



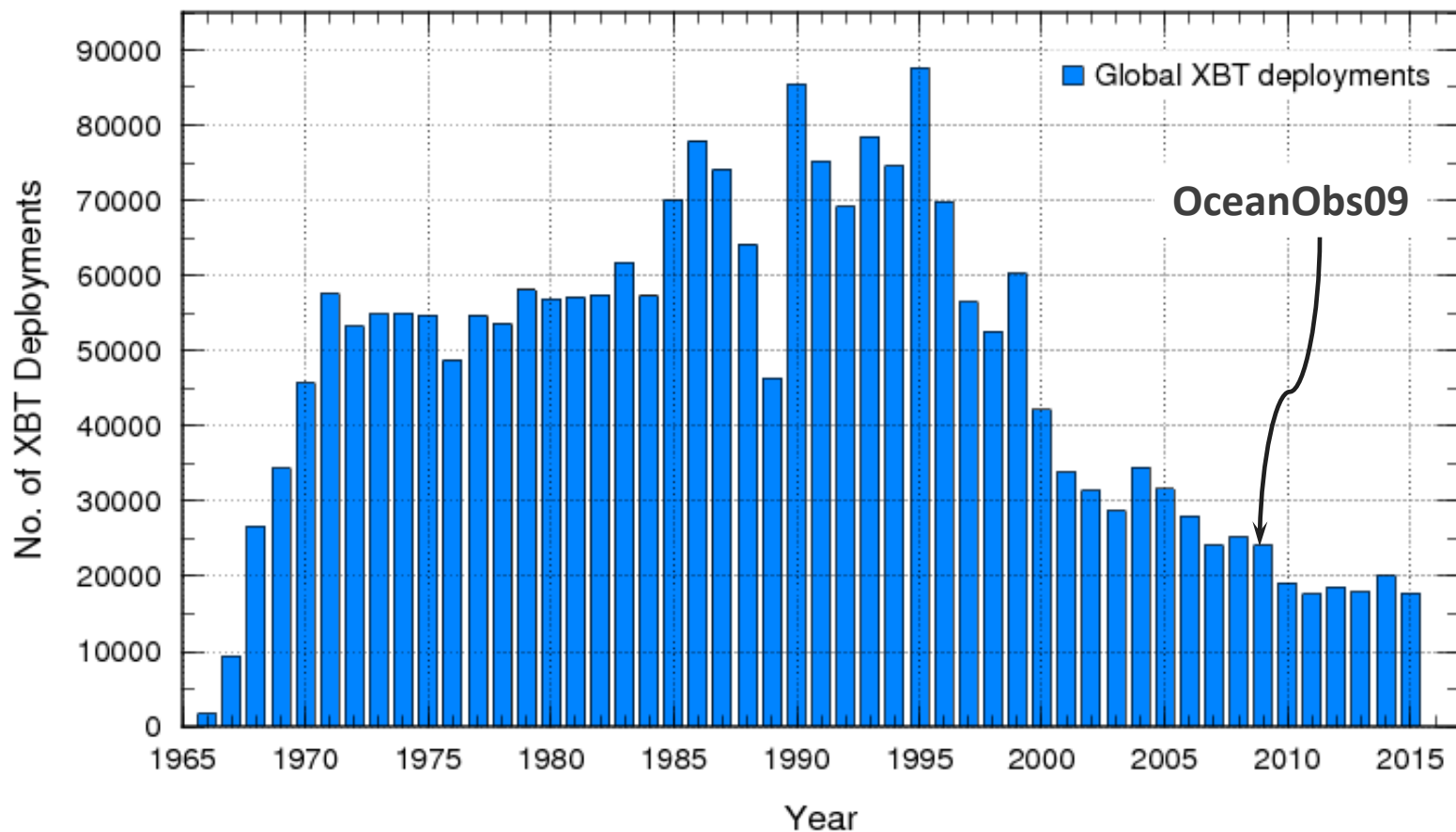
NOAA/AOML XBT Operations

Francis Bringas, on behalf of the AOML XBT
Network team



50 Years of XBT Operations

- AOML started XBT operations in 1967 with deployments along AX10 (Newark to San Juan).
- XBT operations have since been conducted in different modes (low density, frequently repeated, high density) according to scientific and operational needs, and have expanded to global coverage.
- XBT-derived temperature profiles represent now between 10% and 15% of all global, non-mooring, temperature profiles. The main contribution of the XBT network is to provide temperature measurements to:
 - Monitor changes of key surface and subsurface currents,
 - Assess meridional heat transport in all ocean basins,
 - Help initialize and validate climate and weather numerical forecast models, and
 - Supplement other observational platforms to assess the variability of the global upper ocean heat content.

