Compiling a digital bathymetric model of the North Atlantic Ocean: A new resource for ocean circulation modeling and analysis

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IBCNA

International Bathymetric Chart of the North Atlantic

Initiative to assemble and to rationalize all available bathymetric observations from the Atlantic Ocean and adjacent seas north of the Equator and south of 64° N.
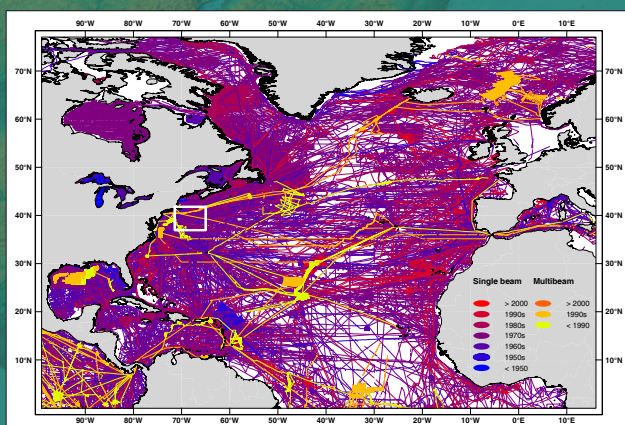

Figure 1: Data coverage in the North Atlantic.

Motivation

- North Atlantic is the best mapped ocean in the world (Fig. 1)
- Broad data basis with tremendous variability in accuracy, resolution & density
- However, large scale DBMs are rather outdated and do not incorporate the comprehensive data basis available
- ⇨ Ideal test area for data compilation

Usage of large scale DBMs

- Boundary condition for atmosphere/ocean modeling
- Providing a regional physiographic context for oceanographic and geoscientific observations
- Future survey and field operation planning
- Deep ocean tsunami propagation research
- Evaluating effect of sea level change
- Assessing geohazard risks (slope failure, slumps...)
- Can be incorporated into future versions of global databases, as was done with IBCAO (Jakobsson et al., 2008) for the Arctic Ocean

Need for up-to-date North Atlantic model

In comparison to commonly used DBMs (Fig. 4) huge improvement possible with

- Multibeam data
- Systematic consideration of metadata
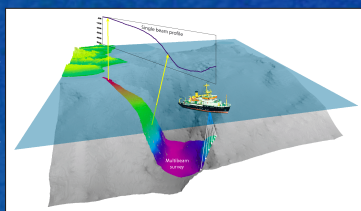- Modern compilation techniques
- Optimal gridding algorithm

Figure 2: Echo sounding principles.

Scientific questions

- How can data and metadata be effectively organized?
- What is the optimal algorithm for gridding such heterogeneous data?
- Can an uncertainty model of the final data set be obtained?
- Is it possible to optimize grid resolution based on geological criteria with variable grids?

Data compilation

Approach: GIS + spatial database

- Store data and metadata in Oracle 10g with Oracle Spatial
- Handle the data through GeoMedia Professional
- 3D visualization in Fledermaus
- Custom scripts work directly on Oracle

Database storage structure

- RDBMS: Great flexibility for storing
  - Raw and processed data
  - Single beam and multibeam data
  - Metadata including information about
    * Acquisition and origin
    * Quality and accuracy
    * Processing
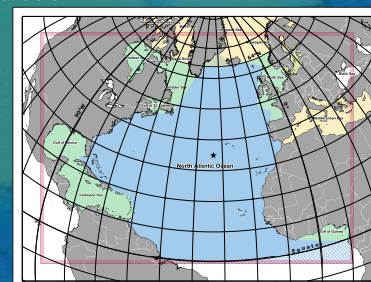- Data-warehouse schema treats data and metadata as integrated, multidimensional data set

Figure 3: North Atlantic as defined by the IHO, including all adjacent seas as suggested by Macnab and Travin (2007), and IBCNA working area.

Ongoing and future work

- Algorithms for merging and gridding heterogeneous sounding data
- Geostatistical interpolation and gridding (Kriging)
- Data quality analysis based on metadata information and cross-survey checks
- Error propagation through the gridding process
- Variable grids for bathymetric models
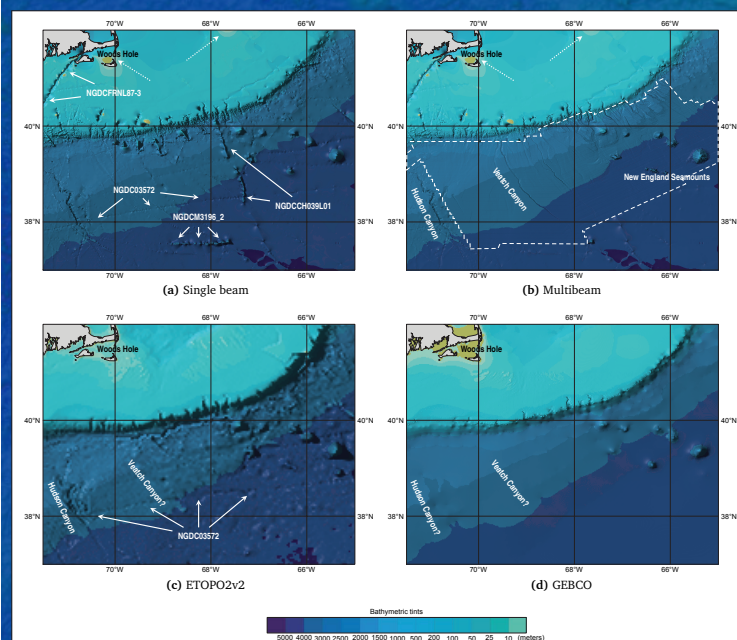- ⇨ Enhance IBCAO compilation process (Macnab and Jakobsson, 2000)

Figure 4: What can be achieved: Comparison of DBMs based on (a) single beam data only and (b) both single beam and multibeam soundings with the (c) ETOPO2v2 and (d) GEBCO DBMs.

References

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Macnab, R. and Jakobsson, M. (2000): Something Old, Something New: Compiling Historic and Contemporary Data to Construct Regional Bathymetric Maps, with the Arctic Ocean as a Case Study. *International Hydrographic Review*, 1 (1), 2–16.

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