The important role of international standards in transforming maritime data into usable information for e-Navigation: methods and application

Gregory Seroka[1], Erin Nagel[2], Kurt Hess[2], Neil Weston[1], Jason Greenlaw[3], Joseph Phillips[4], Edward Myers[1], and Julia Powell[1]

[1]NOAA National Ocean Service
[2]UCAR
[3]ERT, Inc.
[4]NOAA National Weather Service

November 24, 2022

Abstract

e-Navigation—the digitalization and harmonization of data collection, integration, exchange, presentation, and analysis on board and ashore—is an International Maritime Organization initiative that enhances marine navigation and supports safety of life at sea. As e-Navigation and marine activities continue to grow and become more diverse, data providers and users are also becoming more diverse, and the number of data types and sources and amount of data are increasing. Thus, there is an important need to standardize the data into uniform, usable formats so that 1) navigation systems can easily integrate and seamlessly display the data, and 2) mariners can make effective, accurate, and swift navigation decisions based on those data. Effective international standards are developed in consideration of all stakeholder countries' needs, with the flexibility to evolve to cater to new user requirements. Following these principles, the International Hydrographic Organization has developed a framework for standardization of maritime data products (the S-100 Universal Hydrographic Data Model)—a "standard for standards." S-100 serves as the umbrella structure by which all other data products should follow, such as high resolution bathymetry (S-102), water levels (S-104), surface currents (S-111), and weather (S-412). This presentation will provide insight into the development and application of international standards for three maritime data products: S-104, S-111, and S-412. Further, we will provide examples of how a data provider employs the international S-100 standard, via state-of-the-art work at the NOAA/National Ocean Service (NOS)/Office of Coast Survey that is converting in real-time, gridded NOS Operational Forecast System surface current predictions into an S-100/S-111 compliant format. Future work includes developing interoperability standards and testing products to ensure they meet user needs.

2018 AGU Fall Meeting. 10 – 14th December 2018, Washington, DC – Poster OS33E-1944

The important role of international standards in transforming maritime data into usable information for e-Navigation: methods and application

Greg Seroka[1], Erin Nagel[2], Kurt Hess[2], Neil D. Weston[1], Jason Greenlaw[3], Joseph Phillips[4], Edward Myers III[1], Julia Powell[1]
[1]National Ocean Service, [2]UCAR, [3]ERT, Inc., [4]National Weather Service

Abstract: e-Navigation—the digitalization and harmonization of data collection, integration, exchange, presentation, and analysis on board and ashore—is an International Maritime Organization initiative that enhances marine navigation and supports safety of life at sea. As e-Navigation and marine activities continue to grow and become more diverse, data providers and users are also becoming more diverse, and the number of data types and sources and amount of data are increasing. Thus, there is an important need to standardize the data into uniform, usable formats so that 1) navigation systems can easily integrate and seamlessly display the data, and 2) mariners can make effective, accurate, and swift navigation decisions based on those data.

Effective international standards are developed in consideration of all stakeholder countries' needs, with the flexibility to evolve to cater to new user requirements. Following these principles, the International Hydrographic Organization (IHO) has developed a framework for standardization of maritime data products (the S-100 Universal Hydrographic Data Model)—a "standard for standards." S-100 serves as the umbrella structure by which all other data products should follow, such as high resolution bathymetry (S-102), water levels (S-104), surface currents (S-111), and weather (S-412).

This presentation will provide insight into the development and application of international standards for three maritime data products: S-104, S-111, and S-412. Further, we will provide examples of how a data provider employs the international S-100 standard, via state-of-the-art work at the NOAA/National Ocean Service (NOS)/Office of Coast Survey (OCS) that is converting in real-time, gridded NOS Operational Forecast System surface current predictions into an S-100/S-111 compliant format. Future work includes developing interoperability standards and testing products to ensure they meet user needs.

1. Introduction

The primary goal of IHO's S-100 standard is to support a greater variety of hydrographic-related digital data sources, products, and customers. The S-100 framework allows for easier use of hydrographic data beyond Hydrographic Offices and Electronic Chart Display and Information System (ECDIS) users (e.g. coastal zone mapping, security, inundation modeling), and S-100 has a flexible maintenance regime which its predecessor S-57 did not have (it froze standards for lengthy periods). S-100 supports future requirements (e.g. gridded bathymetry, time-varying information), and new components are not developed in isolation.

NOAA is an active participant in new products and services to the S-100 suite of standards under development. This will enable mariners to have more information integrated within their navigation systems which helps them plan optimal routes and make critical decisions at sea.

