

Eleventh Session of the **Ship Observations Team** Online-Meeting, 13-16 September 2021

Agenda Item 2: National Reports

United States of America (USA)
NOAA/NWS/Observation and NOAA/OAR/AOML

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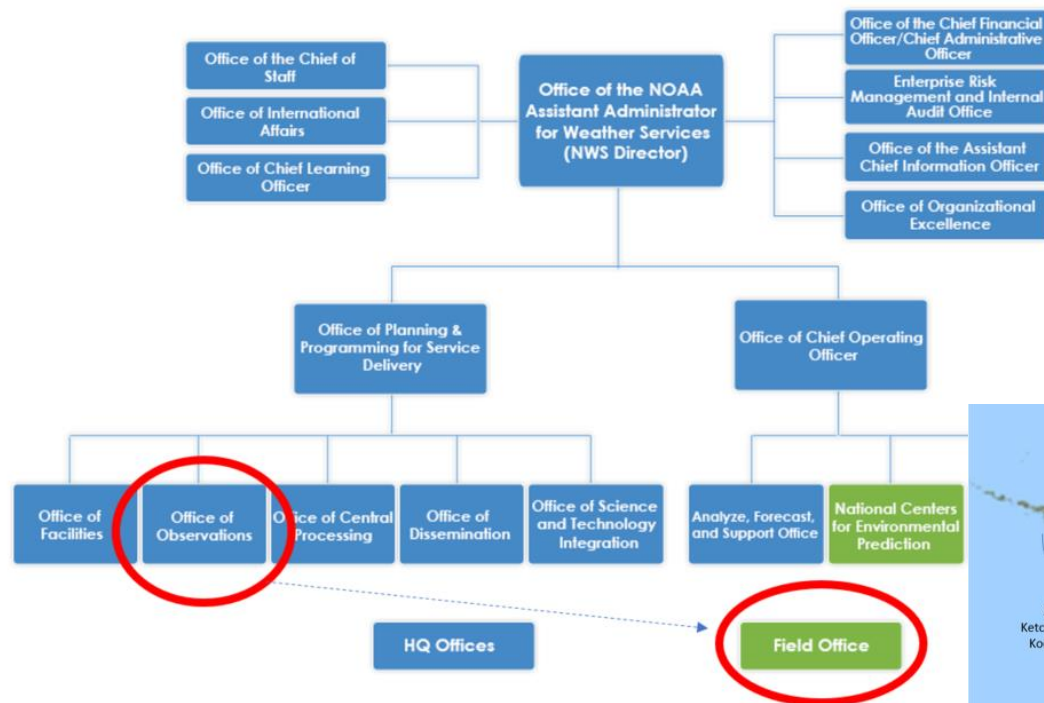
VOS Program Manager, Office of Observation, National Weather Service

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About Organization Met-Ocean Structure

NOAA - National Weather Service



PMO Locations

VOS Program



About Organization

Total 12 PMO

Eastern Region - 4 PMO
 Southern Region - 4 PMO
 Western Region - 2 PMO

Alaska Region - 1 PMO
 Central Region - 1 PMO
 (Great Lakes)

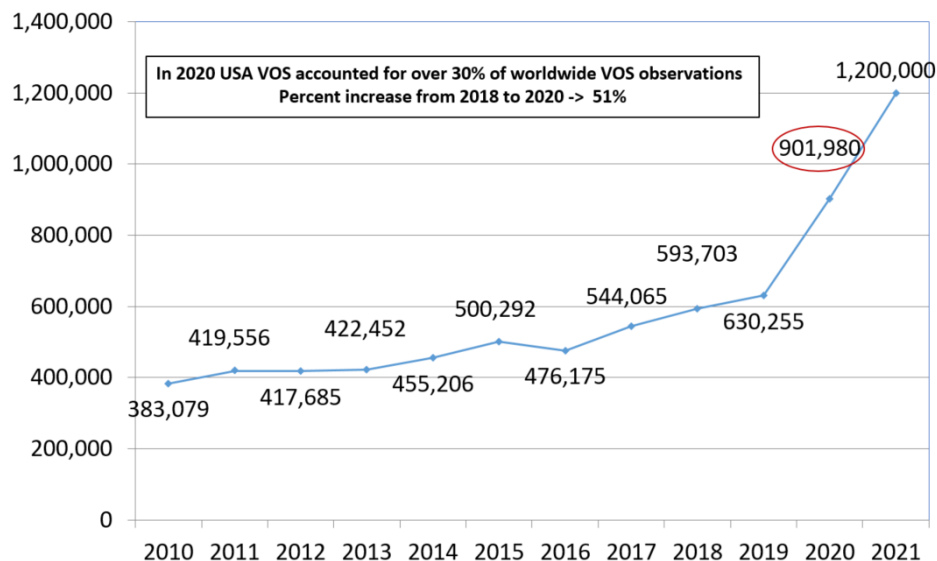
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Real-time Observations and Ship Counts