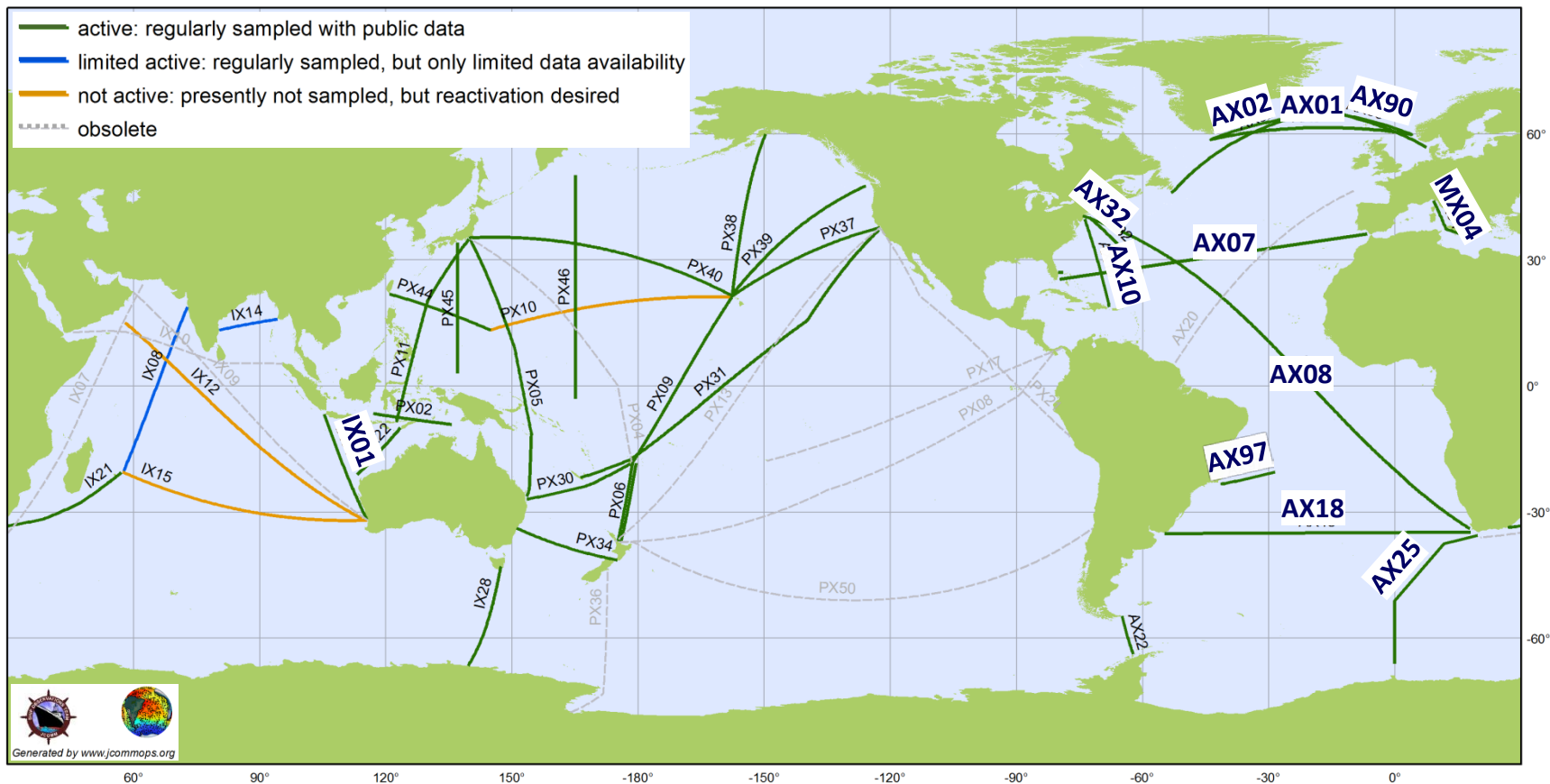


Number of global XBT deployments since 1965. US XBT operations have been consistently responsible for at least 50% of