Observing System Monitoring Center

Steve Hankin[1], Kevin Kern[2], Ray "Ted" Habermann[3]
[1]NOAA/PMEL, Seattle, WA
[2]NOAA/NDBC, Stennis Space Center, MS
[3]NOAA/NGDC, Boulder, CO

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1. Project Summary

The Observing System Monitoring Center (OSMC) 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 variables; 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. The increased emphasis on data integration is a shift in the OSMC project priorities that began in earnest in July 2011.

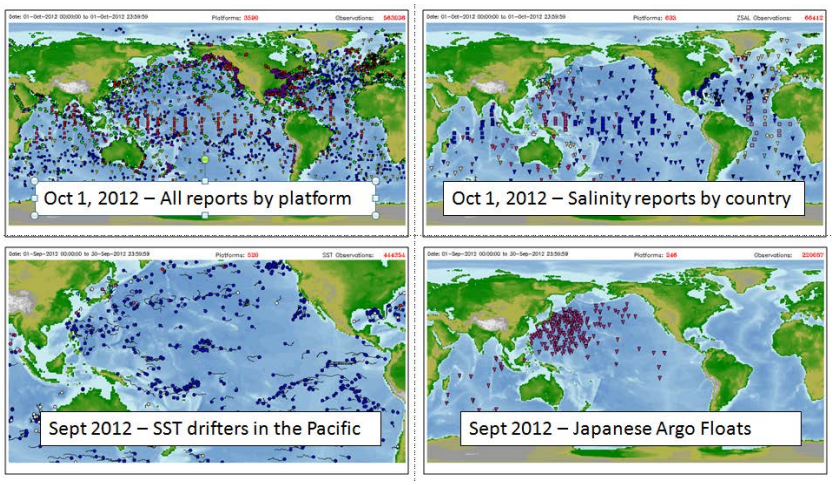


Figure 1. Several examples of maps generated by the OSMC

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.

