The Arctic – North Pacific Ocean Regional Center

Priority areas in the central Arctic Ocean

Analysis of the Seabed 2030 – IBCAO 4.1 depth database reveals two large areas where the IBCAO 4.1 digital bathymetric grid is particularly poorly constrained by depth soundings: Area A off Northern Greenland and the Canadian Arctic Archipelago and Area B encompassing the outer continental shelves and slopes of the western Chukchi, East Siberian, Laptev, Kara and Barents seas (Fig. 1).

The area off North Greenland within Area A as well as the entire Area B are primarily gridded using digitized depth contours of published maps with unpublished and therefore unknown underlying source data. In addition, the eastern portion of the Kara Sea marked C in Figure 1 is gridded more or less entirely using depth contours that were hand drawn from a sparse sounding database, which did not permit direct gridding without the support from contours.

The few multibeam tracks included in IBCAO 4.1 from Area B show in several places that the shelf breaks and slopes are not well portrayed in the digitized maps used as a source to generate the grid. North of Greenland we do not even have any multibeam tracks that can be used to assess the quality of the used depth contours.

The large Areas A and B have been outlined using the Type Identification (TID) map in Figure 1A as well as the distance between soundings analysis shown in Figure 1B. These two reveal several additional smaller areas with equally poor data coverage spread out over the Arctic Ocean.

Additional motivation for mapping in the outlined priority areas

- **The shape and depth of the seafloor influence largely the flow of currents and thereby exert a control on the influx of heat into the Arctic Ocean.** Atlantic water enters the central Arctic Ocean through the Fram Strait and across the Barents and Kara seas to flow along the slopes of the continental shelves. A huge amount of heat is brought into the Arctic Ocean through this process. The intensity and distribution of the Atlantic layer are thus critical factors for a number of climate related oceanographic questions, e.g. disassociation of gas hydrates potentially stored in the continental slope sediments as well as the melting of the Arctic Ocean sea ice, which could come in contact with the warm Atlantic water depending on the future development of the stratification of the upper water masses.
- **Bathymetry dictates where warm Atlantic water is able to reach into some of Greenland fjords to exert melting of marine outlet glaciers draining the Greenland Ice Sheet into the ocean.** This process is causing a considerable ice mass loss. The vulnerability of these outlet glaciers is thus depending largely on the shape of the seafloor. Deep bathymetric channels may lead the warmer subsurface Atlantic water into outlet glaciers while shallow bathymetric sill may on the other prevent the warmer water from coming in contact with the glaciers. IPCC:s Sixth Assessment Report emphasizes the importance of knowing the bathymetry to assess the future fate of the Greenland Ice Sheet in a warming climate and its contribution to sea-level rise. The report states that there is a *high confidence* that bathymetry together with the overall geometry of fjords and other factors controlling ice

dynamics, such as bedrock topography, modulate marine outlet glaciers response to climate forcing.

In summary, to study the linkages between climate, changing sea ice cover, carbon-greenhouse gas release from thawing permafrost and methane hydrates and submarine mass loss of marine outlet glaciers accurate bathymetry is required. Accurate bathymetry around Greenland is needed improve future predictions of sea level rise, where melting of the Greenland and Antarctic ice sheet stands for the largest uncertainties.