these global deployments (68% in average).

Status of AOML XBT Operations



The Global XBT Network



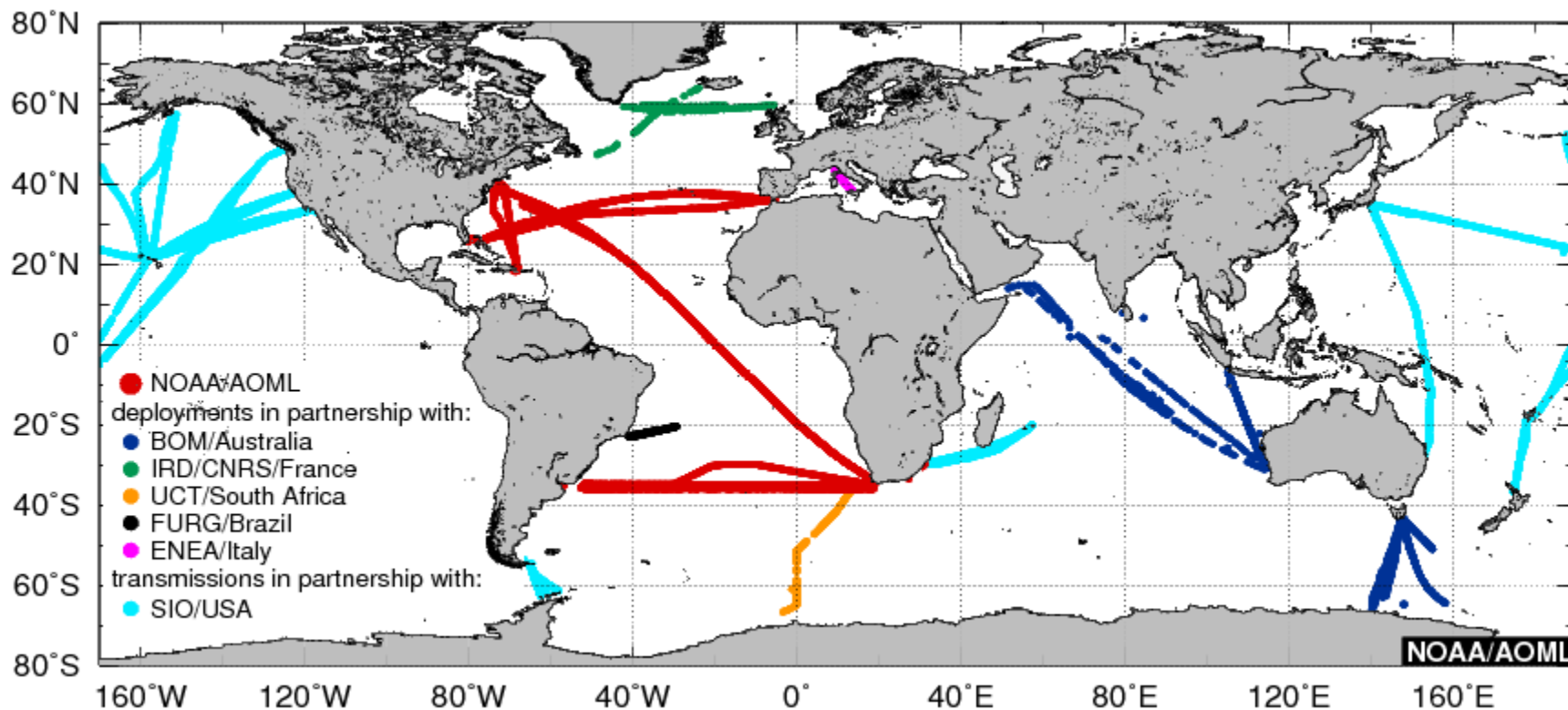
Frequently Repeated:

6 - 8 deployments per day
 1/100 km – 1/150 km
 12 - 18 transects per year

High Density:

1 deployment every 25 - 50 km
 18 - 35 deployments per day
 4 transects per year

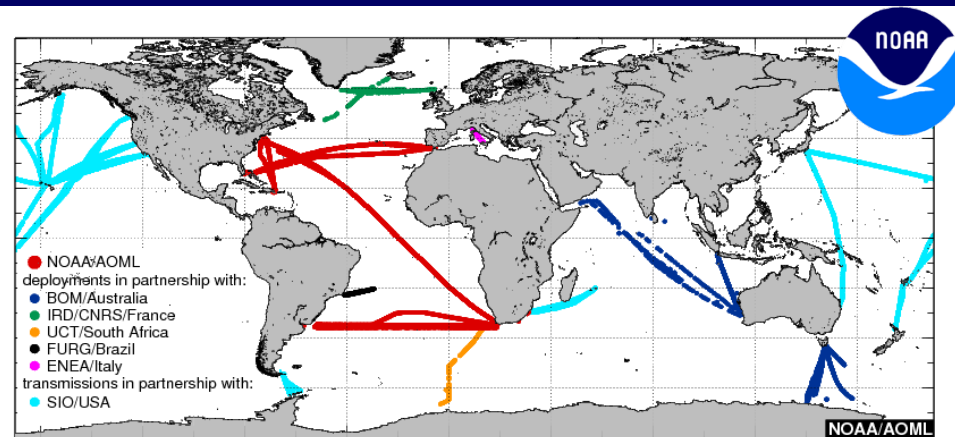
Status of AOML XBT Operations



Location of the AOML XBT deployments and AOML-supported XBT deployments and/or transmissions during FY2016 carried out by AOML or in partnership with national and international collaborators.

Status of AOML XBT Operations

Name	Since...	No. of Cruises*	No. of XBTs*
AX01	1997	90	2,438
AX02	2008	24	1,181
AX07	1994	89	20,437
AX08	2000	65	22,777
AX10	1996	78	7,894
AX18	2002	48	10,013
AX20	1995	9	1,463
AX25	2004	33	4,267
AX32	1975	149	3,277
AX97	2004	65	2,771
MX01 MX02 MX04	1999	223	11,135
IX01	1983	203	13,722



1. More than 100,000 XBTs deployed during ~1100 cruises since 2000.
2. Operations in partnership with 8 countries during recent years.
3. All data distributed in near real-time (GTS) in delayed mode (NCEI).
4. XBT data has been used in more than 1500 scientific and technical publications since 2000.

* Since 2000; AX01 in FR, all other in HD mode.



Ship Recruitment, Logistics, Ship Riders

Luis Yurquina from the Argentine Hydrographic Service during an AX18 Cruise on MOL Triton Ace



High Density XBT cruise equipment installation



AX07 cruise starting at the Strait of Gibraltar



CMA CGM Rabelais and NYK Prometheus Leader ships used during AX07 and AX10 cruises



- More than 15 shipping companies
- Between 30 and 40 ships per year
- More than 45 cruises per year in high density mode
- Operations in partnership with 10 institutions from 8 countries
- Approximately 20 riders from US and our partners





Engineering Developments

AOML XBT Autolauncher



AOML XBT Autolauncher

- Deployments at fix time or distance intervals, or at fixed locations.
- Allows 24h operations with a single rider doing frequent deployments for weeks.
- Portable. Easy installation and removal.

