3 INVITED PARTICIPANTS

The following sections provide a brief description of each invited participant's background and rationale for their attendance at this workshop.

3.1 Mary Albert

Dr. Mary R. Albert is currently a professor of engineering at the Thayer School of Engineering at Dartmouth College, where she serves as thesis advisor to students at undergraduate, Master's, and Ph.D. levels.

Dr. Albert was the U.S. Lead Principal Investigator for the Norwegian-American Scientific Traverse of East Antarctica Program. The field expedition for this international partnership involved scientific investigations along two overland traverses in East Antarctica: one going from the Norwegian Troll Station to the United States South Pole Station in 2007-2008; and a return traverse by a different route in 2008-2009. She was Chair of the U.S. Committee to the International Polar Year (IPY; 2007-2008), a committee of the Polar Research Board of the National Academy of Science, from its inception in 2003 until June 2005. She has spent many field seasons in Greenland and Antarctica investigating the physical properties of snow (microstructure and permeability) and their effects on air-snow transport processes.

Dr. Albert received a B.S. in mathematics from Penn State in 1975, a B.E. and an M.S. in engineering sciences from Dartmouth College in 1983, and a Ph.D. in applied mechanics (computational fluid dynamics) from University of California San Diego in 1993. Before becoming a professor at Dartmouth College, she was a scientist in the Geophysical Sciences Division at the U.S. Army Corps of Engineer's Cold Regions Research and Engineering Lab (CRREL).

Dr. Albert's current research is centered on transfer processes in porous media, including air-snow exchange in the Polar Regions and in soils in temperate areas. Her research includes field measurements, laboratory experiments, and theoretical modeling. Mary conducts field and laboratory measurements of the physical properties of natural terrain surfaces, including permeability, microstructure, and thermal conductivity. Mary uses the measurements to examine the processes of diffusion and advection of heat, mass, and chemical transport through snow and other porous media. She has developed numerical models for investigation of a variety of problems, from interstitial transport to freezing of flowing liquids. These models include a two-dimensional finite element code for air flow with heat, water vapor, and chemical transport in porous media, several multidimensional codes for diffusive transfer, as well as a computational fluid dynamics code for analysis of turbulent water flow in moving-boundary phase change problems.

A8 – Presentation of Mary R. Albert

NOR-USA Scientific Traverse of East Antarctica: Science & Logistics on a Three-Month Expedition across Antarctica's Farthest Frontier

[Slide 1] NOR-USA Scientific Traverse of East Antarctica: Science & Logistics on a Three-Month Expedition across Antarctica's Farthest Frontier; Mary R. Albert, Ph.D., Dartmouth, Hanover, N.H.

[Slide 2] This talk is primarily about the Norwegian – USA traverse, but I have also talked with the Japanese and am familiar with other US traverses that have taken place. This is the team that took part in our traverse. We also attempted to be the first group to use UAVs in the Antarctic.

[Slide 3] This is an overview of how I have laid out my talk and you will see the subjects on this chart highlighted as I move through it.

[Slide 4] Why traverse across Antarctica?

[Slide 5] There is lot of data on climate change in the Antarctic, we need to go there to gather that data through measurements.

[Slide 6] This talk is mostly about the logistics of the traverse, but as science was the driver for the traverse, I want to point out a couple of the overarching science questions the traverse addressed, which I have listed here.

[Slide 7] To answer the accumulation rate and related question, we used both pits and core. The pits primarily for stratigraphy and the cores to do physical, chemical and electrical property analyses as counting layers in a low accumulation area is not practical.

[Slide 8] And we also did surface studies. One of our plans was to use UAVs.

[Slide 9] We also did radar and related it to satellite, particularly SAR, images. The radar measurements allowed us to connect our pits and core sample data and our mapping near those sites to the longer traverse.

[Slide 10] This is a view of our coring activity.

[Slide 11] Notice that the collection of cores is being done with clean suits and brought back to the Desert Research Institute for analysis.

[Slide 12] We used the holes drilled for the cores to implant a thermal monitoring system at each location, which also included an automated weather station.

[Slide 13] Why traverse across Antarctica – you do it for science and to gather that data which you cannot gather by satellite.

[Slide 14] Also, the time was right with world agreeing to International Polar Year activities. The Norwegians needed new infrastructure at their station and as it is not near the coast, they needed to traverse anyway. So they asked the NSF if any American scientists would be interested in joining the traverse to do science. This gave the US community an opportunity to go where we usually do not go.

[Slide 15] Pre-traverse Planning

[Slide 16] From this list of meetings, you can see this did not happen overnight. Fortunately, this was a team that most knew each other and was highly motivated as the first proposals were due in June 2005. We used monthly whole group telecons to keep everyone involved and motivated and to know what was going on, including the development of the vehicle infrastructure by the Norwegians.

[Slide 17] The years of planning contributed to the mission success. The first year at Troll we did our final training and a lot of cargo handling.

[Slide 18] The Field Team and the Team's Attitude.

[Slide 19] This is a picture of us and here you can see a breakdown of our characteristics.

One particular point, John Guldahl, the Chief of Logistics, designed the vehicles and he has spent a lot of time in the Antarctic and said he was not going to freeze his ass off – so, the person designing vehicle not only had the experience, he is also the one using it.

Something that Norwegians did, that was new to us, is that main meal was pre-prepared as a 12-person serving package that only need to be placed in hot water for half an hour.

The nationalities are weighted toward Norwegians as they supplied the logistics support.

