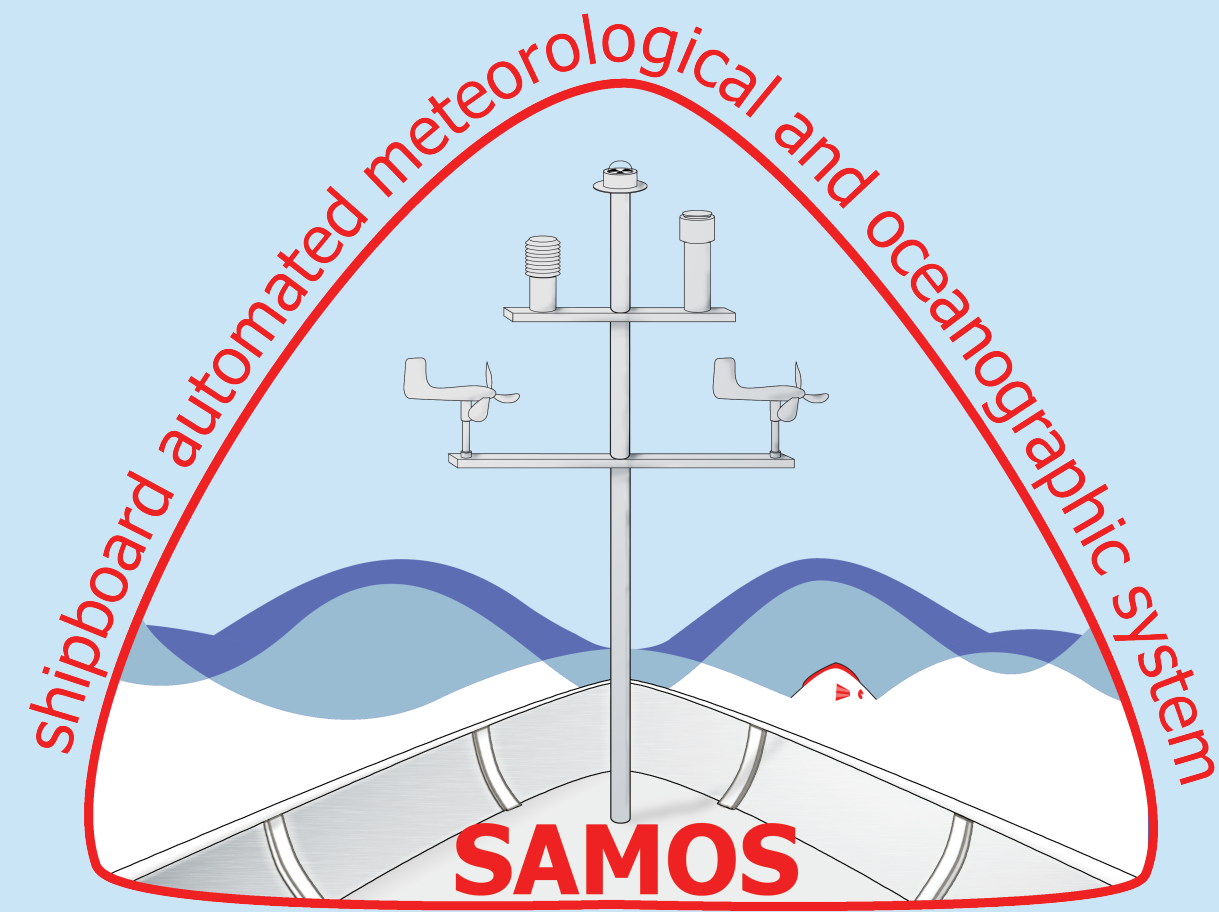


Shipboard Automated Meteorological and Oceanographic System Initiative

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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 volunteer 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 observations to support modeling activities (e.g., reanalysis) and global climate programs

To achieve the science objective, 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 have been deployed on research vessels (Fig. 1a) for several decades and are now being deployed on VOS (Fig. 1b). The typical SAMOS is 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. Parameters of interest are listed in Table 1.

