SAMOS Overview

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SAMOS Stewardship Initiative

- **Focus**: To improve the quality of meteorological and near-surface oceanographic observations collected in-situ on research vessels (R/Vs)

- **Science Goals**:
  - Creating quality estimates of the heat, moisture, momentum, and radiation fluxes at the air-sea interface
  - Improving our understanding of the biases and uncertainties in global air-sea fluxes
  - Benchmarking new satellite and model products
  - Providing high quality observations to support modeling activities, process studies, and global climate programs

History of the SAMOS Initiative

- Developed as an outcome of the World Ocean Circulation Experiment
  - COAPS hosted the WOCE meteorological data center
- Project conceived during workshop on high-resolution marine meteorology in 2003.
- SAMOS data center first funded by NOAA in 2004
- International partnership with Australian Bureau of Meteorology started in 2008
- In 2009, became an active partner in the U.S. Rolling Deck to Repository (R2R) program.
- Schmidt Ocean Institute support for RV *Falkor* in 2013, *Falkor(too)* in 2023.

SAMOS Fleet Overview

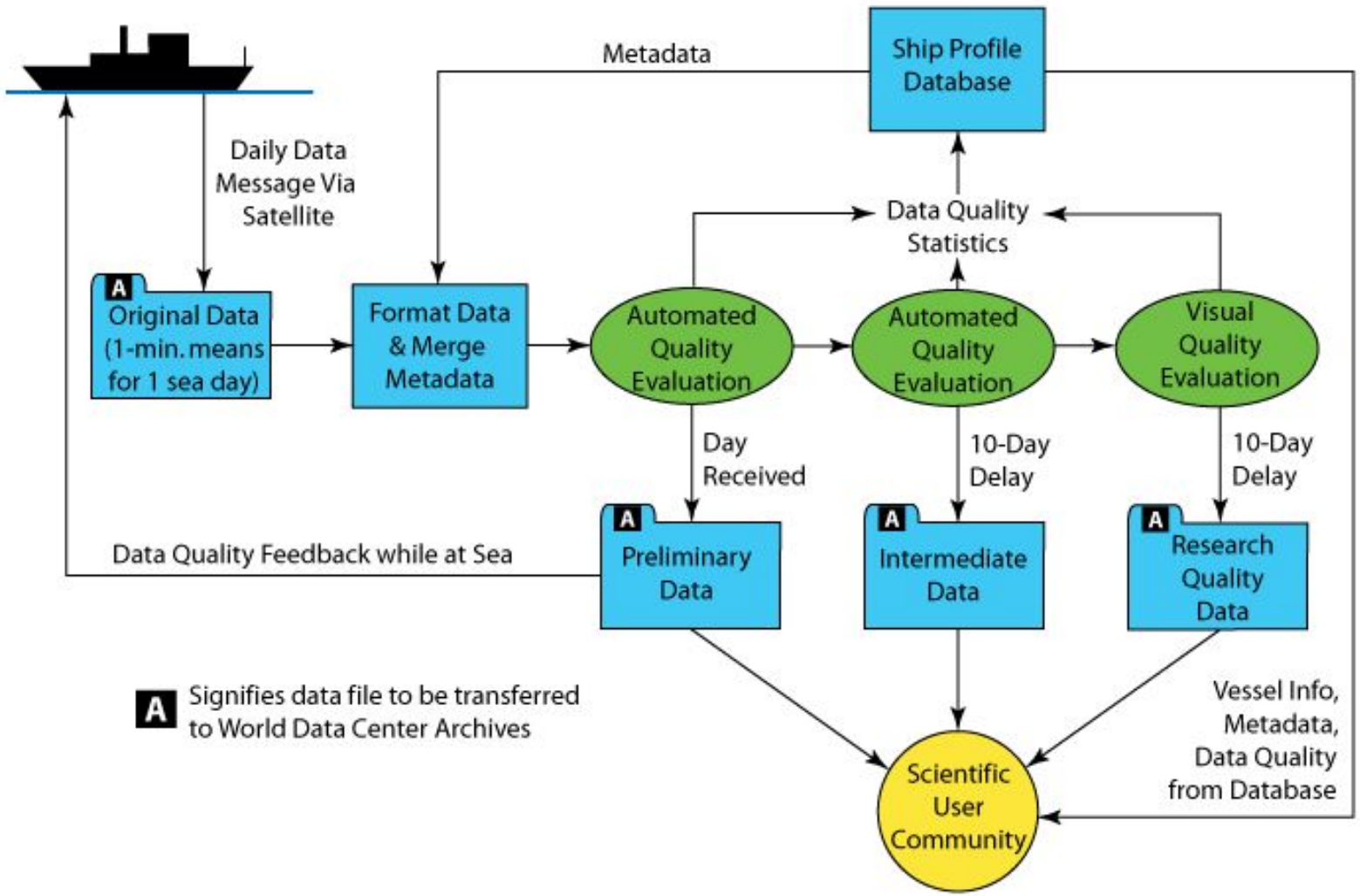
- 30 recruited vessels in 2023
- NSF OITS supports
  - 9 Academic Research Fleet RVs
  - 2 NSF Polar RVs
- NOAA OMAO supports
  - 4 NOAA vessels
- NOAA GOMO supports
  - 11 NOAA vessels
  - USCG Healy
  - 2 International RVs (*Investigator, Tangaroa*, hopefully the *Nuyina* in 2023)
- Schmidt Ocean Institute
  - Contract funding for RV *Falkor (too)*

Cruise maps for 2022

SAMOS
Shipboard Automated Meteorological and Oceanogra

http://samos.coa

Flow of SAMOS Observations

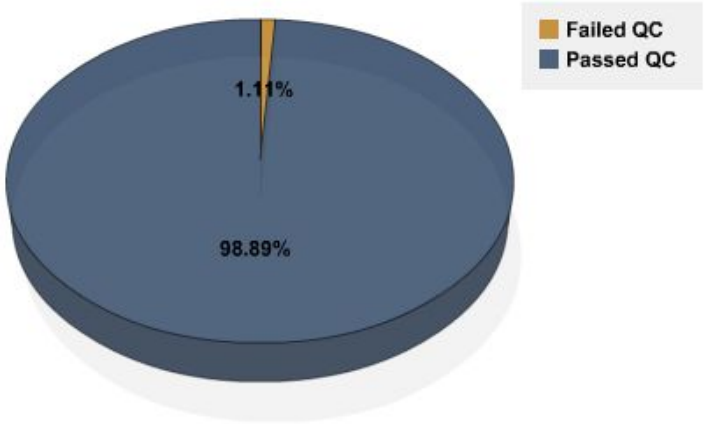


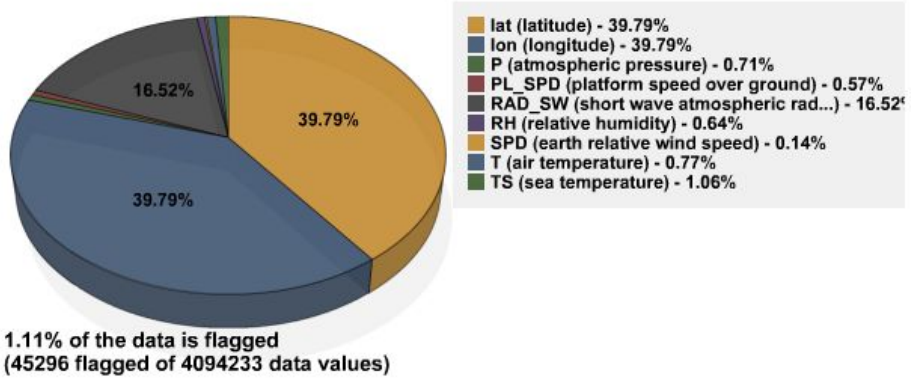
SAMOS on Vessel

- Ship's data acquisition system (DAS) receives sensor data messages at configured intervals (e.g., 1 Hz)
- SAMOS desires 1-minute interval between reported observations
  - Either 1-minute average (preferred)
    - DAS creates scalar or vector averaging using all values available for a given minute (e.g., 60 samples if sensor reporting at 1Hz)
  - Or instantaneous value
    - DAS selects 1 sample to represent each minute (e.g., the 1 Hz value nearest whole minute)
- One-minute average or spot "SAMOS" values written in key:value paired SAMOS 1.0 CSV format
- All records for previous day transmitted via email as near as possible to 0000 UTC.
- This process built into NOAA SCS, CORIOLIX
  - Custom versions exist in institutional DAS versions

SAMOS Data Processing

- Automated processing
  - Combines metadata with data received from vessel
  - Conducts preliminary quality evaluation
- Analyst visually reviews data from each vessel (not 24/7)
  - **Vessel operators notified when problems are discovered**
- Intermediate processing combines all observations for a single calendar day
- Research quality products developed with additional visual quality evaluation

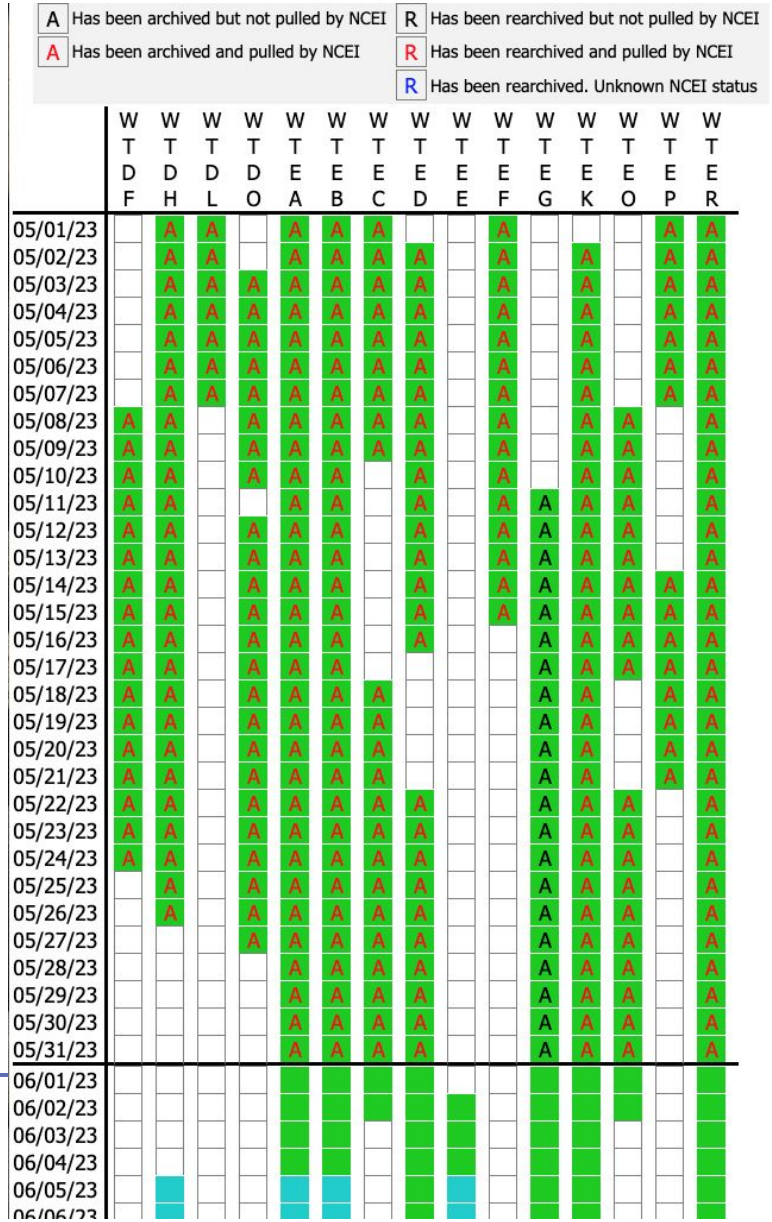




Data Distribution and Archival

- Data distribution
  - Web: http://samos.coaps.fsu.edu/
  - THREDDS: http://coaps.fsu.edu/thredds.php
  - FTP: ftp://www.coaps.fsu.edu/samos_pub/data
  - Additional web services provide statistics for data delivery status and automated QC.

