Mapping the Arctic Ocean

The International Bathymetric Chart of the Arctic Ocean
IBCAO Version 2.0

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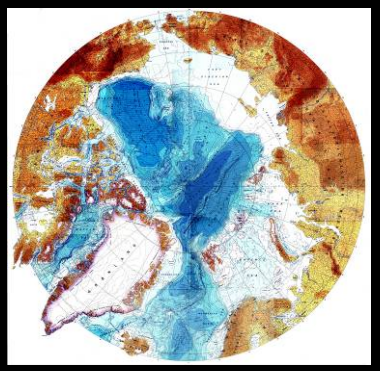
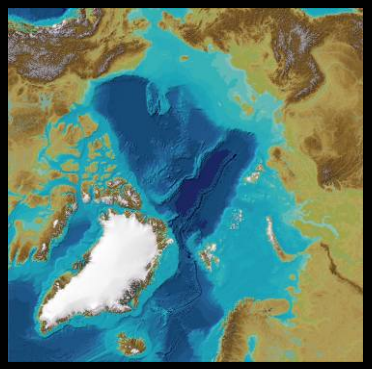
IBCAO Editorial Board

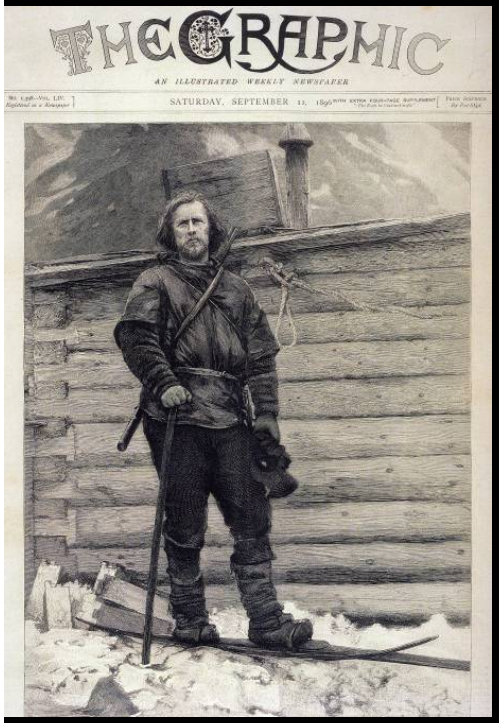


1500 **1800** **1900** **2008**

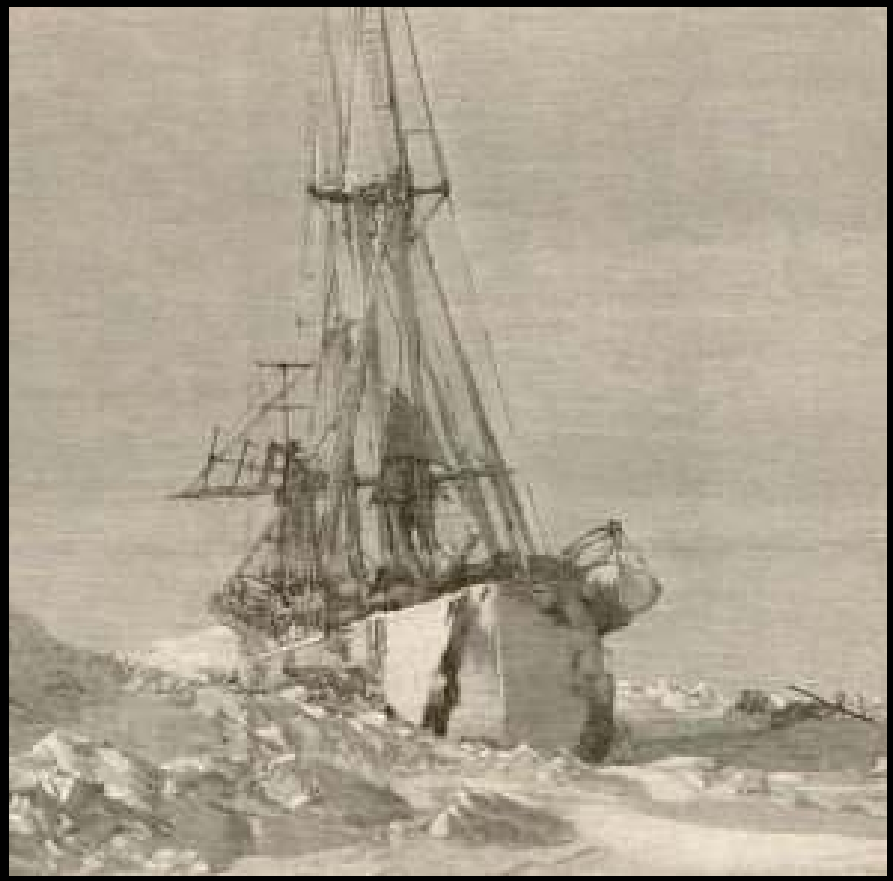
The ship *Jeanette*, under the command of captain De Long, was crushed 12 June 1881 North-West of Wrangell Island.

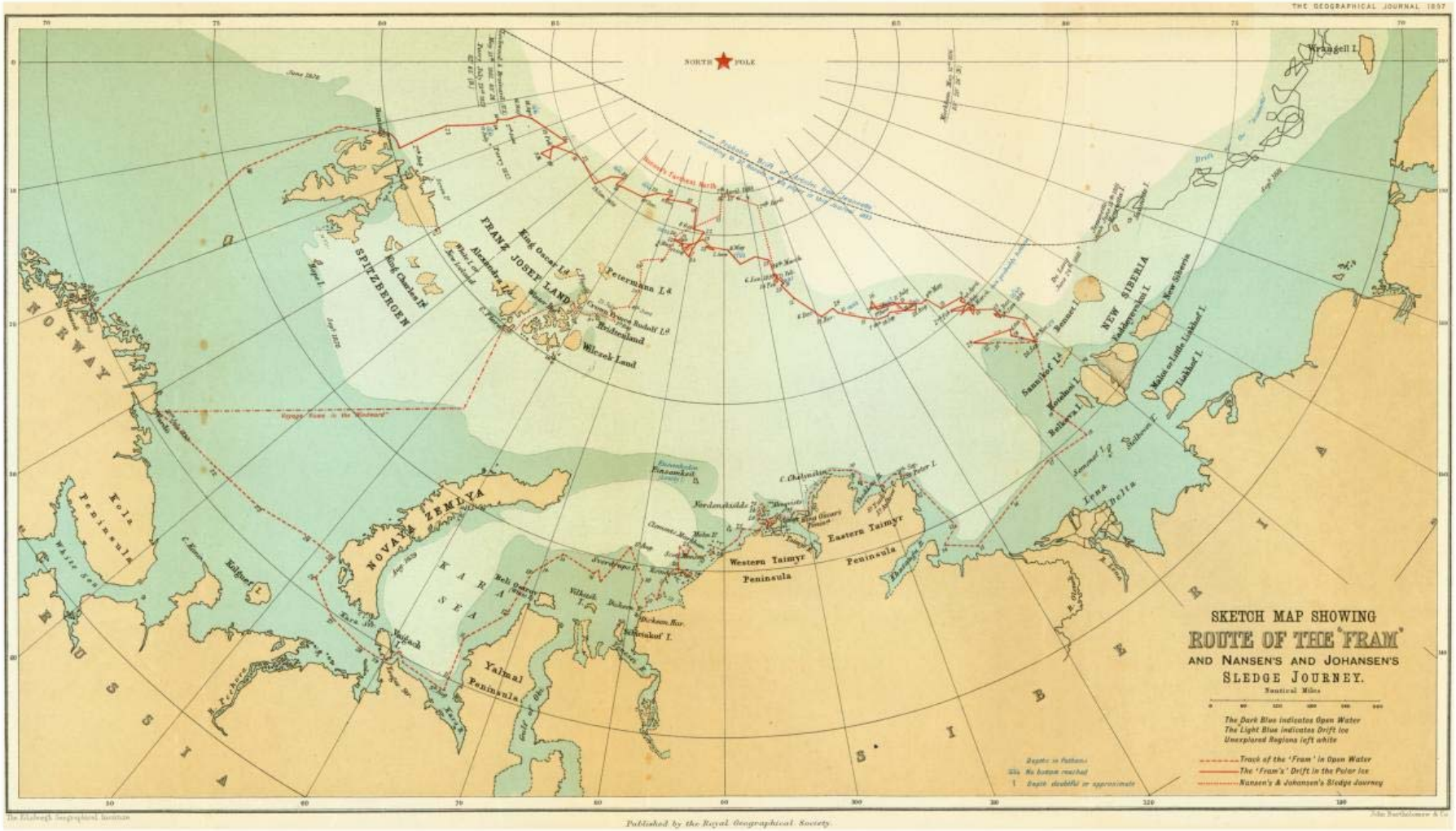
Pieces of the *Jeanette* wreck was found three years later on Greenland.