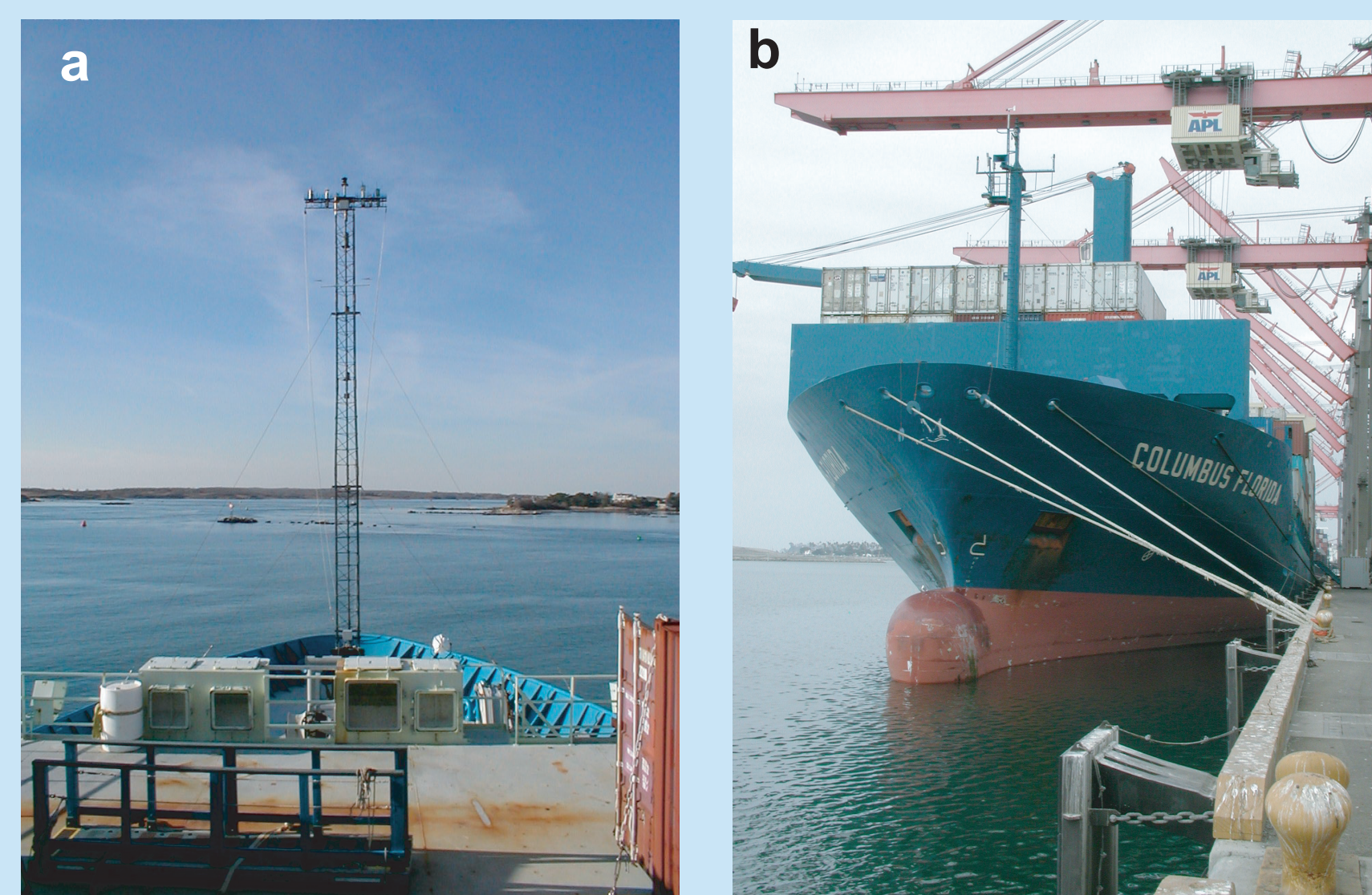


Figure 1: Bow masts with meteorological instrumentation on (a) R/V Atlantis and (b) VOS Columbus Florida. Photos from Woods Hole Oceanographic Institution (WHOI).

