

Meeting Summary
Hydrographic Services Review Panel
September 27 - 29, 2023
Silver Spring, Maryland

Wednesday, September 27, 2023

On the call of the Designated Federal Officer (DFO), Rear Admiral Benjamin Evans, NOAA, the Hydrographic Services Review Panel (HSRP) meeting was convened on February 28, 2023, in the Hotel Silver Spring, Pinnacle Grand Ballroom, 8727 Colesville Road, Silver Spring, Maryland. The following report summarizes the deliberations of this meeting. The agenda, presentations, and documents are available for public inspection online at

<http://www.nauticalcharts.noaa.gov/hsrp/meetings.html>

Copies can be requested by writing to the Director, Office of Coast Survey (OCS), 1315 East West Highway, SSMC3, N/CS, Silver Spring, Maryland 20910.

Opening and Introductions

Rear Admiral Benjamin Evans, Director, Office of Coast Survey (OCS), National Ocean Service (NOS), and HSRP Designated Federal Officer, called the hybrid meeting to order at 9:03 a.m. EDT. RDML Evans reviewed the meeting agenda, provided ethics reminders for members, and discussed privacy considerations for attendees.

Julie Thomas, Chair, HSRP, welcomed the attendees to the meeting. She recognized the NOAA leadership present and called for introductions from the members.

Senator Ben Cardin, U.S. Senate (D-MD), provided comments via letter, welcoming the HSRP to Maryland and expressing his appreciation for NOAA's work. He was proud to vote for both the Inflation Reduction Act (IRA) and Bipartisan Infrastructure Law (BIL), which will further empower NOAA to build a Climate-Ready Nation that is well-prepared to face future weather events. This meeting presents a valuable opportunity to discuss maritime products, services, and data needs with stakeholders and partners. The feedback they receive will inform NOAA and help them better serve the nation. Senator Cardin commended the HSRP for their continued efforts to better serve communities.

Dr. Richard W. Spinrad, Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator, thanked the members for their service and assured the Panel that NOAA's mission-essential activities would continue in the event of a government shutdown. He discussed some of his background in oceanography and his time leading NOS back when the HSRP was first established. Recently, NOAA has put a lot of work into getting the \$6.3 billion of BIL and IRA funding into meaningful investments. NOAA is recapitalizing a quarter of its sea-going fleet and Dr. Spinrad has established a goal for a net zero fleet by 2050. The U.S. recently signed on to a treaty on biodiversity beyond national jurisdictions, which will have extraordinary implications for mapping and charting the global ocean. Two 30x30 initiatives are driving much of NOAA's recent work, the 30 gigawatts of offshore wind by 2030 and the 30% of lands and waters conserved by 2030 initiatives. Deep sea mining and marine debris are also areas experiencing forward movement. By the end of August, the U.S. surpassed 23 billion-dollar disasters for the year. This has profound implications for the work of the HSRP. Given that framing, Dr. Spinrad discussed his top priorities for the next several years. These include building out the New Blue Economy and offshore wind development, Climate-Ready Nation, and

a diversity, equity, and inclusion (DEI) emphasis. NOAA is recapitalizing three major pier facilities in Ketchikan, AK, Newport, RI, and Charleston, SC. The agency is building out the NOAA Corps, looking to build up to 500 NOAA Corps Officers, and they are engaging with academia in training the civilian workforce in a variety of ways. NOAA has been partnering with other agencies within the Department of Commerce, such as Economic Development Administration (EDA) and the Patent and Trademark Office (PTO). A significant portion of the IRA funding is going into areas like coastal resilience that rely on foundational data like shoreline mapping, hydrographic surveys, the National Spatial Reference System (NSRS) modernization, tidal datums, etc. The Coastal Resilience Regional Challenge has concluded its RFP and has received over \$16 billion worth of proposals, a 30-to-1 ratio of proposals to available resources, indicating the size of the demand signal for these activities. Dr. Spinrad briefly discussed some of the specific technical areas that the HSRP will be discussing further later in the meeting, such as data as a service, artificial intelligence and machine learning (AI/ML), NOAA in the Cloud, digital twins, and intellectual property (IP) development. He challenged the HSRP to bring to the agency's attention what NOAA is missing and where there is opportunity space in the hydrographic services remit. This feedback will help make the argument for sustaining the kind of investment NOAA has seen from IRA and BIL funding.

Anuj Chopra asked the Administrator to elaborate on his vision for economic development opportunities and how NOAA can support industry. Dr. Spinrad said there are a few areas, including IP protection and leveraging NOAA's relationship with PTO to raise awareness of issues associated with IP development. EDA has several grant programs for startups in the environmental area and NOAA could be working with the National Institute of Standards and Technology (NIST) on standards development that would benefit the industry and NOAA. Captain Chopra also asked how NOAA can provide data in a way that optimizes U.S. ports and makes them more competitive. Dr. Spinrad said the role of the International Hydrographic Organization (IHO) on standards development is key, as well as leveraging their partnership with the International Trade Administration. He will be attending COP28 with the Under Secretary for International Trade to discuss the commercialization and the overseas market for the full spectrum of New Blue Economy products and services, of which hydrographic services are an aspect.

Nicole LeBoeuf, Assistant Administrator for Ocean Services and Coastal Zone Management, NOS, NOAA, discussed NOS activities since the last HSRP meeting. NOS has been working hard to implement the IRA and BIL requirements. About half of the NOAA funding from each of the bills came to NOS, which was an incredible burden on the staff and programs, but good news for coastal and community resilience efforts. NOS and NOAA have been as strategic as possible around where to direct the funds and how to use them. These include expanding supercomputing capacity, building better climate forecasts, and improving NOAA's aging infrastructure. Coastal and community resilience rely on the foundational datasets that NOAA's navigation services provide and that the HSRP advises on. The funding is also being used to enhance NOAA's ocean and coastal observation programs and they have released a Notice of Funding Opportunity for an Ocean-Based Climate Resilience Accelerator to provide blue tech companies with training and resources to help them bring data and resilience products to market.

One of Ms. LeBoeuf's priority activities has been to make use of the interagency space, for which there has been a strong commitment from the Administration. She was recently appointed Chair of the Committee on the Marine Transportation System (CMTS) Coordinating Board. In the coming weeks, she will have an opportunity to lay out her policy objectives for the coming year, including Climate-Ready Ports. She will provide updates to the HSRP as these develop. Ms. LeBoeuf is also trying to bring these conversations to other interagency fora to share what NOS is doing and find out what data other agencies may have available from their projects. NOS will be releasing their first Strategic Plan soon.

Ms. LeBoeuf was excited to have Rachael Dempsey join NOS as the first Deputy Assistant Administrator (DAA) for Navigation, Observations, and Positioning. She provided an overview of Ms. Dempsey's background and discussed some of the key areas she will be working on.

Rachael Dempsey, Deputy Assistant Administrator, Navigation, Observations and Positioning, NOS, discussed her role as DAA for Navigation, Observations and Positioning, taking over the portfolio of the NGS, CO-OPS, IOOS, and OCS teams. The Directors will all stay in place, while she adds another layer of advocacy in support of the programs. Ms. Dempsey also oversees the NOS' Information Management Office and she fully recognizes the need to ensure their data is secure and can be accessed. She discussed some of the highlights since joining in April, including meeting with a wide variety of stakeholders around the country. She stressed how important the HSRP's input will be on NOS' new strategic vision and that NOS' partnership with the Panel needs to grow. She appreciates the references to the application of information, data, and environmental intelligence. These will be critical to solving the challenges the agency is facing. NOAA has many valuable sensors, but they need to think about how else they can be applied to new issues. Ms. Dempsey shared the example of heavy rainfall from atmospheric rivers that led to shutting down the Port of Stockton and a ship being trapped for 30 days while more ships were offshore waiting to enter. Workforce issues are also a major consideration for NOS, including the critical shortage of expertise in geodesy. They are increasing their recruitment efforts in a variety of ways, including establishing a pathways program for minority serving institutions. She urged the HSRP to share their thoughts on how to move forward in recruiting more geodesists.

Rear Admiral Benjamin Evans provided brief comments welcoming the HSRP to the meeting and pointed to a few of the advantages of holding the meeting in Silver Spring, including access to NOAA leadership and other federal colleagues who bring a variety of perspectives to the discussions. He encouraged HSRP members to engage with the NOAA staff that was in attendance. OCS appreciates the Panel members' time and engagement, and the HSRP's recommendations have a real impact on the actions of NOAA's hydrographic services programs.

Updates: Opportunities, Challenges and Priorities for NOS' Navigation Services Portfolio

National Ocean Service's Office Directors described recent activities within their offices, such as the update to the NSRS, datums, BIL projects, Seabed 2030, surveying, charting, uncrewed systems, remote sensing and lidar, photogrammetry, positioning, sea level rise, and water levels in support of seamless data.

Rear Admiral Benjamin Evans, Director, Office of Coast Survey, National Ocean Service, and HSRP Designated Federal Officer, provided an update on OCS' activities since the previous HSRP meeting. In August, OCS released its Strategic Plan for 2023-2027, which lays out the course for completing the transition from a solely product-focused organization to one that is focused on data, the products and services enabled by it, and how best to deliver it to end users in a timely fashion. The updated Nautical Charting Plan was also released in August. RDML Evans highlighted some of the changes in OCS' leadership, including the departure of Deputy Hydrographer Dr. John Nyberg and Captain E.J. Van Den Aemele, who has been replaced as Chief of the Marine Chart Division by Julia Powell. Matt Kroll is now serving in an acting capacity as the Chief of the Navigation Services Division until the arrival of Captain (sel) Matt Jaskoski in the Spring of 2024. OCS has established the Center of Excellence for Operational Ocean and Great Lakes Mapping, which provides new core capabilities for OCS and NOAA that will improve their ability to support and enable the NOAA mapping enterprise in collaboration with a variety of partners. RDML Evans reported on ongoing progress towards building out the National Bathymetric Source (NBS), compiling a single, authoritative, up-to-date model of bathymetry for U.S. waters. The NBS team expects to wrap up the East and Gulf coasts components by the end of 2023. Based on stakeholder input, they have decided to prioritize the NBS build-out in southeast Alaska as their next project. OCS has dramatically accelerated their ENC regriding project, which they now expect to be complete in 2026. OCS continues to make steady improvements to the NOAA Custom Chart tool and its output, which can be an important tool for augmenting their official ENCs. OCS continues to work with Esri and hydrographic offices around the world to develop future improvements to the tool. OCS is now more than halfway through the cancellation process of their paper

charts and remains on track to complete their retirement by the beginning of 2025. RDML Evans highlighted some of the projects from the 2023 field season, including a series of hydrographic training cruises aboard the NOAA ship *Nancy Foster* and estuary surveys performed in the Chesapeake Bay and Albemarle Sound, which will provide improved bathymetry for marine modeling efforts. NOAA's traditional hydrographic survey projects had great results this year but were severely impacted by staffing shortages. In early September, during the last year of the RICHARD campaign conducting integrated mapping and coral reef research in the water of American Samoa and the Pacific Remote Islands, NOAA ship *Rainier* experienced a major fire at sea. There were no injuries and they were able to get the ship back to American Samoa, but the damage was extensive and OCS is working closely with the Office of Marine and Aviation Operations (OMAO) to recover the mission. The Navigation Response Teams had a busy season, including working with the Quinault Indian Nation to define their fish habitat in Lake Quinault as well as other work in estuaries. They completed a response survey in Florida following Hurricane Idalia and remain on standby through the remainder of the hurricane season. RDML Evans concluded by highlighting OCS' extensive external engagements, domestic and international, to build awareness of what they do. Their most critical engagement has been with coastal communities and he discussed a trip to Alaska in May with key members of OCS staff to meet with a variety of stakeholders, which prompted him to think more deeply about how OCS and its partners engage with communities to build their ownership of the charting process and the outcomes.

Juliana Blackwell, Director, National Geodetic Survey (NGS), NOS, NOAA, provided an update on NGS' recent and upcoming activities. The modernization of the NSRS is making progress towards transitioning to the new geopotential datum. The update will improve accuracy, access, and alignment of geospatial data throughout the U.S. and support NOAA's goals of a Climate-Ready Nation and of providing more equitable access to the information. One of the major milestones of getting this work done was the completion of the airborne gravity collection which will be processed by December 2023. The shortage of eligible applicants for the federal geodesy programs has spurred the creation of the U.S. Government Geodesy Community of Practice (COP), which has been meeting to discuss ways to reinvigorate the field of geodetic sciences and related fields. This year, NGS was able to award \$4 million in grant funding to several projects that will address the nationwide deficiency of geodesists. Ms. Blackwell discussed the international comparison of absolute gravimeters that took place in Boulder, CO, and involved 20 different countries calibrating their devices. This year, NGS completed the State Plane Coordinate System of 2022 and made those available on their Alpha Site. By the time of the next HSRP meeting, NGS plans to roll out a new research plan, release a Beta version of the CORS Station Pages for Data Delivery System, release an Alpha version of the Reference Epoch Coordinate Adjustment, and release a Beta version of their adjustment program, transformation engine, and Euler pole parameters. Additionally, the Geodetic Data eXchange will replace the GNSS Vector eXchange format and NGS will release a tool that provides dynamic heights from GNSS that can be used in water management efforts. Ms. Blackwell briefly highlighted NGS' anticipated activities extending further out as part of their NSRS modernization effort, concluding with the official announcement of the updated NSRS in mid-2025. NGS' Coastal Mapping Program had 21 task orders in FY23 totaling approximately \$30 million.