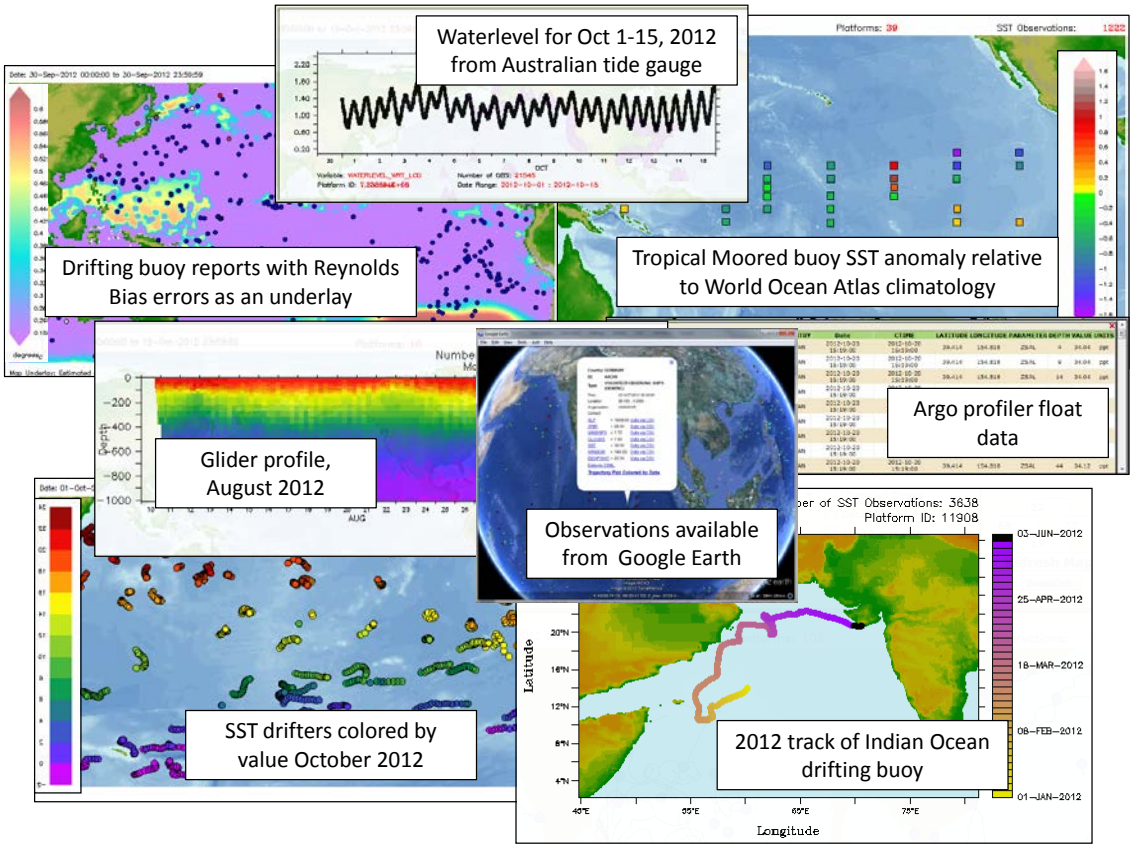


Figure 2. A sample of the drill down products available from the OSMC

The OSMC is also a key component in emerging data integration strategies. Work is underway to serve the realtime data ingested into the OSMC from the GTS and other sources to the public as an integrated, easy-to-use stream. The data will be served out using a number of popular "web services" (including OPeNDAP and SOS) and downloadable file formats, so that it can be accessed in web browsers and popular desktop analysis tools.

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 will extend 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.

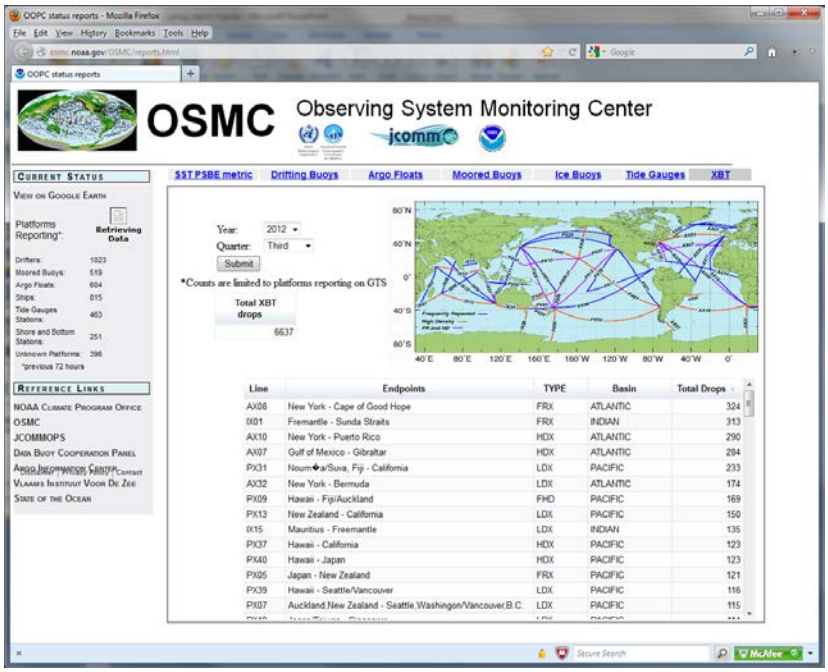


Figure 3. XBT drop metrics from the OSMC

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. 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 progress of completion 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.

