Observing System Monitoring Center (OSMC)

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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 three areas focusing on the needs of specific user groups: 1) it provides realtime monitoring of the integrated observing system assets to assist management in optimizing the cost-effectiveness of the system for the assessment of climate state; 2) it makes the stream of realtime data coming from the observing system available to scientific end users into an easy-to-use form; and 3) it unifies the delayed-mode data from platform-focused data assembly centers into a standards- based distributed system that is readily accessible to interested users from the science and education communities.

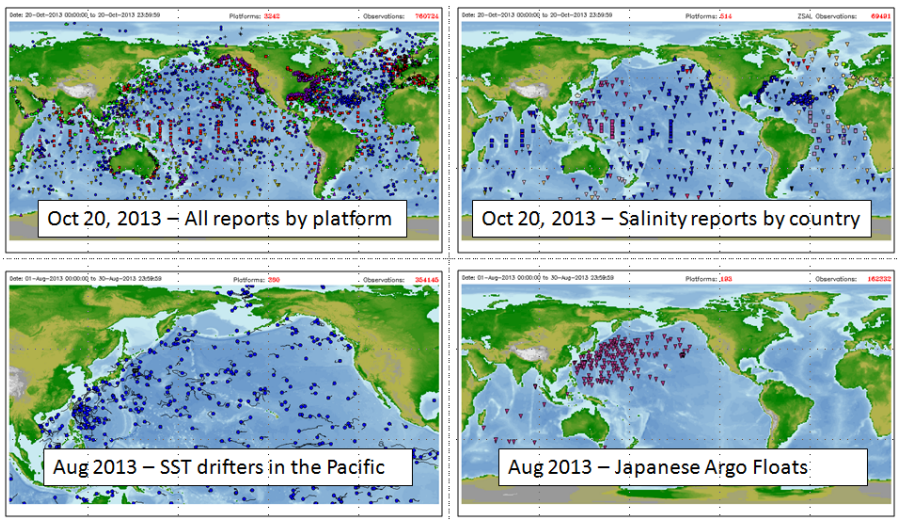


Figure 1. Several examples of observations status maps generated by the OSMC

[1] http://www.osmc.noaa.gov

As a tool for observing system management, the OSMC helps the Climate Observation Division (COD) to ensure that NOAA meets the long-term observational requirements of forecast and modeling centers, international research programs, major scientific assessments, and decision-makers. The OSMC provides observing system managers with custom maps and tables that summarize the contributions of different countries and programs to the system at any point in time. It tracks the deployment progress of observing system elements over time. It provides tools to help scientists track the effectiveness of *in situ* observations for assessing the state climate variables – temperature, salinity, etc.