Derrick Snowden, Acting Director, Center for Operational Oceanographic Products and Services (CO-OPS), NOS, NOAA, provided an update on CO-OPS' recent activities and an outlook on upcoming work. He has been serving as Acting Director of CO-OPS for about two weeks. CO-OPS' update to the High Tide Flooding Outlook included both methodological and visualization enhancements. Users can now view annual and monthly products spatially and drill down to individual stations. The seasonal bulletins have been replaced with a monthly product that provides a direct estimate of the number of high tide flooding days predicted in the coming year. All of the data that powers their visualizations is available through their application programming interfaces (APIs), which can be incorporated into users' own visualization and analysis systems. The Annual High Tide Flooding Outlook shows how the projections might change over decadal time periods out to 2050, based on IPCC projections. CO-OPS has

responded to requests for more dynamic information about the nearshore wave climate on top of the static sea level estimates that water level sensors provide. They have been adapting their signal processing to get estimates of wave set-up, which provides more data on issues like coastal erosion and wave overtopping of sand dunes. CO-OPS has been adding web cameras to select NWLON stations to provide visual context for what their data means for inundation in particular locations. In FY23, CO-OPS updated six PORTS with new sensors. Their 39th PORTS will soon be operational in Pearl Harbor, HI, and they are working towards establishing the 40th in Seattle, WA, in FY24. CO-OPS has been conducting public outreach to solicit feedback on the program itself, trying to get at two key topics: what a fully built-out PORTS program would look like and soliciting input on PORTS governance. They expect to release a report on this in February 2024. In FY23, the National Current Observation Program collected and is now processing data in the Columbia River, Delaware Bay, and Savannah River and the tide tables should be updated in six months. The Charleston Harbor deployment is being planned for 2024. CO-OPS has been working with partners in NOS to update the visualization system powering the entire CO-OPS website, which is slated for Beta release in Q1 of FY24. This tool, OceansMap, will integrate real-time observations with Operational Forecast System forecasts to provide up-to-date assessments of ocean conditions.

Andy Armstrong, Co-Director, Center for Coastal Ocean Mapping/NOAA-University of New Hampshire (UNH) Joint Hydrographic Center (JHC), provided an update on activities at the JHC, focusing on the new Center of Excellence in Operational Ocean and Great Lake Mapping. He provided background on the growth of JHC operations since 2000. Between 2001 and 2023, JHC has graduated 15 PhDs, 78 Master's, 3 NOAA Admirals, and 120 foreign students from 50 different countries. One of the features of the CCOM part of JHC is its Industrial Associates program, which has formal agreements with 64 private partners. The new Center of Excellence was announced on September 19, 2023, and is charged with working across NOAA line offices to leverage public-private partnerships for advancing the nation's ocean and Great Lakes mapping goals. In FY23, the Center received \$10 million in new money to achieve its mission to support the requirements and goals of the NOMECE strategy, the Hydrographic Services Improvement Act, the Coastal and Ocean Mapping Integration Act, and Seabed 2030. The Center will provide a focal point for transitioning developments in mapping platforms, sensors, and concepts into operations. This part of the UNH program will not grant degrees, but will be for career-based applied practical training for professionals in the mapping community. The Center will provide an agency-wide capability to provide technical support for ocean mapping technologies to operators in the field on an increasingly diverse set of platforms. UNH has received strong support from industry and interest from new companies that want to be part of the ecosystem they are developing. The construction of the new Center is expected to be complete by FY26. UNH views this effort as a piece of their innovation hub called The Edge, which will include facilities for innovation, technology transfer, and entrepreneurship with the intent of having a real economic and social impact. Once The Edge is at scale, it will serve hundreds of residents and thousands of UNH employees and industry partners.

U.S. Committee on the Marine Transportation System Update

Brian Tetreault, Acting Executive Director, and U.S. Army Corps of Engineers, Senior Advisor, U.S. Committee on the Marine Transportation System, provided an update on the CMTS. Mr. Tetreault provided some background on the CMTS before focusing on three projects of particular interest to the HSRP. The CMTS is a Cabinet-level interagency maritime policy coordinating board chaired by the Secretary of Transportation with designated members from 15 other agencies. As of August 1, Nicole LeBoeuf serves as Chair of CMTS' Coordinating Board, which has members from 20-30 federal agencies. A staff-level working group of around 30 subject matter experts from member agencies meets monthly to follow up on their work. CMTS also has teams to focus on different topics, both long-term Integrated Action Teams (IATs) and specific working groups or task teams to address particular items. Mr. Tetreault focused on the work of three of the IATs - the Maritime Data IAT, the Future of Navigation IAT, and the

Offshore Energy Facilitation Task Team. The Future of Navigation IAT is co-led by NOAA, USCG, and USACE, and works on coordinating federal efforts around navigation technology and the creation and dissemination of information and products. They are helping to coordinate the implementation of S-1XX products and have completed a Waterways Harmonization effort to synchronize names and abbreviations for rivers, bays, and landmarks. The Ocean Energy Facilitation Task Team was stood up at the request of the Bureau of Safety and Environmental Enforcement and is co-led by them and NOAA to draft guidance for the mitigation of munitions and explosives of concern that are being found by crews looking to establish offshore wind farms. A finalized version of the guidance should be available in early 2024. The Maritime Data IAT focuses on interagency coordination in the collection, processing, dissemination, and storage of data. They look to leverage each other's capabilities to avoid duplication of effort and share collected data.

HSRP Q&A

Anuj Chopra asked if CMTS is working to address the challenges they are having with AIS regarding identification and spoofing. Mr. Tetreault said CMTS is not specifically working on this issue, but its member agencies are. There are new technologies being developed to augment AIS that will be more secure, have higher bandwidth, and include anti-spoofing/jamming capabilities.

Digital Twin Application to NOAA

Dr. Qassim Abdullah and Captain Anuj Chopra, HSRP members, and Galen Scott, NGS, moderated the panel.

Qassim Abdullah provided an introduction to the discussion on digital twins, which are dynamic, up-to-date representations of a physical object, asset, or system that incorporates all of its relevant data in one place and evolves with the flow of real-time input from sensors. It is not simply a 3D model or simulation, but evolves with added data and information. The connection between digital and physical worlds enhances life cycles, informs decision making, and supports predictive capabilities. The UN is working on a Digital Twin of the Ocean, which will be a virtual representation of the ocean with its physical, chemical, and biological properties based on ocean observations and models with the purpose of developing what-if scenarios for decision making. NOAA provides the public and federal agencies with a tremendous amount of data and services, which comes with significant challenges for the agency. Substantial resources and energy are spent on managing large assets using conventional methods. Digital twins could provide a better way. Enabling the development of digital twins would require a holistic approach to data management characterized by data that is updated and served in real or near-real time through a stable and accessible interface, data that is based on AI-driven data science and analytics, trustworthy data that is interoperable with digital twins, and accurate global positioning using a common datum and accuracy standards.

Anuj Chopra discussed the economic value of digital twins. Key areas of impact for digital twins could include port operations optimization, AI/ML and simulation, real-time transparency of supply chain, informed data-driven decision making, increased all-around safety and resilience, sustainability and greenhouse gas emissions, and commercial impacts. Captain Chopra briefly touched on each of these, before focusing on port optimization and greenhouse gas emissions. Optimizing ports would have a direct impact on the trillions of dollars and millions of jobs that center on U.S. ports. He cited the Port of Houston-Galveston's fog challenges that shut down operations and cost large amounts of money, as well as potentially impacting national security. Real-time monitoring of greenhouse gases allows ports to plan which ships are allowed to enter and to what capacity they can be working. There is a clear commercial advantage in this kind of sustainability focus because it optimizes the profitability of companies and ventures over a longer period of time. Digital twins would enhance this. The more data that is made available, the more analytics can happen, which will lead to better research and future products.

Marten Hogeweg, Senior Project Manager, Esri, Inc., discussed GIS, a foundational building block for a Digital Twin of the Ocean. Technology trends like AI/ML, big data analytics, sensors and drones create new opportunities to understand and address the problems the world is facing. All of these require a holistic and collaborative approach, which is where digital twins come in. GIS creates digital twins of the natural and built environment and integrates many types of digital models. Mr. Hogeweg described some of the various users of digital twins today and how they apply it in the fields of landscape management organization, indoor dynamics of climate control and optimization, utility companies for their infrastructure, and smart cities. The gap in this picture is oceans, where there are many opportunities for a digital twin. The ocean is a unique space and understanding the processes and physical characteristics inherently requires thinking in three dimensions. Mr. Hogeweg presented several simplified slides of what a digital twin of the ocean might look like, integrating topo-bathy data, computational fluid dynamics, and multidimensional data in a time-dependent display, and he described how the Port of Rotterdam has implemented some of these techniques to optimize under keel clearance. Time scale will be a factor in a Digital Twin of the Ocean. Deep learning will require a lot of data as inputs and will produce a lot of data that needs to be managed. A Digital Twin of the Ocean must be built on interoperable technologies and with APIs so systems can connect to each other. ArcGIS supports this kind of system and does observing and data collection, presents the data through visualizations, provides advanced analytics of different types of data, and then shares and informs others about the decisions made through outreach and collaboration. Mr. Hogeweg shared a website Esri created that is a GIS for the Ocean and encouraged HSRP members to participate in the Deep Ocean Solution Accelerator workshop on October 2 and 5.

Inching Towards Digital Twin Through Digital Transformation

Kat Rovang, Senior Geoscientist, Fugro, discussed the industry experience with digital twins and attempts to push digitalization forward. Digital twins can help organizations maintain compliance with evolving environmental regulations by providing tools for monitoring and reporting environmental data accurately. They facilitate global collaboration by providing a common platform for sharing data, models, and best practices. Ms. Rovang discussed how Fugro is working towards building a Digital Twin of the Ocean, which requires access to high quality geodata in four dimensions. The challenges of creating and maintaining an evolving digital twin include ensuring quality data is being acquired and subject matter experts are doing quality control, scaling appropriately with an awareness of hardware limitations, and data security and privacy concerns. Fugro's geodata engagement portal is a platform that allows many users from different organizations to access data in a collaborative way by providing a centralized cloud repository that can support quality controlled standardized geodata management. Several use case modules are available to be applied on top of the integrated data produced, which have been used for permitting optimization, foundation design simulation, routing optimization, coastal adaptation simulation, potential site identification, and acquisition survey tracking. She discussed examples of each of these use case modules.

Kim Valentine, NOAA Geospatial Information Officer, discussed NOAA's digital data contents and dissemination, as well as what NOAA is doing to enhance their data governance structure and approach. NOAA is working to improve access to their data using open licensing and other methods that align with their goal of maximizing data use and applying the FAIR (findable, accessible, interoperable, reusable) principles. Each of NOAA's line offices support the NOAA Data Governance Committee through their Assistant Chief Data Officers. The committee has six task teams and working groups tackling specific technology problems, such as developing an open data licensing policy. NOAA has consolidated its efforts to get all of its data enterprise information in one place, and now has a Google Site they update where the information is housed, including the NOAA Data Management Directives Handbook. Ms. Valentine stressed the importance of the NSRS and geodetic control as a foundational component for any GIS. As part of the modernized NSRS roll-out, it should be a priority that NOAA is getting this information out, making it available, and working with NGS to help the user community with tools to be

able to incorporate it into their existing missions. NOAA has to ensure that the georeferenced data they collect and publish are consistent with the new framework. One of their key challenges is making data as discoverable and usable as possible, in particular by local decision makers. The NOAA GeoPlatform is an example of how the agency is using software as a service to serve their authoritative data to the public. GeoPlatform currently has over 7,500 user accounts, 13,000 items of public content, and StoryMaps to provide narratives around the data and topics.