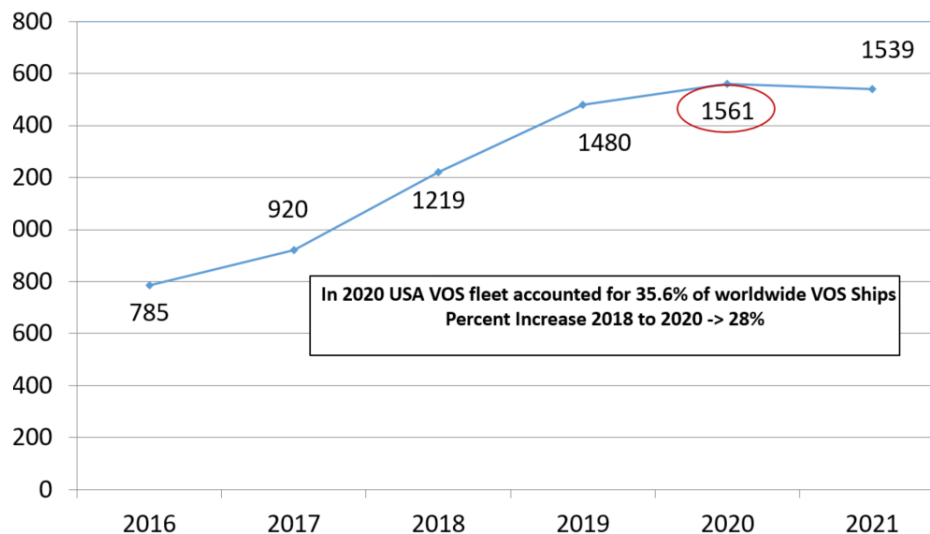
<http://esurfmar.meteo.fr/vos-monitoring/info.php>
VOS Observation Counters

USA VOS Observations



<http://esurfmar.meteo.fr/vos-monitoring/info.php>
IS Observation Counters

USA VOS Ships Reporting



Combination of manual and automated observations

VOS Activities Other Initiatives

Manual Observing (TURBOWIN+)



Enhanced Manual Observing System (EMOS)



Auto-Send Enhanced Manual Observing System (AUTO-EMOS)



Automated Observing System Independent Ship Platform



-----Logging and Auto- Formatting Software (TurboWin+)-----



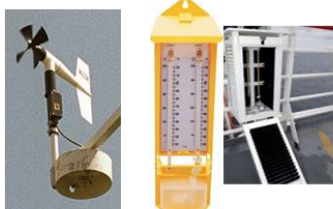
Aneroid Barometer



Mintaka
Star
StarX
StarXG
Duo



-----Wireless Digital Barometer, Psychrometer, GPS-----



Anemometer Wet/Dry Bulb,
psychrometer



Anemometer



Digital Temp/Humidity
(Extech RH300)

Autonomous Weather Reporting System CES Weatherpak 2000 NOAA Config)

- Independent of ships power (Solar)
- Independent of ship communications
- Independent of Ship Crew
- Hourly observations

Enhanced Manual Observation System EMOS

TurboWin+ 4.0 and 4.1

Weather observing Logbook
Creates coded weather message
Requires 64-bit computer

Mintaka Star

Inside Unit
Wireless Network for StarX
GPS Coordinates
Attached to computer via USB cord

Mintaka StarX/XG

Outside Unit
Pressure – Air Temperature – Humidity
Wireless transmission to Star
StarXG – GPS Coordinates

GuardX

Thermoscreen



Manual Transmission

GMDSS
Ship's Email
Web (KNMI Server)

