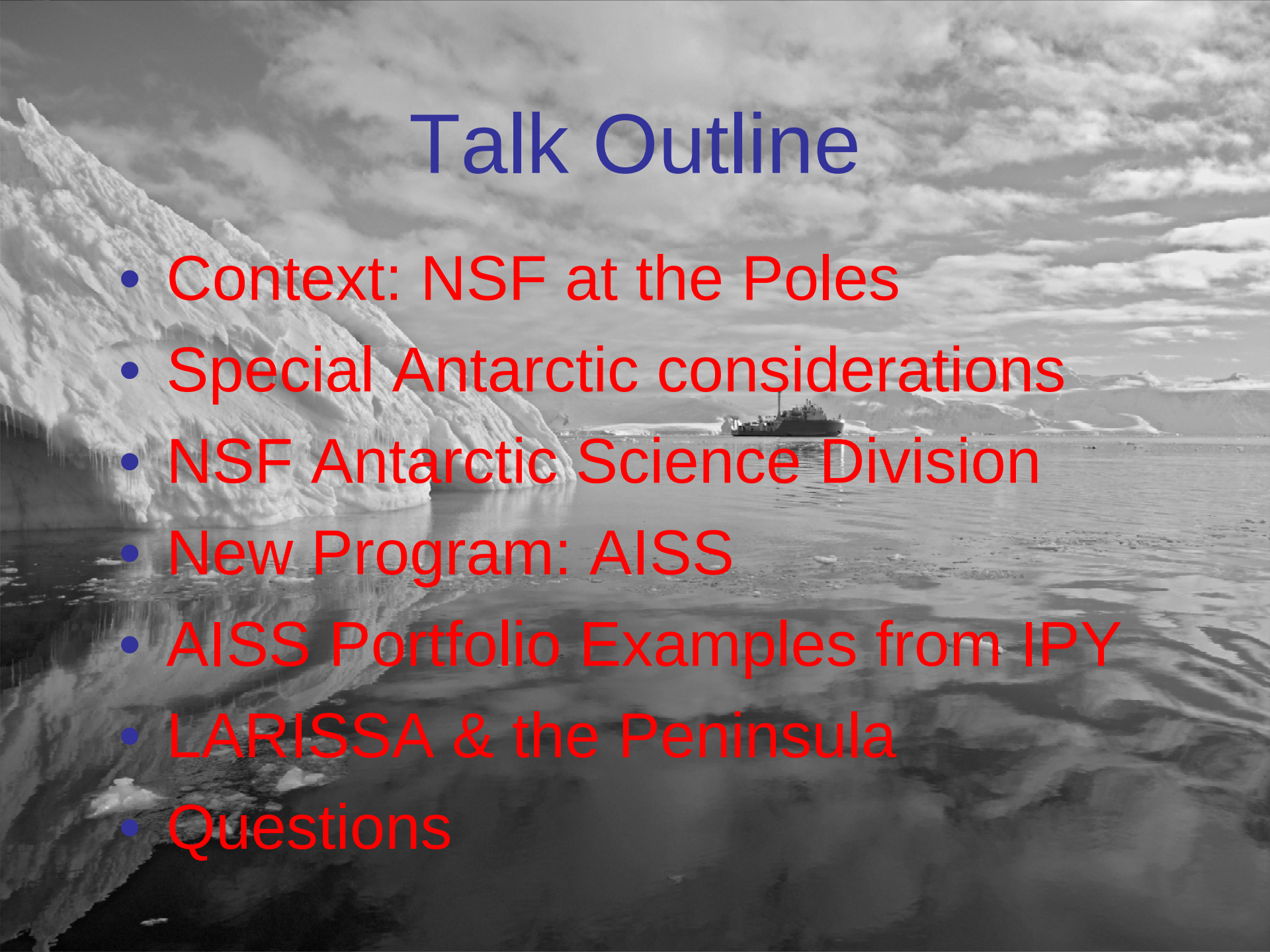
Antarctic Integrated System Science

The Antarctic Peninsula

Dr. Kelly Falkner, Program Director
NSF Office of Polar Programs
aka Professor, Oregon State University



Talk Outline

- Context: NSF at the Poles
- Special Antarctic considerations
- NSF Antarctic Science Division
- New Program: AISS
- AISS Portfolio Examples from IPY
- LARISSA & the Peninsula
- Questions

NSF Polar Responsibilities

National Science Foundation – ($FY09)

- Manages U.S. Antarctic Program on behalf of U. S. Government (includes meeting Antarctic Conservation Act requirements), supports U.S. research in Antarctic and provides $312 million for basic Antarctic research ($65 million) and logistics ($247 million)

- Chairs Interagency Arctic Research Policy Committee (to coordinate Federal Arctic research) and provides $98 million for basic Arctic research ($57 million) and logistics ($41 million).

NSF Office of Polar Programs

Karl Erb

Arctic Science (ARC)
Simon Stephenson

Antarctic Science (ANT)
Scott Borg

Antarctic Infrastructure & Logistics (AIL)
Brian Stone, Acting

Polar Environment, Health and Safety (PEHS)
Mike Montopoli

Antarctic Treaty System

- Treaty signed 1959, entered into force 1961
- Reserved for peaceful uses, commitment to conservation, environmental protection, and scientific research
- Territorial claims in abeyance
- Currently 47 nations party to the treaty
- 29 nations have active scientific programs

Decision Documents

White House Memorandum 6646 (1982)

- NSF shall:

- budget for and manage the entire United States National Program in Antarctica…
- draw upon logistic support capabilities of government agencies on a cost reimbursable basis…
- use commercial support and management facilities where these are determined to be cost-effective…
- provide U. S. presence in Antarctica, including;
  - year-round occupation of South Pole and two coast stations
  - full logistics support to over 650 scientists in Antarctica

Presidential Decision Directive NSF-26 (1994)

- Protect the Antarctic environment
- Protect opportunities for scientific research
- Maintain Antarctica as an area of international cooperation
- Conserve living resources in the oceans surrounding Antarctica

Implementation of Policy

U. S. Antarctic Program **-** supports U.S. Antarctic policy through implementation of scientific research in cooperation with:

- Other Federal civilian agencies
  - science: NASA, NOAA, USGS
  - regulatory: EPA, DOS, NOAA
- Department of Defense, U.S. Coast Guard
- Contractors
- Foreign partners