NOAA AI-Based Earth and Space Observations Digital Twin Prototype

Lynn Mayo, Joint Venture Program Manager NOAA, National Environmental Satellite, Data, and Information Services (NESDIS), provided an overview of NOAA NESDIS' Joint Ventures initiatives. Given the amount of environmental data that NESDIS acquires, the concept of a digital twin is of interest to them, particularly as NOAA transitions to an enterprise satellite architecture. Historically, NESDIS has relied on NOAA-launched satellites along with a few partner satellites. By 2030, they envision a constellation of satellites from various sources in order to meet customer needs. The Joint Venture focuses on leveraging the technologies, capabilities, and data being developed by other government partners and industry to see if they can eventually transition them into NOAA operations. The Joint Venture began the Earth Observation Digital Twin demonstration project to see if a digital twin could enhance their ability to process, quality control, and consolidate environmental data, streamline the satellite data ground processing and dissemination to users. They hope the project will help determine if and how digital twins could serve as the next generation of ground enterprise system in operations. The project is for demonstration purposes only, and there are currently no plans to adopt the Earth Observational Digital Twin into operations. The Joint Venture is looking for a flexible digital earth twin system that allows users to easily access current and past environmental data, a modern visualization toolset to allow the display of the digital twin data, one that is able to ingest several large files from different sources at different scales, and is standardized with other digital twin efforts. The Joint Venture awarded three contracts in 2022 for one- to two-year projects. One of these contracts went to Lockheed Martin.

Dr. Lynn Montgomery, Staff AI Research Engineer, Lockheed Martin, discussed in detail the NOAA AI-based Earth and Space Observations Digital Twin Prototype that is one of the contracts awarded by the Joint Venture. NOAA is looking for a digital twin prototype that is able to ingest, analyze, and display data from across the atmosphere, ocean, cryosphere, land and hydrology, and space weather domains. Lockheed Martin sought to create an all-inclusive prototype for NOAA satellite and ground-based observations along with model output from the Global Forecast System at different temporal and spatial resolutions. It needed to be easily configurable to other geospatial data sources and algorithms. NOAA also wanted it to be able to do data fusion and anomaly detection and integrate some AI/ML algorithms. Dr. Montgomery discussed the architecture of the program and walked through an example of the workflow from initial data acquisition through visualization via their Agatha 4D global visualization tool. The architecture is extremely configurable and allows for plugging in any algorithm the user prefers for processing the data. The program has nearly completed their first of two award years.

HSRP Q&A

Julie Thomas asked for clarification on NOAA not having plans to go operational with the demonstration project. Ms. Mayo said the Joint Ventures program is only looking at the feasibility of the concept. The three vendors are helping NOAA to identify the challenges and benefits, and it is their hope that it will eventually be operationalized.

Julie Thomas asked if Fugro's tool was exclusively in-house or if there were other users in the community taking advantage of it. Mr. Rovang said they offer it to their clients, which typically involves several different organizations per project. Ms. Hargrave noted that the data gathered for Atlantic Offshore

Wind's project with Fugro was provided to a large number of government agencies and has removed the need for the lead agencies on projects to distribute the information.

Ed Saade said this tool needs to be sufficiently simplified that any user can take advantage of it. He asked if clients currently feel comfortable using the platform and working with the data. Ms. Rovang said they see varying levels of expertise in the users working with this platform. Generally, after a one-on-one onboarding session they feel comfortable. Ms. Mayo said vendors are able to make the sources of the data available, which also makes users feel more comfortable working with the information.

Lindsay Gee said this has been building for nearly 20 years and it is now finally useful. The difference between this and what has come before is that previous projects were built once with no ongoing use. The challenge for NOAA is making sure the data is available and ensuring people can use it, while also making it useful for those wishing to add value to it and build proprietary tools. Since NOAA will not be building a digital twin themselves, they need to figure out what they need to do to service all of their data in an appropriate fashion.

Geodesy Community of Practice: Addressing the Geodesy Crisis

Brad Kearse, Deputy Director, NGS, introduced the panel's topic of the U.S. government's response to the nation's loss of capacity and international competitiveness in the field of geodesy. NGS' partnership with the National Geospatial-Intelligence Agency (NGA) led to the development of a memorandum of understanding amongst federal agencies in the geodesy space on how to move forward in addressing the workforce shortage. The Federal Geodesy Community of Practice currently consists of representatives from NGA, NGS, the National Aeronautics and Space Administration (NASA), and the U.S. Geological Survey (USGS). In the future they intend to include academia and industry partners in the group, but are initially working to get the framework on the federal side aligned. The Geodesy COP held its first summit in September, which included 65 agency representatives and 36 people in attendance. The COP has formed four technical working groups (Surveys, Reference Frames and Modeling, GNSS, and Lunar) and four strategic working groups (Academic Partnership Sync, Forums Sync, Hard Problems Review/Sync, and Strategic Planning) to address specific topics of interest. These collaborations have created relationships and synergies that will go a long way towards tackling the problem. They have broadly shared their list of hard problems facing the field of geodesy to raise awareness of the issues and so that institutions can help out in the future. The COP's Strategic Planning Working Group is developing a Geodetic National Framework on how to resolve the crisis. A draft is out now and they hope to have it to agency directors by the end of 2023. In FY24, the COP aims to position itself to become the coordinating body for training future geodesists. They seek to establish geodesy in K-12 STEM education, create undergraduate pathways, find funding for graduate research, create research-to-employment efforts to get graduates in federal service, and develop certification and training for career employees.

Scott Spaunhorst, Technical Executive, Office of Geomatics, NGA, said that the National Geodesy Advisory Committee (NGAC) has highlighted three key things to address the geodesy crisis: educational support, research funding, and government agencies. The work of the COP covers each of these aspects and the Geospatial Modeling Grant will be very helpful in this effort. NGA had been hosting its GEO-ESCON, which is an emerging scientist consortium trying to get agencies and academic institutions to work together to address these hard problems. They are hoping to go into FY24 with a more consolidated effort, though NGA may still offer its own grant opportunities. It will take several years of funding to address these hard problems. Sharing funding across departments is challenging, but if they could find a way to group funding together they would be better situated to address the issue. NGA has shifted its focus from hiring geodesists to hiring math and physics majors and training them on geodesy once they are in-house. In FY24, the COP will be looking at the tradecraft for geodesy from a larger perspective and how to market the field to different age groups. Part of this will be giving universities clear direction on what is needed and allowing them to use their expertise to build something appropriate.

Benjamin Phillips, Lead, NASA's Earth Surface and Interior Focus Area, discussed some of NASA's pre-existing geodetic partnerships and the possibility for more in areas that are relevant to other agencies' missions. He stressed the need for improving the branding of geodesy and potential marketing strategies for recruitment and retention. Agencies should put out a collective message to encourage students or early career professionals to enter the field, without trying to direct them into a specific mission need. This would grow and enrich the broad pool from which the agencies could draw talent from. Geodesy plays a pivotal role for NASA's earth orbiting missions, providing precision orbit determination, earth orientation parameters, the reference frame to tie their measurements to, and is especially important to their gravity, sea surface altimetry, and ice elevation missions, as well as their geodetic imaging missions. Geodesy and its core products are fundamental to enabling measurement and advancing an understanding of the earth system, particularly processes that require high precision, such as plate tectonics and sea level rise. NASA's Space Geodesy Program focuses on developing and deploying geodetic infrastructure, data analysis and distribution, and includes a number of academic partners. They also have competed research programs that explicitly welcome research in geodesy. NASA continues to make these investments but encounters challenges with the recruitment of U.S. citizens for core capabilities in operations. The next step for NASA is to look at how they can better coordinate and leverage initiatives that other agencies are standing up. There is nothing to preclude them from looking to co-funded opportunities in the future to try to more effectively draw an audience and build capabilities.

HSRP Q&A

Qassim Abdullah said the focus of this issue should be expanded to include surveyors, which is a much larger issue. A campaign to clarify what the field looks like today and a rebranding effort would be helpful, perhaps even renaming the field to positional engineering in order to get past the historic image of surveying. While he agreed that injecting money into the field is a good idea, he thought the agencies would find it hard to justify more without a national needs assessment that looks at the next 15 years. He asked if there were any barriers to including academia and trade associations in the COP. Mr. Kearse said that their plan was to get the federal agencies working together first and then extend out from there. They are trying to tackle this issue in many different ways, but felt it was important to start with a more narrow focus in order to gain momentum.

Lindsay Gee said recruiting people with a pathway to citizenship would yield results much more rapidly than some of their other ideas and should be considered. He noted that industry also has recruitment challenges across the various areas that need geodetic expertise. Defining what geodesists and surveyors do will be critical for elevating the field. He stressed that the sooner the COP can include industry and academia the better.

Mary Paige Abbott shared some of her professional experiences with marketing and recruitment. Students are not going to come to geodesy, the field has to go to them with an attractive image of their discipline.

Anuj Chopra said classifying geodesy as a STEM program, which would then get it included in engineering schools, could make a big difference.

Nathan Wardwell encouraged NGS to follow the other agencies' leads on K-12 engagement. He thought including industry within the COP would enhance their work and not slow it down, given that they are facing the same challenges.

Gary Thompson said that hydrographic surveying, photogrammetry, and geodetic surveying are included in the licensing laws for over half the states. The current exams to get licensed require a boundary exam. There has been ongoing work to develop an exam that will offer a pathway for people to get a professional license. They have been trying to convince the National Council of Examiners for Engineering and Surveying (NCEES) that this is needed, and he encouraged participants to let them know

that this would be a way to help attract people to the profession. RDML Evans said that NOAA would need to look at the details but they are open to providing a letter supporting this idea. He invited the HSRP to consider drafting their own letter of support.

Andy Armstrong said the COP should draft a list of competencies that constitute what they are looking for at different levels.

Public Comment

Virginia Dentler read the following comments received during the first day of the meeting:

Rada Khadjunova, Fugro, commented that offshore wind energy development plays an important role in U.S. efforts to achieve our nation's stated clean energy and blue economy goals. Fugro is the world's leading geodata specialist, collecting and analyzing comprehensive information about the earth and the structures built upon it. Fugro maintains offices in 12 U.S. states, where they serve both public and private sector clients on land and at sea. Over the last decade, Fugro has been at the forefront of offshore wind energy developments in the U.S., providing survey and other technical and consulting services to help advance offshore wind energy development while protecting biodiversity and enabling shared stakeholder use of the ocean. Fugro recognizes and supports NOAA's active engagement in the offshore wind energy development process with partnerships at regional and national levels to enable science-driven resource management decisions. A good example of this is NOAA and the Bureau of Ocean Energy Management's (BOEM) joint strategy on fisheries surveys, as well as joint studies on spatial planning and siting of offshore wind energy in the Gulf of Mexico and Central Atlantic, just to name a few. Another area that could benefit from even more inclusive partnership is ocean data management and data sharing. Fugro's experience indicates a high level of interest from the research and ocean user community to access and openness from the developer community to share siting data collected as part of BOEM's site characterization requirements. While BOEM is the lead agency under the NEPA process, it is a regulatory agency, not a science agency. Numerous projects are now entering the construction operation plan stage, which gives an approximately two-year lead time for this data to become eligible for sharing. Known pain points around data in this phase include access, packaging, storage, sharing, management, fidelity, and standards, particularly around metadata. Fugro believes NOAA, through the Integrated Ocean and Coastal Mapping (IOCM) Working Group, is in a unique position to help make the most of limited resources and help share ocean and coastal data and related products so that people who need the data can find it and use it easily. This would align with the agency's "map once, use many times" mantra. In partnership with the private sector, NOAA IOCM can improve the process by which siting data, including bathymetry, met ocean, and morphology data which was acquired as part of study and siting offshore wind energy infrastructure can enter public domain and be used many times. There are successful examples such as the Seabed 2030, an official Action of the United Nations Decade of Ocean Science for Sustainable Development (Ocean Decade) and NOAA's own National Centers for Environmental Information (NCEI) that can be used as models. For Fugro's part, they have been a leading private sector participant in the Seabed 2030 Project, contributing over 2.3 million square kilometers of data acquired by Fugro vessels, and facilitated numerous contributions by their clients to this global ocean mapping initiative. Fugro has specific ideas and resources for this cause and stand ready to help expand public-private cooperation and collaboration in this regard. They strongly believe that such partnership and collaboration directly contributes to and amplifies the benefits of our nation's clean energy and blue economy goals and developments. RDML Evans responded that OCS appreciates Fugro's support and contributions. One of OCS' greatest challenges is getting the right data to people in the right format in a timely fashion. He welcomed the opportunity to discuss possible options for improving this.

Muhammad Zarar commented that machine learning is particularly useful in the application of a hybrid approach to coastal management and blue economy. He asked if NOAA had some working plan in this

sector. RDML Evans responded that NOAA does have a Center of Expertise on AI to bring the power of AI/ML to bear against the NOAA mission.