None of these characteristics made any difference once we were on the traverse; everybody did whatever needed to be done. If the logistics was all done and we needed to finish up some science activities before we could move on, the logistics guys helped. If the reverse was true, the scientists move supplies or helped with tools.

[Slide 20] Humans on Long-Duration Missions

[Slide 21] Humans are chemical machines and on long-duration missions, you need to realize this. John Guldahl realized this and built the vehicles accordingly. There were two heated modules; one was for living and one was for sleeping. There was heat in the floors – heat recovered from the vehicles.

We were organized and within 40 minutes of stopping, we would be cabled up, meal ready and we were ready to eat. We always had meals together. After dinner we would do a review of the day and discuss the plan for the next day. This gave everybody a good feel for how everyone was doing.

In the middle here you can see a real kitchen, small, but real.

After dinner, this became our work area. It had lots of outlets for computers, it was warm and comfortable – with the heated floor you could take off your boots as well as your jacket. Unlike other traverses, I came back not just with cores, but with reduce data – information. The living conditions made that possible. And by being able to analyze the data in the field, we were able to replan and take advantage of opportunities.

[Slide 22] The sleeping module was similarly built. It had three separate bunkrooms with six, six and three bunks. The bunks were each moveable up and down and had ventilation and reading light by your head. For us what was important in deciding the sleeping arrangements was not gender, but how you sleep – light sleeper and non-snoring, snoring , and heavy sleepers that are not bothered by being next to the bathroom. Some of the norms at home do not apply in the field.

[Slide 23] The Norwegians also built a small science tent for me; for which I will be eternally grateful. There was not enough time to setup a tent every time, so this was a real time saver; I could start working as soon as we stopped. It also allowed for us to do quick science at a spot when we had to stop some place for logistics reasons, such as vehicle problems.

[Slide 24] This is the work space for our mechanic. Like the main units, it has a heated floor and gave our mechanic a heated place where he could work.

[Slide 25] We had special events along the traverse to keep a team spirit and keep attitudes up beat. Three months out was too far away to think about, so we had intermediate goals. Here we are at plateau station, seeing the way it was left, 50 years ago.

[Slide 26] Another special event was Christmas. We traveled on Christmas Eve, but once we stopped, we had our main meal; setup a tree; and passed out presents I had brought.

[Slide 27] New Year’s was at the Pole of Inaccessibility with Champaign and cigars.

[Slide 28] We had visitors. Here is a very rich Swede with his friends from Dubai, Germany, and Canada who were on their way in a twin otter to the Pole of Inaccessibility. They heard about us and asked if they could visit. So, we ended up being a tourist attraction on their way.

[Slide 29] Balancing Science and Logistics. In this case, the traverse would not have happened had the Norwegians not needed new infrastructure. But once the infrastructure was available, it was important to do good science. NSF would not have funded us just to go along and survive.

[Slide 30] This distance is about the same as from Miami to Boston and was traveled at the speed of a tractor. The circle sites were deep (90 m) drill sites where we stopped for 5 days. The other labeled sites were 30 m drill sites. Notice that some of these are labeled “B”. Before going on the traverse we planned the route and the sites, balancing travel ability and science return. The “B” usually meant that we were driving along and another differential died. When that happened, it took at least a couple days to fix, so when we were close enough that became the new site. We did have a time constraint, because if the cores were not at the ship in time, they sit in Antarctica for a year.

This is a Bessler, which was used to bring the differentials that needed to be replaced. In all we needed to do six replacements. As it turned out, we were one differential short and had to secure the equipment for winter over about 3 days short of our goal. The Norwegians would go down early the next year, basically setup a garage and replace the drive trains. That basically fixed the differential problem and they sailed back to Troll without problem. The Norwegians had field tested the vehicles and made a number of other adjustments before taking them to Antarctica, but the differential problem had not surfaced – so field test, field test, field test.

[Slide 31-36] Summary of Lessons Learned (well documented on slides as text).

[Slide 37] Acknowledgments

[Slide 38-42] Preliminary Science Results

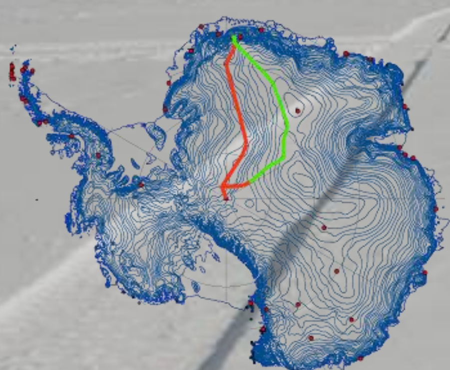
[Slide 41] On the Troll – South Pole – Troll traverses, a 400 MHz Ground Penetrating Radar (GPR) system is used for crevasse detection and navigation along the entire route. The GPR provides very reliable identification of crevasses concealed under a snow cover, and will greatly enhance the travel safety – especially during the second season when the route comes very close to known crevasse zones in the Recovery Lakes region.

NOR-USA Scientific Traverse of East Antarctica: Science & Logistics on a Three-Month Expedition Across Antarctica's Farthest Frontier

Mary R. Albert, Ph.D.
Dartmouth
Hanover, N.H.

