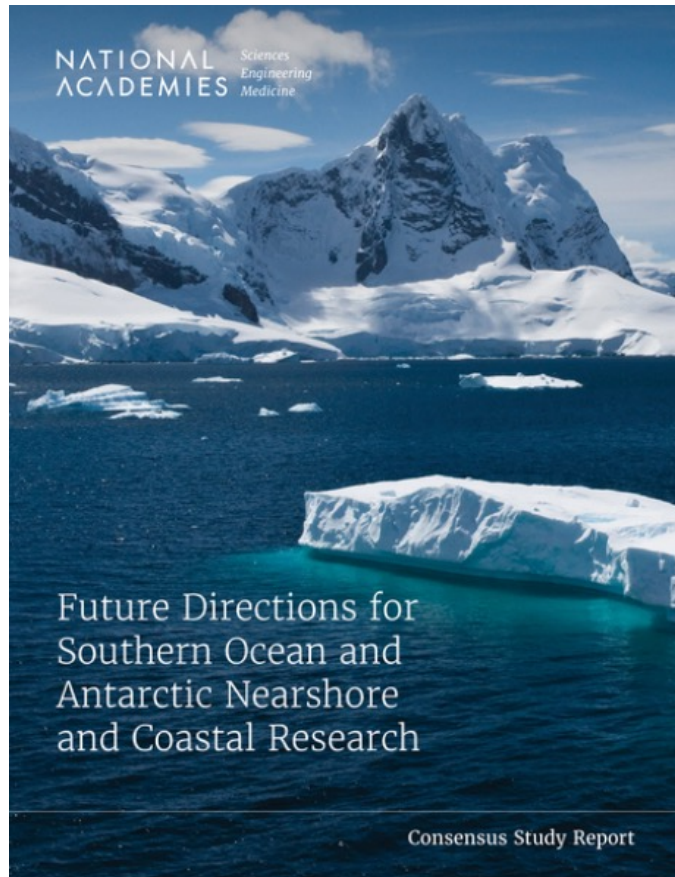
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- Substantial upgrades of South Pole Station would require significant movement of cargo and people and would take ~15 years from today.
 - Needs infrastructure remediation and raise of main Station in early-mid 2030s.
- LC-130H fleet of ski-equipped aircraft is aging, with increased maintenance costs and down-time. Individual aircraft reach end of life in 2030s and early 2040s.
- As yet, DoD has no published plan or budget request for recapitalizing the LC-130 fleet. Without a recapitalized fleet, significant expansion of South Pole Station is not possible.
- **Context: 150-bed Amundsen-Scott South Pole Station is the size of the largest station of any other nation in Antarctica.**

Recent NASEM Study Delivery



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- Identify the highest-priority science drivers for Southern Ocean and Antarctic nearshore and coastal research, based on prior studies and reports. Consider both near- and long-term science priorities.
- Determine the capabilities that are essential to support these science drivers. In a resource-constrained environment, what are the potential tradeoffs among highly specialized and general capabilities? Or among costly vs less expensive capabilities?
- Note any gaps between the science drivers and the proposed portfolio of capabilities and discuss how NSF might address them.
- Report delivered in October, currently under consideration by NSF.

Antarctic Research Vessel (ARV)



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Key Performance Parameters (KPPs)

- Polar Class 3 (PC3); 4.5' (1.4m) ice + 12" (30cm) snow at 3 kts
- 90-day endurance
- 55-science & technical personnel