Matt Borbash, U.S. Navy Deputy Hydrographer, commented that he would like to make the panel and public aware of the excellent, and perhaps unprecedented, interagency coordination and cooperation that takes place within the U.S. federal hydrographic program. U.S. hydro is unique in that three different organizations, NOAA OCS, Naval Oceanography, and NGA Maritime, share national leadership and representation responsibilities to the international community. Policy positions, reports, proposals, interventions and participation relevant to the IHO and the 15 regional hydrographic commissions are discussed and coordinated formally at their monthly U.S. Hydrographic Planning Committee meetings, and on a nearly daily basis amongst the joint team. These relationships and body of work ensure a unified, confident message and strengthen their ability to maximize benefit from the IHO. A great example of this effort is the very successful U.S. participation at the IHO's third assembly in Monaco this past May. Their delegation was comprised of 30+ individuals from the three main organizations, plus the State Department, academia, and contractors. They introduced a much needed and well received proposal to begin transforming how IHO capacity building is resourced, held tours and a reception onboard the Navy oceanographic survey vessel USNS Bruce C. Heezen, which was attended by His Serene Highness Prince Albert of Monaco and the U.S. Ambassador to France, and helped strengthen valuable international relationships. They won the award for best national exhibit, enhanced by displaying examples of national datasets on the Science on a Sphere display. This all culminated with the vote and election of NOAA's Dr. John Nyberg as IHO Director. This one example represents the numerous ways they are working together every day to strengthen the national hydrographic program. Mr. Borbash believes the multi-agency integration represents a government best practice that provides tremendous benefit to our science, industry, and nation and it is important that NOAA and the HSRP are aware of this.

Day 1 Meeting Recap and Round Robin with HSRP Members and NOAA Leadership

HSRP members provided comments on the first day of the meeting, including: they appreciated the workforce development discussion; encouraged NOAA to continue to accept new technologies faster; they were glad to hear about the progress being made on the geodesy crisis; a support letter for the mapping science exam would be good for HSRP to consider and Gary Thompson will begin drafting one; compared to other advisory committees, the HSRP gets a lot of work done and tracks it; making information about digital twins and new technologies available and understandable by the general public, as well as useable by policy makers, is an important step in realizing their value; NOAA needs to be creative generating more awareness about geodesy and one of their best educational resources is the Sanctuaries program; members were glad to see the position of Deputy Assistant Administrator for Navigation, Observation and Positioning was created, which will mean a lot for elevating the issues they face; they saw value in holding the meeting in the D.C. area to get more participation from NOAA leadership; it would be worth exploring if R&D is being done at UNH that would support the build out of digital twins and this may be an area for further discussion; the importance of geodesy to navigation has not gotten much discussion; as part of the Department of Commerce, NOAA's support for business optimization is key; net zero goals for greenhouse gas emissions by 2050 is something the HSRP needs to be thinking about; a geodesy marketing campaign is needed; members were pleased with the Administrator's and Assistant Administrator's visions for NOAA and NOS; there was encouragement for moving faster on connecting the 3DEP program with BlueTopo; the COP needs to include more partners as early as they can; there was interest in hearing more about photographing rip currents; NOAA has a responsibility that the products they put out include training and educational components; and the changes to the seabed over time have a significant impact on a wide variety of projects and building a model for predicting seabed mobility is a topic the HSRP should take up in the future.

Derrick Snowden said NOAA's role in digital twin development is something they need to consider as providers of data. NOAA does not get much feedback on the APIs they put out, so they do not know

which ones work best for users. Any objective feedback on this would be helpful for long-term planning. Rachael Dempsey said NOAA's foundational data is taken for granted but in her new role, she plans to stress its value to the nation. Juliana Blackwell said they have been hearing about digital twins for a long time and it was great to dive into in more detail. She now believes even more strongly that the offices are doing what they should be in their mission areas to support the development of digital twins, but would welcome any specific feedback on what they are missing. She stressed that the NOS offices cannot do more with the same or fewer resources than they currently have, they can only do more with more. It is important to be realistic about what NGS can do because the future is uncertain with regards to how they are going to manage their mission areas. Andy Armstrong thought it would be worth considering what system level was most appropriate to aim for in developing digital twins. He echoed the importance of recognizing the challenges, limitations, and capacity when taking on this concept. More discussion will be necessary to define exactly what NOAA's role should be. RDML Evans said he viewed the geodesy crisis as a subset of a broader geospatial crisis that is incredibly limiting for OCS. While he appreciated the comments about the need to grow the NOAA Corps, NOAA's ships are staffed largely by civilian mariners, which are also in short supply. Seeing what digital twins are and what they could potentially offer was very beneficial for the understanding of NOAA's Navigation Services Division. NOAA's role will certainly include the NBS, which will underpin any Digital Twin of the Ocean. OCS wants to hear any specific actionable recommendations from the HSRP on how they can make their data better serve this.

Thursday, September 28, 2023

NOAA/NOS Opportunities in Modeling Efforts in CO-OPS, NGS, OCS

Julie Thomas, HSRP Chair, and Dr. Shachak Pe'eri, NGS, moderated the panel and introduced the panelists. Dr. Pe'eri provided a brief overview of model development collaborations at OCS, CO-OPS, NGS, and IOOS who partner with academia on vetting and developing models that are implemented into their IT infrastructure.

Patrick Burke, Director, Oceanographic Division, CO-OPS, provided an update on the CO-OPS Operational Forecast System (OFS). In 2021, the U.S Department of Transportation estimated that the U.S. maritime transportation system carried \$4.6 trillion of cargo through U.S. seaports, significantly boosting jobs and the economy. Load planning in a way that provides an extra inch of freeboard on vessels can amount to huge differences in profitability. In addition to forecasts of the currents and water levels, water density measurements are important. In addition to navigation, CO-OPS has a coastal resilience mission and their models can provide predictive capabilities for a variety of uses, including predicting where water is going and how flooding may impact communities. NOS has a modeling strategy to help individuals and communities nationwide understand and use reliable, accurate, and accessible predictions of coastal conditions. The strategy's three goals are: (1) Address user needs through sustained community engagement and partnerships; (2) Develop ocean and coastal models through community modeling; and (3) Issue NOS forecasts through accurate and reliable model operations. There are other parts of NOAA that rely on CO-OPS information, so as they build models they need to be aware of other requirements in order to support as many mission areas as possible. NOS currently has 15 OFSs that are driven by real-time data and meteorological, oceanographic, and/or river flow rate forecasts to provide nowcasts and forecasts of water levels, currents, salinity, and water temperatures for two to five days out. Any model CO-OPS builds has to satisfy multiple navigation requirements before they can consider other additional needs. Mr. Burke described some of the planned upcoming improvements to OFSs around the country, which will allow them to achieve their vision of complete coastal coverage. He

discussed regional applications of OFS that go beyond navigation to support things like ecosystem services, search and rescue, and human health. OceansMap will be Beta released in early FY24 and will integrate real-time observations with OFS forecasts to provide up-to-data assessments of ocean conditions. This will be a much more user-friendly environment for using these applications and will grow confidence in the user community by being able to see how well the predictions performed. Marine Channels Forecasts are a pilot product from NOS and the National Weather Service (NWS) that combine observations from the oceanographic community and weather community and are currently available for Tampa Bay and Mobile Bay. Through BIL funding, CO-OPS is working on building a skill assessment module to better understand how models are being developed and how they are performing. Some of the challenges and opportunities CO-OPS is facing in its modeling program include: improving bathymetry and boundary forcing conditions; building a data inventory with standard QC and interacting with observing entities to exploit new technology to support model validation efforts and improve boundary conditions; supporting and leveraging R&D, including providing NOAA funding opportunities and enhancing coupling and data assimilation of long-term observations; continuing collaboration with the coastal modeling community to develop a comprehensive and standard methodology and criteria for coastal ocean model skill assessment to communicate confidence to users; developing coastal coupling solutions with the National Water Model to improve water quality predictions and navigation applications; requesting more R&D high performance computing allocations to perform longer term hindcasts and sensitivity experiments; and embracing emerging and innovative technologies, such as cloud services and AI/ML.

Dr. Greg Seroka, Physical Scientist, and Dr. Saeed Moghimi, Lead, NOS Storm Surge Modeling Team, OCS, provided an update on NOAA's Surge and Tide OFS' (STOFS) 2D and 3D models. NOS' Storm Surge Modeling Team work from R&D all the way through research-to-operations and operational support, which requires a variety of collaborations with academia, industry, federal, and international partners. Their storm surge models are primarily focused on coastal resilience and disaster mitigation, in addition to satisfying OCS' marine navigation mission. The team works extensively with NWS to generate flood forecasts and warnings during storms. Dr. Moghimi briefly reviewed some of the R&D products and services that the Storm Surge Modeling Team are providing, including NOAA's next generation probabilistic storm surge model (NHC-Psurge), an automated on-demand unstructured mesh generation (OCSMesh), and next generation Coastal Ocean Model Coupling infrastructure (UFS-Coastal), as well as providing support for Department of State's Overseas Buildings Operations and a 3D guidance system for Alaska (STOFS-3D-Alaska). Dr. Seroka focused his remarks on the two STOFS models, STOFS-2D-Global and STOFS-3D-Atlantic. STOFS-2D-Global is comprised of 13 million nodes globally, resulting in ultra-high resolution along the coastlines that produces a 7.5-day forecast of water levels. A skill assessment in 2017 showed that STOFS-2D-Global is the most accurate global non-data-assimilated model with an M2 tide mean absolute error in deep water of 1.95 centimeters. STOFS-3D-Atlantic features layered modeling for temperature and salinity's effects on water levels. They will be producing four-day forecasts of water levels, currents, temperature, and salinity from this model up to <10 meter resolution. An upgrade later this year will include enhancements to its watershed mesh and accuracy improvements by referencing to xGEOID20b. A 2015 skill assessment demonstrated impressive performance even without bias correction. NOS is developing a STOFS-3D-Pacific model, which is currently in pre-operations. In addition to improving the bathymetry in the area, they aim to provide surface currents for navigation in support of under keel clearance and route planning for key Pacific ports. Dr. Seroka also discussed precision marine navigation and the S-1XX suite of hydrographic products, specifically work towards producing S-104 water levels relative to chart datum. STOFS results can be accessed by visiting the nowCOAST website and cera.coastalrisk.live to compare models versus observed measurements for storms.

Dr. Ayumi Fujisaki-Manome, Associate Research Scientist, Geospatial Data Sciences, Cooperative Institute for Great Lakes Research, University of Michigan, discussed the Unified Forecast System

(UFS) Coastal Applications Team (CAT). The UFS CAT is part of a larger development within NOAA that includes federal and academic partners to review NOAA needs and consolidate them into individual modeling systems using a smaller set of coupled Earth System models that would continue to serve its various stakeholders. Under UFS CAT, there are three subapplication themes: safe and efficient navigation, risk reduction, and total water level. She focused her remarks on the first theme for which the CAT has made great progress over the last year. The CAT's mission in supporting safe and efficient navigation is to evaluate the leading oceanographic circulation models that operate in complex coastal environments. The CAT requested that all three sub-application teams generate consensus guidelines for metrics, criteria, and competing numerical oceanographic models for further model evaluation in subsequent phases. The guidelines were published as NOAA Technical Memoranda. NOAA and its partners have collected user requirements from the marine navigation and related communities and found that mariners need forecast guidance for water levels, surface water currents, sea and lake ice, and water temperature and salinity. Dr. Fujisaki-Manome discussed the forecast configuration and accuracy requirements for safe marine navigation. On top of these, there are also operational requirements, including stability and computational efficiency, accuracy, resolution, code management, coupling, community support and license type, NOAA Readiness Levels, and geographic coverage. Based on Phase 1 of the model evaluation, the CAT selected two models, the Finite-Volume, primitive equation Community Ocean Mode (FVCOM) and the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM), for further evaluation studies in New York Harbor. Thus far, the work has been to familiarizing the team with the models and development environment, so no specific results are yet available, though some successes, challenges, and lessons learned have been identified. Successes include communication and team building, learning the models and exposure to NOAA operations, and skill assessments have been conducted. Challenges include consistency and guidance, as well as issues with the DEMs. Based on these successes and challenges, several lessons learned will be implemented in future rounds. These include continuing to have bi-weekly meetings hosted by fellow students in order to create lower stakes environments for collaboration and questions. Additional focus on clearer guidance will address some of the need for consistency, which may involve the CAT providing more support and feedback to the testers. The model evaluation is in its second round, which will incorporate the atmospheric forcing components onto the existing tidal model and switch to running the model in 3D. The co-leads will provide atmospheric, ocean, and river forcing data as well as additional observational data for the testing. The evaluation results will be shared with the developers and with the UFS community for feedback.

