# Shipboard Automated Meteorological and Oceanographic System Initiative


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## Objectives

The shipboard automated meteorological and oceanographic system (SAMOS) initiative aims to improve the quality of meteorological and near-surface oceanographic observations collected in-situ on research vessels (R/Vs) and select voluntary observing ships (VOS). Scientific objectives of SAMOS include:

- 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 data to support modeling activities (e.g., reanalysis) and global climate programs

To achieve the science objectives, the SAMOS initiative seeks to:

- improve access to quality assured SAMOS data for scientific and operational users by providing free and open access to data and metadata
- expand availability of SAMOS observations collected in remote ocean regions (e.g., Southern Ocean)
- improve the accuracy and calibration of SAMOS measurements
- provide standards for data and metadata collected on SAMOS equipped vessels
- ensure routine archival of SAMOS data at world data centers
- develop documentation and training materials for use by data collectors and the user community
- support comparison studies between in-situ platforms (e.g., R/Vs, VOS, buoys)
- develop partnerships within the international marine community

## What is a SAMOS?

SAMOS typically are a continuously recording, computerized data logger connected to sensors that record navigation, meteorological, and near-surface ocean parameters while the vessel is at sea. To achieve the science objectives of the SAMOS initiative, the desired interval between sequential observations is one minute. The SAMOS initiative does not specify the types of sensors used to collect data. Different systems currently exist on research vessels (Figure 1)

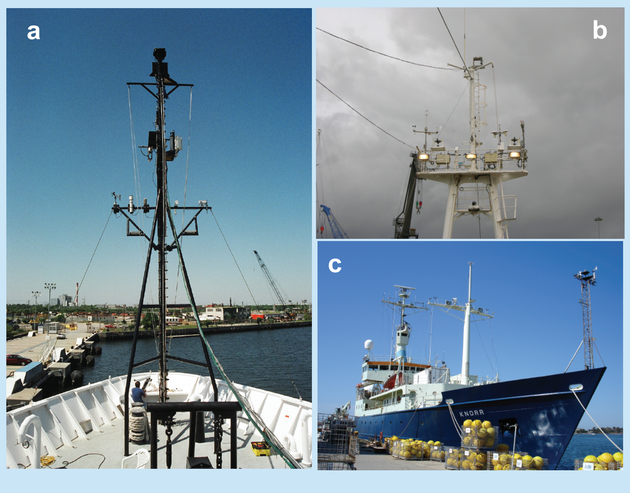


Figure 1: Meteorological instrumentation on the (a) *R/V Ronald Brown,* (b) *RSS Discovery,* and (c) *R/V Knorr*. Photos credits: R. Wanninkhof, B. Moat, and B. Walden.

## SAMOS Data Center History

**The research vessel data assembly center (DAC) at FSU has been evaluating marine meteorological observations since 1993.**

1993: Established as center for marine meteorological data from TOGA/COARE
1994: Began evaluating marine meteorological data from World Ocean Circulation Experiment (WOCE) cruises
2002: Published final (version 3.0) WOCE data set including over 80% of completed cruises
2003: Hosted first High-resolution Marine Meteorology (HRMM) workshop in Tallahassee
- Established objectives for SAMOS initiative

2004: NOAA COD hosted Second HRMM Workshop
- Adopted SAMOS acronym
- Developed implementation plan

2004: SAMOS DAC established at FSU
- Developed data and metadata standards
- Established ship profile database

2005: Pilot data project resulted in daily transfers from two WHOI vessels (Figure 2a)
2007: Recruited additional vessels from NOAA and NSF (Figure 2c)