Auto Transmission

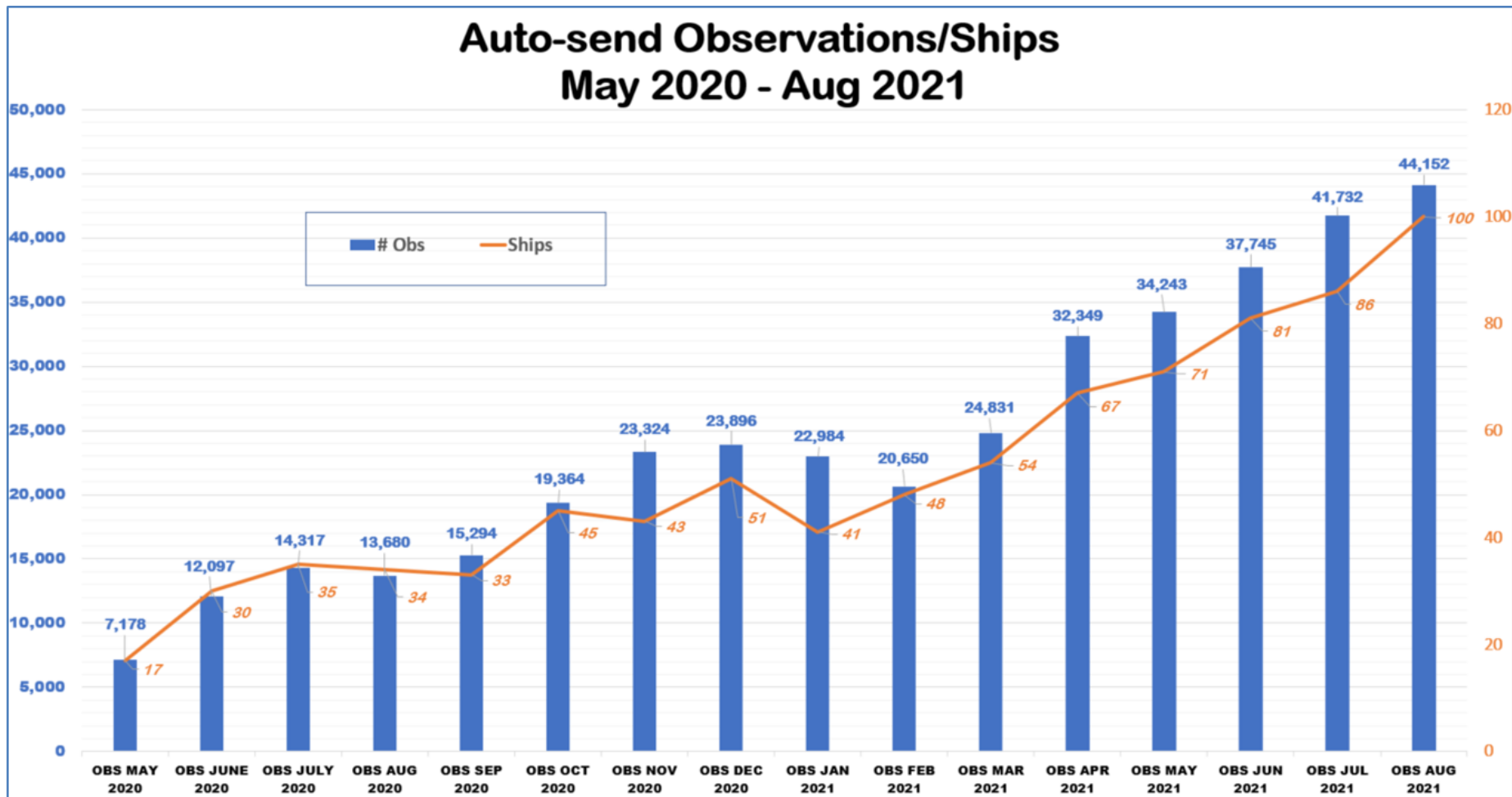
SMTP
Gmail
Yahoo
Web (KNMI Server)

Auto Function

Hourly Transmission of
Sea Level Pressure
Pressure Tendency & Change
Air Temperature
Dew Point



VOS Activities Other Initiatives



VOS Activities COVID-19 Impact

NCEI Final Observation Counts 2020

2019 JAN – DEC NCEI Number of Observations 794,564

2020 JAN – DEC NCEI Number of Observations 880,496

Percent Increase for 2020 = 10.8%

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	61,057	58,083	65,239	69,432	77,302	77,871	76,215	75,725	76,660	79,235	81,450	82,137
2019	50,345	44,019	57,690	67,008	73,608	74,711	76,312	74,270	73,072	68,788	68,054	66,687
% Change	21.28	31.95	13.24	3.62	5.02	4.23	-0.13	1.96	4.91	15.19	19.68	23.17%

COVID-19, shipping industry decline, reduction in research vessels, cruise ships, and ships leaving the program, impacted the first half of the year. Implementation of Auto-EMOS, research vessels, and improvements in the industry provided an increase in the second half of the year. Monthly numbers are from NCEI Reporting. Percent Increase = $100 \times ((2020 \text{ Observation Count} - 2019 \text{ Observation count}) / 2019 \text{ Observation count})$

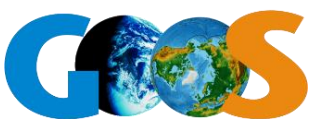
- Implemented Auto-EMOS solution with U.S. flagged shipping companies
- PMOs leveraged technology to work with ship captains and crews remotely
- Worked with shipping company safety, operations, and IT management to promote and implement Auto-EMOS
- Requested moored vessels to continue to report observations (Ship Buoy)
- Maintained contacts with VOS fleet showing appreciation for their observations
- Focus on continuous improvement

VOS Activities

Future Work

- Continue to establish core fleet of Auto-EMOS ships
- Add wind data to Auto-EMOS solution
- Update U.S. VOS Information Technology (IT) systems and migrate to one platform
- Transition to BUFR when downstream systems are ready and funding is available





SOOP Activities During 2019-2020



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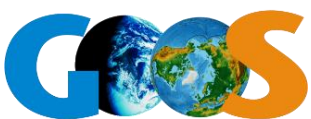
Oceanographer, Atlantic Oceanographic & Met Lab
(AOML)