Dr. Shackak Pe'eri, Division Chief, Geosciences Research Division, and Stephen White, Staff Cartographer, NGS, discussed geodetic control using circulation modeling. Dr. Pe'eri briefly provided an overview of key geodetic concepts for calculating height relationships and stressed the importance of processing all elevation data to the same horizontal and vertical references. Measuring from the ellipsoid or the geoid will not fully account for oceanographic processes. For this, ocean and coastal modeling is necessary. NGS is creating a roadmap to go from a geometric model to a geopotential model and then a translation to the tidal datum. This is very complicated to do and it will get even harder after the NSRS modernization. The link between observation and modeling is key to this effort. Having the Topography of the Sea Surface will provide the link from the global mean sea level to the local mean sea level, and Dr. Pe'eri described some of the work going into improving this. NGS is updating its models every five-to-ten years as they see changes to water levels occurring. NGS is looking to make this process simpler by enhancing VDatum. Version 4 of VDatum is now available, and NGS is planning to focus on the Pacific next. They want to be sure to include the NSRS modernization, geometric, and geopotential models that will be available, as well as the International Terrestrial Reference Frame so it can communicate well with other nations and have interoperability.

HSRP Q&A

Eric Peace said that the Great Lakes ice forecasting is critical for safe winter navigation, and he encouraged work on that to continue. Mr. Burke said that sea ice in their Great Lakes models is turned off right now after overpredicting last year. They feel they have addressed the problem and expect to see an ice forecast this year. They are also aware of salinity issues and are working with customers to see how they can address these.

Qassim Abdullah said industry is confused about why tidal datums are still being used and will be even after the modernization of the NSRS. Dr. Pe'eri said that, from an operational perspective, tidal datums are critical for marine navigation, but from the database perspective, gravity is a challenge. The common denominator amongst previous models for reference is the mathematical ellipsoidal model, so they want to retain in a database all their datasets in an ellipsoidal reference system that they can then translate to a geopotential or a tidal model based on application need. NGS is trying to address the end users' needs by applying the standards their users have.

Nathan Wardwell asked for some discussion on what F4 is doing to directly measure water levels with GNSS and indirectly using GPS buoys and GNSS reflectometry. Dr. Pe'eri said they have been working together with IOOS under the F4 research team and are evaluating observations for different applications, starting with water level observations. They are doing the research now and hope to draft some guidance soon that can be incorporated into VDatum. They are looking at GNSS reflectometry, which is not as accurate as traditional water level observations but could improve coverage and statistically improve their observations. They are also looking at other technologies, including satellite geodesy. Mr. Wardwell also asked if the new National Tidal Datum Epoch will be included in the next version of VDatum. Mr. Burke said that the Tidal Epoch update is underway and they have collected a tremendous amount of observations they are trying to incorporate. The update to the Great Lakes datum is also underway at the same time, which is a significant challenge for CO-OPS. What new technologies they will use is still under evaluation, but their observations do not necessarily have to come from NOAA. They want to work with the community to better understand their uncertainty thresholds for their purposes, but the datum updates have very low uncertainty thresholds.

Lindsay Gee asked if there is coordination amongst NOAA ships and their partners doing work in the Pacific to maximize observations. In his experience on work funded by NOAA's Office of Ocean Exploration, he often felt they could very easily be doing more, particularly reporting back surface sound velocities for model validation.

Ed Saade asked if the changes NGS is observing and trying to keep up with is due to astronomical forces warping and reshaping the earth and waters or warming trends. Dr. Pe'eri said he did not think it was climate, per se. Better observations and denser sampling are now available to build better models that more accurately represent the earth system. Different countries measure the shape of the earth differently but recent coordination has led to greater understanding that will help move towards products that are more universal as opposed to regional.

Qassim Abdullah asked the panel where they see a space in this for digital twins and if the digital twin concept would serve their cause in propagating their results to users and the public. Mr. Burke said these are new concepts to NOAA and the atmospheric community is also looking into how they could utilize them. This is an area where NOAA could learn from the community how best to apply the new technologies. Dr. Moghimi said many of the models they are developing would provide the capability to do data-driven mesh generation, which will mean they will have multiple digital clones based on the definitions they are using to support end users, but they will need external support to help implement it. Dr. Pe'eri cited AI as an example of the importance of good training sets. In the geospatial field, they do not have enough examples to create really good training sets, so having more contiguous seamless models they can provide to a digital twin is the best path for now.

Lindsay Gee asked if the models being created by the offices are or will be provided for others to use with their own applications. Mr. Burke said yes, but they are large datasets and there are additional steps needed to make them accessible. There is an education and training component as well. They have made some strides in this area, and their intention is to make the models accessible to users. They welcomed the HSRP's input on how to improve this. Dr. Pe'eri pointed to Ms. Valentine's presentation on NOAA's service delivery infrastructure as their plan for moving forward.

RDML Evans asked the panel to comment on the sensitivity analysis that OCS has done looking at how model skill is related to bathymetry and how to identify hot spots where new bathymetry or higher resolution bathymetry is most important to improve the accuracy of the outputs. Dr. Moghimi said they have been working to address two questions with their modeling capability: where would be the best place to do new bathymetry to improve models and how to use modeling to help hydrographic missions to decide where to focus to support safe and efficient navigation. They have defined a seed project through which they are now looking to alternative sources in the current bathymetry. They have found there are many sensitivities that do not necessarily collate with the measurements. Continuation of this effort will help address some of the questions RDML Evans is asking. Dr. Pe'eri added that this is a classic example of how traditional hydrography and coastal modeling play a key role together.

Gary Thompson commented on the data gaps in VDatum and asked when they will be filled for users in North Carolina. Stephen White said there have been some delays which pushed the release date back to about five or six years, but it will be a much larger model. Mr. Burke said that they have collected the data and it is currently available on the website.

Nicole Elko emphasized the need for these models and the importance for getting the information out to communities.

Julie Thomas commented on how most of the models break down in complex environments like southern California, which leads to many site-specific models being operated locally. She is interested in what data assimilation is possible for the models and is a strong proponent of NOAA taking advantage of any observations being made for validation purposes.

HSRP Working Group Discussion - Priorities, issue papers, comments

Planning and Engagement Working Group

Julie Thomas, Co-Chair, HSRP Planning and Engagement Working Group, led the discussion.

Deanne Hargrave proposed the topic of seabed mobility as a future issue paper. Fluctuation of the seafloor is an important issue for offshore wind development, the fishing community, and other users of this space, and a better understanding of how this change happens over time is critical. A lot of data on this is currently being collected, and more is available that NOAA could be leveraging. She asked the Panel for their thoughts on the direction they would like to see this topic take. Captain McIntyre said it was a good idea and there are also economic implications for ports, along with navigation issues with sand waves in rivers. A shoal forecasting system would be very valuable, particularly if it was aligned with water levels and other observations. Chair Thomas asked if it was a lack of understanding of seabed mobility or just the measurements that are needed. Ms. Hargrave said both, as the current understanding is based on sparse historic measurements and repeat data acquisition in these areas is needed. Every offshore wind project is acquiring this data, which NOAA could use to create a better understanding. Mr. Saade said this is a promising issue that could have implications for topics like rip currents showing up in places where they have not been previously. The data needs to get gathered in one place, which is something that the HSRP has been discussing. The theme of the paper could be advocating for sharing this data and letting scientists have access. Mr. Wardwell said there would also be value in this for the

telecommunications field, though he struggled with the idea of repeat surveys of certain areas when there are areas that remain unmapped to modern standards. RDML Evans appreciated the need for this data for forecasting impacts on infrastructure and what NOAA's Navigation Services Offices offer in that space. He noted that the U.S. Army Corps of Engineers (USACE) has a lot of capability in modeling sediment transport, though they may not have a responsibility for modeling it in the offshore zone. What foundational data NOAA's Navigation Services Offices can offer to support the effort is a fair question to ask. Captain Armstrong said new affordable technologies are available for crowdsourced bathymetry and if it is accumulated and analyzed in a timely way, that could provide a lot of information that supports an understanding of seafloor change trends without having full scale surveys. Ms. Abbott-Paige said this information would be valuable for safer recreational boating as well as beach renourishment projects. Mr. Duffy said that shoaling in rivers and offshore seabed mobility may be different issues they should keep distinct; Mr. Peace agreed with keeping inland waterways a separate topic. Deanne Hargrave will work on a draft paper to circulate to the Panel members for additional comment.

Qassim Abdullah discussed the proposed digital twin issue paper, clarifying that they are just a different delivery method to make the data more reliable and accessible. Chair Thomas asked the Panel to re-read the draft issue paper and make suggestions based on what they have heard during the previous day's panel and discussion. Galen Scott said there is an opportunity for NOS offices to explore digital twins for asset management, such as helping to maintain the new ships coming online and to understand their performance from the time they are built until they are decommissioned.

Coastal Resilience Planning in the U.S. Using NOAA's Flooding, Inundation, Sea Level Data, Products and Services

Rachael Dempsey moderated the panel. Foundational geospatial data is critical to understanding the impacts of flooding, inundation, and sea level rise on coastal communities. NOAA's navigation services offices are mandated to measure and monitor water levels and shorelines to provide accurate data to decision-makers. Panelists and the NOS Office Directors discussed how the geospatial data is used to meet mission requirements to support community resilience.

Nicole Elko, HSRP Member, reminded the panel of some of the coastal resilience regional needs they have heard about at previous meetings. They have previously discussed how NOAA's navigation and resilience missions rely on the same foundational data, but the Office Directors' missions are primarily navigation. It is essential to find the right balance of how NOAA can address the needs of both through their data. Coastal resilience challenges have been brought to the HSRP's attention by a variety of communities and stakeholders at their previous in-person meetings in Juneau, Alaska, Honolulu, Hawaii, and San Juan, Puerto Rico. They all made a similar request, which was for more frequent and spatially dense hydrographic data. The HSRP has also heard that there are vast data gaps in remote and underserved areas. Addressing these gaps will require partnerships and new technologies.

Mark Osler, Senior Advisor for Coastal Inundation and Resilience Science and Services, NOS, presented emerging trends in coastal resilience across the U.S. government. NOAA's definition of coastal resilience is their ability to measure, model, and predict environmental change at the coast, understand how these changes impact civil society and the environment, and to make better risk-informed decisions by virtue of that understanding. The current national trends are being influenced by the influx of supplemental funding, particularly the IRA and BIL. In addition to investments in infrastructure, the bills include a focus on building local capacity, which is a piece that has historically been difficult to get funded. Trends within NOAA are consistent with the federal trends. There is a repeated call for data and information about how the environment is changing, with specific focus on the coast. Central to NOAA's Strategic Plan are the concepts of Climate-Ready Nation and the New Blue Economy. The importance of NOAA's observation systems and predictive capacity, along with support for communities and economies impacted by NOAA's mission, sit at the heart of the strategic plan. NOS is in the late stages of refreshing

its own strategic plan, the central pieces of which will include coastal resilience, the New Blue Economy, and the importance of the navigation services mission. All of the infrastructure that will come from the IRA and BIL funding will benefit from the nation's modernized NSRS; every piece of the implementation of these bills that involves the coast will benefit from NOS' data. It is imperative to tell that story and help others understand the importance of this critical work. All of these emerging needs center on NOS offices' products and services, but they are not explicitly for the purposes of safe marine commerce and navigation. NOAA anticipates increased demand for its data, services, and subject matter expertise. Partnership requests at an individual and organizational level will also be increasing. There will be demands to customize their observations for the purpose of supporting predictive analyses. Given the expertise in the programs, there will be requests to do things they are not already doing, that are perhaps not central to the navigation mission but are essential to furthering nation's preparedness at the coast. The pace and volume of those requests are quickly getting out of alignment with what the offices can do given their available resources.

Rachael Dempsey moderated a discussion with the panelists and NOS Office Directors, along with the HSRP, to explore how best to support these programs to serve emerging coastal resilience needs while maintaining their continued excellence in meeting their core mission of safe navigation and marine commerce. She asked the Office Directors the following questions:

How do emerging demands for coastal resilience data and services show up in your daily work? Can you give examples of new requests you are getting? Are they for increased amounts of core data, expanding geographic coverage, new types of information, requests to serve new audiences, or something else? RDML Evans said that the application and requirement for this kind of data is strong. By building an authoritative curated model of the seafloor, OCS hopes it has started to address this. They have received requests from the Office of Coastal Management for NBS data to support their seafloor segmentation model and maps and OCS has expanded the NBS coverage to meet those requirements. They have been hearing about the need for OCS to survey in areas they typically would not, but that would be valuable for other purposes. Derrick Snowden said CO-OPS is similarly seeing increased demand for more data in new places, so they are trying to take what they are already doing and flex it in new directions. There has been demand for water level information everywhere, which they cannot afford with high precision NWLON stations, so they are looking to other options to augment the observing system, including novel sensor development packages. Understanding the requirements for their purposes is key to finding lower cost solutions for communities. Another way they can take what they produce and make it more useful is through model predictions. Juliana Blackwell said that NGS' support for non-navigational needs is not new. They have been involved in National Estuarine Research Reserves System (NERRS) work figuring out how to measure land and water level changes for at least 20 years. They also developed a technical manual to help in determining accurate elevations for sea level change at Sentinel sites. The demand for more geographic coverage has been increasing and keeps expanding, including inland bathymetry and coupling that with the coastal data.