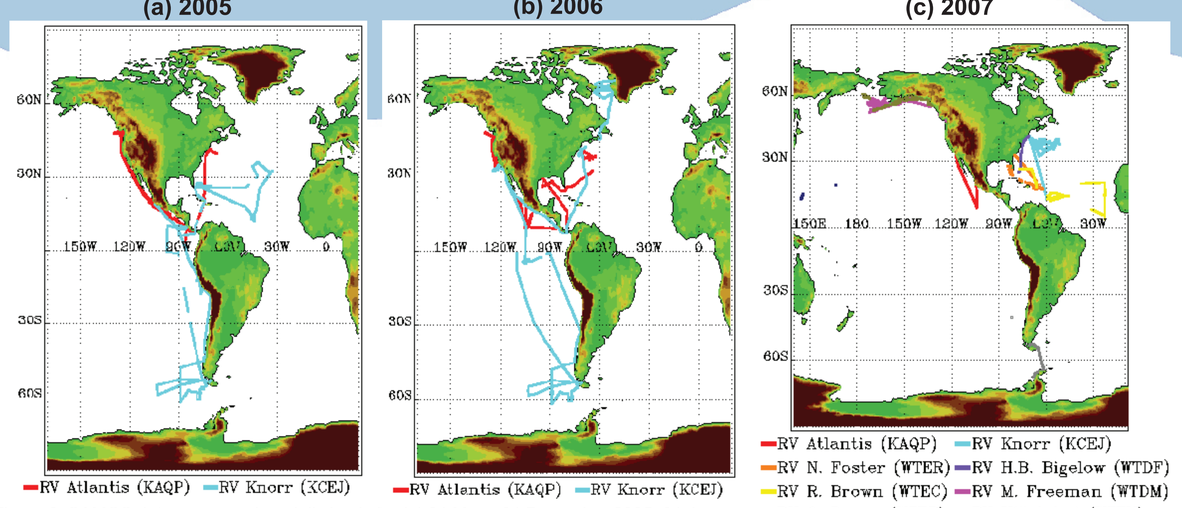


Figure 2: SAMOS data processed on daily basis for (a) 01 May - 31 December 2005, 01 January - 31 December 2006, and (c) 01 January - 21 May 2007. Ship tracks color coded by vessel.

## Data Distribution

All data (with DQE flags) can be accessed through the SAMOS web page:

**http://samos.coaps.fsu.edu/**

Also available:

- Vessel and instrument metadata
- Vessel photos and schematics
- Data searches and selection based on data quality
- Data quality graphics (Fig. 3) for user selected ship and time period

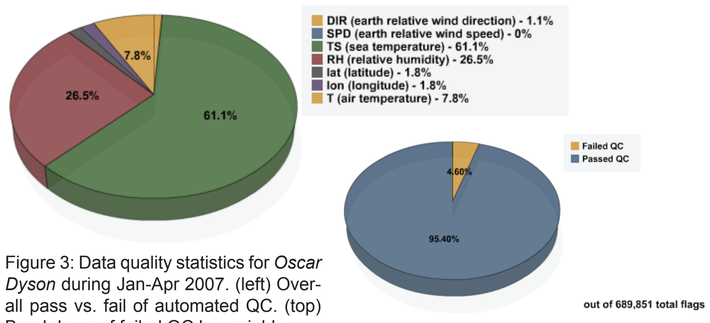


Figure 3: Data quality statistics for *Oscar Dyson* during Jan-Apr 2007. (left) Overall pass vs. fail of automated QC. (top) Breakdown of failed QC by variable.

## Data Acquisition

The SAMOS DAC continually recruits new vessels to participate in the initiative. Since 2005 the DAC has been receiving and processing daily data messages.

### *Ships*

As of February 2008, 12 ships are operationally contributing to the SAMOS initiative.

**WHOI:** *Knorr, Atlantis*
**NOAA:** *Henry Bigelow, Hi'lalakai, Ka'Imimoana, Miller Freeman, Oscar Dyson, Ronald Brown, Nancy Foster, Gordon Gunter*
**Raytheon Polar Services (RPS):** *Lawrence M. Gould*
**United States Coast Guard (USCG):** *Healy*

Future vessels (pending positive recruitment efforts):
**UNOLS:** 16 global, intermediate, & regional vessels
**RPS:** *Nathaniel Palmer*
**NOAA:** 10 additional research & fisheries vessels
**International:** 4 French (via GOSUD), 2 Australian (via IMOS), and 2 Brazilian research vessels

### *Data Volume:*

Typical vessel reports 20 parameters in each 1-min report (navigation, meteorology, and thermosalinograph)

- Approximately 800,000 observations per vessel per month
- Reporting varies due to number of sea days for each vessel. Gap in Oct/Nov 2005 due to lay-up of both WHOI vessels (Figure 4).

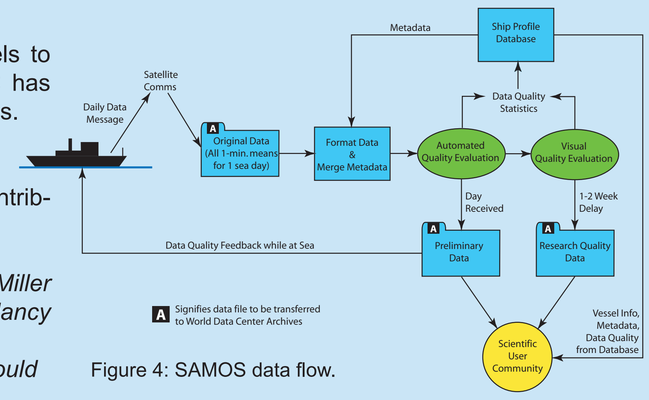


Figure 4: SAMOS data flow.