1

Norwegian – U.S.A. Scientific Traverse of East Antarctica



Mary Albert (U.S.), Jan-Gunnar Winther (Norway)

U.S.: Ross Edwards, Gordon Hamilton, Glen Liston, Joe McConnell, Tom Neumann, Ted Scambos, Eric Steig

Norway: Svein Erik Hamran, Elisabeth Isaksson, Jack Kohler, Rune Storvold

http://traverse.npolar.no

2

Overview

- Why traverse across Antarctica?
- Pre-traverse planning
- The team and the team's attitude
- Humans on long-duration missions
- Balancing science & logistics
- Summary of lessons learned

3

Overview

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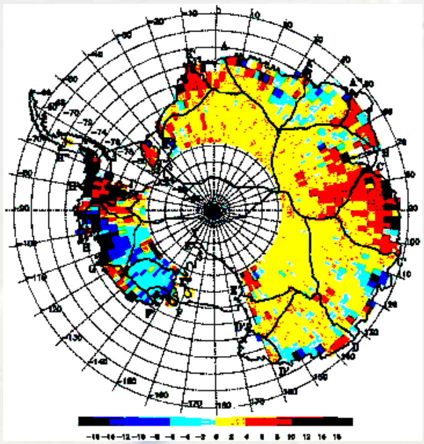
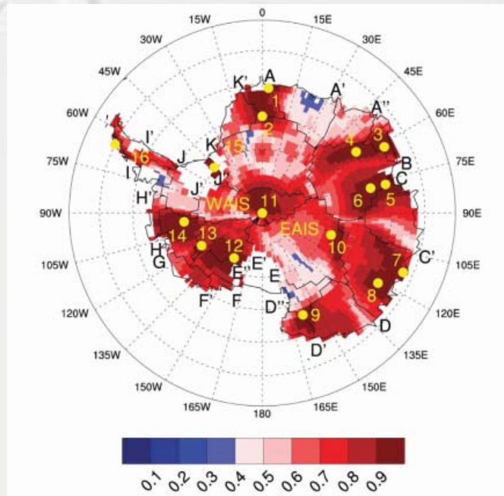
How is East Antarctica reacting to global climate change ?



Davis et al, 2005



Monadhan et al, 2006

Remote sensing signatures contain uncertainties, and few ice cores have been drilled in the interior to constrain models. IPCC 2007 pointed to the need for data.

5

Overarching science questions:

- What is the accumulation rate in this part of East Antarctica, and has it changed in recent decades?
- What regional climate patterns are evident in this area of East Antarctica over the last 1000 years?
- What is the evidence in East Antarctica of anthropogenic activity abroad?
- What is the thermal response of this area to global warming?

6

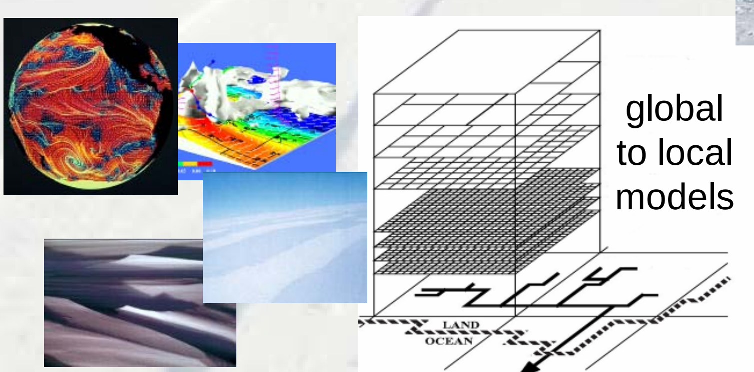
What is the accumulation rate in this sector of East Antarctica, and has it changed in recent decades?

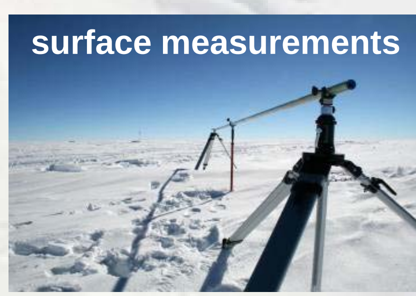
Measurements: snow & firn physical, chemical and electrical properties

7

What is the accumulation rate in East Antarctica, and has it changed in recent decades?

Near-surface spatial variability:
- UAV surveys
- Surface roughness
- Redistribution modeling





8

What is the accumulation rate in East Antarctica, and has it changed in recent decades?

Extrapolation of measurements over larger areas:

Shallow radar & GPS

Satellite imagery

9

What regional climate patterns are evident over the last 1000 years?

Measurements: chemical & isotopic composition of ice cores

10

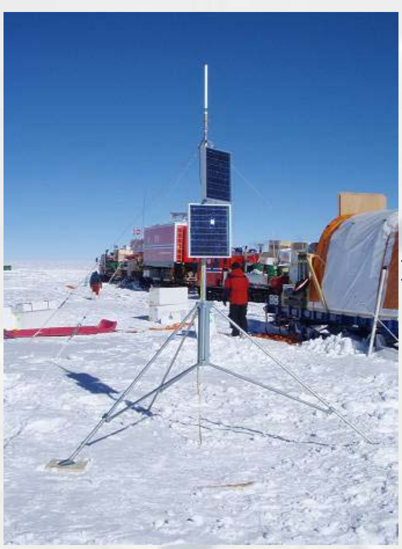
What is the evidence in East Antarctica of anthropogenic activity abroad?

