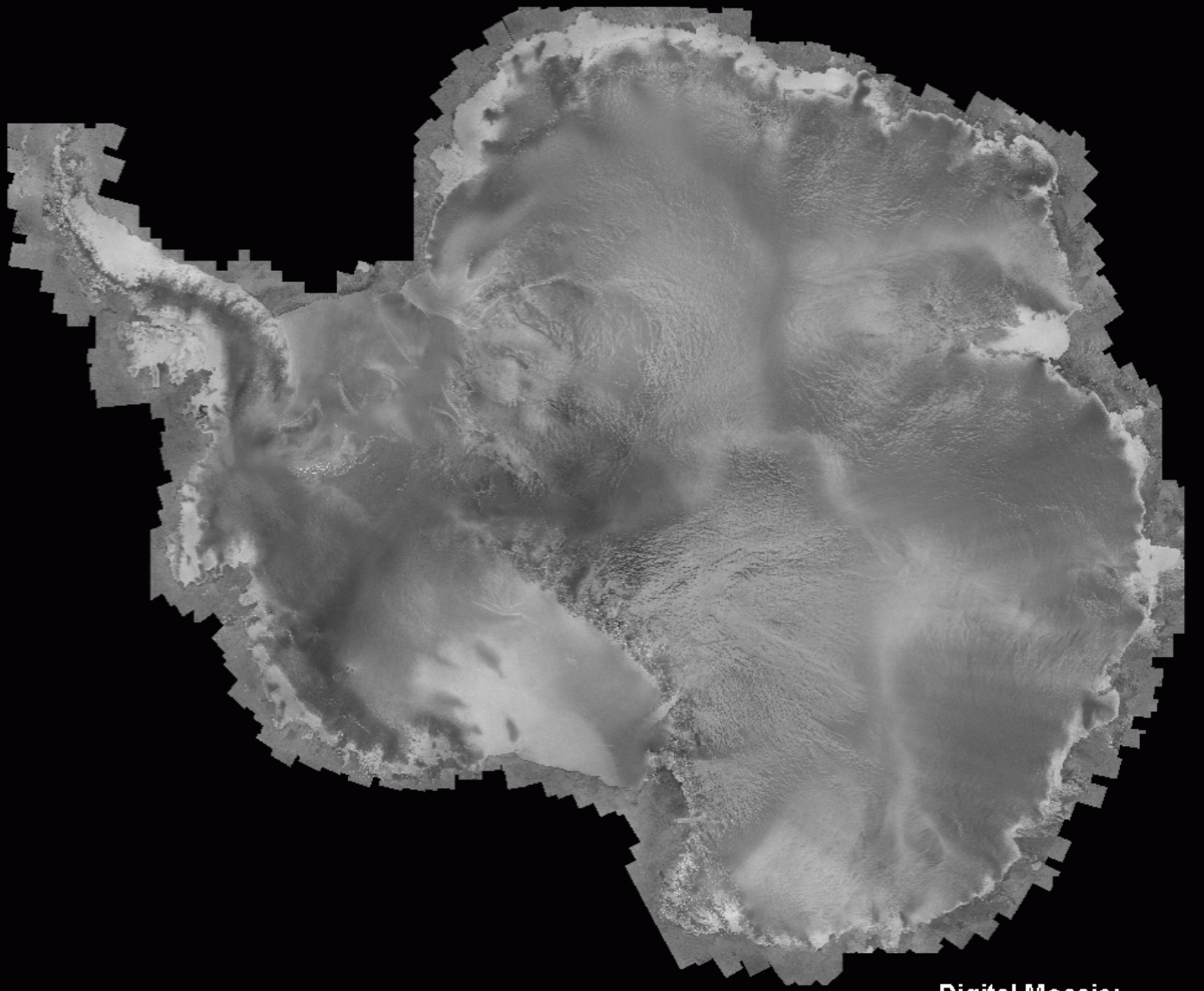
Polar science and big data

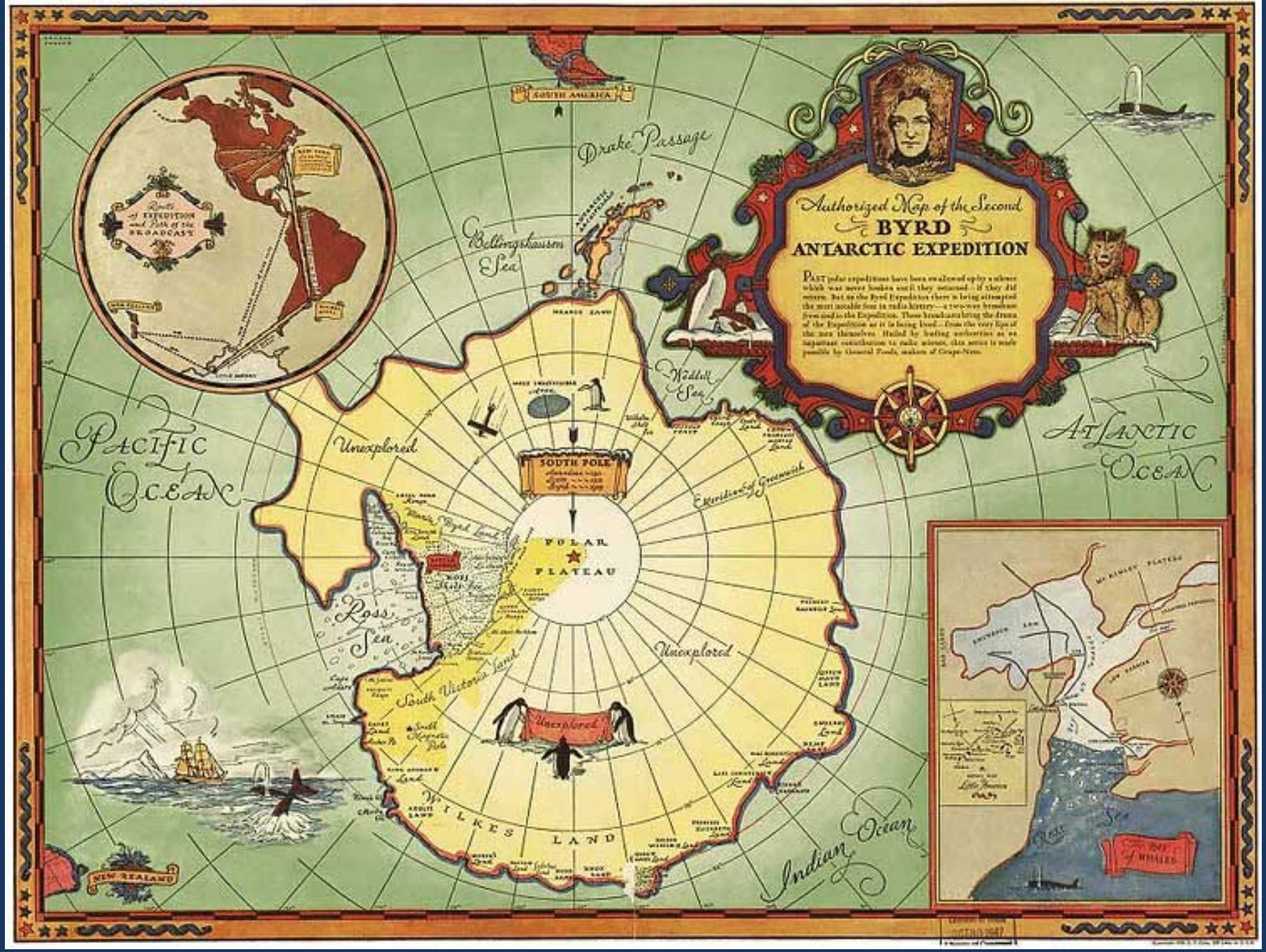
Martin Siegert

- Overview of your work
- How did you start working with methodology side?
- Is your collaborative work with methodology side a win-win relationship, or do you get more benefit than methodology side?
- Can methodology side obtain a new research theme from your collaborative work and write technical papers?
- How do you educate/train pi-shaped scientists?



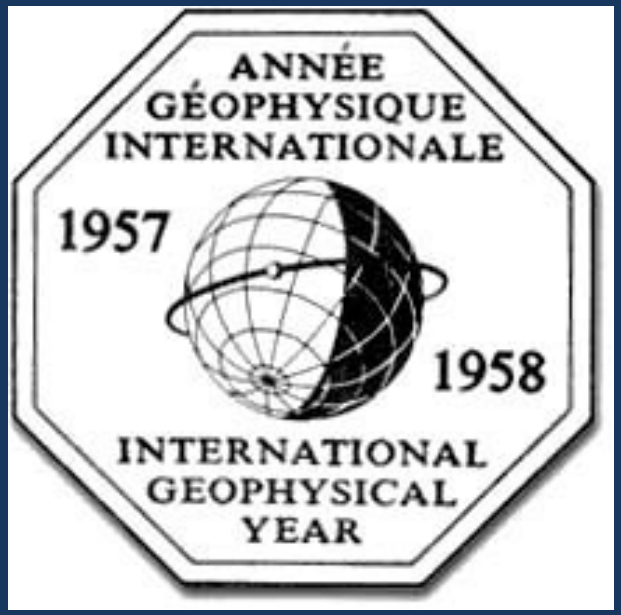
ANTARCTICA

Digital Mosaic:
Alaska SAR Facility
© Canadian Space Agency


Authorized Map of the Second
BYRD
ANTARCTIC EXPEDITION
Past polar expeditions have been swallowed up by a silence which was never broken until they returned—if they did return. But on the Byrd Expedition there is being attempted the most notable feat in radio history—a two-way broadcast from and to the Expedition. These broadcasts bring the drama of the Expedition as it is being lived—from the very lips of the men themselves. Hailed by leading authorities as an important contribution to radio science, this service is made possible by General Foods, makers of Grape-Nuts.
SOUTH AMERICA
Drake Passage
Bellingshausen Sea
Weddell Sea
PACIFIC OCEAN
ATLANTIC OCEAN
Unexplored
SOUTH POLE
Meridian of Greenwich
POLAR PLATEAU
Ross Sea
Unexplored
South Victoria Land
Unexplored
WILKES LAND
Indian Ocean
NEW ZEALAND
Mt. Kirkpatrick
Mt. Nansen
Mt. Wilson
Mt. Gilbert
Mt. Hope
Mt. Lister
Mt. Fridtjof
Mt. Nilsen
Mt. Markham
Mt. Kinsey
Mt. Sidley
Mt. Rea
Mt. Hearst
Mt. Hayes
Mt. Hubbard
Mt. Bartlett
Mt. Gardner
Mt. Crary
Mt. Dickerson
Mt. Hoover
Mt. Russell
Mt. Gilmer
Mt. Balchen
Mt. Siple
Mt. Rees
Mt. Rockwell
Mt. Wade
Mt. Gregory
Mt. Bowman
Mt. Rockefeller
Mt. Ruppert
Mt. Dewey
Mt. Lindbergh
Mt. Hanna
Mt. Hamilton
Mt. Hobbs
Mt. Hull
Mt. Hunter
Mt. Hutchinson
Mt. Hyde
Mt. Hyman
Mt. Hyndman
Mt. Hyslop
Mt. Hyson
Mt. Hyssop
Mt. Hyssop
Mt. Hyssop

IPY answered major questions about the Earth

"...to observe geophysical phenomena and to secure data from all parts of the world; to conduct this effort on a coordinated basis by fields, and in space and time, so that results could be collated in a meaningful manner."