### *SAMOS Data Flow*

- Protocol includes daily transmission of SAMOS data from a vessel at sea to the DAC (Fig. 4).
  - •File transmission via email attachments
  - •Files contain all 1-min. averages sampled during one day at sea
  - •Using SAMOS data exchange format
  - •Daily transfers occur just past 0000 UTC
- Email generation and transmission scripts developed by each vessel operator
- Data arriving at DAC undergo common formatting, metadata augmentation, and both automated and visual data quality evaluation (DQE)
- Visual inspection upon arrival allows at sea notification (email) to quickly resolve problems
- Initial archival to be implemented with NODC and NCAR in 2008

## Data Quality

Both automated and visual DQE (Fig. 6) are conducted for all observations received by the DAC.

- Quality statistics (Fig. 3) are stored in ship database and are accessible via the SAMOS web page.
- Two-way email communication with shipboard technicians provides both feedback on data quality and notification of instrument problems (Fig. 5).
- Dialog with ship operators and technicians improves data quality.
  - • Visual inspection of T, RH, and P from the *Ha'lalakai* detected steps in time series associated with changes in ship-relative winds (Fig. 6)
  - • Photographic metadata (Fig. 7) revealed T, RH, and P sensors to be poorly sited (behind mast, aft of exhaust stacks)
  - • SAMOS DAC recommended moving sensors (to A, B, or C in Fig 7)
  - • NOAA designing new mast at B, will move sensors in 2008.

Figure 5: Frozen anemometer on the *Oscar Dyson*. Photo provided by onboard technician.

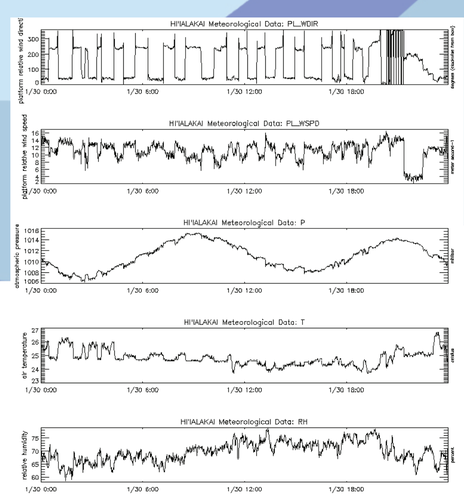


Figure 6: Ship-relative wind direction and speed, pressure (P), air temperature (T), and humidity (RH) from the *Ha'lalakai* on 30 January 2008. Note: the changes in ship-relative winds are due to variations in course, heading, and/or speed of the vessel (and should not be detected in T, RH, or P).


Figure 7: Side photo of NOAA vessel *Ha'lalakai* with sensor locations noted. A, B, and C marks are possible locations for air temperature, humidity, and pressure sensors recommended by SAMOS DAC.

## Partnerships

Partnerships are essential to the success of the SAMOS initiative. The initiative thanks those who have already contributed and continues to seek new expertise and resources.

- **User Community:** Provides scientific input to establish sampling methods and accuracy targets. SAMOS will continue to engage a wide user community to develop products for both research and operations.
- **Ship Operators:** NOAA OMAO, RPS, the USCG and WHOI have gone to great lengths to develop and maintain shipboard software to transmit SAMOS formatted data.
- **JCOMM SOT:** Opened a dialog in 2007 to improve connectivity between SAMOS and VOS/Automated VOS programs.
- **GOSUD:** A pilot data exchange with the Global Ocean Surface Underway Data (GOSUD) project is underway. The SAMOS DAC will provide DQE of meteorological data collected by GOSUD (starting with French R/Vs) while the GOSUD data center (at Coriolis) will evaluate the near-surface ocean data collected by SAMOS.
- **WCRP WGSF:** Led development of ***A guide to making climate quality meteorological and flux measurements at sea***. First distributed at INMARTECH 2006 at WHOI.
- **NOAA ESRL:** Ongoing collaboration with C. Fairall (and others) to improve data quality and accuracy via a portable seagoing air-sea flux standard, through training documents, and a proposed program of computational fluid dynamics modeling of airflow around R/Vs.


### *Acknowledgements*

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