Identification and Editing of Incorrect Soundings in V9.1 Global Predicted Depth

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Abstract

The National Geospatial-Intelligence Agency (**NGA**), the Naval Meteorology and Oceanography Command (**NAVO, METOC**), the National Oceanographic and Atmospheric Administration (**NOAA**), and the Scripps Institution of Oceanography (**SIO**) are working under a memorandum of understanding to improve the global predicted bathymetry. Our primary objective is to improve bathymetric charts of the global oceans using a combination of ship soundings and satellite-derived gravity anomalies. More important, we plan to assign depth uncertainties to our global charts. These charts will serve as cautionary overlays for navigation, and will have numerous other scientific and practical applications. We also want to merge our effort with the General Bathymetric Chart of the Oceans (**GEBCO**) to improve the global grid even more.

APPROACH

Task 1 Improved gravity from satellite altimetry (Year 1, complete)
This 3-year effort was funded by National Science Foundation, NASA, ConocoPhillips, and ExxonMobil. Work was performed by David Sandwell and Walter Smith (NOAA). This involved retracking all of the raw radar altimeter waveforms from the ERS-1 and Geosat altimeters and constructing a new global marine gravity model. Before this effort, the satellite-derived gravity models had accuracies of 4-7 mGal in comparison with shipboard profiles [Sandwell and Smith, 1997]. The new models have accuracies of better than 3 mGal. The V16.1 gravity data are available in a variety of formats at: http://topex.ucsd.edu/WWW_html/mar_grav.html

Task 2 Cleanup of unclassified ship soundings (Years 1 and 2)
We are evaluating and editing bathymetry data from 5700 cruises of archive ship data; approximately 1800 of these cruise data were not used in our previous global bathymetric grids because they failed statistical tests. These data come from a variety of sources including: 4900 cruises from the National Geophysical Data Center (NGDC); about 500 cruises from the SIO and Lamont archives; and 104 cruises from IFREMER. This data cleanup effort involves: 1) hand editing of the soundings in the 5700 cruises to flag bad data; 2) separating the cruise data into well-navigated and poorly-navigated groups; and 3) constructing trial bathymetry grids to identify additional outliers. In addition to the contributions from our partners we have assembled grids and multibeam swath data from a variety of sources:

LDEO - Ridge Multibeam Synthesis Project
IFREMER - Marcia Maia and Louis Geli
WHOI - GLOBEC - Robert Beardsley
JAMSTEC - Ryoichi Iwase
GEOMAR - Wilhelm Weinreb
Univ. of Hawaii - Brian Taylor
Univ. of New Hampshire - CCOM
GEBCO - Colin Jacobs
GEBCO - Pauline Weatherall (Digital Atlas Manager, BOD)
International Hydrographic Bureau - Tony Pharaoh

Task 3 Construct new global bathymetry at 1 minute resolution (Years 1, 2 and 3)
This task will be performed in collaboration with NOAA, MOTOC, and NGA. Here we will use the 1-minute gravity grid from Task 1 and all available edited soundings to develop the regional variations in topography/gravity transfer function that are used to map band-pass filtered gravity into bathymetry [Smith and Sandwell, 1994]. A preliminary version of this grid V9.1 is available at:

http://topex.ucsd.edu/WWW_html/mar_topo.html

The raw sounding data come in a wide variety of formats including; point soundings, single-beam trackline data, multibeam data, and gridded data. Prior to gridding, all data are converted to a common format which includes:

time or seq #	lon	lat	depth	sigma_pos	sigma_depth (9999 - flagged)	source_id	pred_depth
2082	144.93000	42.22910	-2325	0	-1	63	-2608
2083	144.93500	42.22970	-2347	0	-1	63	-2608
2084	144.93700	42.22900	-2353	0	-1	63	-2608
2085	114.94200	42.22800	-2354	0	-1	63	-2638

Identification of Incorrect Soundings

The 1-minute global bathymetry model consists of two separate grids of 2-byte integers. A minumum curvature approach is used to force the predicted depths to match the soundings forming the depth grid (right). A second grid is formed from the source_id number for each sounding (left). To identify bad source data, both grids are imaged in ER Mapper. Highlighting the source_id grid in the area of the suspect soundings reveals the offending data which are subsequently edited. Version 9.1 still contains a few bad tracks. The editing process is endless as errors become more subtle.