BIL included funding for NGS' GRAV-D to CO-OPS to support new products like the monthly High Tide Flooding Outlooks. Does meeting the emerging coastal resilience needs come solely down to funding or are there other factors at play that need to be understood? Ms. Blackwell said the funding going out to partners to enable them to do their work is very important and also requires work on the same resources NGS has in-house to help make all that happen. It is more work; there are some opportunities for additional support but there are labor shortages limiting what they can do. It is important that the geospatial aspects of the work being performed with funding from BIL and IRA gets tied correctly to the NSRS, not only as it exists today but as it gets modernized in 2025. Mr. Snowden said BIL presents an exciting opportunity but there are expectations around how the works gets done that will require significant changes to how they do things. Everything CO-OPS is going to be doing for BIL is going to set them up for a new product line they may not be able to continue once the funding runs out. One

example is that it will enable them to be able to start coupling the ocean models with the National Water Model on near-term time scales and CO-OPS should be able to deliver those predictions into operations by the time the funding runs out. After that, they will need a partnership to continue maintenance and updates. Extending their near-term navigation services projections into climate time scales is a capability that may not be within NOS currently. RDML Evans added that there is an element of awareness needed. Knowing that there are resources like NBS available will be key.

How might NOAA strengthen partnerships with the ports and navigation communities to understand the impacts of things like sea level rise on their operations and what data or services would be most useful to them? Mr. Snowden said there are opportunities for building on existing relationships, but CO-OPS is formulating their ideas around Climate-Ready Ports and how their data might be more useful for preparing for changes in port structures. These are slow moving, highly political, highly leveraged operations, which will push CO-OPS to think about what information they have today that may help ports 10 years from now. They have created a Stakeholder Service Branch within CO-OPS just for this purpose of codifying and solidifying their approach to stakeholder engagement. RDML Evans said NOS and OCS have relationships with many organizations that represent different components of the maritime community and economy, in ports specifically. The convening power of HSRP is a great mechanism for this engagement. NOS and OCS are on the cusp of delivering incredible new enhancements to their products and services, including precision marine navigation. This will allow ports to maximize their value by increasing efficiency and throughput which reduces the impacts when there is some perturbation causing restrictions. Having a better understanding of the nation's system of ports will allow for load balancing and redistribution that could not be done otherwise. None of this is possible without the full integration of bathymetry, water levels, surface currents, weather, etc. Ms. Blackwell said sea level change is being monitored but it also needs to be tied to the land, which is also changing. There is a lot of data and technology NGS can bring to the table to help the nation better understand what is happening with land deformation and how those land changes will affect what is happening with sea level changes. Vertical land motion and land deformation go far beyond NGS, so they are partnering with NASA, USGS, and others.

HSRP Q&A

Lindsay Gee asked how the Office Directors were planning to address the workforce issues they are facing, specifically making sure they get the people they need to be able to support the navigation mission plus all the extra requirements that are being asked of them. Ms. Blackwell said NGS plans for their staffing needs and what they think they need to address their mission. They look at their 100% needs, knowing they cannot afford it all, so they decide what to push off into the future and what they need temporarily for achieve a particular goal. All the offices go through a biannual staffing needs assessment. There are opportunities, through supplemental funds, to bring in expertise they need but this is not a long term solution.

Julie Thomas asked how the offices make the decision of which customized products they develop. Mr. Osler said NOAA's data is not only customizable and relevant, but it also carries a stamp of authority. There is a commitment to open data standards and that the agency is providing the foundational pieces that can then be customized, primarily by the private sector. RDML Evans added that OCS' goal is to get out of the custom products business. They would prefer to provide data at the highest resolution the sensor will support and build workflows that lead to navigation products. The Custom Chart tool is a good example from a navigation perspective of how OCS is providing a means for users to reach into their data and build their own products. Ms. Snowden pointed to the Administrator's remarks about the emerging New Blue Economy and that there is a big market for this data. CO-OPS is always looking for ways to support PORTS and NWLON, but one of the ways to attract interest is to show their utility to new applications. Ms. Blackwell noted that NGS provides opportunities for stakeholders to give feedback through Alpha and Beta releases of their products, tools, and services.

Qassim Abdullah agreed that NOAA should not be in the business of custom tools. NOAA should highlight opportunities for products with high potential for commercialization.

Nathan Wardwell said VDatum could be a great model but there are gaps in the coverage, so communities in these areas are doing coastal resilience planning without those tools. He appreciates all the work that has gone into the tool and urged its further development.

Deanne Hargrave asked if the idea of a reference seabed level is something that has been raised with NGS. Ms. Blackwell was not aware of that concept. RDML Evans said he was not aware of the term either, but he assumed that something the size of a sandwave would be fully resolved in the datasets they are providing.

Public Comment

Virginia Dentler read the following comments received during the second day of the meeting:

Pamela Chelgren-Koterba, USCG Auxiliary, National Branch Chief, Chart Updating, commented that the top contributing cause to boating fatalities was alcohol use, according to the 2022 USCG Boating Statistics report.

Brian Meyer, NCEI and NOAA Center for AI (NCAI), commented that more information about the NCAI is available in a newsletter at <https://www.noaa.gov/noaa-center-for-artificial-intelligence/noaa-center-for-artificial-intelligence>.

Anne McIntyre read the following email from the interim president of the Cal Maritime Academy concerning their declining enrollment: As you know, Cal Maritime has been experiencing declining enrollment since 2016. We are not alone in this as other state maritime academies in the U.S. Merchant Marine Academies, all report troubling declines in enrollment. This is a nationwide issue that is going to be exacerbated by the demographics in 2025 and beyond. Demographers tell us that birthrates in the United States began to decline in 2008 after rising to their highest level in two decades and the decrease appears to be linked to the recession of 2007-2008. High schools in the U.S. are now feeling the impact of reduced high school populations. This impact will soon be felt in colleges, universities, and the military for the foreseeable future as all pull from the same demographic. I recently met with our U.S. congressional representative and asked for federal assistance with a nationwide marketing effort for the maritime academies, much like the military employs. If NOAA leadership also raised the alarm with Congress, it would help. Further, we are hosting a career day on October 10 and have invited participants from the industry, the tech sector, USG agencies. NOAA is sending two recruiters to the campus for career day. Additionally, if NOAA leadership would consider an accredited NOAA Officer for assignment to Cal Maritime for a one or two year assignment as a NOAA faculty member, we would be pleased to have that discussion. Having a NOAA Officer on faculty would help with recruiting efforts.

Making Sense of Sensors

Sean Duffy, HSRP-Co-Chair, and Chris DiVeglio, PORTS Program Manager, CO-OPS, moderated the panel and introduced the speakers.

Dr. Thomas Butkiewicz, University of New Hampshire, discussed interactive air gap visualizations for precision navigation on the Lower Mississippi River and technology that is pushing sensor metrics. Large deep draft vessels are transiting the Mississippi River using 99% of the available air gap under bridges, making it essential that accurate air gap values are available to enable safe precision navigation. Only two of the bridges over the Mississippi River have sensors that provide real time clearance data; for the rest, gap calculations have to be done by the pilot. Pilots navigating the river want more detailed clearance information and improved PORTS visualizations, and they have questions about clearance calculations

and what reference gauges to use. An allision in 2018 involving a crane barge striking the Sunshine Bridge shut down the bridge for 49 days and caused \$7 million in damage. This all stemmed from the fact that a lot of the sources of navigational information only listed the clearance value for the main span but not the secondary spans. The National Transportation Safety Board recommended that NOAA update clearances and publish them for all navigable spans of these bridges. Pilots also want additional detail on the clearance on the inside of the span, so they know they have a few more feet in the center of the span than the low steel point. Following a recent policy change, lidar scans can now be used to calculate bridge spans. Dr. Butkiewicz discussed the process CCOM came up with for calculating bridge spans using lidar and displaying the information. CCOM produced a white paper on this approach and sought feedback from stakeholders. The biggest concerns were simplicity, confusing indicators on the PORTS website, stale data, and bridge sag. The CCOM team made further adjustments to the product to address these concerns. The new interactive web visualization for PORTS provides air gap values anywhere under the span of a bridge and simple, customized go/no-go indicators. CCOM is looking at how they can include other obstacles, such as overhead powerlines, and how they can present air gap data over time. Future applications for this approach include incorporating it into their augmented reality interface. More air gap sensors are needed along the Mississippi River along with more water level gauges closer together or near critical navigation points.

Dr. Heidi Mehl, The Nature Conservancy, discussed the comprehensive monitoring system for the Mississippi River Basin. Risks to the basin include increased frequency and intensity of weather and climate extremes, health hazards to people and wildlife from nitrogen and phosphorus runoff, invasive species that displace native species, loss of natural coastal wetlands, and inadequate navigation data. In the Spring of 2021, The Nature Conservancy brought together scientists and monitoring experts to determine whether the current monitoring system was adequate to determine the levels of risk and the effects of actions to mitigate those risks for the waterways in the basin. The experts said there was some highly effective monitoring, but data collection is often hampered by inconsistent and insufficient funding that lead to gaps in the data set and the fact that data is collected using different techniques or different geographical reference systems. They began building a broad coalition of over 50 active members to start envisioning what it would take to create a sentinel monitoring system that would provide more consistency in data collection. They have completed the design and costing process and are moving into the advocacy phase. The coalition identified key priorities for what the system needs to address, including: water quality and hypoxia, navigation safety, flood risk management and resilience, and ecosystems and habitat quality. This effort seeks to build upon and leverage monitoring systems that are already in place and getting new funding for the agencies that are doing the monitoring. The objectives of a fully funded sentinel monitoring system across the Mississippi River for the next five years include: (1) Obtain consistent, comparable information on loads and trends in streamflow, water quality, and sediment to understand how changes in climate, land use, and landscape management affect the Mississippi River, major tributaries, and the Gulf of Mexico; (2) Provide real time information to guide decisions on flood risk management and resilience, navigation safety, and diversions on the Mississippi River; and (3) Develop interfaces to provide transparent and timely data to the public. Dr. Mehl went into detail on each of these objectives and what it would take to achieve them. The cost to operate and maintain the current piecemeal system next year will be \$20 million; the additional investment needed to build the sentinel system would be \$23.4 million. Investing an additional \$356 million over 25 years would create an integrated monitoring system that meets the necessary quality standards and provides timely, readily accessible data to multiple public users. The Nature Conservancy and their partners are currently engaging with internal and external audiences to advocate for funding to build and maintain the system for 25 years and develop an accountable process to ensure the funds allocated to the system go to priority needs.

HSRP Q&A

Julie Thomas asked if CCOM has applied this technology to other PORTS with air gap sensors or if this was a prototype. Dr. Butkiewicz said they have done it for every bridge and power line on the Mississippi River up to Baton Rouge, but they have not done this for any areas outside of the Mississippi yet.

Anuj Chopra asked how they get the information to the mariner on the bridge. Mr. Duffy said that what was presented has not yet been implemented live. Their hope is that it will eventually be available through the Lower Mississippi River PORTS and that the trade associations will direct traffic there. Captain Chopra said that if it is made available to the pilots, it needs to be available to the rest of the navigation team as well, in order to provide a common operational picture that everyone is working from.

Juliana Blackwell asked if there was a plan for how the sensors in the sentinel system would be positioned accurately to the NSRS. Mr. Duffy said that the focus was on the agencies adding or installing new sensors and, given the federal engagement, that connection to proper datums would be done. Ms. Blackwell suggested avoiding this assumption and stressed the importance of having the positional information tied to the NSRS as they talk about bringing new sensors online.

Hydrographic and Topographic Data Quality and Accuracy

Lindsay Gee, HSRP Member, and CDR Briana Hillstrom, Chief, Hydrographic Surveys Division, OCS, moderated the panel. Over the last couple of decades there has been significant development of new technology for the acquisition and processing of digital data and a parallel transition to electronic charting and other digital services. For bathymetry this has resulted in a shift from the chart as the single authoritative product to multiple digital options for the increased range of users. This panel focused on foundational elements of the digital infrastructure, and establishing the metadata requirements from acquisition, to better utilize the new processes of data analytics, AI, and improved modeling to support new authoritative products and services.

Katrina Wylie, Team Lead, Operations Branch, National Bathymetric Source, OCS, discussed the importance of quality metadata for the NBS. She highlighted two of the goals in the NOAA Strategic Plan: (1) To support data-driven decision making with this foundational data and (2) To evolve OCS' systems and process to improve timely product development and delivery. Policy changes to bring in external source data has led to a flood of data. In order to be useful, sufficient metadata must be present to enable a quality assessment. All hydrographic metadata should include depth, quality, and origin. Quality metrics are defined by the IHO in terms of coverage, uncertainty, and feature detection. There are many internal and external data sources coming into the NBS, but there are still many potential sources that have a lot of data and repeatability that are not being incorporated. These include USGS CONED lidar, EK60/80 water column data, NCEI Bathy Warehouse, satellite-derived bathymetry, crowdsourced bathymetry, wave kinematic bathymetry, and others. One of the challenges to including this data is the increased quantity of data coming in. This puts an emphasis on the need for automation, which would require open formats, standard formats, and standard metadata. They also need to know what datum was used and have the coverage for the transformations and the uncertainties available. If the external source data coming in is fully resolved with high quality metadata, it is still challenging to incorporate because things keep changing. Throughput also matters, and OCS needs to be able to build the NBS as well as maintain it. NBS is made available to the public through BlueTopo, which is on the national datum, and through modeling, which is on the navigational datum. Ms. Wylie reiterated that metadata is key to automation, efficiency, repeatability, and reliability. It informs the NBS compilation and downstream product use and enables the best bathymetry to be available for digital twins.