Antarctic Science Division

Division Director Scott G. Borg

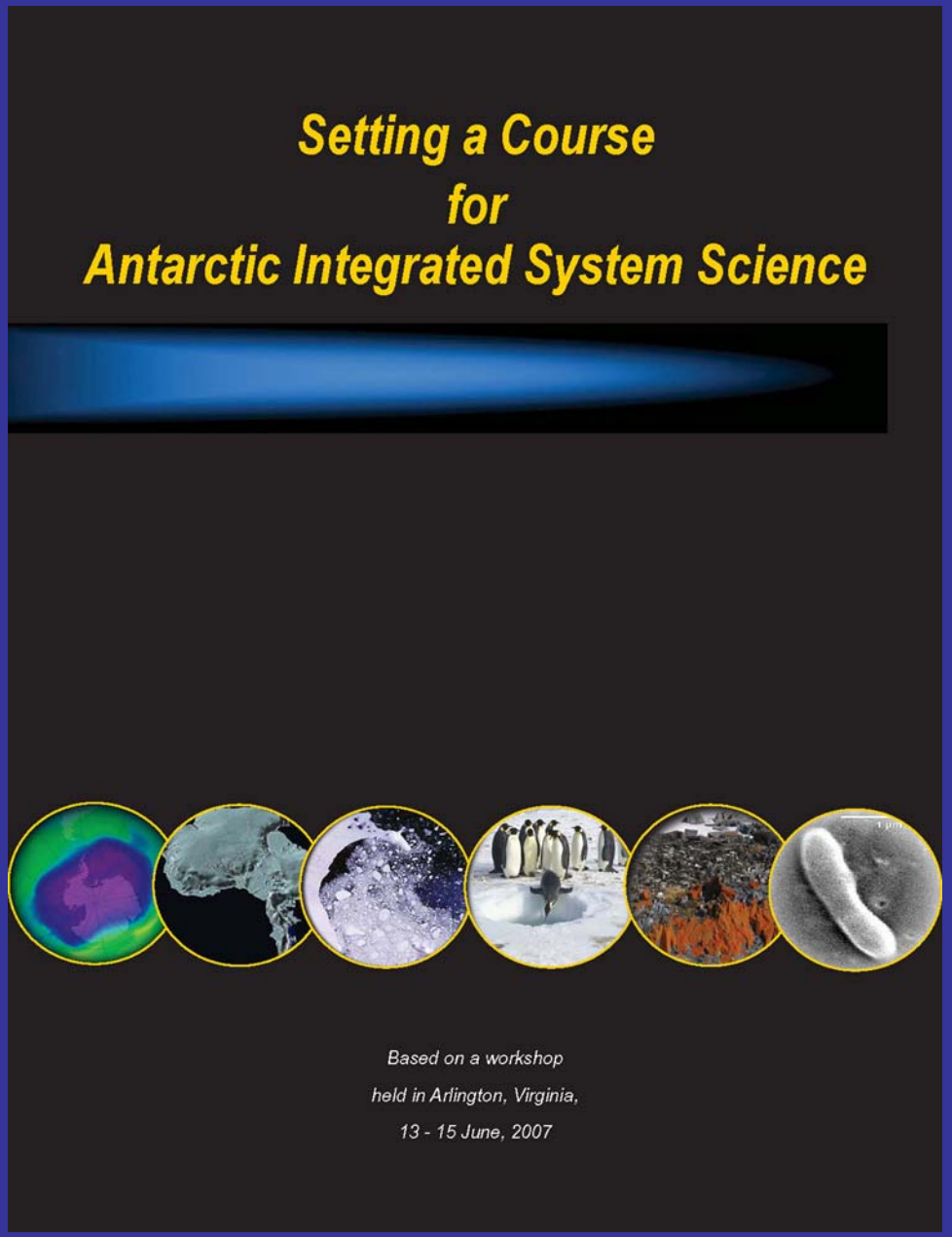
Programs & Directors

- **Aeronomy & Astrophysics Sciences Vladimir Papitashvili**
- **Earth Sciences position open applications due 4 May 09**
- **Glaciology Julie M. Palais**
- **Integrated System Science Kelly K. Falkner**
- **Ocean & Atmospheric Sciences Peter Milne**
- **Organisms & Ecosystems Roberta L. Marinelli**
- **Antarctic Artists and Writers under review**
- **Web Manager Winifred M. Reuning**
- **Program Coordination Specialist Desiree Marshall**
- **Program Specialist Elana Khanna**

AISS Workshop Report

http://cresp.tamu.edu/AISSWorkshop

attended by 40 scientists representing broad spectrum of earth & environmental research fields, institutions and career stages



AISS Workshop Report Highlights

Recent advances and demonstrated linkages within Antarctica and to the rest of the globe provide the impetus for a program to facilitate Antarctic science focused on questions that transcend disciplinary boundaries.

AISS projects are highly integrated, involve more than one discipline and address questions broader in scope than those typically supported by disciplinary Antarctic programs.

The enriched polar science landscape that AISS is poised to foster promises to be an important legacy of IPY 2007-2008.

Sea-level rise potential of present-day glaciers

Modified from Williams and Hall (1993) Glaciers in Chapter on the Cryosphere, Gurney, Foster and Parkinson, eds., Atlas of Earth Observations Related to Global Change, Cambridge University Press, p. 401-422.

Location	Volume (km^3)	Potential sea-level rise meters (feet)
East Antarctic ice sheet	26,039,200	64.8 (213)
West Antarctic ice sheet	3,262,000	8.1 (26.6)
Antarctic Peninsula	227,100	0.5 (1.6)
Greenland	2,620,000	6.6 (21.7)
Other	180,000	0.5 (1.6)
Total	32,328,300	80.5 (264)

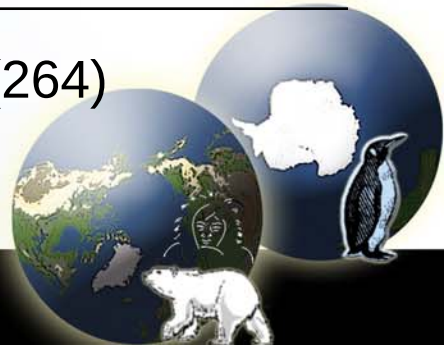


Table 4.1: *Area, volume and sea level equivalent (SLE) of cryospheric components. Indicated are the annual minimum and maximum for snow, sea ice and seasonally frozen ground, and the annual mean for the other components. The sea ice area is represented by the extent (area enclosed by the sea ice edge). The values for glaciers and ice caps denote the smallest and largest estimates excluding glaciers and ice caps surrounding Greenland and Antarctica.*

Cryospheric Component	Area (10^6 km^2)	Ice Volume (10^6 km^3)	Potential Sea Level Rise (SLE) (m)[g]
Snow on land (NH)	1.9–45.2	0.0005–0.005	0.001–0.01
Sea ice	19–27	0.019–0.025	~0
Glaciers and ice caps			
Smallest estimate[a]	0.51	0.05	0.15
Largest estimate[b]	0.54	0.13	0.37
Ice shelves[c]	1.5	0.7	~0
Ice sheets	14.0	27.6	63.9
Greenland[d]	1.7	2.9	7.3
Antarctica[c]	12.3	24.7	56.6
Seasonally frozen ground (NH)[e]	5.9–48.1	0.006–0.065	~0
Permafrost (NH)[f]	22.8	0.011–0.037	0.03–0.10

Notes:

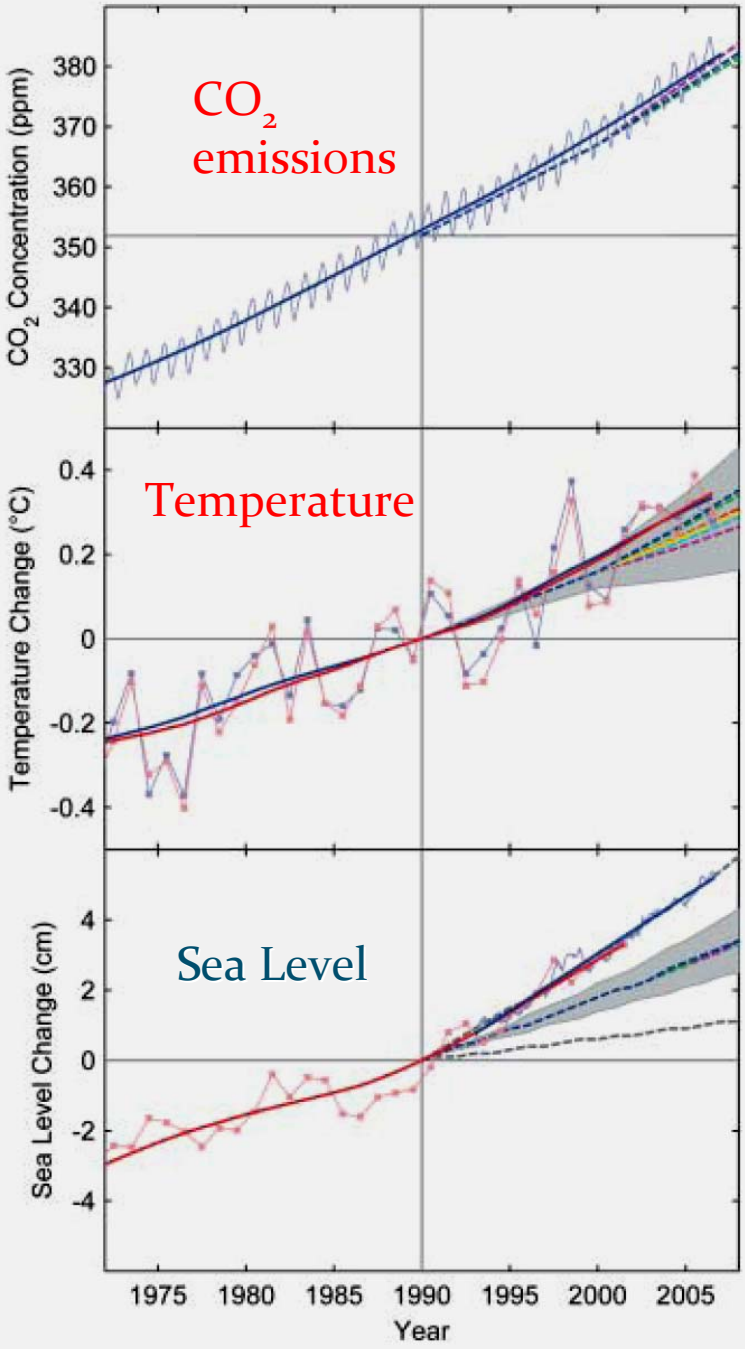
[a] Ohmura (2004); glaciers and ice caps surrounding Greenland and Antarctica are excluded.
[b] Dyurgerov and Meier (2005); glaciers and ice caps surrounding Greenland and Antarctica are excluded.
[c] Lythe et al. (2001).
[d] Bamber et al. (2001).
[e] Zhang et al. (2003).
[f] Zhang et al. (1999) , excluding permafrost under ocean, ice sheets and glaciers.
[g] Assuming an oceanic area of 3.62×10^8 km^2, an ice density of 917 kg m^{-3}, a seawater density of 1,028 kg m^{-3}, and seawater replacing grounded ice below sea level.

SCIENCE VOL 316 4 MAY 2007

Recent Climate Observations Compared to Projections

Stefan Rahmstorf,[1] Anny Cazenave,[2] John A. Church,[3] James E. Hansen,[4] Ralph F. Keeling,[5] David E. Parker,[6] Richard C. J. Somerville[5]

Fig. 1. Changes in key global climate parameters since 1973, compared with the scenarios of the IPCC (shown as dashed lines and gray ranges). (**Top**) Monthly carbon dioxide concentration and its trend line at Mauna Loa, Hawaii (blue), up to January 2007, from Scripps in collaboration with NOAA. ppm, parts per million. (**Middle**) Annual global-mean land and ocean combined surface temperature from GISS (red) and the Hadley Centre/Climatic Research Unit (blue) up to 2006, with their trends. (**Bottom**) Sea-level data based primarily on tide gauges (annual, red) and from satellite altimeter (3-month data spacing, blue, up to mid-2006) and their trends. All trends are nonlinear trend lines and are computed with an embedding period of 11 years and a minimum roughness criterion at the end (*6*), except for the satellite altimeter where a linear trend was used because of the shortness of the series. For temperature and sea level, data are shown as deviations from the trend line value in 1990, the base year of the IPCC scenarios.



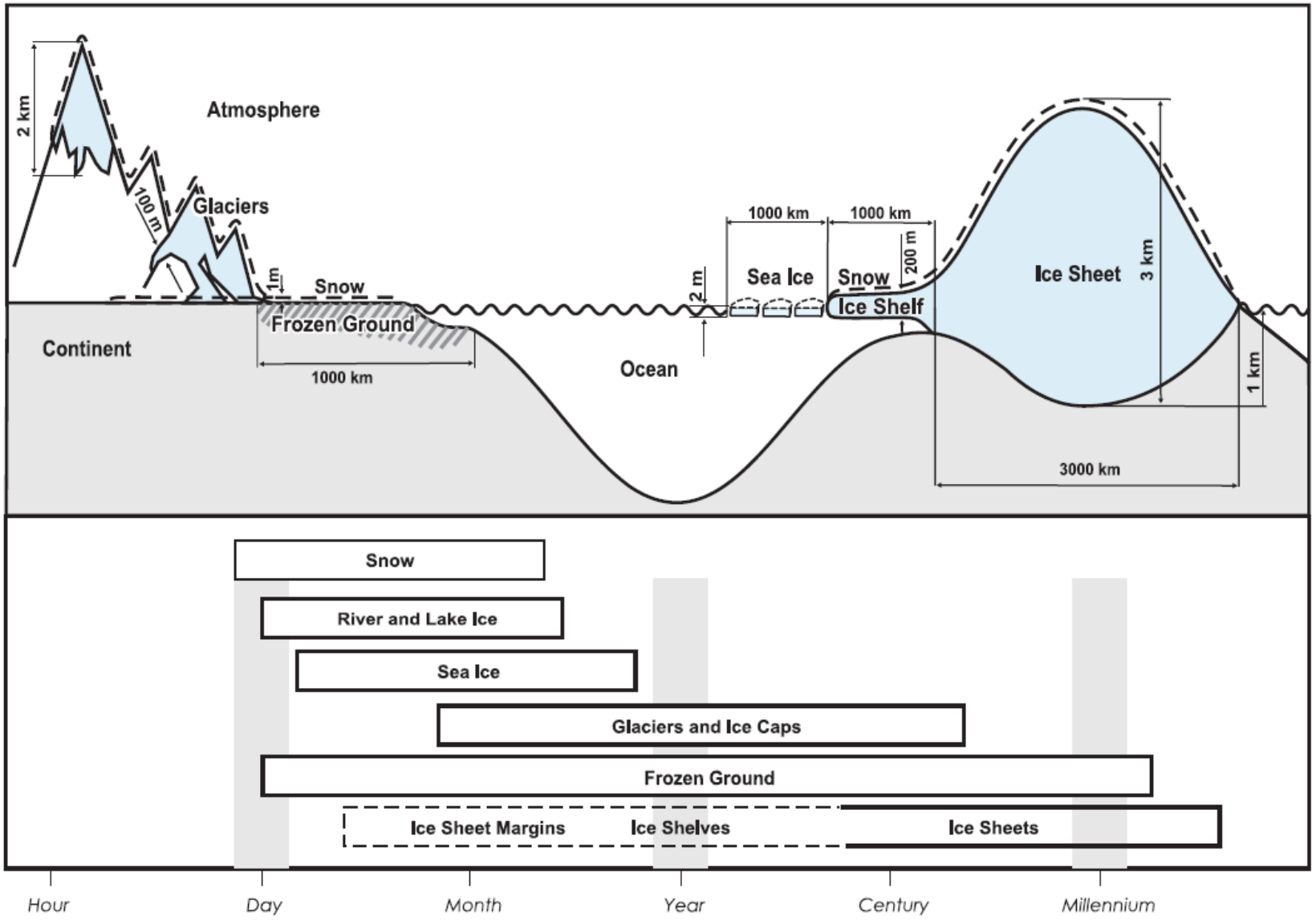
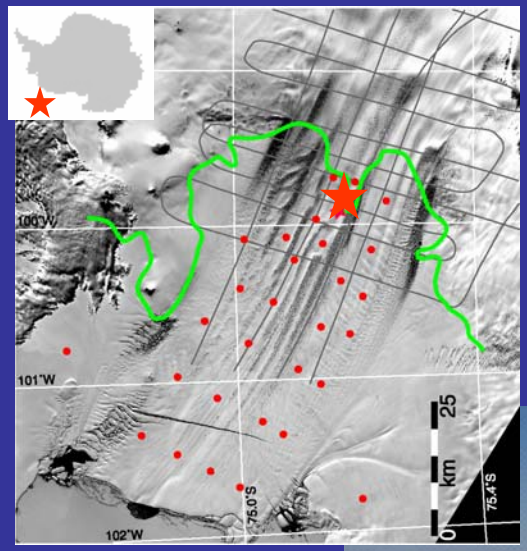


