Summit Station, Greenland

Past – Present - Future

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Tracy Dahl - CPS

Science Coordination Office – Mission Statement


aanaaq
Thule
Upernavik
Uummannaq
Qeqertarsuaq
Godhavn
Ilulissat
Jakobshavn
Aasiaat
Egedesminde
Kangaatsiaq
Qasigiannguit
Christianshåb
Sisimiut
Holsteinsborg
Kangerlussuaq
Maniitsoq
Sukkertoppen
NUUK
Godthåb
Tasiilaq
Ammassalik
Paamiut
Frederikshåb
Ivittuut
Narsaq
Qaqortoq
Julianehåb
Nanortalik
KALAALLIT NUNAAT
Grønland
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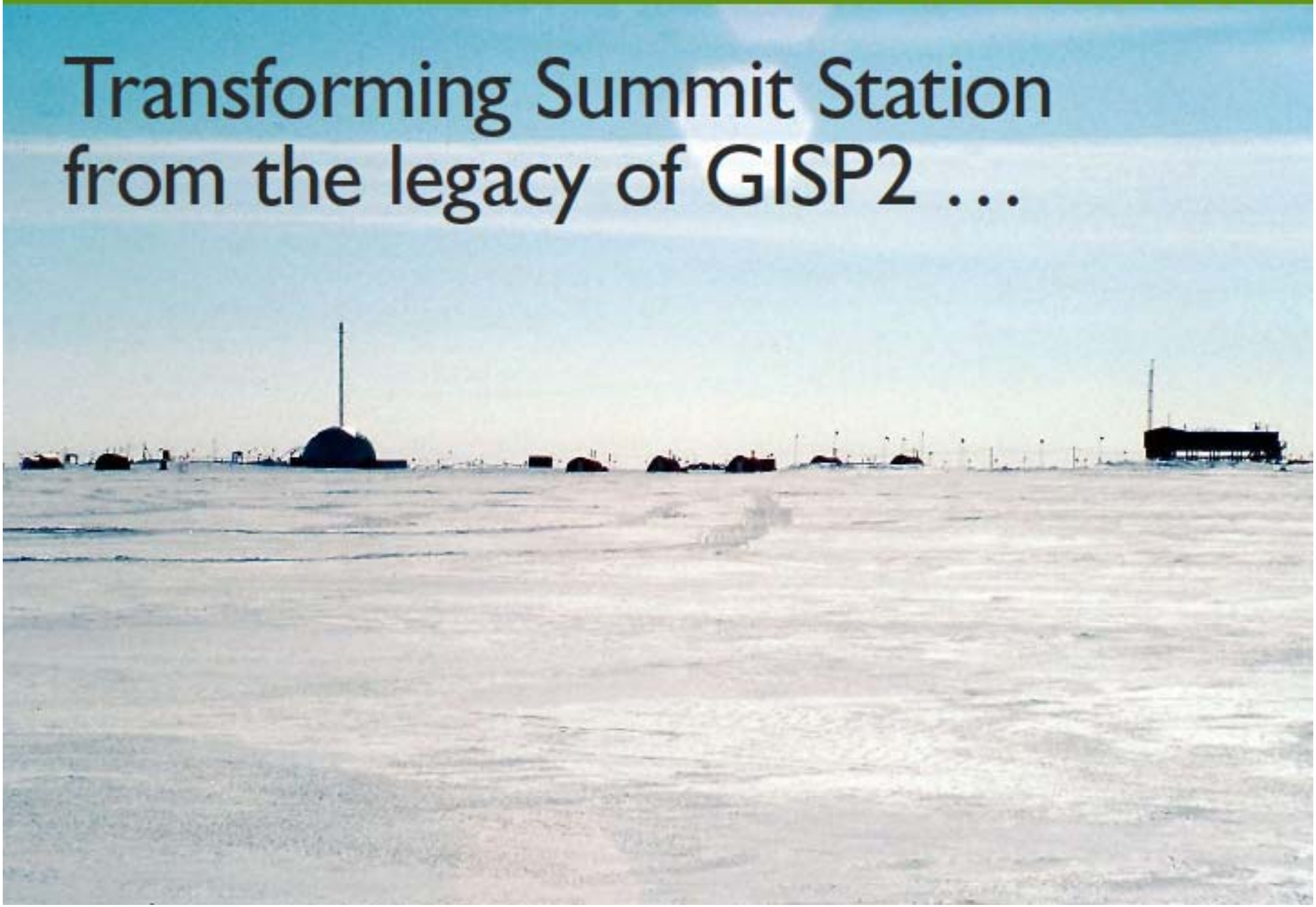
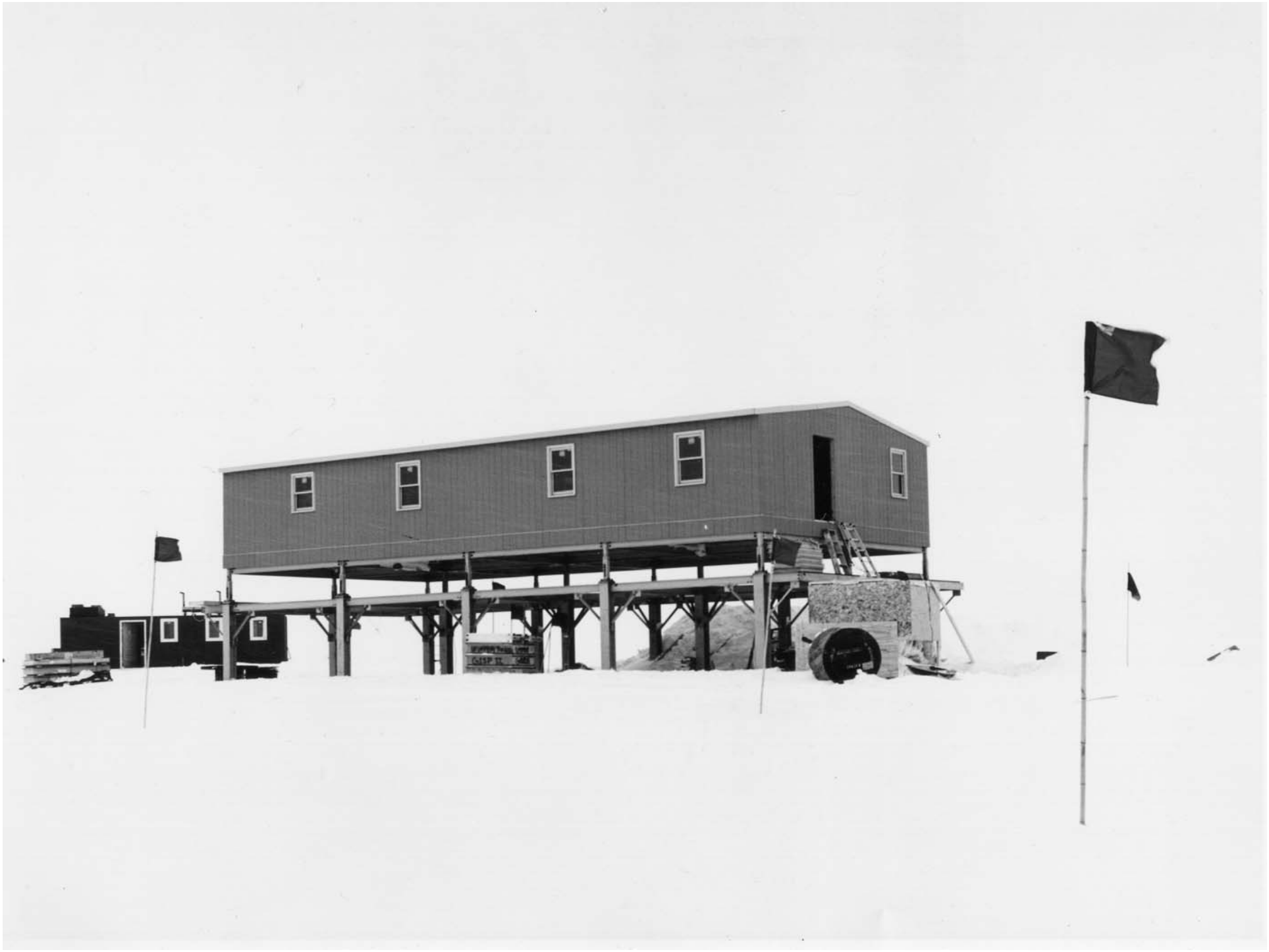
Geodætisk Datum WGS 84, projektion UTM zone 24

Transforming Summit Station from the legacy of GISP2 …



… into a sustainable future.

Artist sketches depicting future Summit Station were prepared by Maria Coryell-Martin