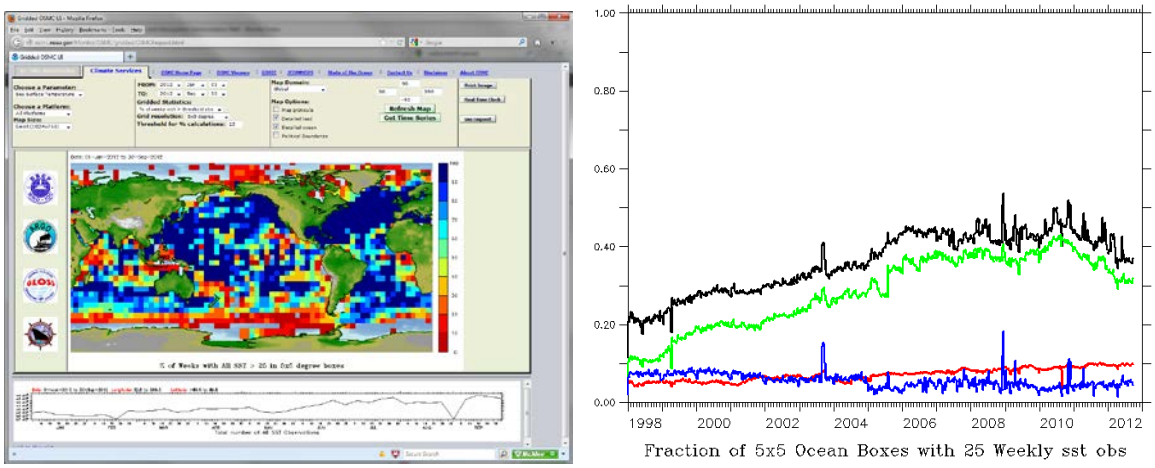


Figure 4. On the left, a metric measuring the percentage of weeks that 25 or more SST observations occurred in a given 5x5 degree box is shown. On the right is a time series showing the evolution of the SST observing system.

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 is a platform for climate product integration as well as climate observations monitoring. Some illustrations of current capabilities are shown below 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),

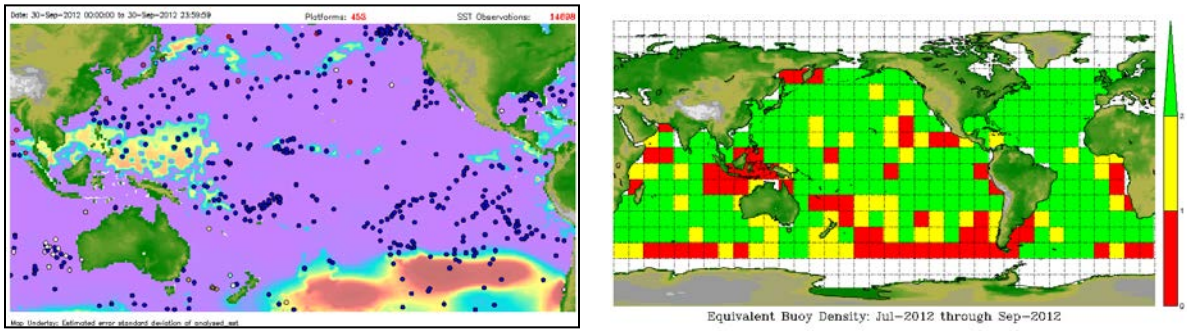


Figure 5. Observations over Reynold's SST bias errors (left); EBD for Jul–Sep, 2012 (right)

which shows where additional drifting buoys should be added in order to reduce satellite bias errors for SST – similarly hosted remotely at NCDC.

The web site for the program is http://www.osmc.noaa.gov

2. Scientific and Observing System Accomplishments

The following milestones track the progress made by the OSMC project during fiscal year 2012. 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: organized the OSMC annual planning meeting in Seattle during April 2012; hosted regular weekly technical telcons; oversaw the tracking of bug fixes, milestones, and deliverables; coordinated plans of high level strategy; ensured that group-wide communications continued to flow smoothly.
- **Guiding COD-wide data integration**
  - Developed and documented a strategy for integrating data access which is based upon:
    - implementing a uniform set of web services for data delivery ("download" capabilities, less formally) across all COD network data stream;
    - creating modern metadata records for each network;
    - making data "discoverable" both through a search portal installed for OSMC and at community portals;
    - creating an informative set of Web pages that explain to users the options available to access the integrated data.
  - Presented this strategy at the COD Annual meeting in Silver Spring, MD, June 2012
  - Presented this strategy also in whitepaper submitted for IOOS 2012 summit
- **Clearly define complementary roles of OSMC and its partner, JCOMMOPS**
  - At the April 2012 meeting the two groups agreed on complimentary missions: JCOMMOPS will focus primarily on the deployment of platforms and management of platform metadata, while OSMC directs its effort primarily at the integration of the data generated by the networks
- **Prototyped and deployed capability to request OSMC realtime data through REST data services.**
  - Capability was prototyped at PMEL using the Environmental Research Division's Data Access Program (ERDDAP) in early FY012
  - In late FY012, the capability was integrated with the OSMC data base at NDBC from which it is available to the public. (See figure 6)
    - The performance of ERDDAP on large collections remains an element that we believe we can improve. A technical workshop is planned for early FY13 to address these issues with the ERDDAP developer. ERDDAP capabilities from OSMC will be more widely advertised once performance problems have been addressed.