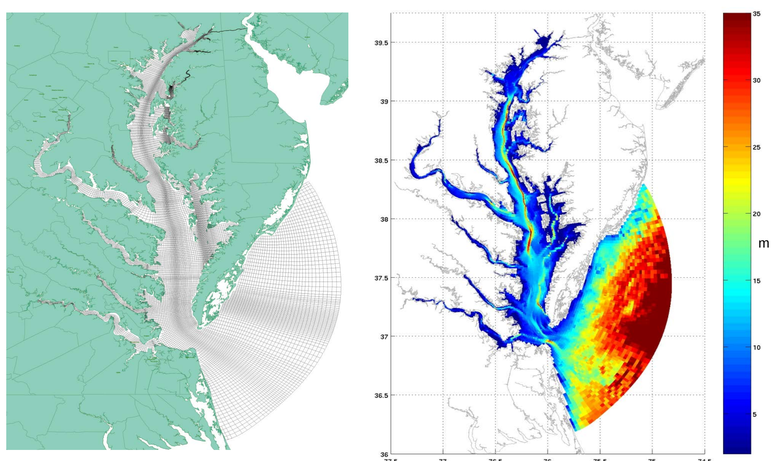

Fig. 1. National Ocean Service (NOS) Chesapeake Bay Operational Forecast System (CBOFS) model domain and grid (left). CBOFS water depth (m) (right).

2. Application: OFS S-111 Surface Current Data

In addition to its contributions to data standard development (e.g. S-100, S-111, S-412), NOAA is also paving the way internationally as a provider of S-100 compliant data. One project disseminates NOS Operational Forecast System (OFS, tidesandcurrents.noaa.gov/models.html) surface current information in S-111 format. OFS are national networks of operational nowcast and forecast models to support NOAA's mission goals and priorities. An OFS consists of the automated integration of observing system data streams, hydrodynamic model predictions, product dissemination and continuous quality control monitoring. Nowcasts and forecasts are scientific predictions about the present and near future states of a coastal marine environment or region. S-111 is an IHO standard under S-100 that outlines formats for storing and sending surface ocean current data and metadata, designed for interoperability with Electronic Navigation Charts and other IHO S-100 product specifications. S-111 aims to standardize surface currents for use in navigation systems in order to improve Navigation Decision Support for mariners.

NOS/OCS/Coast Survey Development Lab (CSDL) converts the irregular gridded OFS output to a regular grid, and then subsets the data to provide an easily digestible size and format (HDF5) for consumption by ECDIS, portable pilot units (PPU), and electronic charting systems (ECS).

Currently, S-111 HDF5 datasets are being produced in real-time for the Chesapeake Bay OFS (CBOFS) (**Fig. 1**) and the Delaware Bay OFS (DBOFS), with the New York & New Jersey OFS (NYOFS) under development. The S-111 HDF5 datasets for the other OFS across the U.S. will be posted to the OCS FTP site (listed in Section 5) as soon as they become available.

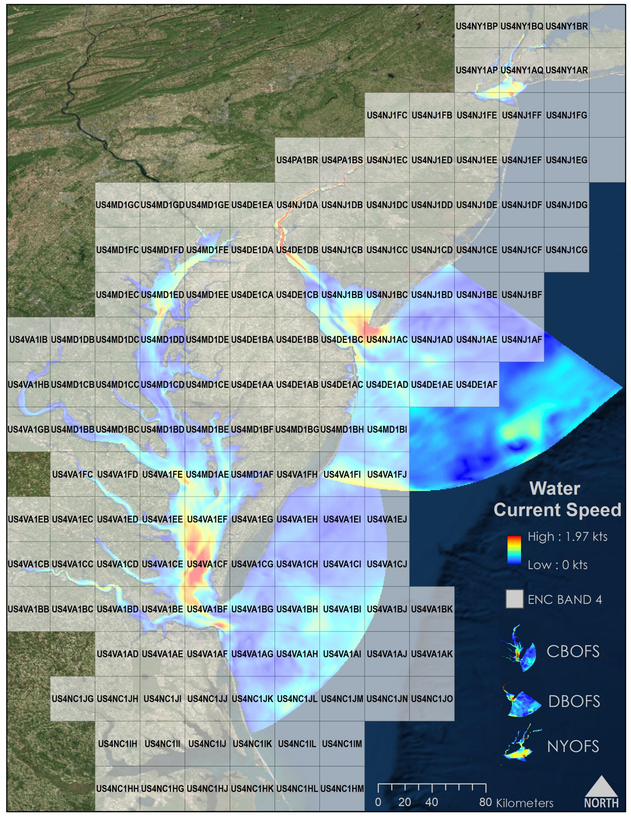

Fig. 2. New re-schemed NOAA Electronic Navigation Chart (ENC) Band 4 coverage (gray boxes with 8 digit labels) overlaid New York & New Jersey OFS (NYOFS), Delaware Bay OFS (DBOFS), and Chesapeake Bay OFS (CBOFS) current speed (colors) valid 1900 UTC on December 3, 2018. Band 4 standard scale is 1:40,000 to 1:80,000.