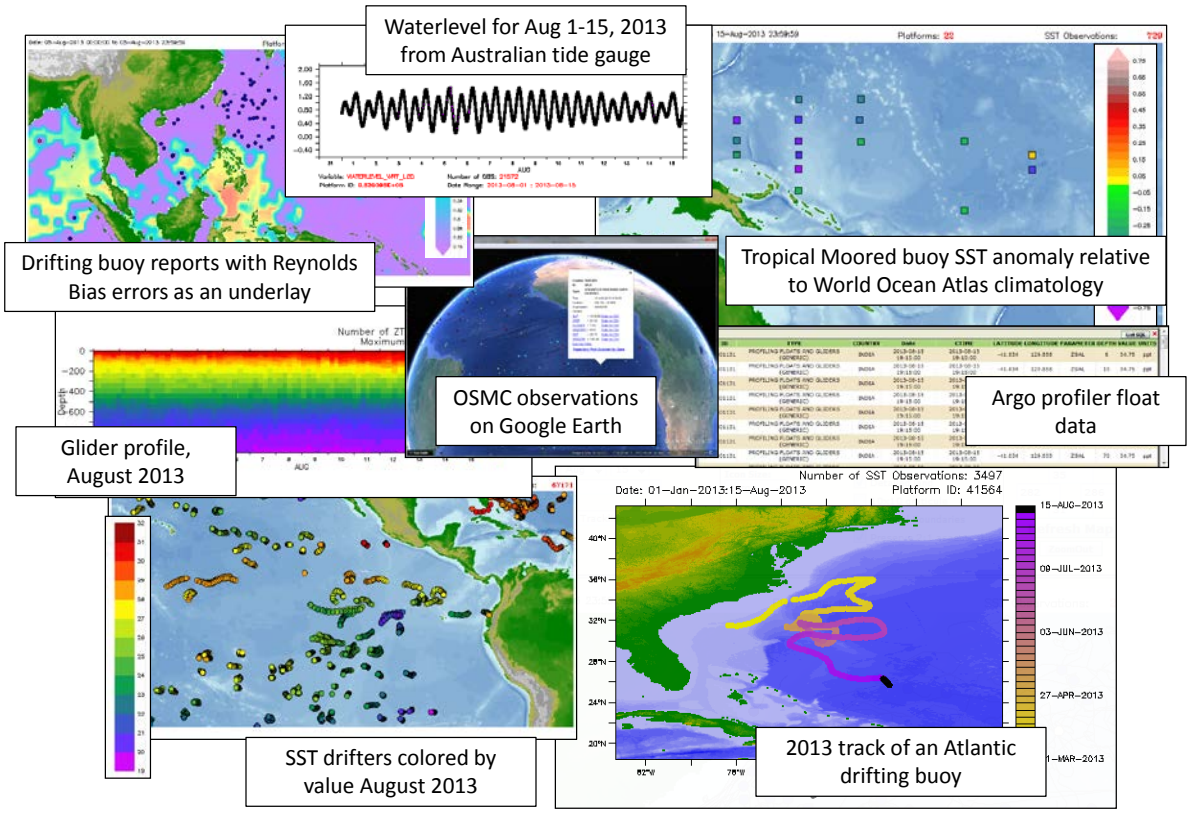


Figure 2. A sample of the drill down products available from the OSMC

The OSMC is also a key component in emerging data integration strategies. Services are provided that make the realtime data ingested into the OSMC from the GTS and other sources available to the public as an integrated, easy-to-use stream. The services allow the selection of arbitrary data subsets with output delivered as OPeNDAP, OGC/SOS and many downloadable file formats, enabling data to be directly used popular desktop analysis tools and web browsers.

The OSMC project is working to unify access to the platform-focused, delayed-mode data assembly centers that perform quality assurance and quality control over elements of the ocean-climate data record. The OSMC data integration strategy extends beyond *in situ* observations, including synthesis products, satellite observations and model outputs, with a target vision that managers and scientists should be able to compare and contrast *in situ* observations with all other data sources for the same space-time locations in support of such activities as IPCC AR5/CMIP5.

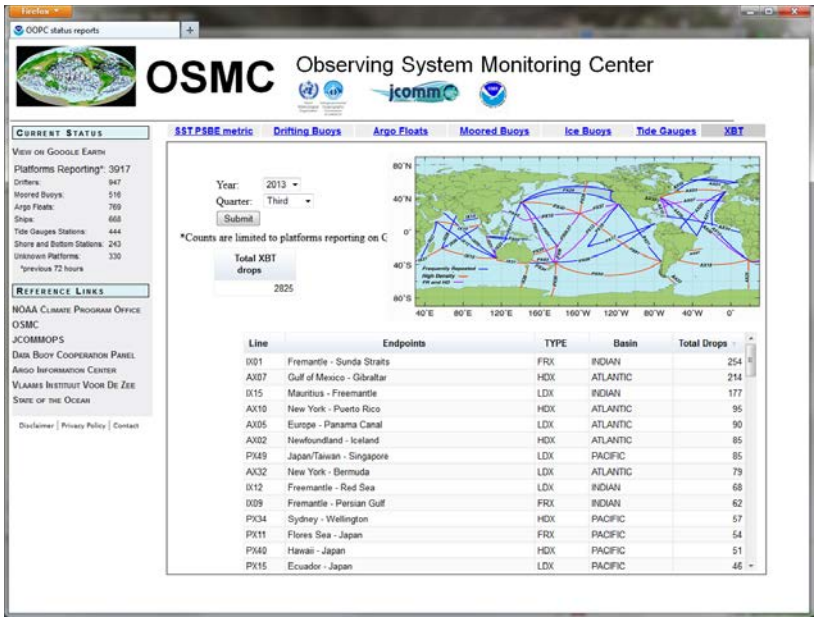


Figure 3. 2013 third quarter XBT drop metrics from the OSMC

Figure 1 illustrates how the OSMC maps display the status of the global observing system for *in situ* ocean surface meteorological and oceanographic measurements. Observing system managers may constrain their selections of observations by factors such as the platform type, the programs associated with platforms, the parameter that is observed (temperature, sea level height, etc.), the contributing nation, or the instrument ID. With a click the user can "drill down" to access details of a particular platform and the measurements it has made as shown in Figure 2.