The wreck parts together with e.g. drift wood, which was discovered to have drifted from Siberia to Svalbard, inspired the Fram expedition

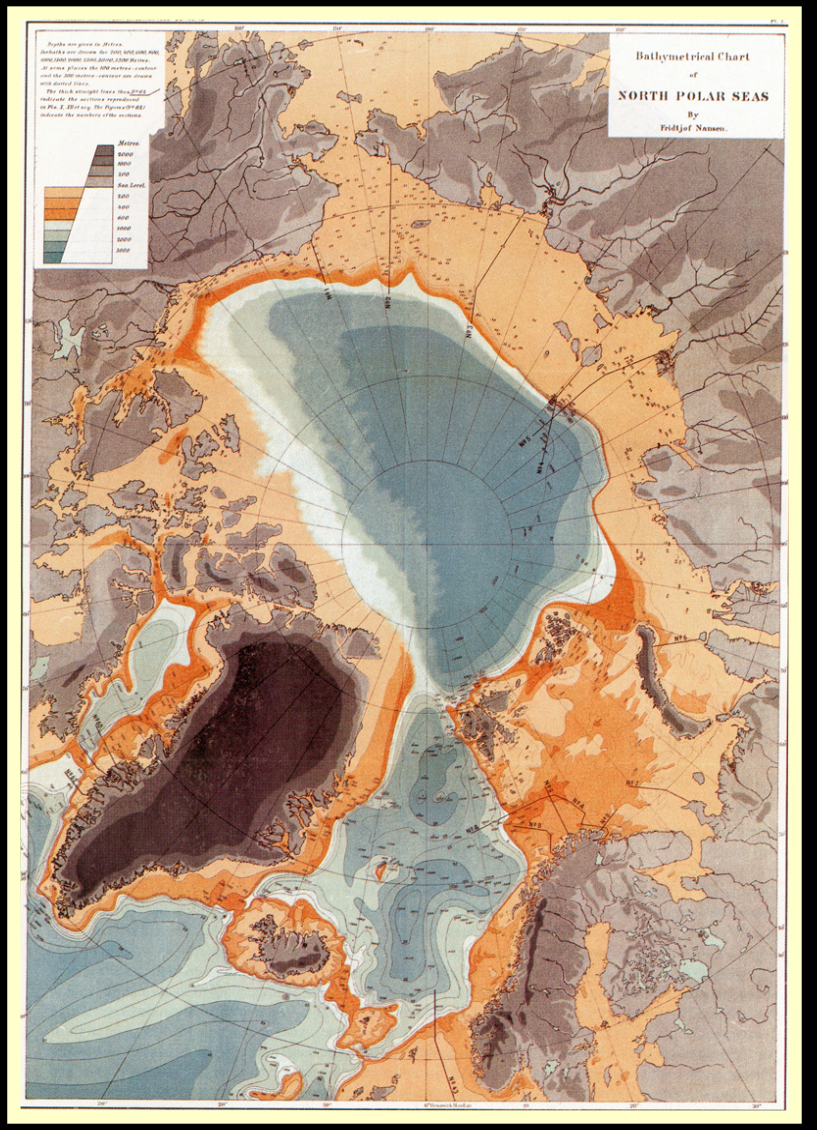
1893-1896

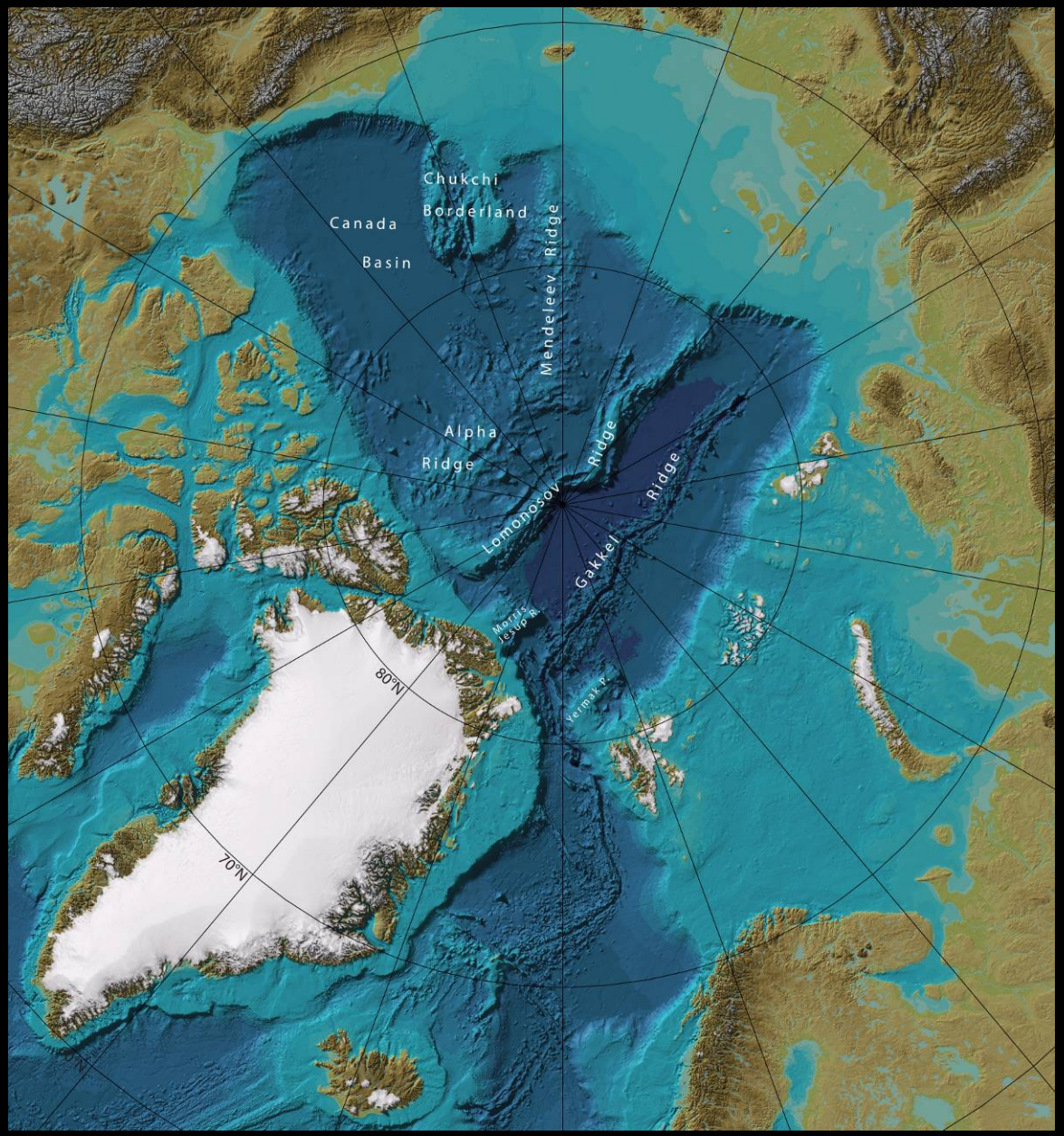


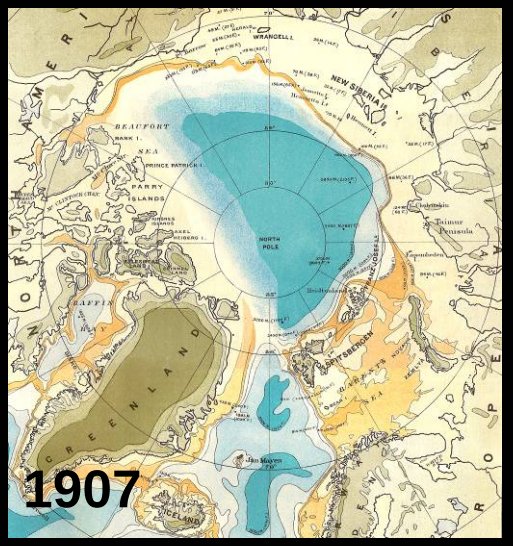


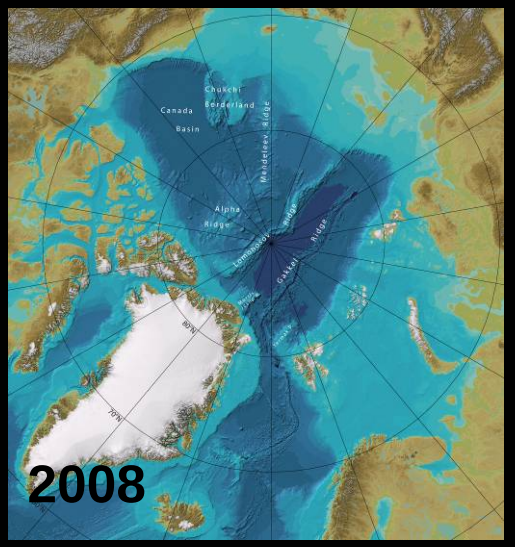
På denne samme is må også en ekspedisjon kunne føres den samme vei

Nansen, 1890









Jakobsson et al., 2008, GRL

OCEANOGRAPHY

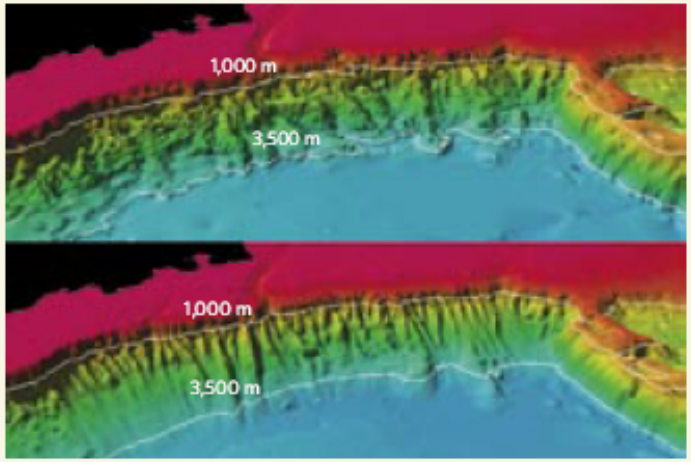
Bottom of the top of the world

