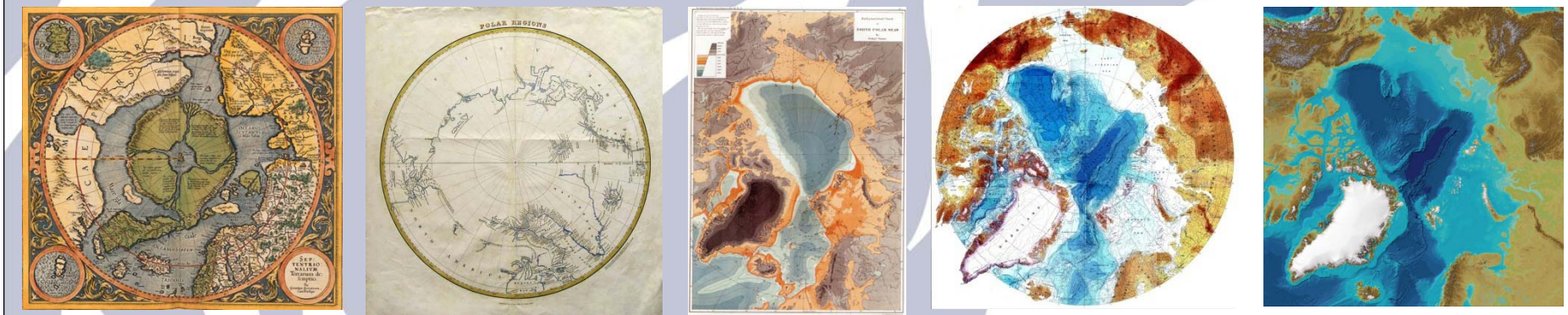
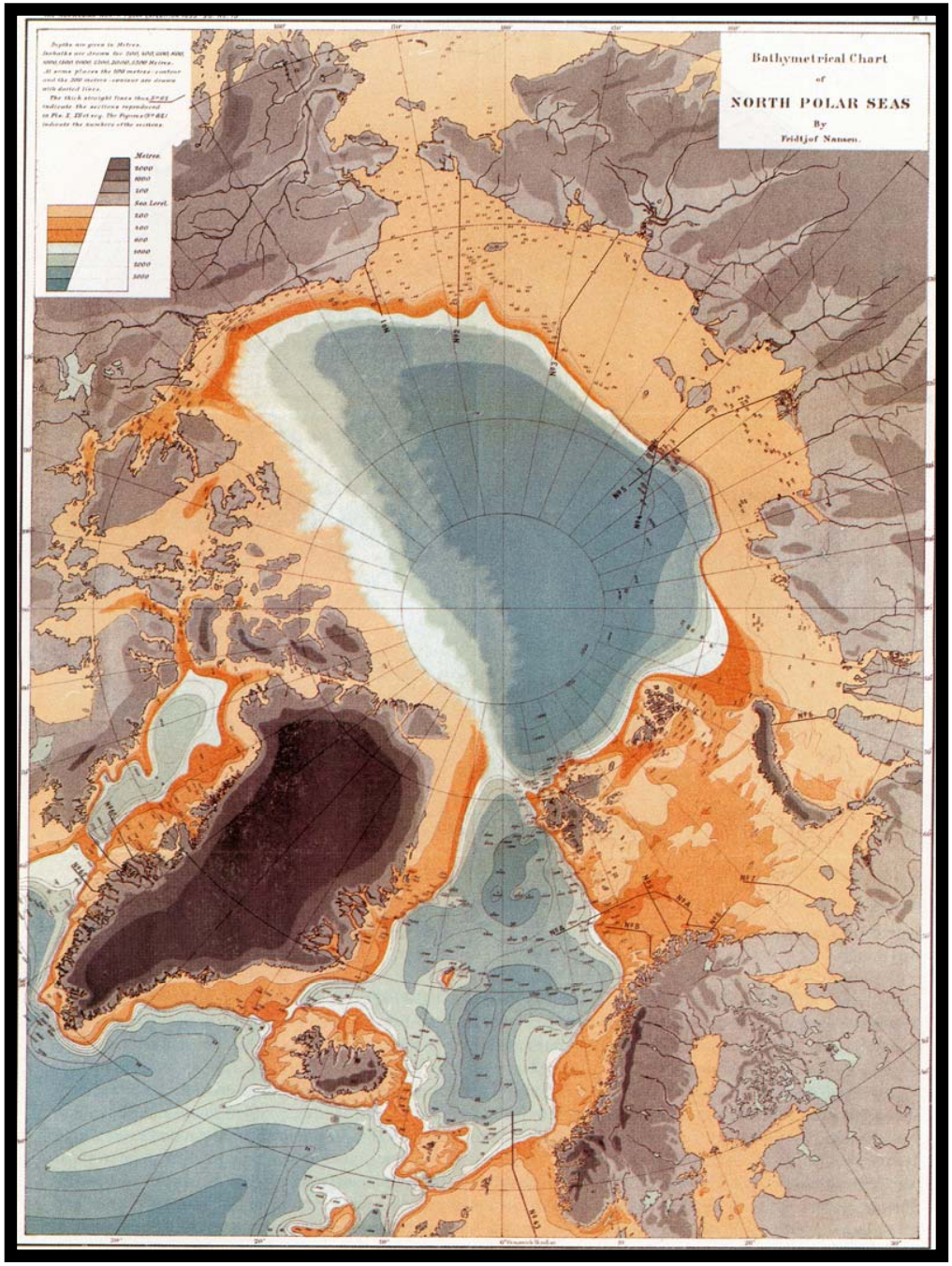
International Bathymetric Chart of the Arctic Ocean (IBCAO)

Martin Jakobsson

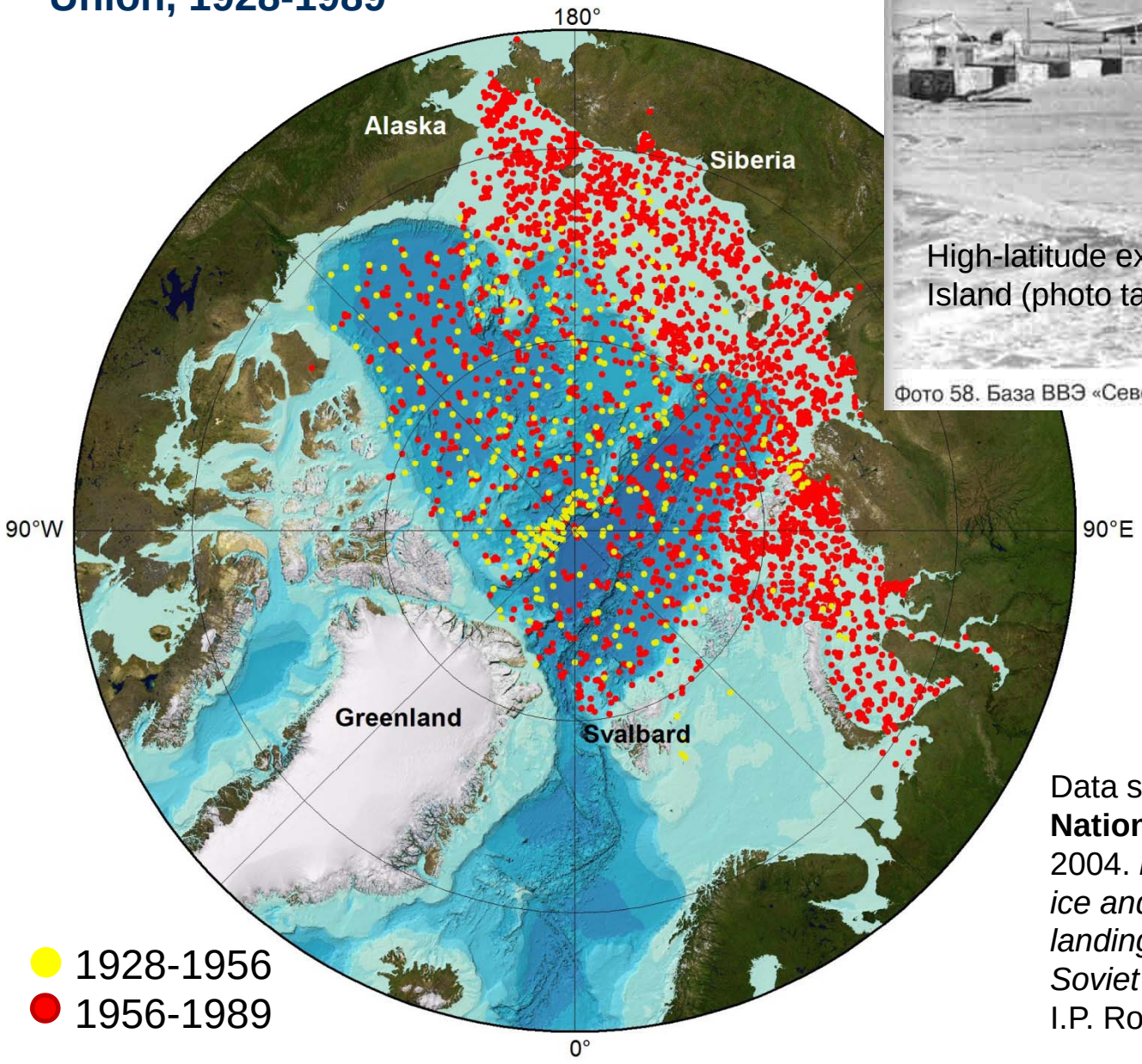
Department of Geological Sciences, Stockholm University