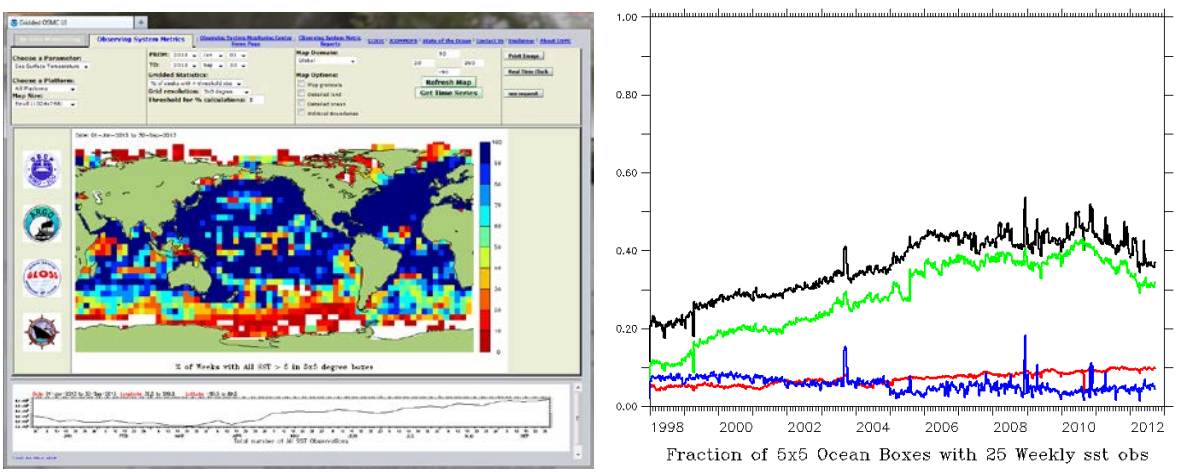


Figure 4. On the left, a metric measuring the percentage of weeks that 25 or more SST observations occurred in a given 5x5 degree box is shown. On the right is a time series showing the evolution of the SST observing system.

A variety of more detailed reports, summarizing the state of the observing system are available through a special reporting interface. Figure 3 illustrates one such example, the current progress of XBT drops along named lines The OSMC also displays observing system metrics, incorporated into the system as they are developed by NOAA observing system scientists and others. These analysis capabilities help managers and scientists to assess the adequacy of the

observations to infer critical ocean state fields, such as sea surface temperature. Figure 4 shows two such examples.

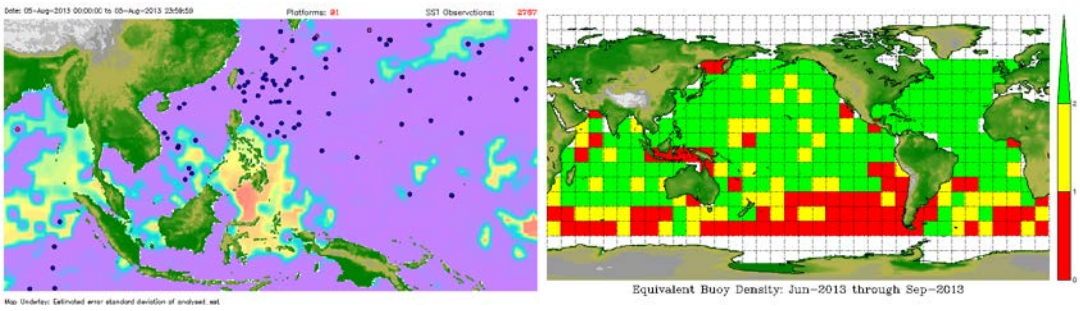


Figure 5. Observations over Reynold's SST bias errors (left); EBD for Jul–Sep, 2013 (right)

One of the great challenges in earth science data integration that must be addressed during the coming decade is the integration of observations and products. The OSMC can integrate climate products with the ocean observations that it monitors. Some illustrations of current capabilities are shown in figure 5 -- the integration of OSMC observation records with SST bias errors computed by Dick Reynolds at NCDC and served by OPeNDAP (left); and the Equivalent Buoy Density (EBD) product on a 10x10º grid (right), which shows where additional drifting buoys should be added in order to reduce satellite bias errors for SST – similarly hosted remotely at NCDC.

2. Scientific and Observing System Accomplishments

The following milestones track the progress made by the OSMC project during fiscal year 2013. For clarity the accomplishments are broken out by collaborating institution (PMEL, NDBC, NGDC).