Data Stewardship

Data stewardship activities are essential to improve access to and integrity of high-quality SAMOS measurements. During 2005, the data assembly center (DAC) at the Florida State University (FSU) has

- ◆ set standards for parameters to be routinely observed (Table 1), essential metadata, and uniform averaging methods
- ◆ established a protocol for data transport (ship-to-DAC-to-users)
- ◆ began scientific data quality evaluation (for the R/Vs Knorr and Atlantis; Fig. 2)
- ◆ established a free and open distribution system for SAMOS data from participating vessels
- ◆ opened a dialog with world data centers to preserve the integrity of the SAMOS observations through routine archival

Overall, SAMOS data stewardship activities are consistent with the GCOS climate monitoring principles. [Available at www.wmo.ch/web/gcos/Second_Adequacy_Report.pdf]

Primary data	Secondary data (desired if available)
• Observation time (UTC)	• Ship speed over water ³
• Latitude	• Vessel pitch, roll, and heave
• Longitude	• Photosynthetically Active Radiation (PAR)
• Ship course over ground	• Ultraviolet radiation
• Ship speed over ground	• Total Radiation
• Ship heading	• Visibility ⁴
• Ship-relative wind direction ¹	• Ceiling ⁴
• Ship-relative wind speed ¹	• Salinity
• Earth-relative (true) wind direction	• Conductivity
• Earth-relative (true) wind speed	• Radiometric Sea Surface Temperature
• Atmospheric pressure	• Swell & wind wave heights and directions ⁴
• Air temperature	• Weather, cloud cover, and cloud height ⁴
• Atmospheric moisture ²	
• Precipitation	
• Shortwave radiation	
• Longwave radiation	
• Sea temperature	

¹As measured by anemometer
²One or more measurements of wet-bulb temperature, dewpoint temperature, relative humidity, and/or specific humidity
³Fore-aft and along beam components
⁴If available from automated sensors

SAMOS Data Flow

- ◆ Protocol includes daily transmission of SAMOS observations from a vessel at sea to the DAC (Fig. 3).
 - File transmission via email attachments
 - Files contain all 1-min. averages sampled during one day at sea
 - Using SAMOS version 1 data exchange format
 - Daily transmission to 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 data quality evaluation (DQE)
- ◆ Preliminary data processing fully operational, research quality processing to start in summer 2006.
- ◆ Recruiting additional R/Vs is underway, but remains a challenge under current vessel operating budgets.