Oceanic and Atmospheric Research
(OAR)

About Organization (Met-Ocean Structure)

- SOOP responsibilities:
 - Implement, maintain, and monitor specialized instrumentation and practices for ocean observations from Ships of Opportunity;
 - Coordinate the exchange of recommended practices, and technical and developmental information about oceanographic instrumentation relevant to the SOOPIP;
 - Ensure the transmission of SOOP data to the GTS and relevant data centers according to operational and scientific requirements;
 - Where relevant, serve as a platform for other observational programs;
 - Maintain close communications with the scientific community and periodically meet and discuss ongoing research performed with observations relevant to SOOPIP.

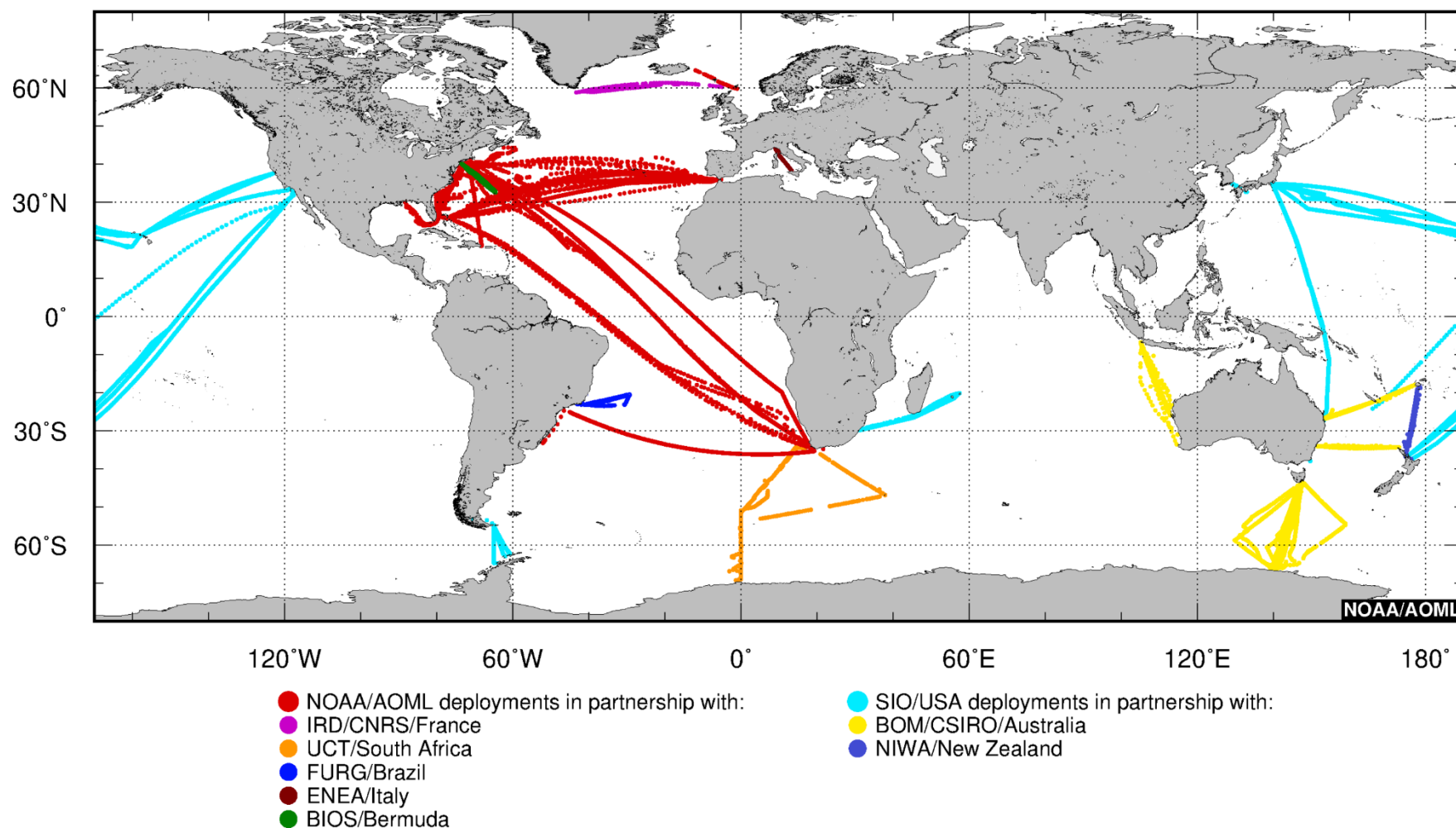
SOOPIP Terms of Reference: <https://www.ocean-ops.org/sot/programmes.html#SOOP>