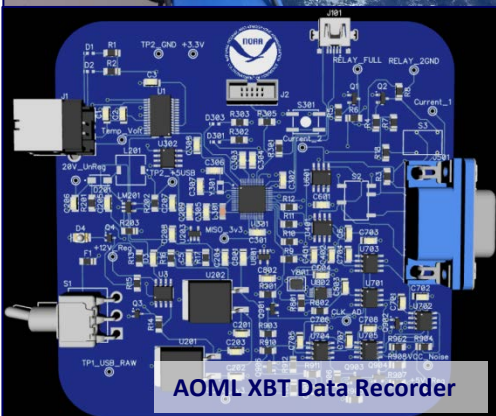
AOML Iridium Transmitter

- Developed at AOML in 2010-2012, fully transitioned into operations since 2015.
- Reliable and efficient transmissions of arbitrary types and amounts of data.
- Reduced costs from \$15 to \$0.95 per profile (saving of over \$200,000 a year).
- Development team received a NOAA Team Member of the Month award and a NOAA Administrator's Award during 2016.

AOML Iridium Transmitter



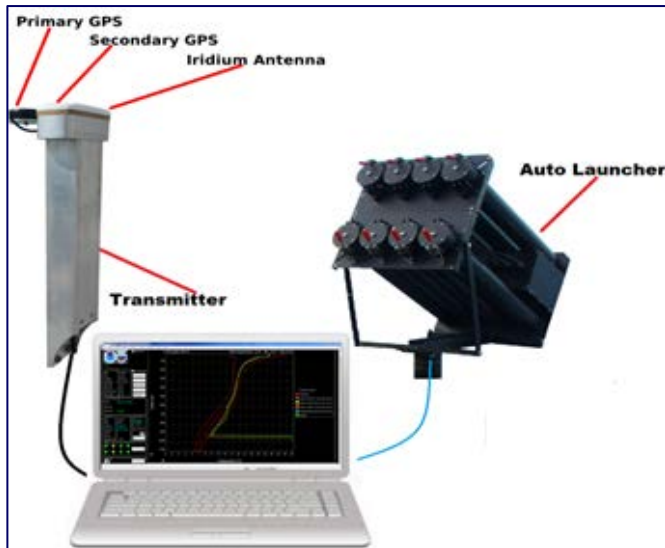
AOML XBT Data Recorder



AOML XBT Data Recorder (AXR)

- Under development, prototype already tested on the field.
- Will replace current recording units (\$9,000 per unit).