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.

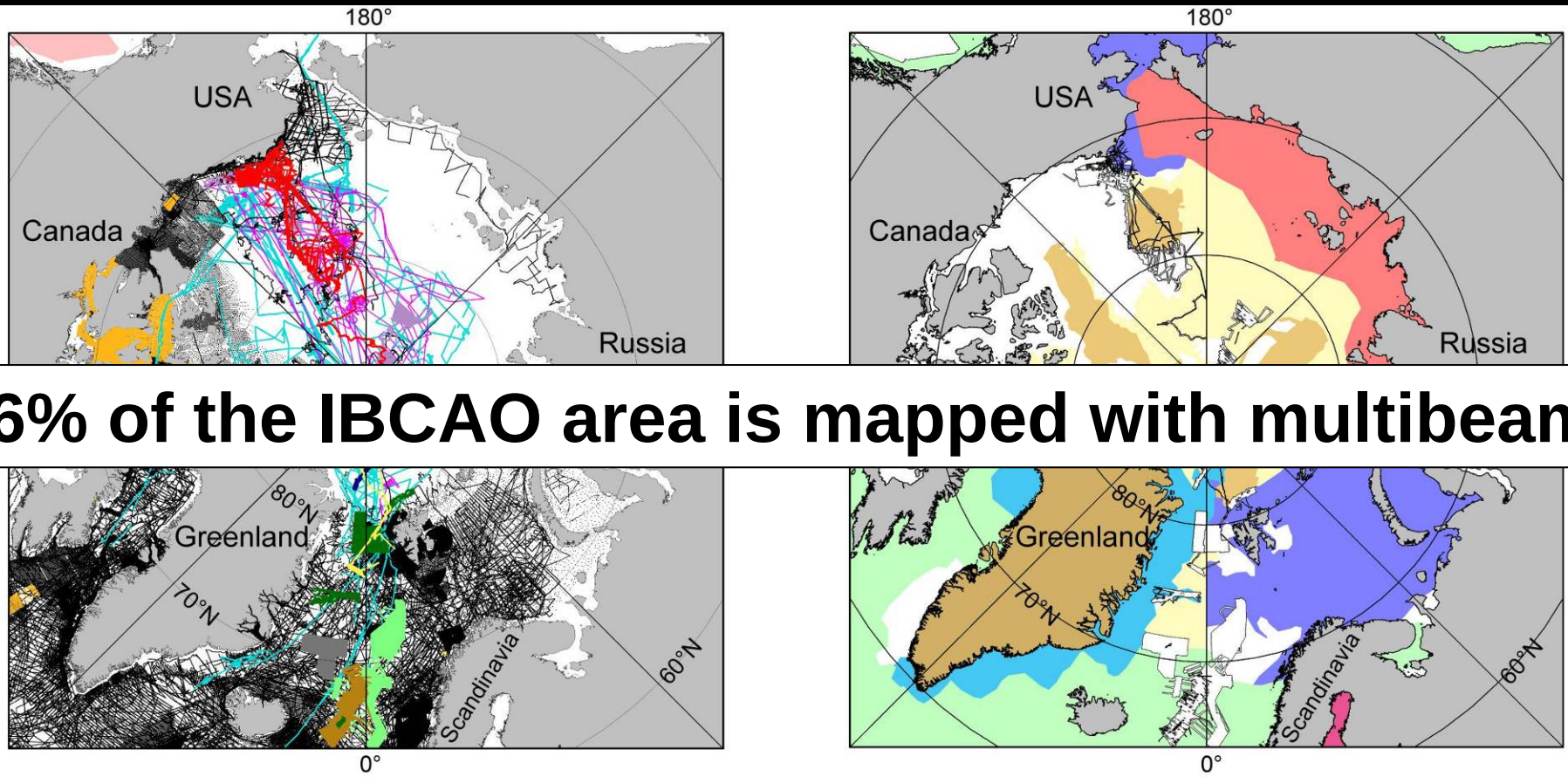


The three-dimensional views shown here are depictions of the Alaskan Slope and Northwind Ridge before (upper image) and after Jakobsson and colleagues' exercise in producing version 2. The image is about 650 km across, and the black area at the upper left is Alaska; the Northwind Ridge is the 'peninsula' 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 of it are available from www.ibcao.org.