SOOP Activities during 2019-2020



- US XBT operations were conducted in frequently repeated (FR) and high density (HD) modes according to scientific and operational needs.
- US XBT deployment have global coverage. There were 22 XBT active transects (10 in the Atlantic, 9 in the Pacific, 2 in the Indian Ocean, and 1 in the Mediterranean Sea).
- A total of 8,926 (3,248) profiles were submitted to the GTS in 2019 (2020). Operations were conducted with the participation of 40 (19) ships of the SOOP in 2019 (2020). US participated in ~85% of some component of all global XBT operations.
- The largest changes in the XBT Network from previous years were conducted in response to the COVID19 pandemic, including an increase in FR transects and deployments in new locations and with new objectives.
- XBT deployments provide temperature measurements that are used 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.
 - Deployments in coastal areas in support of hurricane intensity forecast efforts.



Location of US XBT deployments and US-supported XBT deployments and/or transmissions during 2019-2020 carried out by NOAA/AOML and SIO or in partnership with other national and international institutions.

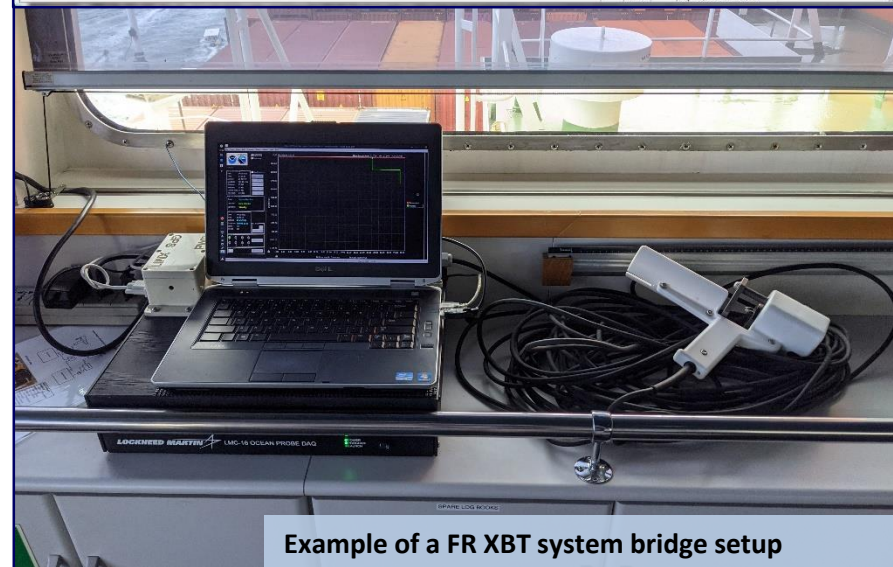
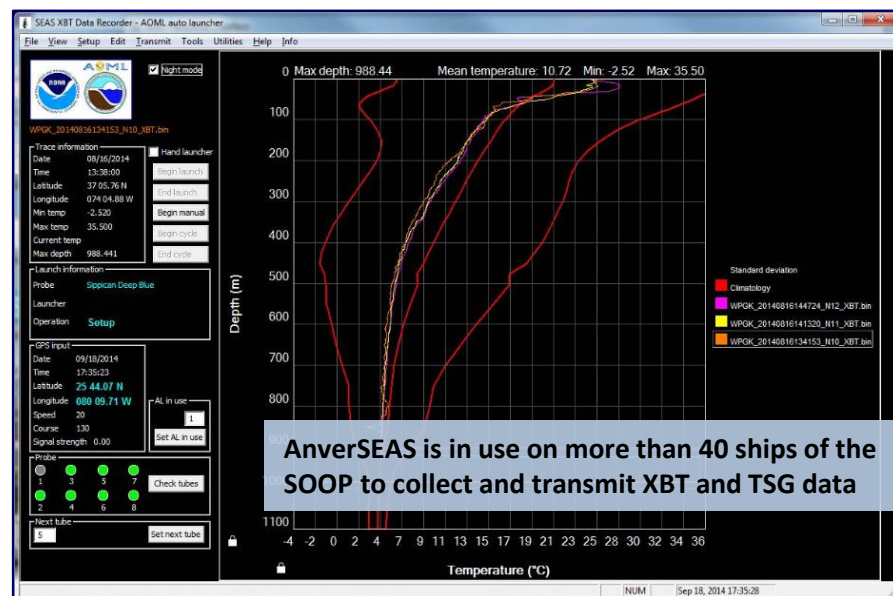
Challenges and Difficulties

- Strong restrictions in travel, ship and facilities access since 2020 require a high level of adaptability in order to maintain operations.
- Level funding for ocean-spanning routes, and high scientific value in sustained boundary current observations, lead to challenges in adapting the design of existing networks to meet the new constraints and requirements.
- Limited budget available to contribute with probes and equipment to international and US collaborators.