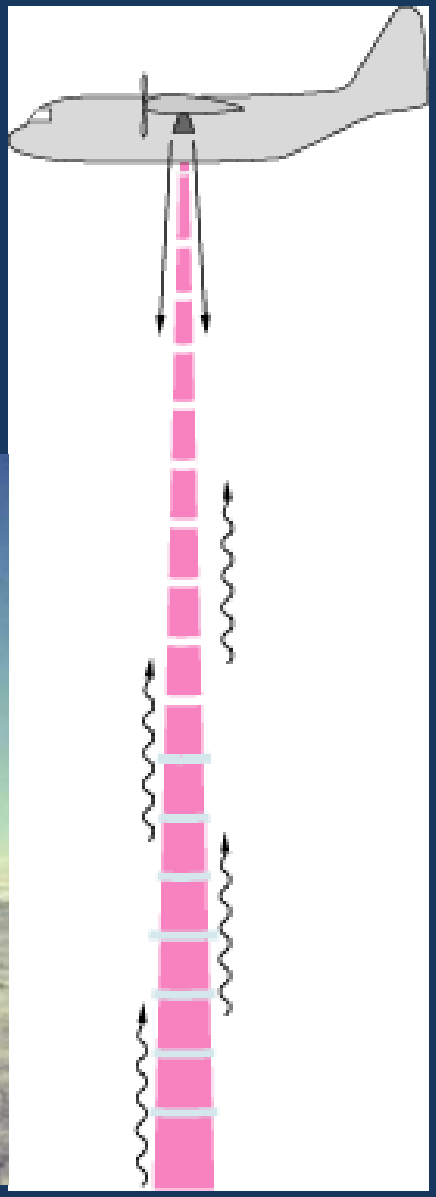


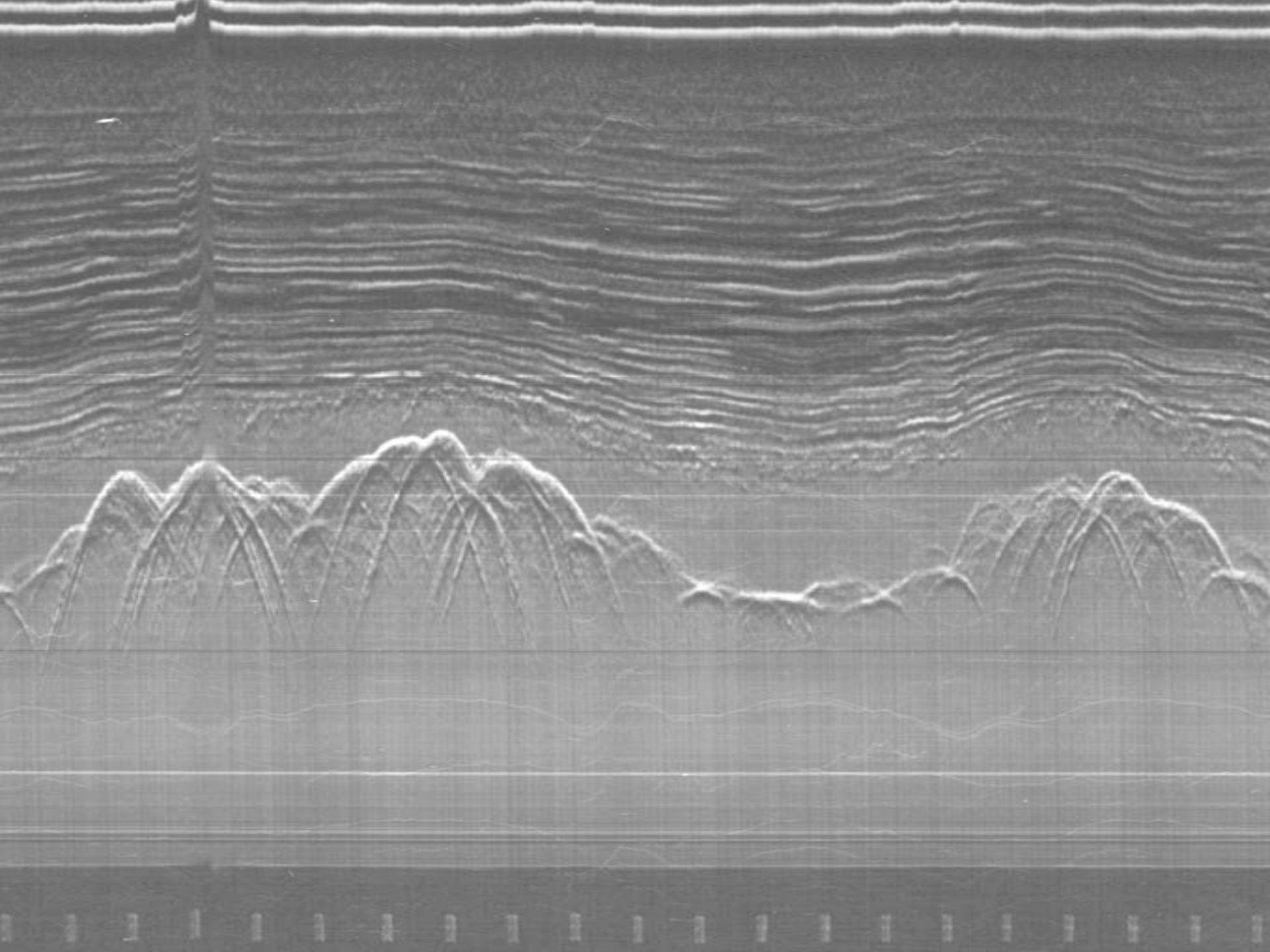
http://www.egy.org/background.html

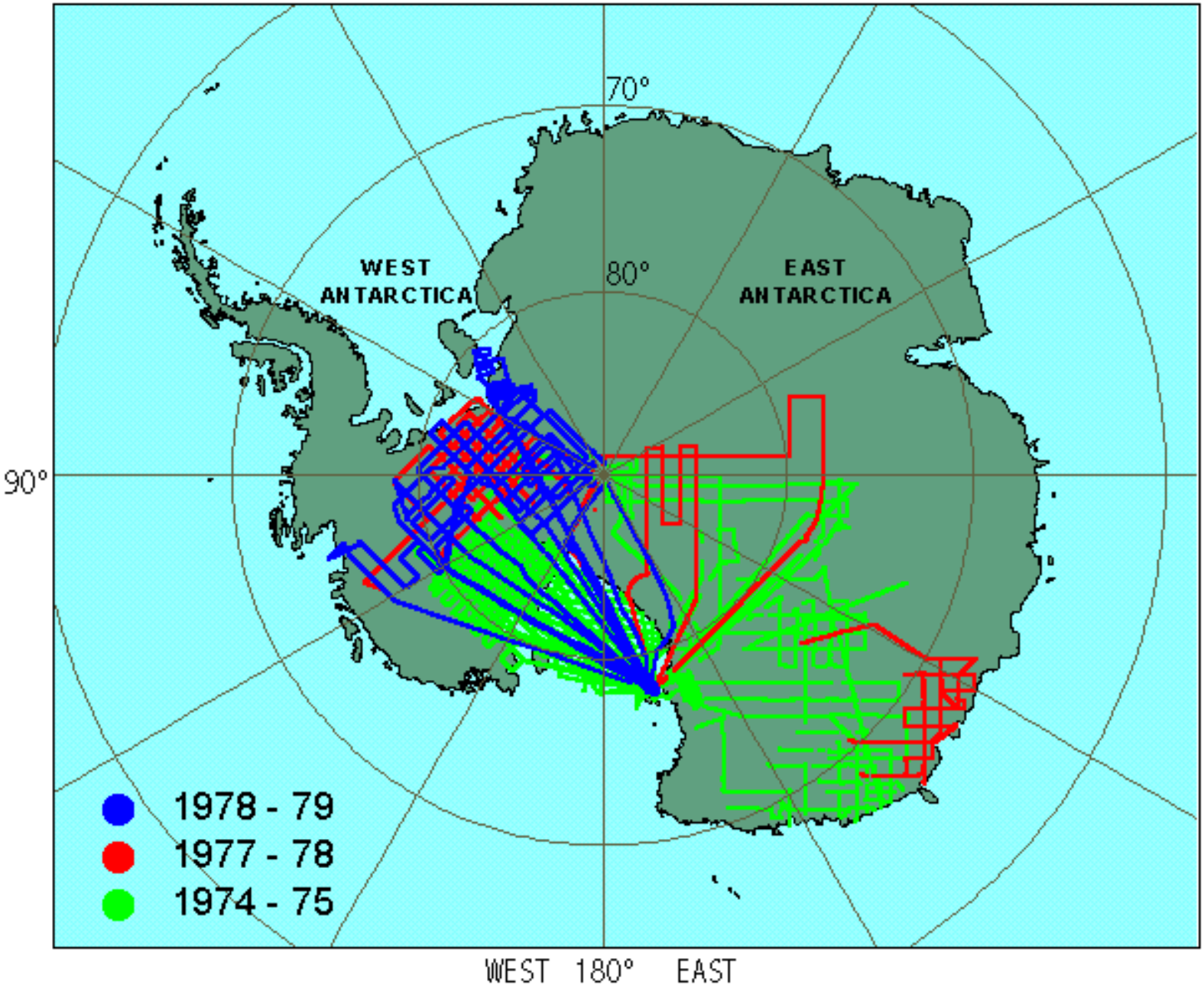
Age of Geophysics, 1957 - present

Gordon Robin, 1921-2004

“One of his most inspired decisions was to advance the charting of glacier and ice cap thickness by airborne radio echo-sounding rather than explosions conducted on the surface” (Telegraph, 5 Oct 2004)

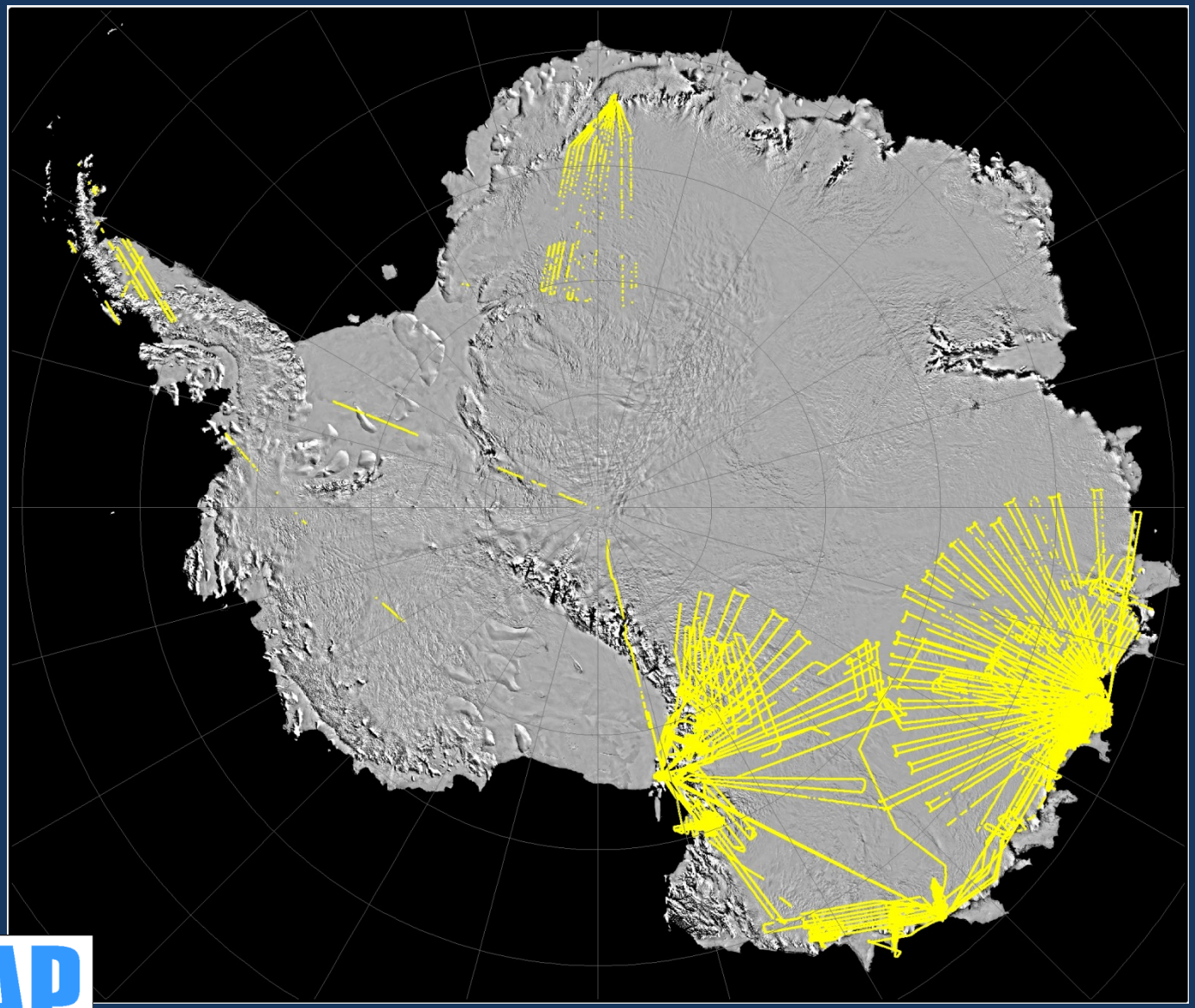





70°
80°
90°
WEST
ANTARCTICA
EAST
ANTARCTICA
1978 - 79
1977 - 78
1974 - 75
WEST 180° EAST

ICECAP: 2008 – present (6 seasons)

