Auxiliary Material:

An improved bathymetric portrayal of the Arctic Ocean: Implications for ocean modeling and geological, geophysical and oceanographic analyses

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S1.0. IBCAO compilation

Bathymetric soundings are commonly stored as xyz points with associated descriptions (metadata) that, in a perfect world, at the minimum, should include information on the bathymetric sounding acquisition system, navigation system, horizontal and vertical datum, sound speed correction approaches, associated errors and data post-processing methods. The metadata can play an important role in this process, i.e. if older data sets have been acquired using celestial navigation techniques a lower accuracy may be expected. The first version of IBCAO was compiled using Intergraph's Modular GIS Environment (MGE™), which was based on the Computer Aided Design (CAD) platform Microstation™. The common file format for this system is the "design file" (.dgn). This drawing file format is capable of handling geospatial objects, but there are constraints on the number of objects that can be stored in each file. Furthermore, it was not practical, using the design file structure, to associate metadata with depths stored as xyz points. Due to these limitations, all the bathymetric data (soundings and digitized contours) stored in a large collection of design files were moved to a more modern GIS spatial database for the IBCAO Version 2.0 compilation work. The GIS system Geomedia Professional by Intergraph™ was used for the data migration as it contains tools for converting data stored in design files to a proper GIS spatial database. Thus, the new GIS platform for IBCAO is Geomedia Professional with an underlying spatial database. The following steps summarize the IBCAO bathymetric data compilation procedure:

1. Gather bathymetric single beam soundings, contour maps and grids from multibeam surveys (Figure S1).
2. Import all bathymetric data to the IBCAO GIS database and include the critical metadata. It should be noted that only limited metadata exist for much of the Arctic Ocean's historical bathymetric data. The lack of metadata may cause errors that are hard to detect; one example is the case for the US Navy submarine data described in the main text. Other examples are soundings that are not referenced to the assumed horizontal or vertical datum.
3. Analyze the individual data sets for internal consistency and eliminate outliers etc.
4. Analyze the data sets together; i.e. check depth differences at crossing tracklines (Figure S2).
5. Flag soundings from sparse single beam tracks or digitized contours in areas where single- or multibeam surveys fully cover the area (Figure S2). This is automatically done using spatial GIS tools. Full cover is here assumed to be achieved when the

distance between the data points is closer than half of the IBCAO grid resolution; IBCAO Version 2.0 is gridded at a resolution of 2×2 km.

6. Modify digitized contours to fit bathymetric soundings. The depth contours from compilation maps may not fit depths from soundings or at the edges of multibeam surveys (Figure S2). In these cases, the contours are simply adjusted to honor the bathymetric data; a process which is time consuming but greatly improves the final gridded product.
7. Pre-process all the data for gridding. This step consists of applying a spatial block median filter of 2×2 km to all the bathymetric data; a procedure that to some extent prevents spatial aliasing and eliminates redundant data points when gridding (Figure S2).
8. Interpolate (grid) depth values from the block median filtered data onto a Cartesian Polar Stereographic (true scale set to 75°N) grid with a cell spacing of 2×2 km. The cell spacing has been decreased compared to earlier IBCAO versions (2.5×2.5 km) because more data are available now; it was not possible to capture some critical seafloor features with the coarser resolution. Gridding was done with the continuous spline in tension algorithm [*Smith and Wessel*, 1990] with the tension parameter set to 0.32.
9. Visualize the gridded IBCAO model together with the bathymetric source data. This is one of the most powerful approaches to detect data outliers or other artifacts arising from inherited systematic or random errors in the source data. Once errors are detected, the offending data points can be adjusted if possible, or else removed so a new grid can be created. IBCAO is thus constructed in a process that iterates between the steps 3 and 9 above.

The technical specifications of the new IBCAO are listed in Table S1. In addition to the Polar Stereographic version, a 1×1 minute latitude longitude grid has been produced through reprojection. The 1-minute IBCAO may for example be used to update global bathymetric databases such as the 1-minute GEBCO and 2-minute ETOPO2.

Table S1. IBCAO Version 2.0 specifications.