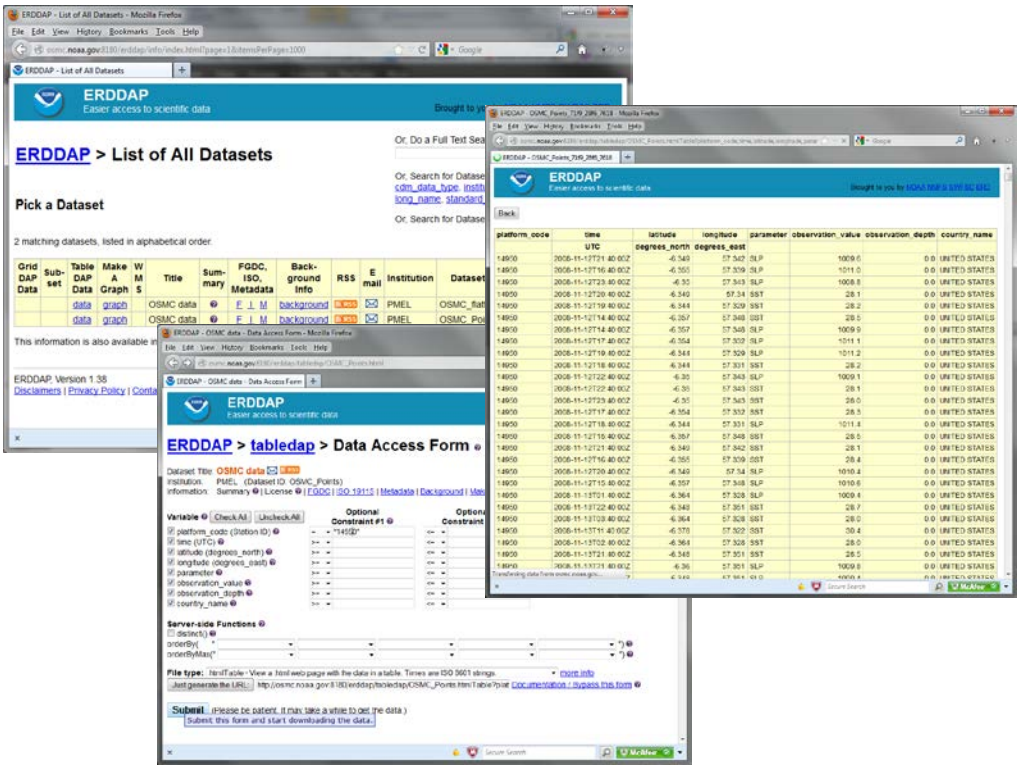


Figure 6. ERDDAP-based access to SLP data from drifter #14950

- **The ability to track XBT lines from the OSMC viewer was incorporated into the operational server.**
- **Upgraded computations of gridded summary counts**.
    - The improved method allows COD to track platform counts for all platforms, not just ships, drifters and moored buoys (See figure 7).