DC-3T Basler

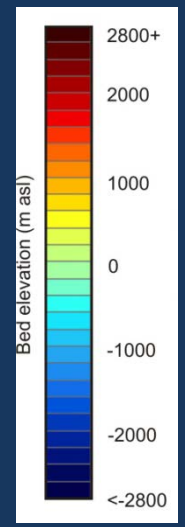


ICECAP flightlines

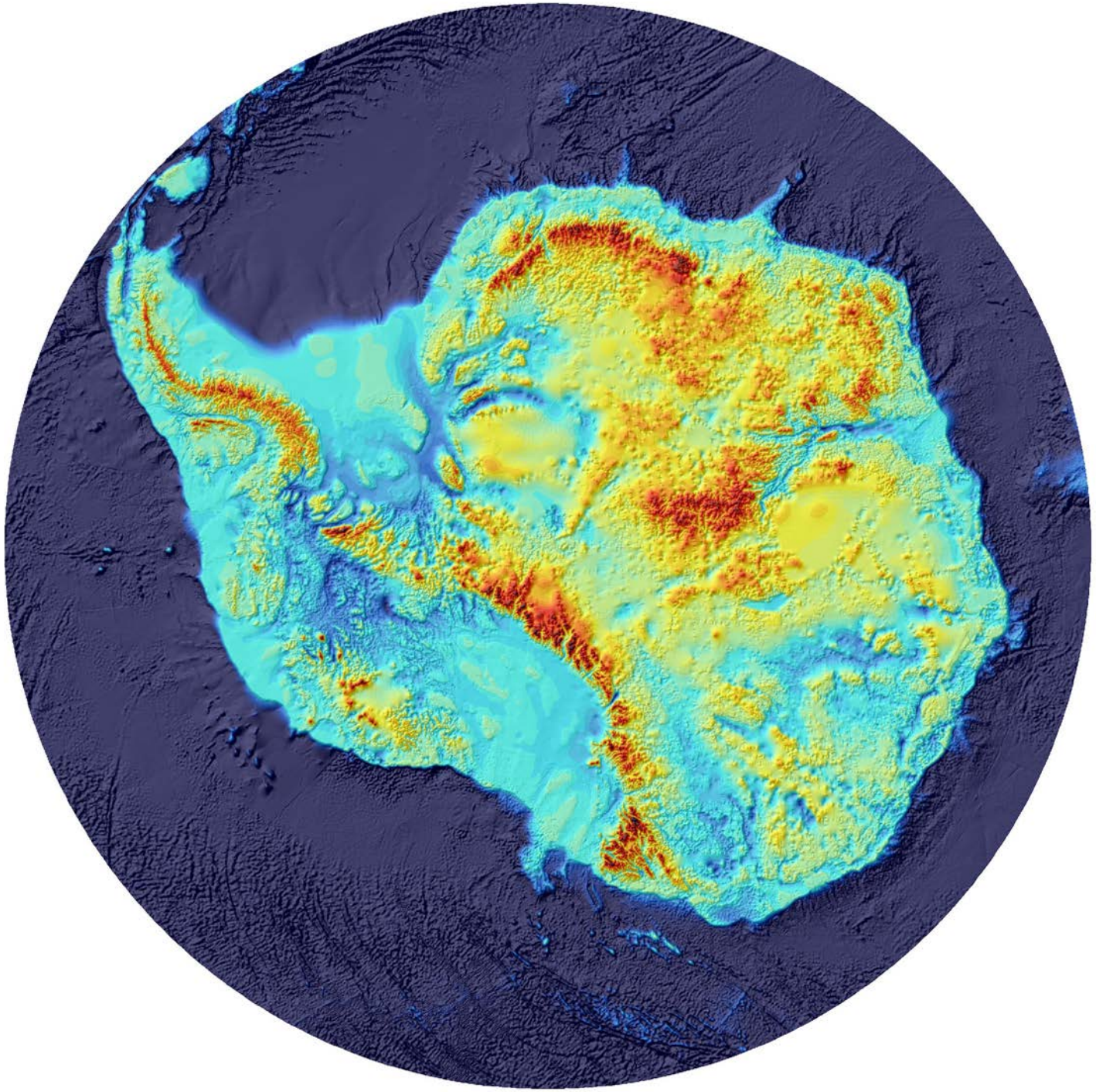
UK Institute Ice Stream: 2010-11

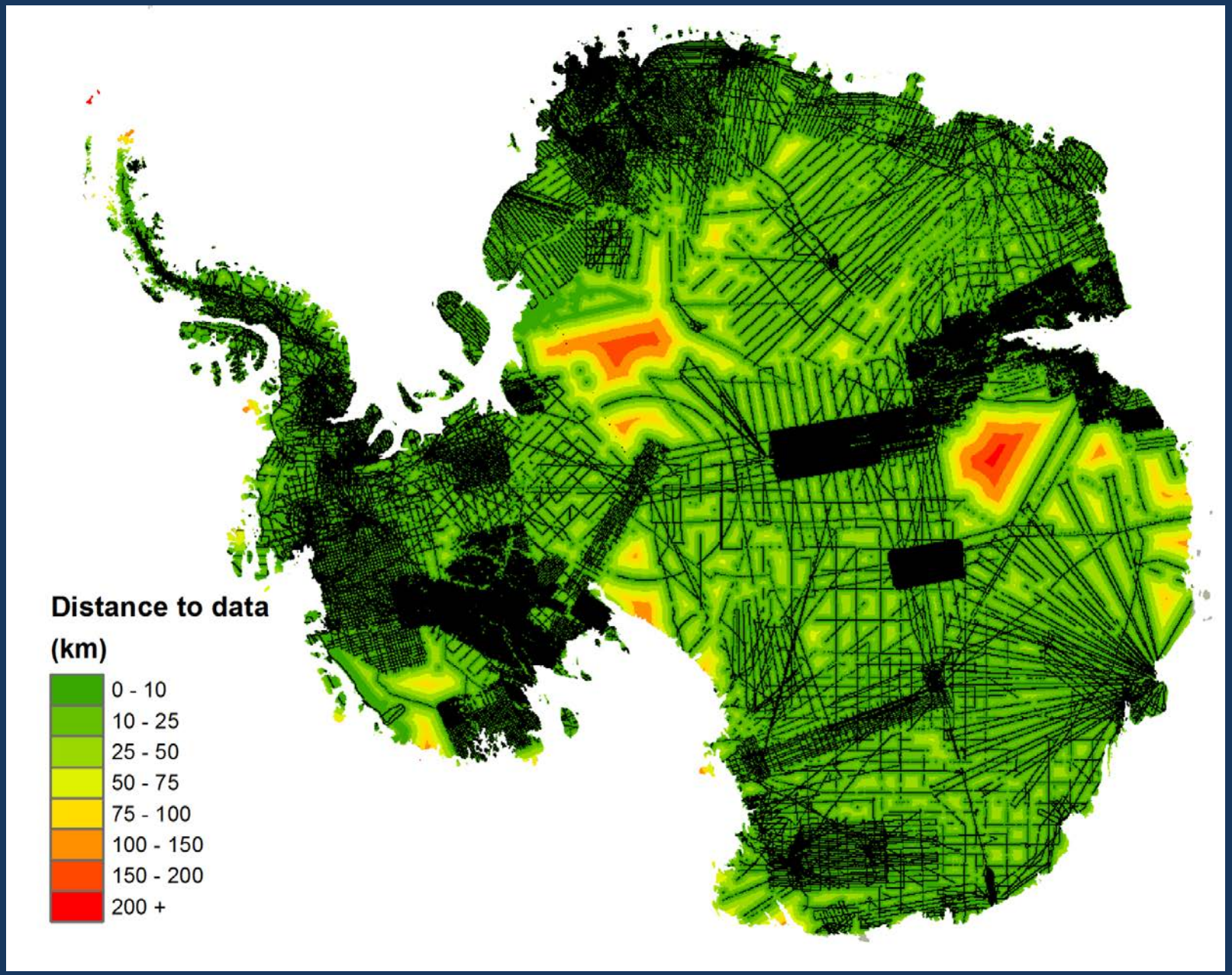
Twin Otter

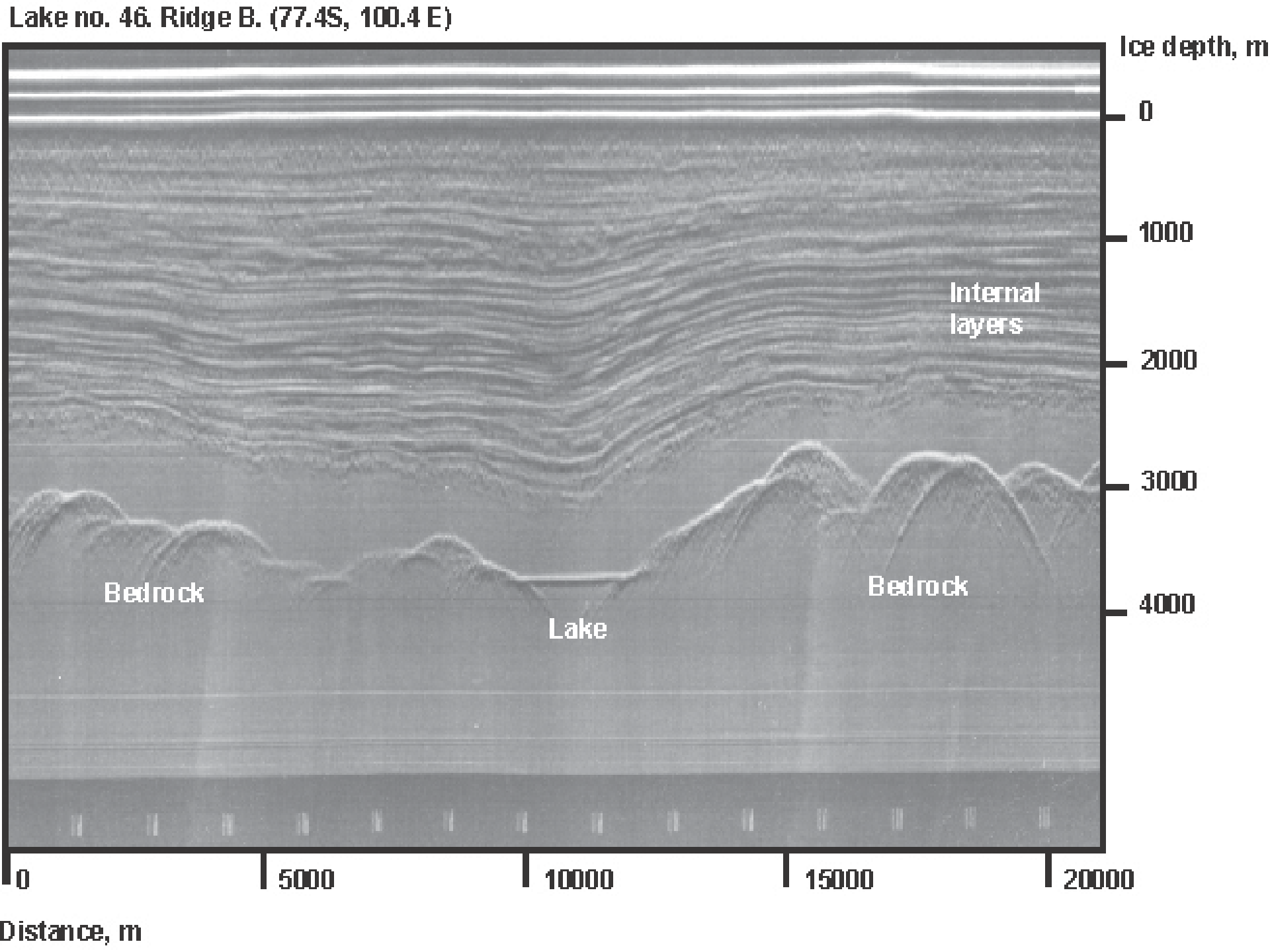
2001



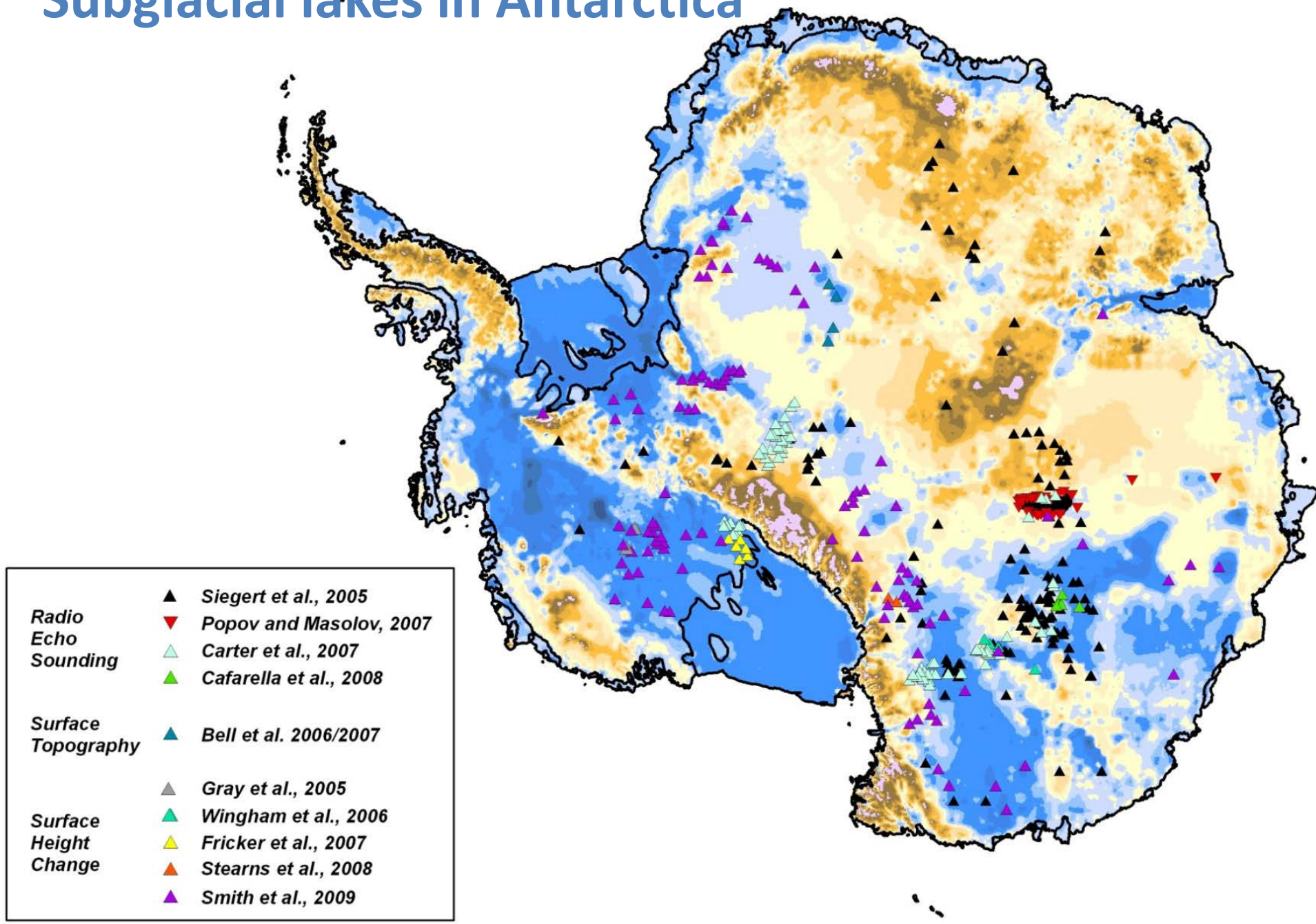