Brian Meyer, Physical Scientist, NESDIS/NCEI, Geomagnetism Team, NOAA Center for Artificial Intelligence, Extended Continental Shelf, NOAA Science and Technology Synergy Committee, discussed bathymetry at NCEI, from receiving it to archiving to distribution. NCEI is responsible for hosting and providing access to one of the largest archives of atmospheric, coastal, geophysical, and

oceanic data in the world. NCEI has been stewarding bathy data since the first day NOAA existed. NCEI hosts petabytes of bathymetric data coming in from every corner of the world from public, academic, government, and industry in a range of formats. All the data types that come in have their own data management stovepipes that follow the same structure: data is received by NCEI, it is reorganized into well-known structures, metadata is harvested and databases are populated, it is sent to the archive, and the data is published to map viewers. NCEI has multiple web viewers for each primary dataset and a combined Bathy Viewer. Each of the map viewers has different data access portals, which becomes a big challenge for feeding into a digital twin. Increasing that interoperability will be a real challenge, but NCEI is experimenting with different ways of displaying the data. They will be leveraging the cloud as an opportunity to work together with the global community towards interoperability and accessibility. As more and more observing platforms with increased density come online, the amount of data coming to NCEI will grow exponentially. NCEI has to get ahead of this by morphing the stovepipes into a single cohesive NCEI in the Cloud system. Ideally, the providers will eventually send the data to NCEI in the Cloud and the users will be able to build their products there so that NCEI is not moving data. The more metadata is available, the longer the usefulness of that data will be. NCEI has developed a tool called CruisePack that will help data providers provide the correct metadata and package it in the right format so that NCEI can increase the throughput.

William Gavin, Geographer and eHydro Project Manager, USACE, discussed eHydro and the role data standards and data sharing play within the world of navigation. eHydro's contains 92,489 surveys dating back to 1985. eHydro standardizes a common set of geospatial data products that cover shape files, KMLs, file geodatabases, etc., and automates it within USACE across their 38 districts. While USACE's mission focuses on keeping federal channels open for navigation, they are also engaged in better understanding sediment transport. There is now a new framework of geospatial data referred to as the National Sediment Management Framework, which complements the National Channel Framework also managed under eHydro. There is an ongoing effort to create a national USACE-wide metadata standard that is expected to be completed in 2024. This standard will utilize the ISO-19115 format and will ensure all of their surveys are licensed appropriately so that users know how far they can apply them. District-level data is being integrated with Spatial Data Standards for Facilities, Infrastructure, and Environment so it is in a format that can be shared and can be extended for machine-to-machine readability. One of the communication tools they have been working on is an online up-to-date catalog that shows how the districts are managing their datasets. eHydro is providing information to the Coast Guard's Inland Electronic Navigational Chart program to allow them to programmatically build project depth contour lines as an S-57 overlay and get that to USGC vessels to enable them to follow the track line on their ECDIS, leading to much more efficient operations. Metadata is a big concern for USACE and they are implementing standards as best they can. Through standardization, data stewardship, and using all of their existing technology automation, they are trying to get all of this information into the cloud in order to continue to provide the data layers they are responsible for.

Lindsay Gee presented on behalf of **Shannon Hoy, Office of Ocean Exploration (OE), OAR, and Dr. Vicki Ferinni, Research Scientist, Lamont-Doherty Earth Observatory, Columbia University**, on perspectives on non-navigation/charting bathymetry quality standards and metrics. The key principles of exploration mapping are to always collect data, systematically maximize coverage, collect useful and quality data, produce useful products, report necessary metadata and release open access data in a timely manner. Their primary goal is to provide ocean mapping data that are useful for numerous stakeholders with a variety of needs. For each dataset, OE strives to provide Level 00, 01, 02, and 03 data, along with necessary metadata for their various stakeholders. OE also provides both proprietary and non-proprietary formats and frequently reviews their acquisition, processing, and data delivery methods with various communities to identify ways to improve. OE is also active in various domestic and international ocean mapping communities to maintain consistency across users and sectors. Future proofing is one of the key considerations for mapping when it is unknown who the stakeholders are going to be. Ensuring there is a

path and a process to store the data for future needs is essential. While they would love to meet every possible stakeholder's objective, OE must frequently choose between coverage and ideal resolution. Mr. Gee also presented on Global Multi-Resolution Topography (GMRT) data synthesis. The goal for GMRT is to create a seamlessly integrated bathymetry and land elevation dataset while ensuring it is accessible for specialists and non-specialists. Its bathymetry coverage should continuously expand by integrating new data and highlighting data gaps and should be scalable and efficient in all aspects of the data stewardship continuum. Mr. Gee provided a brief overview of the elements of GMRT and its data processing flow. The grid resolution for the dataset is mostly at 100 meters and it blends the tiles from each of the processes, though there is also a raster for each cruise which is then combined into the GMRT data. The GMRT data stewardship approach delivers multiple products to ensure ease of access and future-ready data. GMRT data curation focuses on processing swath data from U.S. Academic Fleet, but goes far beyond that and complements the role of the NCEI multibeam archive.

Leslie Ruta, Port of Corpus Christi, discussed how the Port of Corpus Christi uses surveys and facility inspections to collect data and make decisions, as well as future plans for an active digital twin for asset management. Corpus Christi is the number three port in the U.S. and number one exporter of crude in the country, the third in the world. They are a landlord port, so they hire out all of their operations. They fund all of their infrastructure projects through fees paid by customers and users. Their primary job at the port is to keep the channel open and ensure commerce is moving through. When moving a million barrels of oil on a tanker, it is essential to know where it is and that it is not going to hit ground anywhere. The port spent \$681 million for deepening their channel and the bathymetry has become very important for maintaining that depth. In addition to moving fossil fuels, they are the number two port for moving natural gas out of the country to our allies and also move tons of wind energy components. The port has recently entered the business of carbon management, with a lease underway to sequester carbon. They plan to feed the data they collect under their Carbon Safe grants into a digital twin so they can show their stakeholders what carbon sequestration means. The port is now looking to become a hydrogen hub. The Port of Corpus Christi is a state entity, and all of their revenues go back into the port to create facilities, products, and services for their customers to better enable commerce. They are creating a digital twin in their security space that will be live by August 31, 2024. They are also standing up an enterprise asset management system which will be geospatially located. Their incident management team also uses GIS to be able to capture damage across the port space from storms. Once they finish with their security digital twin, they plan to build one for their channel that they can make accessible to pilots.

Julie Thomas, HSRP Chair, commented on the Port of LA-Long Beach's Precision Navigation Project as a model of putting all these efforts together. The Port of LA-Long Beach has been running an under keel clearance project operationally for four years. They could not do this without standardization and metadata. In support of bringing in 1,200' oil tankers, they deepened the channel to 76' from 69', for every foot of draft gained it significantly improved profitability. Long Beach-based Jacobsen Pilots contacted a company in Rotterdam called Charta that has a software application called PROTIDE, which the Port of Rotterdam has implemented and allows them to bring in tankers that draw 69' of draft into channels dredged to 70' draft. Chair Thomas discussed the various observations and forecasts needed for bringing a tanker into the harbor using PROTIDE.

Dr. Quentin Stubbs, Regional Navigation Manager, Customer Affairs Branch, OCS, commented on the value of regional/local translators and interpreters between data users and producers. Pilots, recreational boaters, academia all speak different languages. Each of them provides valuable data in different formats with different metadata. In order to be efficient, these need to be standardized. OCS is working with USACE, who gets lots of valuable data from ports, on possible ways to gather and collect data, standardize it, and turn it into something that can be formatted and processed in an efficient manner.

HSRP Q&A

Anuj Chopra congratulated the Port of Corpus Christi for their use of digital twins. The Lone Star Harbor Safety Committee has been trying to convince the Houston Ship Channel to buy fog and air gap sensors, but nobody has been willing to fund them.

Qassim Abdullah emphasized the importance of standardization amongst the data producers. The Standard Ocean Mapping Protocol could be useful in coordinating this nationally. Mr. Meyer agreed, and NCEI's discussions around moving to the cloud have included the issue of provenance. Ms. Wyllie added that OCS has an ongoing effort to update their specifications.

Nathan Wardwell asked if Ms. Ruta had any input on the use of digital twins and what NOAA data they are using in its application. Ms. Ruta said they are not yet using NOAA data but incorporating PORTS data will be the next step in further developing it. Chair Thomas suggested including that there are ports currently exploring the digital twin concept in the letter to the Administrator.

Day 2 Meeting Recap and Round Robin with HSRP Members and NOAA Leadership

HSRP members provided comments on the second day of the meeting, including: the Administrator's plans to protect IP will be very valuable, especially with the new technology accelerators starting up; the importance of filling data gaps in VDatum; publicly available inherently governmental navigation safety data provided by PORTS needs to be resourced by the government; encouragement for HSRP members to continue to ask Office Directors difficult questions about where they are already overextended and how the HSRP can advocate to get them what they need; members appreciated the look at the technical side of ports and the HSRP; improvements to the process for producing, ingesting, processing, and delivering data is an area that could yield significant economic impact and NOAA needs to support U.S. businesses in getting this done; the Panel should consider an issue paper on the importance of connecting BlueTopo to 3DEP in order to bring support to that project.

Derrick Snowden said the HSRP is a great venue to help expand their networks and help with the prioritization process. Rachael Dempsey thanked the outgoing HSRP members for their service. Andy Armstrong said it will be important to identify what the data gaps in resilience efforts are so it is clear what need to be done to fill them. RDML Evans appreciated the call for openly discussing the challenges the NOS offices are facing. He said that resourcing data stewardship is a tremendous challenge for NOAA. Automated machinery that allows them to bring in data from disparate sources that can ingest it, assess it, qualify it, and get it out in a useable format is where he would spend new funds.

Friday, September 29, 2023

HSRP Discussions

Planning and Engagement Working Group

Gary Thompson discussed the new issue paper on the geodesy crisis to try to bring more attention to the workforce issues in the field. He presented the revisions to the draft and asked for any further input. Dr. Abdullah suggested expanding the paper to include the larger geospatial workforce challenges. He also asked if the document was shareable outside of NOAA. RDML Evans said it is a public document and there is nothing preventing members from sharing it broadly, at least in their private capacity and most likely as a panel. Captain Armstrong thought it was inappropriate to include surveying and maritime workforce challenges with the geodesy crisis because they were different in character and would have to be addressed differently. Chair Thomas proposed a similar paper for the broader workforce. Panel members agreed with this approach. Captain Chopra said that they had discussed recommending that

NOAA pursue getting geodesy including in STEM curricula by approaching ACE and ACUE to see how they can make this work. Ms. Blackwell will follow up with the COP on this to see if it is something they can take up. RDML Evans said it would be helpful to connect this issue to the core navigation services mandate of the HSRP. Ms. Blackwell said her preference would be for keeping the paper focused on geodesy and building the academic network that is needed in the U.S. to bring in the people the field needs. The draft will go through further minor edits by staff before a final version is sent out to the Panel.

Gary Thompson made a motion to accept the geodesy crisis issue paper pending further edits by staff. Sean Duffy seconded the motion, and it passed unanimously.

Qassim Abdullah will continue revising the digital twin issue paper and send it out to the HSRP for feedback. Chair Thomas noted that the Panel can also approve papers over email.

Gary Thompson volunteered to work on a future issue paper on larger surveying and maritime workforce issues. He thought it should be two separate papers to focus on each distinctly. RDML Evans encouraged them to consider a paper solely focused on shortages in the hydrographic surveying. There are other bodies that are focused on the maritime workforce. Mr. Gee suggested that the paper focus on surveying while mentioning that the maritime workforce issues need to be addressed by the appropriate bodies and that NOAA should engage with them on doing so. Lindsay Gee and Gary Thompson will work on a draft of a workforce shortage issue paper.

Nathan Wardwell provided an update on a potential issue paper on underserved communities. The group is still formulating what they want it to include.

Qassim Abdullah volunteered to draft an issue paper on connecting NOAA's BlueTopo data with the inland data from the 3DEP program and to encourage NOAA to work with USGS on this.