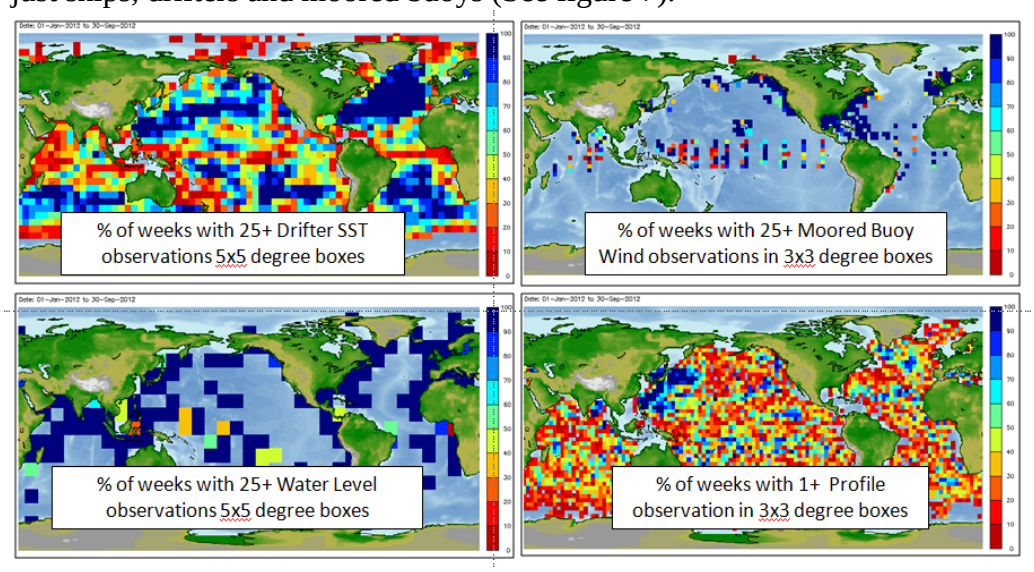


Figure 7. A sampling of the platform count summaries now available

- **Operational support**
  - Continue to support and maintain the quarterly platform reporting statistics at http://osmc.noaa.gov/reports.html . (See figure 4)
  - 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)
  - Supported integration of OSMC Google Earth capabilities into the Global Drifter Program's drifter tracking products at AOML
  - Supported the Adopt a Drifter program by assisting in redesign of the program home page in Spring, 2012 to ensure efficient access to OSMC-generated visualizations of student-adopted drifter data.
  - Modernize software infrastructure at NDBC in support of OSMC LAS. These modernizations included upgrades of Apache Tomcat and Java software packages to increase performance and reliability while reducing security risks
  - Maintained support of the State of the Ocean Website (see Figure 8 below) by continuing weekly updates that track various ocean indices, in partnership with Dr. Andrew Chiodi. (http://stateoftheocean.osmc.noaa.gov)

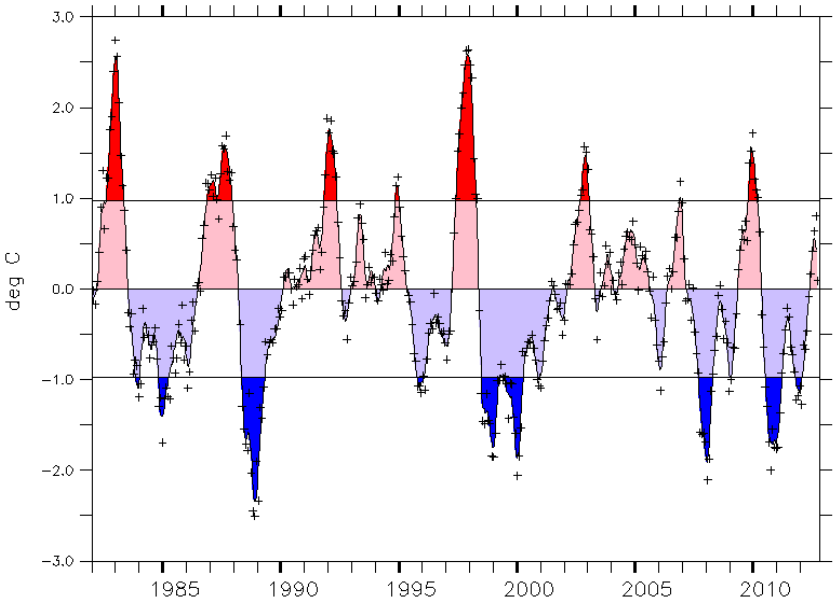


Figure 8. Niño3.4 SST anomaly index of central tropical Pacific El Niño conditions

NDBC Accomplishments

- **Managed the OSMC database environment:**
  - Managed the daily ingest of data from various sources as detailed below:
    - Global Telecommunications Systems (GTS): extract and decode all ocean observations into the OSMC databases.

        - U.S. GODAE: download from the US Navy FTP site the quality controlled meteorological and profile data (until 10/2012).
        - OceanSITES: extract the long time series data from the NDBC Ocean Sites Thematic Realtime Environmental Distributed Data Services (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.
        - World Meteorological Organization's Pub 47 metadata is used to update ship metadata, such as ship name and country.
        - JCOMMOPS data is used to update metadata for drifting buoys, ice buoys, Argo floats, and moored buoys.
        - VOSClim data is used to update the 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
    - As agreed at the April 2012 OSMC meeting the GODAE feed was permanently removed from the OSMC as of 10/01/2012.