2013




Distance to data
(km)
0 - 10
10 - 25
25 - 50
50 - 75
75 - 100
100 - 150
150 - 200
200 +

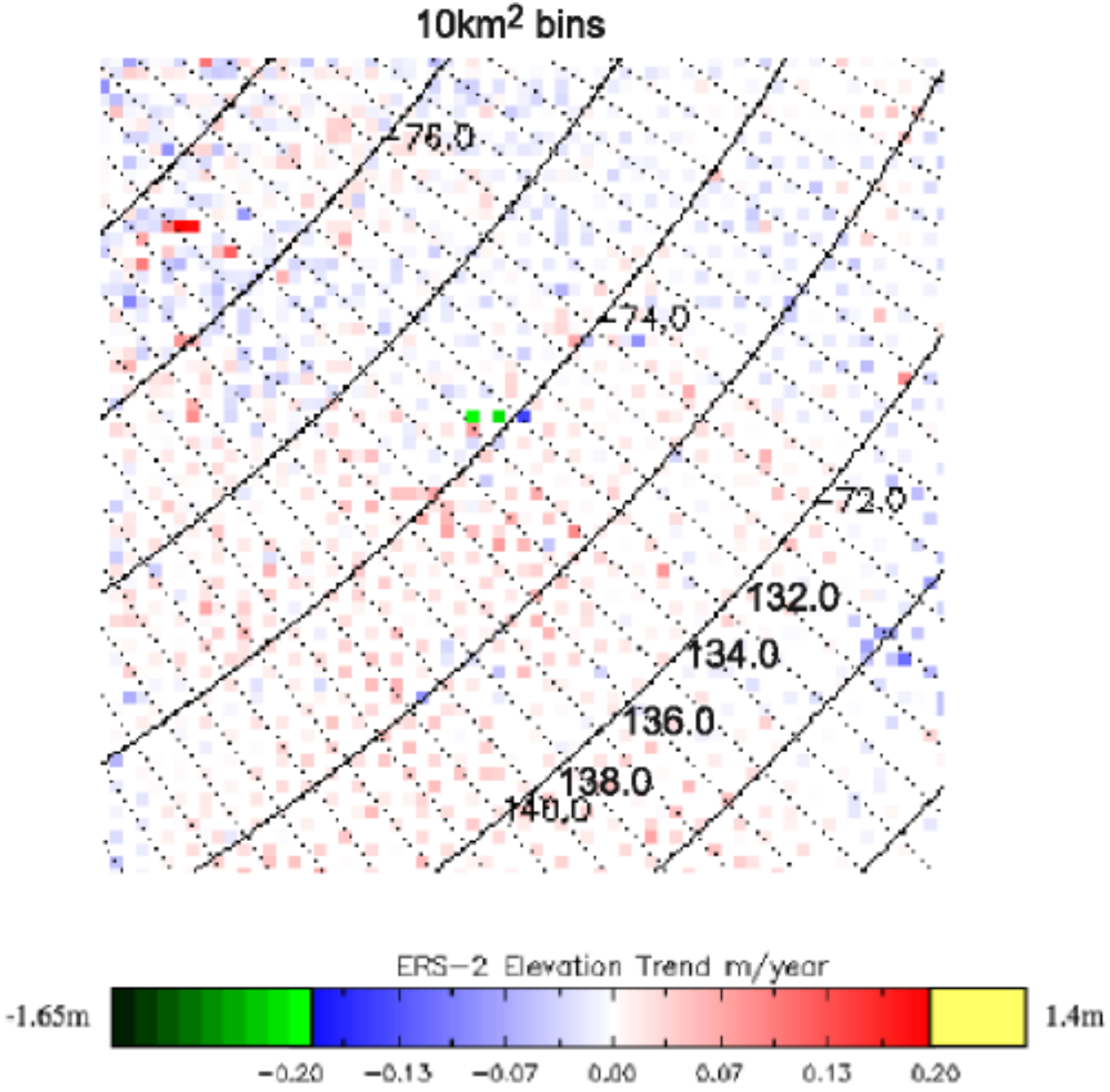

Lake no. 46. Ridge B. (77.4S, 100.4 E)
Ice depth, m
0
1000
2000
3000
4000
Internal layers
Bedrock
Lake
Bedrock
0
5000
10000
15000
20000
Distance, m