Arctic Ocean sea ice

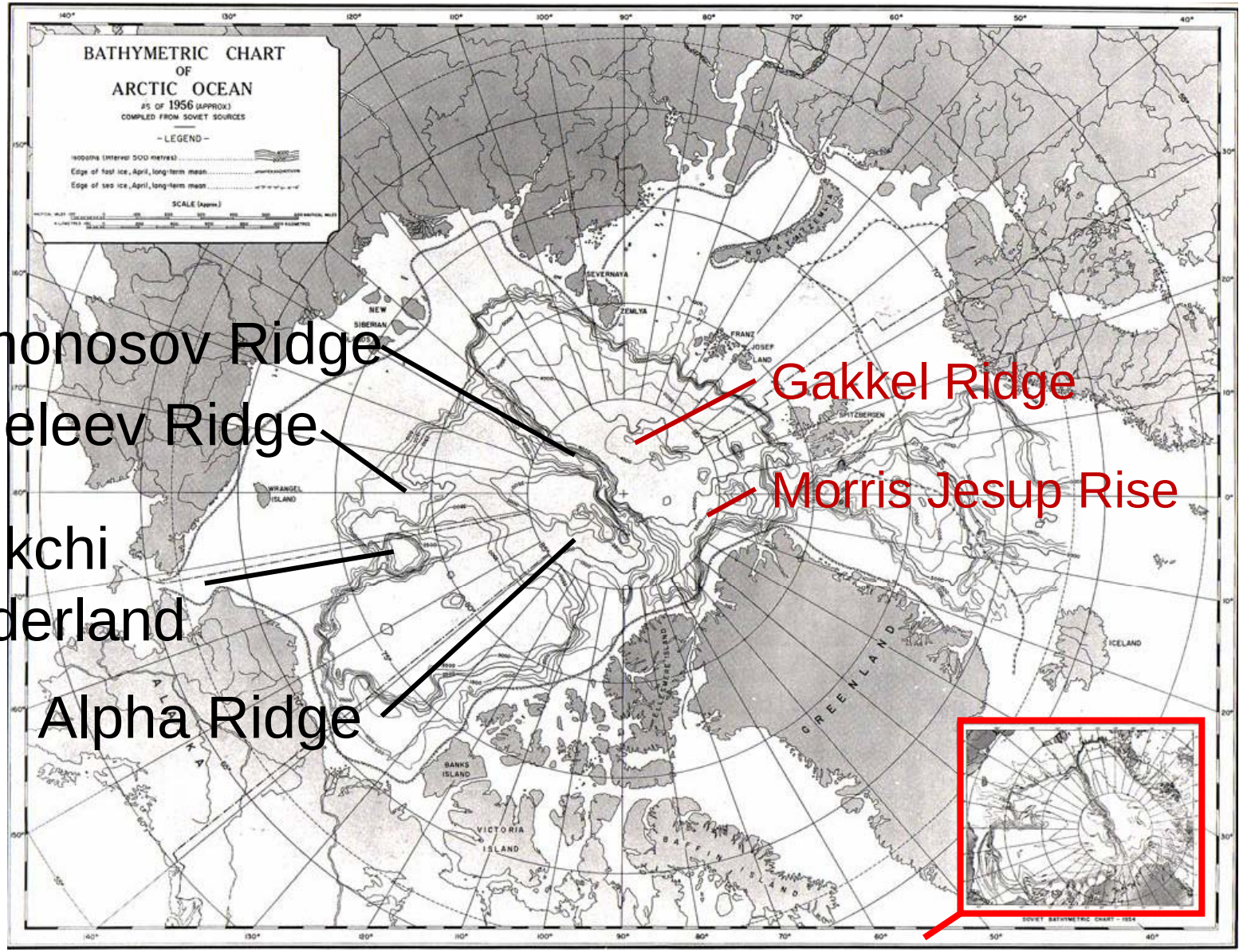

Bathymetrical Chart
of
NORTH POLAR SEAS
By
Fridtjof Nansen.
Metres.
Sea Level.

Ice and Snow characteristics from aircraft landing observations by former Soviet Union, 1928-1989



Data source:
National Snow and Ice Data Center. 2004. *Morphometric characteristics of ice and snow in the Arctic Basin: aircraft landing observations from the Former Soviet Union, 1928-1989*. Compiled by I.P. Romanov. Boulder, CO

Defense research board of Canada 1956



Soviet Union map, 1954, Burhanov

USS Nautilus, first nuclear driven submarine to cross over the North Pole on August 3, 1958

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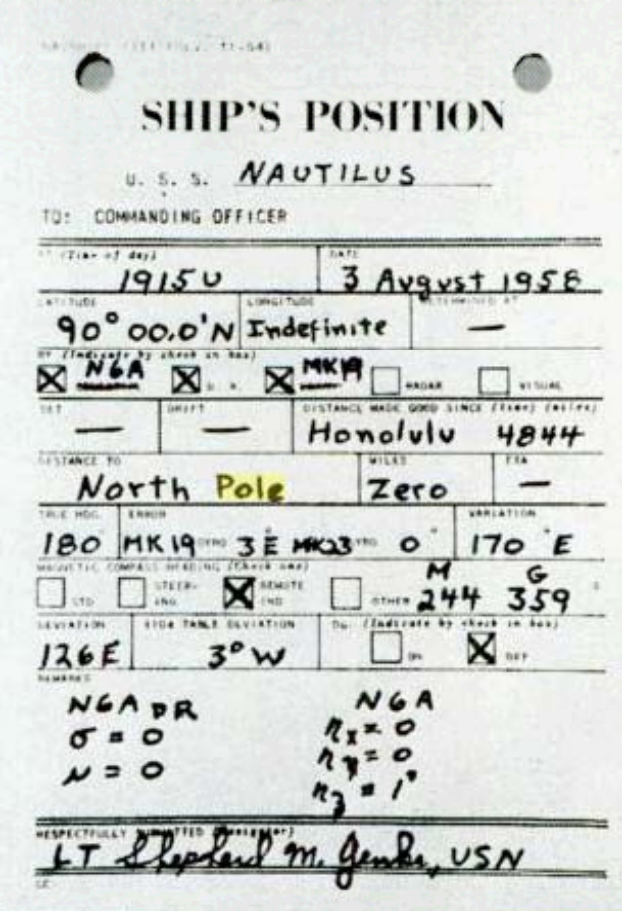


SHIP'S POSITION

U. S. S. NAUTILUS

TO: COMMANDING OFFICER

1915 U	3 August 1958
90° 00.0' N	Indefinite
Honolulu 4844	
North Pole	Zero
180	MK 19 3 E MK 23 0
170 E	
M 244 G 359	
126 E	3° W