Projection	Polar Stereographic, true scale 75°N
Horizontal datum	WGS 84
Vertical datum	Mean Sea Level
Grid cell size	2 km
Extension	Upper Left: X=-2904000, Y= 2904000 Longitude= 135° W, Latitude=53°47'58.4"N Lower Right: X=2904000, Y=-2904000 Longitude= 45° E, Latitude=53°47'58.4"N
Dimensions	Rows= 2905 Columns= 2905 Each pixel is registered at the grid node

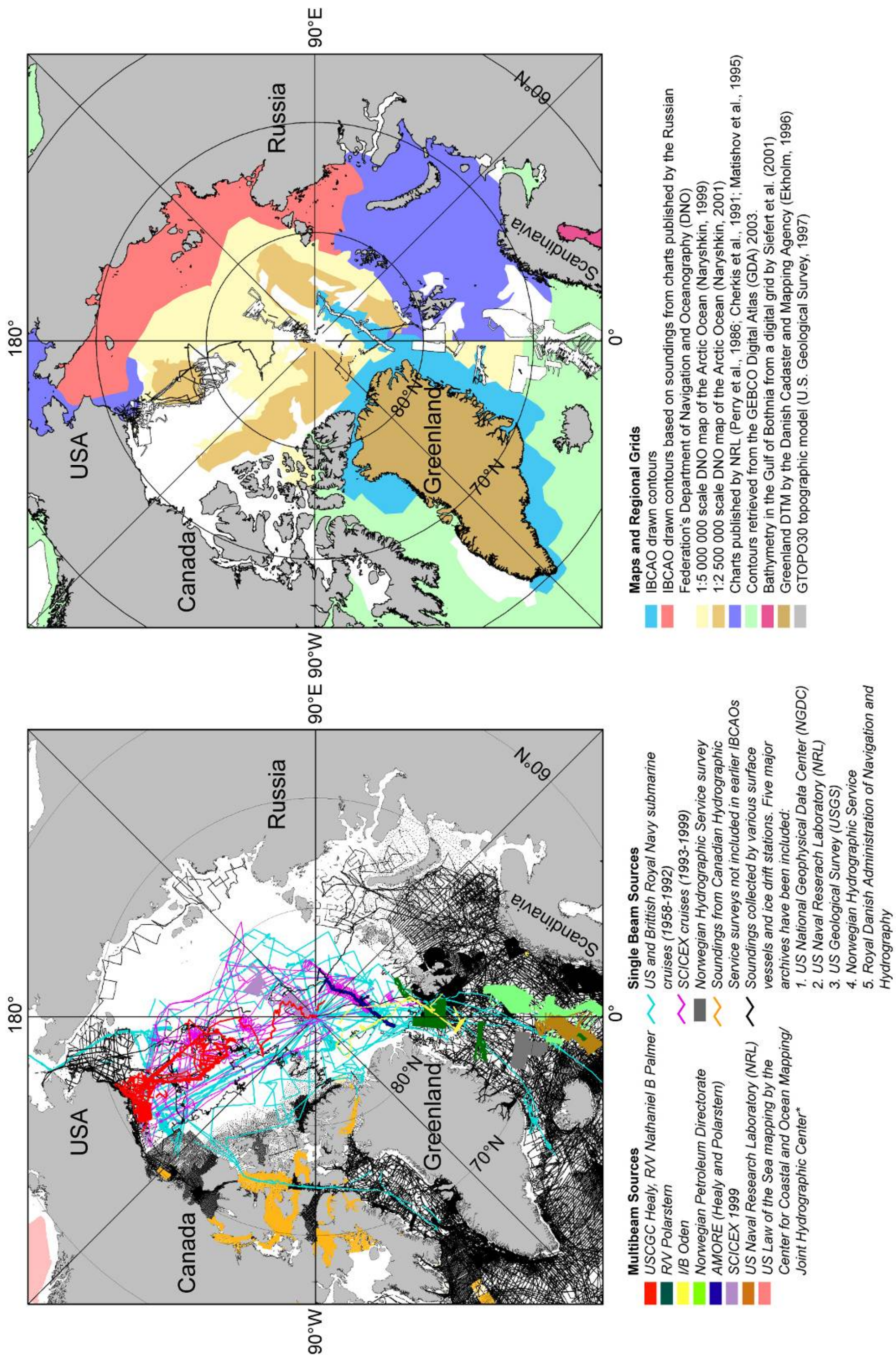

Figure S1. Bathymetric data used for the compilation of IBCAO Version 2.0. **Left Map**: Single beam tracks, multibeam surveys and individual spot soundings; **Right Map**: Areas where digitized contours have been used from existing maps. Note how the contours have been removed where enough original sounding data exist for gridding purposes. The multibeam surveys are listed with references in the Table S1. *Several cruises with *USCGC Healy* off northern Alaska shown in red have been carried out for the US Law of the Sea mapping [*Gardner, et al.*, 2006] that is shown in pink in other areas.

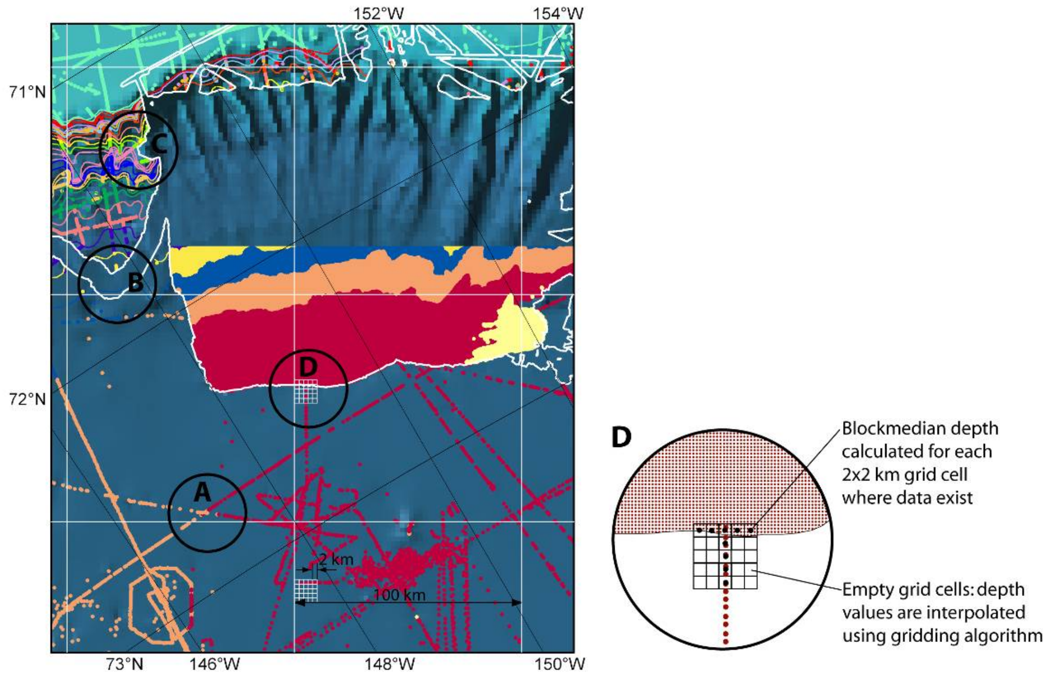

Figure S2. Some selected bathymetric data sets from the northern Alaskan continental slope and Canada Basin, illustrating the main steps in the IBCAO compilation procedure. The white polygon encloses areas covered by multibeam mapping. Data points from a portion of one of the multibeam mappings are shown: *USCGC Healy* cruise HLY0405 [*Gardner, et al.*, 2006]. Circle **A** indicate an example where two submarine tracks intersect. Depth differences at track crossings are first detected simply using depth color coding. Circle **B** shows where single beam soundings are removed (flagged) from the gridding in areas that have been mapped with multibeam. Digitized contours are not used where enough single beam soundings exist for gridding purposes, or where an area is mapped by multibeam (Circle **C**). In some cases, however, contours are required in order to produce a good grid. A time-consuming part of the IBCAO compilation consisted of modifying digitized contours from published bathymetric maps in certain areas so they fit with soundings. It should be noted that the fit in some areas have been so poor that essentially new contours have been drawn. Circle **D** is enlarged to show how a median value is first calculated for each 2×2 km grid cell where bathymetric data exist. Empty grid cells have to be interpolated using the gridding algorithm continuous spline in tension [*Smith and Wessel*, 1990].