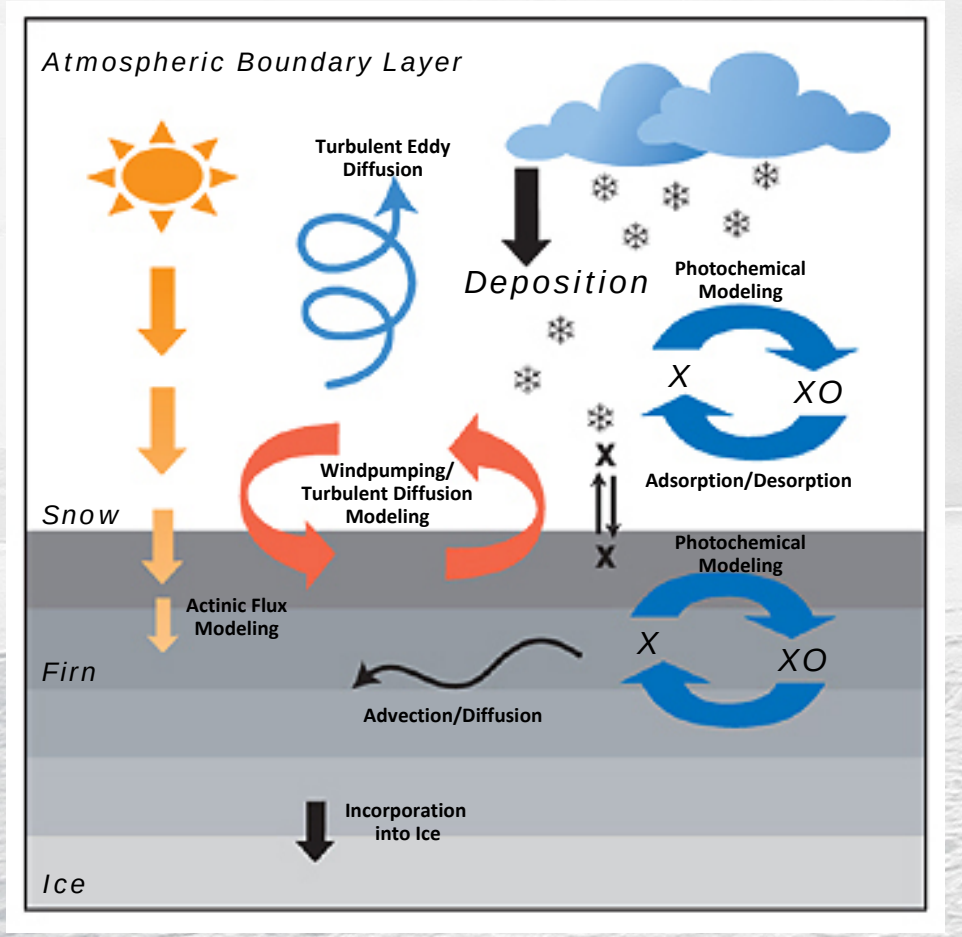


View of 2003 mobile lab from the main satellite lab

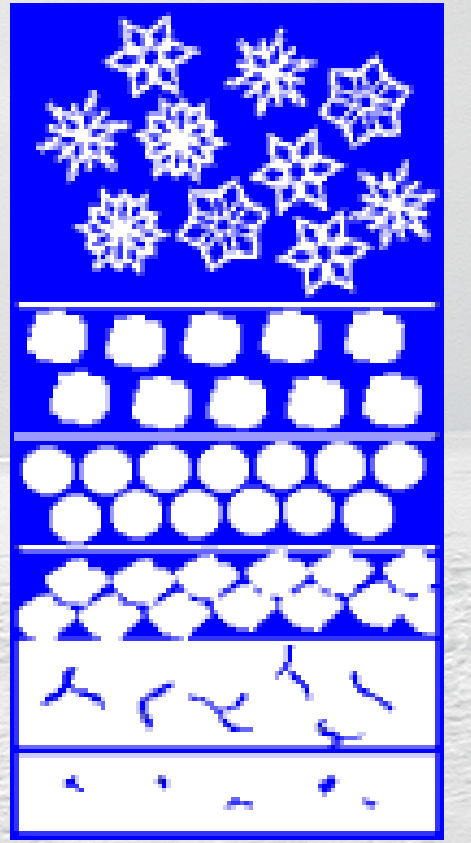
We have learned...

..that the way impurities get incorporated into snow (and ice cores) is much a more complex process than we thought!

More like this model

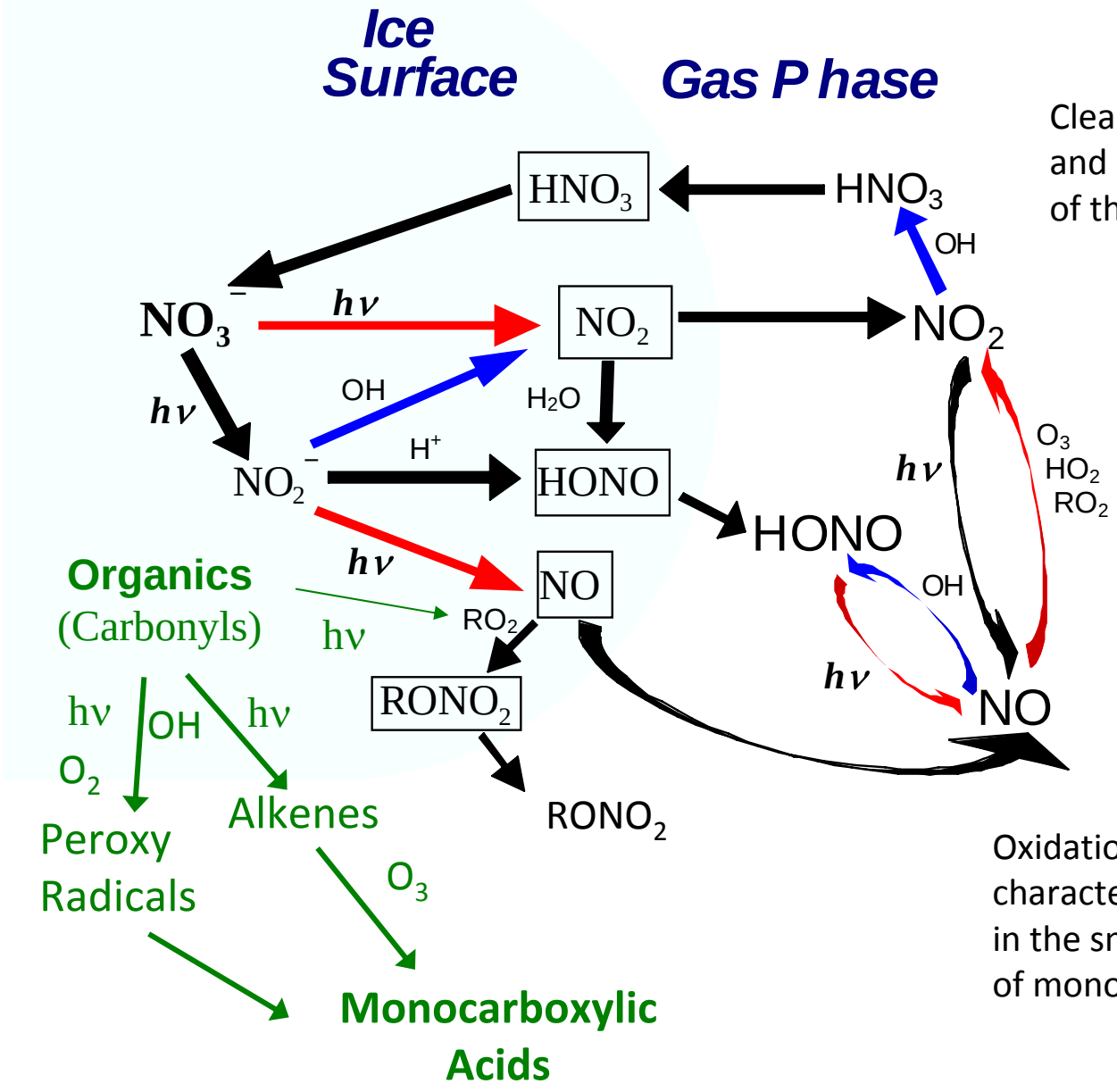


Than this!



Formation Mechanisms??

Our work at Summit, in Michigan, and ISCAT, and that of others at Alert,Halley and Neumayer has confirmed that photolysis of nitrate in snow releases NO_x into the firn air.



Clearly, OH is enhanced above the snow and is likely even higher in the upper part of the pack.

It is not yet clear whether subsequent cycling of N oxides is dominated by homogeneous reactions (in and above the snow) or is mediated by surface chemistry in the porous snowpack.

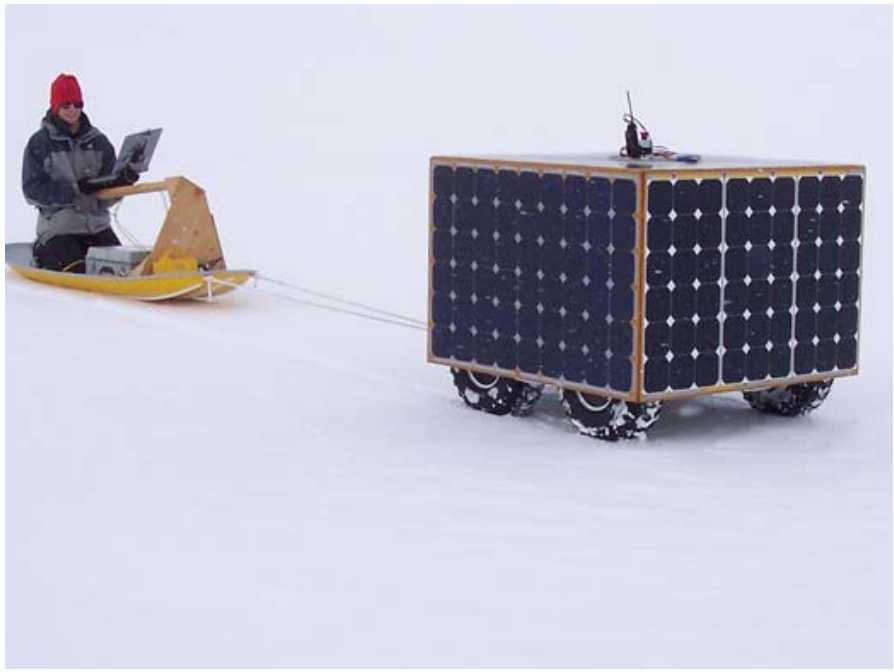
Oxidation of the abundant (but poorly characterized) supply of organic compounds in the snow appears to result in production of monocarboxylic acids and their precursors.

Cool Robot: Autonomous measurements of snow properties and atmospheric chemistry

•Polar solar robot developed by Dartmouth students to detect snow properties and atmospheric chemistry on forays out from Summit.

• Dartmouth (Laura Ray) is the lead, in collaboration with UNH (Dibb) and CRREL (Lever).

• This builds on a highly successful SGER grant to L. Ray some years ago.