NGA DR
σ = 0
ν = 0

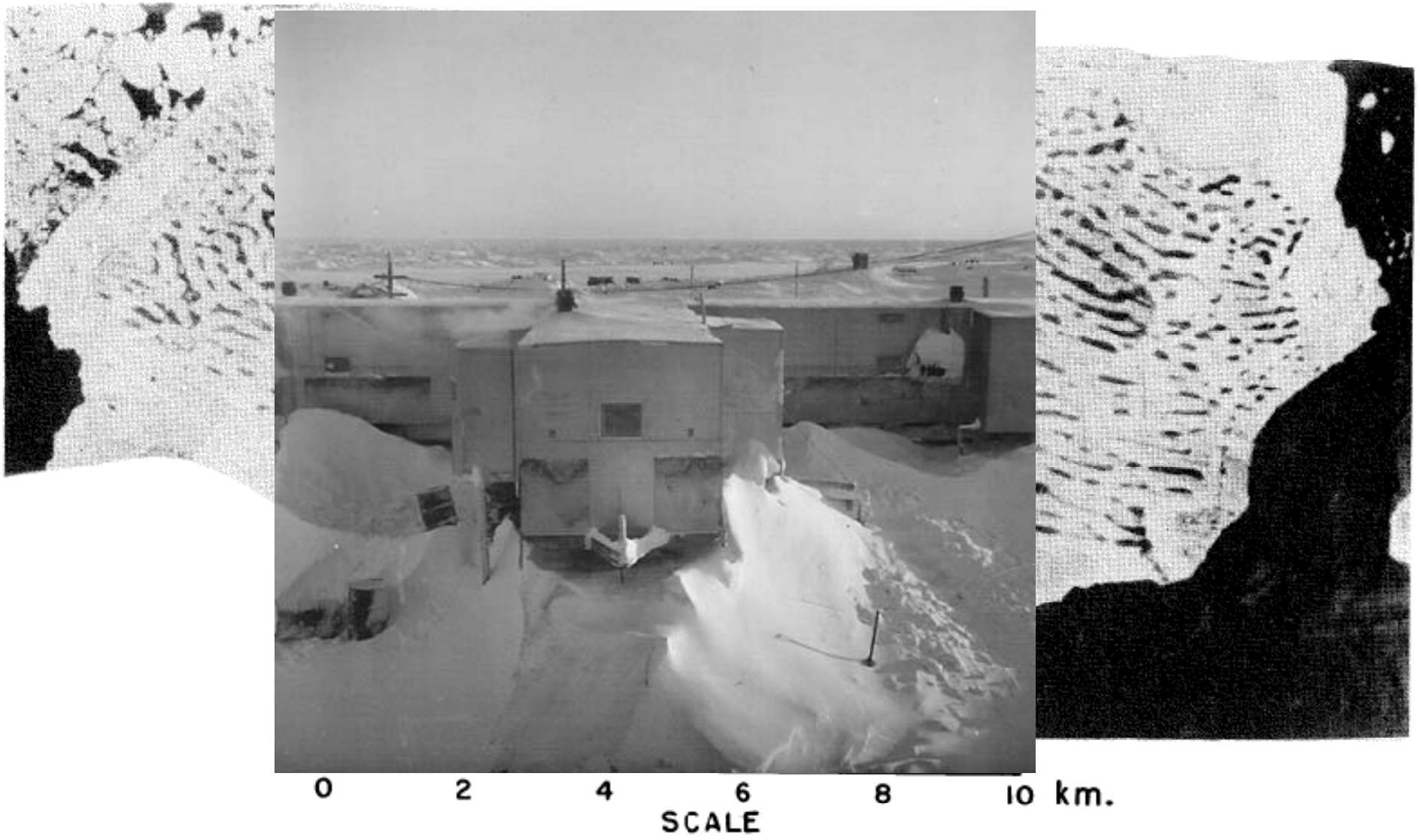
NGA
$n_x = 0$
$n_y = 0$
$n_z = 1'$

RESPECTFULLY SUBMITTED
LT Eugene P. Wilkinson, USN

Source: Wikipedia

Commanding officer was CDR William R. Anderson

Fletcher’s Ice Island T-3 (1952-1974)



Large tabular iceberg discovered by U.S. Air Force Colonel Joseph O. Fletcher

GEBCO Sheet 5.17 source data

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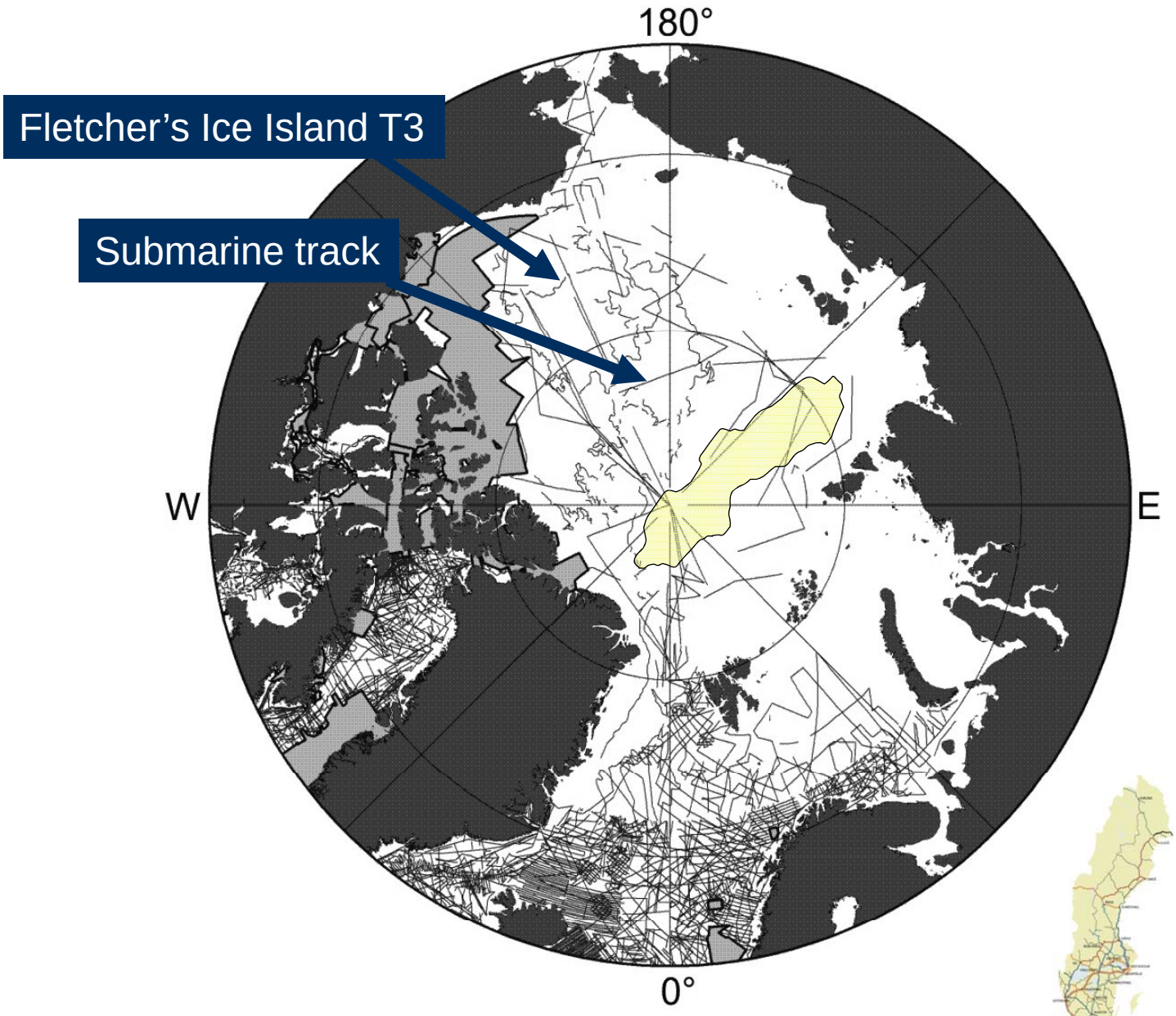
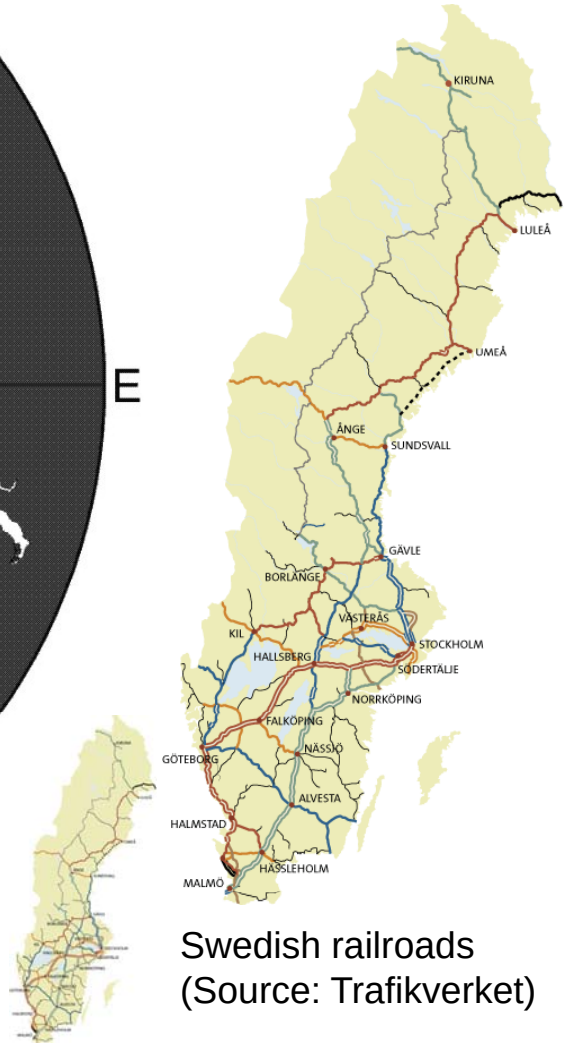
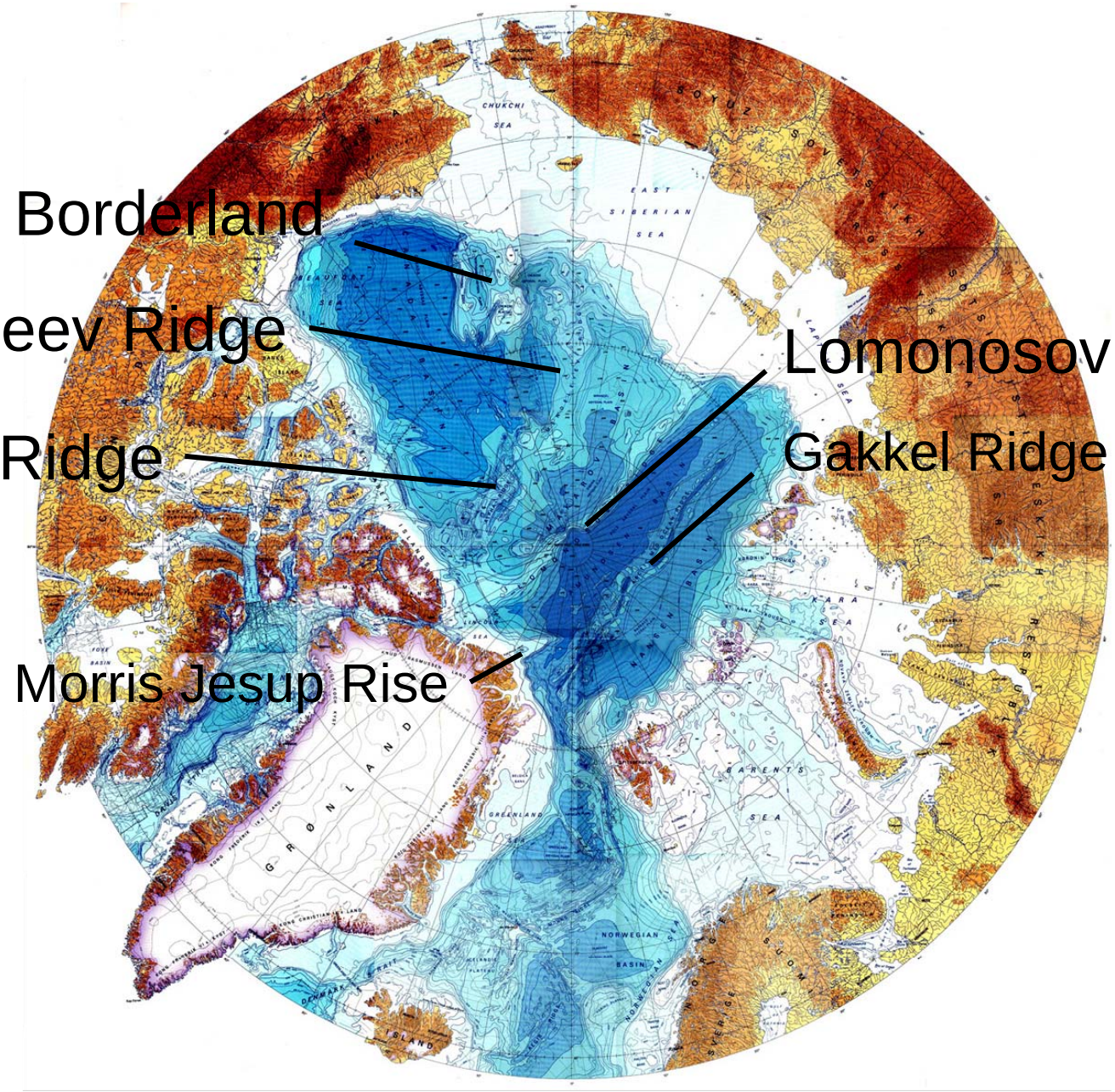