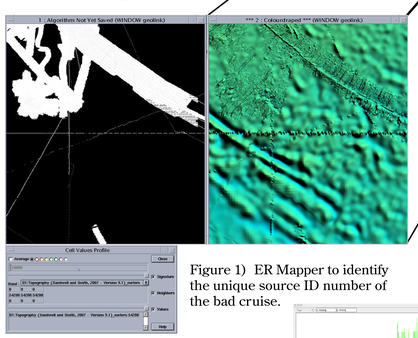

Figure 1) ER Mapper to identify the unique source ID number of the bad cruise.

Editing of Soundings

cmEditor, a program written by JJ Becker, was used to display and edit sounding data by hand. After identifying the source_id number of the bad cruise, the raw data that were converted to a common format above are reviewed and outliers flagged.

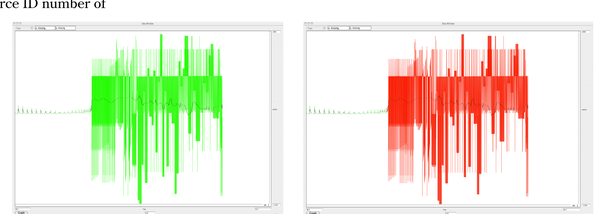

Figure 2) cmEditor. The data window shows predicted sea floor depths in black and measured sounding data in green (left) and allows the user to flag bad data points (right). Bad flagged data is shown in red.