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NSF

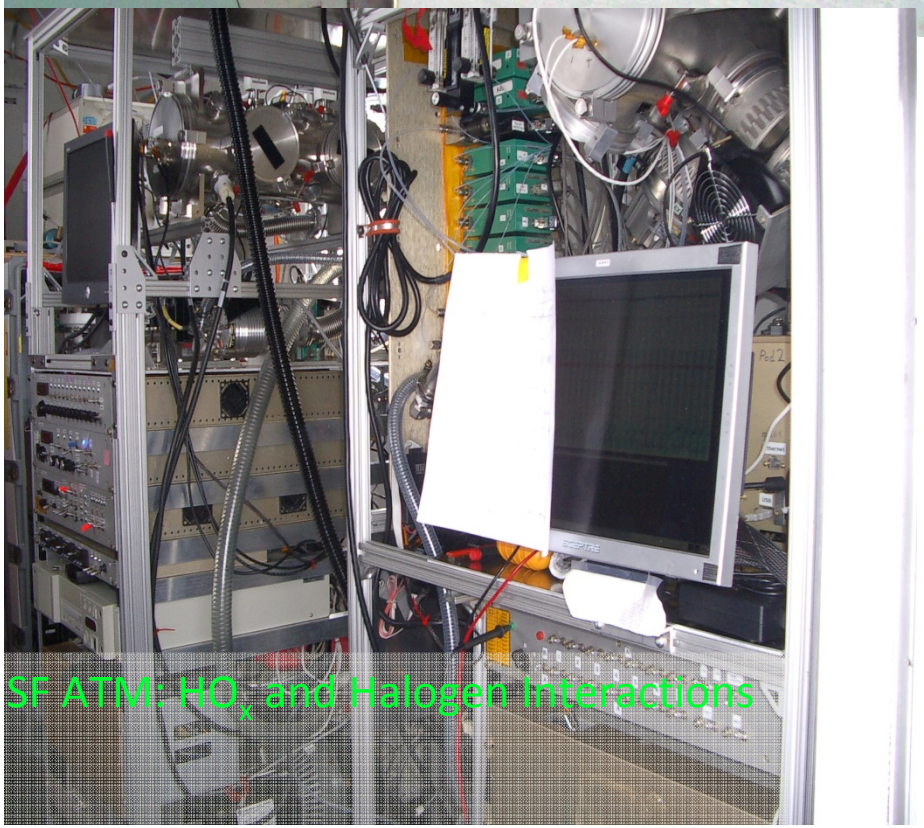

ARCTIC PROGRAM

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

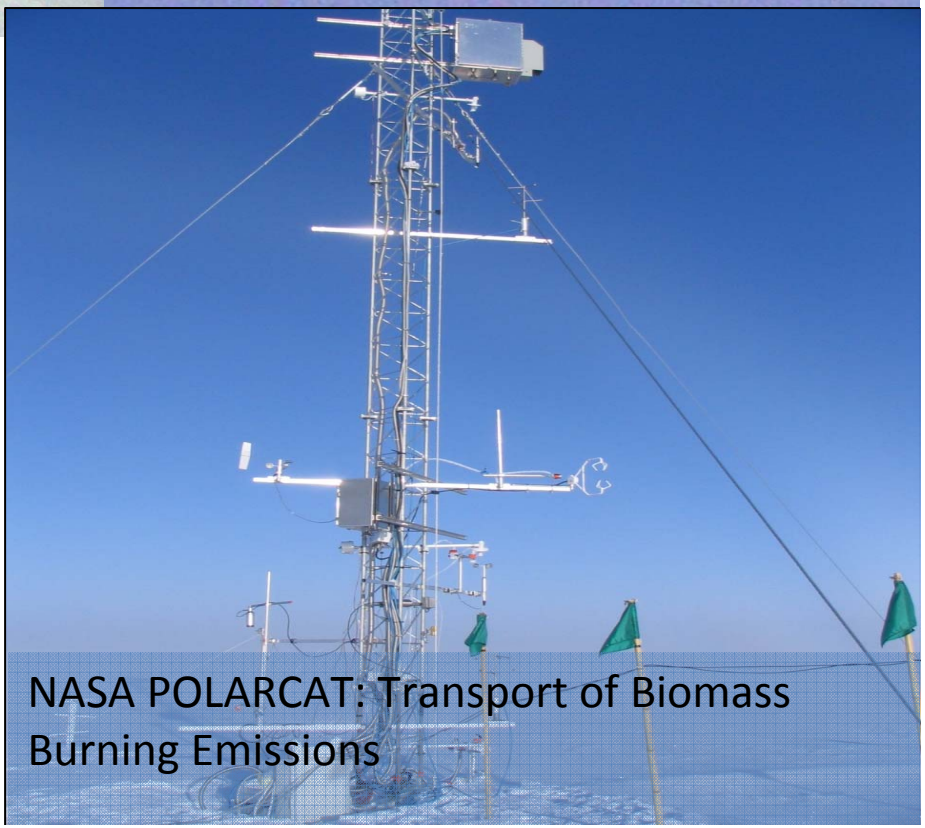
POLARCAT & AICI-IPY at Summit, Greenland

http://www.geosummit.org

NASA ARCTAS overflights



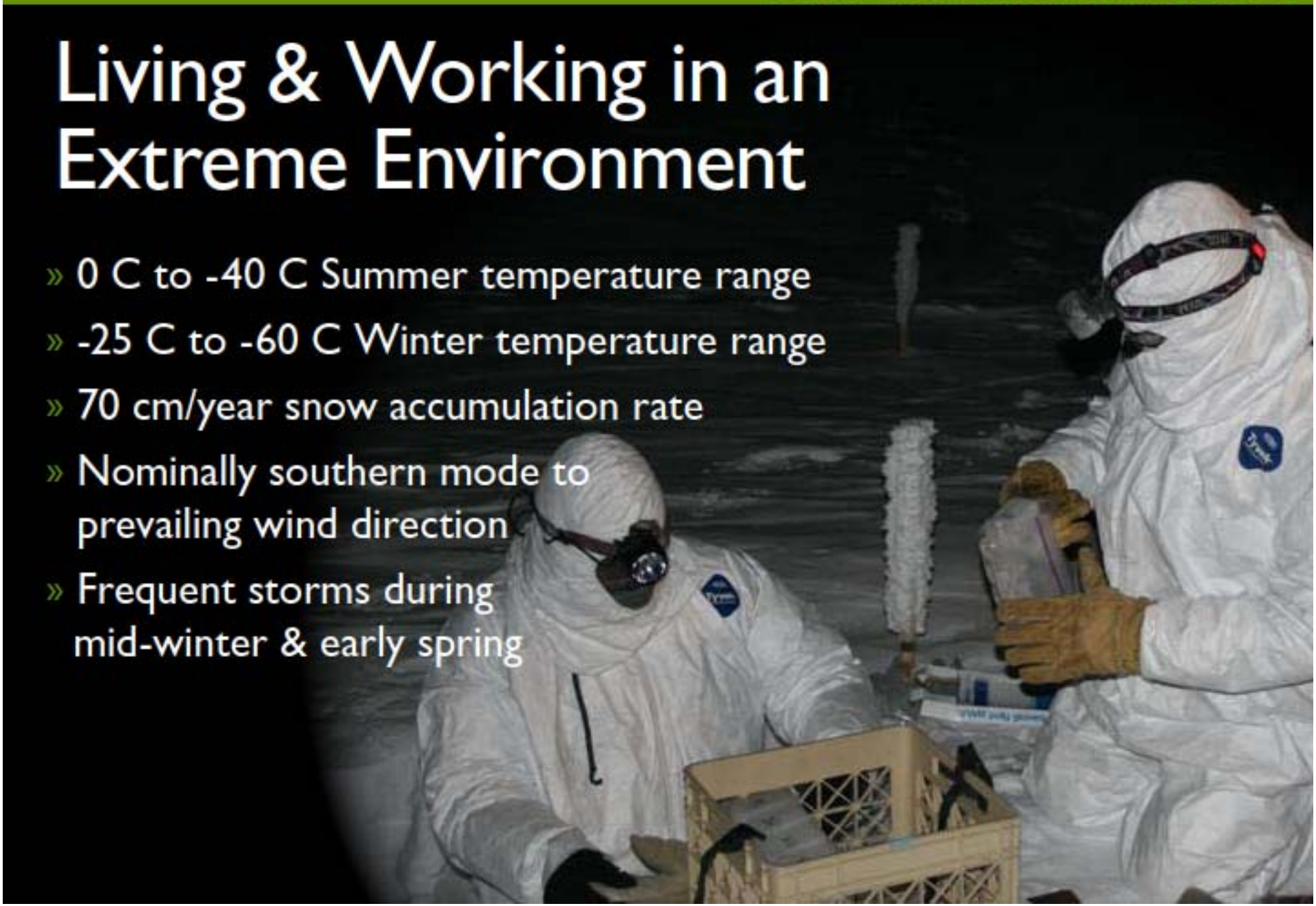
SF ATM: HO_x and Halogen Interactions



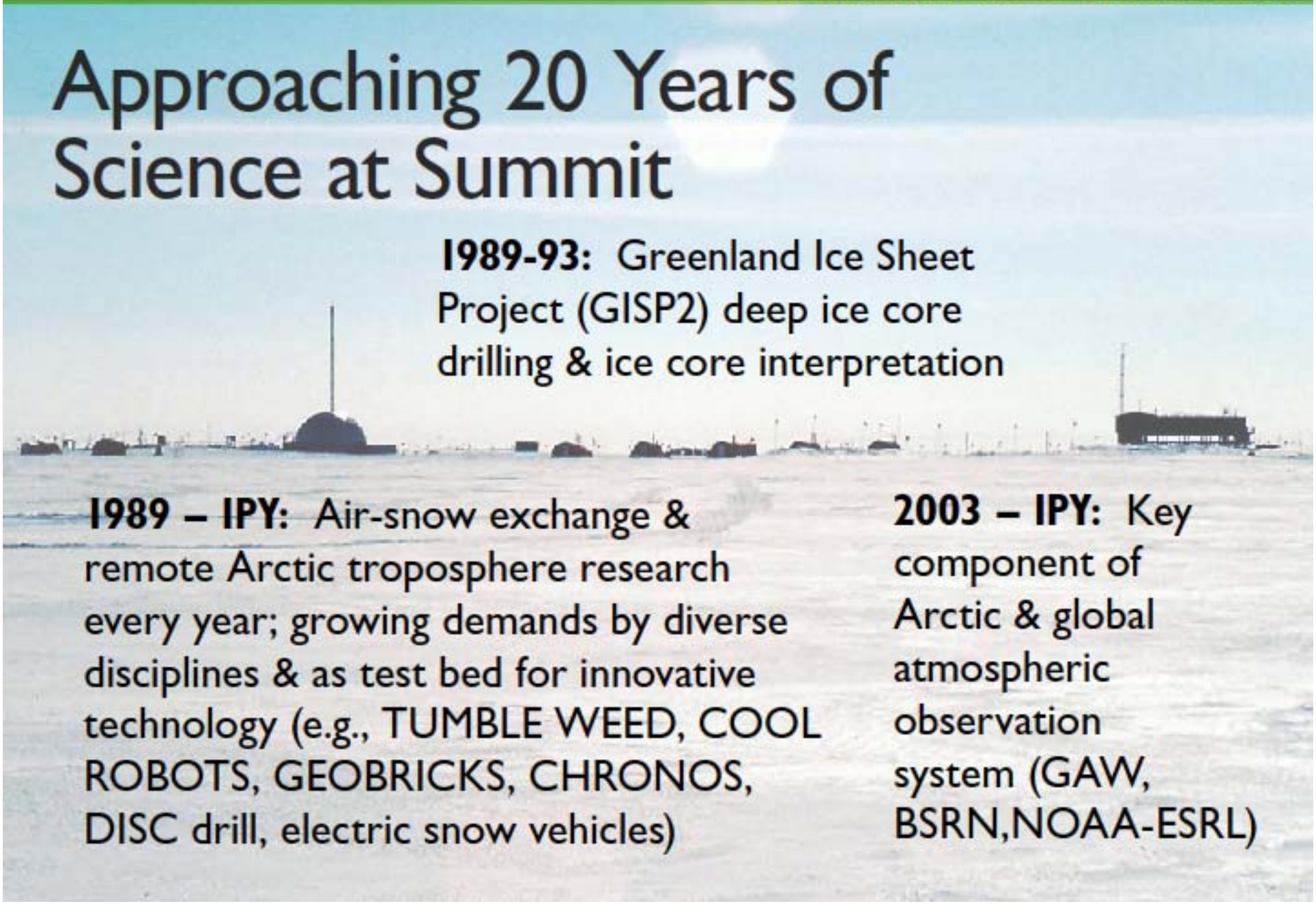
NASA POLARCAT: Transport of Biomass Burning Emissions

Living & Working in an Extreme Environment

- 0 C to -40 C Summer temperature range
- -25 C to -60 C Winter temperature range
- 70 cm/year snow accumulation rate
- Nominally southern mode to prevailing wind direction
- Frequent storms during mid-winter & early spring



Approaching 20 Years of Science at Summit



1989-93: Greenland Ice Sheet Project (GISP2) deep ice core drilling & ice core interpretation

1989 – IPY: Air-snow exchange & remote Arctic troposphere research every year; growing demands by diverse disciplines & as test bed for innovative technology (e.g., TUMBLE WEED, COOL ROBOTS, GEOBRICKS, CHRONOS, DISC drill, electric snow vehicles)

2003 – IPY: Key component of Arctic & global atmospheric observation system (GAW, BSRN,NOAA-ESRL)

Summit's Science Legacy

Ice Coring

- GISP2 provided unprecedented high resolution record of 110k yr of Earth's climate & atmospheric chemistry
- Studies of air-snow chemical exchange defined important "transfer functions"

In 1993 GISP2 recovered a 3,053.44 m ice core, the deepest recovered in the world at the time.