3. Operational Deployment

HDF5 files for CBOFS and DBOFS are produced in real-time every 6 hours following each model run cycle. The full forecast period is downloaded in its native Regional Ocean Modeling System (ROMS) NetCDF format, interpolated to a regular grid, and appended to a single S111 file (for the entire model grid) or a set of 62 (26) S-111 files, one per Band 4 ENC cell with CBOFS (DBOFS) coverage (**Fig. 2**). Each S-111 HDF5 file contains 48-hour forecast projections for each forecast cycle as well as the required S-111 metadata. Currents are interpolated to a depth of 4.5 m below the sea surface, and half the depth of the water column for areas shallower than 9 m.

Table 1. Specifications for real-time production of S-111 surface current data from NOS OFS

Variable	Value
IHO Specifications	S-100 Edition 4.0.0 S-111 Edition 1.0.0
Format	Hierarchical Data Format 5 (HDF5)
Operational Forecast System (OFS) Parameter(s)	Surface Currents
Coordinate System	WGS 84
Frequency	4 times daily cycle (0, 6, 12, 18 UTC)
Time Resolution, Duration	Hourly out to 48 hours
Time Zone	UTC
Resolution	~500 m (regular grid)
Depth	4.5 m below surface
Data Coverage	Chesapeake Bay, VA/MD/DC (CBOFS); Delaware Bay, DE/NJ (DBOFS) (as of Dec '18)
Hydrodynamic Model	Regional Ocean Modeling System (ROMS)

4. Concluding Remarks

Figure 3 shows a zoom in of surface currents at the mouth of the Chesapeake Bay, approximating what portrayal of S-111 data in vectors might look like (Fig. 3 right). Portrayal of the S-111 data to ensure it meets user needs, and developing operational dissemination of the data is currently being worked on. Future work includes producing output across different ENC Band coverages, and interoperability of S-111 data with other S-100 data (e.g. water levels, weather, bathymetric data). Finally, investigation of S-104 water level data from NOS OFS is part of the NOAA plan in the coming year.

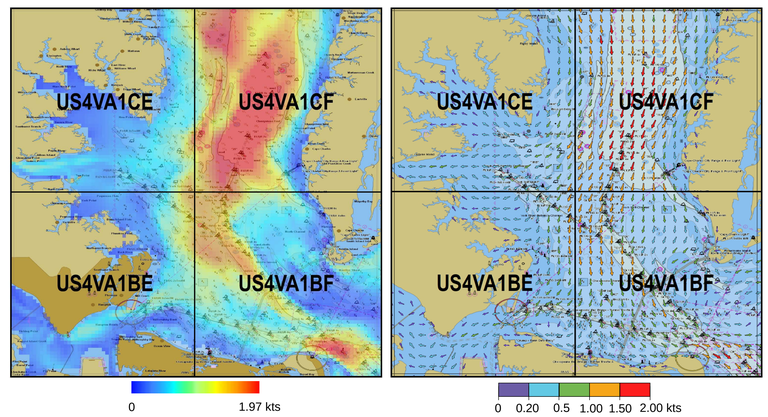

Fig. 3. Zoom in of Fig. 2 at mouth of Chesapeake Bay with surface current speeds now overlaid NOAA ENCs (left). Vector portrayal of surface currents (right), following S-111 portrayal specification and general color scheme (vector size, spacing, and distribution of colors to speed not S-111 portrayal compliant). Note that the vectors are on a regular grid.

5. More Information

OCS FTP: ftp://ocsftp.ncd.noaa.gov/OFS_Data/
IHO: iho.int
IHO S-100: https://iho.int/iho_pubs/standard/S-100_Index.htm, http://s100.iho.int/S100/
HDF5: https://support.hdfgroup.org/HDF5/

Contact Information: Greg Seroka (NOAA), Gregory.Seroka@noaa.gov