Tim Lincoln

IBCAO Version 2.0: Source Data



6% of the IBCAO area is mapped with multibeam

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*

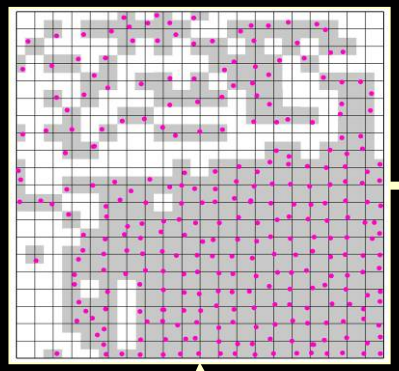
Maps and Regional Grids

- 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)

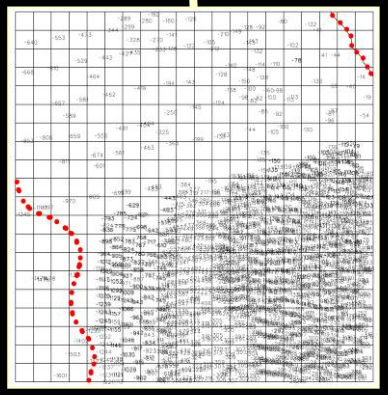
Raw data

Processed data

Block median filtering



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

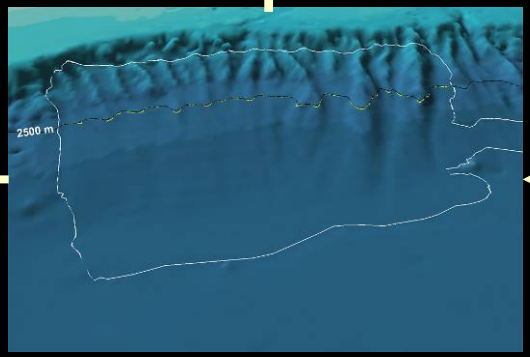


Error correction
(data flagging)

Database

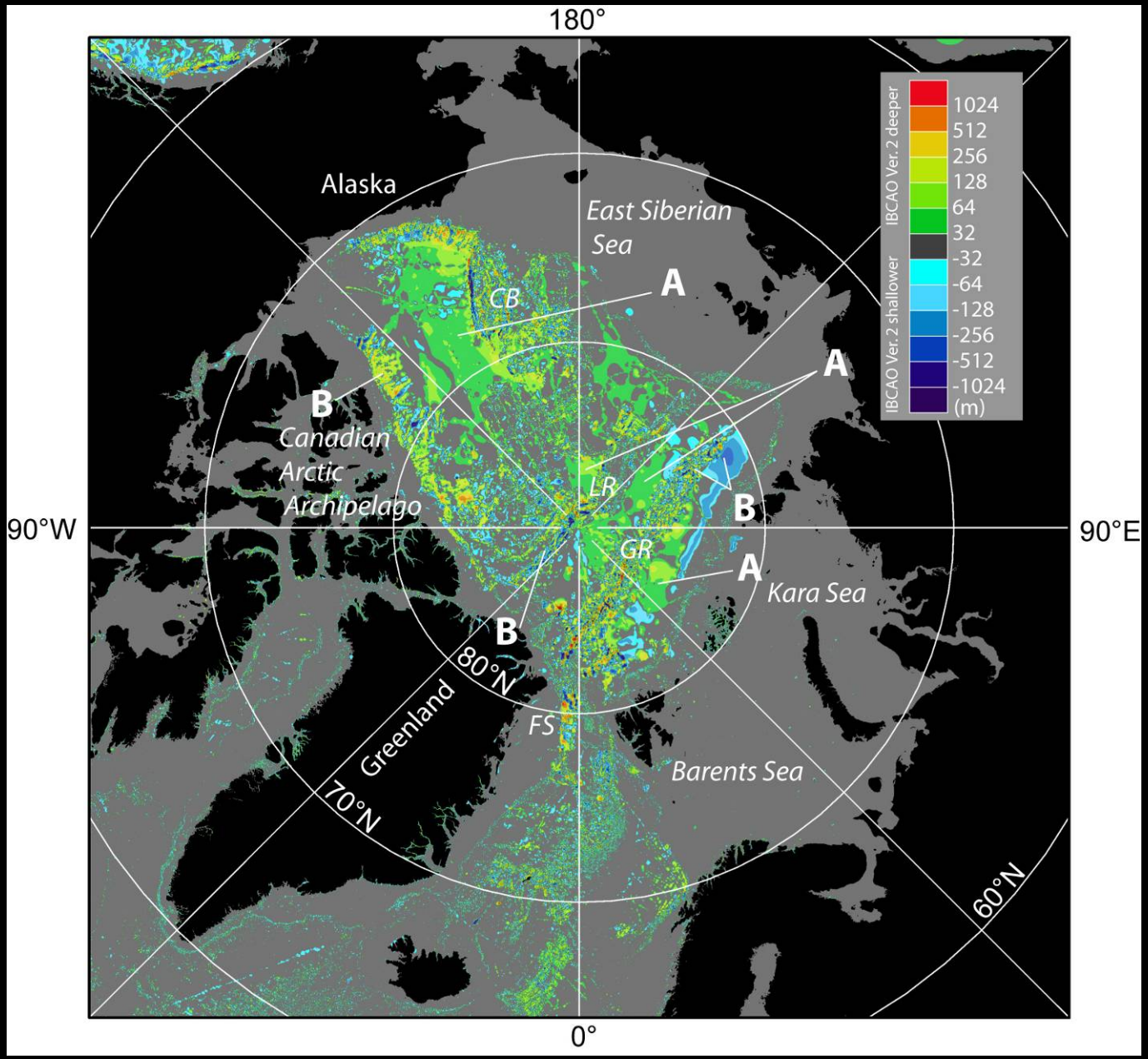
Data mining
(cross track analyzes, contour splicing etc.)