Summit's Science Legacy

Atmospheric Chemistry

- 1st measurements of NO_x production in sunlit snow **launched field of snow photochemistry**
- Improved understanding of global oxidation cycle through H_2O_2 & CH_2O experiments

- Stratospheric ozonesondes launched by NOAA monitor ozone hole
- Site for baseline measurements of globally important gases & aerosols in troposphere & stratosphere

Uniquely at Summit

High-elevation location on ice sheet

» Year-round access for sampling Arctic free-troposphere

Sole northern hemisphere analog for Antarctica

» Facility for polar ice sheet intercomparisons with Antarctic locations (i.e. Dome-C and WAIS)

» No melting (yet!)

1989 1997 2003 **IPY** Phase 1 Phase 2 Phase 3

SUMMIT STATION LONG RANGE PLAN

Snow removal = Air pollution

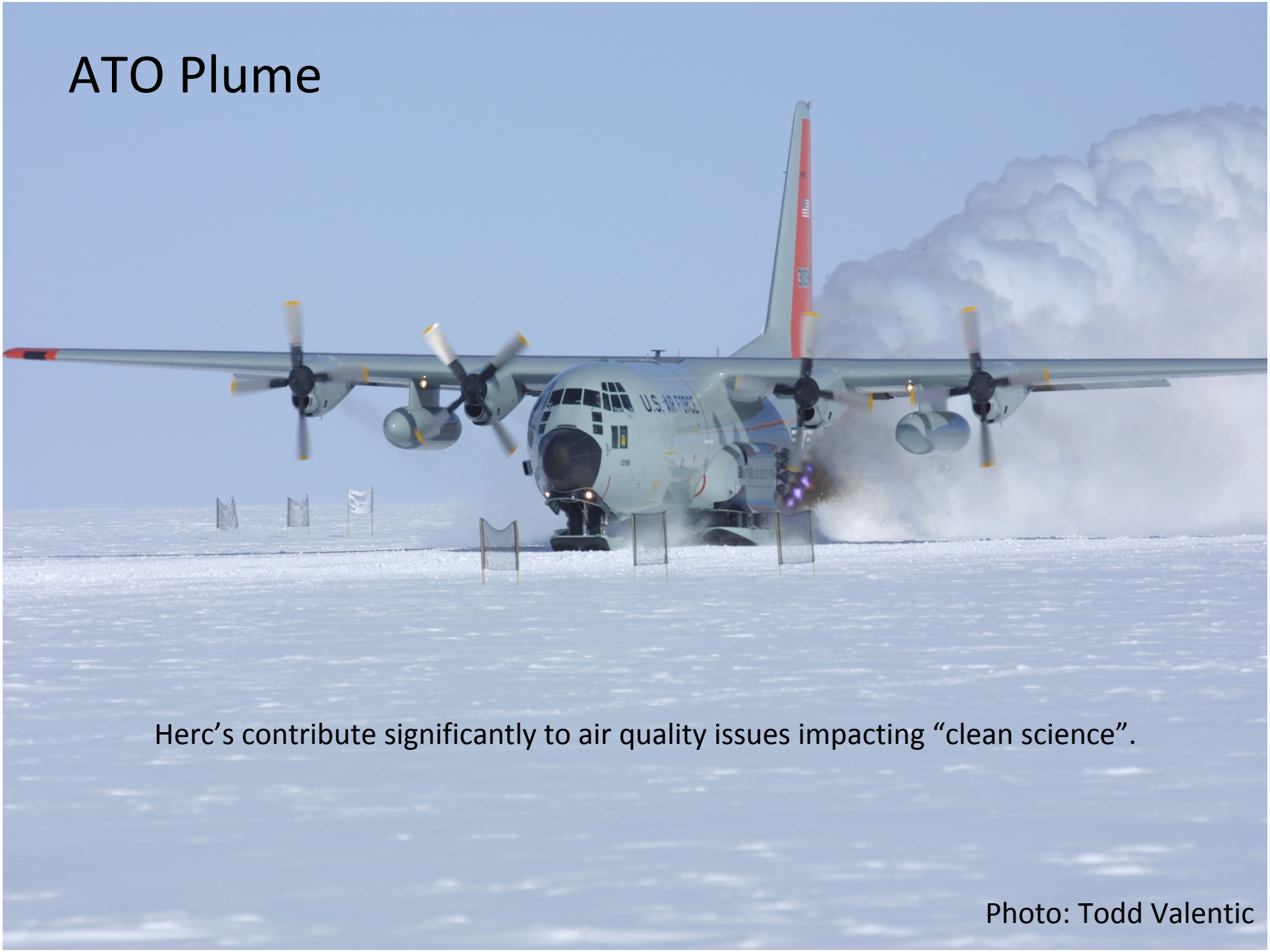
Station reliant on diesel power

Each C-130 flight burns an average of 345 gallons of diesel fuel **on station**

LC-130 ATO Take Off

Photo: Todd Valentic

ATO Plume



Herc's contribute significantly to air quality issues impacting "clean science".