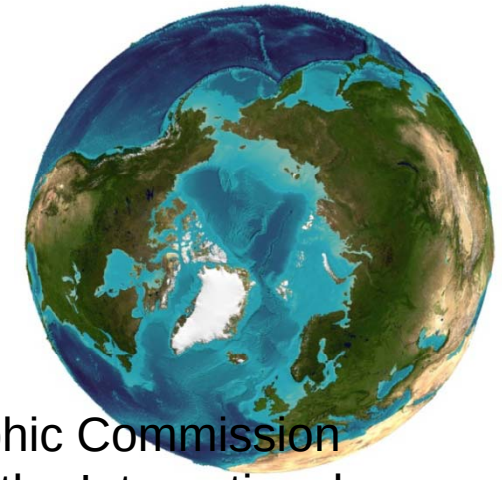


Swedish railroads
(Source: Trafikverket)

GEBCO Sheet 5.17 (Canadian Hydrographic Survey et al., 1979)



International Bathymetric Chart of the Arctic Ocean (IBCAO)

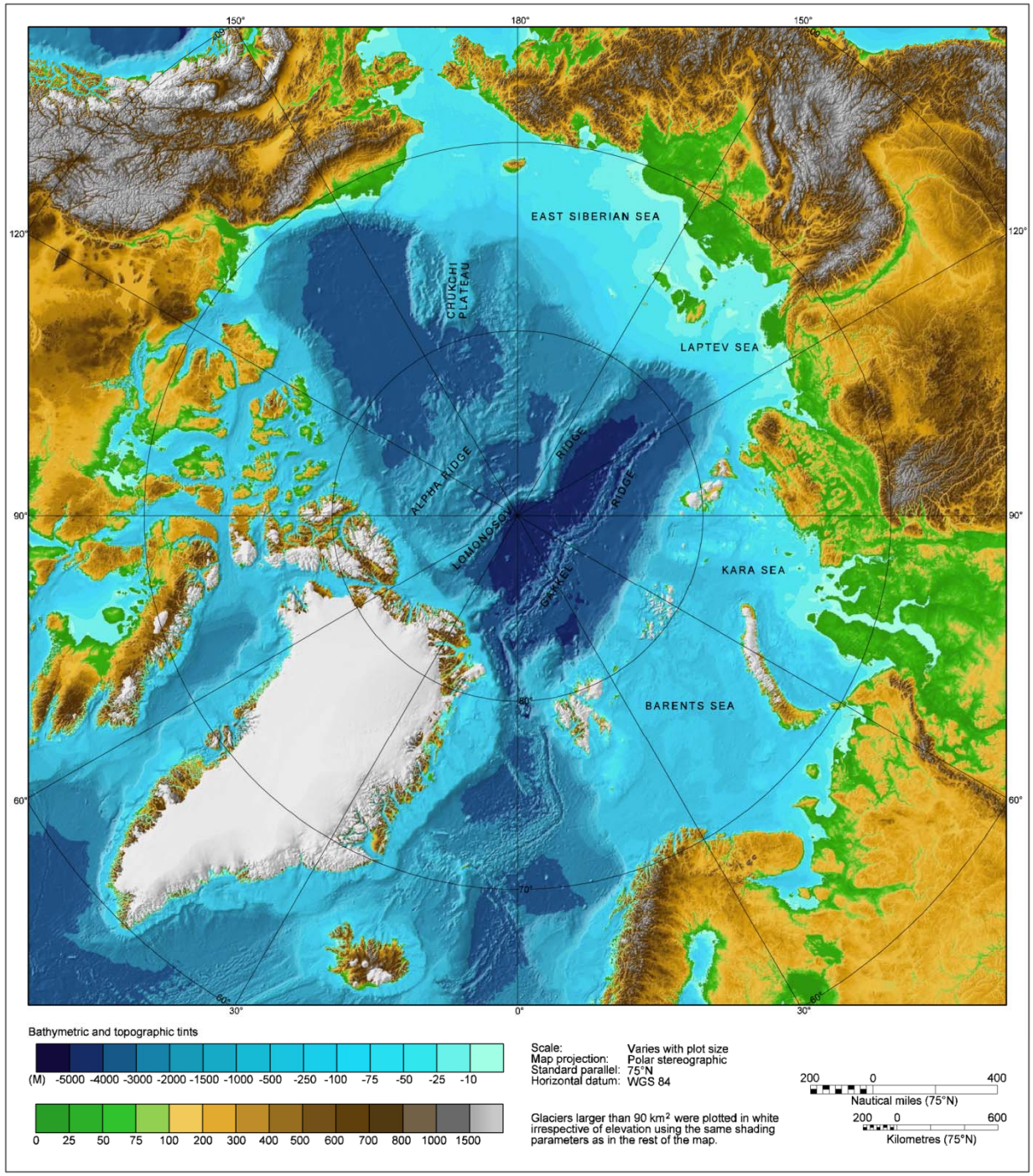


- Initiated 1997 in St Petersburg, Russia
- Originally endorsed by the Intergovernmental Oceanographic Commission (IOC), the International Arctic Science Committee (IASC), the International Hydrographic Organization (IHO)

Chairman: Ron Macnab

First compilation published 2000 with an article in EOS:

Jakobsson, M., Cherkis, N., Woodward, J., Macnab, R., Coakley, B., 2000. New grid of Arctic bathymetry aids scientists and mapmakers. EOS, Transactions American Geophysical Union 81, 89, 93, 96.



