Progress Report
Observing System Monitoring Center

Period of Activity: 01 October 2022 – 30 September 2023

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Budget Summary
FY 2023: PMEL: $192,339 NDBC: $146,510

Observing System Monitoring Center
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1. Project Summary

The Observing System Monitoring Center (OSMC)[1] project exists to join the discrete "networks" of *in situ* ocean observing platforms -- ships, surface floats, profiling floats, tide gauges, etc. – into a single, integrated system. The OSMC addresses this goal through capabilities in five areas: 1) it captures the real-time ocean data stream from the NOAA feed of the WMO Global Telecommunications System (GTS) into a database, and makes those data available at minimal delay to scientific end users through easy-to-use, service-oriented techniques; 2) it utilizes these data to compute metrics, indices and indicators of effectiveness of the observing system (the scientifically useful data it produces); 3) it strives to integrate the community of delayed-mode data assembly centers under a unified set of data services; 4) it provides real-time monitoring of ocean parameters measured by the integrated networks of in situ platform; and 5) it is working to improve near-real time data distribution via the GTS through the Open-GTS project.

OSMC serves the real-time data, ingested into the OSMC from the GTS and other sources, to the public as an integrated, easy-to-use stream. The real-time data are served out via Web Services using the popular ERDDAP[2] program from NOAA/NMFS. ERDDAP products include data in several popular delivery formats that can be accessed through web browsers and many desktop analysis or visualization tools. The OSMC project is working to unify access to the platform-focused, delayed-mode data assembly centers that perform quality assurance and

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[1] http://www.osmc.noaa.gov
[2] The ERDDAP server is a development of the Environmental Research Division of NOAA/NMFS/PFEL -- http://coastwatch.pfeg.noaa.gov/erddap

quality control on the output on individual observing "networks". The OSMC data integration strategy extends beyond *in situ* observations to include synthesis products, satellite observations and model outputs.

Through involvement in the GOOS Observations Coordination Group (OCG), OSMC is also bringing these data integration and interoperability ideas to the international community. The OSMC has also conceived, developed and implemented the Open-GTS project with support of the OCG. This project is designed to improve distribution and access of near-real time data to benefit both data producers and consumers, with particular focus on improving model forecasts and developing a better understanding of the value of in situ observations in the various forecasts. There is now a OCG data implementation strategy that is in development to improve data integration among the global networks, and to benefit international data efforts.
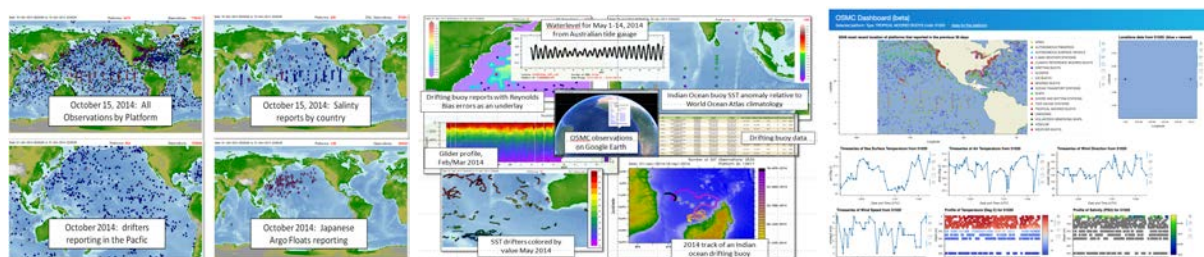

Figure 1. A few of the OSMC products available

2. Scientific and Observing System Accomplishments

PMEL Accomplishments
- **OSMC project leadership**
  - PMEL provided project leadership for the OSMC collaboration: hosted weekly technical teleconferences; oversaw the tracking of bug fixes, and deliverables; and coordinated planning and troubleshooting between groups.
- **Maintain Operational capability to OSMC real-time data via data services**
  - In FY23, we maintained operational access to OSMC real-time data from the Global Telecommunications System (GTS) at NDBC using the Environmental Research Division's Data Access Program (ERDDAP)[3]. The following "views" corresponding to the discrete sampling geometry conventions of the Climate and Forecast CF conventions[4] have been maintained:
    - Surface Trajectories – drifters, surface-based ship obs, etc
    - Profiles – Argo, CTDs, moorings, etc.
    - TimeSeries – Moored observations, etc.