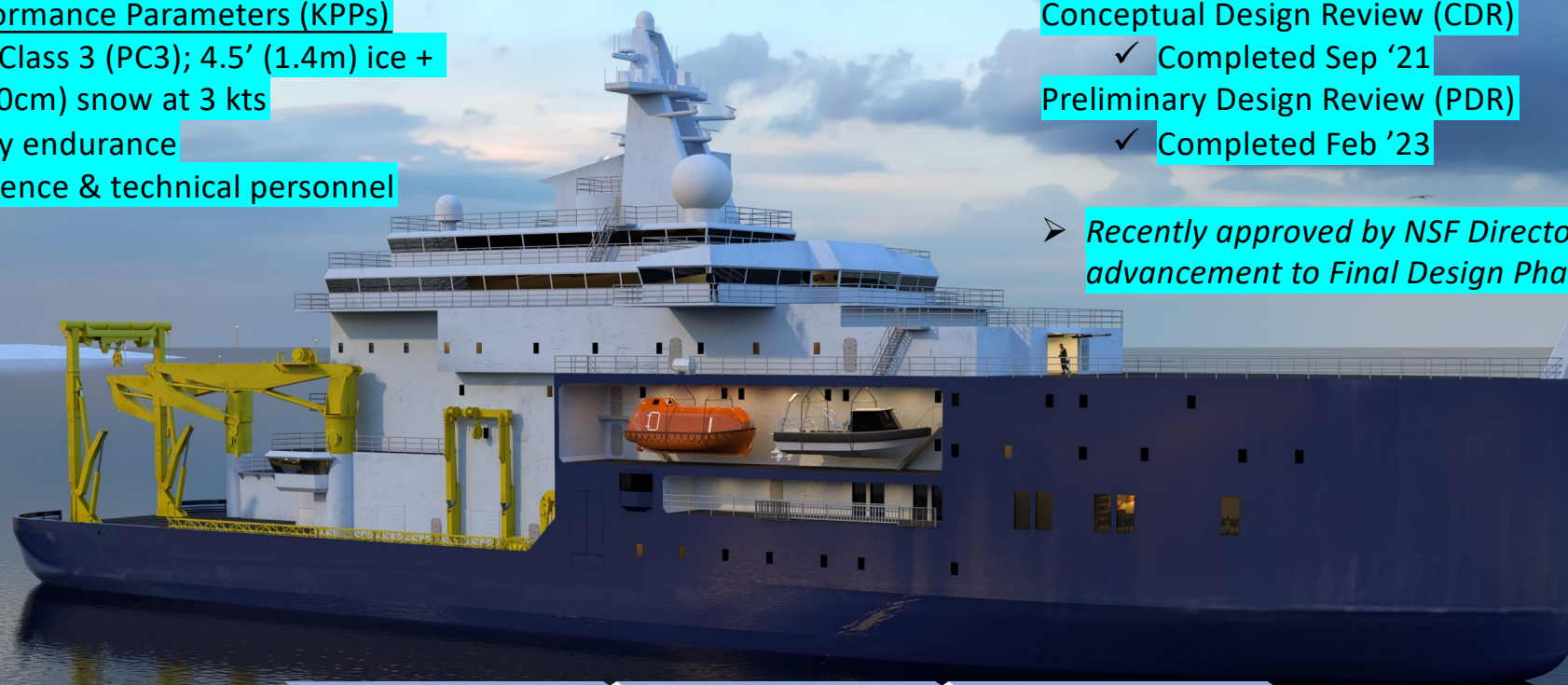
Conceptual Design Review (CDR)

✓ Completed Sep '21

Preliminary Design Review (PDR)

✓ Completed Feb '23

➤ Recently approved by NSF Director for advancement to Final Design Phase



Conceptual Design
Phase

2021

Preliminary Design
Phase

2022-2023

Final Design
Phase

2024-2026

COVID-19 Impacts



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- OPP, and especially U.S. Antarctic Program, still recovering from several years of COVID-19 impacts.
 - Much of 3 seasons of Antarctic infrastructure repair and refurbishment was deferred; catching up will require ongoing constraints on science program.
- COVID-19 reached Antarctica in 2022/23 season and is now being managed as an “endemic” disease.
- 2023/24 COVID protocols for Antarctica reviewed extensively by external advisory committee including field researchers, medical doctors with experience from remote environments, and epidemiology specialists.

SAHPR Activities



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- SAHPR Program Office established in Office of Equity and Civil Rights (OECR)
 - OECR discussion at Arctic Science Summit Workshop in February 2023.
- On-ice victim's advocate and crisis hot line established.
- NSF Antarctic Help Line in place April 10.
- Enhanced screening procedures for contractors similar to federal employees.
- Enhanced security measures on ice. E.g., door viewers, improved key control, extra satellite phones for field teams.
- SAHPR Incident Review Team collects reports, improved case management system.
- First USAP Climate Survey to launch this fall.
- New coordinator hired in Office of Director this week.

Summary



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- NSF striving to identify and support the highest priority science in Arctic and Antarctic regions.
- U.S. Antarctic Program is still recovering from several years of cutbacks due to COVID-19 pandemic.
- Continued development/design of exciting new capabilities, notably Antarctic Research Vessel and Summit Modernization and Recapitalization.