United States – Canada Hydrographic Commission
Charting Advisors Committee Teleconference

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Navigation Surface and CUBE Update
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I. Navigation Surface
      A. Background

      Historically, a final product of a hydrographic survey would be a shoal-biased sounding set, reduced so that individual soundings do not overlap at a specific scale (smooth sheet or fair sheet). "Cleaning" a multibeam data set such that it could be reduced to a valid shoal-biased sounding set is a tedious, time intensive and subjective process that can quickly overwhelm a survey team. The Navigation Surface processing workflow offers a new approach to managing, archiving, and creating multiple products from hydrographic survey data. The horizontal and vertical uncertainty of each sounding is used in a weighting scheme to create a high resolution gridded surface or elevation model of the seafloor. The intent is to preserve the highest resolution data, even if such resolution will never appear on a navigational or charting product. Charting products are created from scale appropriate generalizations of the elevation model.

      Several papers are available upon request that introduce the concept in more detail, including;
      Implications of the Navigation Surface Approach for Archiving and Charting Shallow Survey Data, A. Armstrong, LT R. Breenan and LT S. Smith, Shallow Survey 2003.
      NOAA's Office of Coast Survey Adopts A Surface-Based Approach to High Density Hydrographic Data Analysis and Archiving, A Brief Overview, LT R. Breenan, 2004.
      The Navigation Surface and Hydrographic System Uncertainty at NOAA's Office of Coast Survey, S. Allen and J. Ferguson, US Hydrographic Conference 2005.

      B. CARIS Implementation

      NOAA uses CARIS HIPS for all shallow water multibeam data processing. HIPS version 5.4 released last year included BASE (Bathymetry Associated with Statistical Error) Surface processing. BASE is the CARIS implementation of the Navigation Surface concept. Testing, evaluation and development of field procedures were conducted in 2004. For the 2005 Field season all NOAA field units will be processing and submitting data using BASE surfaces.

C. Products

The final product of a survey will now be a surface. The BASE Surface will be used to create an S-57 exchange set, called an H-cell. Depth Areas and contours will be derived directly from the surface. NOAA's Marince Chart Division (MCD) will then use the H-cell to update the master ENC and raster chart databases.

D. Archiving

The final high resolution Navigation Surface from the survey will be archived at the NGDC (National Geophysical Data Center) for access by the public. Final formats and distribution options will be developed.

II. CUBE
A. Background

The CUBE (Combined Uncertainty and Bathymetric Estimator) algorithm was developed by Dr. Brian Calder at CCOM/JHC. The current BASE Surface in CARIS uses all soundings to compute a statistical depth for each node of the grid. "Noise" in the data will affect the depth value at the node. If the affect is great enough, the hydrographer will need to 'reject' the bad data, to ensure the grid properly models the seafloor. CUBE is designed to accommodate areas where the data may conflict. Areas with multiple statistically valid depths are represented as different "hypotheses". A hypothesis is defined as a depth estimate, which corresponds to a group of soundings that are internally self-consistent. For example, a school of fish might trigger its own depth hypothesis along with that of the seafloor.   The hydrographer can then review these secondary hypotheses and determine their validity. If the CUBE algorithm chooses the correct hypothesis, no action is required by the hydrographer.

B. CARIS Implementation

CARIS HIPS version 6.0 will include a CUBE implementation. NOAA is currently testing a beta version of the software. We don't expect a final, stable version until late Spring, early Summer 2005. At that time, we will need to complete testing and validation of the software and develop field procedures and documented processes. Partial implementation should occur late this year, with full CUBE implementation across the NOAA hydrographic fleet for the 2006 field season.

C. Future Steps and Challenges

Develop and maintain Field Procedures Manual, Office Procedures Manual, and Data Archiving Procedures.
Update *NOS Hydrographic Surveys Specifications and Deliverables* and receive Navigation Surface and/or CUBE products from our contractors.
Continued research and testing of new algorithms, procedures and methods.