Figure 4.1. *Components of the cryosphere and their time scales.*

COLLABORATIVE RESEARCH; IPY: Ocean-Ice Interaction in the Amundsen Sea Sector of West Antarctica

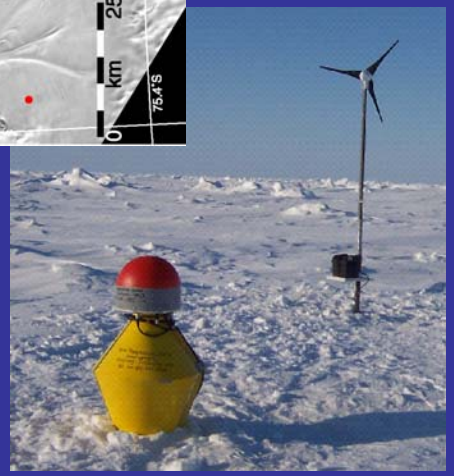
Integrated oceanographic and glaciological field studies linked with local and regional-scale modeling activities to advance prediction of future sea level change due to ice sheet behavior, particularly the active portion that drains into the Amundsen Sea



Depth of ocean cavity beneath ice shelf at 29 seismic stations requires helicopter support.

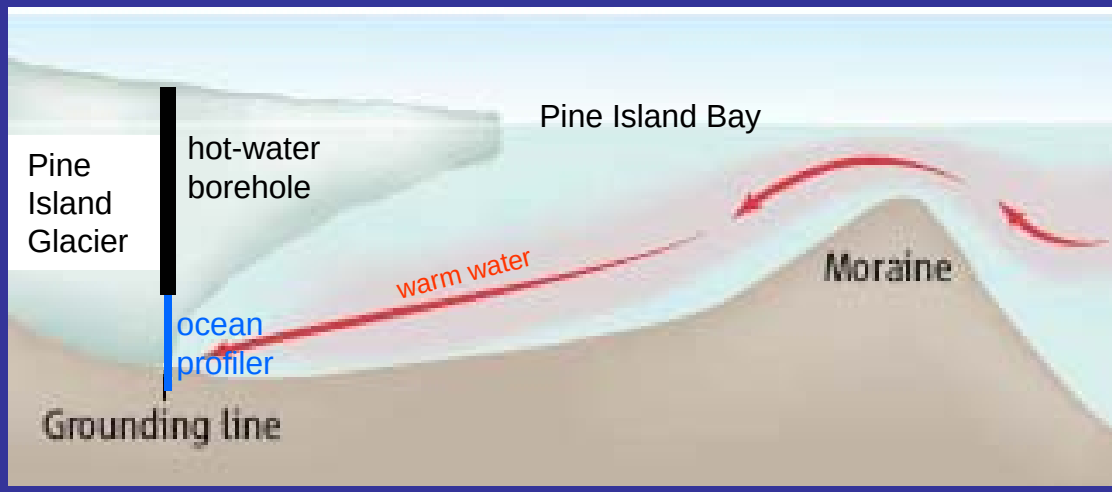
8 institutions, 13 investigators, 2 countries and 3 funding sources:

NASA: R. Bindschadler (PI) and A. Behar 25K (+683K, NASA)
New York University: D. Holland 596K (+79K, NASA)
Naval Postgraduate School: Tim Stanton and W. Shaw 1,484K
University of Alaska: M. Truffer 551K
Penn State: S. Anandakrishnan 254K
McPhee Research Corporation: M. McPhee 199K
British Antarctic Survey: D. Vaughan, A. Jenkins, A. Smith and H. Corr
University of Bristol: A. Payne



Wind-vane powered Iridium phone (inside surface pod) will transmit data and receive control commands to modify data collection from sub-shelf profilers

Four ice boreholes through 550-m thick ice shelf will permit video-camera exploration of sub-shelf environment and deployment of new oceanographic profilers to measure evolving water properties for up to three years.