- Archival at NCEI
  - Monthly submission of original, preliminary, intermediate, and research quality data
  - Automated handshake API confirms archival
    - Links accession in SAMOS database
  - All files are cataloged and verified with MD5 checksums.
  - Data DOI: **doi:10.7289/V5QJ7F8R**
  - Landing Page: http://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:COAPS-SAMOS

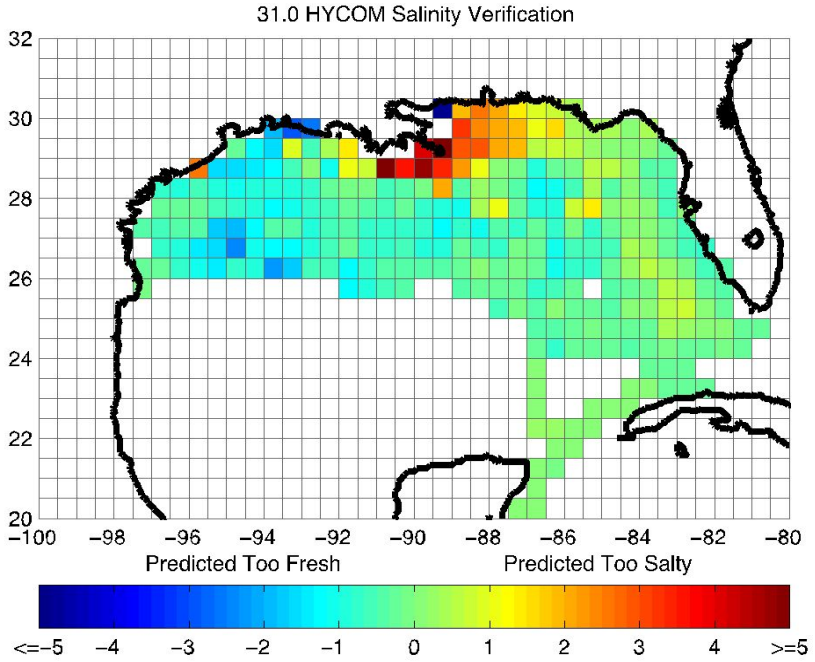


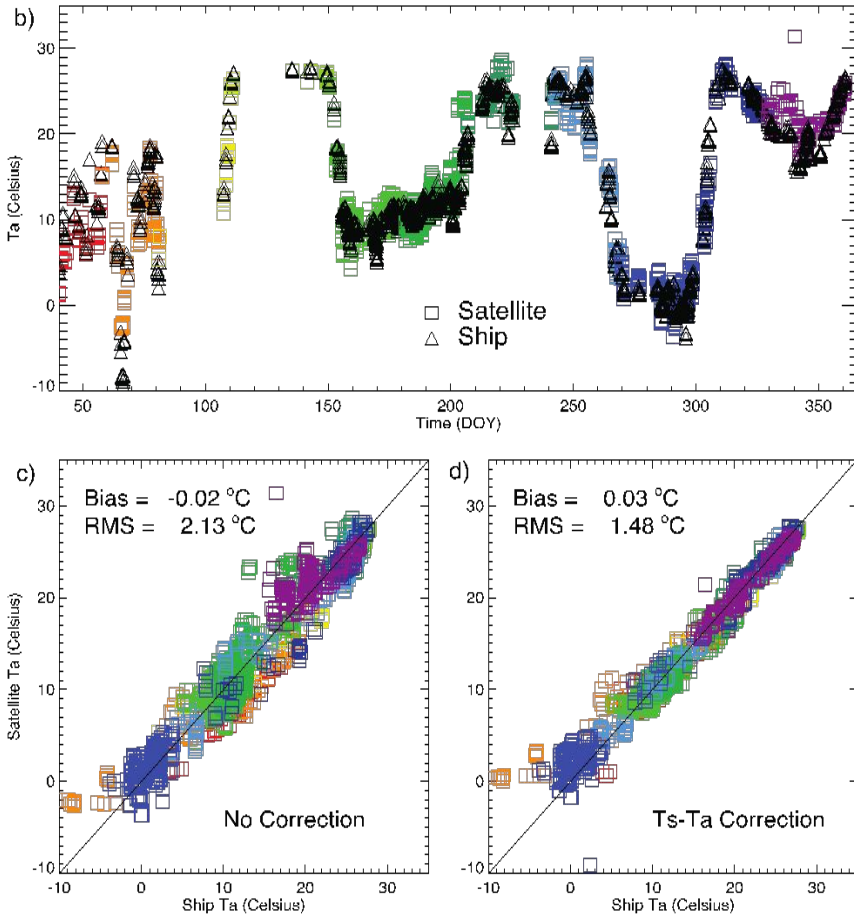
SAMOS
Shipboard Automated Meteorological and Oceanographic System

http://samos.coaps.fsu.edu

Why We Care

- SAMOS data uses:
  - Validating model analyses, air-sea flux fields, and satellite products
  - Satellite retrieval algorithm development



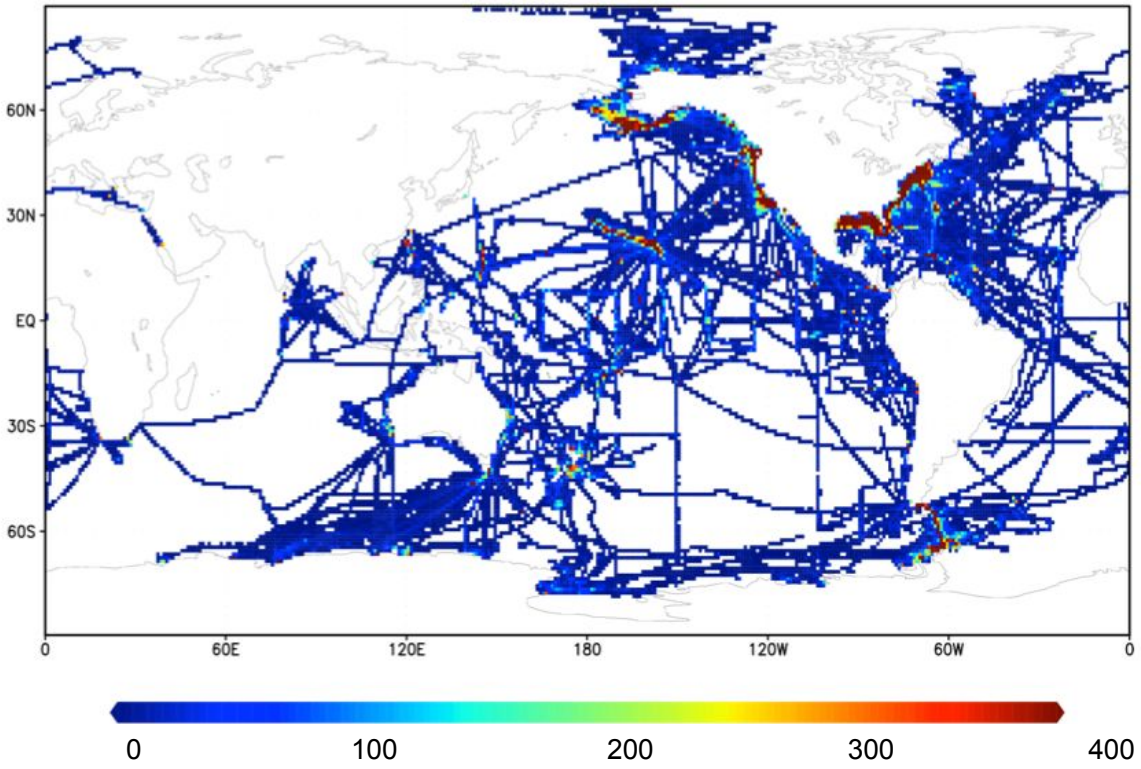


Adapted from Smith, Bourassa, and Jackson, *Sea Technology*, June 2012

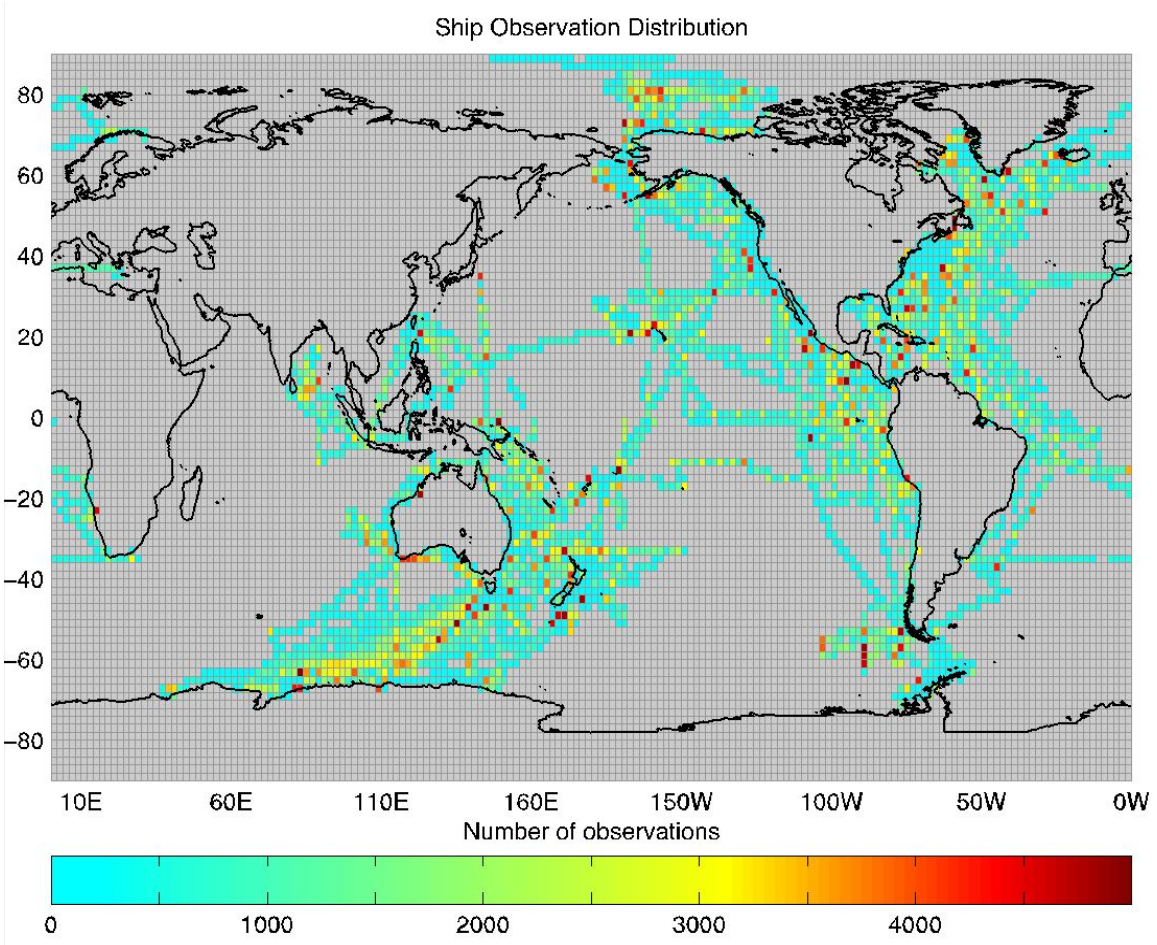
SAMOS in Global Data Syntheses

- An hourly subset of SAMOS 1-min data is included in Release 3.0 of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS).
  - Average 10-min. at top of hour to mimic synoptic reports from merchant vessels
  - Takes advantage of SAMOS QC
  - ~750 K hourly reports: 2005-2014
- SAMOS also in NCEI's surface underway marine database