Software Developments



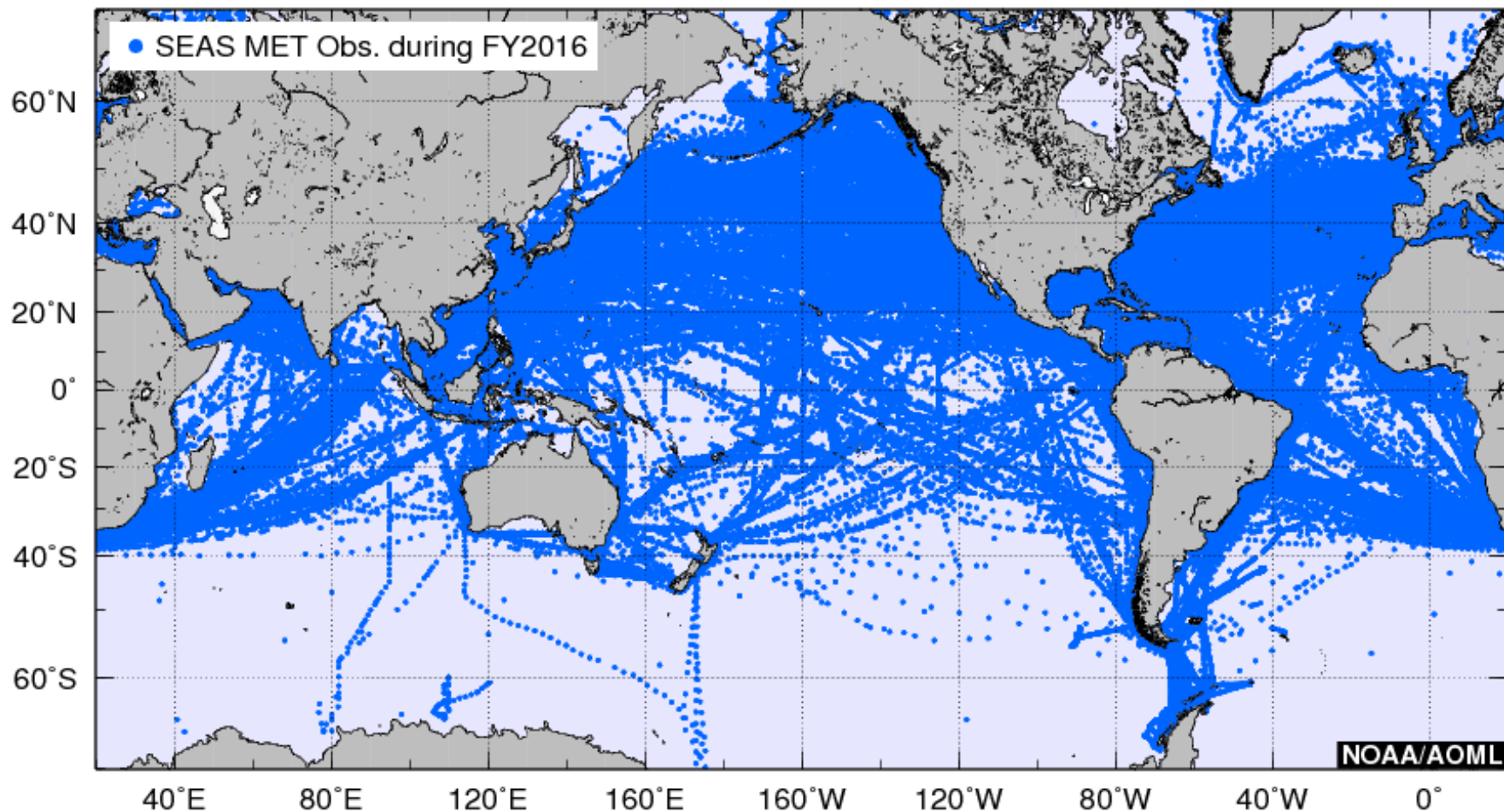
AMVERSEAS and SEAS Server

- AMVERSEAS software developed at AOML to collect and transmit XBT, TSG and MET observations
- Installed in more than 50 ships of the XBT Network (14,000 XBT profiles per year)
- Also used to send Amver bulletins to the US Coast Guard for search and rescue
- AMVERSEAS and the SEAS server also distributes 500,000 marine weather reports obtained from 800 ships of the Voluntary Observing Ship program



Crew of the M/V Cape Nelson and survivors from the fishing vessel Abound that sank 625 miles off the coast of San Francisco, whose rescue was facilitated through AMVERSEAS on October 26, 2005

