Version 2.0 of the International Bathymetric Chart of the Arctic Ocean: A new Database for Oceanographers and Mapmakers

Jakobsson, M.
martin.jakobsson@geo.su.se
Department of Geology and Geochemistry, Stockholm University, Svante Arrhenius väg 8c, 106 91 Stockholm, Sweden
Macnab, R.
ron.macnab@ns.sympatico.ca
Geological Survey of Canada (Retired), 11 Lyngby Avenue, Dartmouth, Nova Scotia B3A 3T6, Canada
Edwards, M. H.
margo@soest.hawaii.edu
Institute of Geophysics and Planetology, University of Hawaii, 1680 East-West Road, Post 815, Honolulu, Hawaii 96822, United States of America
Schenke, H. W.
hans-werner.schenke@awi.de
Alfred Wegener Institute for Polar and Marine Research, Van-Ronzelen-Straße 2, 27568 Bremerhaven, Germany
Hatzky, J.
joern.hatzky@awi.de
Alfred Wegener Institute for Polar and Marine Research, Van-Ronzelen-Straße 2, 27568 Bremerhaven, Germany

The International Bathymetric Chart of the Arctic Ocean (IBCAO) was first released to the public after its introduction at the American Geophysical Union (AGU) Fall Meeting in 1999 (Jakobsson et al., 2000). This first release consisted of a Digital Bathymetric Model (DBM) on a Polar stereographic projection with grid cell spacing of 2.5 x 2.5 km derived from an accumulated database of all available bathymetric data at the time of compilation. The IBCAO bathymetric database included soundings collected during past and modern expeditions as well as digitized isobaths and depth soundings from published maps. Compared to previous bathymetric maps of the Arctic Ocean, the first released IBCAO compilation was based upon a significantly enhanced database, particularly in the high Arctic. For example, de-classified echo soundings acquired during US and British submarine cruises between 1958 and 1988 were included as well as soundings from icebreaker cruises conducted by Sweden and Germany at the end of the last century. Despite the newly available data in 1999, there were still large areas of the Arctic Ocean where publicly available data were completely absent. Some of these areas had been mapped by Russian agencies, and since these observations were not available to IBCAO, depth contours from the bathymetric contour map published by the Head Department of Navigation and Oceanography (HDNO) (Naryshkin, 1999) were digitized and incorporated in the database.
The new IBCAO Version 2.0 comprises the largest update since the first release; moreover, the grid spacing has been decreased to 2 x 2 km. Numerous multibeam data sets that were collected by ice breakers, e.g. USCGC Healy, R/V James Clarke Ross, R/V Polarstern, IB Oden, now form part of the database, as do the swath bathymetric observations acquired during the 1999 SCICEX expedition. The portrayal of the Eastern Arctic Basin is vastly improved due to e.g. the Arctic Mid Ocean Ridge Expedition 2001 (AMORE) and Arctic Gakkel Vents 2007 (AGAVE) expedition while mapping missions aboard the USCGC Healy have revealed the "real" shape of the sea floor of the central Lomonosov Ridge and in areas off Northern Alaska in the Western Arctic. This paper presents an overview of the new data included in Version 2.0 as well as a brief discussion on the improvements and their possible implications for IBCAO users.

Jakobsson, M., Cherkis, N., Woodward, J., Macnab, R. and Coakley, B. (2000)
New grid of Arctic bathymetry aids scientists and mapmakers. EOS Transactions, American Geophysical Union, Vol. 81, No. 9, pp. 89, 93, 96
Naryshkin, G. (1999)
Bottom relief of the Arctic Ocean. Bathymetric contour map. Head Department of Navigation and Oceanography and All-Russia Research Institute for Geology and Mineral Resources of the World Ocean (Editors), Russian Academy of Sciences

American Geophysical Union, Fall Meeting, 10-14 December 2007, San Francisco, USA

HR: 1340h	DE: 0930 Oceanic structures
AN: OS43A-0984	DE: 3045 Seafloor morphology, geology, and geophysics
DE: 0525 Data management	SC: Ocean Sciences [OS]
DE: 0910 Data processing	MN: 2007 Fall Meeting