SAMOS Data Density: 2005-2014



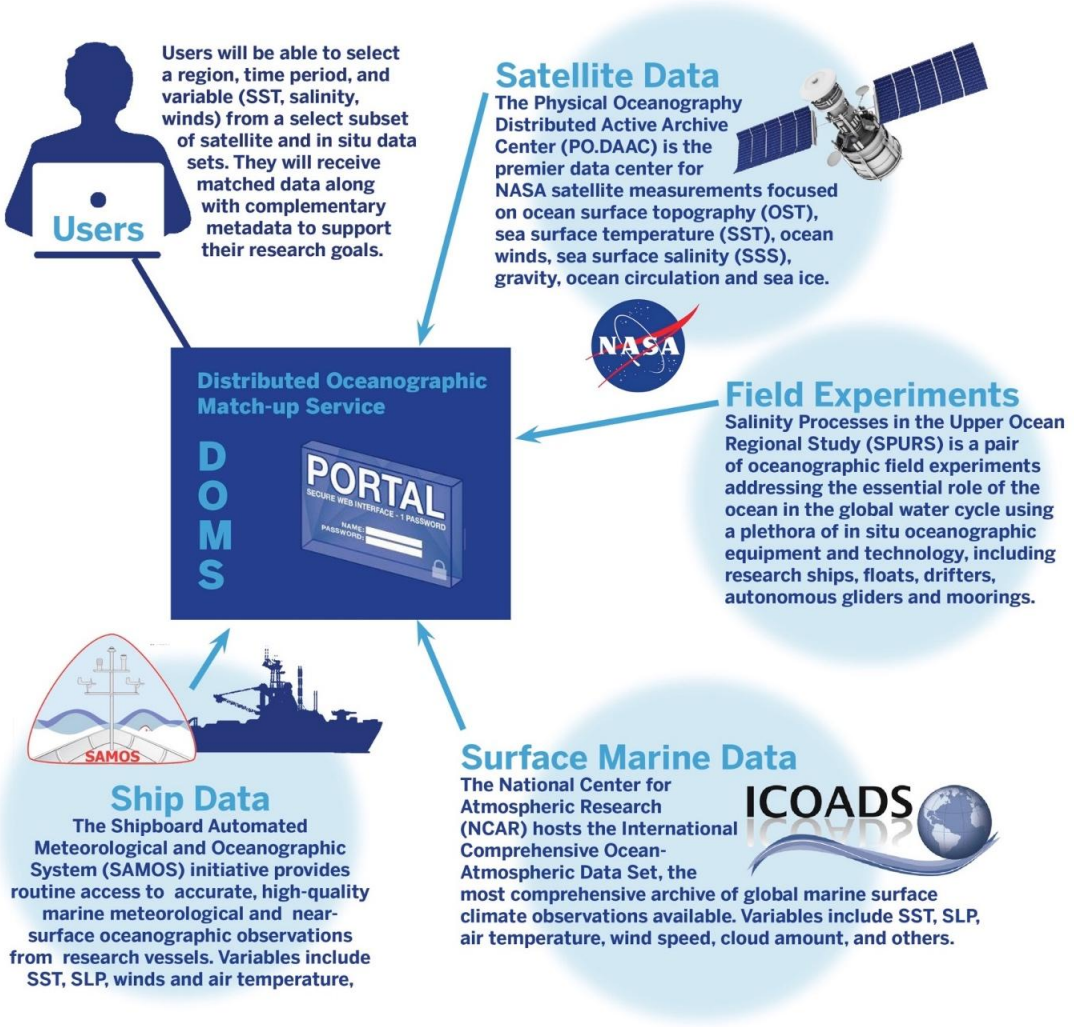
SAMOS Flux Product



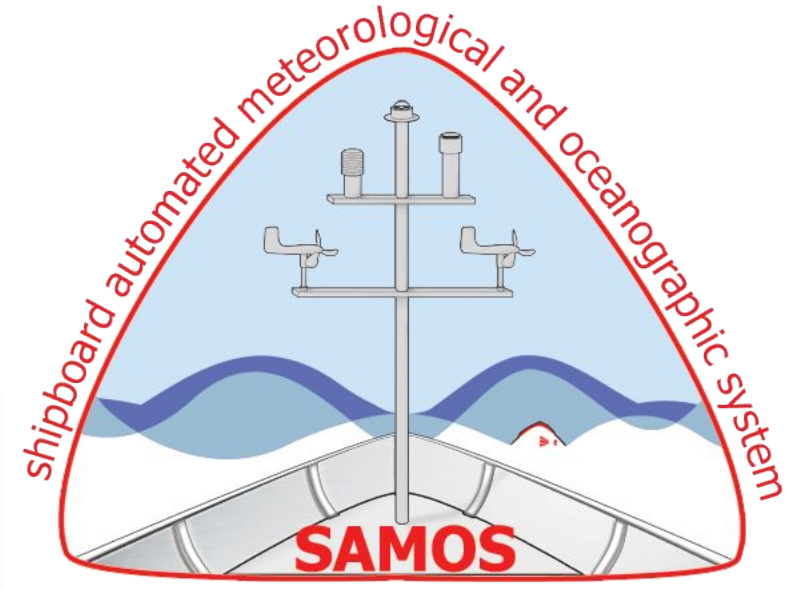
- SAMOS air-sea flux product released early in 2016
  - One-minute interval latent and sensible heat flux, wind stress, and other calculated parameters
  - Period: 2005-2014
- Data available from NCAR
  - doi: 10.5065/D6930R70
- Described in Smith et al., *Geosci. Data J.* (2016), doi: 10.1002/gdj3.34
- **NOAA presently funding MarineFlux project which will update and serve new version.**

SAMOS in Integrated Analysis Tools

- *Cloud Data Match-Up Service (CDMS)*
  - NASA ACCESS project
  - NASA Jet Propulsion Lab (lead), with FSU, National Center for Atmospheric Research, and Saildrone
  - Extending Distributed Ocean Match-up Service to support cloud environment on AWS
  - Will provide users tool to match in-situ and satellite data on the fly.
  - SAMOS data one of the in-situ data sources



Questions So Far?

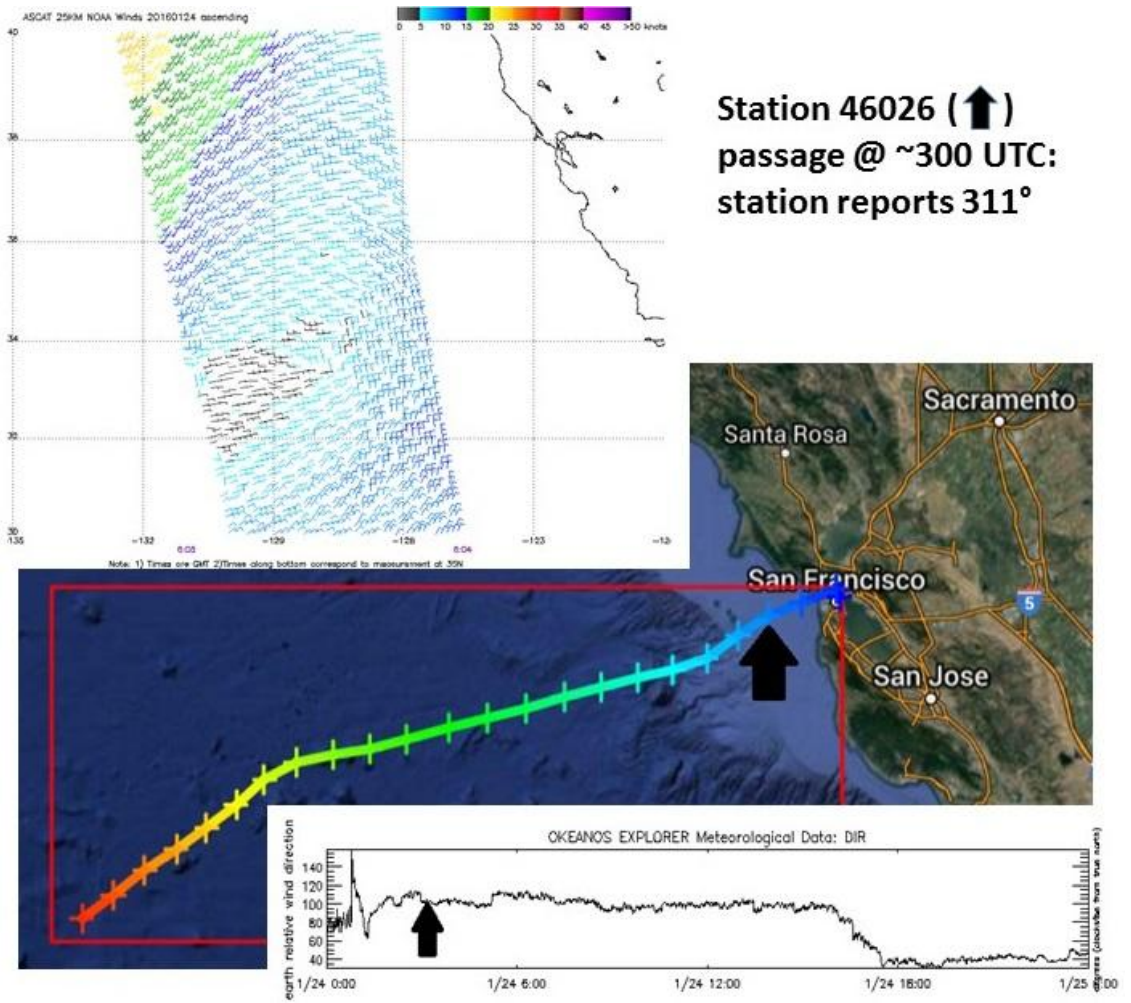


Benefits for Vessel Operators

- Routine data quality evaluation by experienced marine meteorologists
  - At sea notification of data problems
  - Near real-time distribution of science observations
  - Long-term archival of data
- Metadata tracking (and inclusion into all data files)
- Educational opportunities for technicians
  - Showing value of their data collection efforts
- Decision support for vessels wishing to improve their sensor suites and/or instrument exposure

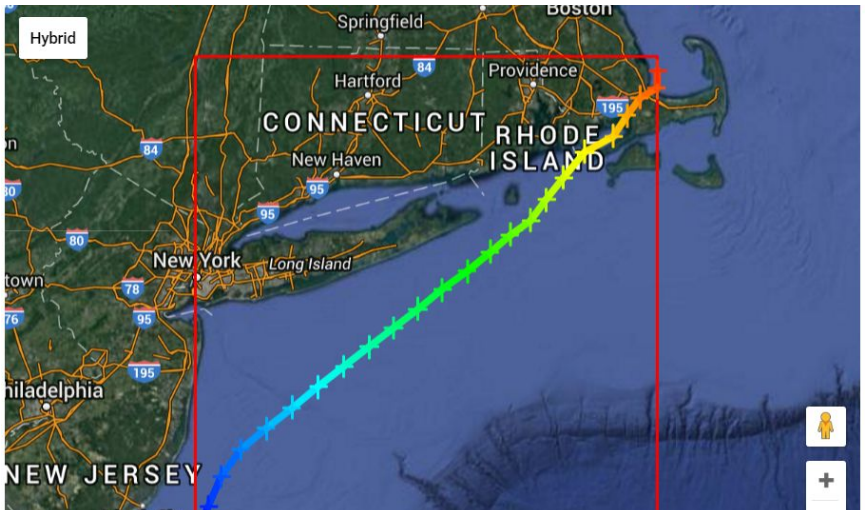
Lessons Learned (1)