Julie Thomas announced that Mary Paige Abbott and Eric Peace will be the new Co-Chairs of the Planning & Engagement Group following this meeting.

Julie Thomas led a discussion on the status of the HSRP priority matrix items and took suggestions for changes to update it. Members will send additional comments to Chair Thomas to be added to the matrix. Members will also send Chair Thomas items they would like included in the letter to the Administrator.

Gary Thompson said NGAC has a subcommittee that is going to be making recommendations on the National Spatial Data Infrastructure Strategic Plan for how the federal government handles spatial data that is currently being drafted. He will send more information to see if the Panel is interested in contributing input to its development.

Technology Working Group

Qassim Abdullah said the group will start working on a technology panel for the next HSRP meeting. Mr. Thompson said they have a speaker planning to present from the Department of Transportation on GPS jamming and spoofing. Captain Chopra wanted the working group to continue their focus on digital twins and suggested asking the Port of Corpus Christi to present. He also wanted precision navigation to stay on their agenda. RDML Evans suggested that the HSRP wait to see the outcomes of the study that CO-OPS is undertaking before making recommendations on PORTS. Panel members agreed with this. Mr. Peace would like to know more about the input that is going into the study and what sectors the input came from. Mr. Snowden said he believes he can share that when CO-OPS reports out on the study.

Arctic Working Group

Nathan Wardwell said they have been talking about rolling this working group into the P&E Working Group. Their discussions have been focused mostly on underserved communities, which goes beyond the Arctic. Incorporating a remote Pacific and Caribbean focus would be a good idea. Chair Thomas said they would take the Arctic Working Group off the HSRP's agenda and make their discussions part of the Planning & Engagement Working Group activities.

Public Comment

RDML Evans read the following public comments into the record:

Muhammad Zarar commented that the maritime workforce shortage is a global phenomenon. Therefore, he recommended the immigration department to relax their terms for expertise in this sector.

HSRP Discussion (continued)

Julie Thomas asked members for ideas on possible topics for the next meeting. Some of these included: a presentation by Dana Caccamise from NGS; Climate-Ready Ports; under keel clearance/precision navigation presentation; a presentation from Charta on digital twins; a local coastal resilience session, including ongoing projects; a status update on metadata and standardization of bathymetric data; a seabed mobility briefing, perhaps as a panel on the broader offshore wind topic; an update on digital twins, perhaps tying in Charta and the Navy; a presentation from NERRS and how their work leverages hydrographic products and services; an update on PORTS. Nathan Wardwell wanted an update on the Alaska Coastal Mapping Strategy at some point; Chair Thomas said they could include that in a P&E meeting, and Ashley Chappell volunteered to provide the update. Additional topics will be discussed in P&E meetings.

HSRP member discussion on the recommendation letter and HSRP round robin recap and closing comments

HSRP members shared their thoughts on the final day of the meeting, including: the value of holding a meeting in D.C. to get access to leadership; the importance of distinguishing boundaries for digital infrastructure and what role NOAA plays in supporting the development; NOAA's transition to the cloud is encouraging to see; the HSRP may want to focus more on workforce issues in the future; the potential for using NOAA's satellite capability to measure hot spots of greenhouse gases from fixed and floating objects as a way forward to bring transparency to the industry; with increased reliance on technology, there has been a degradation in the human ability to predict and forecast when navigating; the new funding available has an expiration date and appropriations will likely be a lot tighter going forward and the ideas the HSRP brings up need to be grounded in the reality of budget constraints; the importance of supporting ports, including for national security reasons; NOAA Corps needs to advertise to and work with the Merchant Marine Academy as part of their workforce development effort; the interagency activities were great to see; the importance of data provenance; including language in the letter to the Administrator about supporting underserved communities; advocating for sustained funds core programs; one of the HSRP's subcommittees may want to take up the topic of vessels calling on ports in areas they cannot make full revolutions; the proposed new rules around protecting Rice's whale in the Gulf of Mexico could have impacts on the navigation industry and the Panel should discuss that in some capacity; and the inclusion of the eHydro presentation was appreciated.

Qassim Abdullah read Ms. Valentine's key takeaways from her presentation that she did not have time to include. These were: (1) NOAA provides the critical foundational and authoritative geospatial data that supports the National Spatial Data Infrastructure, the public and our partners. We are committed to ensuring all NOAA's geospatial data supports the new modernized National Spatial Reference System (NSRS) framework; (2) NOAA's data management framework is evolving and maturing to support the

FAIR principles, but is currently under resourced. Additional attention, focus and resources across the organization must be dedicated to proper data management moving forward; and (3) Potential and future of Digital Twins is exciting, but without accurate and quality data and information, the Digital Twin concept is useless.

Derrick Snowden said data management issues are not dependent on the particular topics discussed at the HSRP and are getting a lot of attention throughout several fields. Juliana Blackwell and others thanked the departing HSRP members for their work over the years and encouraged them to continue to be engaged. She appreciated the Panel's attention to the geodesy crisis. Andy Armstrong said not having local issues being discussed at this meeting allowed the Panel to focus on internal matters. RDML Evans echoed others' comments about the value of meeting in a neutral location to discuss nationwide issues and they will work that into future meeting plans. He invited members to submit recommendations for future meeting locations and include a case for why it would be valuable. Dr. Spinrad and Ms. LeBoeuf have given the HSRP a broad remit to opine on a wide range of issues related to the work of NOAA's Navigation Services Offices. It could be helpful to differentiate things that are for the Administrator to think about as strategic aims and the specific things the Navigation Services Offices ought to be working on. He encouraged the Panel to consider the resourcing required for data stewardship and dissemination and the sustained fleet recapitalization as items for inclusion in the letter.

Members will send additional ideas for items to include in the letter to the Administrator to Virginia Dentler and Amber Butler.

Amanda Phelps responded to questions around measuring coastal resilience efforts NOAA is doing. The upcoming NOS Strategic Plan calls for a road map to track some of the actions related to coastal resilience. The program offices are measuring things related to BIL and IRA funding and they will share whatever information they are able to.

Next Meeting

The next HSRP meeting will most likely be in the Long Beach, California, area in March of 2024.

The meeting was adjourned at 12:04 p.m.

HSRP VOTING MEMBERS IN ATTENDANCE:

Mary Paige Abbott	Commander at United States Power Squadron
Qassim Abdullah, Ph.D.	Vice President and Chief Scientist, Woolpert, Inc.; Adjunct Professor, Penn State University and University of Maryland Baltimore County
Capt. Anuj Chopra	Co-Founder and CEO, ESGplus LLC
Capt. Alex E. Cruz	Owner, West Indies Marine Services, and Vice Chairman, South Coast Harbor Safety Committee, Puerto Rico
Sean M. Duffy, Sr., Co-Chair	Executive Director, Big River Coalition
Nicole Elko, Ph.D.	Science Director, American Shore and Beach Preservation Association; Executive Director, South Carolina Beach Advocates; President, Elko Consulting
Lindsay Gee	Hydrographic and Strategic Development Consultant
Deanna Hargrave	Geoscience Manager, Atlantic Shores Offshore Wind, LLC
Capt. Anne McIntyre	Business Manager, San Francisco Bar Pilots
Eric Peace	Vice President of Lake Carriers Association
Edward J. Saade	Chairman, Circum-Pacific Council; President, EJS Solutions
Julie Thomas, Co-Chair	Senior Advisor, Southern California Coastal Observing System; Program Manager, Coastal Data Information Program, Scripps Institution of Oceanography (ret.)
Gary Thompson	Deputy Hazard Mitigation Chief and Chief, North Carolina Geodetic Survey, North Carolina Department of Public Safety
Nathan Wardwell	Managing Partner, JOA Surveys LLC

NOAA and NOS LEADERSHIP PRESENT:

Rick W. Spinrad, Ph.D.	Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator
Nicole LeBoeuf	Assistant Administrator for Ocean Services and Coastal Zone Management, NOS, NOAA
Rachael Dempsey	Deputy Assistant Administrator, Navigation, Observations, and Positioning, NOS, NOAA
RDML Benjamin K. Evans	Director, Office of Coast Survey (OCS), NOS, NOAA, and HSRP Designated Federal Officer
Capt. Andy Armstrong (NOAA, ret.)	Co-Director, UNH-NOAA Joint Hydrographic Center, University of New Hampshire
Juliana Blackwell	Director, National Geodetic Survey (NGS), NOS, NOAA
Derrick Snowden	Acting Director, Center for Operational Oceanographic Products & Services (CO-OPS), NOS, NOAA

NOS AND NOAA STAFF PRESENT:

Lynne Mersfelder-Lewis	HSRP Program Coordinator
Amber Butler	OCS
Robin Czerwinski	NOS
Virginia Dentler	CO-OPS
Chris DeVeglio	CO-OPS
Rachel Fontana, Ph.D.	NMFS
Christine Hayes	PCAD
CMDR Briana Hillstrom	OCS
Nathan Littlejohn	NGS
Amanda Phelps	OCS

Megan Schwinden OCS

Galen Scott NGS

SPEAKERS:

Patrick Burke Director, Oceanographic Division, CO-OPS

Thomas Butkiewicz, Ph.D. University of New Hampshire

Aymui Fujisaki-Manome, Ph.D. Associate Research Scientist, Geospatial Data Sciences, Cooperative Institute for Great Lakes Research, University of Michigan

William Gavin Geographer and eHydro Project Manager, U.S. Army Corps of Engineers

Marten Hogeweg Senior Project Manager, Esri Inc.

Brad Kearsse Deputy Director, NGS

Lynn Mayo Joint Venture Program Manager NOAA, NESDIS

Heidi Mehl, Ph.D. The Nature Conservancy

Brian Meyer Physical Scientist, NESDIS/NCEI, Geomagnetism Team, NOAA Center for Artificial Intelligence, Extended Continental Shelf, NOAA Science and Technology Synergy Committee

Saeed Moghimi, Ph.D. Lead, NOS Storm Surge Modeling Team, OCS

Lynn Montgomery, Ph.D. Staff AI Research Engineer, Lockheed Martin

Mark Osler Senior Advisor for Coastal Inundation and Resilience Science and Services, NOS

Shachek Pe'eri, Ph.D. Division Chief, Geosciences Research Division, NGS

Benjamin Phillips Lead, NASA's Earth Surface and Interior Focus Area

Kat Rovang Senior Geoscientist, Fugro

Leslie Ruta	Port of Corpus Christi
Greg Seroka, Ph.D.	Physical Scientist
Scott Spaunhorst	Technical Executive, Office of Geomatics, National Geospatial-Intelligence Agency
Quentin Stubbs, Ph.D.	Regional Navigation Manager, Customer Affairs Branch, OCS
Brian Tetreault	Acting Executive Director, and U.S. Army Corps of Engineers Senior Advisor, U.S. Committee on the Marine Transportation System
Kim Valentine	NOAA Geospatial Information Officer
Katrina Wyllie	Team Lead, Operations Branch, National Bathymetric Source, OCS

ATTENDEES:

Surafel Abebe
Brent Ache
Corey Allen
Nicolas Alvarado
Marissa Anderson
Mike Aslaksen
John Blackwell
Matt Borbash
Paul Bradley
Scott Brotemarkle
Rosemary Burkhalter-Castro
Julio Castillo
Michelle Levano
Pamela Chelgren-Koterba
Edward Davis
Jay Dawsey
Sam Debow
Shelley Devereaux
Rob Downs
Colleen Fanelli
Tyanne Faulkes
Jeffrey Ferguson
Joseph Fillingham
Audra Fischer
John Gerhard
Heather Gilbert
Yekaterina Glebushko
Karen Hart
Olivia Hauser
Jacob Heck
Matt Hommeyer
Michael Janis
Eric Johnston
John Kelley
Rada Khadjinova
Matt Kroll
Alexander Kurapov
Elan Kysey
Anjani Ladhar
Jason Ledet
Lou Licate
Carolyn Lindley
Jay Lomnicky
Kayla Maurer
Claudia Mazur
Maddi McArthur
Laura Rear McLaughlin

Rosemarie McKeeby
Anna Miller
Noah Moore-Sobel
Guy Noll
Summer Ohlendorf
Brandon O'Shea
Percy Pacheco
Steven Paul
Miya Pavlock
Jeremy Penton
Seth Pollack
Julia Powell
Frank Powers
Ramesh Rangachar
Katie Reser
Jack Riley
Starla Robinson
Colleen Roche
Mojgan Rostaminia
Maryellen Sault
Joanna Seth
Lei Shi
Viviane Silva
Debbie Spring
Stephanie Sterling
Helen Stewart
Peter Stone
Danielle Stuby
Yunfang Sun
Lauren Talbert
Courtney Thompson
Grant Voirol
Jennifer Walden
Kyle Ward
Leslie Weiner-Landro
Sarina Weiss
Dave White
Holly Woytak
Darren Wright
Cathleen Yung
Muhammad Zarar
Dave Zilkoski