Research and Development

- All SEAS XBT data continue being transmitted from SOOP ships to NOAA in full resolution profiles and all data are placed into the GTS by NOAA.
- AOML/SOOP continues to develop and upgrade AMVERSEAS for the recording of XBT and thermosalinograph (TSG) observations, and data transmissions in real-time using Iridium.
- Regular XBT data transmissions to the GTS using BUFR format, along with ASCII BATHY bulletins.



Engineering Developments



AOML XBT Weather Station (AXWS)

- Developed at AOML in 2010-2012, fully transitioned into operations since 2015.
- Measure relative humidity, temperature, and atmospheric pressure along XBT transects
- Data used together with XBT profiles to compute heat budget



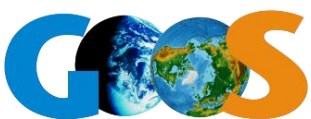
AOML XBT data recorder (AXR) prototype

- Under development at AOML, as an alternative to MK21 units.
- Field tests performed during 2019.
- Currently in the test and validation stage.



AOML Iridium Transmitter (used by AOML and SIO)

- Developed at AOML in 2010-2012, fully transitioned into operations since 2015. In operation on all ships of the US-SOOP with real-time transmission capabilities.
- Reliable and efficient transmissions of files of any type and size.
- Reduced costs from \$15 to \$0.95 per profile (saving of over \$200,000 a year).

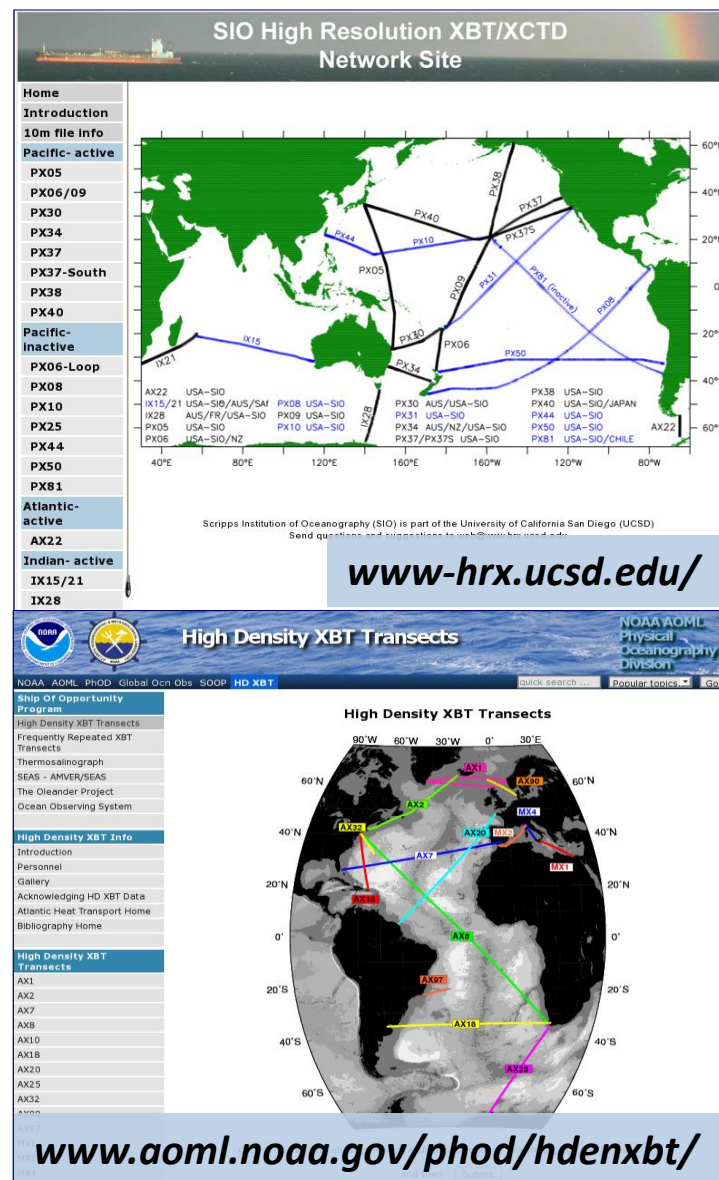


International Partnerships

- NOAA/AOML continues to participate in collaborative programs with other institutions involved with XBT deployments. In particular, during 2019-2020 AOML continued its collaboration in support of AX01 (IRD/France), AX08, AX18 and AX25 (South Africa), AX32 (Bermuda), AX97 (Brazil), and MX04 (Italy).
- SIO continue to participate in collaborative programs with other institutions involved with XBT deployments. In particular, during 2019-2020 SIO continued its collaboration in support of AX22, PX30, PX34, IX28 (Australia), and PX06 (New Zealand).
- Real time transmission and quality control procedures for the TSG data collected by ships of the SOOP and the NOAA fleet continue in operation. The TSG data set, including quality control flags, is being distributed through NOAA/NCEI and GOSUD.
- US SOOP operations were conducted in partnership with:
 - **USA:** NOAA/AOML, Scripps, University of Miami, WHOI, University of Rhode Island, Stony Brook University
 - **Bermuda:** Bermuda Institute of Ocean Sciences
 - **Brazil:** Federal University of Rio de Janeiro
 - **South Africa:** University of Cape Town
 - **Italy:** ENEA
 - **Australia:** CSIRO, BOM
 - **Argentina:** Naval Hydrographic Service
 - **France:** CNRS, IRD, IFREMER