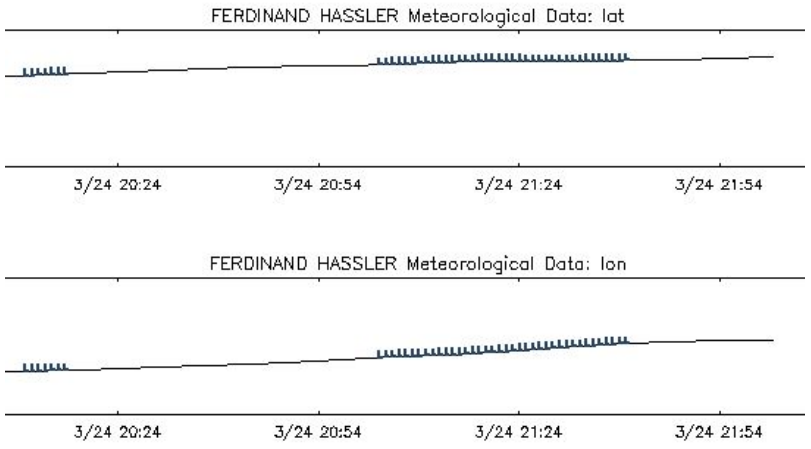
- Shore-side data monitoring works!
  - Disciplinary data centers provide expertise that shipboard technicians may not possess.
- Shipboard technicians benefit from at-sea feedback
- Corrects problems before a whole cruise of useless data is collected



Lessons Learned (2)

- Automated quality control can miss problems in data
  - Landmasks do not contain all canals and smaller waterways
  - Airflow distortion, stack exhaust, electronic noise hard to diagnose
- Duplicate sensors can help, but third data source often needed to verify which sensor is correct
- Visual QC frequently flags 5-10% more data





Lessons Learned (3)

- SAMOS advocates for fluid dynamics modeling of ship structures in design phase
  - Implemented for *Sikuliaq* and RCRVs
  - Allows instrument mast changes early in process
- SAMOS reviews results and makes recommendations for sensor siting

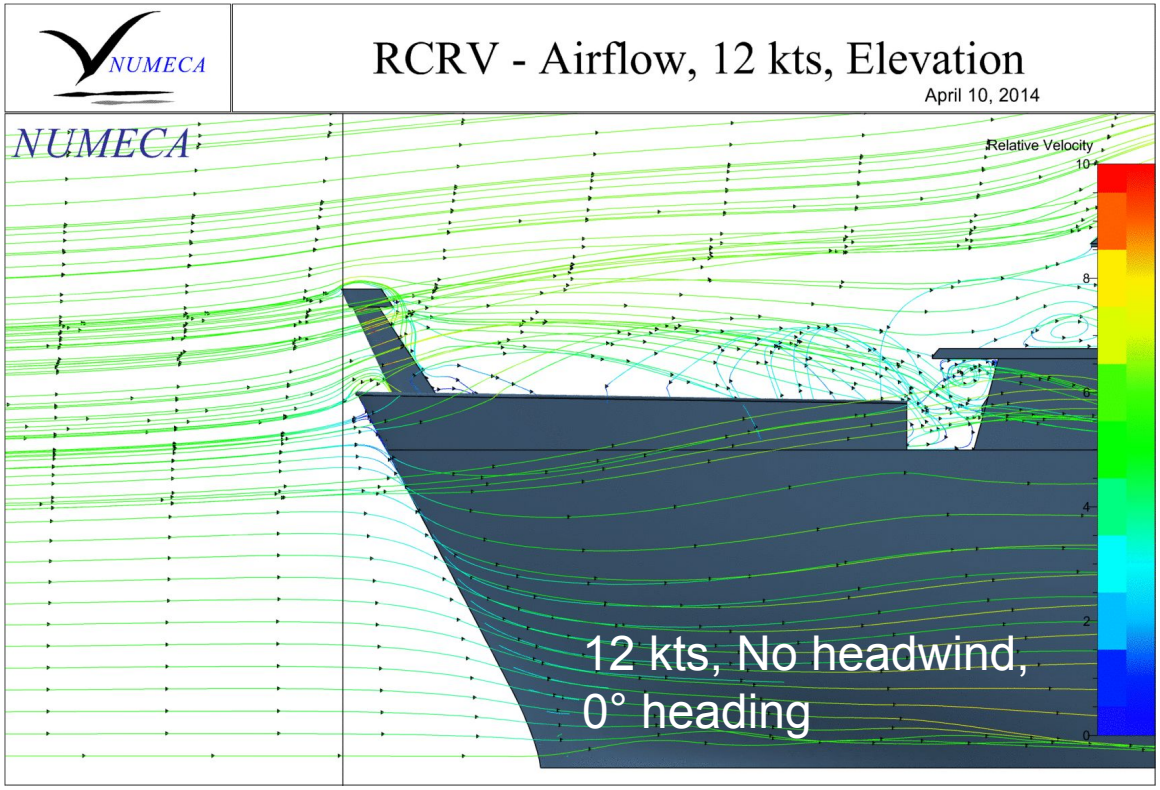
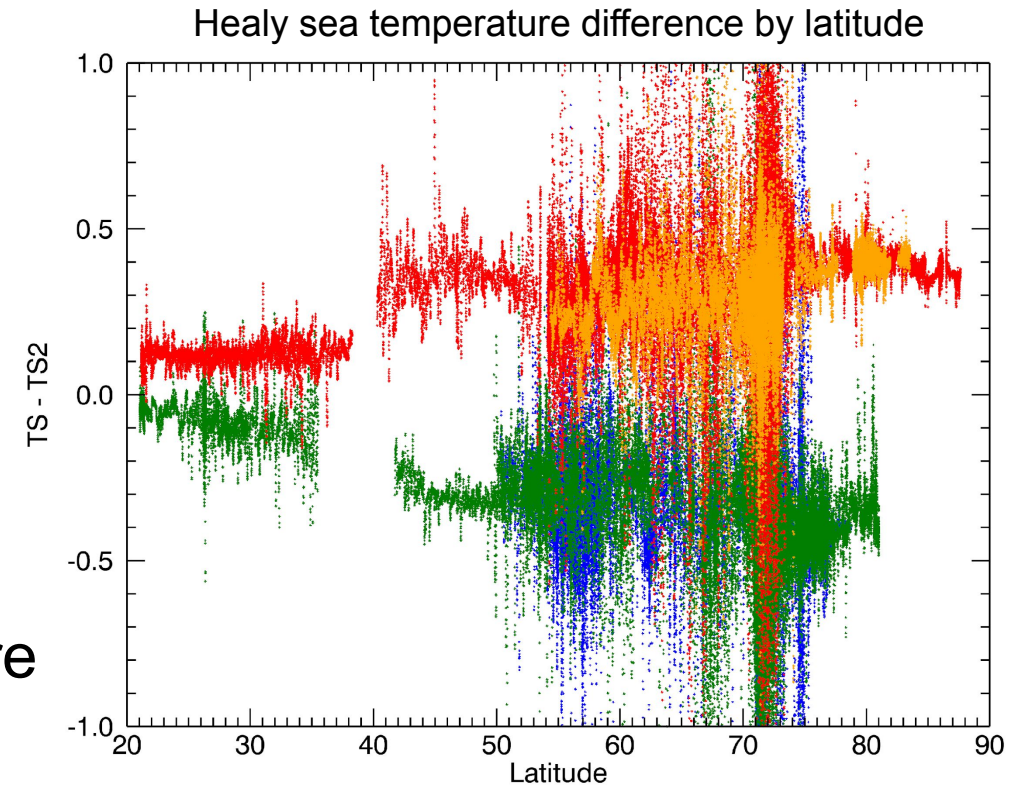


Image courtesy The Glosten Associates

Lessons Learned (4)

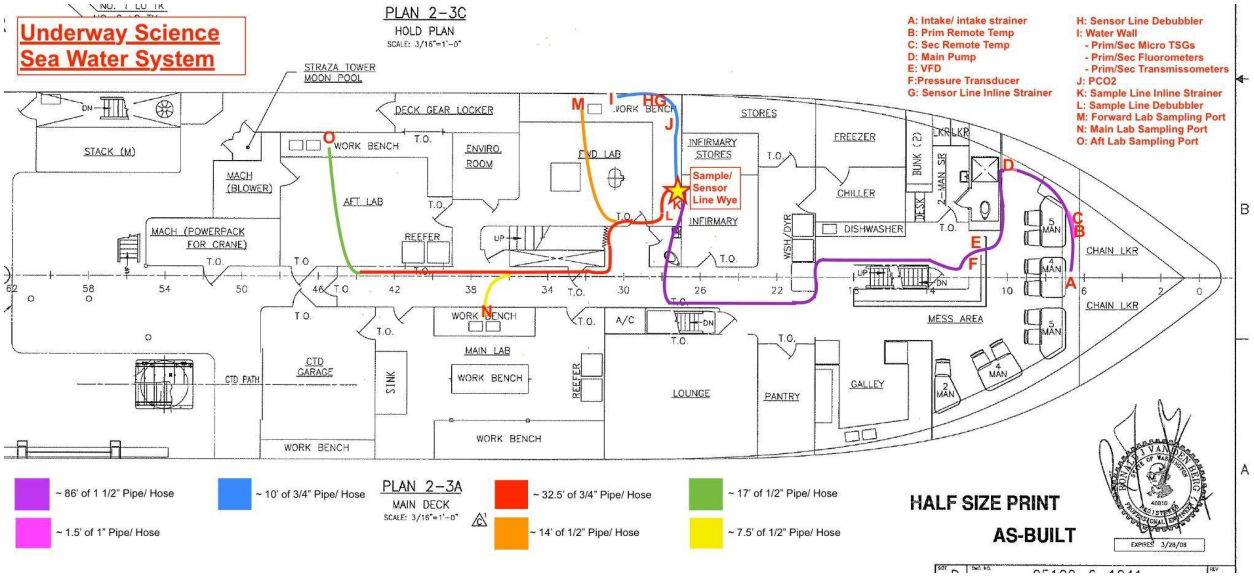
- Never enough metadata!
  - Critical for data reuse (FAIR)
  - Supports visual QC
  - Recommends controlled vocabularies (no free text)
- Never enough focus on metadata collection and preservation
  - Easier to capture as data collected
- Example: Sea temperature
  - Need absolute knowledge of sensor location
  - Distance from water intake affects measurement



2008-2010: Blue, Green
2011-2012: Red, Orange

New Metadata for SAMOS

- New metadata we collect
  - Intake info
    - x, y, z location
    - distance to sensor (pipe run)

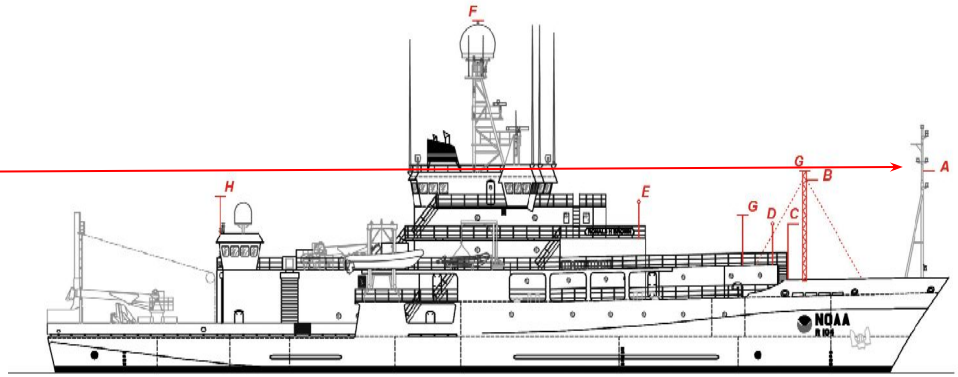


Atlantic Explorer. Image courtesy BIOS.