AGU Fall Meeting 2007: OS43A-0984

Version 2.0 of the International Bathymetric Chart of the Arctic Ocean: A new Database for Oceanographers and Mapmakers

Martin Jakobsson[1], Ron Macnab[2], Margo Edwards[3], Hans-Werner Schenke[4], Joern Hatzky[4] and IBCAO Editorial Board*

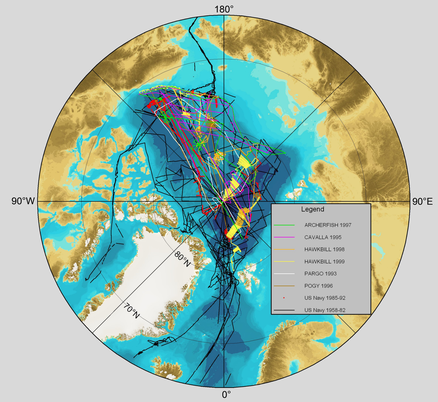
[1]Department of Geology and Geochemistry, Stockholm University, Sweden
[2]Geological Survey of Canada (Retired), Dartmouth, Canada
[3]Department of Geology and Geophysics, University of Hawaii, Hawaii, USA
[4]Alfred Wegener Institute, Bremerhaven, Germany
*Editorial Board Members are listed below

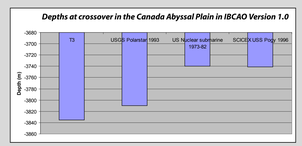
Background

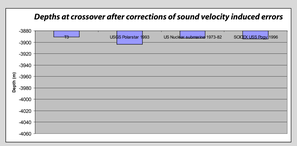
The International Bathymetric Chart of the Arctic Ocean (IBCAO) was first released to the public after its introduction at the American Geophysical Union (AGU) Fall Meeting in 1999 (Jakobsson et al., 2000, EOS). This first release consisted of a Digital Bathymetric Model (DBM) on a Polar stereographic projection with grid cell spacing of 2.5 x 2.5 km derived from an accumulated database of all available bathymetric data at the time of compilation. The IBCAO bathymetric database included soundings collected during past and modern expeditions as well as digitized isobaths and depth soundings from published maps. Compared to previous bathymetric maps of the Arctic Ocean, the first released IBCAO compilation was based upon a significantly enhanced database, particularly in the high Arctic. For example, de-classified echo soundings acquired during US and British submarine cruises between 1958 and 1988 were included as well as soundings from icebreaker cruises conducted by Sweden and Germany at the end of the last century. Despite the newly available data in 1999, there were still large areas of the Arctic Ocean where publicly available data were completely absent. Some of these areas had been mapped by Russian agencies, and since these observations were not available to IBCAO, depth contours from the bathymetric contour map published by the Head Department of Navigation and Hydrography (HDNO) (Naryshkin, 1999) were digitized and incorporated in the database..

IBCAO Version 2.0

The new IBCAO presented here comprises the largest update since the first release; moreover, the grid spacing has been decreased to 2 x 2 km. Numerous multibeam data sets that were collected by ice breakers, e.g. USCGC Healy, R/V James Clarke Ross, R/V Polarstern, IB Oden, now form part of the database, as do the swath bathymetric observations acquired during the 1999 SCICEX expedition. The portrayal of the Eastern Arctic Basin is vastly improved due to e.g. the Arctic Mid Ocean Ridge Expedition 2003 (AMORE) and Arctic Gakkel Vents 2007 (AGAVE) expedition while mapping missions aboard the USCGC Healy have revealed the "real" shape of the sea floor of the central Lomonosov Ridge and in areas off Northern Alaska in the Western Arctic. Another major improvement is the correction of previous erroneous time-depth conversions applied during the compilation of IBCAO Version 1.0 on some batches of the US submarine soundings released in public domain. Through cross track analysis between the declassified submarine soundings and icebreaker multibeam and single beam data as well as bathymetric data from the drifting ice station T3, systematic offsets were detected between the datasets. Subsequent data detective work resulted in that the proper correction of the submarine data could be applied, which significantly reduced the cross over errors between tracks. Therefore, IBCAO Version 2.0 contains noticeably less track line artifacts compared to Version 1.0.