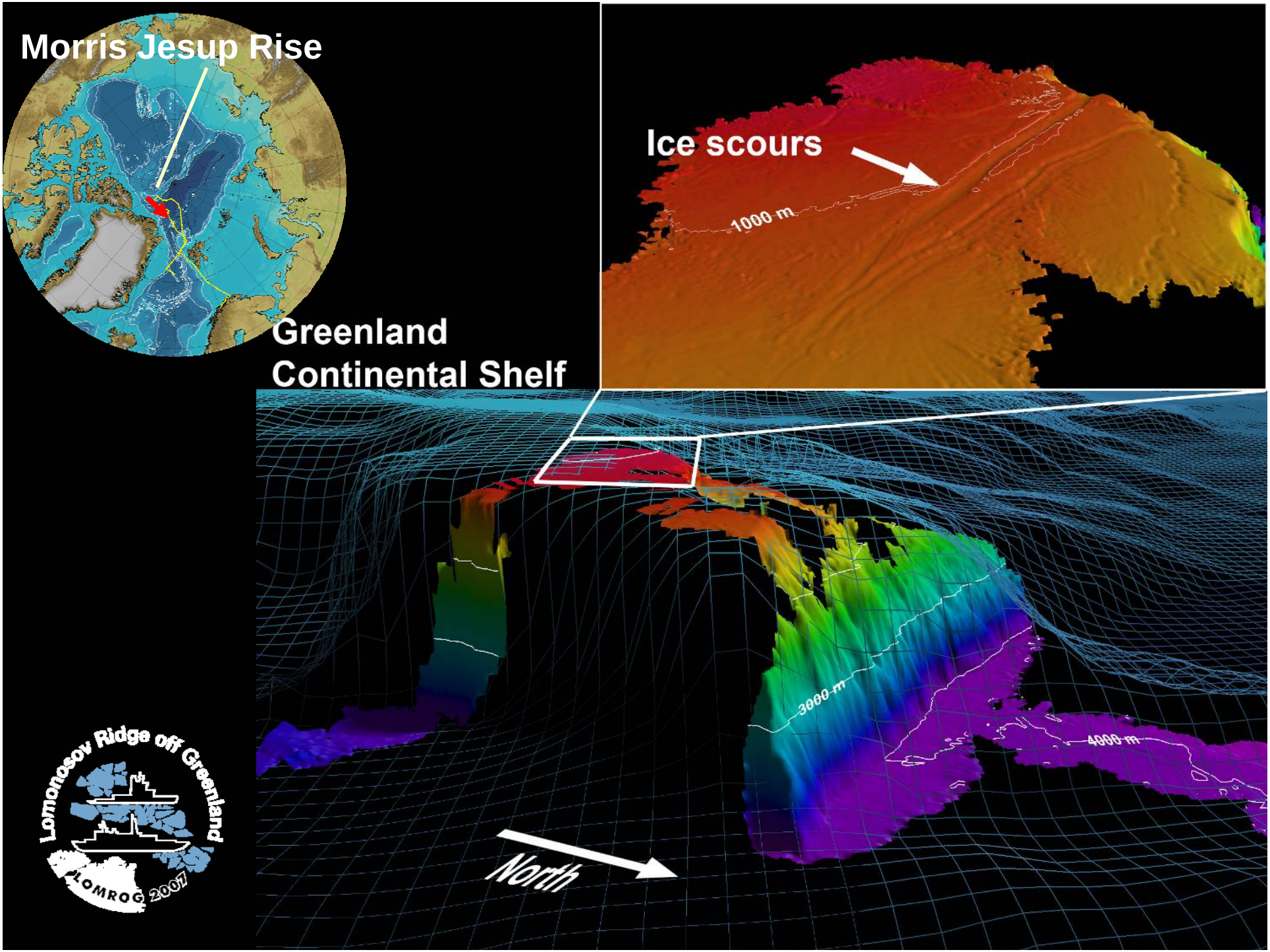
Visualization and inspection

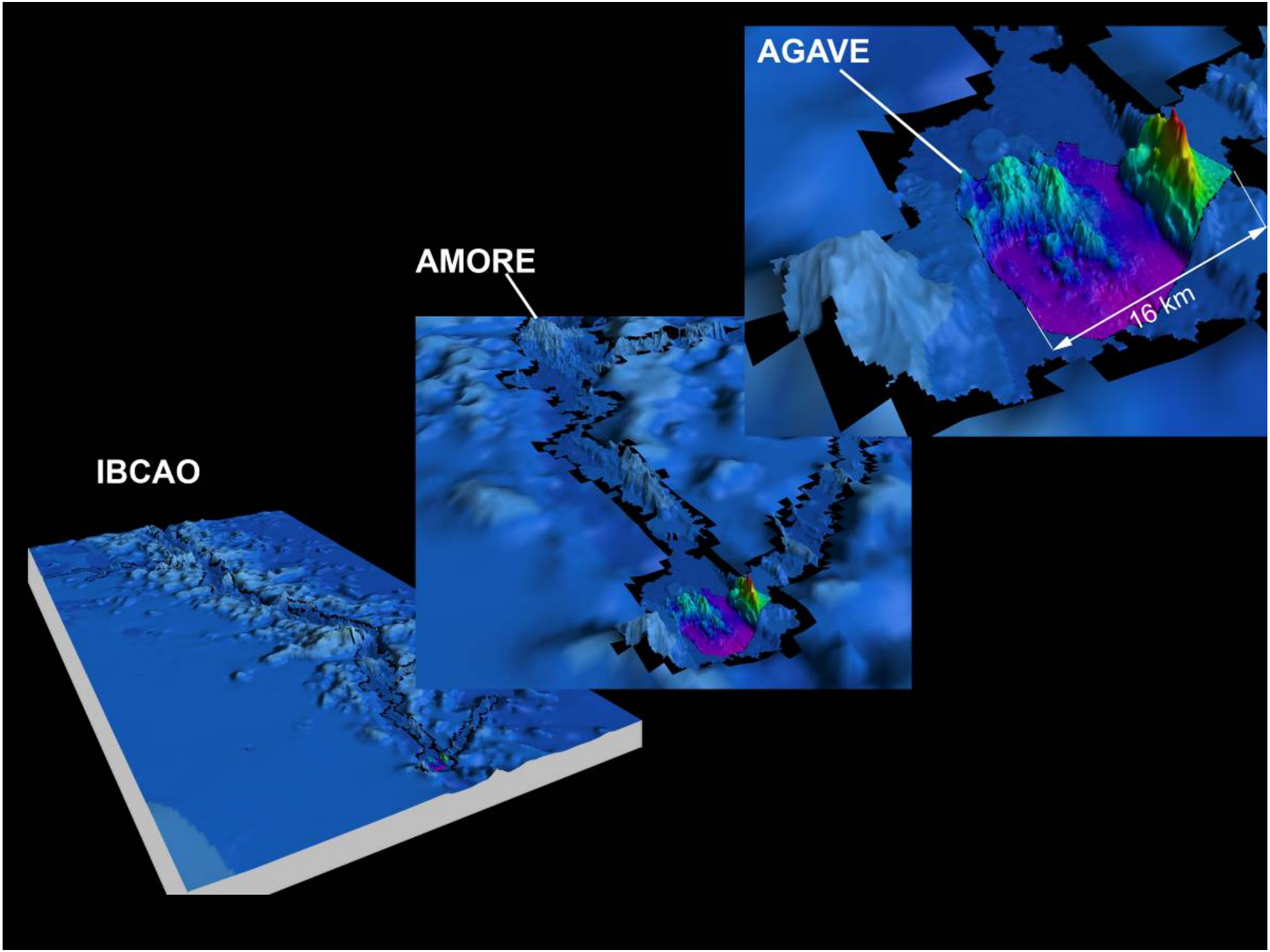


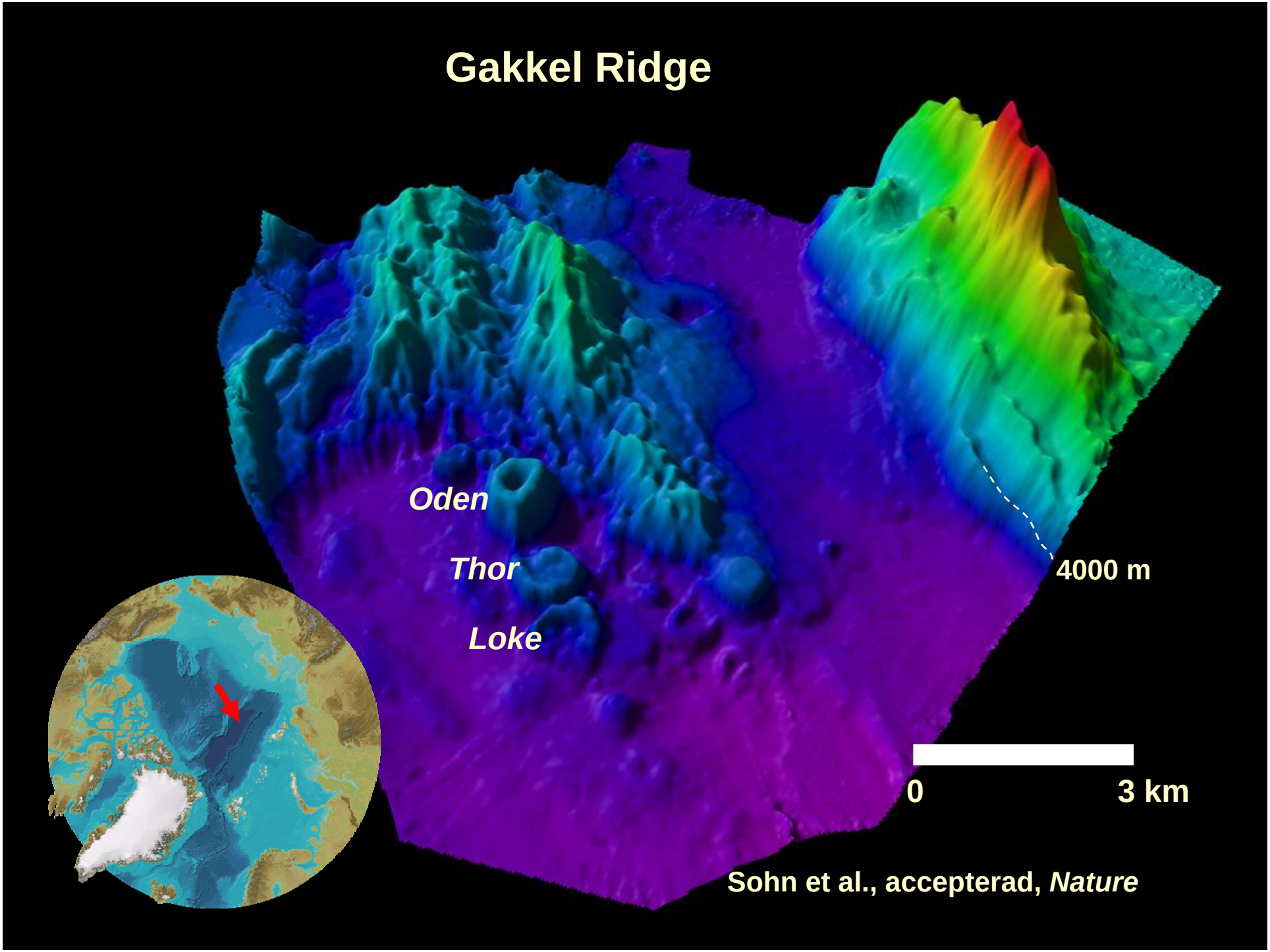
Gridding (Continuous curvature splines in tension algorithm, GMT algorithm: Smith & Wessel, 1990)

Difference IBCAO Version 1 and 2




Morris Jesup Rise
Ice scours
1000 m
Greenland
Continental Shelf
3000 m
4000 m
North
Lomonosov Ridge off Greenland
LOMROG 2007


AGAVE
AMORE
16 km
IBCAO


Gakkel Ridge
Oden
Thor
Loke
4000 m
0
3 km
Sohn et al., accepterad, Nature

Submarine data information

- **Submarine data collected prior to 1988 were digitized from analogue PDR records**