- Associated parameters
  - links SAMOS SOG, COG, heading, and relative wind variables associated with true wind derivation
  - In future, may use to associate other sensors that result in derived values (e.g., TSG)

Operator Best Practices

- Site meteorological sensors as far forward and as high as possible to avoid influence of ship on measurements
- Avoid sources of RF on vessel, which result in noisy data – particularly from radiation sensors.
- Avoid sources of heat.
- Record sensor locations with respect to known vessel coordinate system.
  - Document system with data
- Ensure proper calculation of true winds to remove ship motion.



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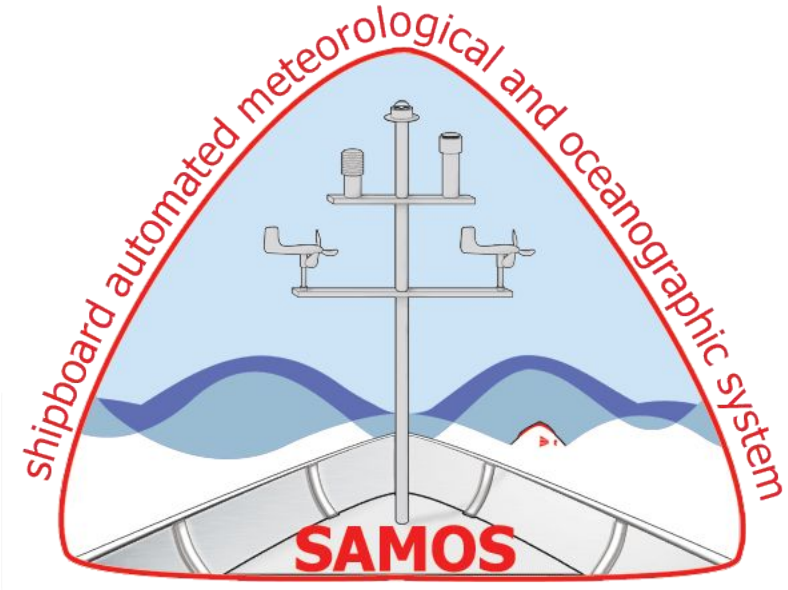

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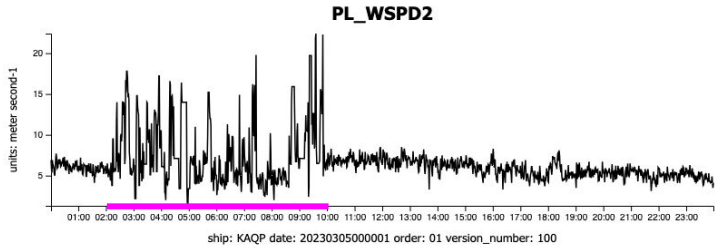
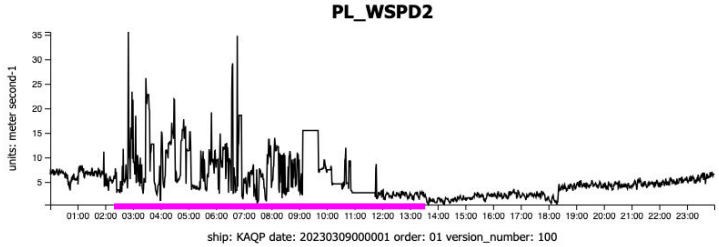
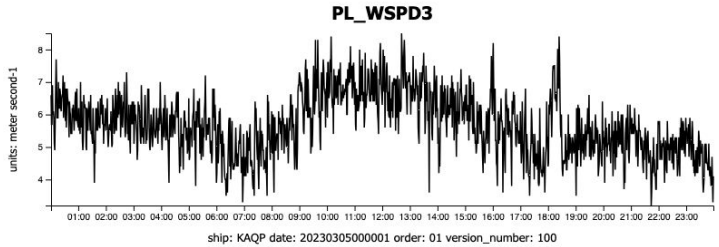
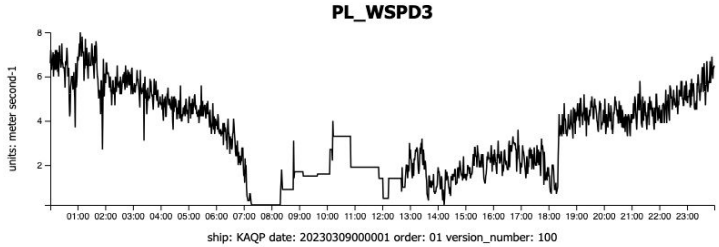
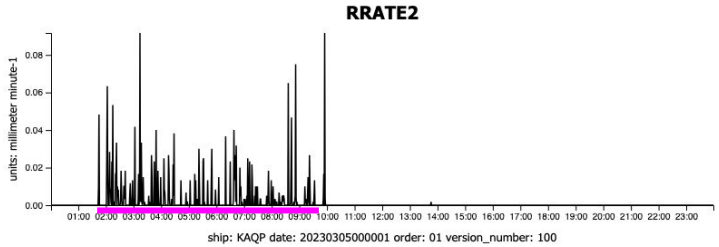
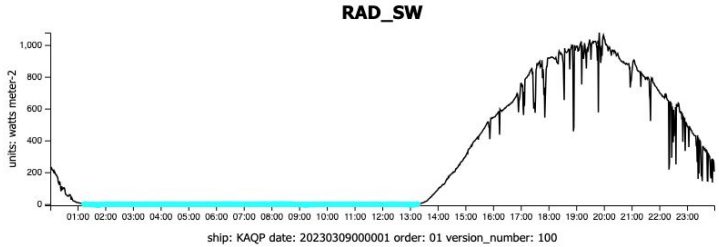


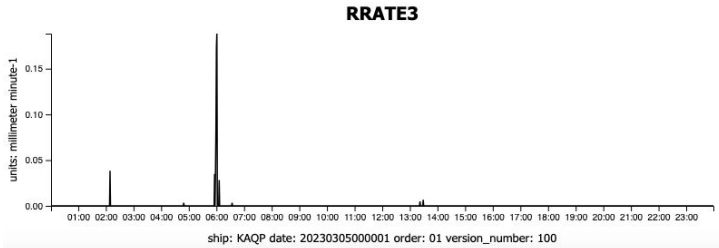


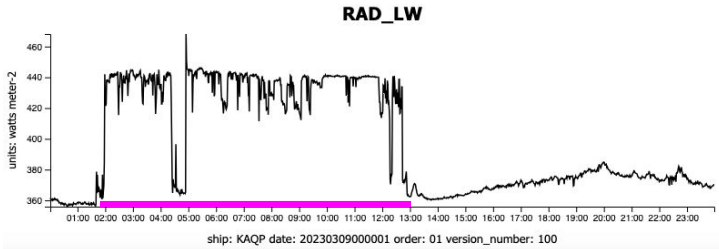












Recent Data Issues

- Bird is the word!

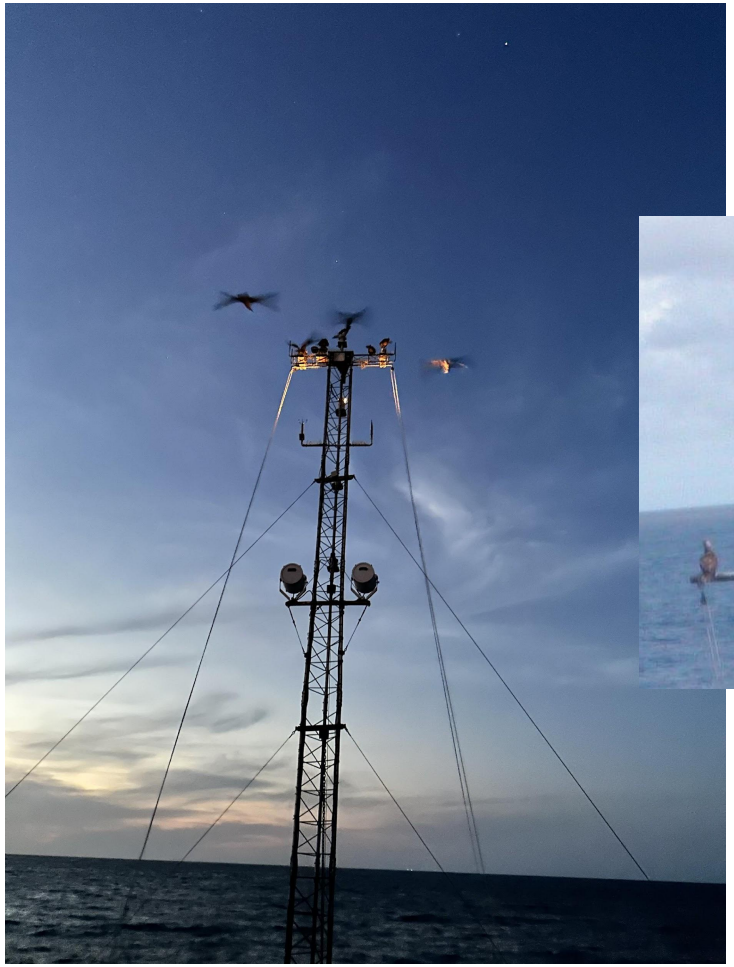
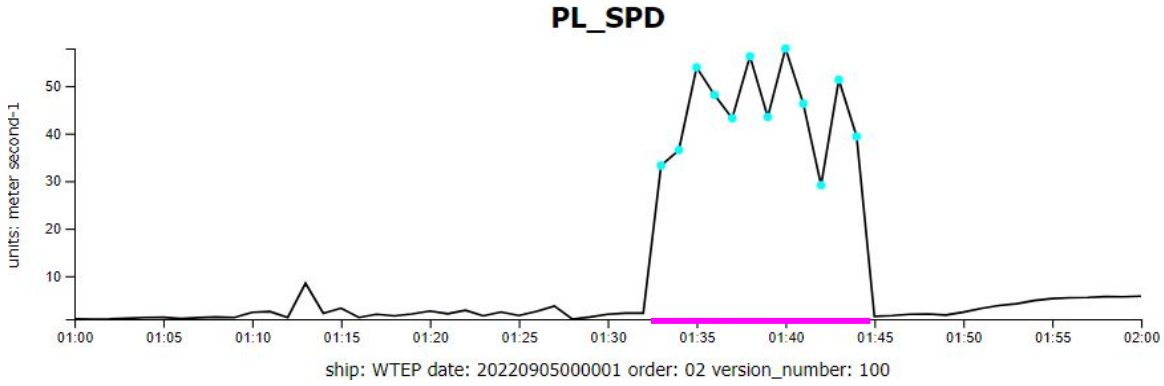