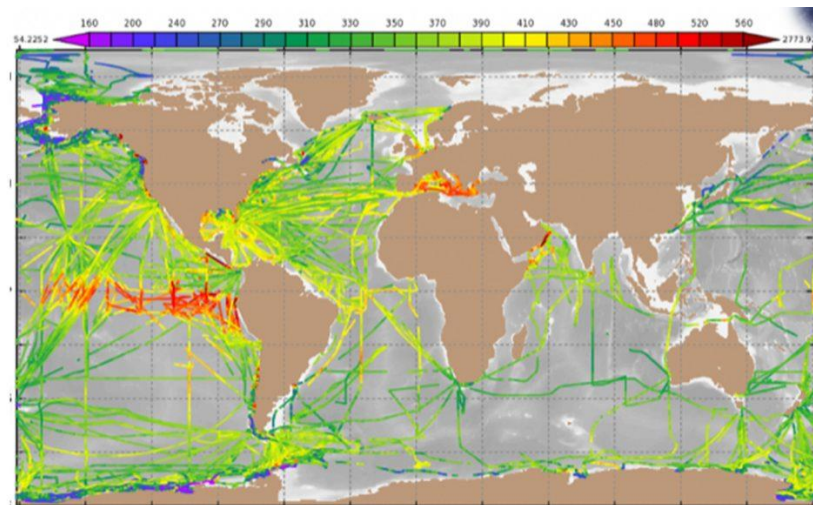
Data Flow and Data Management

- At least 90% 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).
- All US-SOOP XBT profiles collected during HD and FR 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.



pCO₂ Operations

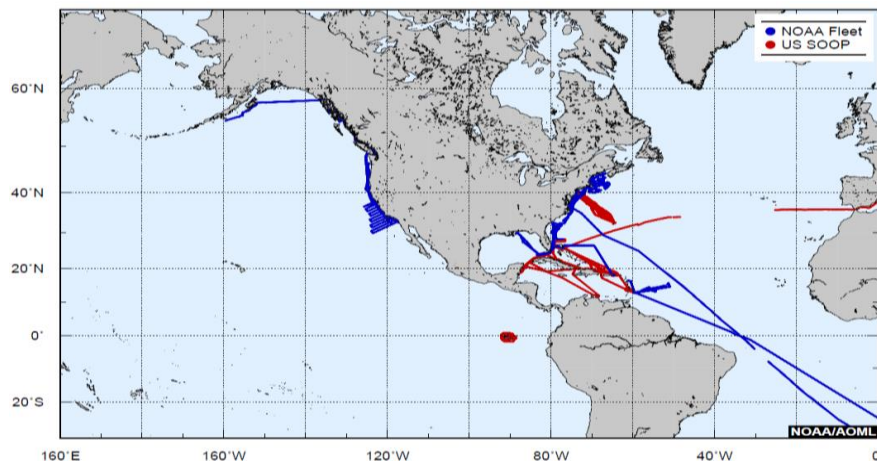
- pCO₂ network has been incorporated as part of the SOOPIP
- Operations aim at reducing uncertainty in air-sea flux in CO₂ and quantification of temporal and spatial variability
- ~50 automated underway CO₂ systems
- ~550,000 partial pressure of CO₂ measurements around the globe with ships sailing from the Pacific to the Atlantic and high latitude seas
- US-SOOP pCO₂ effort contributes roughly 30% of the global surface data available in the Surface Ocean CO₂ Atlas (SOCAT)
- Review of metadata requirements for pCO₂ operations continues



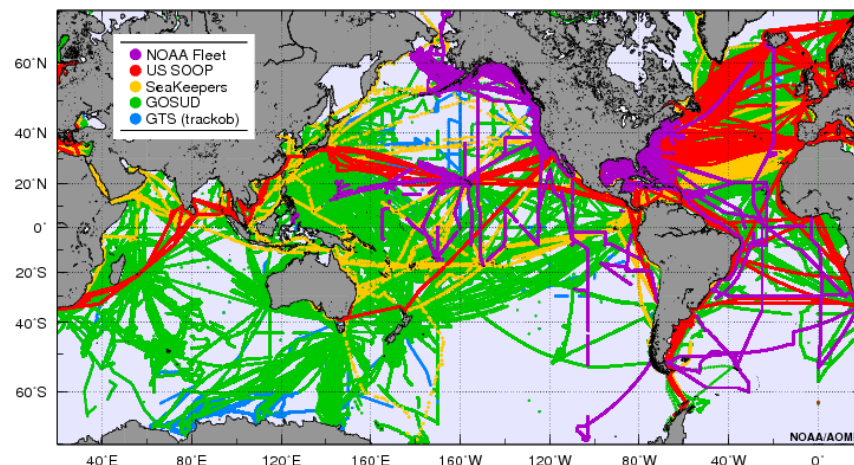
US-SOOP pCO₂ has contributed with 8.7 million pCO₂ records (approximately 30%) to the global Surface Ocean CO₂ Atlas (SOCAT version 2020)