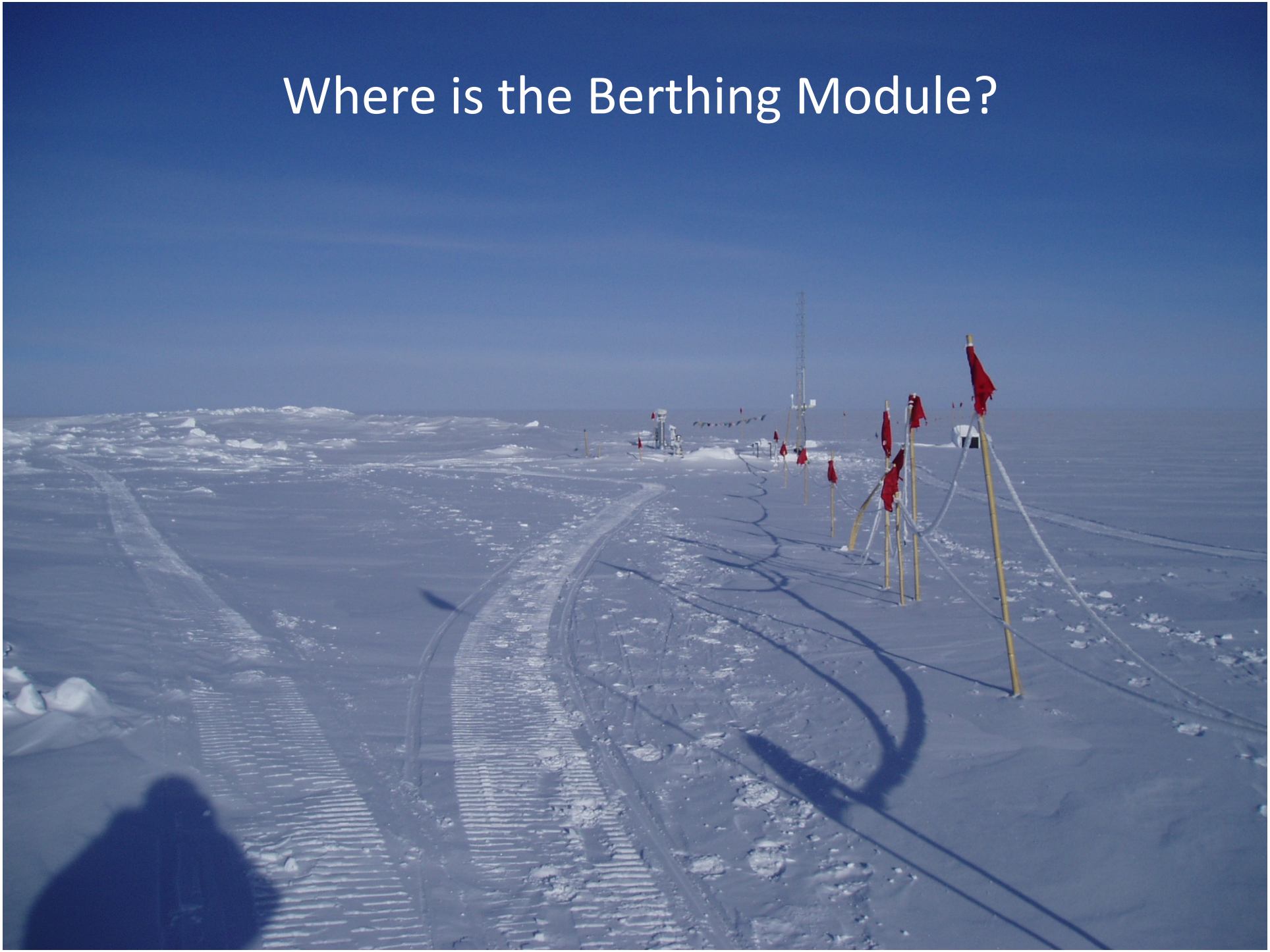
Photo: Todd Valentic

1989 1997 2003 **IPY** Phase 1 Phase 2 Phase 3

SUMMIT STATION LONG RANGE PLAN

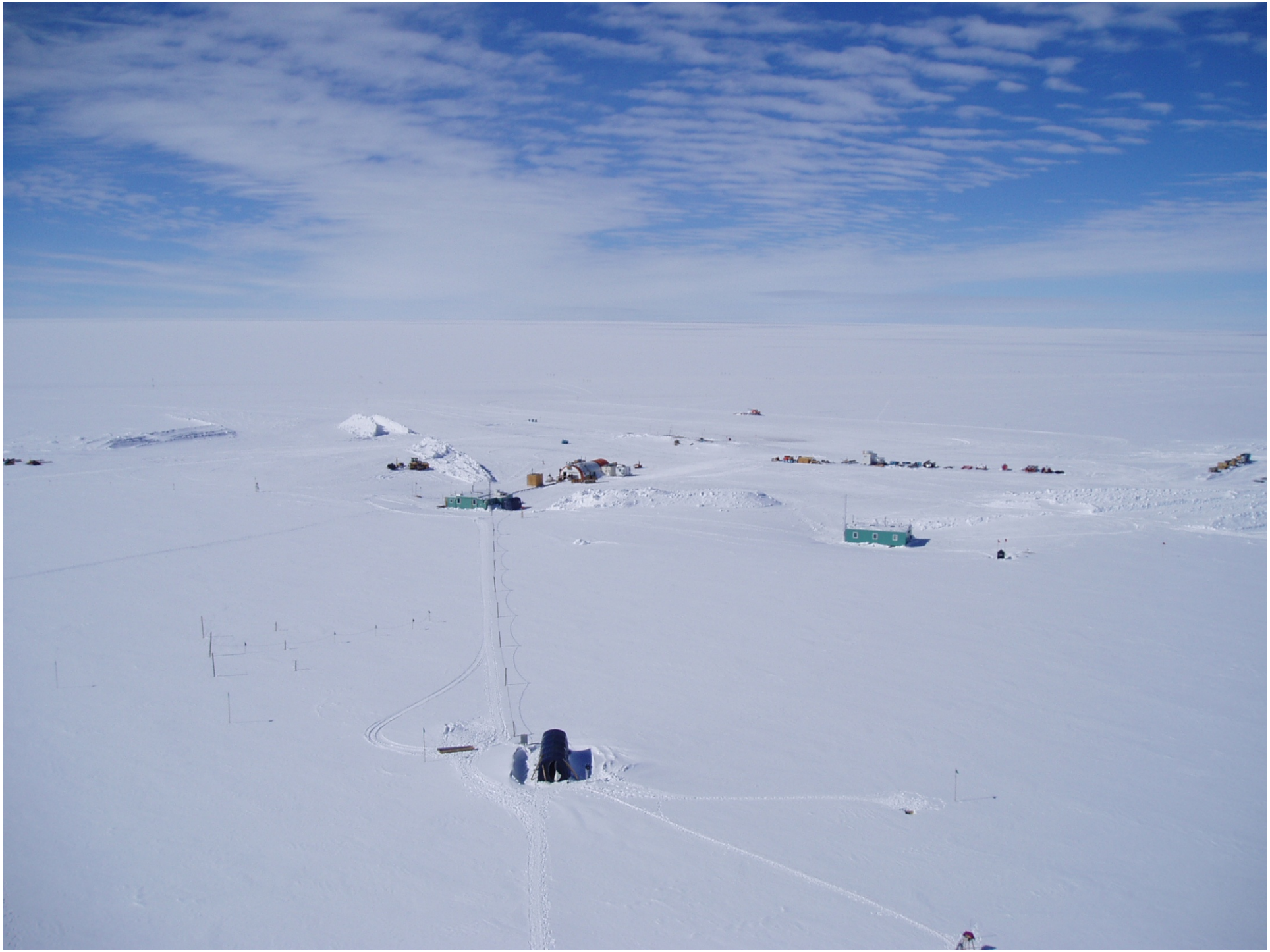

About time to move the buildings back to the surface.
One wind storm can easily bury it at this point.

Where is the Berthing Module?



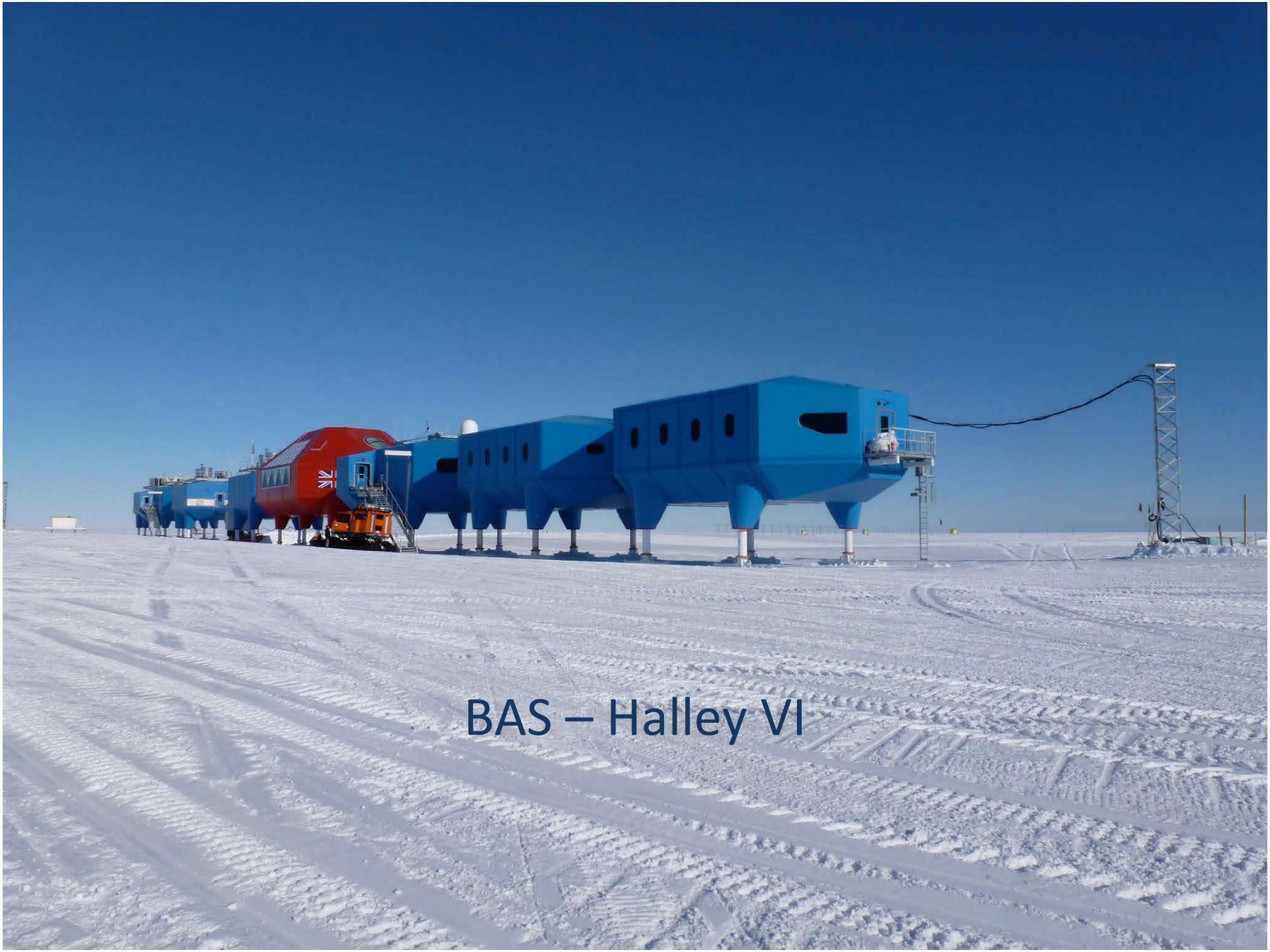
Summit Snow Management

Walking the pile…….. Mountains of snow to remove annually.

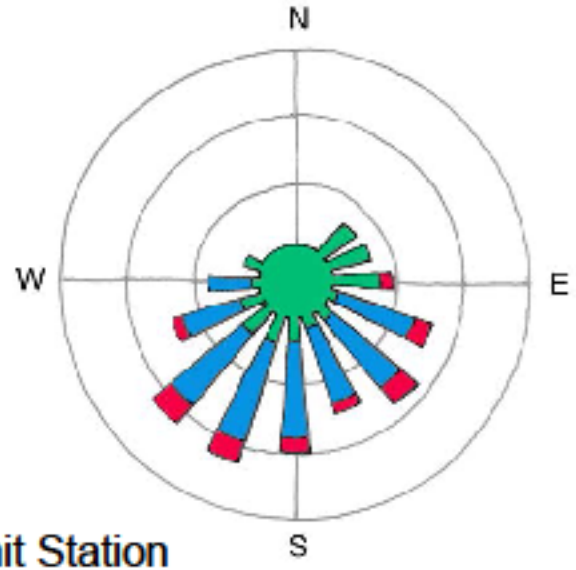


DYE II – near Camp Raven

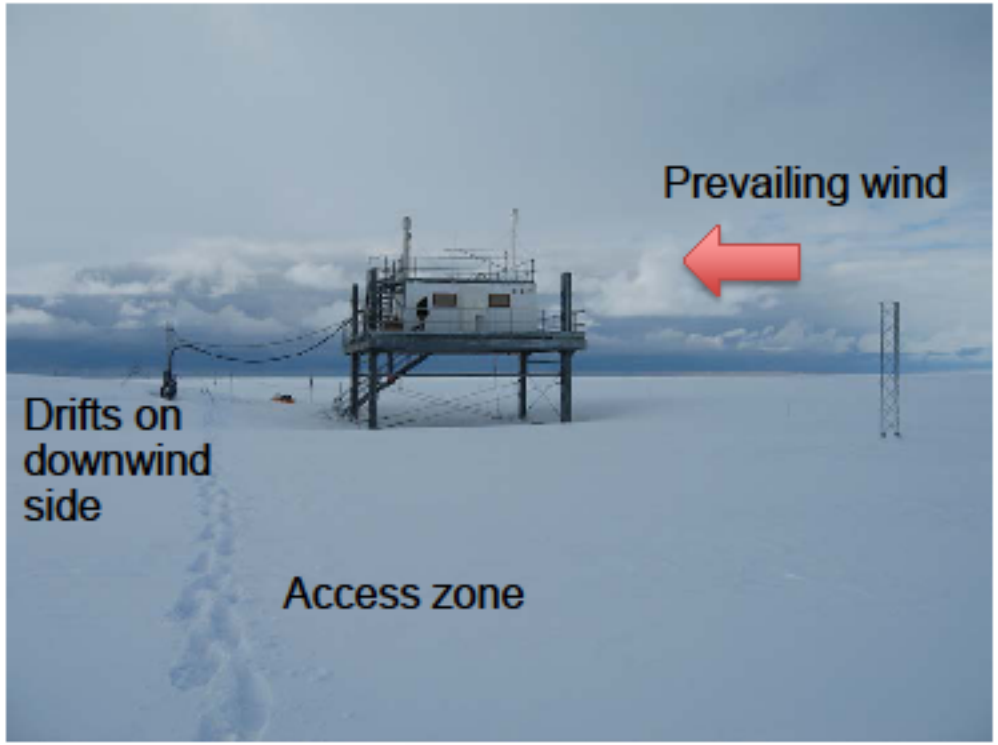
The elevated station concept is not new – built circa 1958