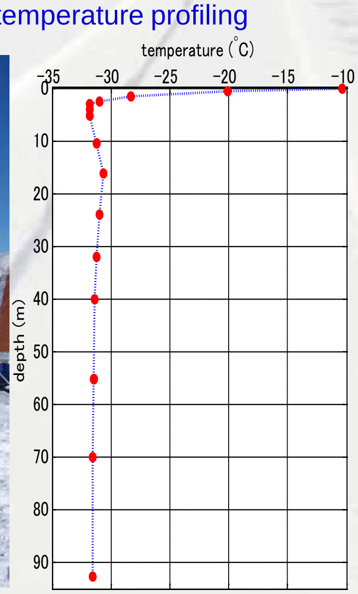
Chemistry of snow and ice contains tracers for industrial pollution
Careful sampling and analysis is essential to avoid contamination!

11

What is the thermal response of East Antarctica to global warming?

Past (30~50 years): Firn temperature profiling





Present and future: AWS

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Overview

- **Why traverse across Antarctica?**
- Pre-traverse planning
- The team and the team's attitude
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The time was right

ICSU
International Council for Science

THE NATIONAL ACADEMIES
Advisors to the Nation on Science, Engineering, and Medicine

INTERNATIONAL POLAR YEAR 2007-2008

WMO

Norges **forskningsråd**

"An intense, internationally coordinated campaign of polar observations, research and analysis that will further our understanding of physical and social processes in polar regions, examine their globally-connected role in the climate system, and establish research infrastructure for the future."

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Overview

- Why traverse across Antarctica?
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Years of Pre-Traverse Planning

Whole-group meetings:

- Tromso Norway May 2005
- Arlington, VA (NSF) Oct 2006
- Jackson NH, June 2007
- Hanover NH, July 2007 (w/ Bentley, Orheim, Clough)
- (traverse year 1: Nov2007 – Feb 2008)
- Tromso Nowary, April 2008
- (traverse year 2: Nov 2008-Feb 2009)
- Fairlee VT, August 2009
- Plus Monthly whole-group teleconferences 2006-2008
- Norwegian development of the vehicle infrastructure 2005-2007

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Years of planning plus pre-departure training contribute to success

Medical training

Safety training

Cargo handling

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Overview

- Why traverse across Antarctica?
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The Team

7: PhD scientists
5: support

3: women
9: men

6: Norwegian
3: American
2: German
1: Japanese

Ages from just under 30 to over 50

Attitude: together we can do it.

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- Why traverse across Antarctica?
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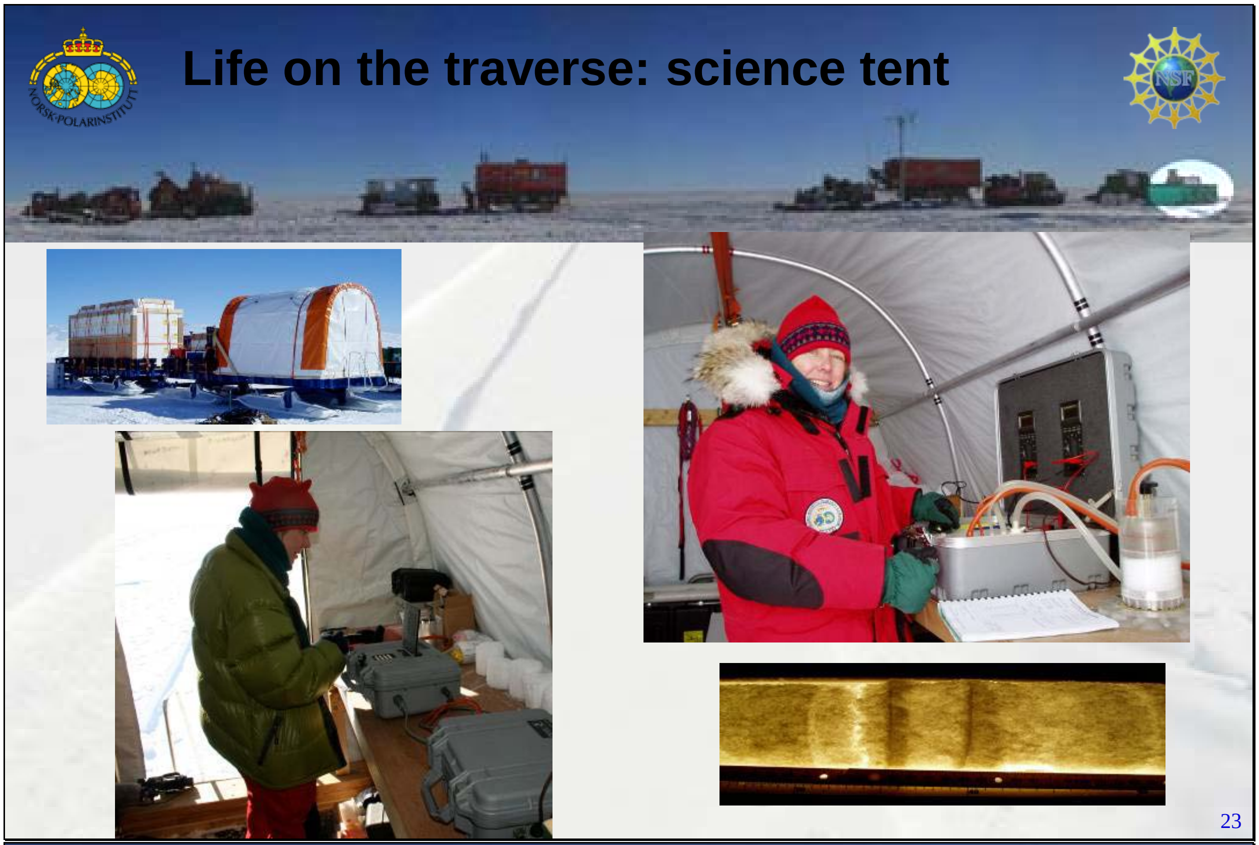
Life on the traverse: living module
NORSK-POLARINSTITUTT
NSF
21