TSG Operations

- Thermosalinograph (TSG) observations are used for the determination of boundary regions in ocean currents, climate and ocean dynamic research, input for climate and weather forecast models
- Support efforts to globally inventory carbon dioxide in the ocean. Provide critical information to determine frontal regions and mixed layer depths for ocean acidification assessments and pCO₂ inventories
- US-SOOP collects ~200,000 TSG observations (3-min resolution) annually from ~15 ships of the SOOP and the NOAA fleet
- Data distributed in real-time and near real-time through GOSUD and archived in NOAA/NCEI. Data is also distributed in delayed-mode by GOSUD



Locations of ~200,000 TSG records (3-min resolution) collected during 2020 by 15 ships of the US-SOOP and NOAA

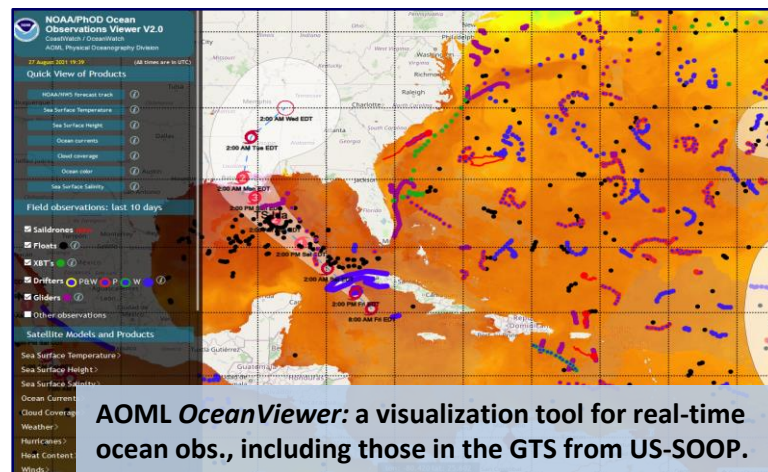
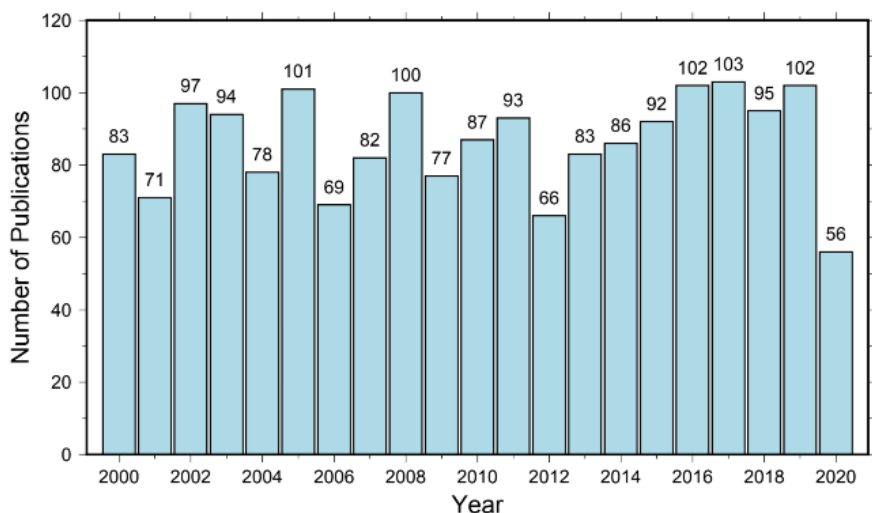


Locations of TSG observations collected globally since 2000

Other Activities

- Ships of the SOOP continues to support the deployment of other observational platforms such as drifters and Argo floats.
- Close partnership between SOOP and the XBT Science Team: 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).
- US XBT Network members participate in global data management activities including GTSP and IQuOD.
- XBT data has been used in more than 1800 scientific and technical publications since 2000

XBT Bibliographic Entries Since 2000



Future Work

- Continue the application/development of new technologies for data acquisition and transmission (AmverSEAS, Iridium Transmitter, Weather Station, XBT data recorder).
- Continue the development and maintenance of a flexible XBT data management system that meets all the community requirements for data dissemination and applications.
- Extend the installation and deployment of atmospheric sensors in some XBT cruises to increase the value and applications of XBT data.
- Participate in projects to facilitate data distribution, such as OpenGTS.
- Apply to the XBT profiles the QC experience and software development currently underway at AOML for glider observations.