- **SCICEX single data was directly saved to disk through the submarines' PDR's automated digital bottom tracker**

When the data reached IBCAO, the metadata stated that depths referred to a sound velocity of 1500 m/s

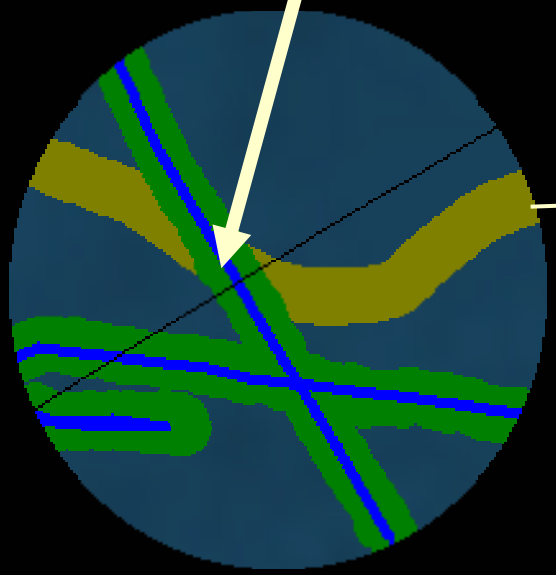
Carters tables were subsequently applied in the IBCAO processing scheme to convert depths to corrected meters assuming that that all submarine soundings referred to 1500 m/s as stated by metadata

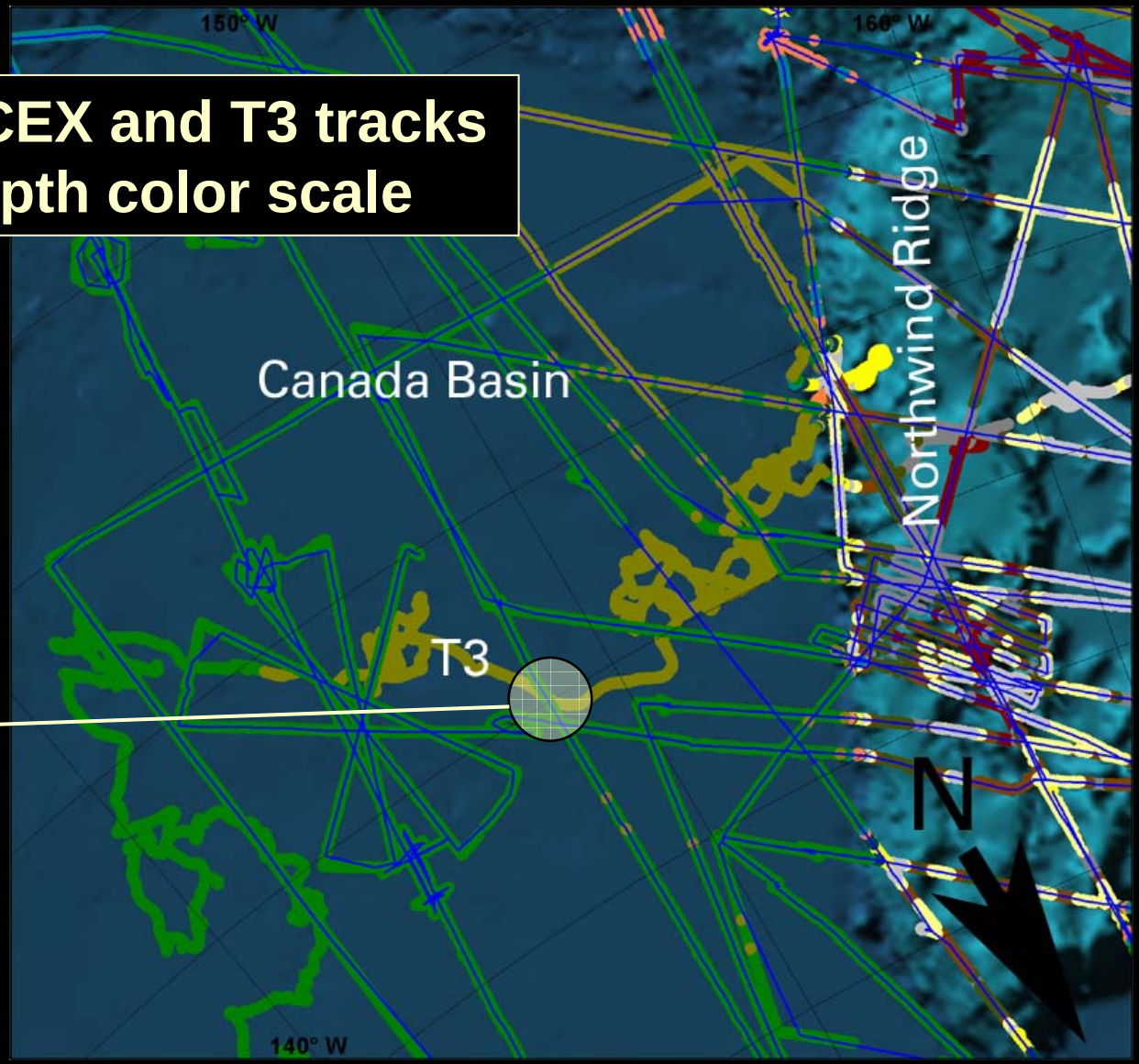
Soundings from ice island T3 highlighted inconsistencies in the flat Canada Basin