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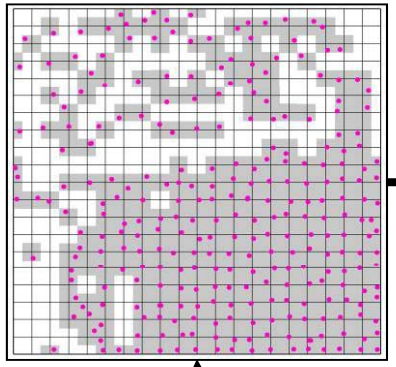
Map presented in EOS:

Jakobsson, M., Cherkis, N., Woodward, J., Macnab, R., Coakley, B., 2000. New grid of Arctic bathymetry aids scientists and mapmakers. EOS, Transactions American Geophysical Union 81, 89, 93, 96.

Raw data

Processed data

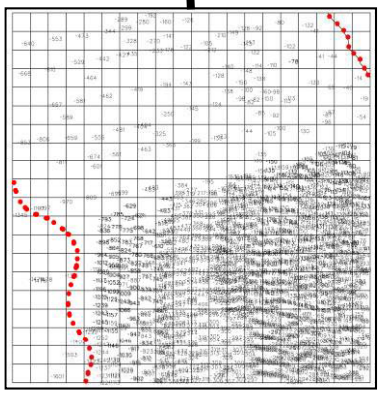
Block median filtering



Data processing
(sound velocity correction, outlier removal etc.)

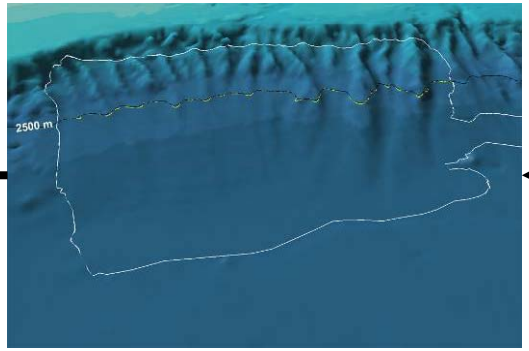
Error correction
(data flagging)

GIS Database



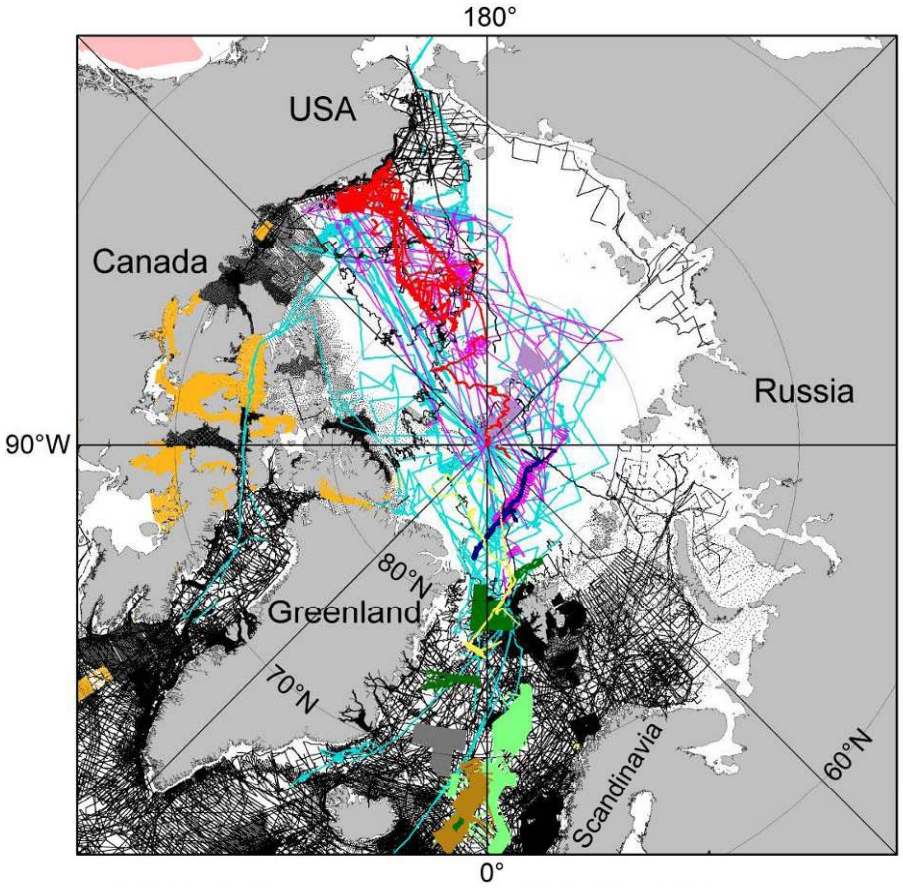
Data mining (cross track analyzes, contour splicing etc.)

Visualization and inspection



Gridding (Continuous curvature splines in tension algorithm, GMT algorithm: Smith & Wessel, 1990)

IBCAO Version 2.0: Source Data

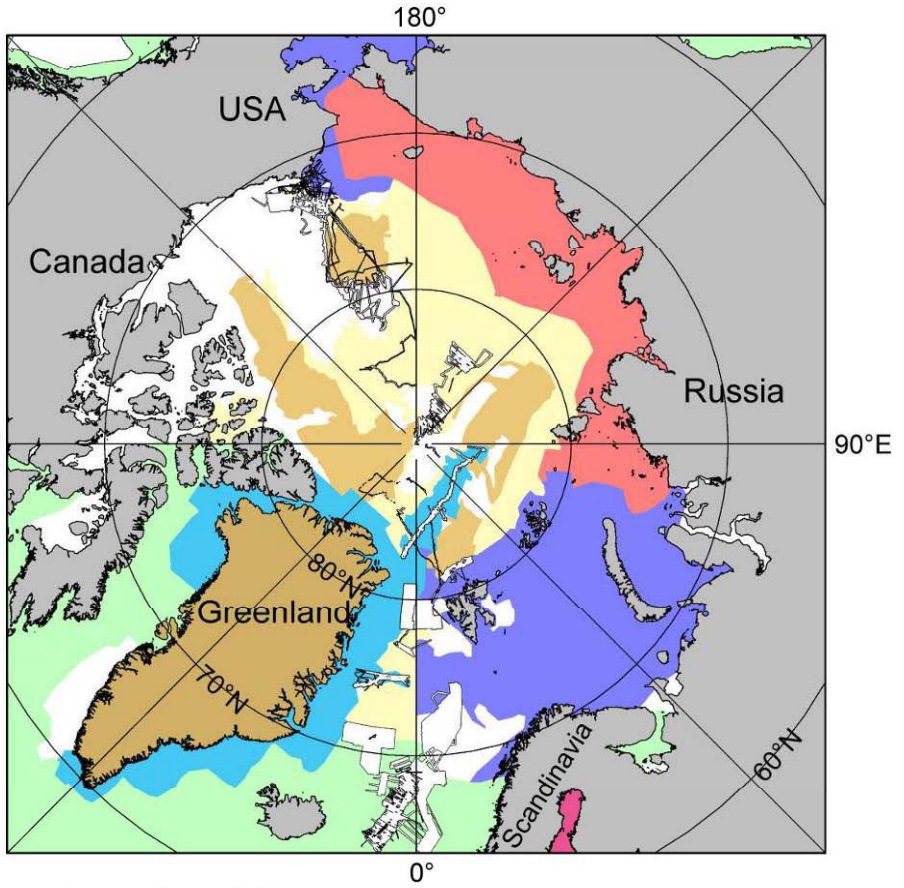


Multibeam Sources

- *USCGC Healy, R/V Nathaniel B Palmer*
- *R/V Polarstern*
- *I/B Oden*
- *Norwegian Petroleum Directorate*
- *AMORE (Healy and Polarstern)*
- *SCICEX 1999*
- *US Naval Research Laboratory (NRL)*
- *US Law of the Sea mapping by the Center for Coastal and Ocean Mapping/ Joint Hydrographic Center**