Subglacial lakes in Antarctica

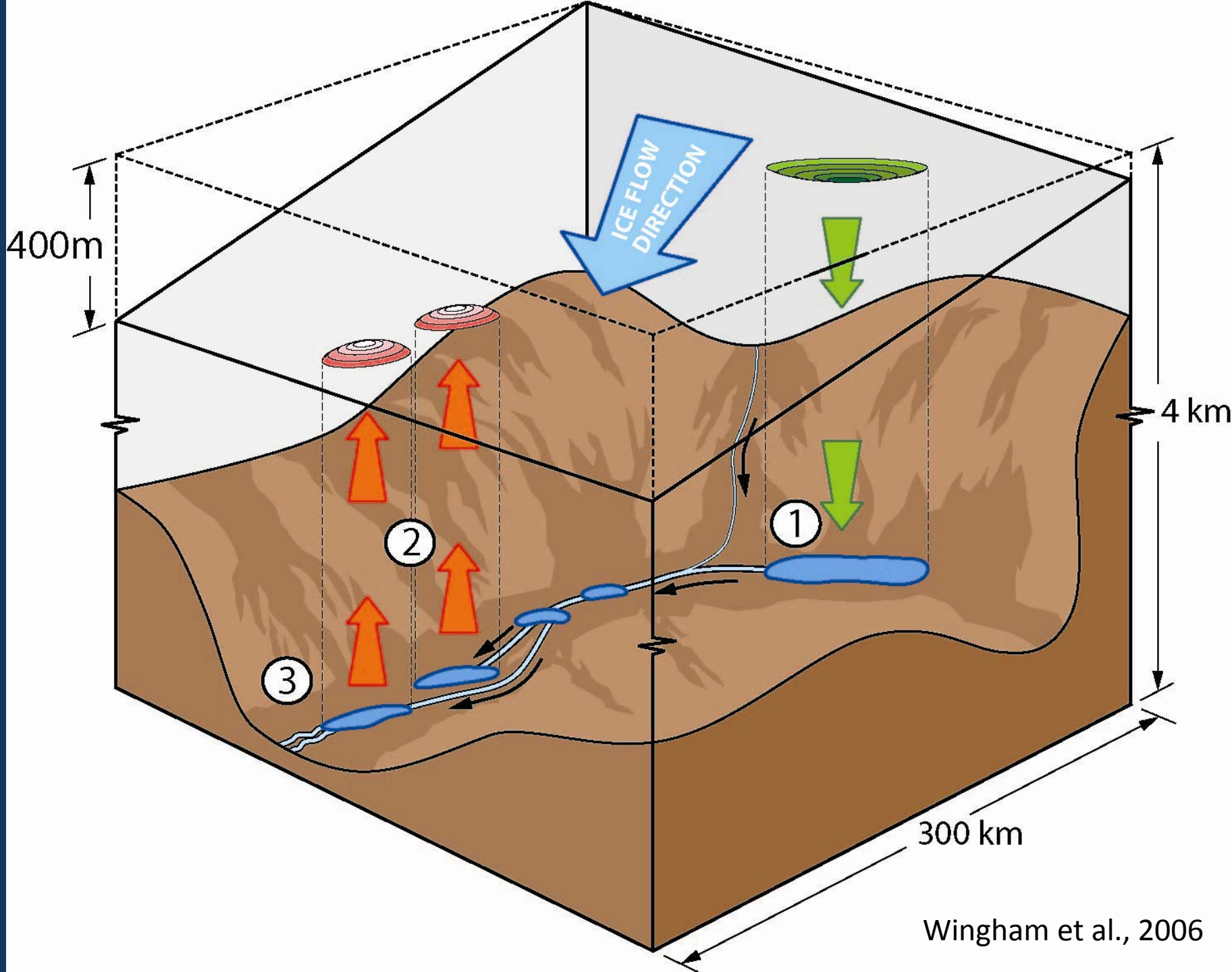


Antarctic Elevation Trend 1995-2003

from ERS-2 Radar Altimeter Crossover Analysis



Wingham et al., 2006



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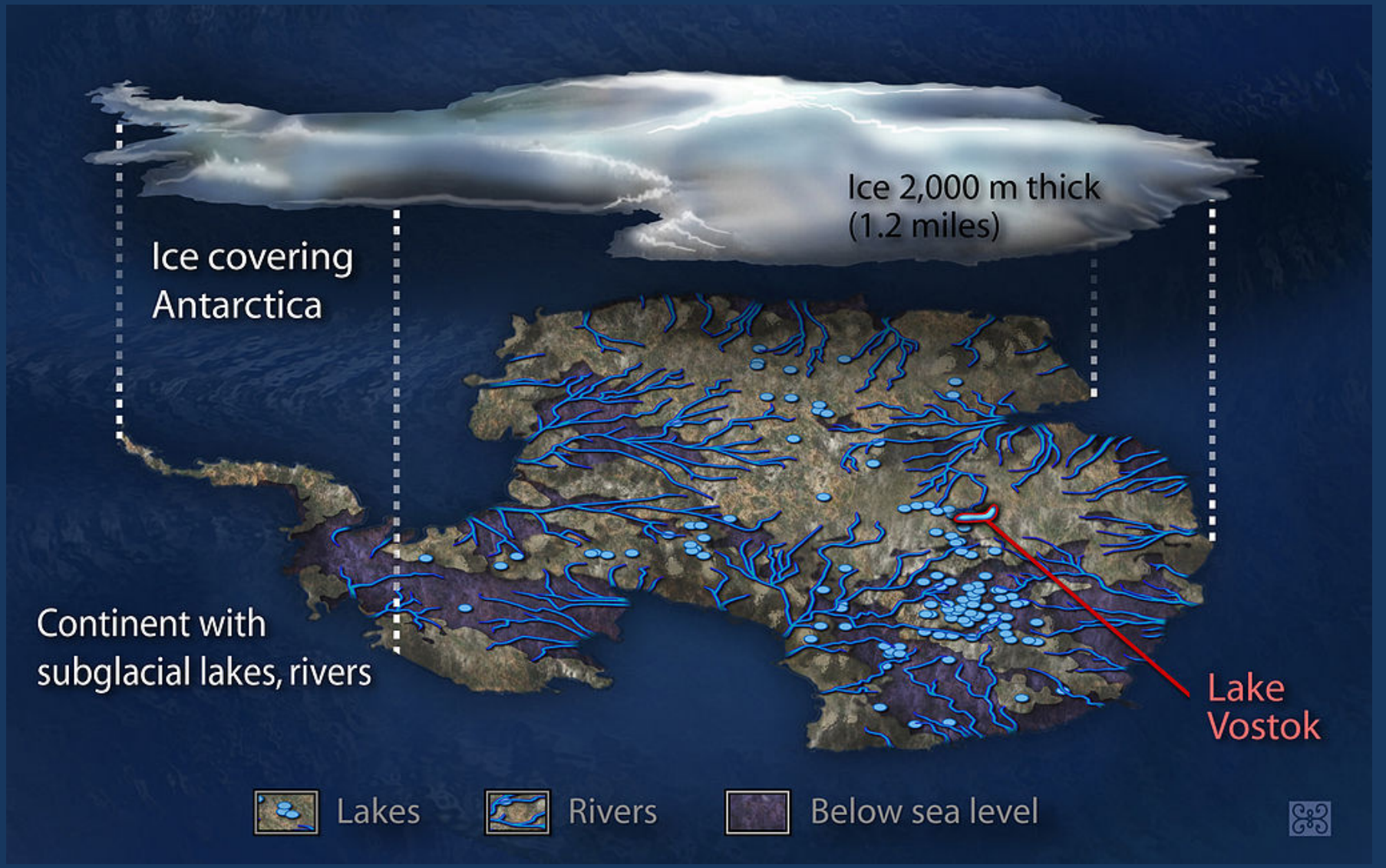
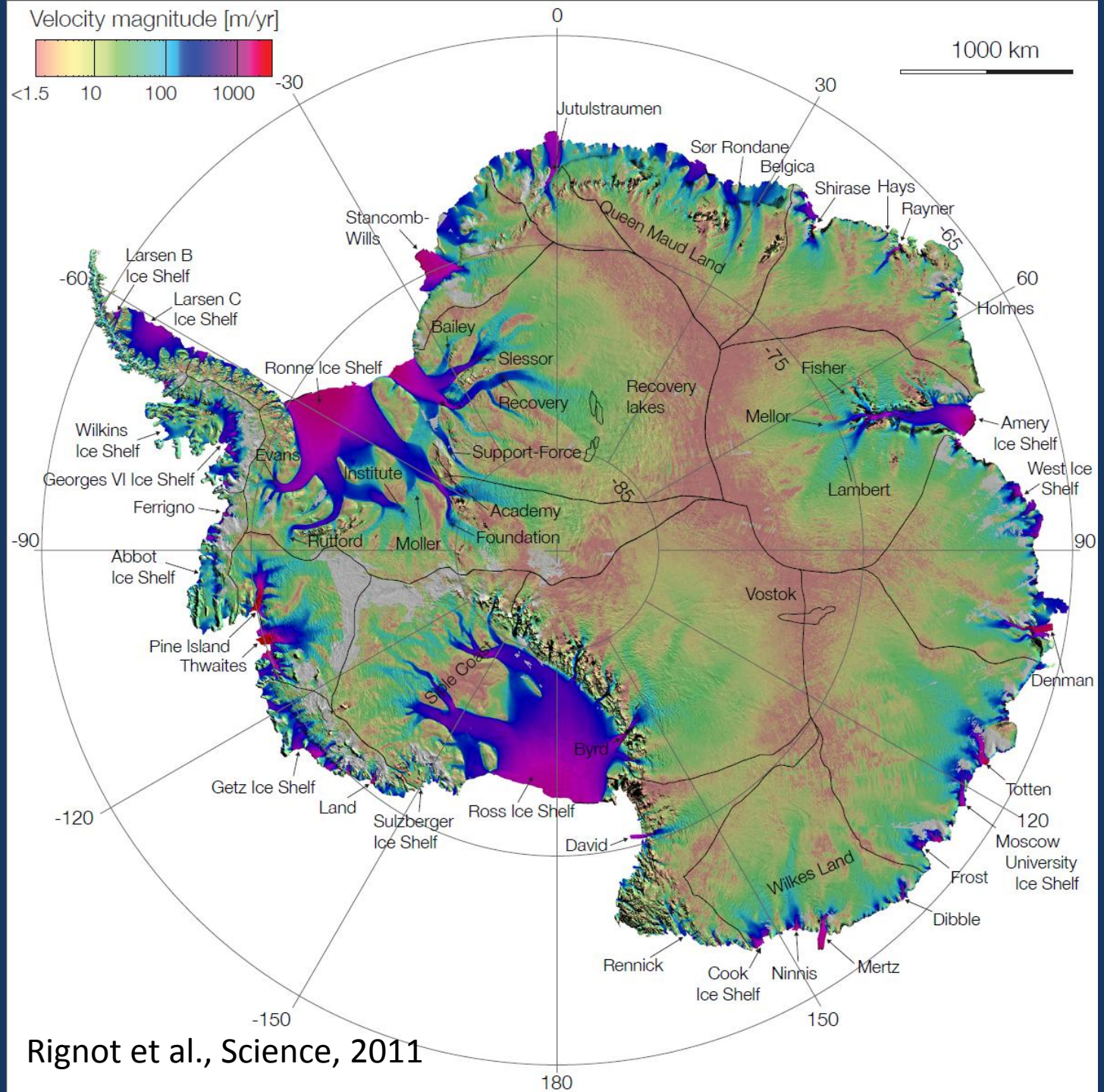
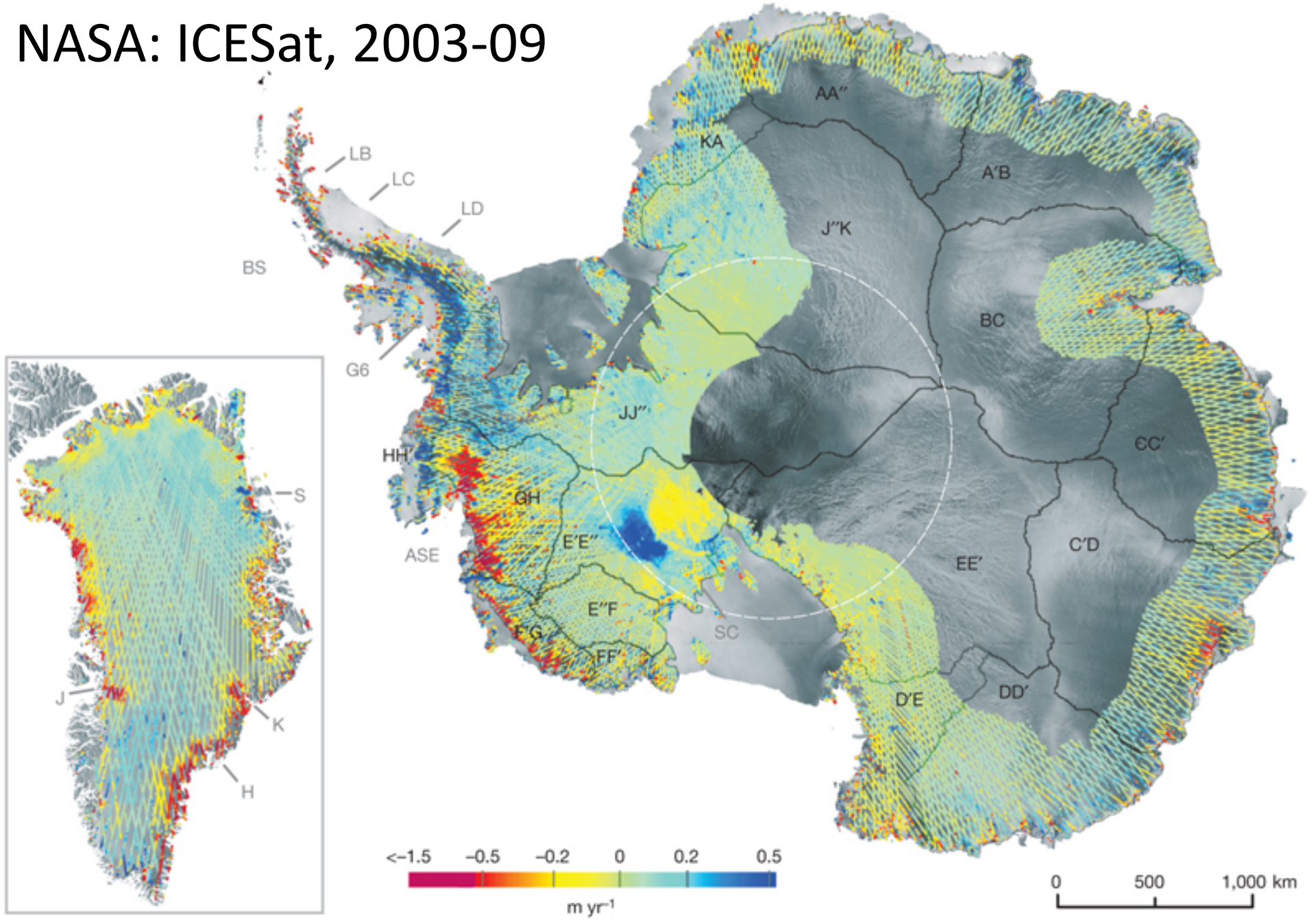