- **Increased data/metadata available via OSMC:**
    - Resolved issues with data and metadata loads as they arose
    - Developed and implemented a program to ingest OceanSites data from the OPeNDAP THREDDS server hosted at NDBC. OSMC now ingests 63 OceanSites platforms.
    - Developed a program to ingest UHSLC tide station data from their THREDDS server. Utilization of this capability is awaiting UHSLC to resolve parameter issues in NetCDF files.
    - Added additional GTS bulletin headers related to Argo floats, drifting buoys, and ships to the NDBC/OSMC queue based on GODAE data analysis, prior to permanently removing the GODAE data feed. This analysis was done to ensure we were capturing the full suite of ocean platforms reporting on the GTS.

- **Miscellaneous Support:**
    - Implemented additional 'views' (a technical database term) of the OSMC database to enable the ERDDAP server access to the OSMC database
    - Re-engineered the GTS data ingest process to reduce the daily data load time by 40%. This is a significant first step towards our project goal of updating the data in the OSMC database a minimum of four times a day (6 hour updates).
    - Investigated the contribution of the US GODAE feed and documented the differences found between GODAE and GTS as data sources. Confirmed that the GODAE feed was no longer required to support OSMC operations.
    - Assisted PMEL with resolving performance issues of specific database queries.

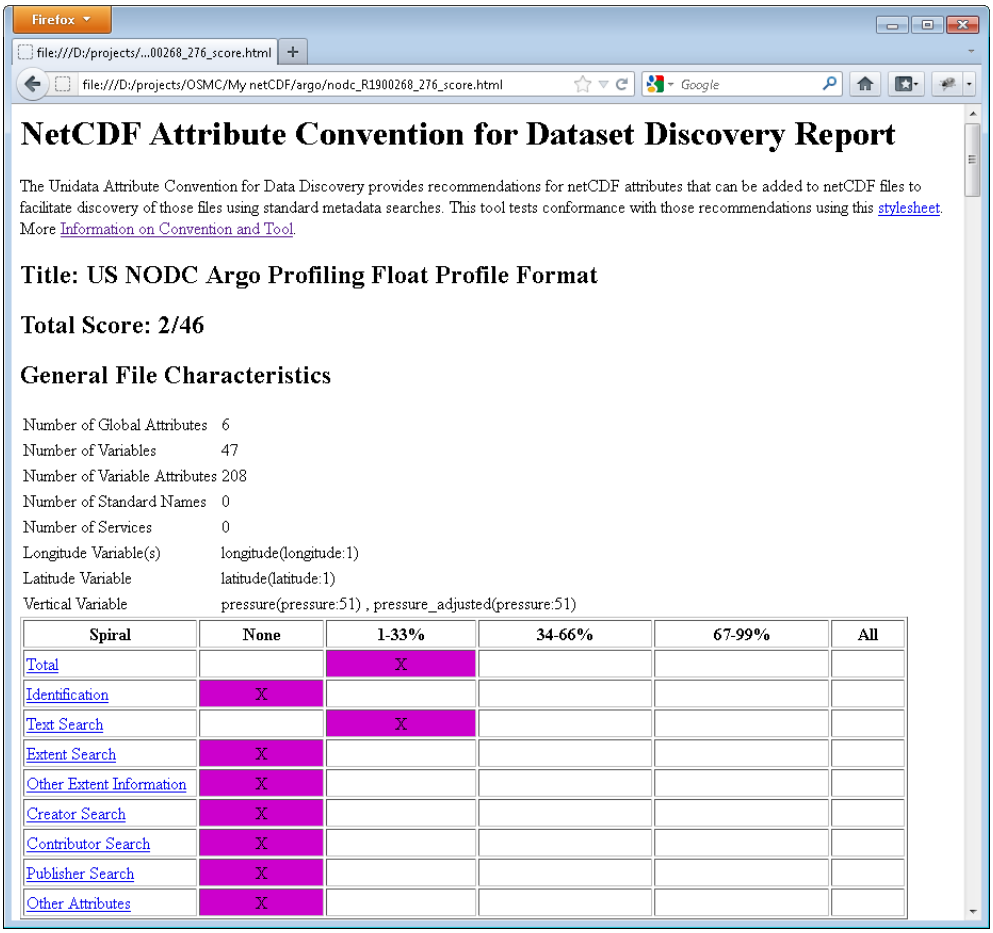
- Hosted the OSMC IT environment; provided system administration and DBA support
- Managed the security environment for OSMC as a part of the NDBC Certification and Accreditation process.