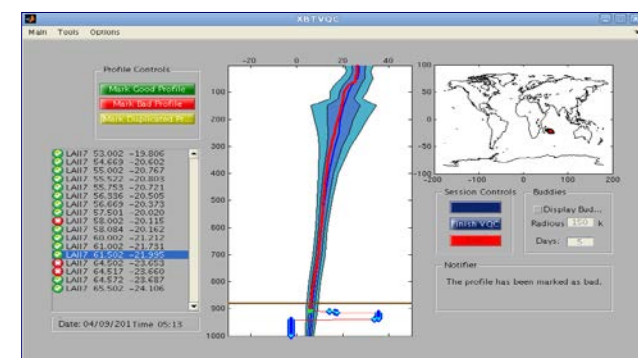
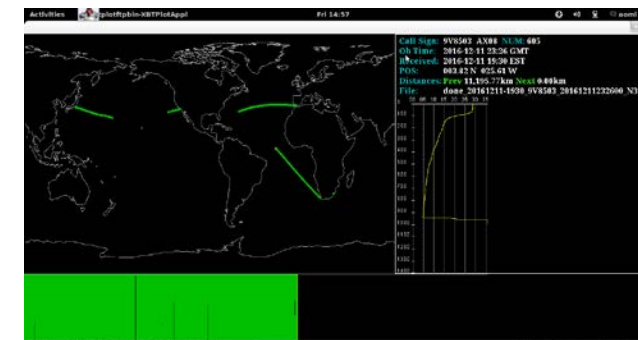
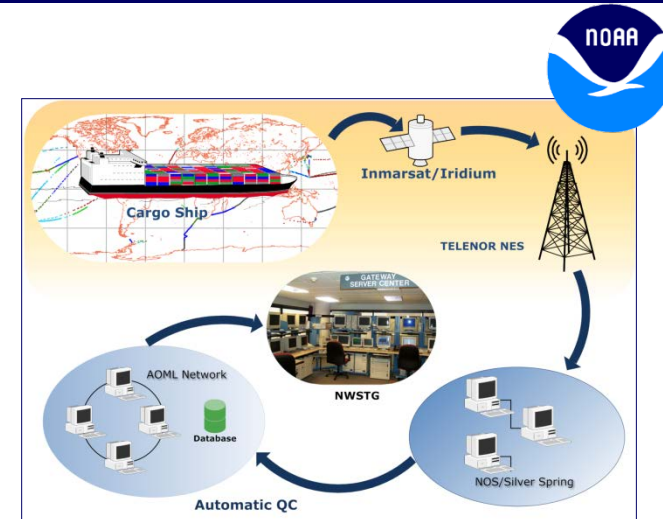
Software Developments



Locations of the approximately 500,000 marine weather reports obtained from 800 ships of the VOS distributed through the GTS using SEAS software during FY2016.