Map showing SCICEX and T3 tracks using the same depth color scale

SCICEX: 3741 m

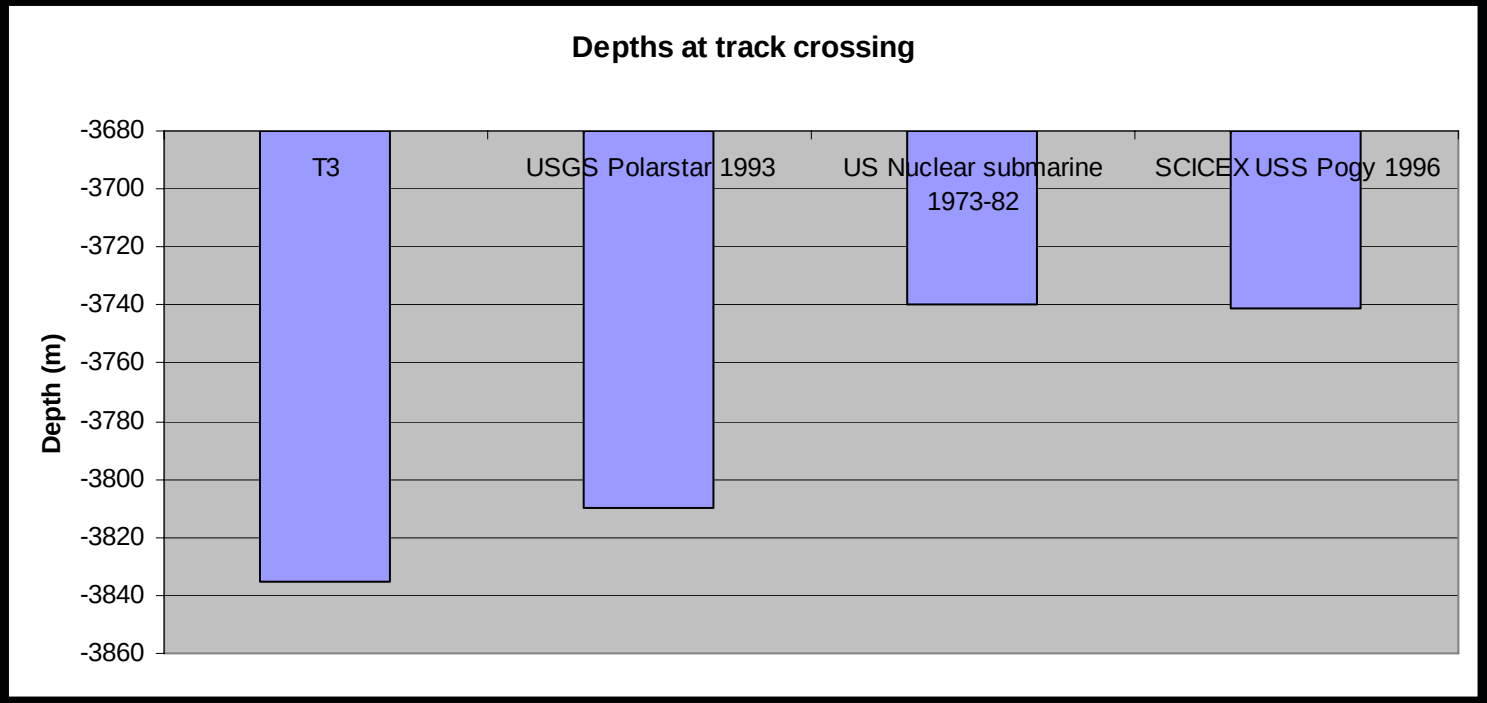
T3: 3835 m





Depths where T3, Polarstar, SCICEX and US Navy submarine tracks cross in the flat Canada Basin

Depth difference at crossover: 95 m



Unrevealed metadata

Submarine data 1957-1982: Collected using 800 fathoms/sec (about 1463 m/s)

SCICEX data: Collected using 800 fathoms/sec

The above submarine data was not converted to 1500 m/s before release

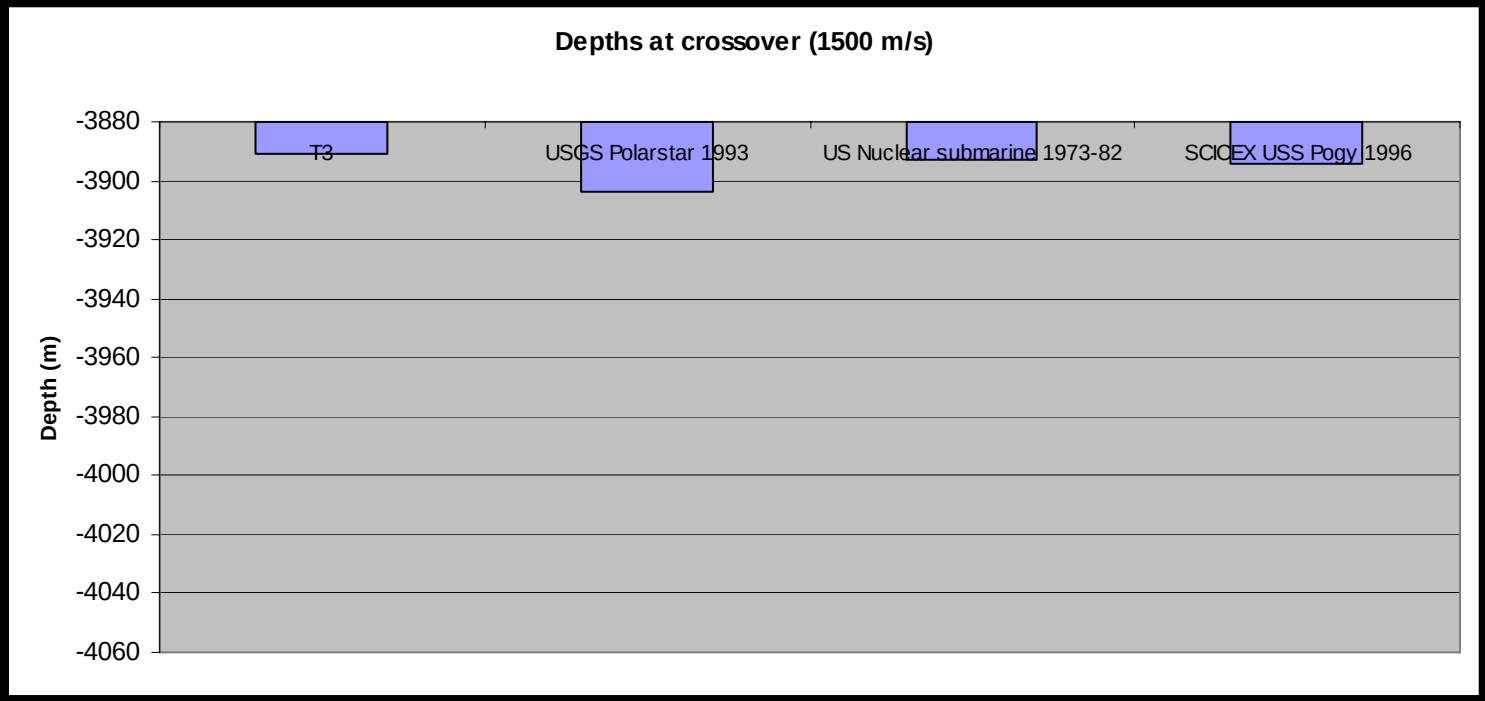
Submarine data 1983-1988: Collected using 820 fathoms/sec (about 1500 m/s)