NGDC Accomplishments

NGDC provides database design, and programming support for the OSMC development team, and metadata training, tools and services for COD data providers as its contributions to the OSMC project team. Specific NGDC accomplishments include:

- **Metadata Documentation, Tutorials**

  COD metadata includes deployment metadata in the Network Common Data Form (NetCDF) and station, network and collection metadata in the International Standards Organization (ISO) metadata standard for geographic information. NGDC provides tools that translate between NetCDF and ISO dialects and facilitates assessment using a metadata rubric. Figure 9 below shows a sample metadata assessment report that can help data managers improve compliance with documentation standards and conventions. This sample indicates that the ARGO metadata are currently not compliant with the Attribute Convention for Data Discovery (ACDD). Guidance for improving compliance with these conventions is available here: https://geo-ide.noaa.gov/wiki/index.php?title=NetCDF_Attribute_Convention_for_Dataset_Discovery#Translation_Revisions.



NetCDF Attribute Convention for Dataset Discovery Report

The Unidata Attribute Convention for Data Discovery provides recommendations for netCDF attributes that can be added to netCDF files to facilitate discovery of those files using standard metadata searches. This tool tests conformance with those recommendations using this stylesheet. More Information on Convention and Tool.

Title: US NODC Argo Profiling Float Profile Format

Total Score: 2/46

General File Characteristics

Number of Global Attributes	6
Number of Variables	47
Number of Variable Attributes	208
Number of Standard Names	0
Number of Services	0
Longitude Variable(s)	longitude(longitude:1)
Latitude Variable	latitude(latitude:1)
Vertical Variable	pressure(pressure:51) , pressure_adjusted(pressure:51)

Spiral	None	1-33%	34-66%	67-99%	All
Total		X			
Identification	X				
Text Search		X			
Extent Search	X				
Other Extent Information	X				
Creator Search	X				
Contributor Search	X				
Publisher Search	X				
Other Attributes	X				

Figure 9. ncISO Metadata Assessment of Argo Profiling Float

- **Context Specific Metadata for COD Partners**

  The **OceanSITES** project involves a number of international partners that share a commitment to uniform data management across a variety of in-situ ocean platforms. They are using netCDF and have developed a data management plan that defines community practices. OSMC is able to leverage these community practices by providing translation tools that generate metadata based on the latest international standards. Utilizing these metadata standards allows key datasets to be discovered and used by a much broader community. A crosswalk between the OceanSITES user guide and the ACDD is available on the GEO-IDE wiki: https://geo-ide.noaa.gov/wiki/index.php?title=OceanSITES_Documentation.