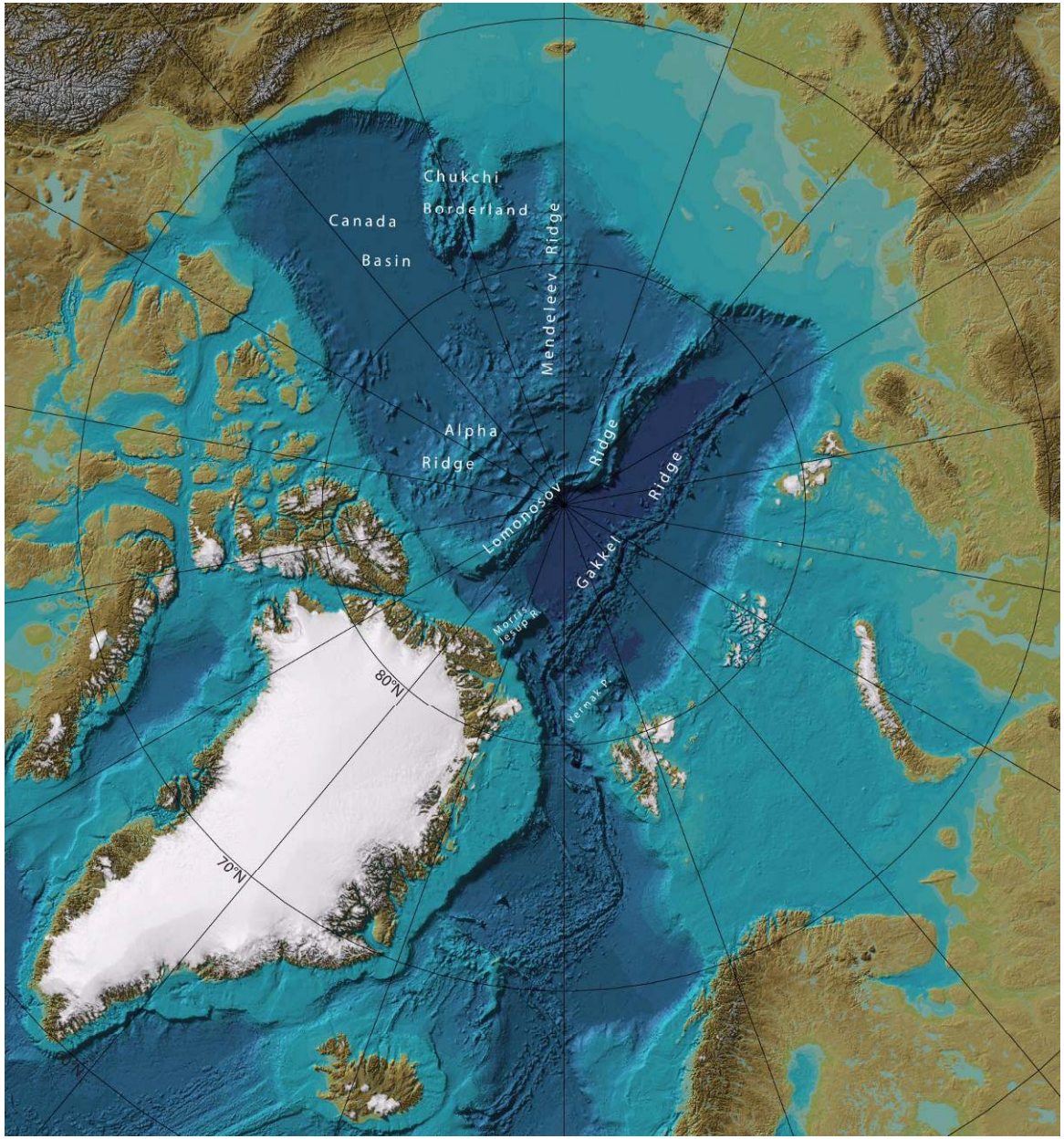
Single Beam Sources

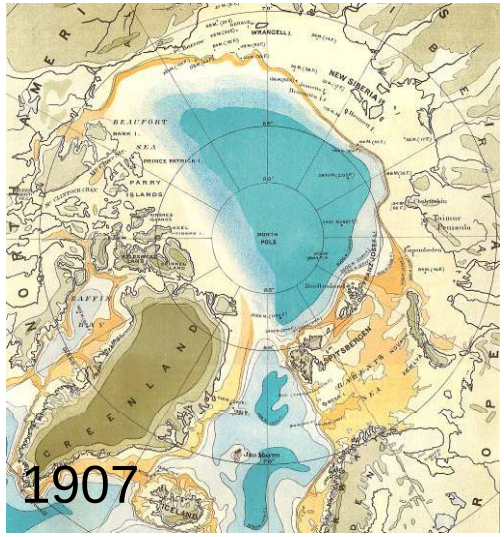
- *US and Brittish Royal Navy submarine cruises (1958-1992)*
- *SCICEX cruises (1993-1999)*
- *Norwegian Hydrographic Service survey*
- *Soundings from Canadian Hydrographic Service surveys not included in earlier IBCAOs*
- *Soundings collected by various surface vessels and ice drift stations. Five major archives have been included:*
  1. *US National Geophysical Data Center (NGDC)*
  2. *US Naval Reserach Laboratory (NRL)*
  3. *US Geological Survey (USGS)*
  4. *Norwegian Hydrographic Service*
  5. *Royal Danish Administration of Navigation and Hydrography*

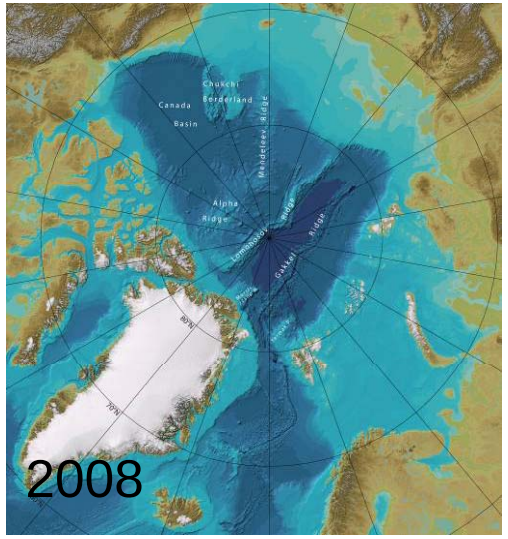


Maps and Regional Grids

- IBCAO drawn contours
- IBCAO drawn contours based on soundings from charts published by the Russian Federation's Department of Navigation and Oceanography (DNO)
- 1:5 000 000 scale DNO map of the Arctic Ocean (Naryshkin, 1999)
- 1:2 500 000 scale DNO map of the Arctic Ocean (Naryshkin, 2001)
- Charts published by NRL (Perry et al., 1986; Cherkis et al., 1991; Matishov et al., 1995)
- Contours retrieved from the GEBCO Digital Atlas (GDA) 2003.
- Bathymetry in the Gulf of Bothnia from a digital grid by Siefert et al. (2001)
- Greenland DTM by the Danish Cadaster and Mapping Agency (Ekholm, 1996)
- GTOPO30 topographic model (U.S. Geological Survey, 1997)







Jakobsson et al., 2008, GRL

OCEANOGRAPHY

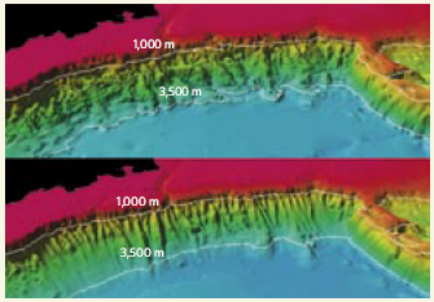
Bottom of the top of the world

The floor of the Arctic Ocean comes into sharper focus with the publication of an improved version of a bathymetric chart first released in provisional form in 1999, and as version 1 in 2001. Accurate mapping of the ocean bottom is essential for modelling deep ocean circulation, but also has a political angle in defining the extent of the continental shelf — a serious consideration in such a politically sensitive part of the world as the Arctic.

The story behind the improved bathymetric chart — IBCAO Version 2.0 — is told by Martin Jakobsson and colleagues in *Geophysical Research Letters* (M. Jakobsson *et al. Geophys. Res. Lett.* **35**, L07602; 2008). Its production is an instructive case of new data being married to a reinterpretation of old.