Life on the traverse: sleeping module
NORSK-POLARINSTITUTT
NSF
22


Life on the traverse: science tent
23


Life on the traverse: workshop
24

Special events: Plateau Station

25

Special events: Christmas

26

Special events: New Year

27

Special events: visitors

28

Overview

- Why traverse across Antarctica?
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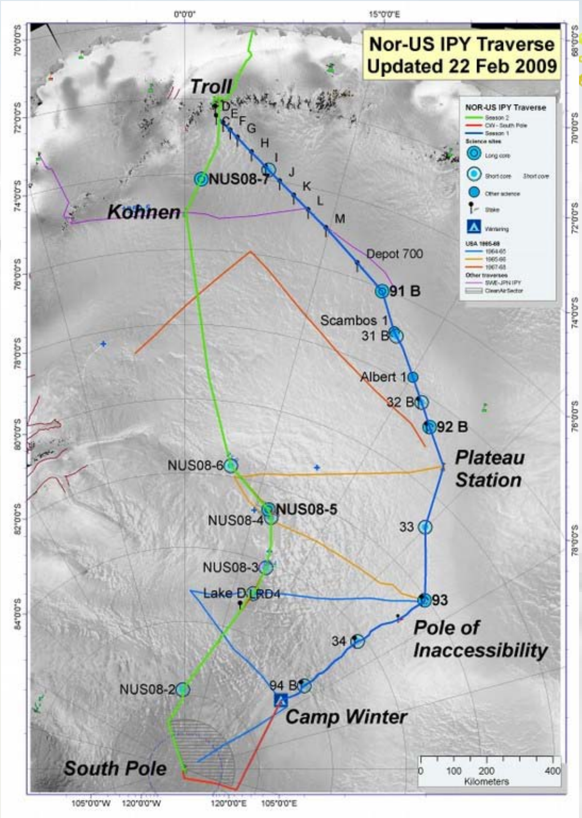
Science & logistics are negotiated decisions