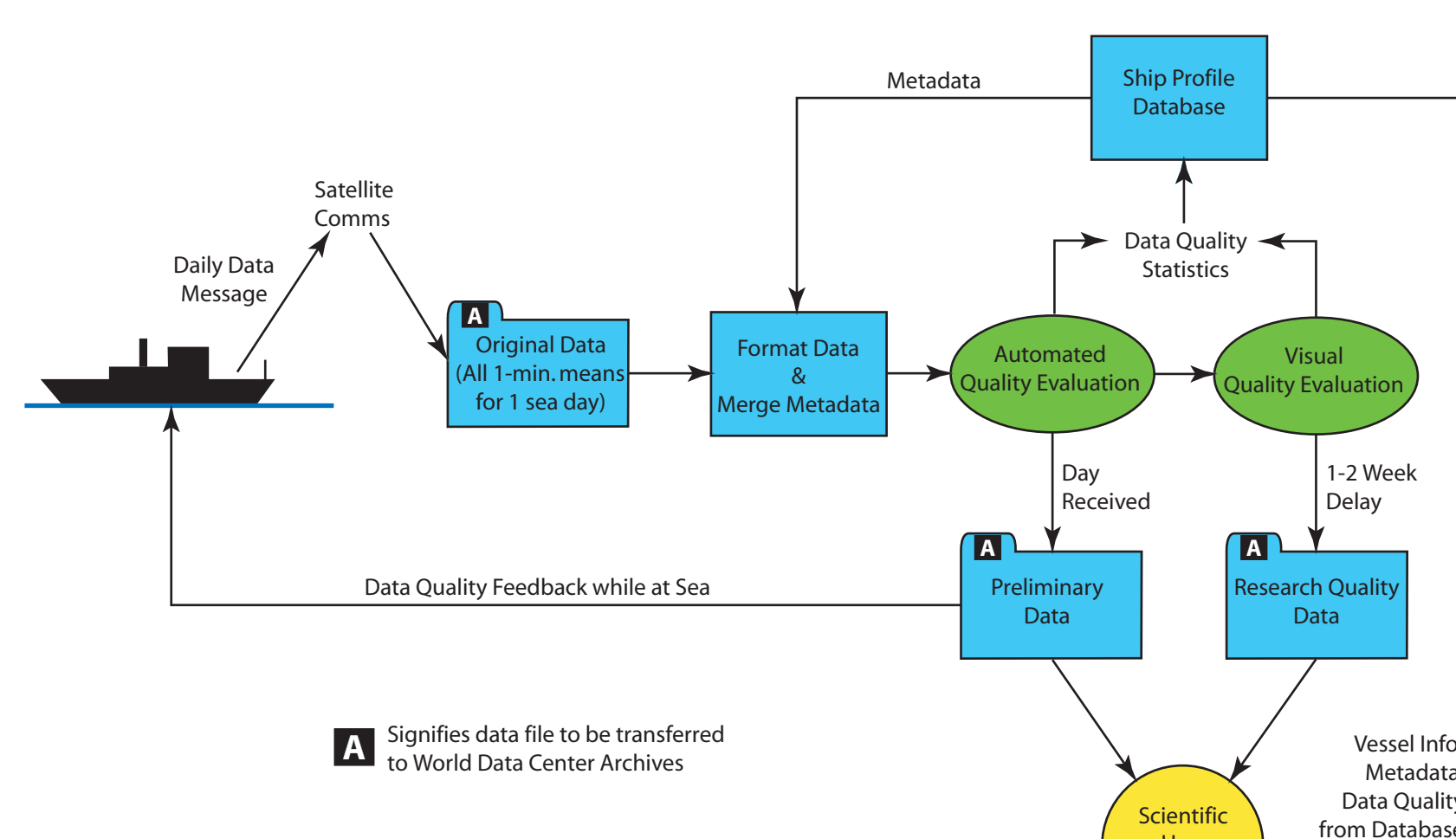


Figure 3: Schematic showing SAMOS data flow as planned for the 2005 pilot project.