Ice 2,000 m thick
(1.2 miles)
Ice covering
Antarctica
Continent with
subglacial lakes, rivers
Lake
Vostok
Lakes
Rivers
Below sea level



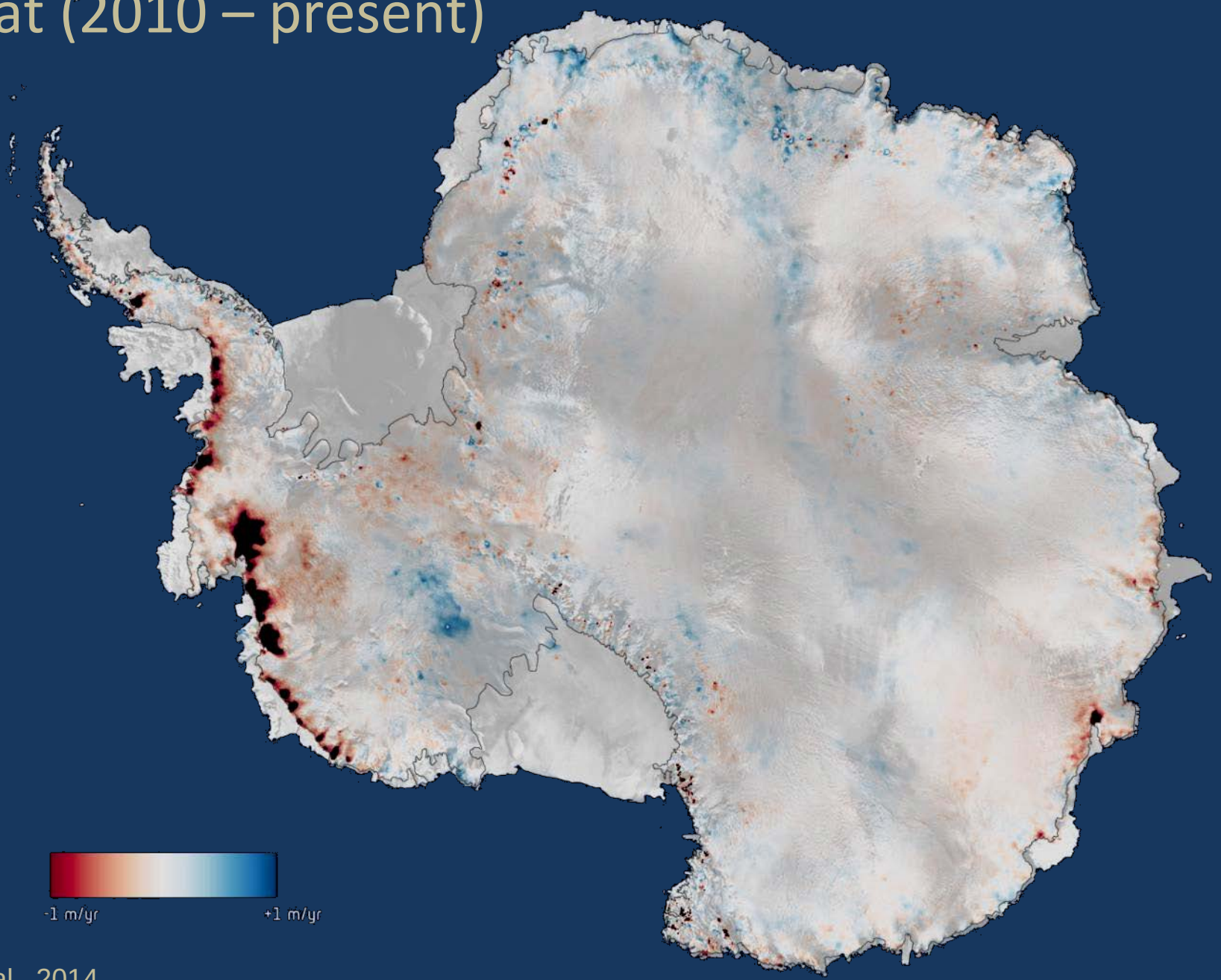
Rignot et al., Science, 2011

NASA: ICESat, 2003-09



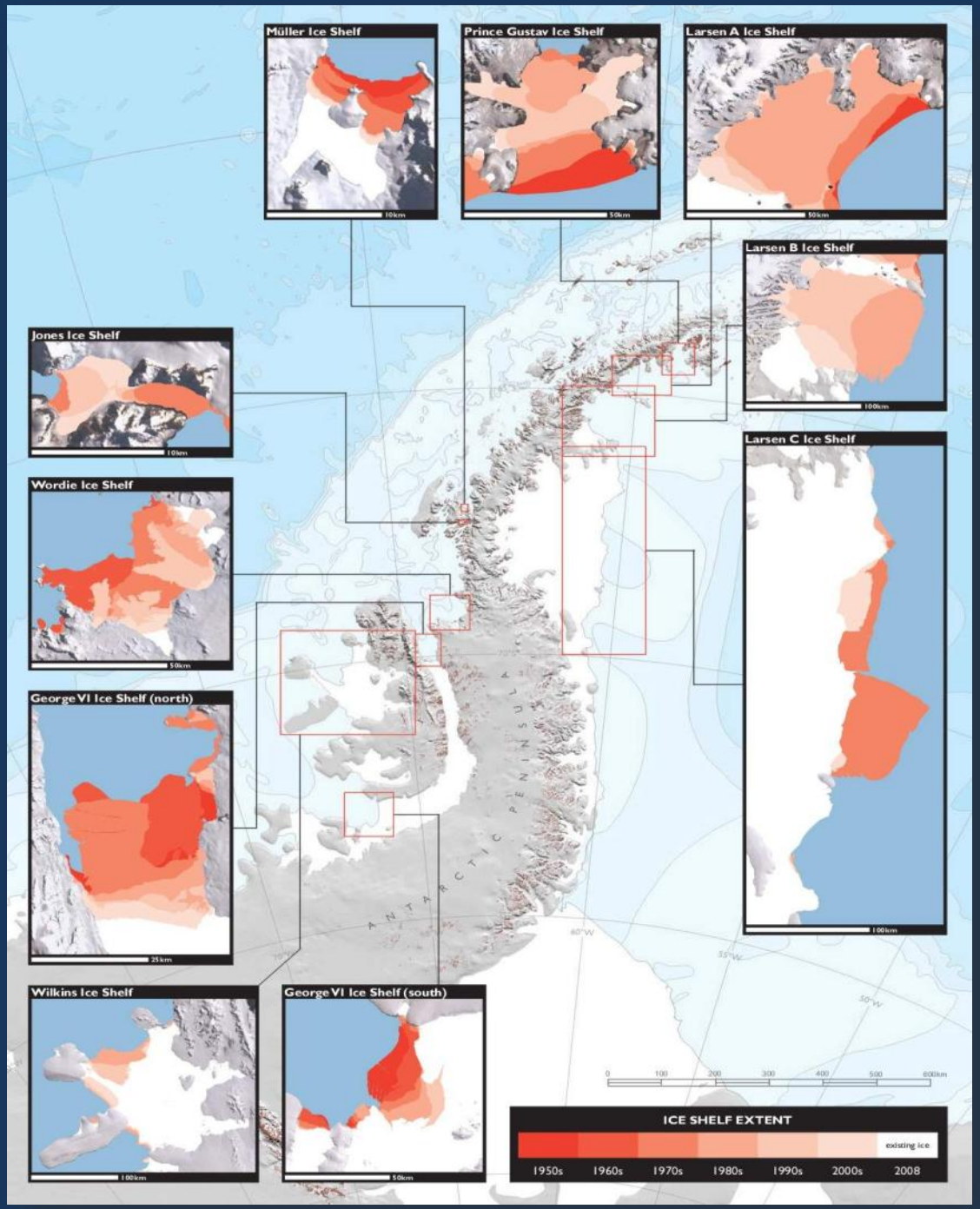
http://cdn.antarcticglaciers.org/wp-content/uploads/2014/02/nature08471-f2.2.jpg

Cryosat (2010 – present)



McMillan et al., 2014

Ice-shelf retreat on the Antarctic Peninsula



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Larsen Ice Shelf A, 1995

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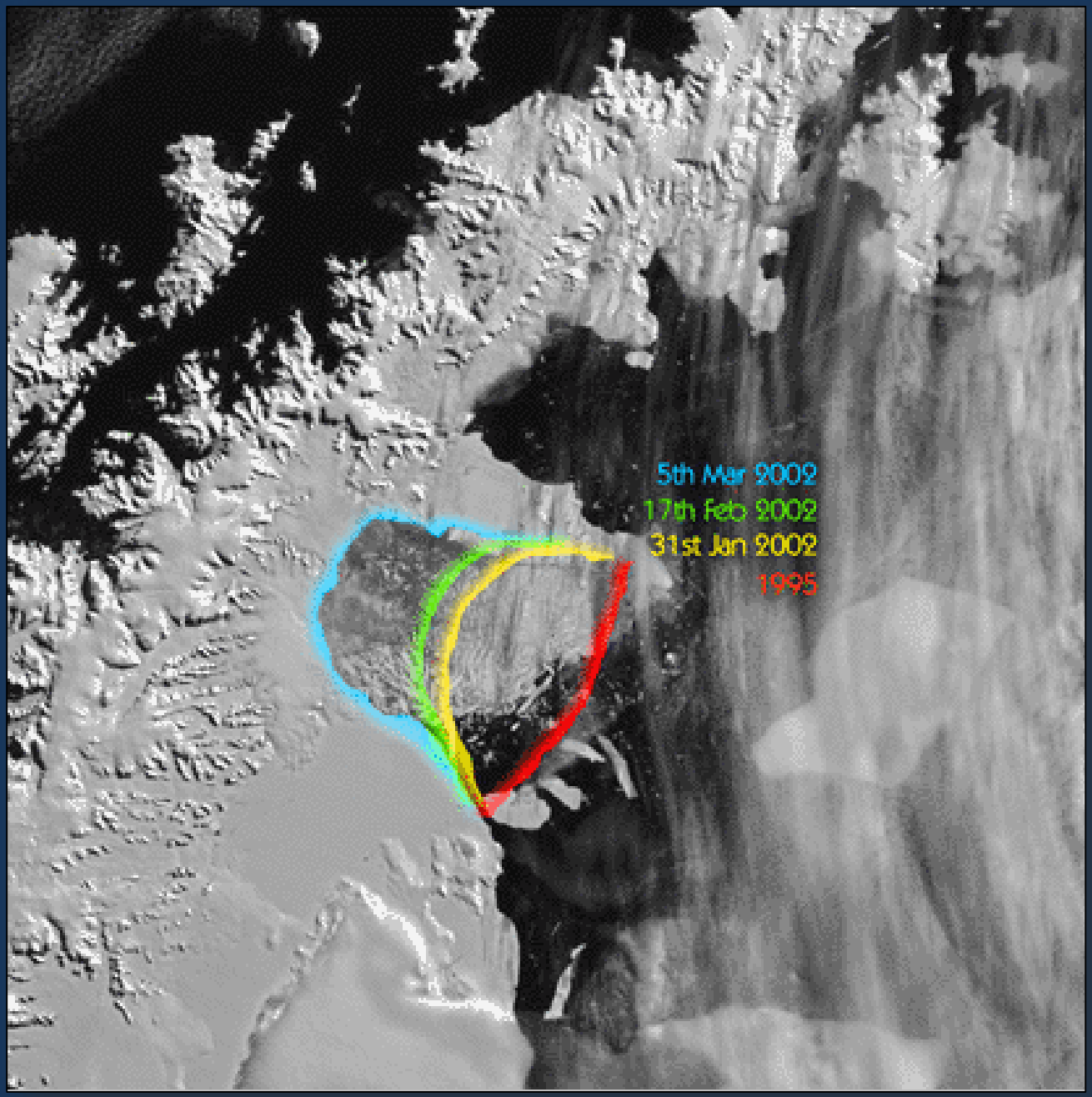
Larsen Ice Shelf B, 2002