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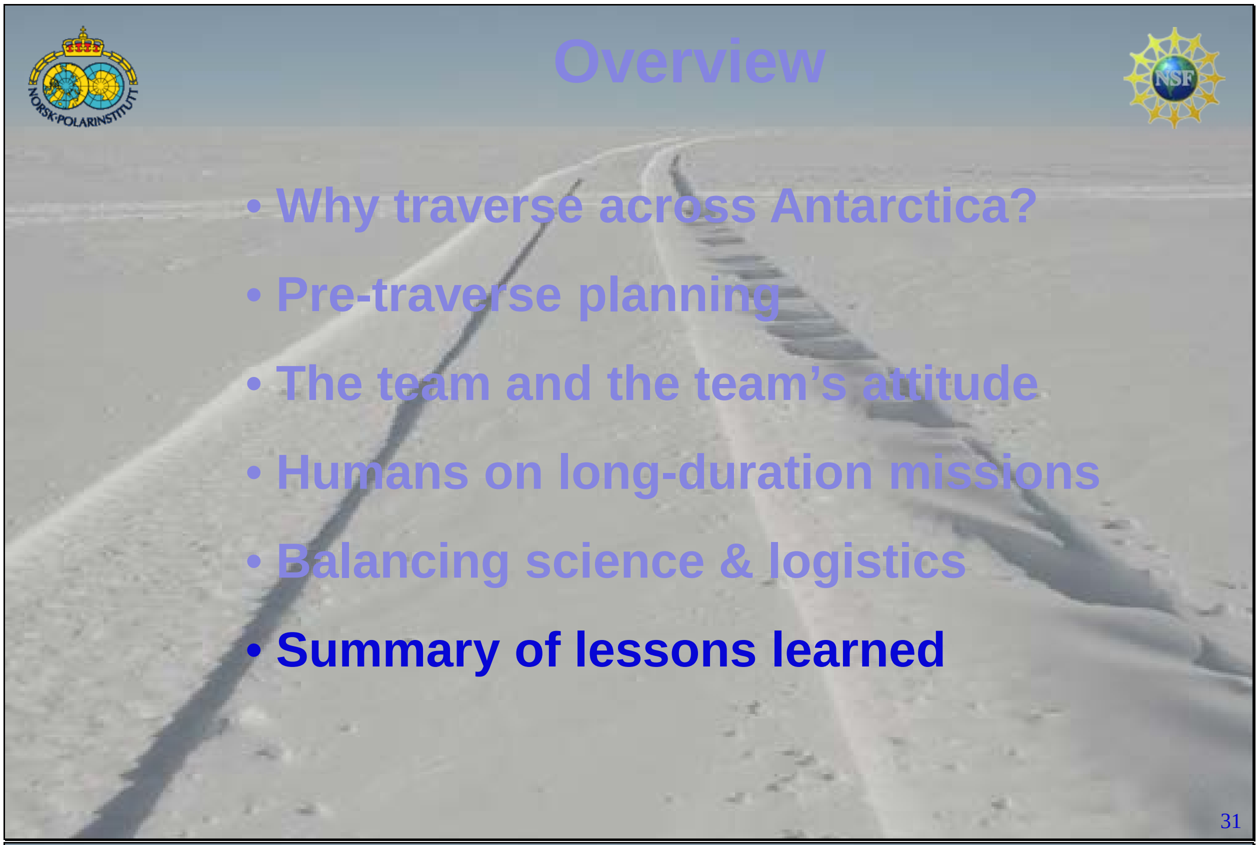
NORSK POLARINSTITUTT
Overview
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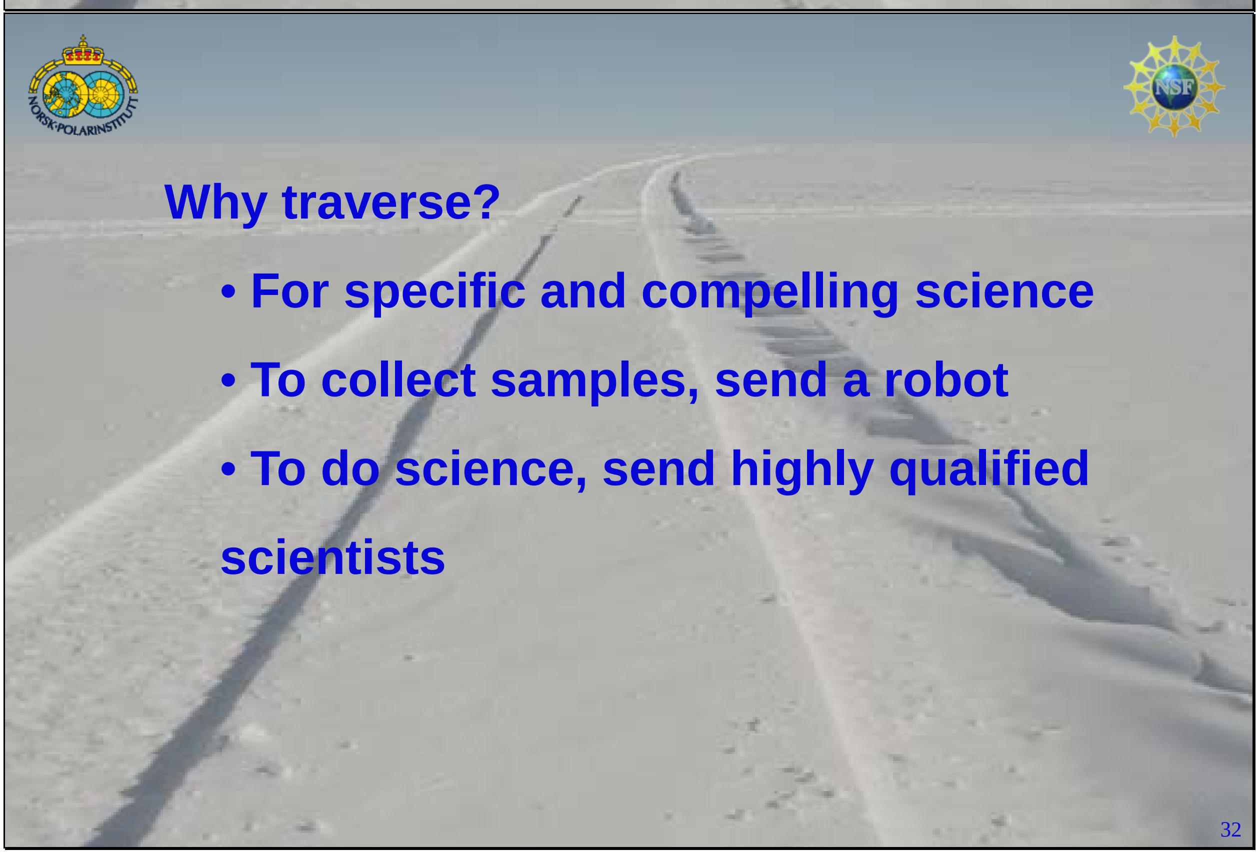
NORSK POLARINSTITUTT
NSF
Why traverse?
• For specific and compelling science
• To collect samples, send a robot
• To do science, send highly qualified scientists
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Pre-traverse planning

- Planning is crucial for all aspects of science, logistical, and human elements
- Planning needs active involvement of everyone on the field team

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The team and the team's attitude

- Highly capable, committed, compassionate people who respect one another and get along
- People who are sincerely interested in and committed to what they are doing, and not just there to rack up a badge.
- Need at least as many scientists as support with no barriers between them; everyone is busy all the time, and all take care of one another.