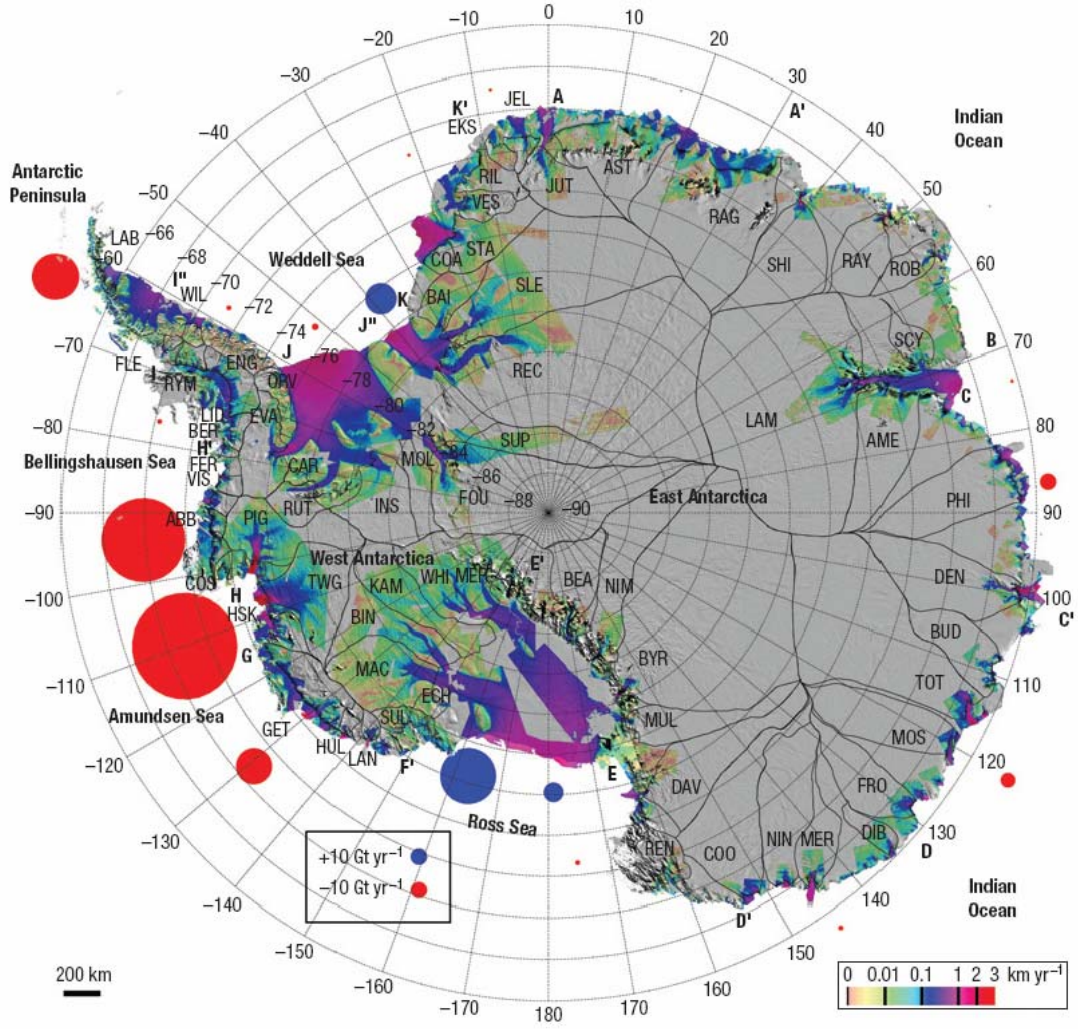


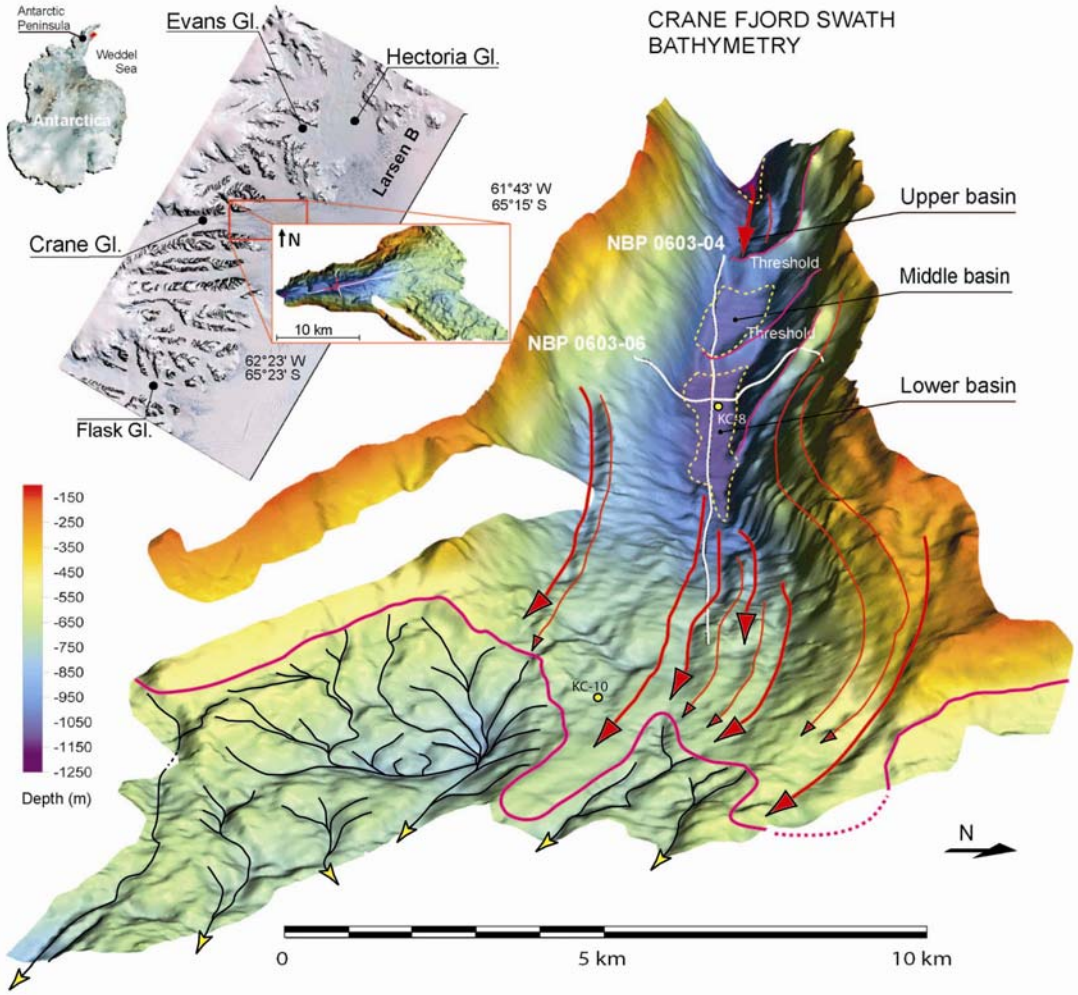
NSF NASA

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rignot et al. (Nature, 2008)

"In the Peninsula, **losses increased by 140%** to reach 60±46 Gt yr−1 in 2006. Losses are concentrated along narrow channels occupied by outlet glaciers and are caused by ongoing and past glacier acceleration."



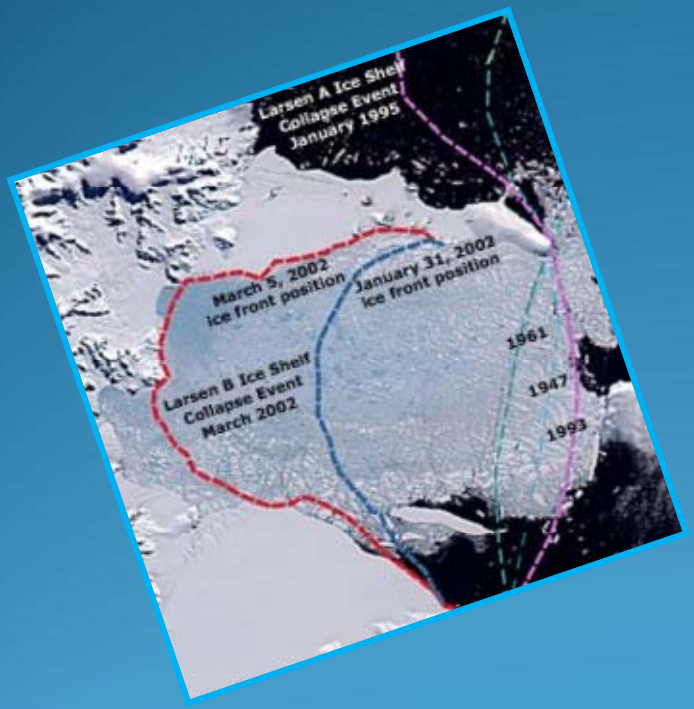


Ice volume estimates are on the low side (30%) potential contribution to sl change on low side