PMEL Accomplishments

- **OSMC project leadership**
  - PMEL provided project leadership for the OSMC collaboration: hosted weekly technical telcons; oversaw the tracking of bug fixes, and deliverables; and coordinated planning and troubleshooting between groups.
- O**perational capability to request OSMC realtime data via data services**
  - In FY013, we added operational access to OSMC data at NDBC using the Environmental Research Division's Data Access Program (ERDDAP)[2] (figure 6). Our methodology is to offer "views" corresponding to the discrete sampling geometry conventions of the Climate and Forecast CF conventions[3]:
    - Surface Trajectories – drifters, surface-based ship obs, etc
    - Profiles – Argo, CTD's, moorings, etc.
    - TimeSeries – Moored observations, etc
    - Points – all observations -- as either multivariate tuples (implying many voids) or individual variable reports (more condensed)

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

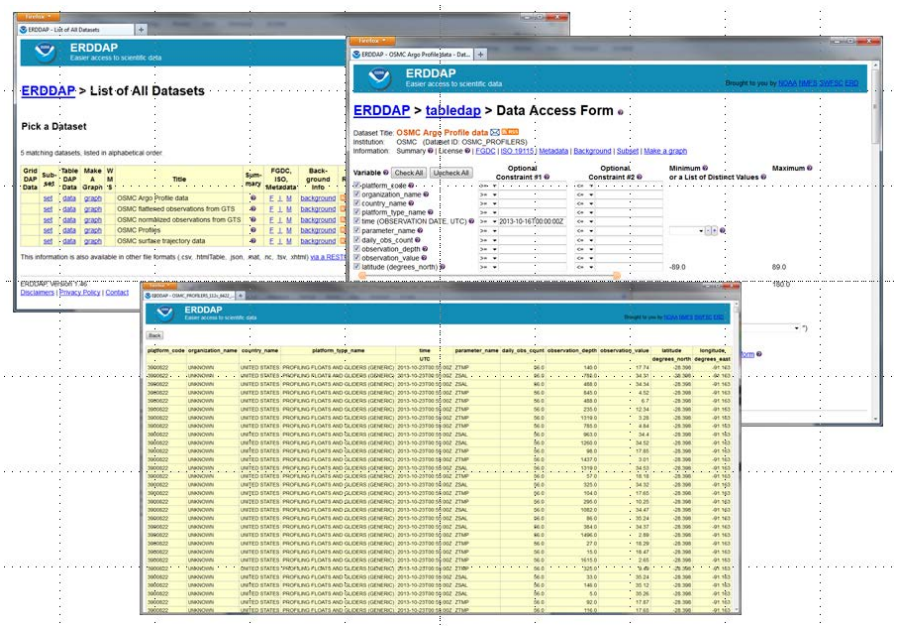


Figure 6. ERDDAP-based access to near real time profile data from Oct 23, 2013

- Operational testers, John Wilkin and Elias Hunter, of Rutgers U. and IOOS/MARACOOS used the near real time data stream to access realtime SOOP XBT, Argo Profiles and Mooring data for ingestion into ROMS model coastal ocean forecasts (see figure 7). They reported "*I [can] select a lon/lat/time box...encompassing the Mid-Atlantic Bight for the last 5 days extracting all ZSAL and Bingl! I have what I want. This is awesome.*"

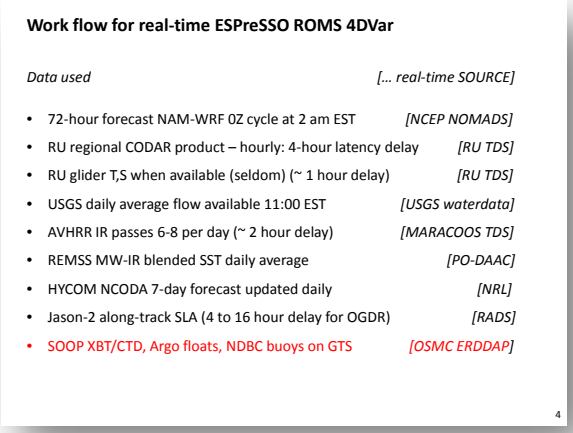


Figure 7. From Wilkins slide presentation, discussing data used as part of his real-time ESPreSSO ROMS 4DVar workflow. Note use of OSMC ERDDAP data in red

- While the performance of ERDDAP is acceptable for automated machine-to-machine requests of data, we recognize that increased performance will be important for interactive use. In FY014, we will address this goal.

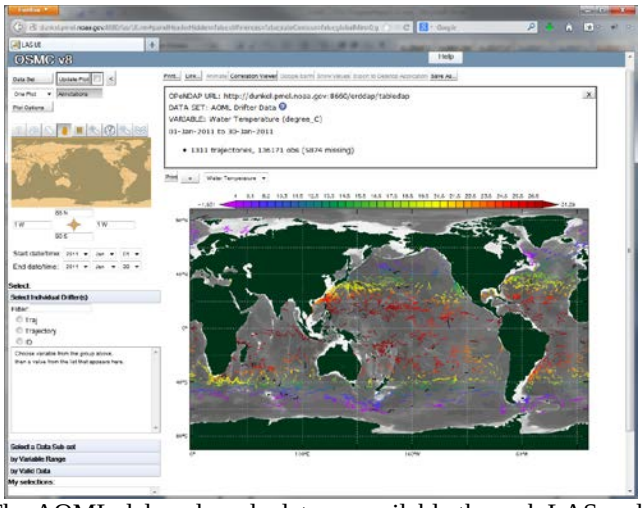


Figure 8. The AOML delayed mode data as available through LAS and ERDDAP.