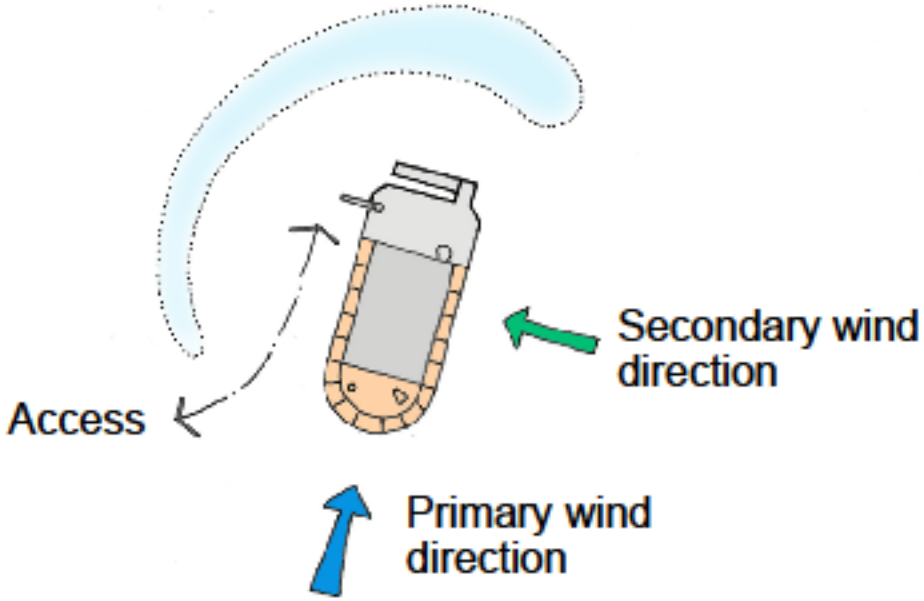

BAS – Halley VI

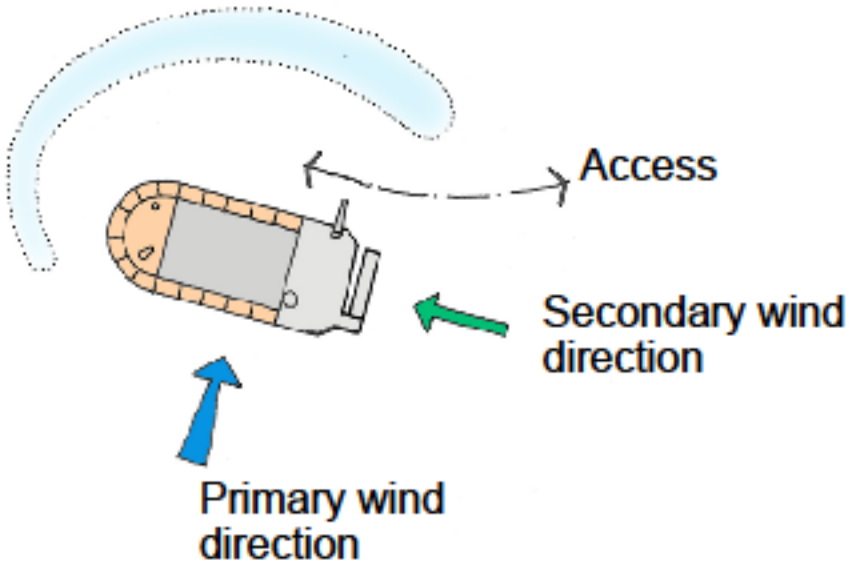
Orientation studies



Summit Station
Year round wind rose







Goals for Summit

- Develop innovative, comprehensive solutions that maximize energy & operational efficiency while supporting a growing research program
- Provide state of the art year-round facilities based on a solid understanding of the emerging needs of the research community
- Provide flexible, seasonal facilities that meet a range of demands
- Increase dissemination of knowledge from Summit to the global community

Planning Principles for Summit:

Appropriate Technology

- Renewable energy
- Superior building standards
- Low maintenance innovations
- Zero-emissions vehicles

An Informed Approach

- Detailed requirements gathering and studies
- Phased, modular development
- Proven technology

Teamwork

- NSF OPP, VPR & SCO
- Involve experts - e.g., National Renewable Energy Laboratory (NREL), Cold Regions Research & Engineering Lab (CRREL)

Core Power System

Innovative master controls facilitate renewable energy integration

Appropriate Technology

Phased, modular development

Teamwork (NREL)

1989 1997 2003 IPY **Phase 1** Phase 2 Phase 3

SUMMIT STATION LONG RANGE PLAN

Vehicle Maintenance Facility
for Haley Station in Antarctica
– Photo Courtesy BAS

1989 1997 2003 IPY Phase 1 **Phase 2** Phase 3

SUMMIT STATION LONG RANGE PLAN

Sustainability: It All Fits Together

Sustainable solutions are
comprehensive & inter-reliant.

Though phased & modular, each element is
necessary to the whole picture.

Using Experience to Support the Vision

NREL

» High penetration hybrid power system design assistance

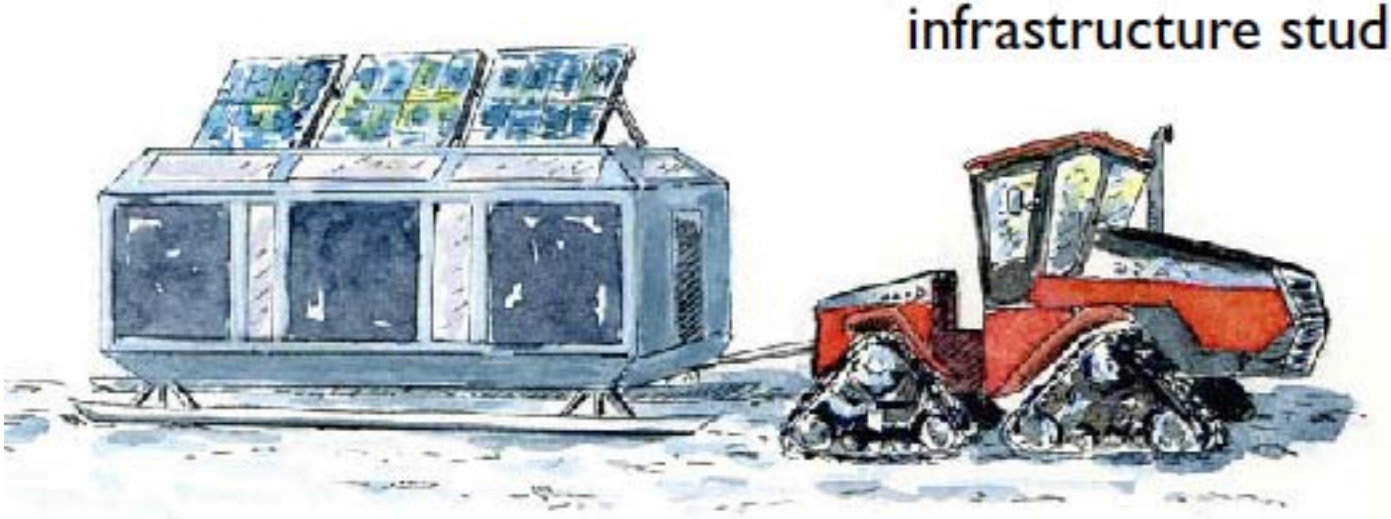
CRREL

» Traverse feasibility study

» Snow accumulation site study

» Sled-mounted infrastructure studies

» Platform-mounted infrastructure studies



Current Mobile Science Facility

Current Emissions Reduction Strategies

Energy Efficiency – Pedestrian Culture – Generator waste heat recovery - Electric Vehicles – Oxygenated Fuels – Exhaust After-Treatment – Renewable Energy – GrIT

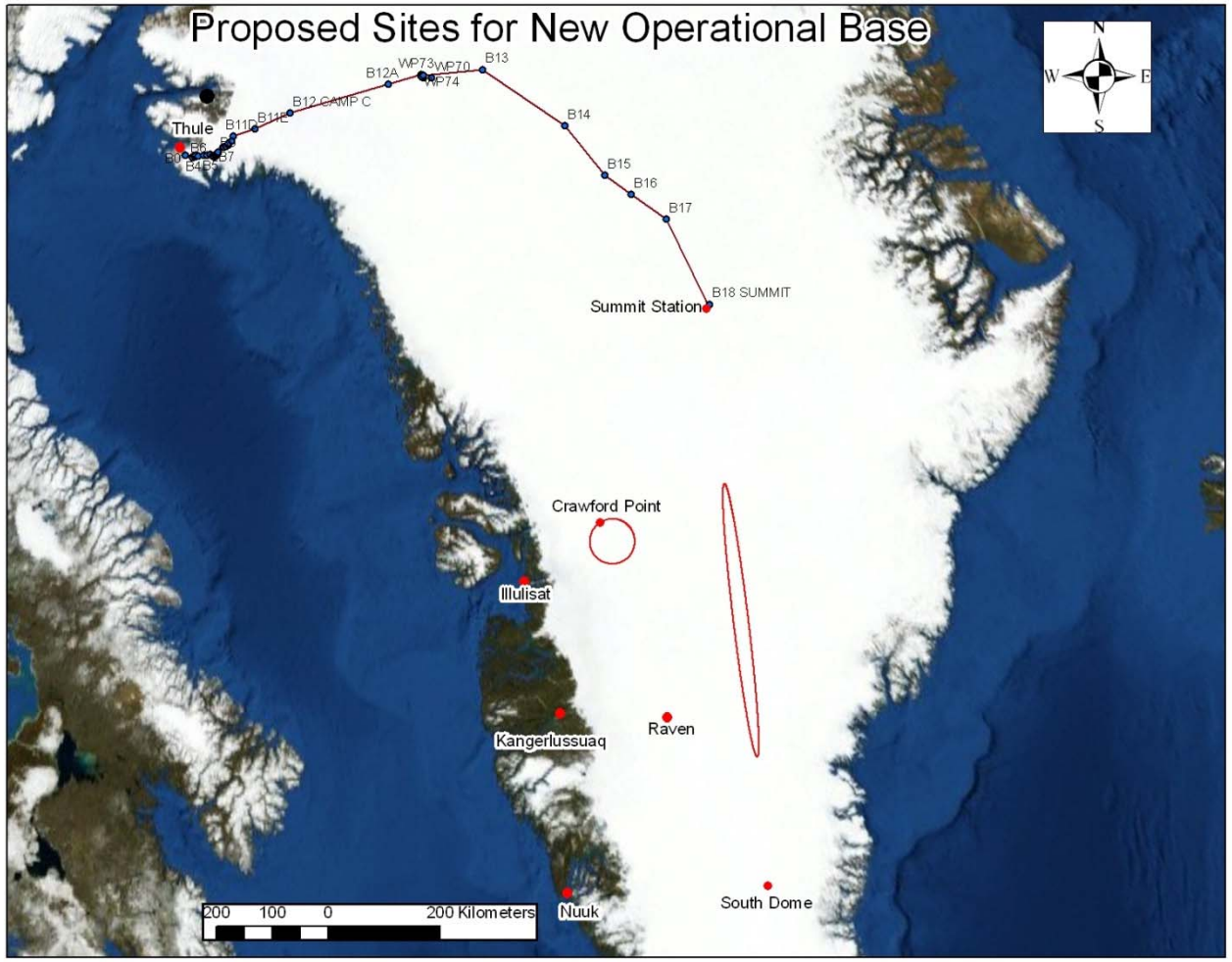
Raising the 6kW Proven wind turbine - 2007