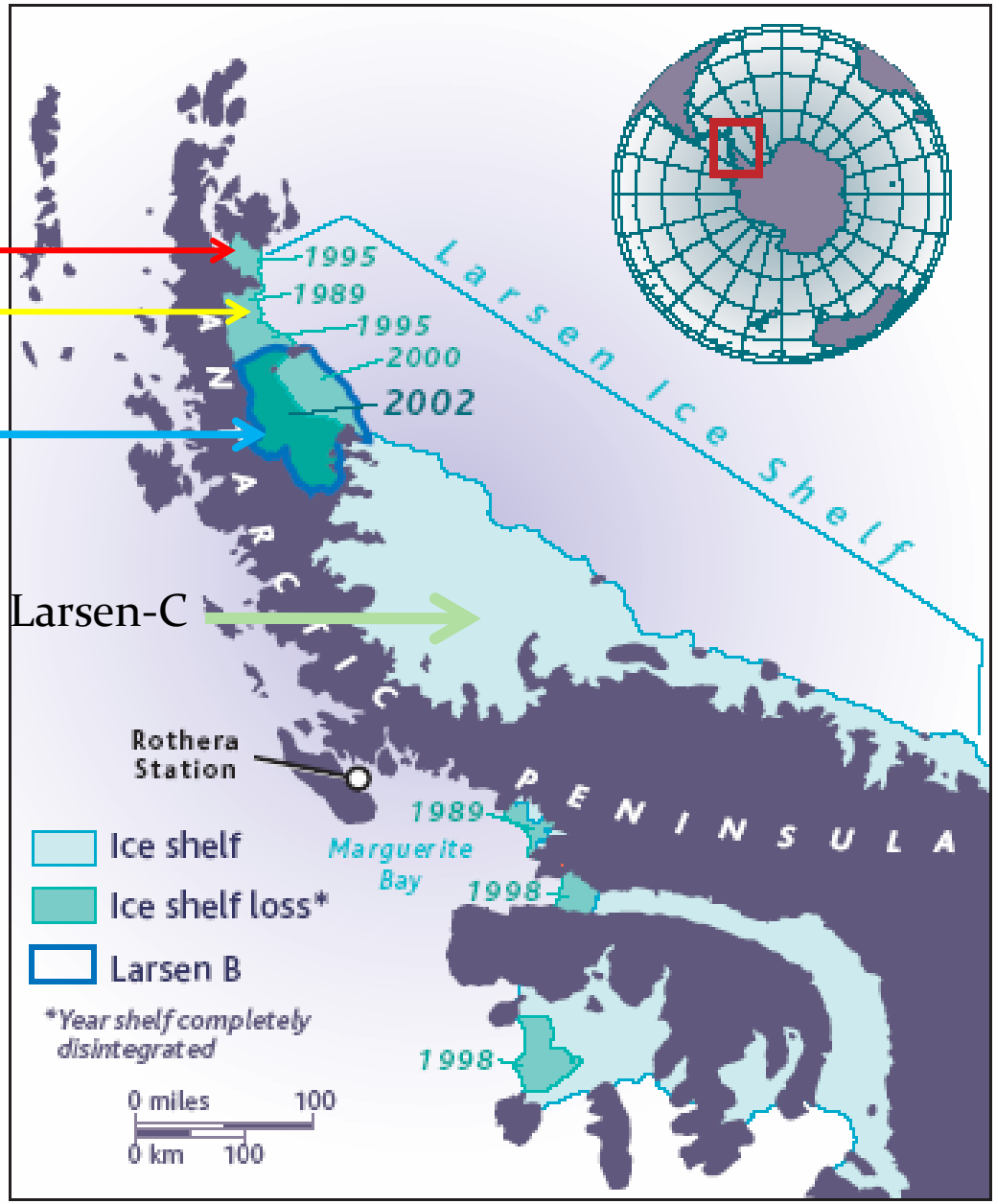
Prince Gustav

Larsen-A

Larsen-B



Larsen-C



Falling like dominoes. The Antarctic Peninsula has lost large chunks of its ice shelves to climate warming in recent years.

Collaborative Research in IPY: Abrupt Environmental Change in The Larsen Ice Shelf Region A Multidisciplinary Approach

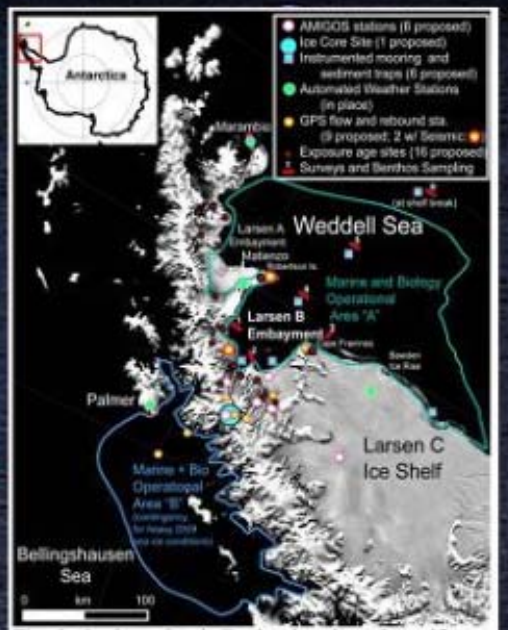
-Marine & Quaternary Geosciences
(Domack, Leventer, Brachfeld, Ishman, Wellner, Balco)

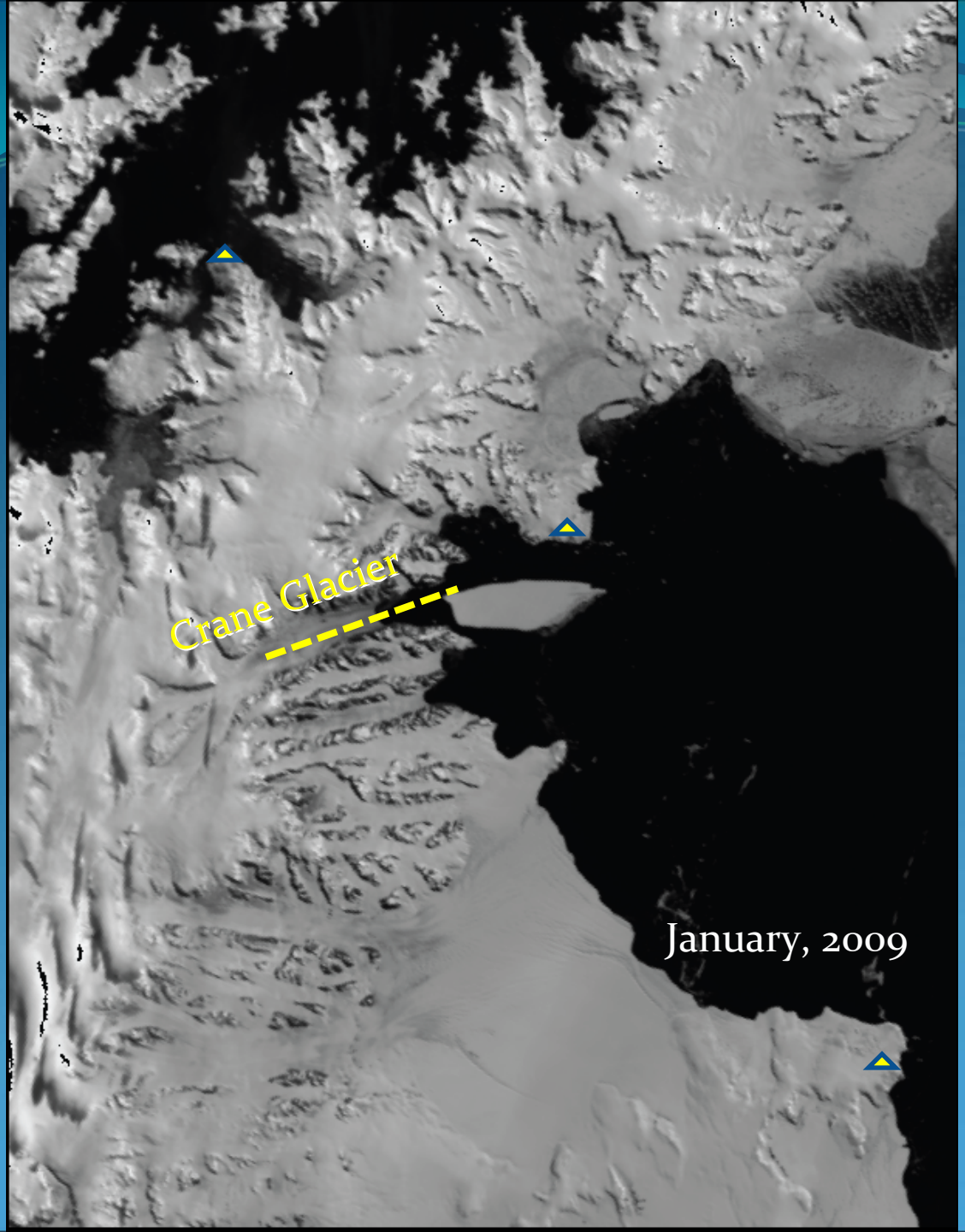
-Cryosphere & Oceans
(Scambos, Pettit, Truffer, Thompson & Mosley-Thompson, Gordon, Huber)