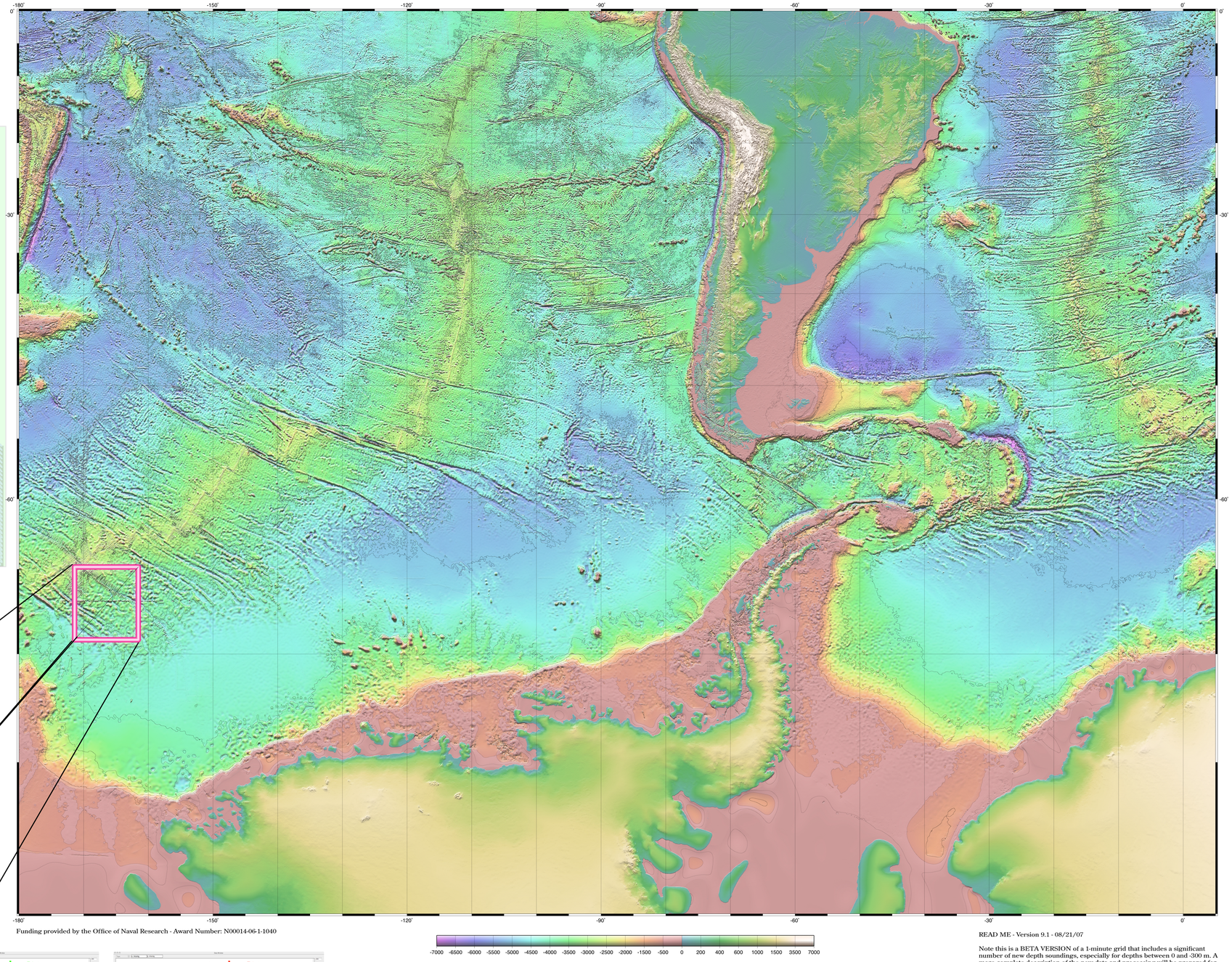

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Figure 3) The final global grid - V9.1 has a 1 minute longitude spacing and extends to a latitude of +/- 81°. The grid is available in a variety of formats at http://topex.ucsd.edu/WWW_html/mar_topo.html. Please report errors or omissions. The grid still contains a few bad cruises that were not identified previously (pink box). Land data are based on SRTM30 - V2 except in Antarctica where elevations were measured by the GLAS altimeter aboard ICESAT.

READ ME - Version 9.1 - 08/21/07

Note this is a BETA VERSION of a 1-minute grid that includes a significant number of new depth soundings, especially for depths between 0 and -300 m. A more complete description of the new data and processing will be prepared for publication in early 2008. This is a collaborative effort between NGA, NOAA, NAVO and SIO. The predicted depths are based on the V16.1 gravity anomaly model in an adjacent directory. Please send comments to dsandwell@ucsd.edu

Version 9.1 has a very different FORMAT than V8.2. The main differences are that the grid spacing in longitude is now 1 minute, rather than 2 minutes. In addition, the latitude range is increased to +/- 80.738. Like the old versions, the elevation(+) and depth (-) are stored as 2-byte integers to the nearest meter. An odd depth of say -2001 m signifies that this pixel was constrained by a real depth sounding while an even depth of say -2000 m is a predicted depth.

There are variety of ways to access the data:
1) If you just want an ASCII xyz file of some area I recommend using the web-interface. http://topex.ucsd.edu/cgi-bin/get_data.cgi

2) If you use General Mapping Tool (GMT) then the following command will extract a subset of data:
img2grd topo_9.1.img -T1 -S1 -V -R-180/-160/-80/-60 -m1 -D -Gtopo_all.grd
img2grd topo_9.1.img -T2 -S1 -V -R-180/-160/-80/-60 -m1 -D -Gtopo_hit.grd
The first commanad gets all the depths while the second command just gets the depths that are constrained by soundings.

3) If you use ER Mapper, you will find the appropriate header file in the directory. Topo_9.1.img.ers