Big House and Wind Turbine

Summit Station Models

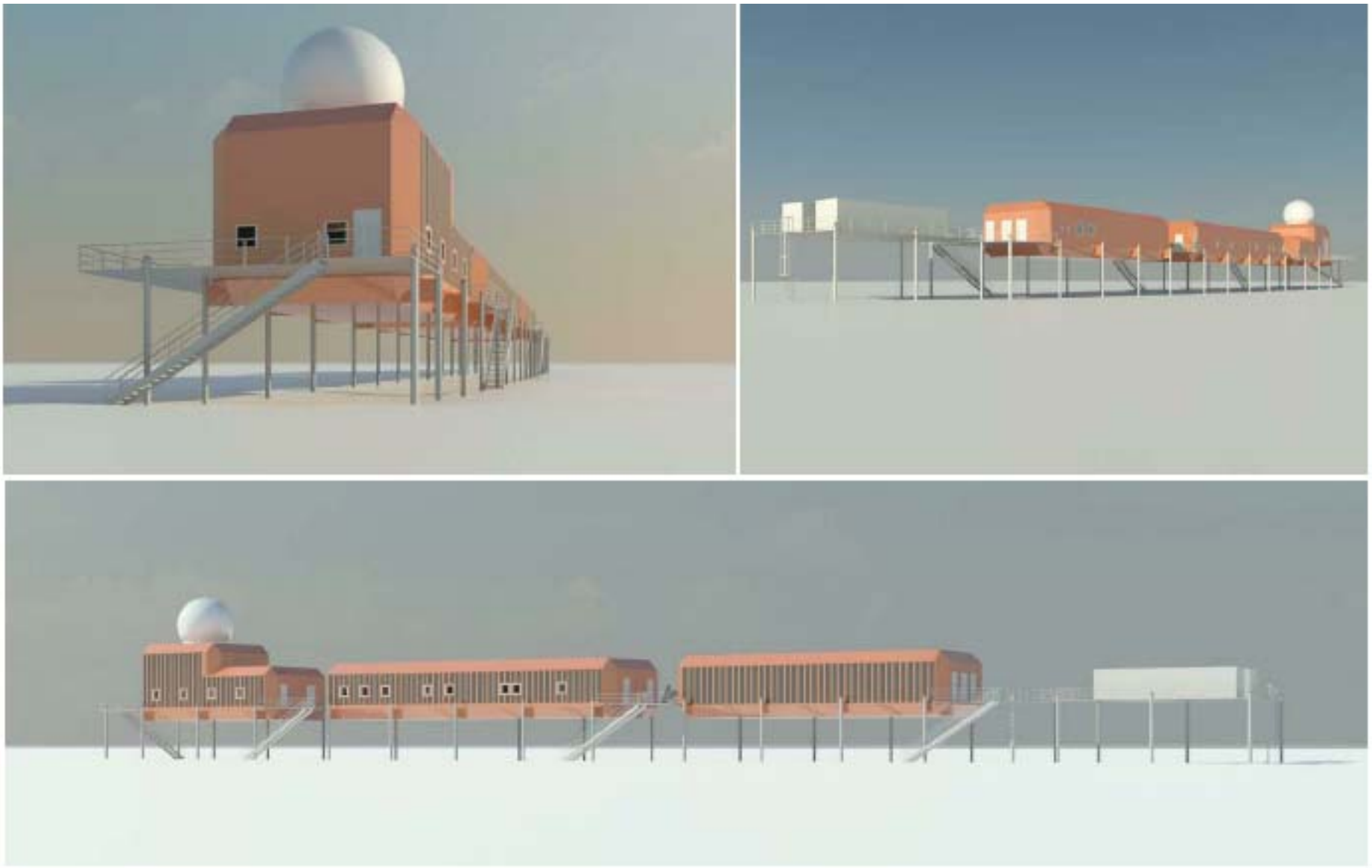
Model	Name	Concept
1	Business as Usual Model	Summit continues along as it historically has. No large upgrade projects, just sustain existing infrastructure and replacing infrastructure at the end of its life with functional equivalent.
2	Stainless Steel Towers	Summit science is supported off of a small collection of platforms that can run autonomously for months. Routine maintenance is supported by Twin Otter and cold camp.
3	Growth, Observatory & Campaign	Summit develops permanent year round facilities and scalable seasonal facilities commensurate with historical growth patterns. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.
4	No Growth, Observatory & Campaign	Summit develops permanent year round facilities and scalable seasonal facilities commensurate with freezing growth at current levels. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.
5	No Growth, Observatory -Only	Summit develops permanent year round facilities commensurate with supporting currently funded, year-round science only. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.
6	Scalable Campaign Summer Camp	Summit develops scalable seasonal facilities commensurate with currently funded, campaign science only. Seasonal camp will scale up and down with funding levels. Structures and utilities reflect strong emphasis on energy efficiency, renewable energy, operational efficiency.

The new Summit will be exclusive, but OPP ARSL is



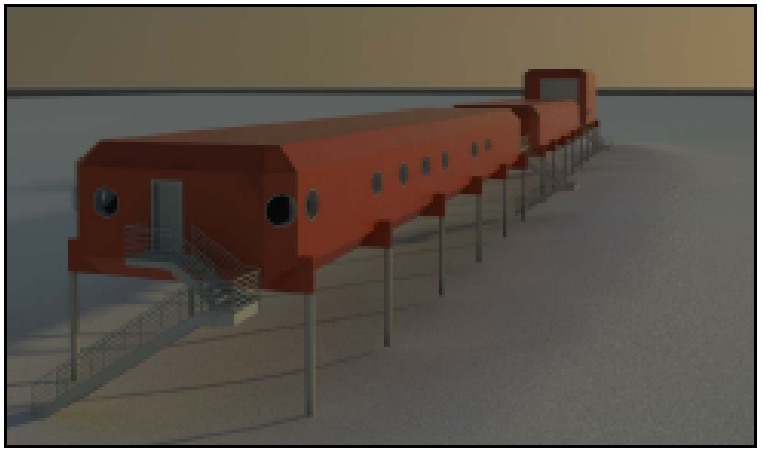
striving to open up entire ice sheet for research.

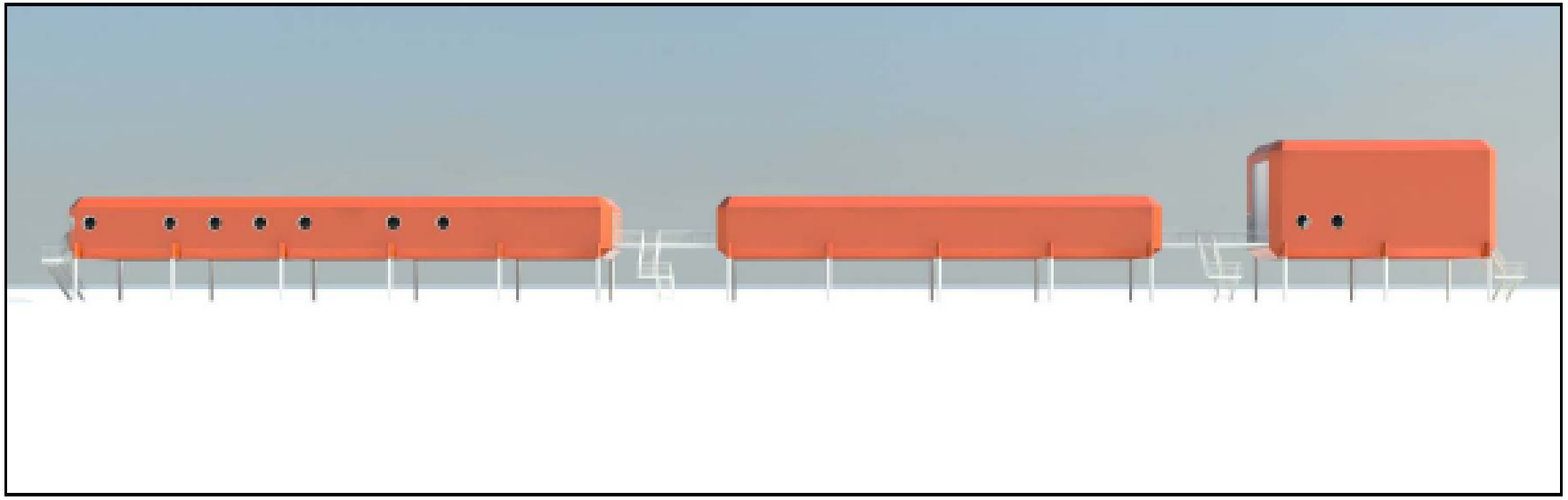
New, Smarter, Summit Station??



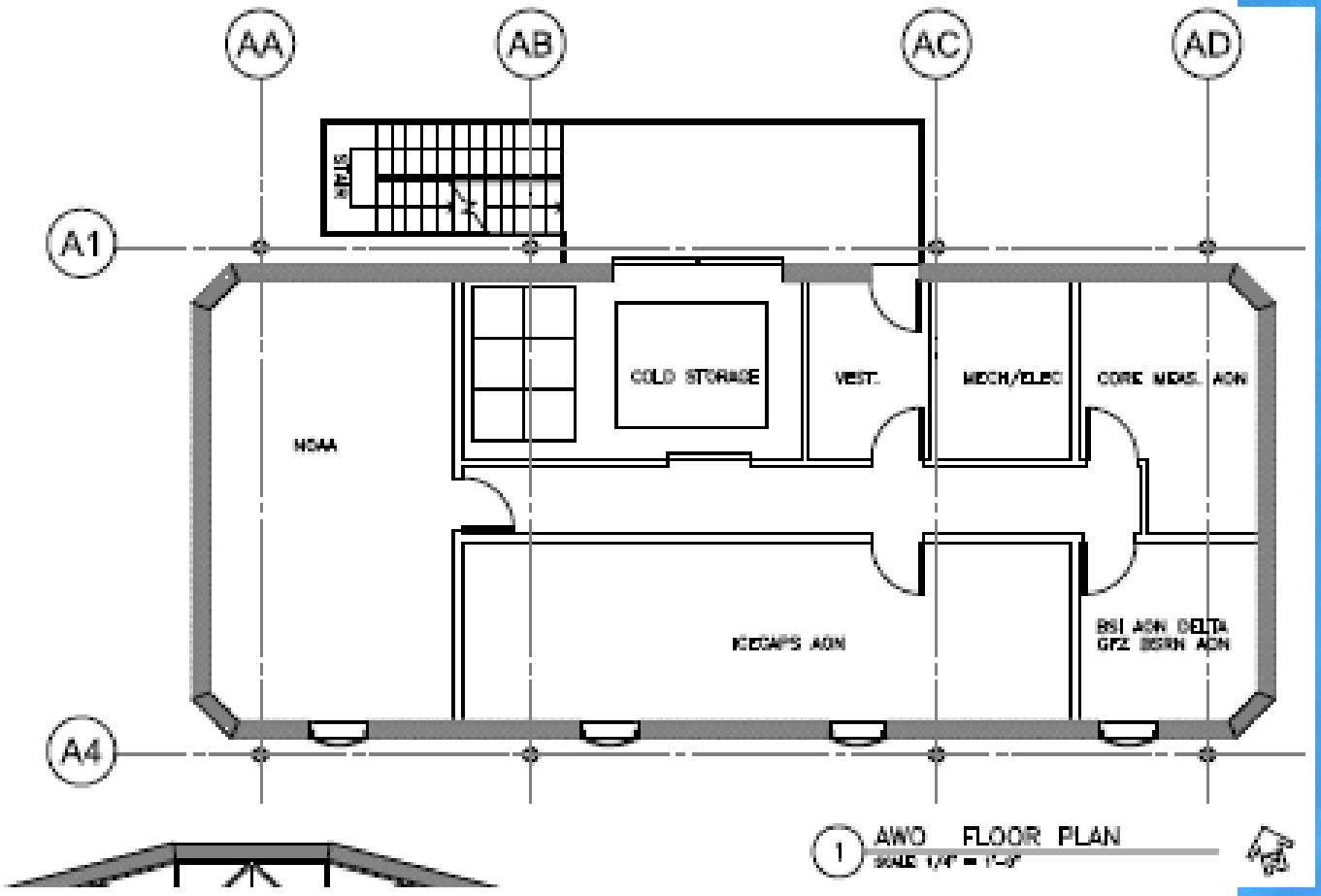
RFP for final design of Phase 1 to be released soon