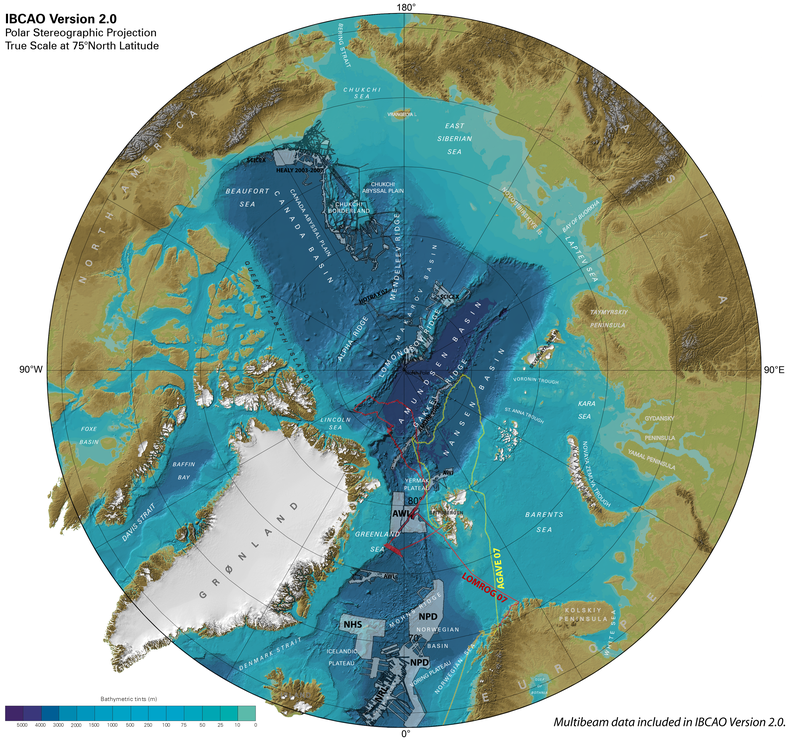


Sound Velocity Corrections of Echo Sounding Data from US Navy Submarines

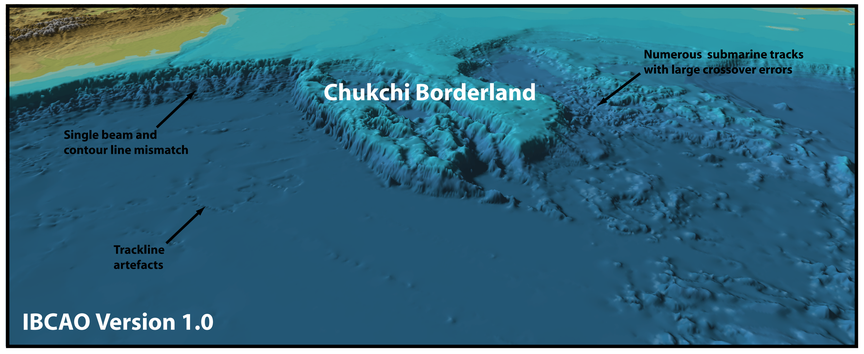
Echo soundings collected prior to 1988 by the US Navy from their nuclear submarines were digitized from analogue PDR records while the SCICEX data was directly saved to disk through the submarines' PDR's automated digital bottom tracker (pers. comm. Dianne Bentley, US Arctic Submarine Laboratory). When these data first were included in IBCAO, the metadata stated that all depths had been derived using a nominal sound speed of 1500 m/s. Therefore, Carters tables were subsequently applied to convert depths to "corrected meters" assuming that all data originally were referring to 1500 m/s. Large cross over errors were detected, but assumed to result from the poor navigation under sea ice. However, even large cross over errors between the submarine tracks in the extraordinary flat Canada Abyssal Plain were evident, also compared with other data than collected by the US Navy submarines. The observed cross over differences were on the order of 100 m in 3800 m water depths (2.6 %), a not particularly large difference considering that older deep water echo sounders are accurate to approximately 2%, but the errors were found to be systematic. All this lead to a metadata analysis revealing:

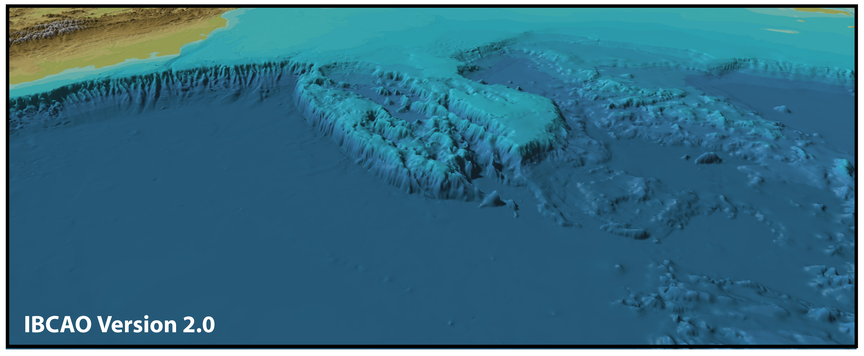
1. *US Navy submarine data from 1957-1982 were in fact collected using 800 fathoms/sec (about 1463 m/s)*
2. *The US Navy SCICEX cruises were also found to be collected using 800 fathoms/sec*
3. *US Navy submarine data from 1983-1988 were collected using 820 fathoms/sec (about 1500 m/s)*

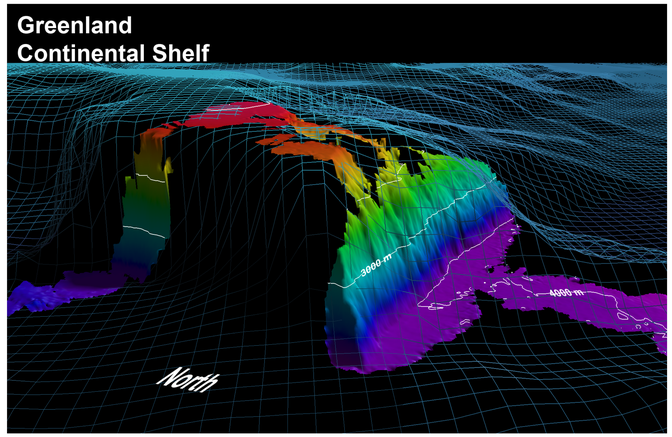
Soundings from the drift island T3 and USCGC Polastar were first used in the cross over analysis with the submarine data. However, to complicate the matter further, we found that the USCGC Polarstar depths retrieved from the USGS Infobank, which had a sound velocity of 1500 m/s listed, in fact was referring to a sound velocity of 1464 m/s! When all the erroneous assumptions of applied sound velocities were sorted out, a significant reduction of cross over errors was achieved. For this reason, the new IBCAO Version 2.0 has much less visibly trackline artifacts.



Multibeam data included in IBCAO Version 2.0.







IBCAO Version 1.0 is here shown as non-shaded mesh overlaid on the bathymetric data collected during the LOMROG 07 expedition with the newly installed Kongsberg EM120 multibeam in Swedish icebreaker Oden. It is evident that the slopes of the Morris Jesup Rise are much steeper in reality than what was shown in IBCAO Version 1.0, which here was based on contours from the Russian chart published by HDNO 2001. The new IBCAO Version 2.0 contains all the LOMROG 07 multibeam data.

Multibeam data collected during USCGC Healy cruises have significantly improved IBCAO Version 2.0 compared to 1.0 in this area off Northern Alaska. In particular, the dedicated multibeam mapping missions carried out by the Center for Coastal and Ocean Mapping/ Joint Hydrographic Center (CCOM/JHC), University of New Hampshire.