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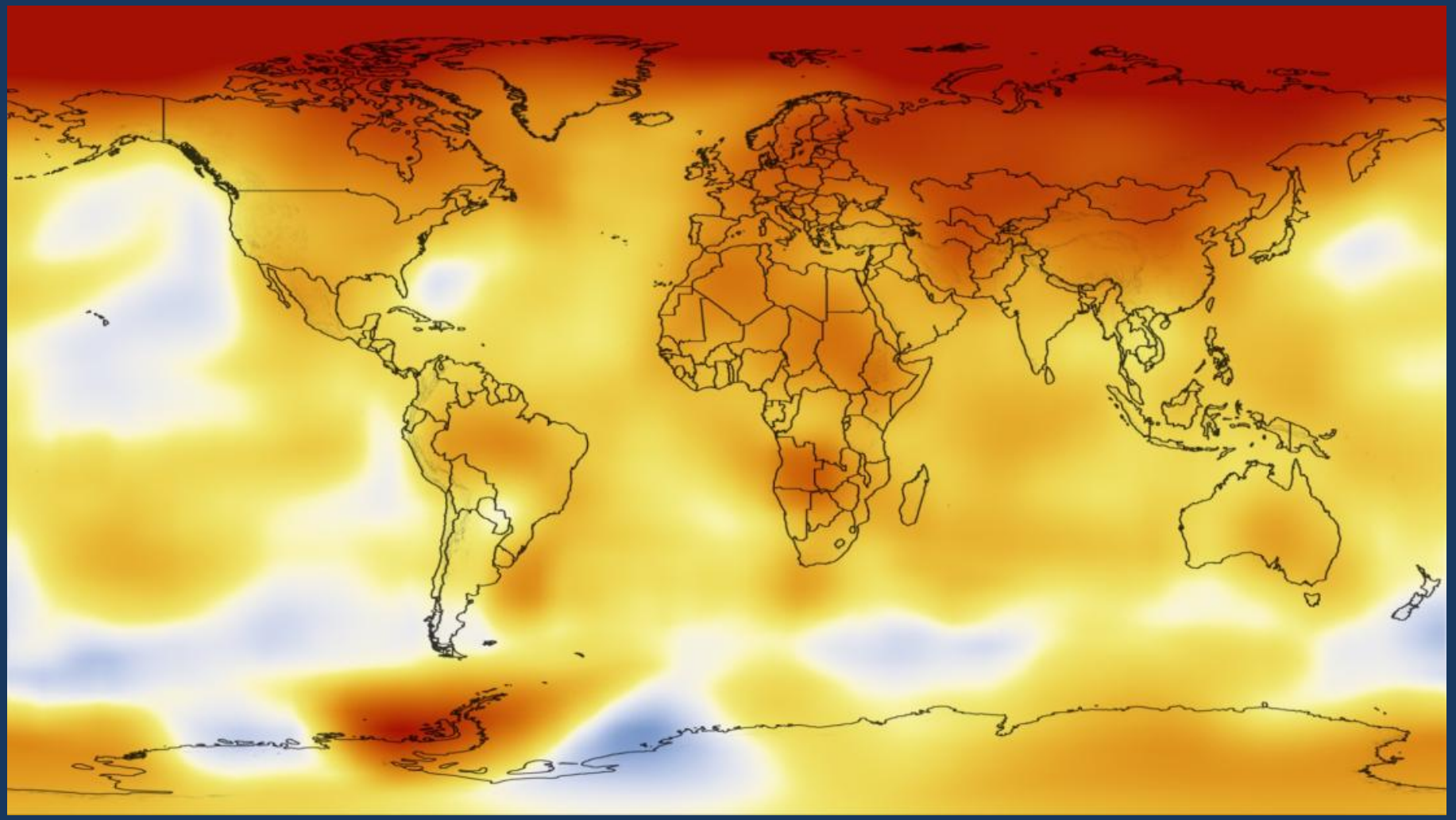
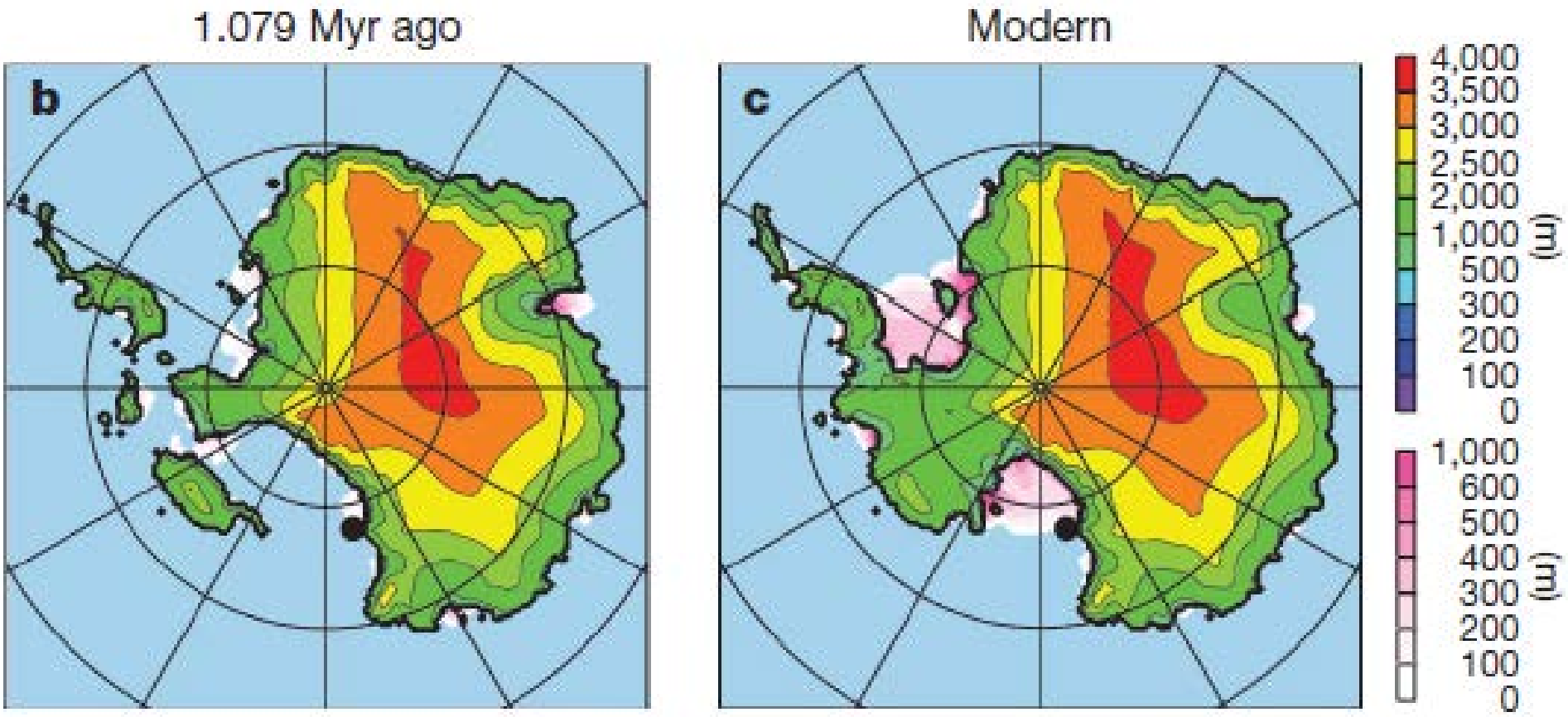
Global temperature (2005-2009) relative to (1951-1980)



Source – NASA/GISS

Numerical modelling of past scenarios

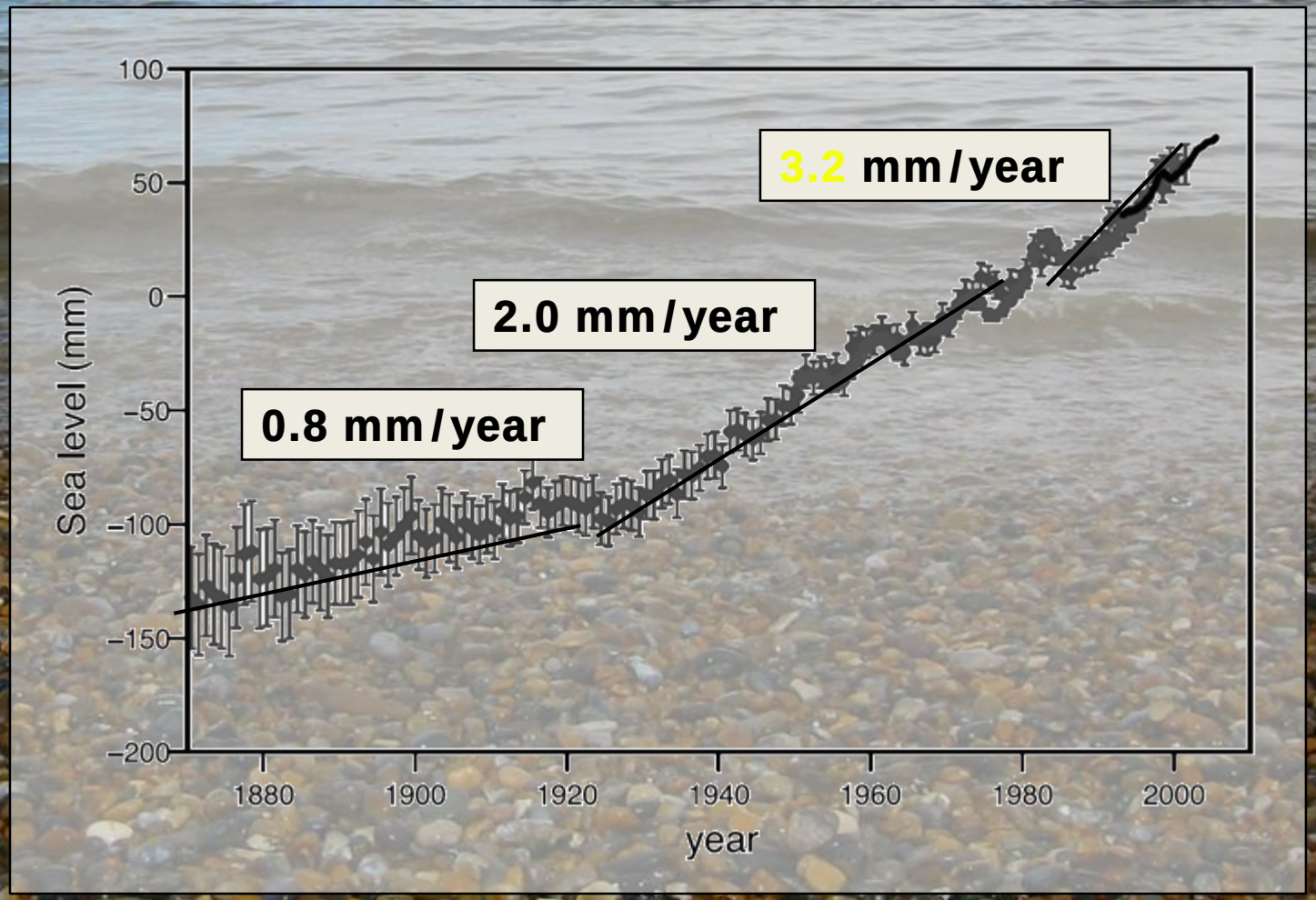


Pollard and DeConto, Nature, (2009)

Animations available at:
http://www.essc.psu.edu/essc_web/research/Pollardanim.html
And videos 1&2 at:
http://www.nature.com/nature/journal/v458/n7236/suppinfo/nature07809.html

Why should we care?