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[3] http://osmc.noaa.gov/erddap/
[4] http://cf-pcmdi.llnl.gov/documents/cf-conventions/1.6/cf-conventions.html#discrete-sampling-geometries

- - - Points – all observations – as either multivariate tuples (implying many voids) or individual variable reports (more condensed)
  - Extensive use of the OSMC GTS data stream continues by various groups, including the IOOS MARACOOS group out of Rutgers University, led by John Wilkin, Pacific Gyre Corporation of San Diego. In fact, based upon email messages received by users, it is clear that use of the OSMC as a data service has increased significantly in the last few years.
  - The IOOS Glider Data Assembly Center (DAC) continues to rely on the OSMC GTS data stream to verify that glider data is successfully being exchanged via the GTS. In the past year, working with the Glider DAC we were able to identify an issue with some of the decoded glider data and implement a fix.
  - The DBCP community, in particular the drifting buoy data users, continue to rely heavily on the OSMC for GTS data reported from the drifting buoys. Many of the users do not have the capacity to decode the BUFR data messages from GTS, and therefore rely on the OSMC data access functionality for this service.
- **Open Access to GTS effort**
  - The Open Access to GTS effort continues to gain prominence in the global ocean data community.
  - In FY23, the Open Access to GTS was accepted as an endorsed Decade Action, No. 143.2. We look forward to the possibilities that the endorsement may offer.
  - In cooperation with PMEL, OSMC has continued to place Saildrone meteorological measurements from current missions onto the GTS
    - This includes Saildrone missions supporting NOAA Fisheries, TPOS, NOS, and NOAA Hurricane.
    - In FY23, these data were exchanged on the GTS using the official WMO TM315011 BUFR template designed in part by PI O'Brien for Autonomous Surface Vehicles.
      - The issue with NOAA NWS being unable to decode this information remains. OSMC has provided NWS/AWIPS with example BUFR messages to try and alleviate this issue. However, it is likely not something that will happen in the near term.
    - We continue to put met data from AIS systems from a dozen or so commercial ships onto the GTS. This data is being sent using TM315008 BUFR template under the ISSX40 KWNB header
    - In addition, this year, under SOT guidance, we continue to send met data from an additional research vessel to the Open-GTS flow
      - The ship is called the Xaymaca and is part of the Science Research on Commercial Ships (Science RoCS)[5] project based out of Woods Hole.

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[5] https://www.whoi.edu/oceanus/feature/science-rocs-argo-monitoring/

- - This is another pilot effort to see how the ScienceRoCS effort can integrate their data with the global operational systems. This is high quality data that is carefully \validated.
    - This data is being sent to the gts with the same BUFR template as the AIS data but under the header ISSX41 KWNB. This is being done in order to easily differentiate the source of the data from the aforementioned AIS observations.
  - The goal of these pilots continues to be two fold: 1) To track the observations from collection to use in operational forecasts and 2) To demonstrate the viability of using commercial ship-based data to increase the amount of observations available to operational forecasts and processes.
  - We have also started a discussion with OceanSync, who is interested in submission to the GTS of met data collected on commercial ships that use their software. We are looking forward to further details on FY24.
  - The WMO cointues to show increased interest in the Open-GTS project as it looks to support greater volumes of ocean data exchanged through modern services.
    - PI O'Brien is working directly with the WMO, specifically Dr. David Berry, to develop a wrapper around ERDDAP services that integrates the use of MQTT IoT message to notify subscribed users of new data availability.
      - This distribution mechanism will be WIS 2 compliant and showcase the exchange of NetCDF data files.
    - PI O'Brien continues to chair the WMO Task Team for CF-NetCDF
      - In FY23, the WMO INFCOM approved two TT-NetCDF developed WMO data profiles: Ocean Trajectory and, CF Radials.
  - PI O'Brien has been involved in the UN Ocean Decade activities in FY23 as well.
    - PI O'Brien continued to serve on the UN Decade Data Coordination Group and more details regarding this are included below.
    - PI O'Brien was invited to serve as vice-chair of the UN Decade Data Strategy Implementation group and, with GOMO PM blessing, accepted. More details below.
- **GOMO and GOOS-based data integration activities**
  - PI O'Brien continues to serve as the Vice-chair for Data and Information on the GOOS Observations Coordination Group (OCG).
    - This position on the OCG Executive board involves bi-weekly meetings, organization, participation and attendance at annual meetings, and acting as a representative of GOOS as needed.
  - In FY23, PI O'Brien released the GOOS OCG Cross-Network Data Implementation Strategy prior to the OCG 14 meeting in June.