Most of the new data come from mapping missions carried out since 2000 with multibeam sonar equipment aboard various vessels, including USCGC *Healy*, RV *Polarstern* and IB *Oden*. Multibeam sonar systems differ from the sidescan systems used, for example, to look at the shape of the sea floor or to detect wrecks, in providing information mainly about depth.

The more dramatic changes to version 2 over version 1 are that, as the authors laconically put it, the "deep abyssal plains are systematically ca. 50–60 m deeper ...". The revision stems from a metadata analysis of records collected by US Navy submarines over several decades, which are a central source of bathymetric information at high northern latitudes in particular. Conversion of data for version 1 was based on an assumption that the figure for the speed of sound in water used for the original calculations was 1,500 m s^{-1}. But in many cases the figure applied



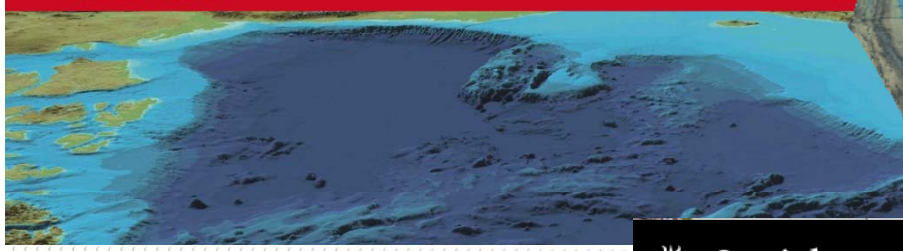
was 1,463 m s^{-1}. Hence the change in estimated depth, which also helps to explain several anomalies evident in version 1.

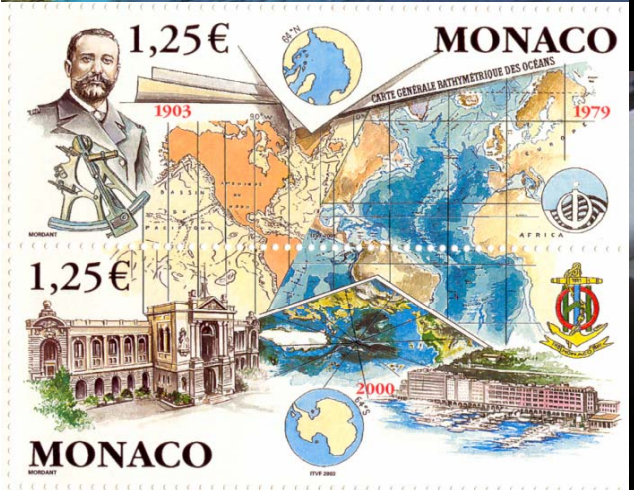
The three-dimensional views shown here are depictions of the Alaskan Slope and Northwind Ridge before (upper image) and after Jakobsson and colleagues' exercise in producing version 2. The image is about 650 km across, and the black area at the upper left is Alaska; the Northwind Ridge is the 'peninsula' on the right. The improved definition is evident in the sharper depiction of the gullies, caused by erosion, that scar the Alaskan Slope.

The new map is far from the final word. The authors point out that a near-perfect bathymetric model will require comprehensive multibeam coverage, which won't be available anytime soon. Meanwhile, more details on version 2 and derivations o it are available from www.ibcao.org