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Humans on long-duration missions
• A healthy, well fed and well rested team of people who are sincerely interested in what they are doing can successfully continue for a long time.
• Periodic private communication with home is important and makes a difference
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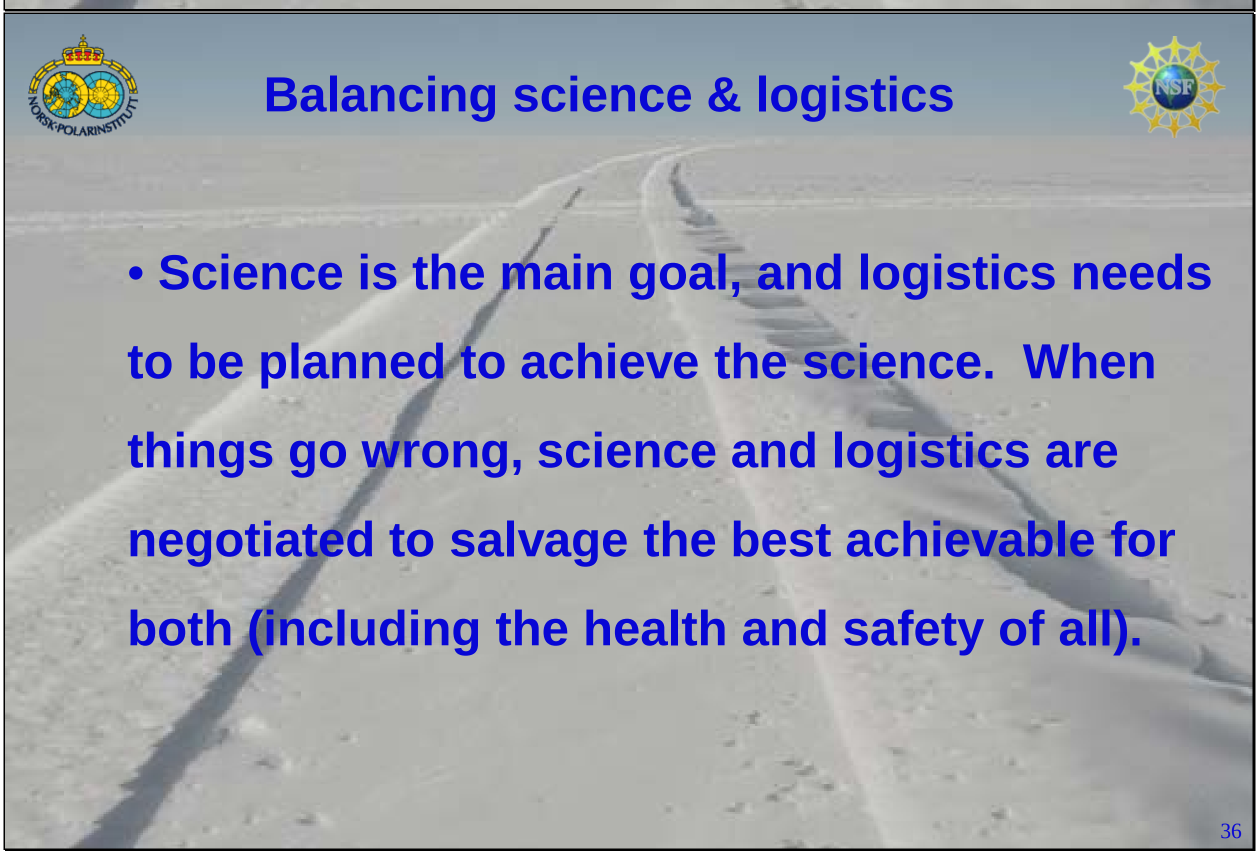

Balancing science & logistics
• Science is the main goal, and logistics needs to be planned to achieve the science. When things go wrong, science and logistics are negotiated to salvage the best achievable for both (including the health and safety of all).
36

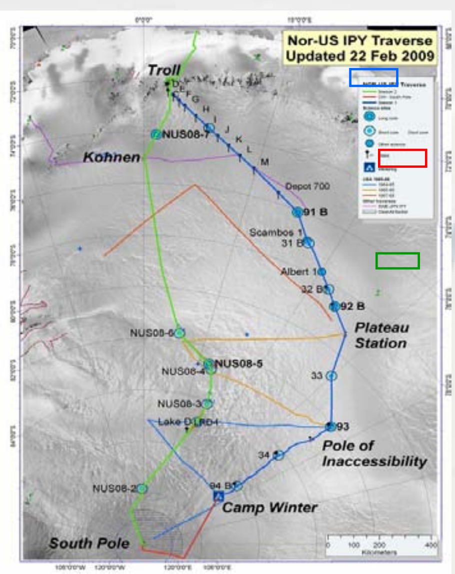
Acknowledgments

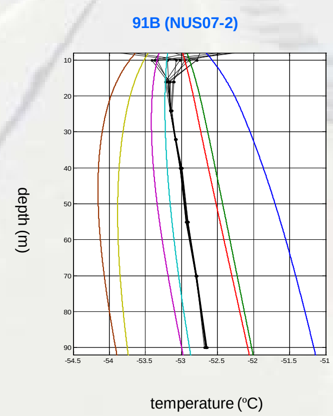
- U.S. National Science Foundation
- Research Council of Norway
- Air National Guard
- ACLI
- Safair
- Raytheon
- Crews at Troll, Amundsen-Scott, and McMurdo Stations
- Capt Edward A Murphy

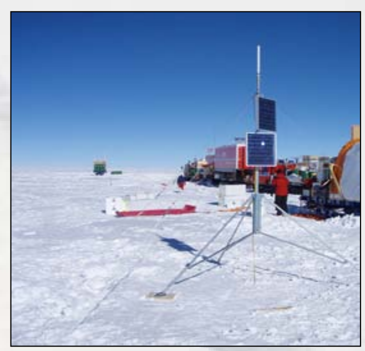
- and a long list of individuals and institutes who provided advice, inspiration, information, and other kinds of assistance

37

Preliminary Results: East Antarctica near the ice divide has warmed over the past few decades