- After discussion and requests for some minor clarification on definitions of metadata during the meeting, the strategy was endorsed by the OCG networks.
- This was an expected yet still wonderful development and network endorsement paves the way for the implementation phase to begin.
- There have been some minor revisions to the strategy since June.
- The OCG data team, including OceanOPS representatives, has continued the quarterly data/metadata roundtable meetings with the OCG networks
  - In FY23, topics during the roundtable meetings included:
    - Introduction of OCG Cross-Network Data Implementation Strategy
    - Metadata content and flows to OceanOPS and the development of a mandatory set of metadata.
  - These roundtables have proven to be an invaluable way to connect with the data teams from the OCG networks and will continue in FY24.
  - FY23 showed that many of the OCG networks are still struggling to get their metadata to OceanOPS in an automated way, and this will be a strong focus of FY24.
- A significant component of the OCG implementation strategy is providing FAIR-based data access to network data. OCG will implement ERDDAP services to provide this capability.
- In FY23, we continue to build out the federated OCG ERDDAP service[6] for the distributed OCG ERDDAP installations. This will continue to grow as other ERDDAP services come on line.
  - This will be the focal point through which projects like IODE's Ocean Data Information System (ODIS) will be able to harvest information about OCG data holdings.
- In FY23, PI O'Brien spent time with several of the individual network data teams and at relevant meetings, including:
  - AniBOS: PI O'Brien developed an ERDDAP metadata solution for the AniBOS group that will eventually be hosted by Ocean Tracking Network (OTN) in Canada.
  - DBCP: O'Brien attended and presented at the DBCP meeting in FY23, and was involved in metadata side-meetings - in particular with the Mooring community.
  - At AMS, in Jan 2023, PI O'Brien was invited to present on the Open Access to GTS as part of a panel discussion regarding the modernization of data dissemination into operational services.
  - Smart Cables: PI O'Brien was invited to attend and present on the roles of GOOS and OCG to the emerging Smart Cable network in Jan, 2023.

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[6] http://osmc.noaa.gov/erddap/index.html