SAMOS data received daily 2005 - 2006

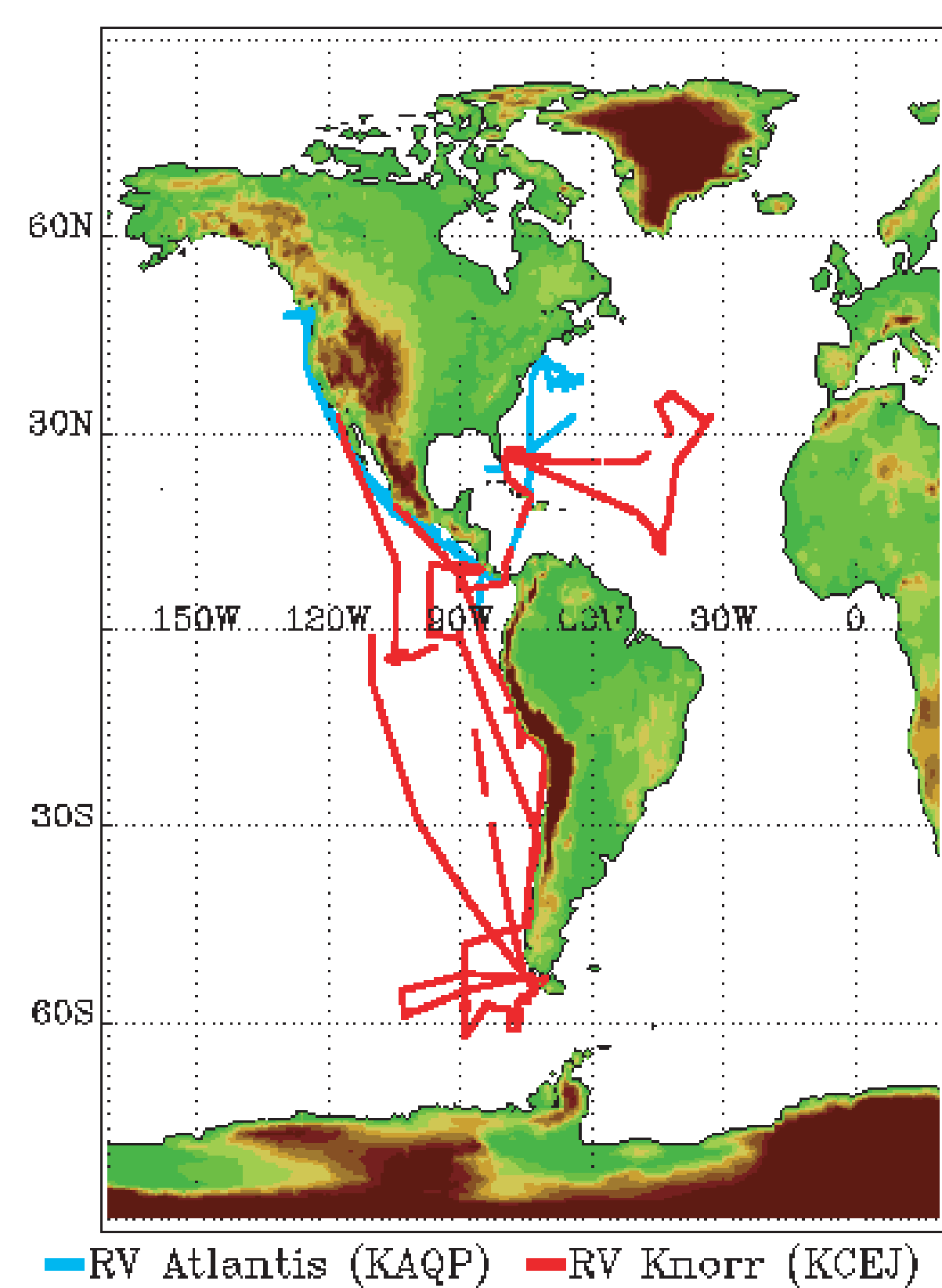


Figure 2: SAMOS data processed on daily basis from May 2005 through 8 May 2006 (a total of 596,663 independent one-minute data reports).

Data Access

All preliminary data (with DQE flags) along with metadata for each participating vessel can be accessed through the SAMOS web page: <http://samos.coaps.fsu.edu/>.

Improving Data Accuracy

The SAMOS initiative seeks to improve the accuracy of marine meteorological and near-surface ocean parameters by

- ◆ developing new data accuracy standards for the parameters listed in Table 1 (setting targets for instrument developers)
- ◆ deploying a roving standard instrument system for shipboard evaluation of R/V SAMOS installations
- ◆ conducting air flow modeling of vessels
- ◆ providing guidelines for sensor calibration and deployment
- ◆ promoting routine comparison studies between SAMOS equipped ships, buoys, and flux reference stations (Fig. 4a)



Roving Flux Standard and Shipboard SAMOS Evaluation

NOAA's Earth Systems Research Laboratory, Physical Sciences Division (PSD), and WHOI have been collaborating on a project to evaluate and improve SAMOS observations from R/Vs in the U.S. fleet. Initial funding to develop and build a roving standard and deploy it on cruises of opportunity has been secured.

- ◆ PSD has begun construction of roving standard flux instruments and WHOI will begin basic development in Fall 2006.
- ◆ PSD made two cruises (2003:R/V Roger Revelle [SIO]; 2004:R/V Ronald H. Brown [NOAA]) associated with WHOI deployments to the Stratocumulus flux reference buoy (20° S, 85° W). The existing PSD flux system (high quality data but not intended as a standard) was used (Fig. 4b).
- ◆ The 2003 Revelle cruise was a test case for the concept and a number of instrument issues were found. Due to short notice for the exercise and shipping delays in freshly calibrated ship sensors, the principal lesson learned was that planning needs to start months in advance for meaningful onboard comparisons.
- ◆ In 2004, comparison on the Ronald H. Brown looked very good, except for anemometer placement.