S1.1. Data Sources

All the sources used to compile IBCAO Version 2.0 are shown in Figure S1. Table S2 specifically lists all the multibeam sources with available references. Only the multibeam data off the Norwegian shelf provided by the Norwegian Petroleum Directorate and a subset of the Fram Strait mapping by *R/V Polarstern* were incorporated in IBCAO Version 1.0 [*Jakobsson and IBCAO Editorial Board Members*, 2001], that is before this present major upgrade. References to datasets that were used in the first released IBCAO Beta version can be found in Jakobsson et al. [2000]. The new IBCAO grid as defined in Table S1 covers an ocean area of ~16022×10^3 km^2 calculated on a Lambert Equal Area projection. Less than approximately 6% (~930×10^3 km^2) of this area has been mapped by multibeam. This estimation is based on that each survey has been enclosed by a polygon. In areas where large parts of surveys are overlapping each other, the overlapping areas are accounted for in order to avoid that they are included more than once in the area estimation.

Table S2. Multibeam data used in IBCAO Version 2.

Multibeam source	**Available references**
US Naval Research Laboratory (NRL): Aegir Ridge	[*Jung and Vogt*, 1997]
USCGC Healy cruises HLY0102 (AMORE), HLY0201, HLY0203, HLY0302, HLY0303, HLY0402, HLY0403,HLY0405, HLY0503 (HOTRAX), HLY0703: Chukchi Borderland and Northern Alaskan Continental Margin area, Arctic Ocean HOTRAX 2005 transect	[*Björk, et al.*, 2007; *Darby, et al.*, 2005; *Gardner, et al.*, 2007; *Gardner, et al.*, 2006; *Jakobsson, et al.*, 2005; *Michael, et al.*, 2003]
R/V Nathaniel Palmer cruise NBP03-04a: Northern Alaskan Slope	Online at: http://gcmd.gsfc.nasa.gov/records/GCMD_NBP0304A.html
I/B Oden cruise LOMROG 2007 cruise: Eastern Arctic Ocean, east of Greenland and off the northwestern coast of Norway	[*Jakobsson, et al.*, 2008; *Marcussen, et al.*, 2008]
Norwegian Petroleum Directorate (NPD): Off Norwegian Continental Margin	
R/V Kilo Moana: Gulf of Alaska	[*Gardner, et al.*, 2006]
R/V Polarstern cruises ARK VIII-3 ARK II-4, ARK III-2, ARK III-3, ARK IV-1, ARK IV-3, ARK VII-3, ARK VIII-3, ARK XI-2, ARK XIII-3, ARK XV-2, ARK XVII-1, ARK XVII-2, ARK XVIII-1, ARK XVIII-2, ARK XVIII-4 (East of Greenland, Fram Strait area, Lomonosov Ridge)	[*Gauger, et al.*, 2001; *Hatzky and Schenke*, 2003; *Jokat, et al.*, 2003; *Jokat, et al.*, 1995; *Klenke and Schenke*, 2002; *Thiede, et al.*, 1990]
SCICEX 99: Chukchi Borderland and Lomonosov Ridge	[*Edwards and Coakley*, 2003]