- **COD-wide data integration**
  - Moved forward with a strategy for integrating data access to ocean observations:
    - a uniform set of web services for data delivery across COD data streams;
    - modern metadata records created for each network;
    - data made "discoverable" through an OSMC search portal and other community portals;
    - informative Web pages that explain the options available to access data.
- **Interoperable access to delayed mode data through ERDDAP**
  - We have been working with delayed mode data from the AOML drifter program as an initial example of a COD delayed-mode source. We are serving this drifter data with ERDDAP server and attaching visualization tools, such as Live Access Server, to provide easy comparisons between data streams (including model outputs) as shown in Figure 8.

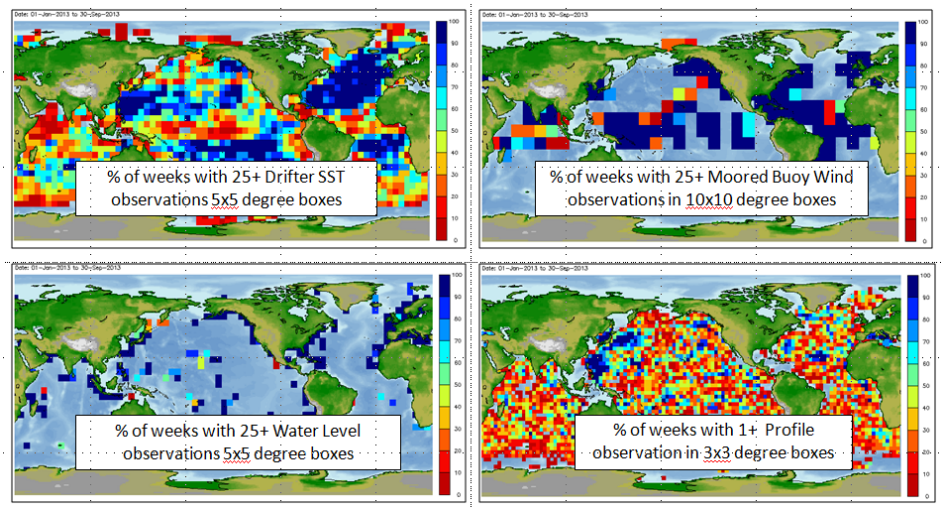


Figure 9. A sampling of the platform count summaries now available

- **Ongoing Operational support for OSMC**
  - Continue to provide and maintain the quarterly platform reporting statistics at http://osmc.noaa.gov/reports.html (figure 4).

- Continue to update the "% complete metric" describing, in one figure, the percentage of completeness for the Global Ocean Observing System.
- Continue to provide, through standard web services, an aggregated version of the Equivalent Buoy Density product. (http://ferret.pmel.noaa.gov/thredds/dodsC/ebd.html)
- Maintain gridded summary counts (figure 9)
- Maintain the State of the Ocean Website (figure 10) that tracks ocean indices through weekly updates, in partnership with Dr. Andrew Chiodi. (http://stateoftheocean.osmc.noaa.gov)

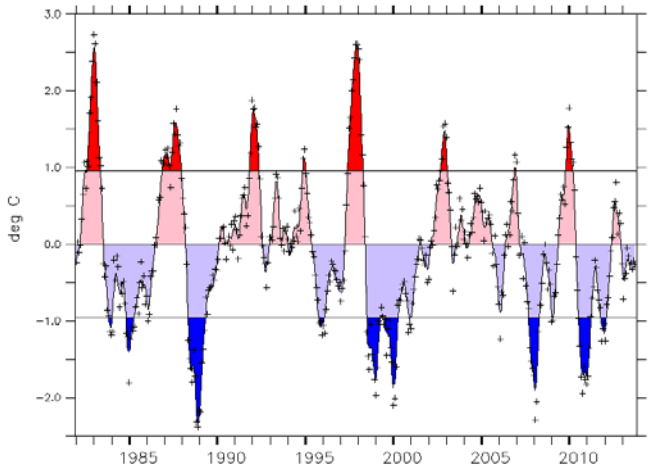


Figure 10. Niño3.4 SST anomaly index of central tropical Pacific El Niño conditions

NDBC Accomplishments

Increased data/metadata available via OSMC:

- Added additional GTS bulletin headers as required when new data sources were identified such as drifters in IOOS coastal research programs
- Improved the update intervals for ingestion of GTS data into OSMC from daily to hourly, thereby increasing the range of uses to which OSMC data may be applied.
- Resolved issues with data and metadata loads as they arose

Managed the OSMC production database environment (Database schema version 4):

- Managed the daily ingest of data from the following sources:
  - Global Telecommunications Systems (GTS): extract and decode all ocean observations into the OSMC databases.
  - OceanSITES: extract the long time series data from the NDBC Ocean Sites THREDDS server and populate the OSMC databases. OSMC currently has 63 OceanSites platforms.
  - Flanders Marine Institute (VLIZ): updates of sea level station data which are extracted from the IOC Sea Level Monitoring Facility website.
  - World Meteorological Organization's Pub 47: metadata is used to update ship metadata, such as ship name and country.
  - JCOMMOPS: updates to metadata for drifting buoys, ice buoys, Argo floats, and moored buoys.

- VOSClim: updates to metadata on ships that participate in the Voluntary Observing Ship's (VOS) Climate Program.
- 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.
- AOML: metadata is used to identify drifting buoys

Managed the OSMC test (software development) database environment (Version 4.5):

- Managed the ingest of data from various sources as detailed above.
- Added new tables to the test database to track platform metadata and to assist in developing a process to track platforms for which WMO reuses ids.

Miscellaneous Support:

- Implemented additional database "views" into the OSMC test and production database to support direct access to data by users via ERDDAP. The new views provide an easy method to extract data by sampling geometry: vertical profiles, trajectories, and time series.
- Migrated the OSMC web server (Web07) to the replacement web server (OSMCWeb01.)
- Worked with PMEL to migrate the final processes off of the Version 1 database and shut down all processing related to the OSMC Version 1 database.
- Due to space limitations on the existing database server migrated older data (prior to 2010) to secondary storage.

NGDC Accomplishments

NGDC had two OSMC objectives during FY 2013.

A. Improve the quality and completeness of metadata and documentation of observations and products produced with COD support.

B. Develop a metadata dashboard to capture and display those improvements.

A. Improve Completeness and Quality of Metadata and Documentation

To achieve this objective NGDC has leveraged capabilities and services developed under other funding. Those services include the Enterprise Metadata Management and Architecture (EMMA) dashboard and the Geoportal search engine from ESRI.

A.1 Metadata Infrastructure to Support Outreach and Communication

We re-engineered the look and feel of the metadata resources developed at NGDC to provide cohesiveness across different technologies and user interfaces. Now users will experience a smooth transition between the various features offered within the system. This will aid in the communication and outreach activity as it provides a consistent look and usability to enable users to be more productive. (http://www.ngdc.noaa.gov/metadata/emma)

We developed a metadata registration service for EMMA that allows metadata providers to define the format, location, type, harvest start date, and harvest interval and other information essential to integrate metadata on an on-going basis.

A.2 Automated Tools to Harvest Metadata

The EMMA system can retrieve metadata automatically from a variety of dialects and data services, such as THREDDS, ERDDAP, FGDC, ISO Web Accessible Folders, Sensor Observation Services and Web Map Services. This past year we have added new capabilities and tested extensively to ensure the completeness and robustness of those services. The Collection Source table, Figure 11, lists services registered with EMMA for harvesting. (https://www.ngdc.noaa.gov/docucomp/collectionSource/list?layout=fluid)