- IODE Ocean Data Conference: PI O'Brien was a keynote speaker at this conference in Paris, March 2023, and provided a presentation regarding the GOOS OCG Data Implementation Strategy
  - Through OCG work, PI O'Brien also continues to be involved with the IOC/IODE community.
    - O'Brien is serving on the IOC Ocean Data Information System (ODIS) Steering Group to help ensure that OCG data work remains compatible with the IOC developments and the ODIS architecture.
    - O'Brien worked with IODE developers to investigate the use of ERDDAP harvesting for populating the ODIS catalog.
      - The investigation was successful, and paved the way for ODIS to begin harvesting metadata records from the OCG Federated ERDDAP.
  - In FY23, PI O'Brien continued as a UN Decade Data Coordination Group member.
    - One major goal of this group was to develop an overarching data strategy for the projects of the UN Ocean Decade.
    - The UN Decade Data Strategy was released in FY2023.[7]
    - As mentioned above, PI O'Brien is now serving as Vice-chair for the UN Decade Data Strategy Implementation Group.
      - The goal of this group is to develop an implementation strategy which supports the released data strategy.
      - This group will be releasing a first draft of the implementation strategy in April, 2024
  - During summer of 2023, both O'Brien and Burger helped to organize and helped to lead sessions at the summer GOMO Community meeting.
  - Co-PI Burger is a member of the WMO Standing Committee on Information Management and Technology (SC-IMT) and an oceans representative to the WMO Infrastructure Commission (WMO InfCom). Burger is also co-chair of the Expert Team on Audit and Certification (ET-AC). ET-AC has been active in the certification of weather and oceanographic data centers to provide data to the WMO.
- **OSMC Data Asset tool development**
  - In FY23, software developer Schweitzer continued to make improvements to the OSMC visualization tool, as needed.
  - The old OSMC monitoring console was shut down in FY23, and the new tool remains the only OSMC visualization tool.
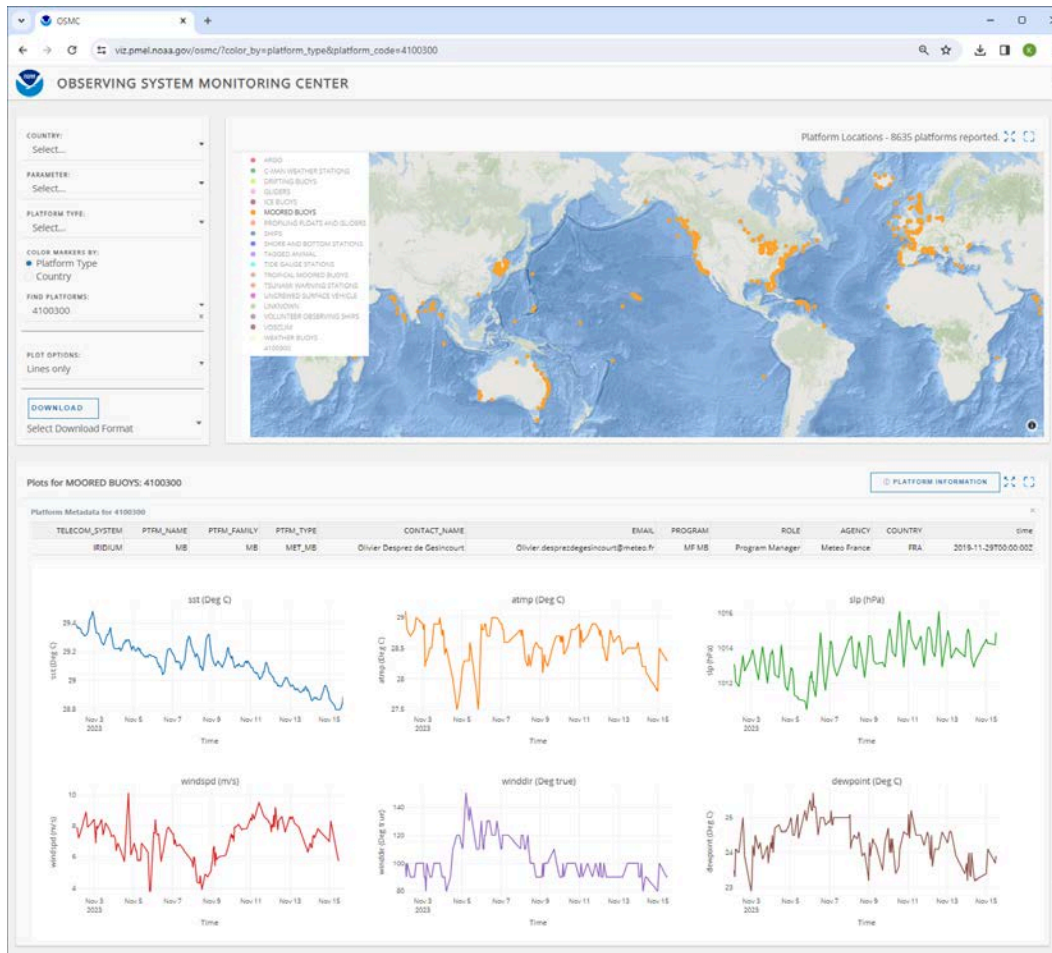
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[7] https://unesdoc.unesco.org/ark:/48223/pf0000385542