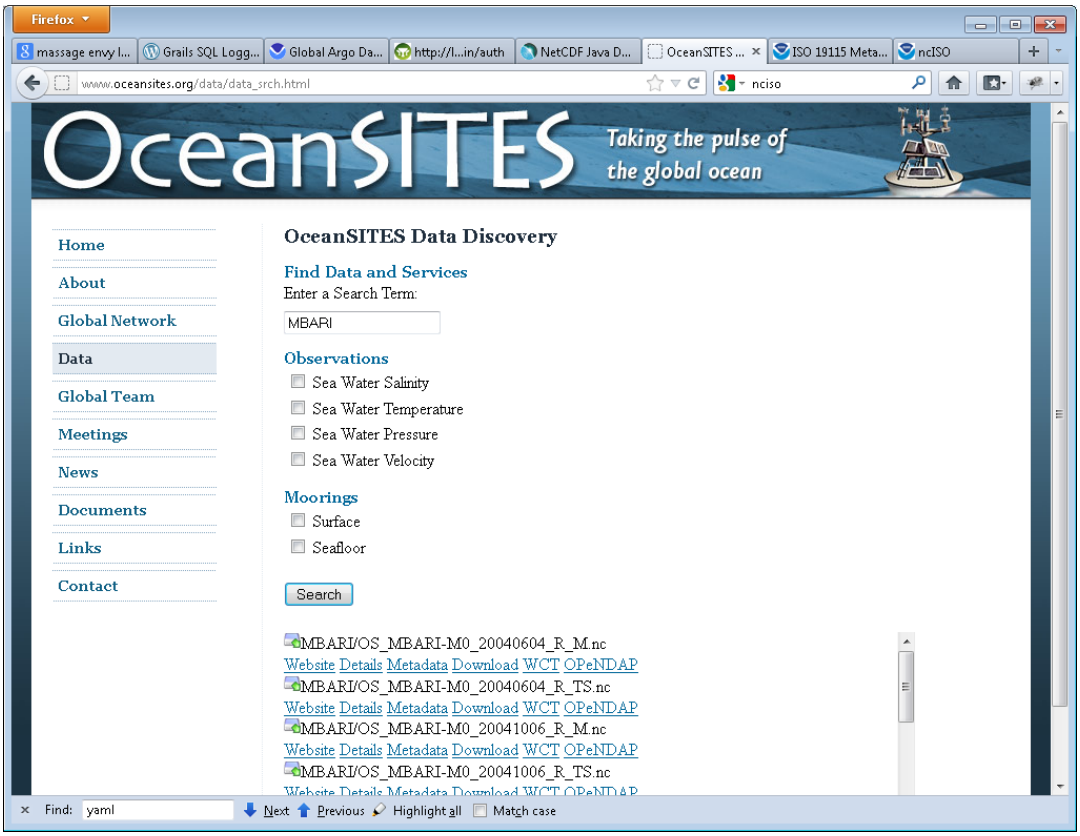


Figure 10. Custom Data Discovery Portal for OceanSITES

NGDC interaction with OceanSITES so far this year included:

- Participation in the OceanSITES Data Management Team (DMT) monthly telecons.
- Development of a custom client to improve data discovery and data access from within the OceanSITES web page. This data discovery page leverages the metadata work by NGDC and the OceanSITES community and enables search and discovery by the public and other researchers. NGDC worked with JCOMMOPS to host the page within the standard OceanSITES web page framework (see Figure 10 -- http://www.oceansites.org/data/data_srch.html)
- Feedback on the new data discovery page from the OceanSITES DMT is ongoing and has identified a number of potential improvements to be enacted in FY 13.

- **Metadata Automation Tools**

  - ncISO version 2.2.0 was released August 16, 2012. It addressed needs brought forward by the OceanSites project, the IOOS modeling test bed, and other end users of ocean obs metadata to improve community search needs, geospatial accuracy, and data use restrictions.

    Separately, we completed the integration of additional Open Geospatial

Consortium (OGC) supported services (e.g. Sensor Observation Services GetCapabilities response) into ncISO-generated ISO metadata.

- **Data Discovery Tools Collaboration**

  NGDC has been working closely with NODC, NCDC, and IOOS to improve data discovery tools based on ISO metadata. In particular, we expect recent ontology work by IOOS to be integrated with ESRI's Geoportal to improve search response. In addition, our collaboration with ESRI will enable improved Java Script Object Notation (JSON) content from Geoportal. This is critical for improved portal integration similar to what already has been accomplished with OceanSITES.

2.1. Outreach and Education

The OSMC is involved in several areas of outreach. 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 work closely 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. In addition to the Adopt a Drifter Program LAS, OSMC-produced visualizations and tables 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. These same capabilities have also been requested by the JCOMMOPS data managers for their tracking tools. We also assist the scientific community at large with our continued support and maintenance of the State of the Ocean site.

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

- 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)

3. Publications and Reports

3.1. Publications by Principal Investigators

3.2. Other Relevant Publications and Presentations

- Kevin O'Brien, Steve Hankin, Kevin Kern, Michelle Little, Roy Mendelssohn, David Neufeld, Bob Simons, (2011), "The Observing System Monitoring Center: an Emerging Resource for Ingegrated In-Situ Ocean Data", Abstract IN33D-1489 presented at 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.
- Kevin O'Brien, Steve Hankin, Ted Habermann, David Neufeld, Kevin Kern, Michelle Little, (2012), "The Observing System Monitoring Center", presented at 2012 Climate Observations Division Annual Meeting, Silver Spring, MD, 25-27 June.
- Kevin O'Brien, Steve Hankin, Kevin Kern, Michelle Little, Roy Mendelssohn, David Neufeld, Bob Simons, (2012), "The Observing System Monitoring Center: Moving Toward an Integrated Global Ocean Observing System", (2012), submitted, Integrated Ocean Observing System Summit 2012.