Model 5 Example





Model 5: AWO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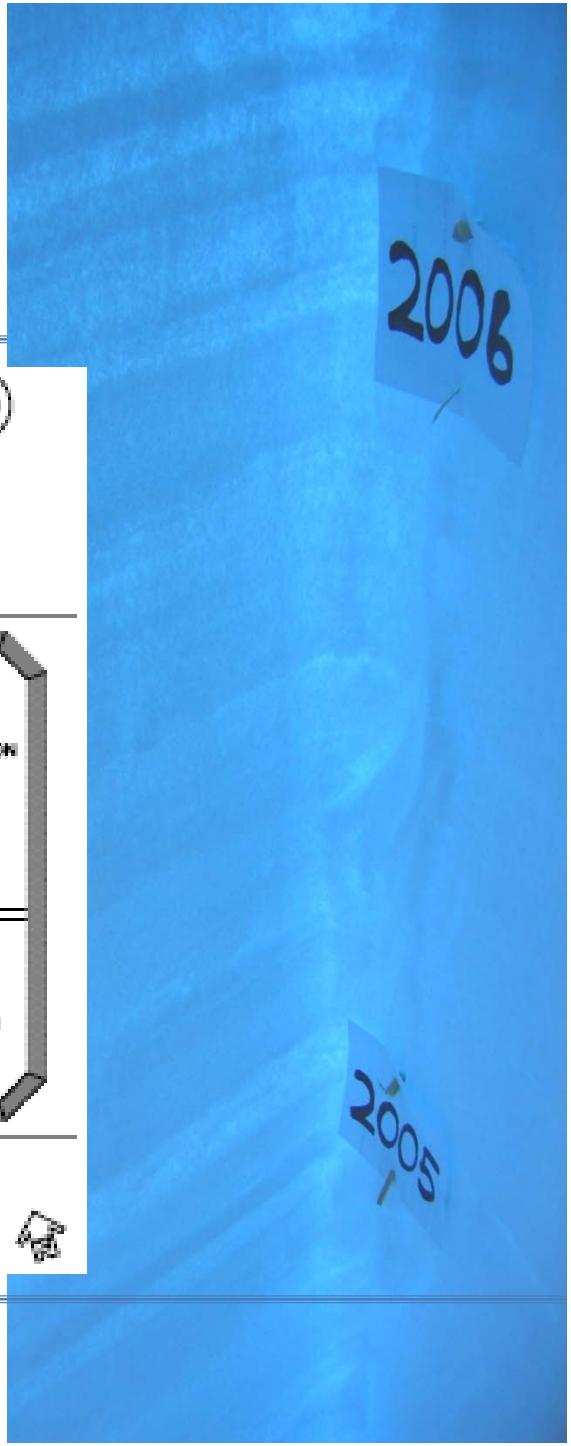
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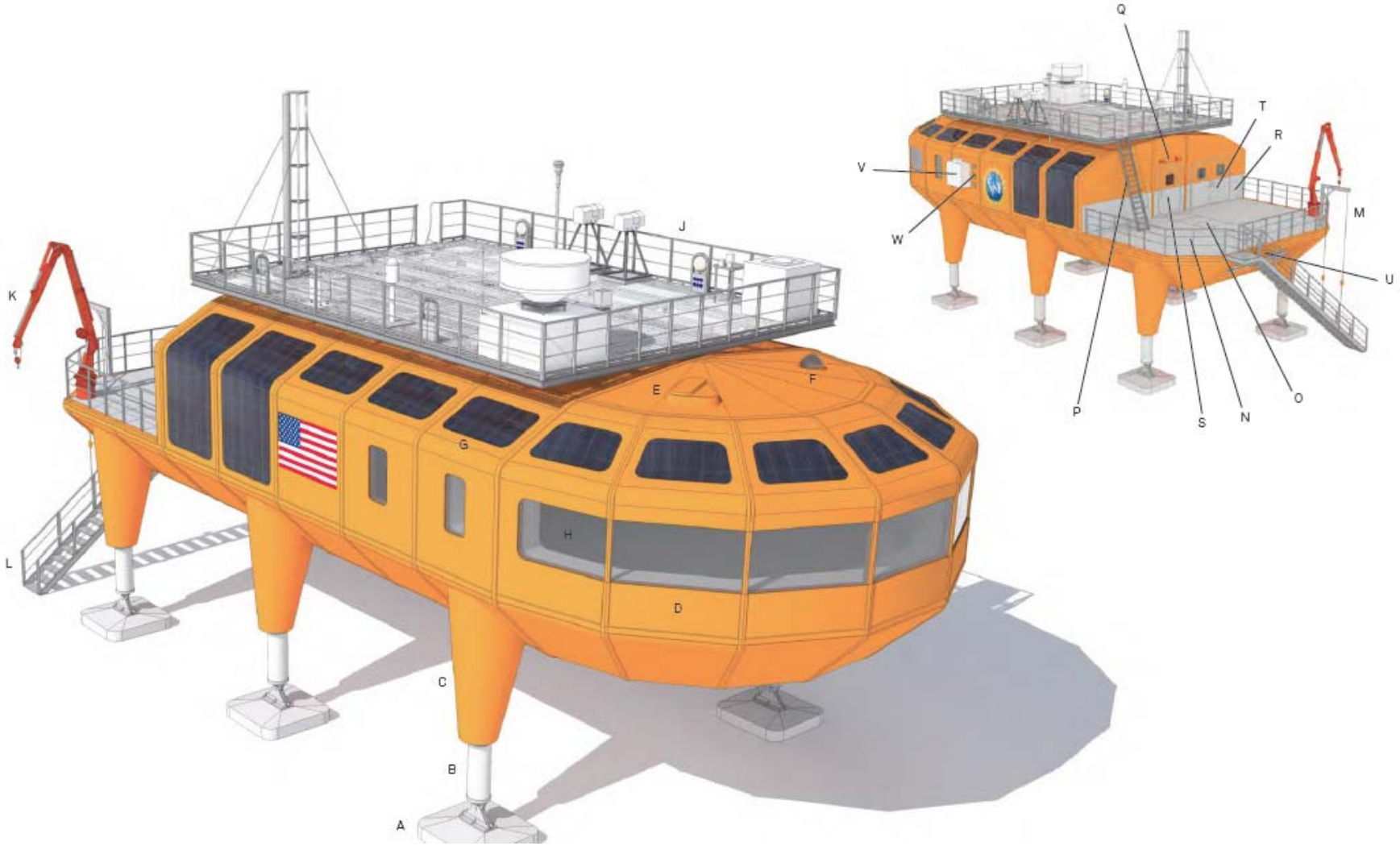
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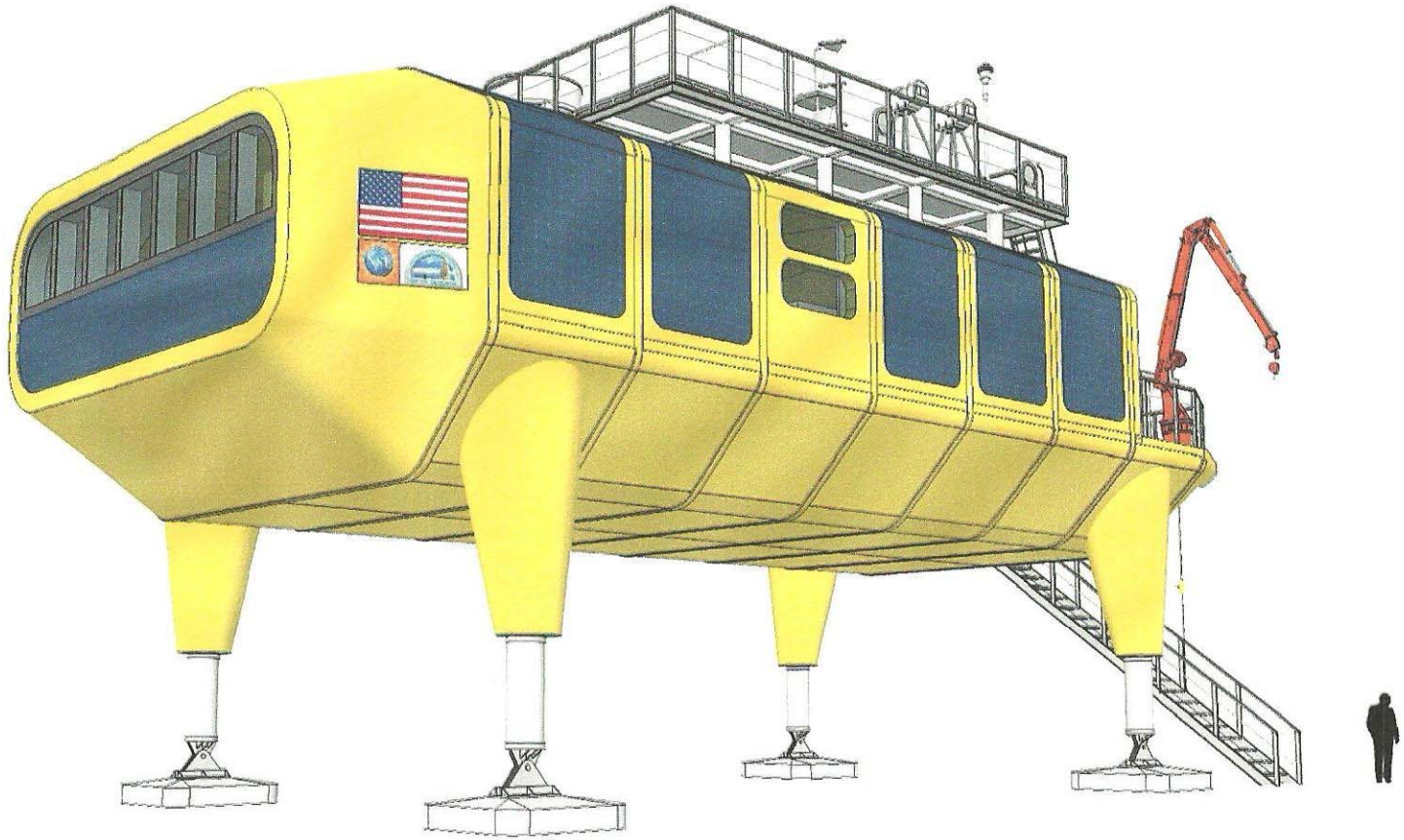

Just when the NSF is about to pull the trigger.....

The Latest Wrinkle- APEX Station:

Astro-Physics EXperiment

- Appears to be a great science project
- Entirely different focus from current science operations
- Up to 200kW total load for telescope and facilities
- 5 miles north of Summit
- Largest project on Greenland ice cap since DYE sites
- Many budgetary, engineering, logistics and construction challenges
- Many questions…….

- How will it affect existing science?
- Power Summit from APEX or independently?
- House personnel at APEX or Summit?
- Commuter transport?
- How much renewable energy?
- How to make a really expensive project fit within budget constraints?

Fortunately, we thrive on challenges!