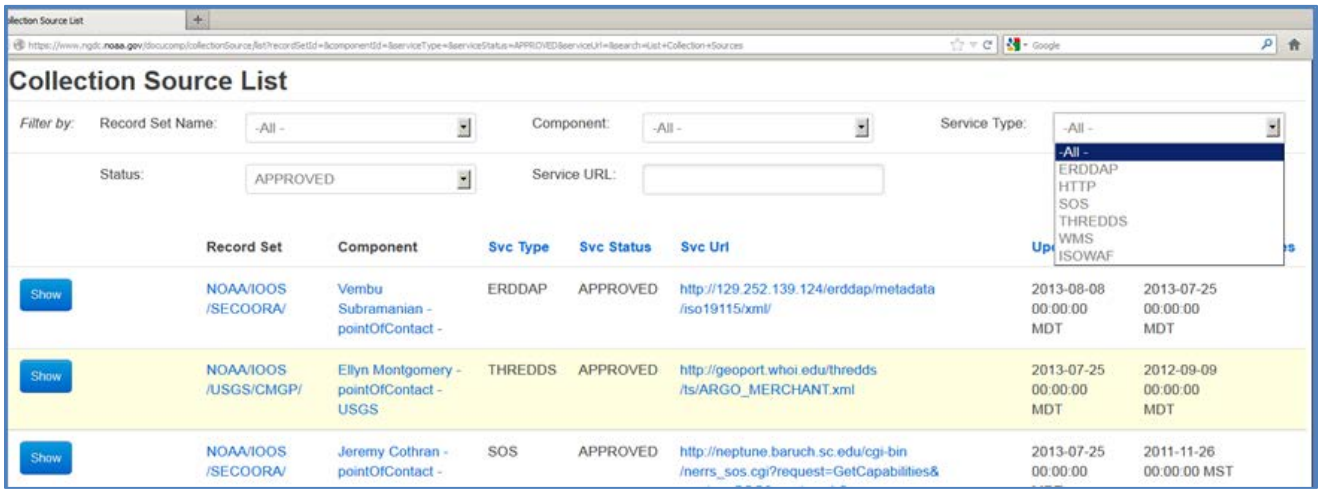


Figure 11. Collection Source Table

This automated harvest mechanism accomplishes integration in the following ways:

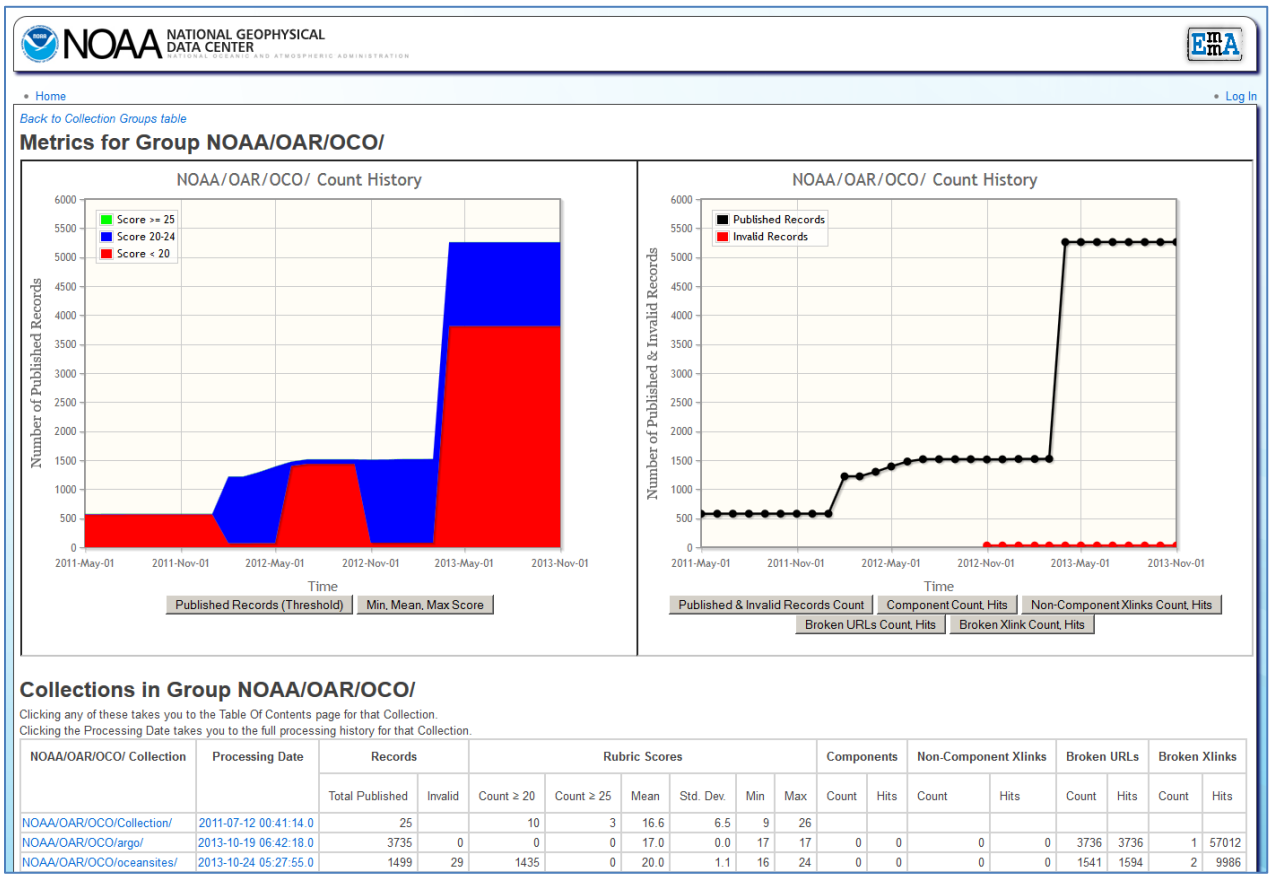
- Ingest a metadata collection on a schedule or as needed
- Calculate metrics about a particular metadata collection over time
- Provides opportunity for communication, outreach and metadata improvements