S2.0. IBCAO versus full resolution multibeam

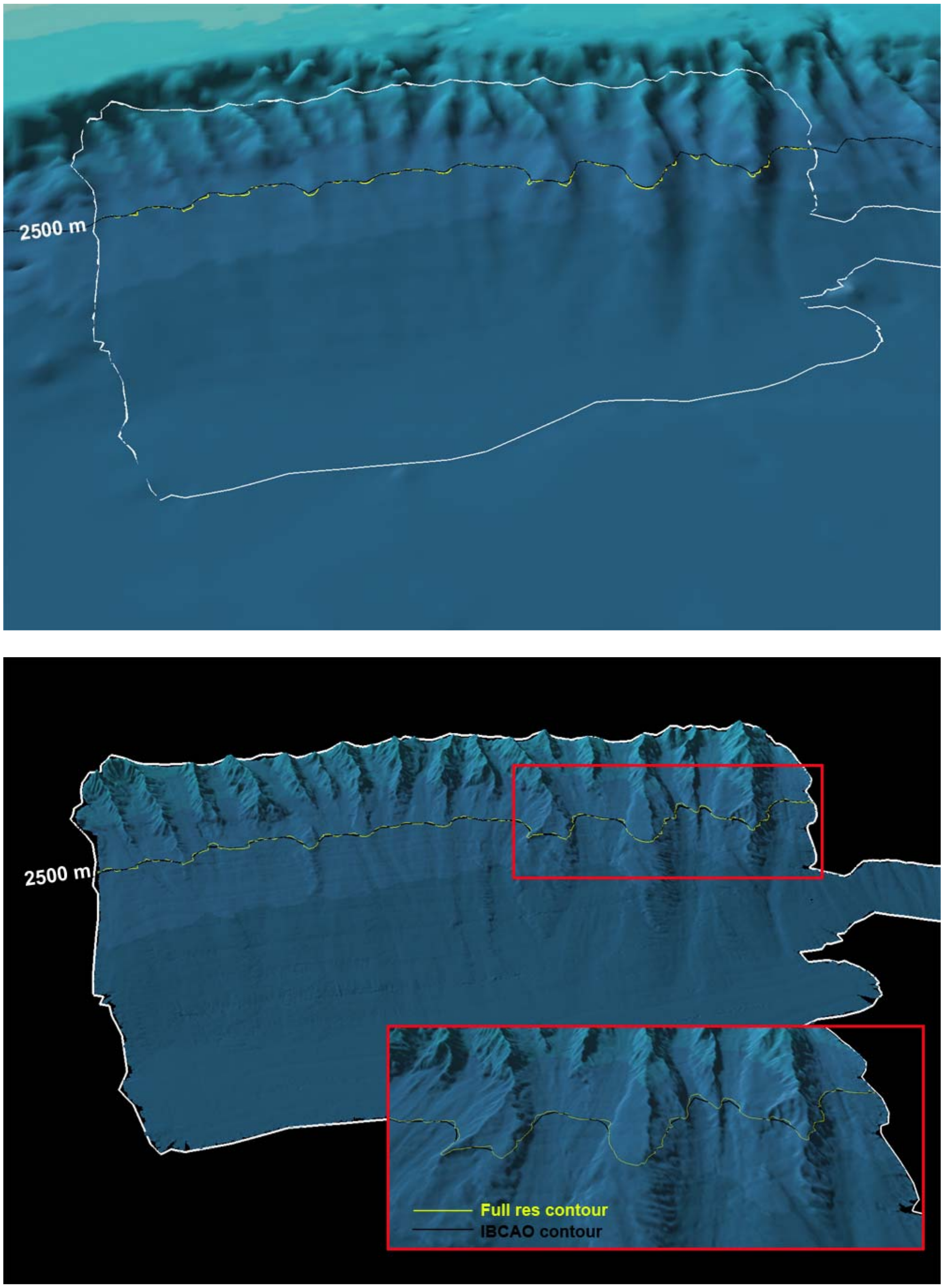

Figure S2. A comparison between the IBCAO 2×2 km grid (upper image) and the multibeam collected during the *USCGC Healy* HLY04005 cruise (Table S2) gridded at 200×200 m (lower image). The selected area for this comparison is the area shown in Figure S1. The locations of the main erosional gullies are preserved in the ten times coarser IBCAO grid, although the visible smaller erosional features on the sloping sides of the remaining ridges between the gullies are lost. The contours derived from both grids generally match well, however, as expected the IBCAO contour appear smoothed.

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