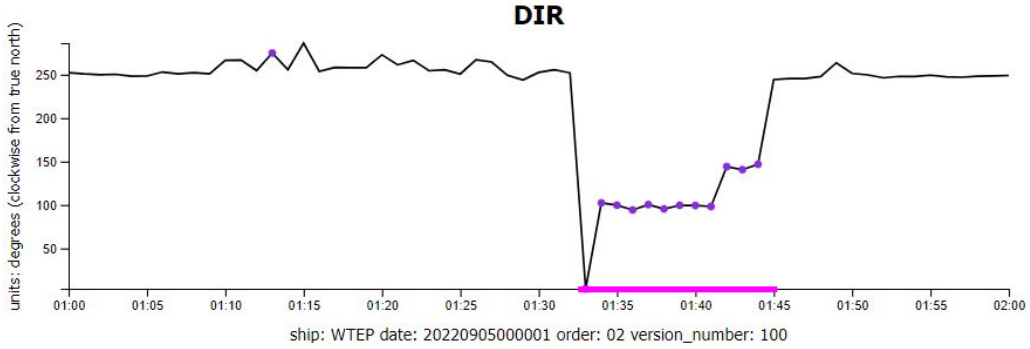
Image courtesy UW

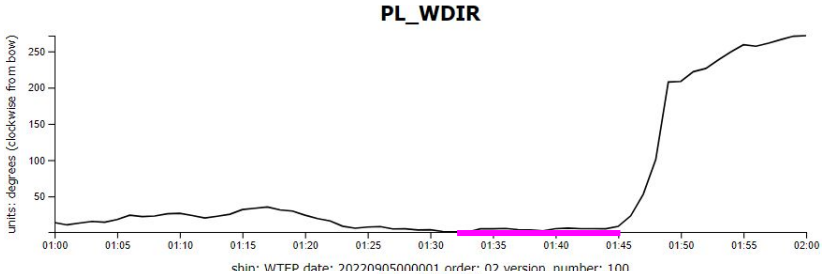
Images courtesy WHOI

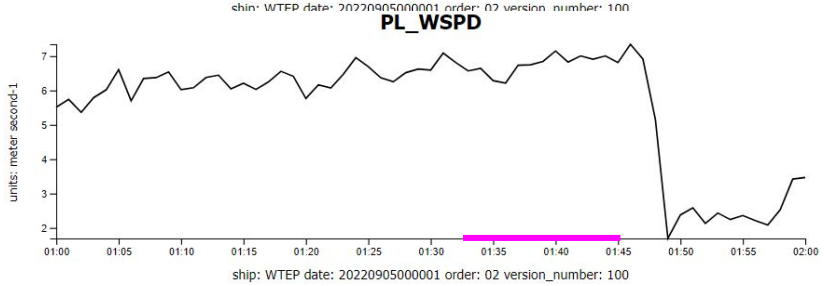
Recent Data Issues

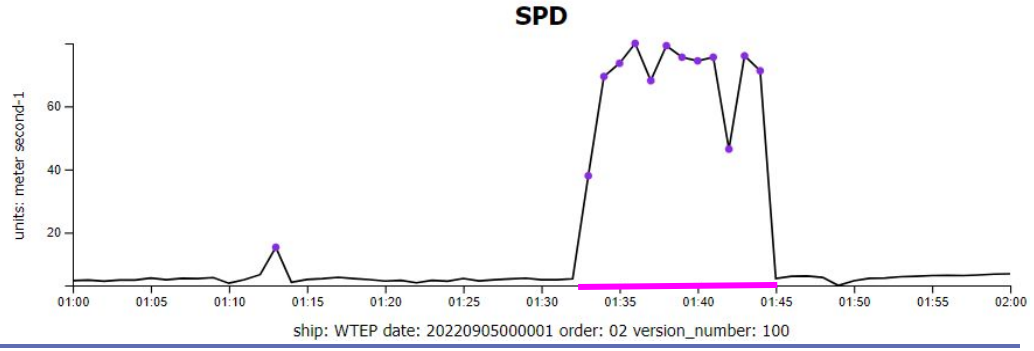
- POSMV “thrashing” events
  - characterized by extreme ship speeds
  - affects true winds
  - Applanix aware; software patch does not entirely resolve occurrences











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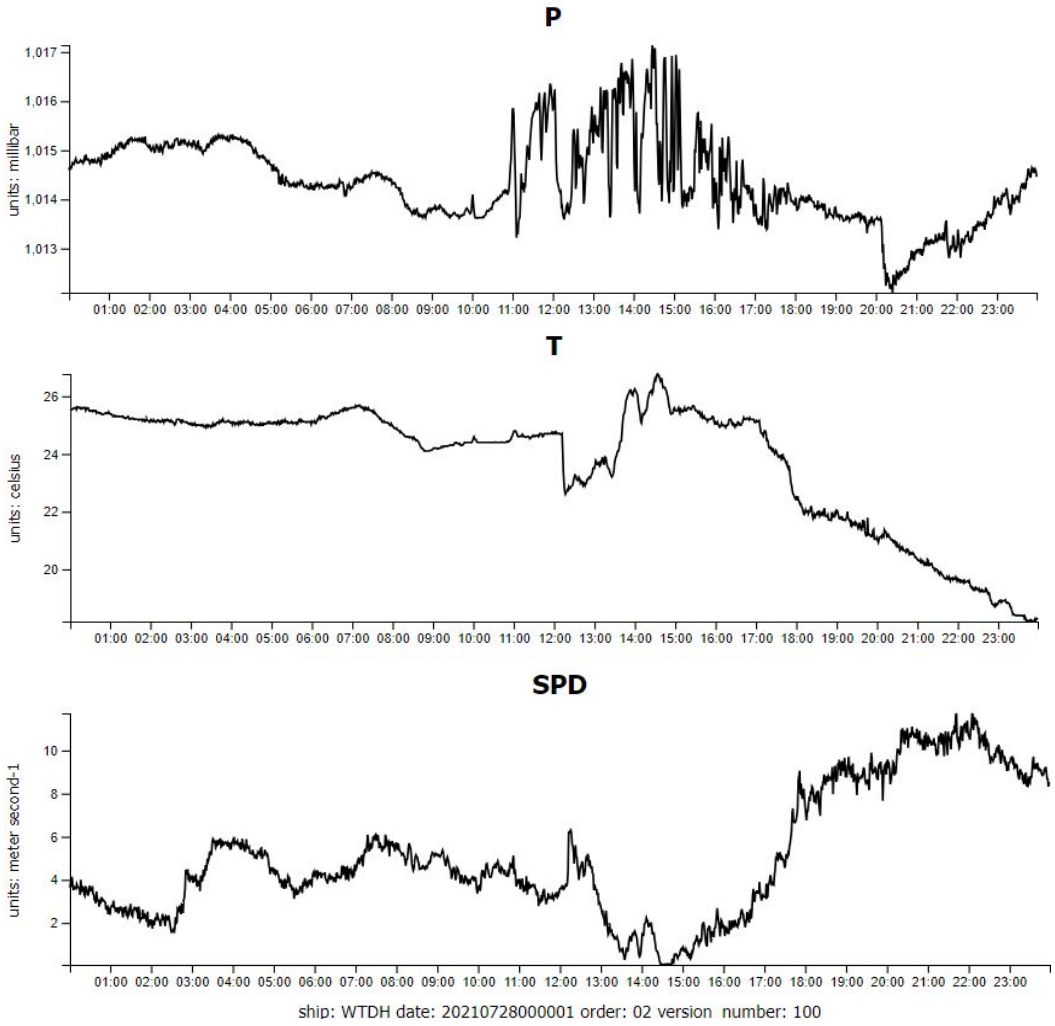
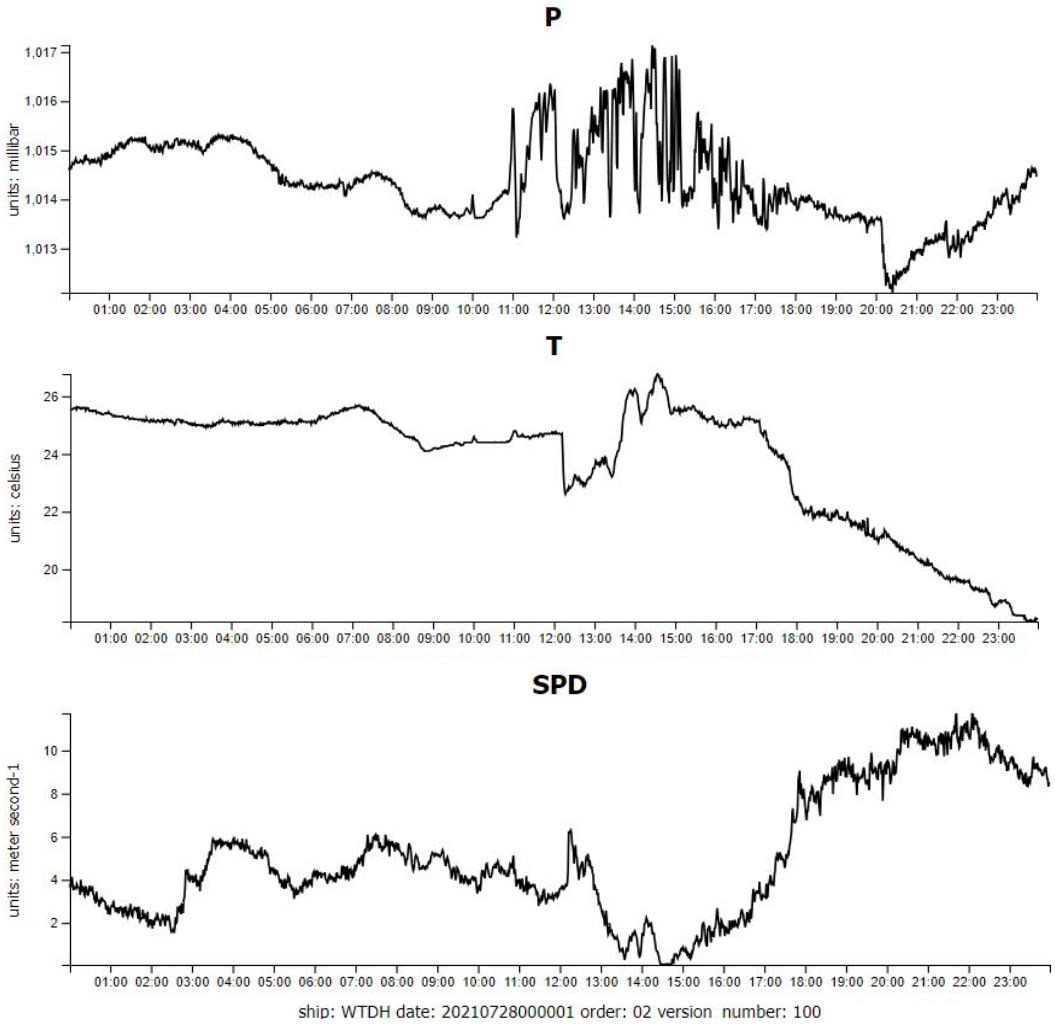


- High-frequency pressure variations, often > 1-2 mb
- No supporting evidence in T/RH or wind speed