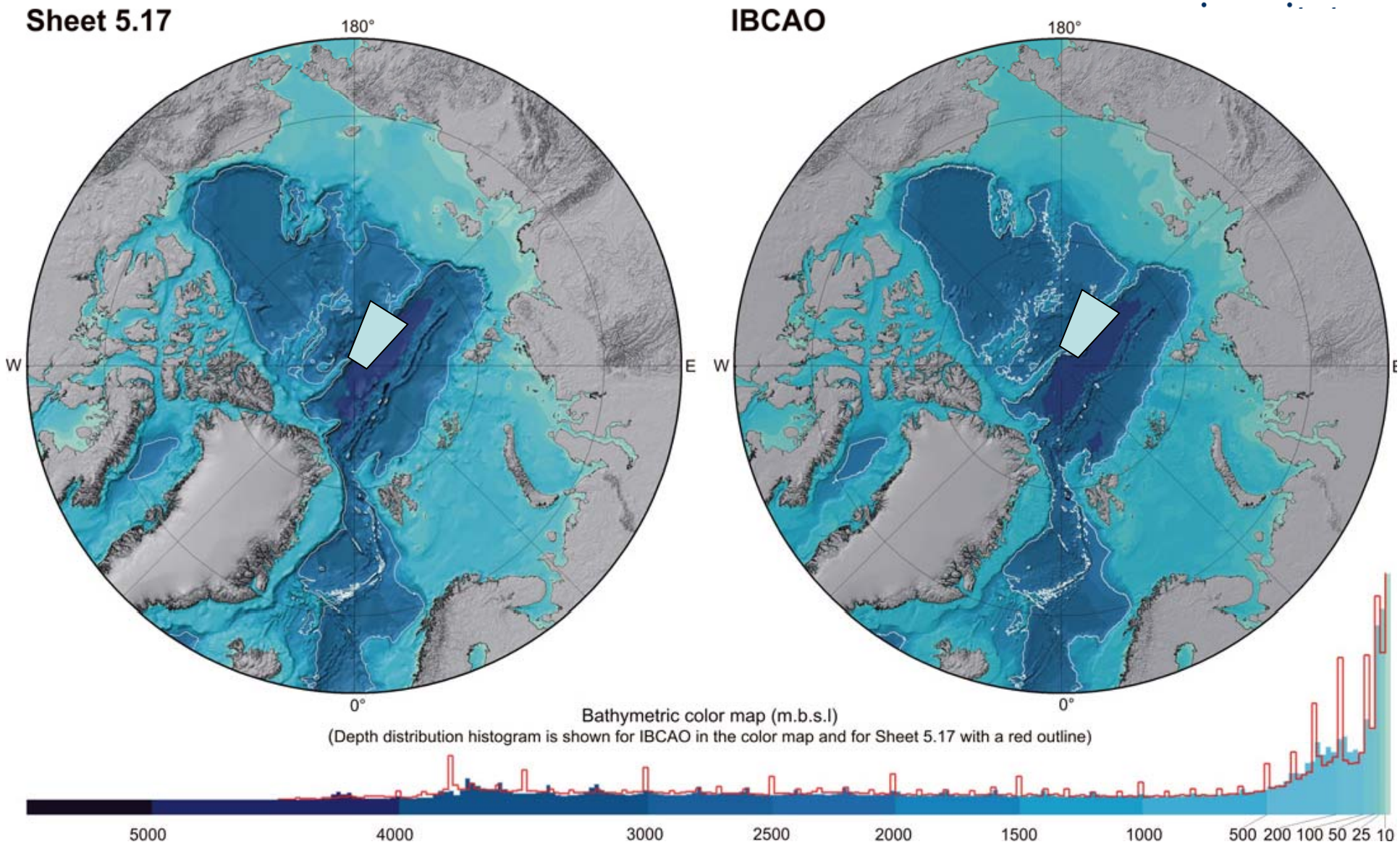
Tim Lincoln

NEWS FEATURE NAT





Comparing GEBCO and IBCAO over the Lomonosov Ridge



Jakobsson and Macnab, Marine Geophysical Researches, 2006

Comparing GEBCO and IBCAO over the Lomonosov Ridge

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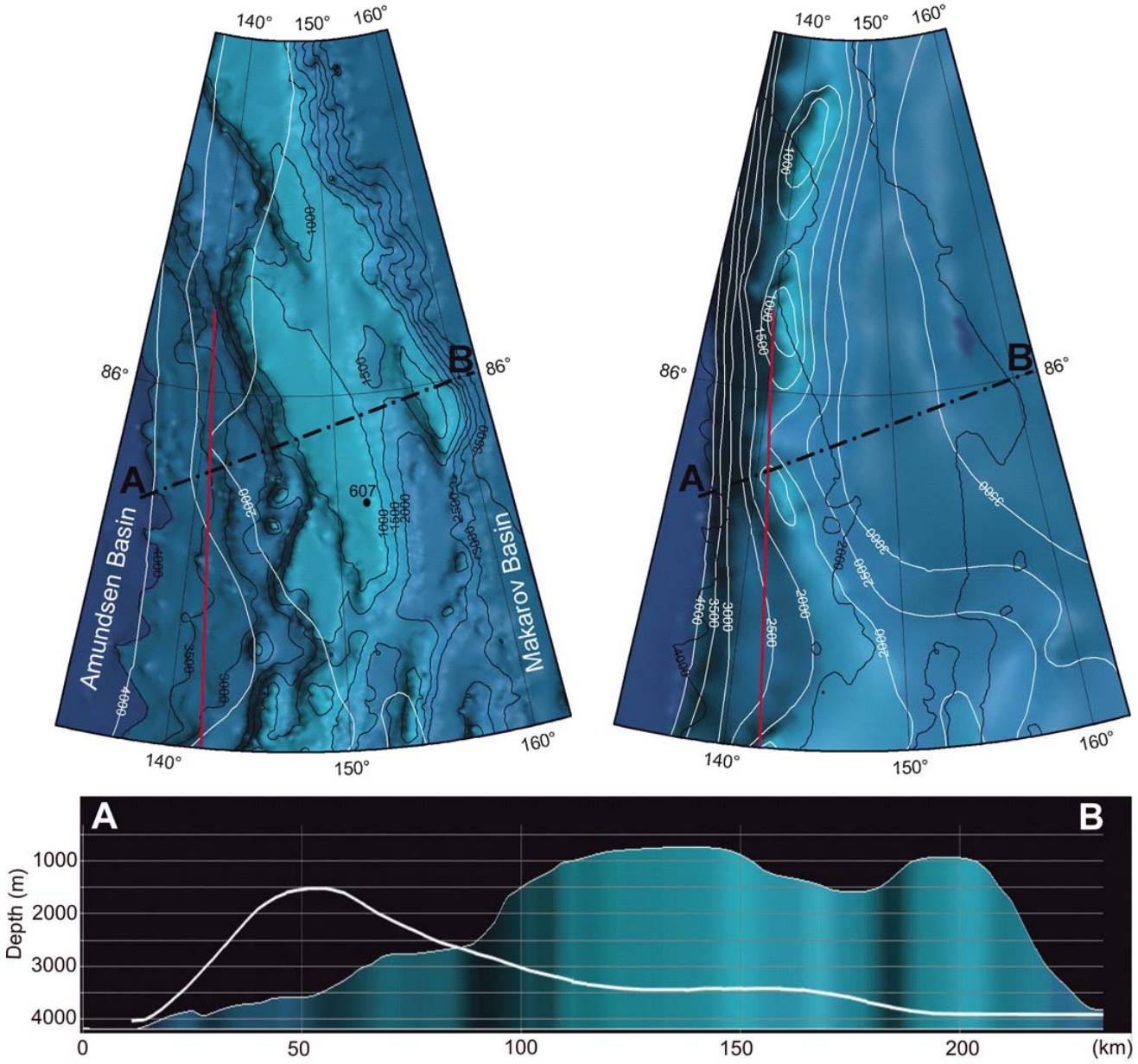

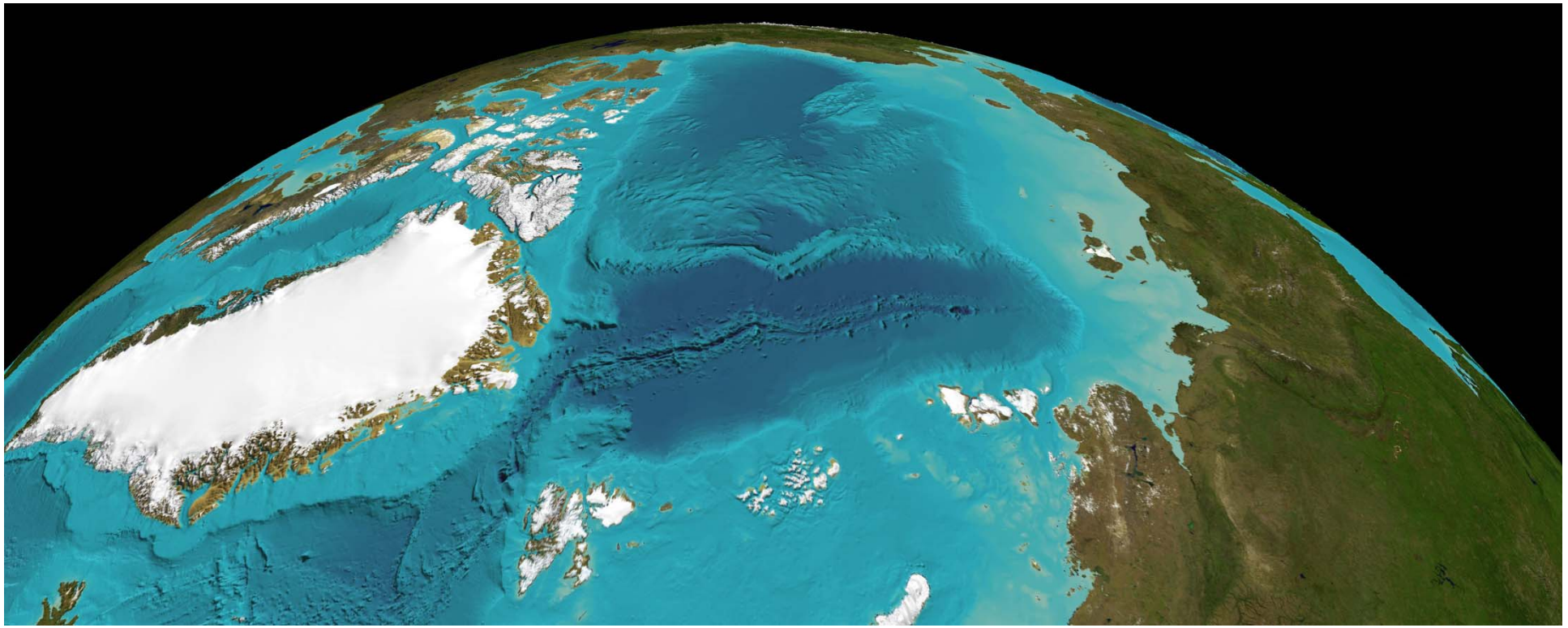

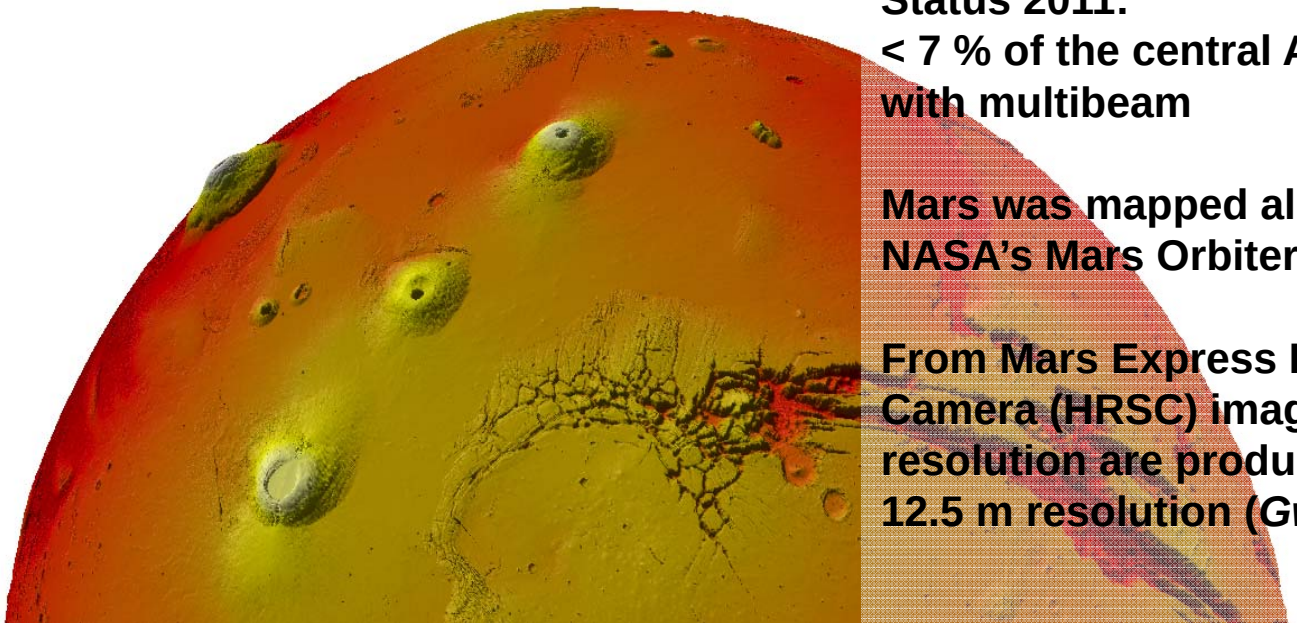

Status 2011:
< 7 % of the central Arctic Ocean is mapped with multibeam

Mars was mapped already in 1998 and 1999 by NASA's Mars Orbiter Laser Altimeter (MOLA).

From Mars Express High-Resolution Stereo Camera (HRSC) images, DTMs of 50x50 m resolution are produced and ortho-images with 12.5 m resolution (*Gwinner, et al,., EPSL, 2010*)