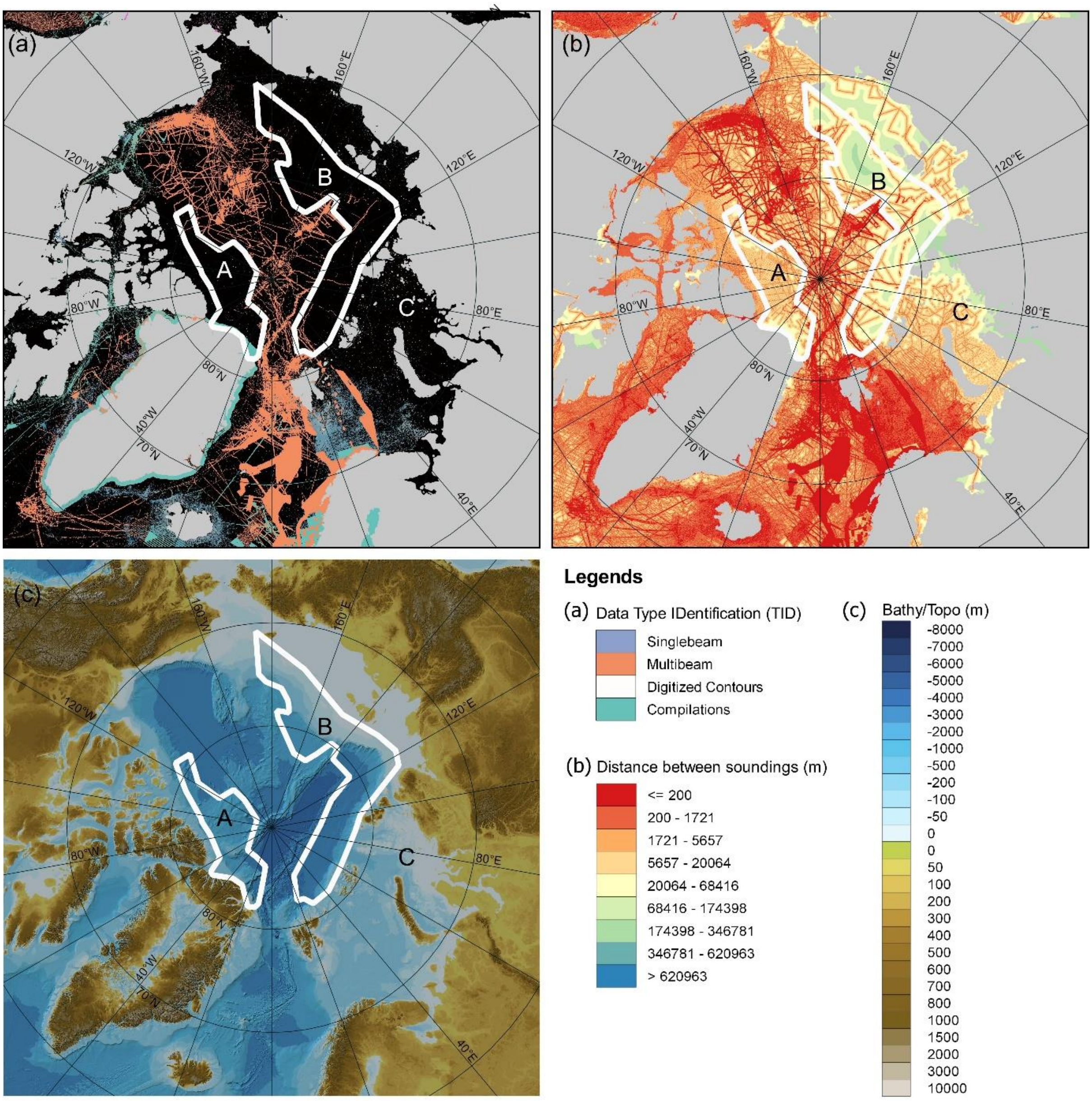


Figure 1.