Recent Data Issues

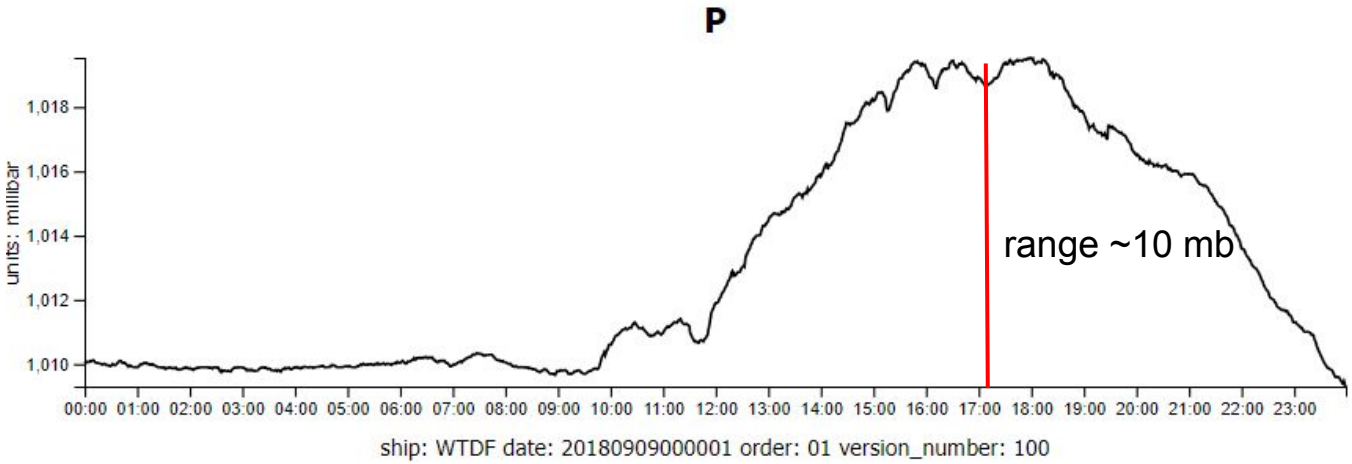


- resolved by replacing pressure tubing
  - sensor installed ~1 meter above pilot house roof
  - degraded, loose, or cracked/kinked tubing makes sensor vulnerable to flow/localized pressure variations

Recent Data Issues

- Pressure data ranging too much diurnally
- Verified against nearby stations
  - 1-2 mb lower at night
  - 5+ mb greater during the daytime

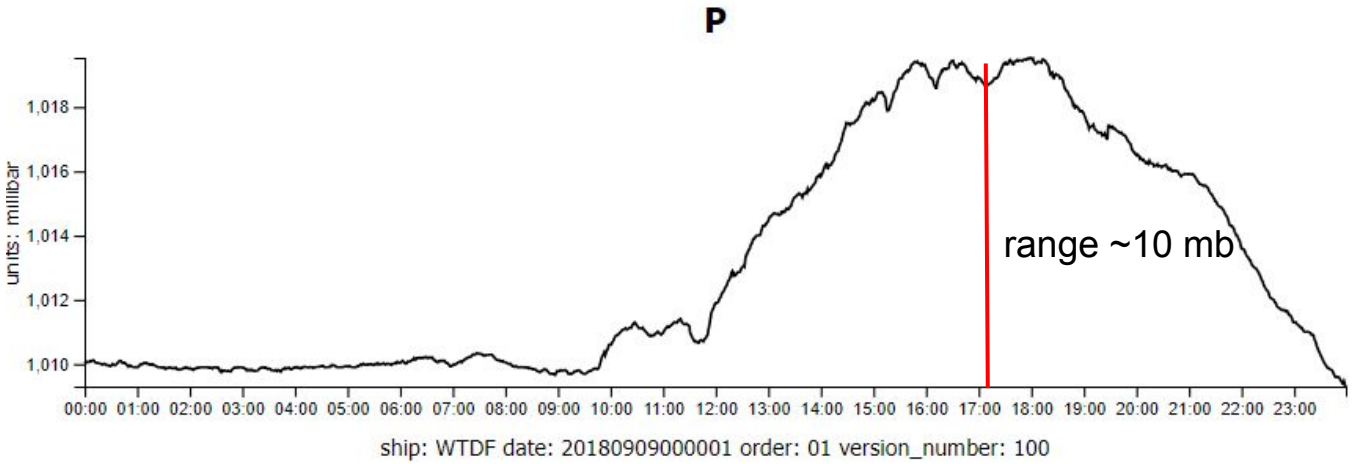
Diamond Shoals and Hatteras Bay buoys showed a range of ~1012-1015 mb over the course of the day



Recent Data Issues

- Moisture identified in the barometer tubing
- Technician used a vacuum cleaner to blow out the tubing
  - Problem solved!

Diamond Shoals and Hatteras Bay buoys showed a range of ~1012-1015 mb over the course of the day



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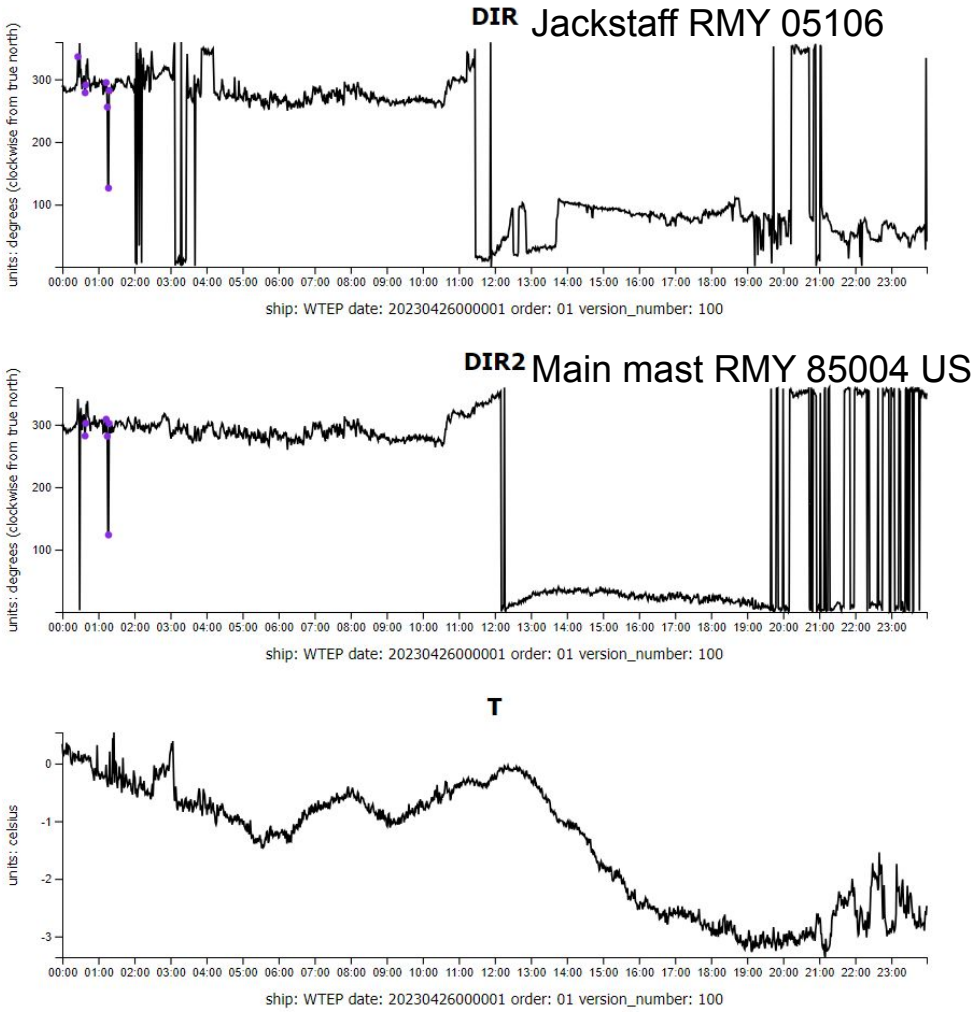
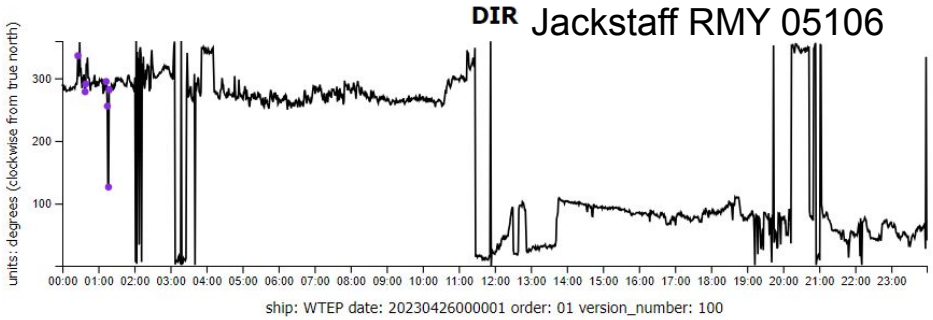
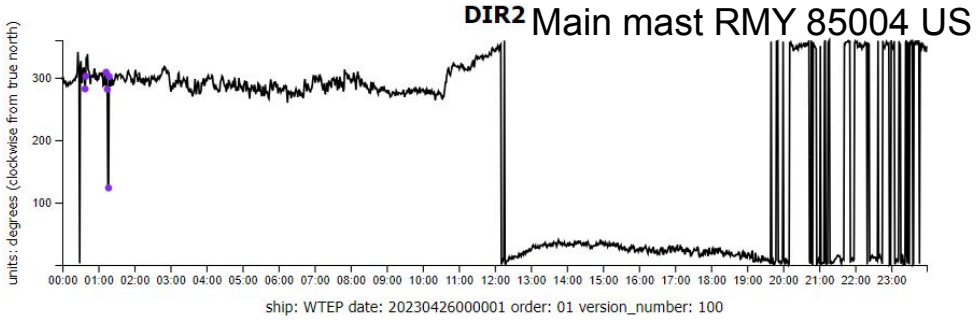
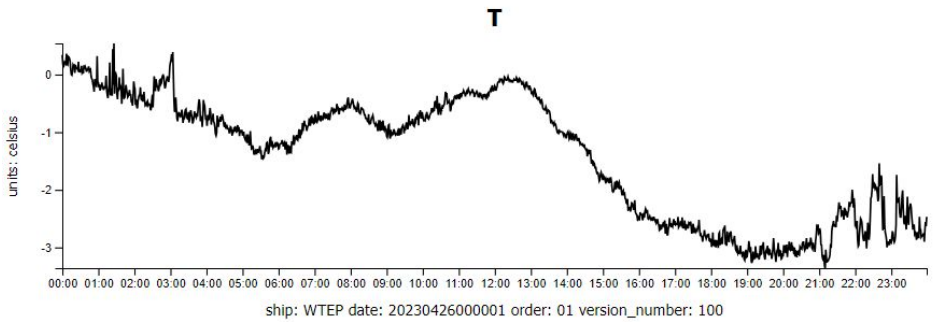


- Bad direction data sometimes from windbird
  - ~60 degrees “off” from ultrasonic sensor
- Most notable when operating in freezing temperatures