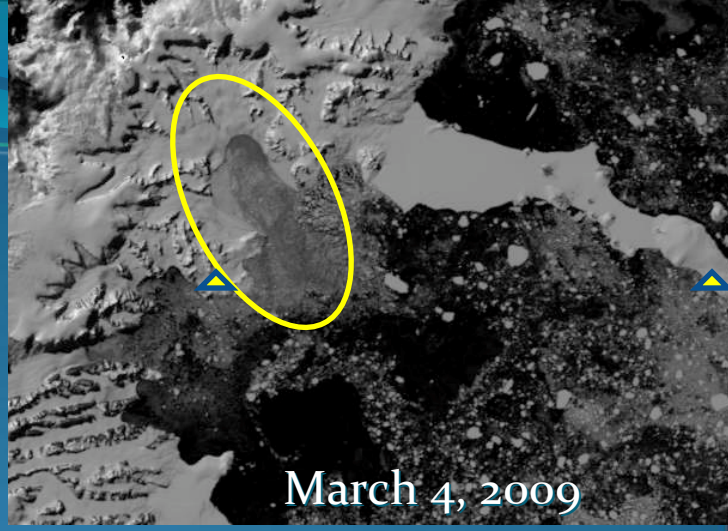
-Marine Ecosystems
(Vernet, VanDover, Smith, McCormick)

Funded International Partners
Belgium-Ghent University
Argentina-Argentine Antarctic Institute

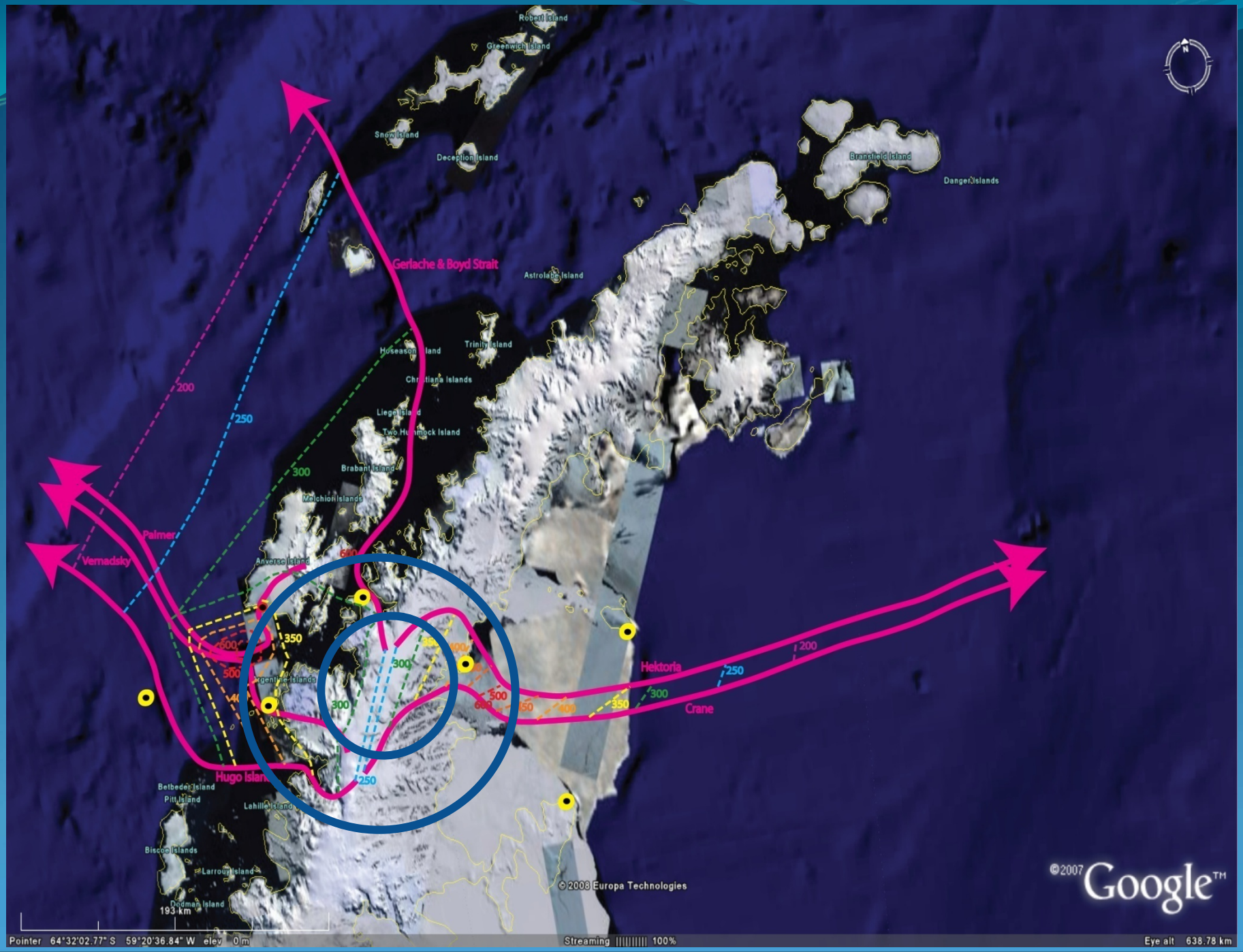
media link




Crane Glacier
January, 2009


March 4, 2009


March, 2002
Photo courtesy of NASA/GSFC/LaRC/JPL, MISR Team


Robert Island
Greenwich Island
Snow Island
Deception Island
Bransfield Island
Danger Islands
Gerlache & Boyd Strait
Astrolabe Island
Trinity Island
Christiana Islands
Liege Island
Two Hummock Island
Brabant Island
Melchior Islands
Palmer
Vernadsky
Anvers Island
Hektoria
Crane
Hugo Island
Betbeder Island
Pitt Island
Lehille Island
Biscoe Islands
Larrouy Island
Dodman Island
193 km
200
250
300
350
400
500
600
© 2008 Europa Technologies
©2007 Google™
Pointer 64°32'02.77" S 59°20'36.84" W elev 0 m
Streaming 100%
Eye alt 638.78 km

What will the GPS rebound stations take into account?

Tectonic movement, 12-15 mm/yr to NNE, coherent across entire Peninsula from SCAR campaign, **subtract** this vector from new data to resolve:

1)Isostatic rebound, decelerates over long term, ka constant over short term, magnitude function of time since ice removal and ice thickness.