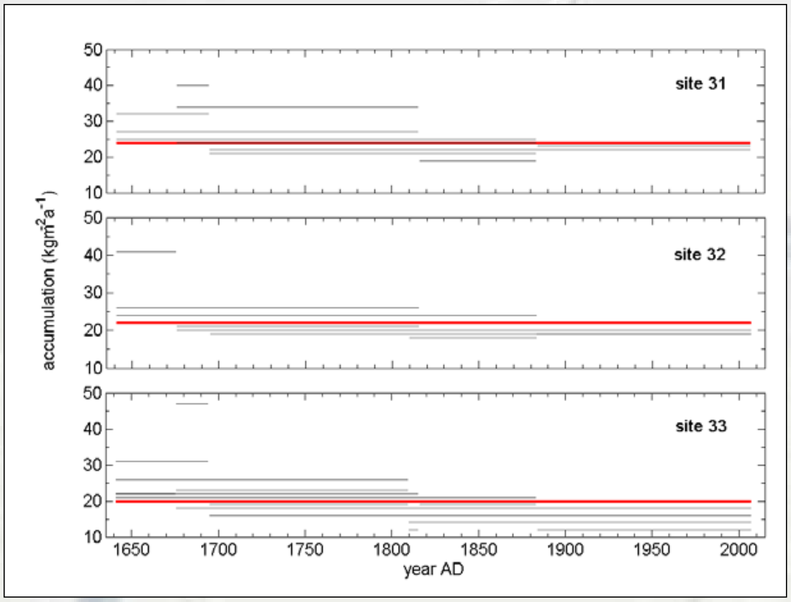






Muto, Scambos, Steffen,
Excerpts from a poster at AGU, 2008 38

Preliminary results: East Antarctic accumulation shows decreasing trend after ~1800



Site 31:
24 mm/yr w.e

Site 32:

22 mm/yr w.e

Site 33:

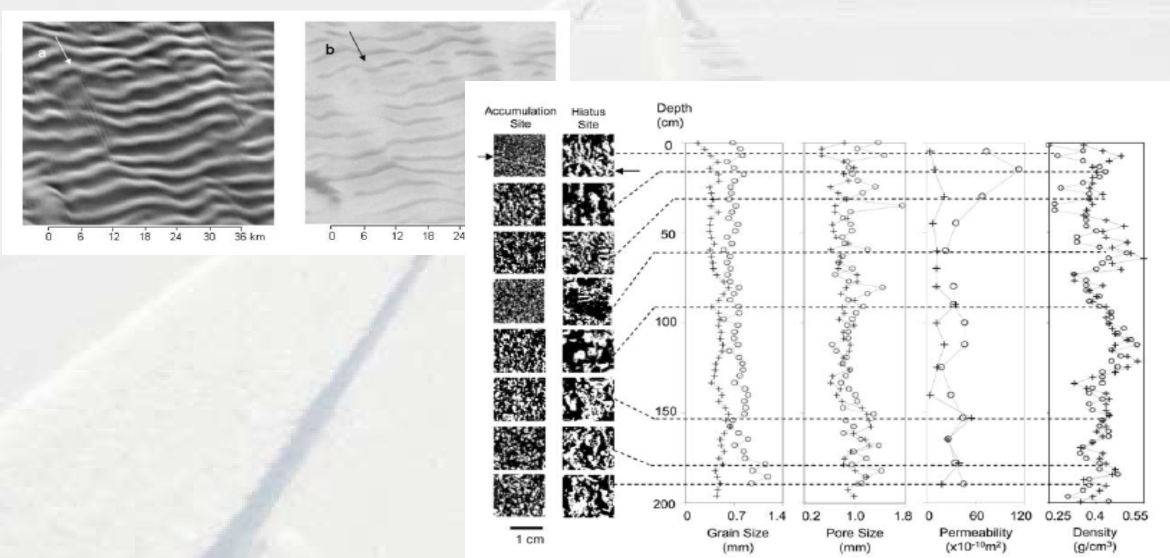
20 mm/yr w.e

All sites showed decreasing trend

Anschütz et al., manuscript in preparation

39

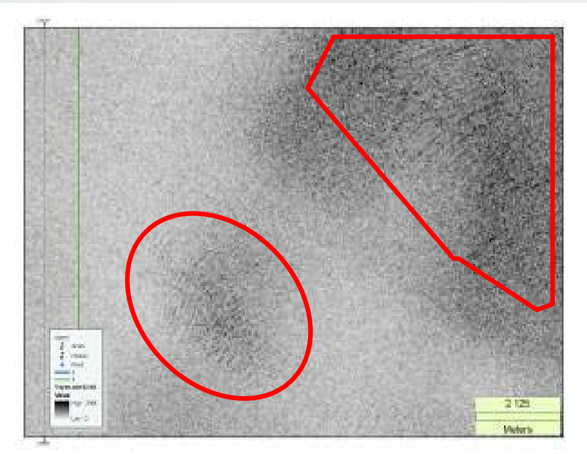
Preliminary results: Accumulation rate can be mapped from satellite images of firn properties



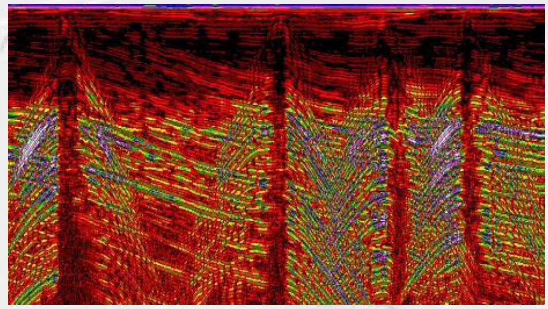
Albert et al, manuscript in preparation

40

Safety: Crevasse detection



Pre-traverse route planning used satellite imagery to identify possible crevassed areas



”The sniffer”, a 400 MHz GPR