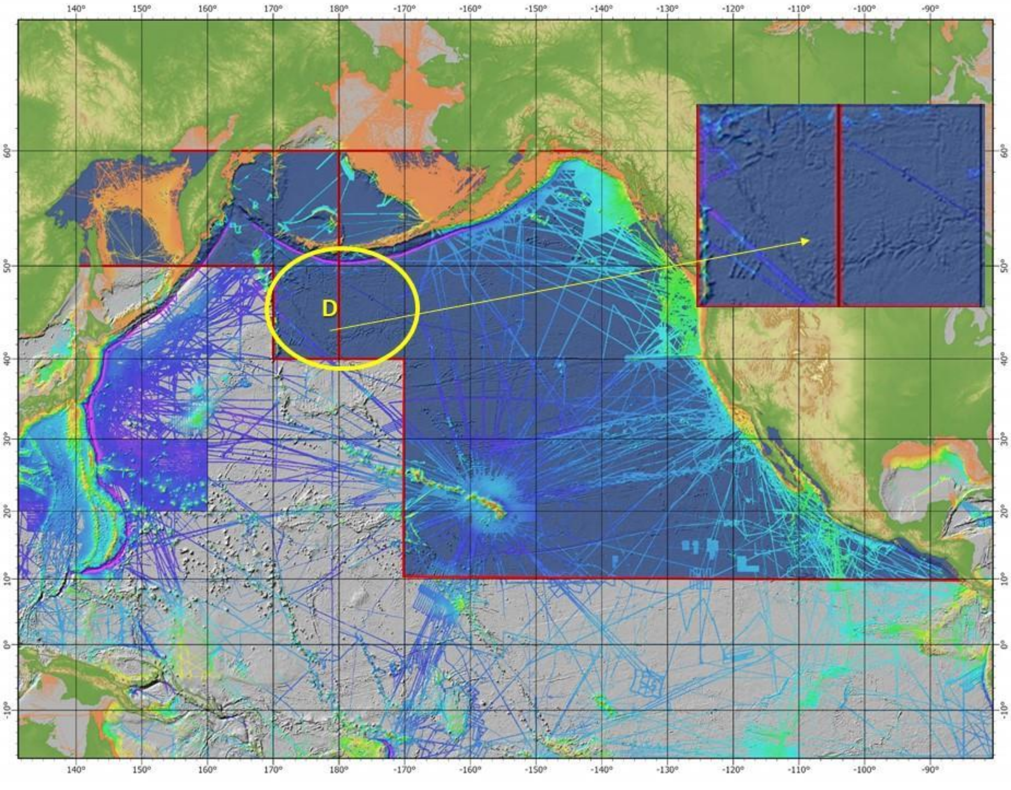
Priority area in the North Pacific Region

Analysis of the Seabed 2030 depth and TID databases in the North Pacific region reveals a large area beyond national jurisdiction where the GEBCO digital bathymetric grid is particularly poorly constrained by depth soundings: Area D, in the central northern Pacific, south of the Aleutian Trench (Fig. X and Y).

Remarkably, through this area of more than **3,000,000 sq km** of seafloor, there are **only four** recorded multibeam lines. The low-resolution bathymetric predictions based on satellite altimetry indicate the potential for much complex structure on the seafloor in this region – yet this is not resolvable in the satellite altimetry data (Figure X).

Additional motivation for mapping in the outlined priority areas

- **Unraveling the tectonic history of the Pacific.** The unmapped region represents some of the oldest crust in the Pacific. The morphology of the seafloor including trends in seamounts and abyssal hills records the history of plate motion and with it the history of the evolution of the Pacific and other ocean basins. Much has been learned from studying the trends of the Hawaiian / Line Island Seamount chain. What trends can be found in this unmapped area? Low resolution satellite altimetry indicates a potentially complex terrain with hints of fracture zone patterns. All this can be resolved with more complete mapping of this region.
- **Understanding the response of the Pacific Plate to subduction.** The unmapped region represents a transitional zone where the Pacific Plate begins to feel the influence of both the Aleutian Trench and the deep trenches off Kamchatka and the Japanese Islands. Understanding the changes in seafloor morphology as the plate approaches these subduction zones will provide important insight into plate mechanics and rheology and our overall understanding of tectonic processes.
- **Tracking and mapping seamounts of the Pacific** The distribution and seamounts in the Pacific (and other regions) offers important insight into both volcanic and tectonic processes and also can impact safety of navigation for both submerged and surface vessels. Detailed mapping of the seafloor in the Marianas region revealed many hundreds of unmapped seamounts less than 500 m deep and several that came within 10s of meters of the surface and were thus hazards to surface vessels.
- **Better understanding of the general roughness of the seafloor.** The distribution of heat in the ocean is closely tied to turbulence generated through interaction of currents with the seafloor. To have such a large area of the seafloor virtually unmapped puts constraints on the ability of climate models to properly account for the role of turbulence in the distribution and dissipation of heat in the ocean.



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