T3 data: Immediately corrected using Mathews Table for the Arctic Ocean

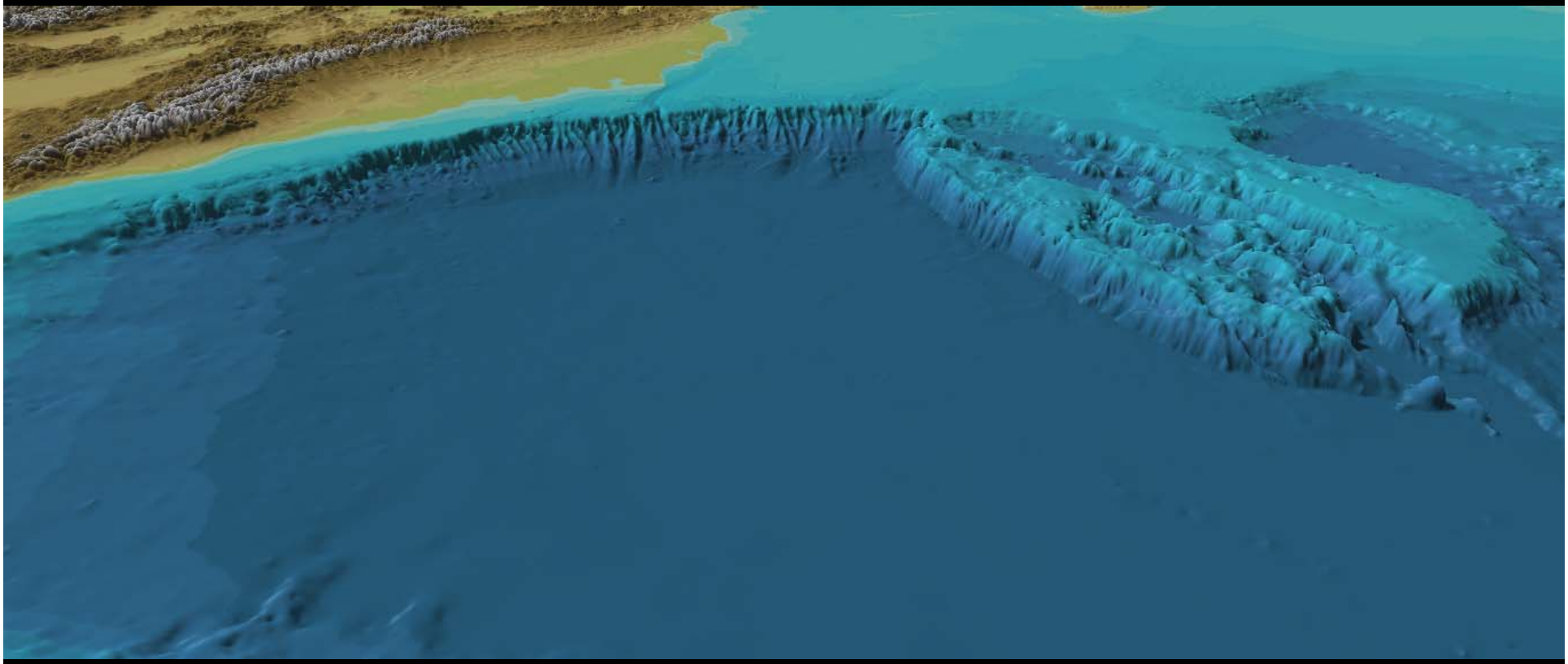
USCGC Polarstar: Collected using a sound velocity of 1464 m/s. At the USGS infobank a sound velocity of 1500 m/s is listed for the downloadable data. This is in error!

Depths after reverting all corrections and applying 1500 m/s

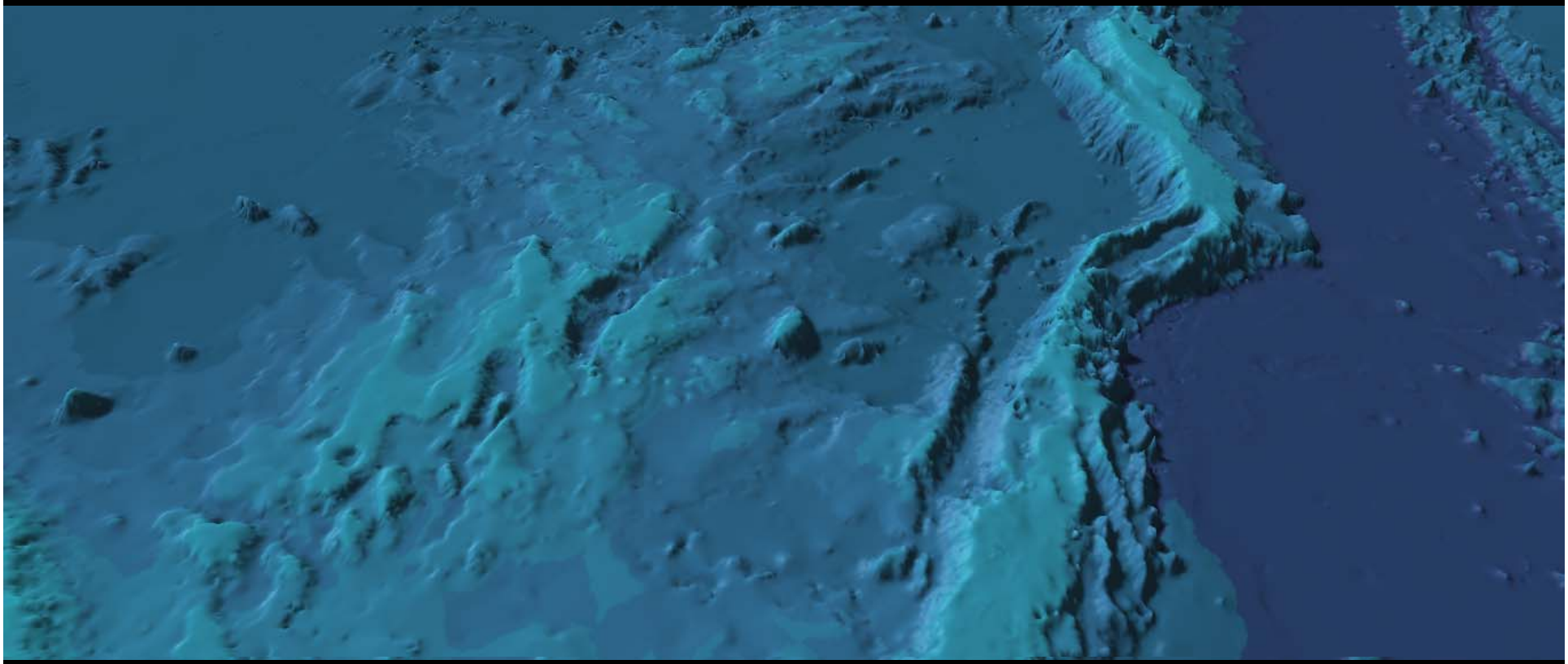
Depth difference at crossover: 12 m



Version 2



Version 2



We would like to know the Arctic Ocean seafloor as good as we know the topography of Mars

Thanks for listening!