Figure 2. The OSMC Ocean Asset Dashboard, or OSMC console. This figure shows observations and metadata for Mooring with WMO ID of 4100300

NDBC Accomplishments
- **Managed the OSMC database environment:**
  - Managed the daily ingest for the production and test environments of data from various sources as detailed below:
    - Global Telecommunications Systems (GTS) subscribe and decode all ocean observations into the OSMC database.
    - OceanSITES extract the long time series data from the NDBC Ocean Sites THREDDS server and populate the OSMC databases
    - Flanders Marine Institute (VLIZ) updates of sea level station data which are extracted from the IOC Sea Level Monitoring Facility website.

- NDBC/IOOS platform metadata are used to identify NDBC stations and update metadata as well as to identify stations that are part of the IOOS Program.
- **Managed the OSMC database:**
  - Added Yearly table partitions for OSMC Production and OSMC Test/Dev databases.
  - Ran "gather stats" utilities on the OSMC database as required to address performance issues related to record selects and inserts.
  - Added tablespace as required, based on table growth.
  - Rebuild the views as needed to address missing data.
  - Rebuild daily partitions as needed.
  - Reloaded data as required when processing issues arose.

- **Managed the OSMC environment in terms of IT Security:**
  - Patched servers, database, and application software as required by monthly scans for both the test and production environments.
  - Included the OSMC environment as a part of the NDBC Authorization and Accreditation (A&A) process annually.
- **Increased data/metadata available via OSMC:**
  - Resolved issues with data and metadata loads as they arose.
  - Updated metadata for newly deployed assets.
  - Added additional headers to the NDBC GTS processing queue in support of OSMC as required/identified
- **Supported the Open-GTS Initiative:**
  - The Open-GTS project now releases data under the following GTS headers: IOBX03 KWNB (buoy data), IORX01 KWNB (Saildrone data), ISSX40 KWNB (AIS Ship data), ISSX41 KWNB (non AIS Ship data)
  - Setup additional Saildrone to support the 2023 Hurricane project.
  - Added sensor heights to Saildrone data.

- **Miscellaneous Support:**
  - Support the weekly OSMC teleconference with PMEL to discuss current issues/problems and discuss future plans related to OSMC.
  - Opened up the OSMC environment to additional PMEL IPs.
  - Modified the OSMC URL to point to the new OSMC console developed by PMEL.
  - Modified the Ocean Ops metadata update to use the PMEL ERDDAP server feed.
  - Migrate the OSMC web environment to a new server
  - Added the new TAO BUFR headers to the OSMC ingest process

3. Outreach and Education

4. Publications and Reports

4.1.   Publications by Principal Investigators

Published:
Boyer, T., and Coauthors, 2023: Effects of the Pandemic on Observing the Global Ocean. *Bull. Amer. Meteor. Soc.*, **104**, E389–E410, https://doi.org/10.1175/BAMS-D-21-0210.1.

5. Data and Publication Sharing

The OSMC, as a data integration project itself, doesn't create any data. We do, however, work with projects to ensure that they can meet the NOAA requirements for data access, documentation and archival. The OSMC is well-placed to help other GOMO projects which may be having difficulties meeting these requirements. We would be delighted to talk further to any projects which find themselves not able to meet NOAA data management requirements, or look to extend the value of their data though publication to operational data networks (GTS).

The OSMC project does provide interoperable access to real-time data from the GTS system, as described in the project summary, as well as delayed-mode data from the GOOS OCG networks as the federated ERDDAP focal point.

6. Project Highlight Slides

Project highlight slides will be submitted with the progress report.