A.3 Geoportal Enhancements

We have begun the effort of re-engineering and deploying a newer version of Geoportal. This new version includes SOLR, a faceted search engine used in many commercial applications. This capability will provide a large return on investment by enabling a more refined and easy to use search and filter interface. (http://www.ngdc.noaa.gov/geoportal)

B. Develop a Metadata Dashboard

The metadata dashboard development started in late 2012 and was refined this past fiscal year. This activity has received much excitement and praise by both the scientific community, as well as NOAA senior staff. The Environmental Data Management Committee uses the EMMA dashboard to highlight and present the status of documentation across NOAA.



NOAA/OAR/OCO/ Collection	Processing Date	Records		Rubric Scores						Components		Non-Component Xlinks		Broken URLs		Broken Xlinks	
		Total Published	Invalid	Count ≥ 20	Count ≥ 25	Mean	Std. Dev.	Min	Max	Count	Hits	Count	Hits	Count	Hits	Count	Hits
NOAA/OAR/OCO/Collection/	2011-07-12 00:41:14.0	25		10	3	16.6	6.5	9	26								
NOAA/OAR/OCO/argo/	2013-10-19 06:42:18.0	3735	0	0	0	17.0	0.0	17	17	0	0	0	0	3736	3736	1	57012
NOAA/OAR/OCO/oceansites/	2013-10-24 05:27:55.0	1499	29	1435	0	20.0	1.1	16	24	0	0	0	0	1541	1594	2	9986

Figure 12. EMMA dashboard of OCO group

Figure 12 is a screenshot of the dashboard view of OSMC metadata displaying the metrics captured from the metadata[4]. The EMMA system calculates metrics for the number of records in a collection, completeness scores (within the metadata content), broken links and validity of all OSMC metadata it harvests. We also aggregate metrics over a user defined hierarchy of levels. Users are able to define a specific rollup hierarchy for collections of metadata that they are interested in. This provides senior staff with insight into how classes of metadata can be improved, thereby increasing the visibility and usability of data resources within the scientific community.

3. Outreach and Education

The OSMC is involved in several areas of outreach. i) As the backbone of the Adopt a Drifter Program (ADP) tracking webpage, the OSMC allows students and teachers to track drifters that have been deployed at sea. We have worked closely in the past with Dr. Diane Stanitski and Richard Rivera to ensure that the drifting buoy tracking is functioning and also respond to requests for enhancements to ADP products. ii) LAS, OSMC-produced visualizations and tables

[4] https://www.ngdc.noaa.gov/docucomp/page?view=WafGroupsTable&title=Collection%20Groups

are also included dynamically among the products distributed by the AOML Global Drifter Program. Users are able to view OSMC-generated tracking products, such as viewing observations on Google Earth. iii) We assist the scientific community at large with our continued support and maintenance of the State of the Ocean site. iv) Beginning this year, we are providing operational access to integrated ocean observations (including COD obs.) via web services for model forecasters such as John Wikin at Rutgers/MARACOOS. We are expanding the use of this service to other interested IOOS participants with the help of Senior Systems Engineer Derrick Snowden.

The OSMC continues to function as an outreach arm of the COD community for data integration activities. This includes interaction with the following groups:

- JCOMMOPS
- GODAE and related global ocean operational forecast endeavors
- NOAA's Integrated Ocean Observing System (IOOS) program
- NOAA's Global Earth Observations Integrated Data Environment (GEO-IDE) and the Unified Access Framework (UAF)
- NOAA's Environmental Data Management Committee (EDMC)
- DoE's Earth Systems Grid (ESG), supporting WCRP CMIP5
- NASA's Earth Systems Information Partners (ESIP)
- Climate and Forecast Conventions standard for netCDF (CF)

4. Publications and Reports

4.1. Publications by Principal Investigators

4.2. Other Relevant Publications and Presentations

- John Wilkin, Julia Levin, Javier Zavala-Garay, Hernan Arango, Eli Hunter, David Robertson, Naomi Fleming (2013), "Rutgers Ocean Modeling Group ROMS 4DVar data assimilation Mid-Atlantic Bight and Gulf of Maine", presented at MARACOOS Modeling Meeting, Washington, DC, July 22-23, 2013
- COD data integration strategy submitted as a whitepaper to the IOOS 2012 Summit
- Presented COD data integration strategy at the Annual meeting in Silver Spring, MD, June 2012