Data Flow and Data Management

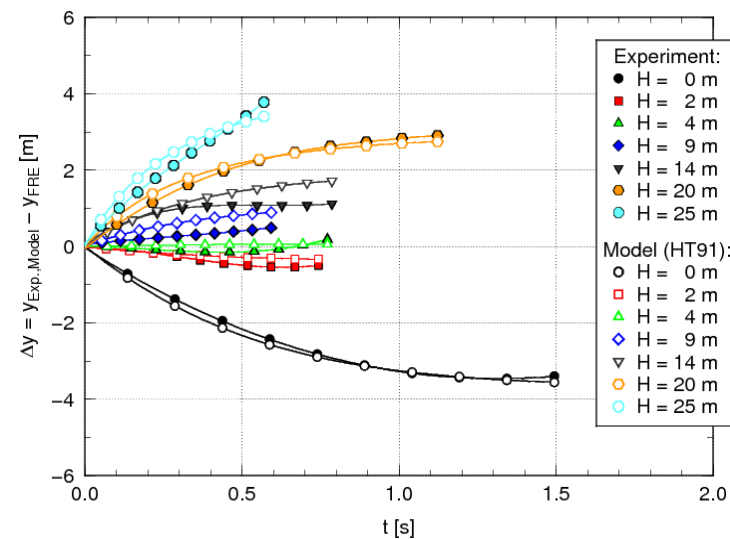
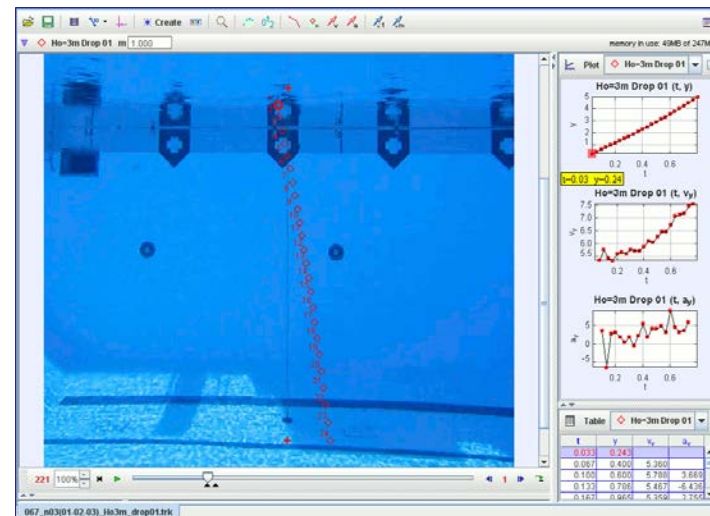
- Almost 100% of XBT profiles are transmitted in real-time using Iridium Transmitters.
- AOML and SIO XBT profiles undergo near-real time automatic quality control (AQC) procedures at AOML + Visual QC for profiles that fail the AQC.
- Good profiles (95%) are transmitted to the GTS in near real-time and distributed / archived at NCEI (WOD and GTSP).
- AOML XBT profiles collected in HD cruises also undergo a science quality delayed time QC. Final QCed profiles are delivered to NOAA/NCEI for archival and replacement into the “Best Quality” GTSP data set.
- Transmission into the GTS are done according to all data format requirements, including data in BUFR format and additional meta-data.
- Data management procedures ensure that the XBT data reaches the operational and scientific community in a timely manner and with the highest possible quality.





Data Quality Improvements

- AOML conducts experiments in order to improve XBT data quality.
- AOML maintains a strong collaboration with Sippican for the improvement and development of new, more accurate, XBT probes.
- AOML is actively involved in the use of new technologies for data collection and transmission, including the development of a new XBT data recorder.
- New file formats (i.e. BUFR) are constantly used in order to include additional metadata needed for data corrections.
- The integration of meteorological sensors in some cruises will increase the value of the XBT data collected.





Meetings and International Panels

- AOML XBT Network is implemented through the Ship Of Opportunity Program, a participating member of JCOMM and JCOMMOPS.
- AOML XBT Network is represented during bi-annual WMO/IOC Ship Observations Team (SOT) meeting. Dr. Gustavo Goni is the vice-chair of the WMO/IOC Ship Of Opportunity Program Implementation Panel (SOOPIP).
- Other members of the AOML XBT group are part of Meta-T panel and the JCOMM Data Management Programme Area (DMPA) Task Team on Table Driven Code Forms, JCOMM DMPA Task Team on Table Driven Code Forms, the SOT Task Team on Instrument Standards and the SOT Task Team on Training.
- Dr. Gustavo Goni is the co-chair for operations of the XBT Science Team, together with Dr. Janet Sprintall (SIO, for science) and Ms. Rebecca Cowley (CSIRO, for data management). Other members of the AOML XBT group are also part of the XBT Science Team.
- AOML conducts an annual XBT Operations meeting.
- AOML participate in other data management groups including GTSP and IQuOD.



Intergovernmental
Oceanographic
Commission



Future Work



- Continue the application/development of new technologies for data acquisition and transmission (Amverseas, Iridium Transmitter, AOML XBT recorder).
- Continue the development and maintenance of a flexible XBT data management system that meets all the community requirements for data dissemination and applications.
- Add atmospheric sensors in some cruises to increase the value and applications of XBT data.
- Take advantage of the BUFR format capabilities for the dissemination of XBT data in near real time in full resolution and with a complete set of meta-data and quality control (QC) flags.
- Apply to the XBT profiles the QC experience and software development currently underway at AOML for glider observations.