Recent sea-level rise



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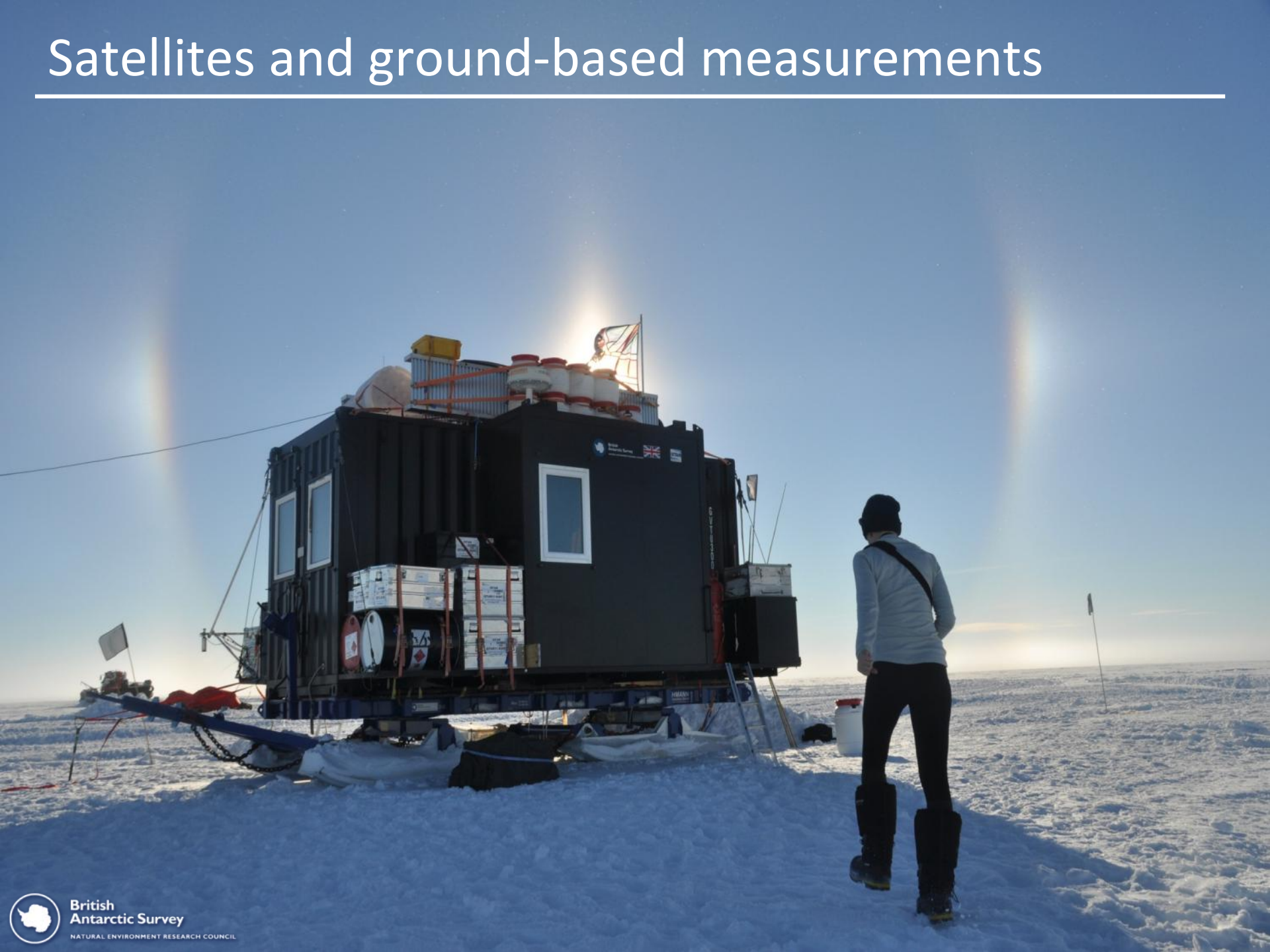
- How do you educate/train pi-shaped scientists?

- Better processing of radar data
- Real time satellite data
- Autonomous aircraft and underwater vehicles
- Expansion of ground-based measurements
- Better models of ice, ocean, earth system

Satellites and ground-based measurements



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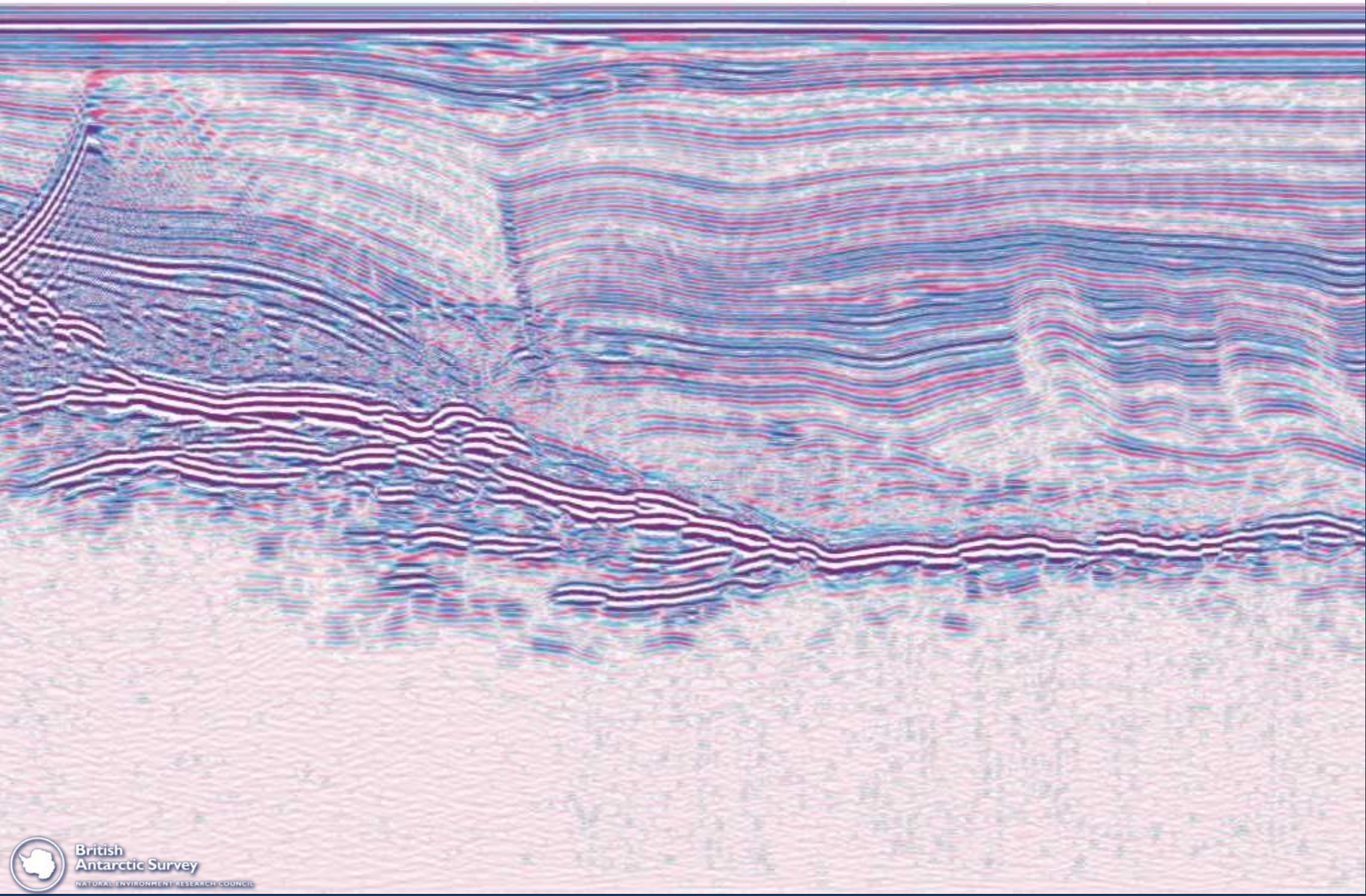
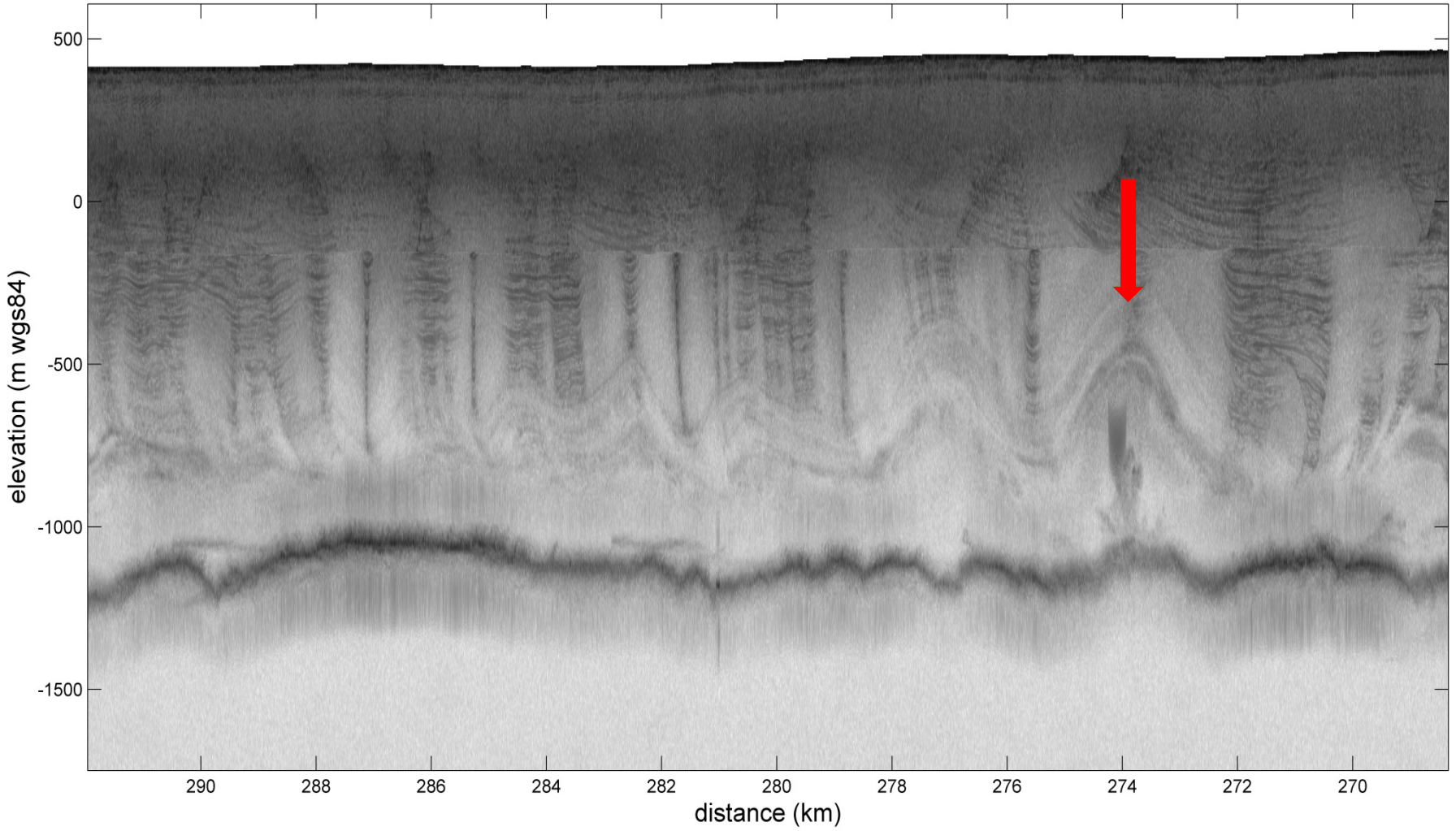
Automation and autonomy

Exploit the data





Ice flow is approx. into the page

We need to understand data that's needed