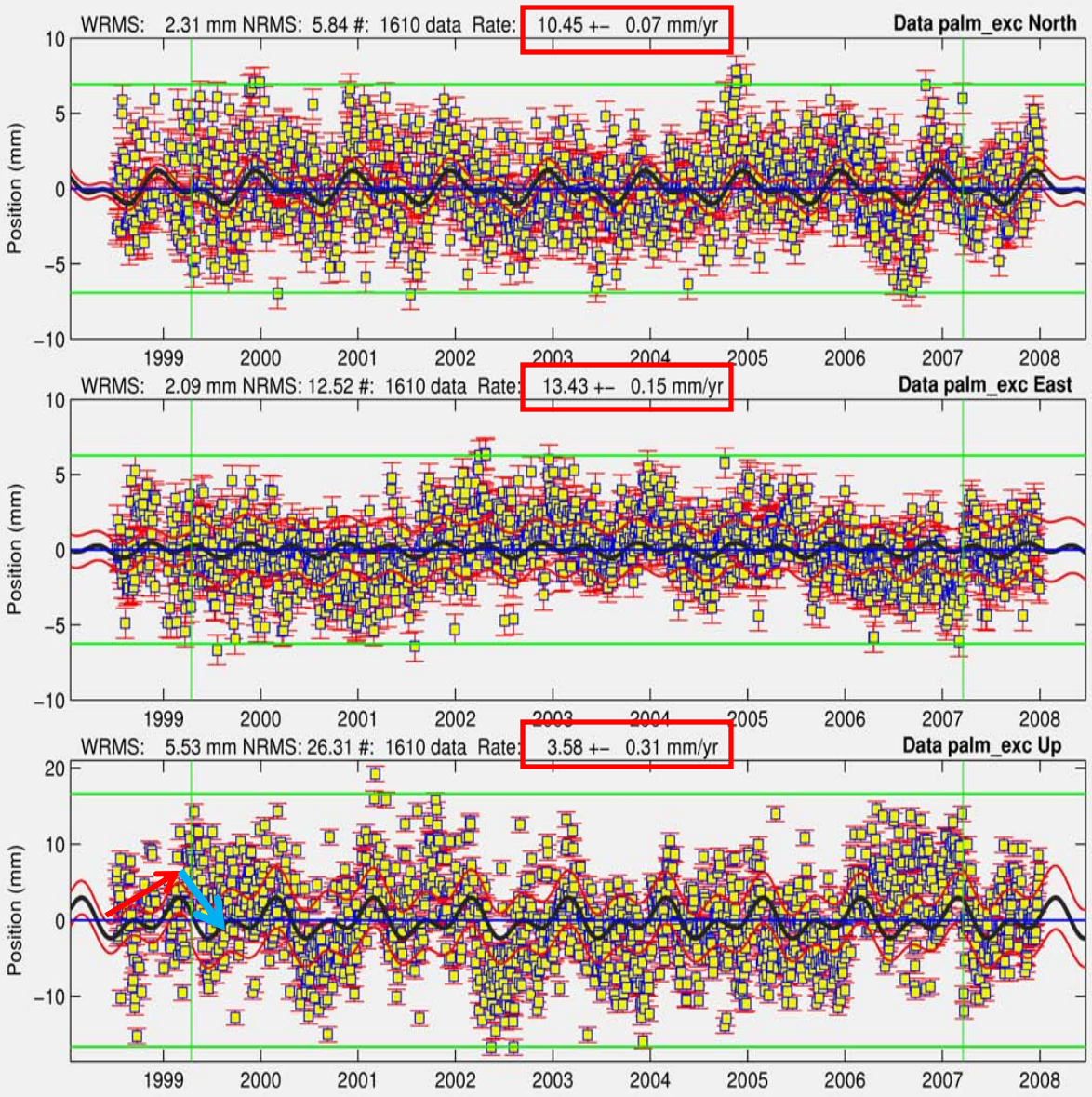
2)Modern ice deloading (melting and calving) will accelerate rebound in short term.

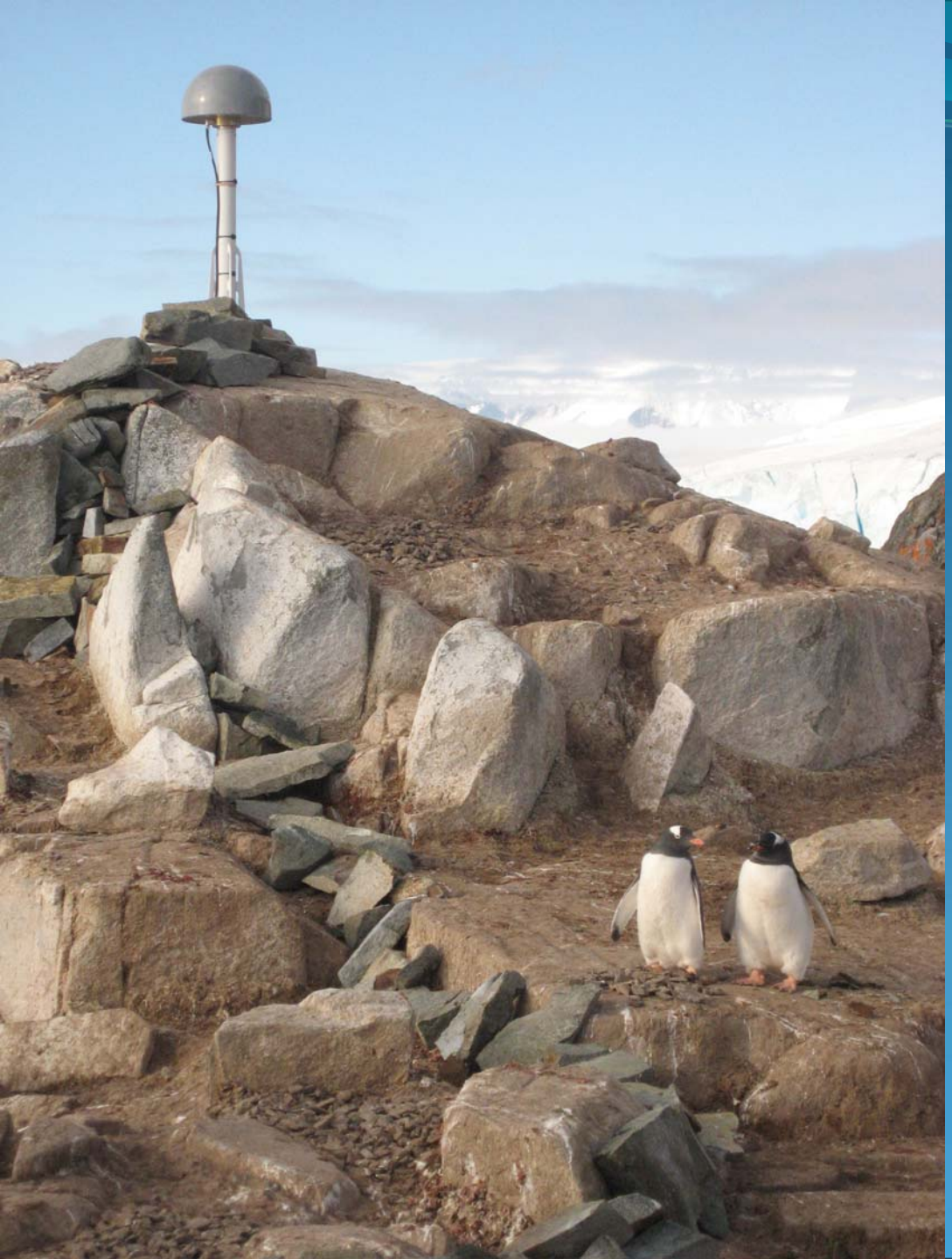
Palmer Station GPS Data

northward

eastward

vertical





LARISSA

Phase 1 complete:
LMG-0903

Phase 2:
Cruise NPB & helos
Jan-Feb 2010

Ice Core
Fixed wing via Rothera
Jan-Feb 2010

Phase 3:
Instrument recovery
2012 and/or 2013


Questions??