Recent Data Issues



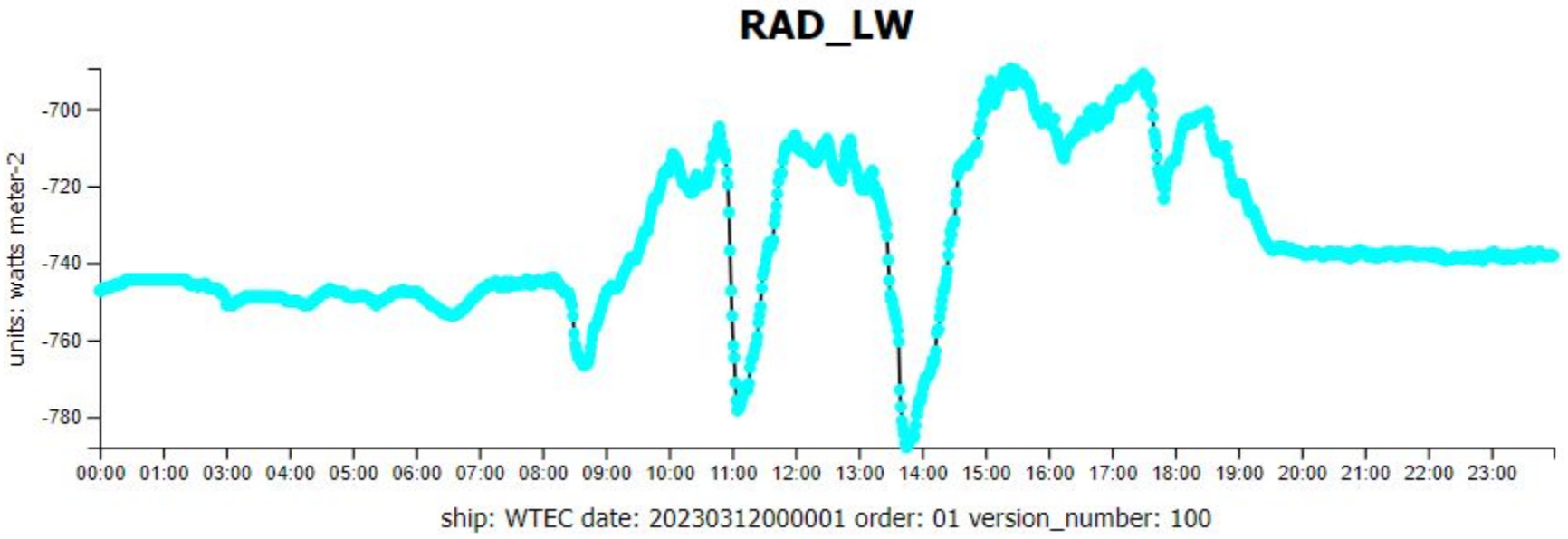




- Water discovered in junction box for jackstaff sensor
- Junction box was cleaned out and windbird issue resolved

Recent Data Issues

- Negative long wave radiation values

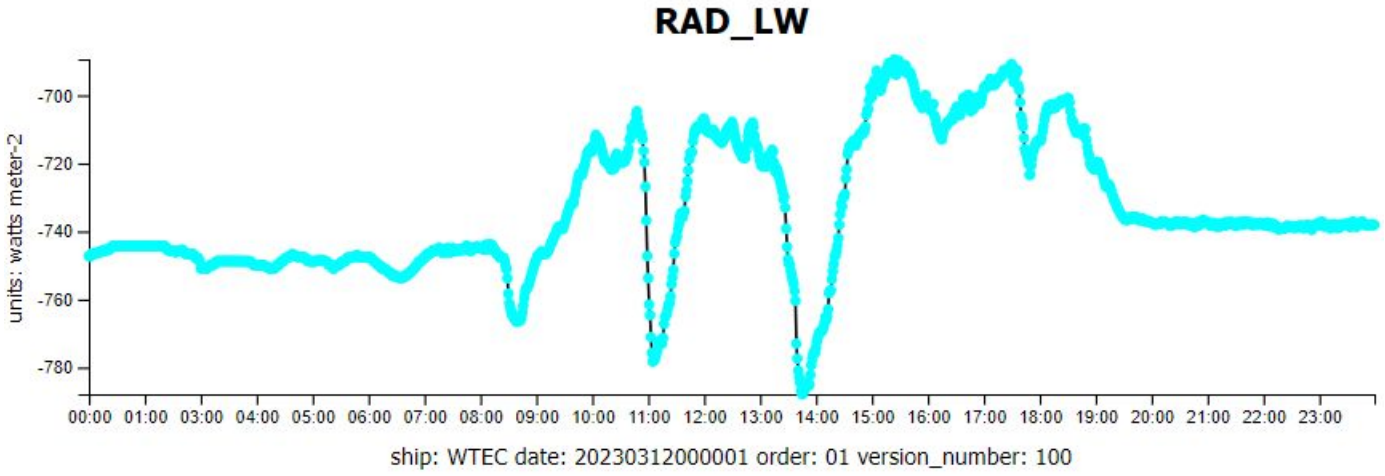


Recent Data Issues

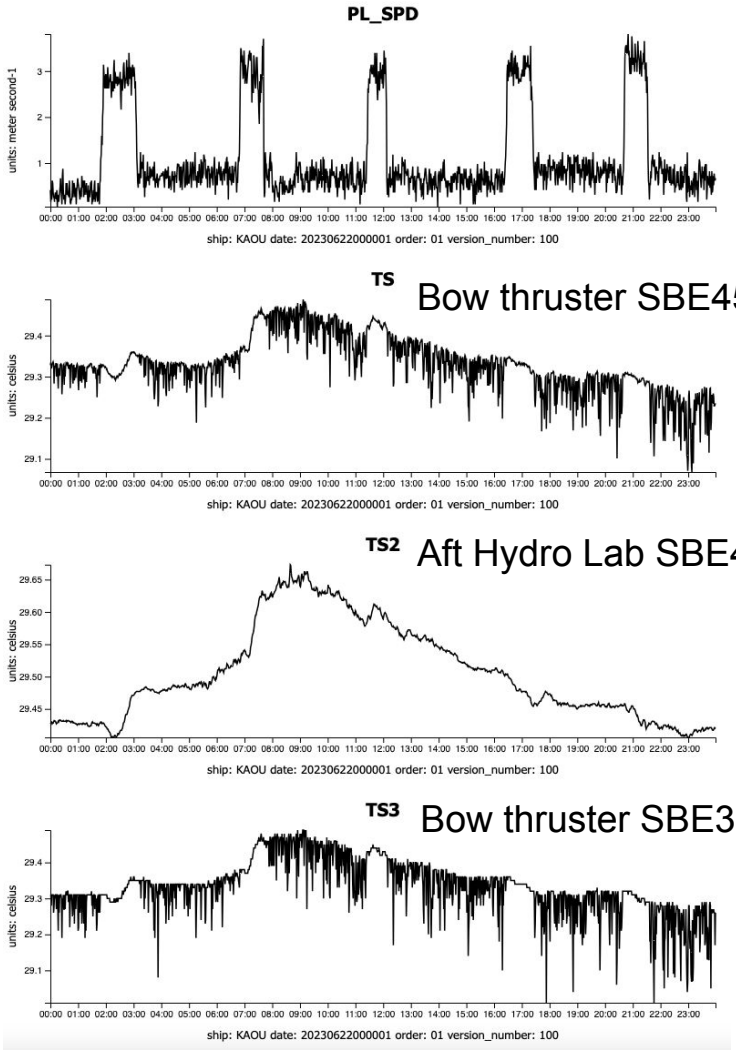
- Examination of data messages revealed a temperature issue:

$WIR35,23/03/17,00:10:30, 176, -13.2,-712.82, 28.04, 67.12, -0.88, 34.0, 11.5

  - PIR case temperature = 28.04 ℃
  - PIR dome temperature = 67.12 ℃
  - dome and case temperatures usually about the same
  - difference pointed to compromised dome temperature thermistor or compromised dome seal

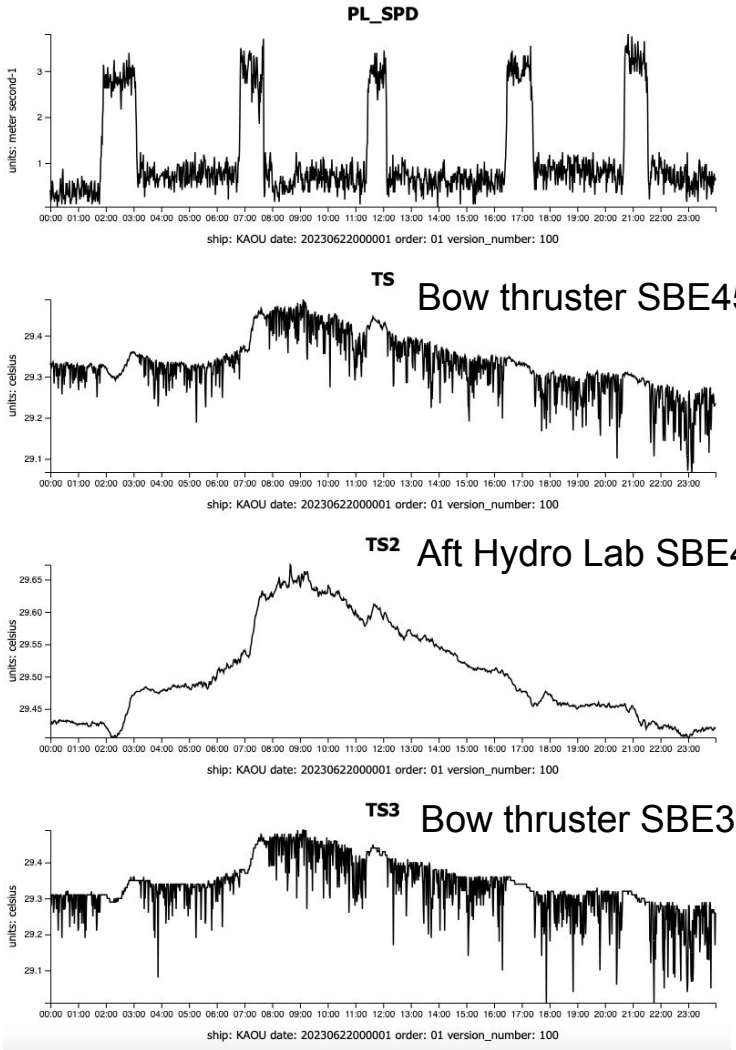


Recent Data Issues



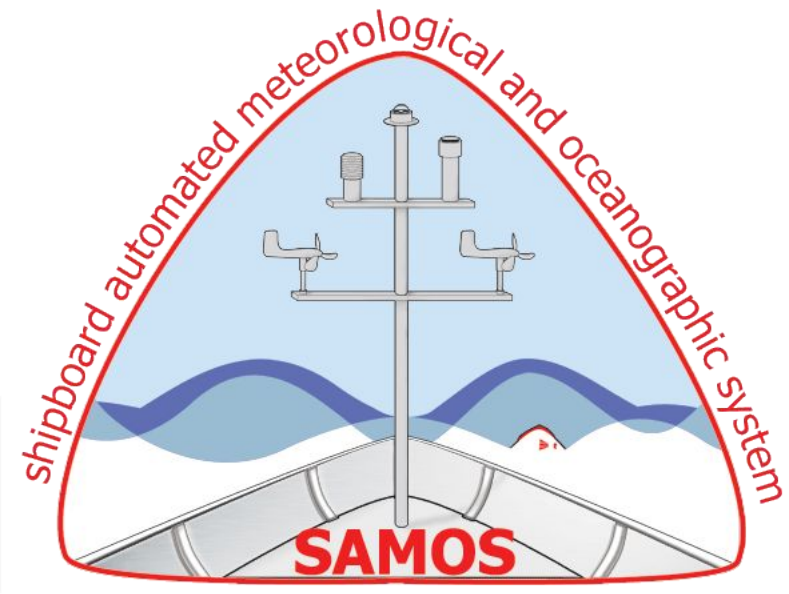
- Spikey flow through data.
- Vessel on/off station for over side work

Recent Data Issues



- Air/bubbles confirmed in bow intake line when bow thruster was offline
- Spikes exist when ship is traveling very slowly and is *traveling against* the dominant swell
- Problem not present when ship is traveling with the swell

Other Questions and Discussion



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