Figure 4: (a) R/V Roger Revelle and WHOI flux reference buoy. (b) PSD direct flux sensors. Photo credit: Chris Fairall.

ESRL plans call for 2 comparison cruises per year, scheduled in piggy-back mode on regular science cruises. Comparisons to begin in mid-2007.

Training Activities

Discussions at the first two SAMOS (formerly High Resolution Marine Meteorology) workshops revealed a need for additional training materials that would target marine technicians and users of SAMOS observations. Technicians noted that they rarely received adequate training on marine meteorological observation methods and they welcomed access to better training materials. The technicians also felt that receiving additional scientific rationale for marine meteorological observations would encourage the technicians to spend more of their busy shipboard schedule on SAMOS data acquisition. To address these issues, the SAMOS initiative

- ◆ drafted a handbook (in cooperation with the WCRP WGSF) focusing on the best procedures and practices for marine meteorological measurements. The handbook will
 - include both hard copy versions and a dynamic, on-line version that is easily expanded and updated
 - provide drill down capacity keeping the top level simple, allowing users to search for more technical details, as desired in a series of appendices.
- ◆ contain: background on air-sea fluxes, bulk flux algorithms, and standard meteorological sensors; measurement systems; sensor exposure; instrument calibration and accuracy; intercomparisons; metadata standards and documentation; problems encountered when making measurements on ships (flow and heat distortion, vessel motion, salt and spray contamination); properly securing data.
- ◆ ensure free and open access to all handbook information
- ◆ be introduced at the International Marine Technicians workshop at WHOI in fall 2006.
- ◆ is considering hosting training workshops or summer schools for marine technicians
- ◆ encourages funding agencies to support human capital development through training and education.

International Participation

The SAMOS initiative currently is focused on U.S. research vessels; however, expansion to include international vessels is desirable.

- ◆ Necessary to achieve SAMOS science goals and develop a sustained global network of high-quality SAMOS observations.
- ◆ A future focus on the polar oceans is one goal of SAMOS, and the International Polar Year provides an opportunity to include international polar vessels (DAC recently requested IPY funding).
- ◆ Securing additional funding for international vessel involvement is primary limitation.
- ◆ International vessel operators, scientists, and data users interested in the SAMOS initiative should contact: smith@coaps.fsu.edu



Figure 5: U.S. Coast Guard Icebreaker. Photo courtesy of Philip McGillivray.

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.
- ◆ **UNOLS:** Several vessels are providing routine data and other operators have expressed interest in contributing observations. Members have provided critical feedback on data exchange methods, metadata standards, etc.
- ◆ **VOSclim Program:** Participants provided expertise to create the SAMOS metadata specification.
- ◆ **GOSUD:** The Global Ocean Surface Underway Data (GOSUD) pilot project provided input on data and metadata standards. Plans are being developed for a data exchange whereby the SAMOS DAC will provide DQE of meteorological data collected by GOSUD and the GOSUD data center will evaluate the near-surface ocean data collected by SAMOS.
- ◆ **WCRP WGSF:** Interested in SAMOS goal to improve marine meteorological observations. SAMOS initiative will provide critical data for benchmarking air-sea flux products. WGSF members contributing to marine handbook.
- ◆ **Others:** Constructive feedback has been provided by members of JCOMM, SOT, and the international research vessel community. The SAMOS initiative welcomes ongoing collaboration with the NOAA Office of Climate Observation (OCO) and the U.S. National Science Foundation (NSF).

Acknowledgements

The SAMOS DAC at FSU is supported by the NOAA OCO. Additional funds for data center activities at the Center for Ocean-Atmospheric Prediction Studies (COAPS) are provided by the Physical Oceanography Section of NSF. COAPS receives base funding through an Applied Research Center from the NOAA Office of Global Programs.

The shipboard contributions to the pilot project are supported by the Operational Scientific Services at WHOI and NSF. PSD and WHOI funding for their contribution to the SAMOS initiative are provided by NOAA OCO.

