The Shipboard Automated Meteorological and Oceanographic Systems (SAMOS) Initiative

Shawn R. Smith

Center for Ocean-Atmospheric Prediction Studies
Florida State University, Tallahassee, FL USA

smith@coaps.fsu.edu

Foreword

- The SAMOS initiative is seeking to ensure routine delivery of calibrated, quality assured, surface observations collected using shipboard automated meteorological and oceanographic systems (SAMOS) on research vessels (R/V) and a select set of Volunteer Observing Ships (VOS)

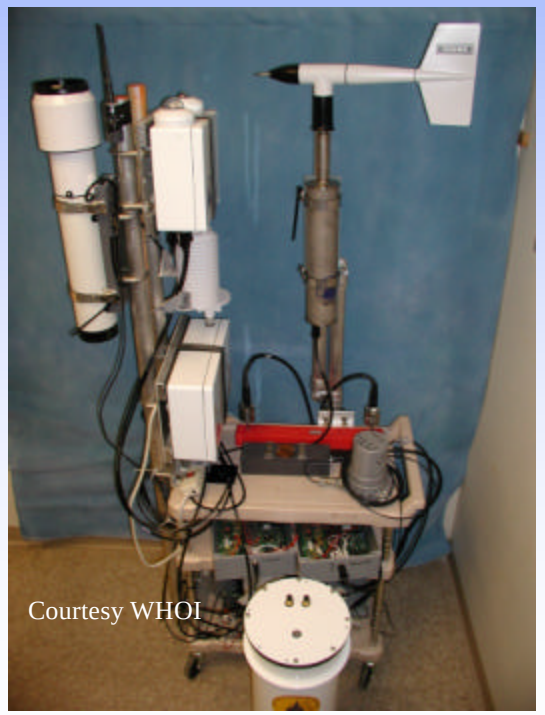
- The initiative is a response to a growing need for high-quality observations from all regions of the ocean to support climate and ocean research and operations

- Primary SAMOS science goals center on providing benchmark data for:
  - Validation studies (e.g., global model fields, satellite observations)
  - Air-sea flux fields (SAMOS are capable of providing observations with sampling rates and accuracy desired for estimating air-sea fluxes)

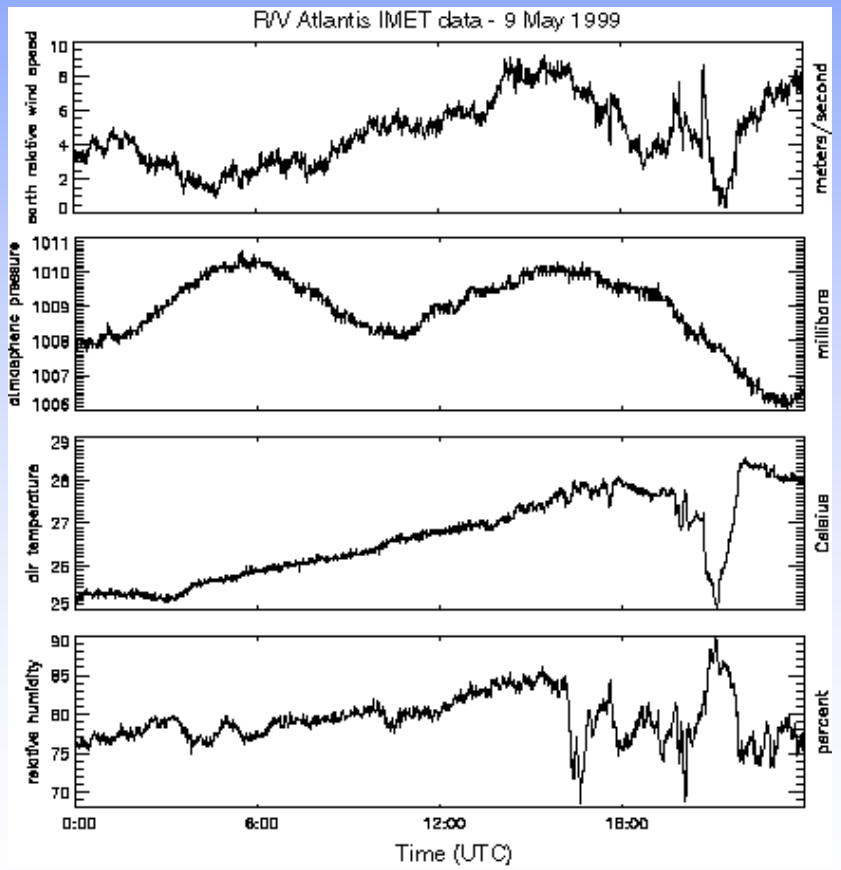
- Two recent workshops have provided a series of recommendations and actions to establish a network of routine SAMOS observations

Definitions

- Typical SAMOS
  - Sampling rates 1-60 minutes
  - Continuous recording
  - Typically bow or mast mounted on R/V



  - Raw data typically available after cruise, but faster delivery schedules are desired to meet future science objectives

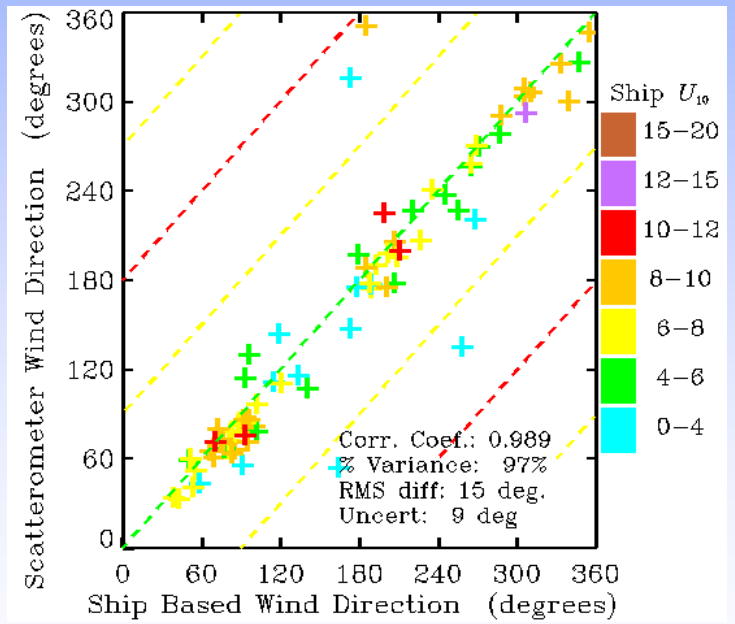


SAMOS Data Application

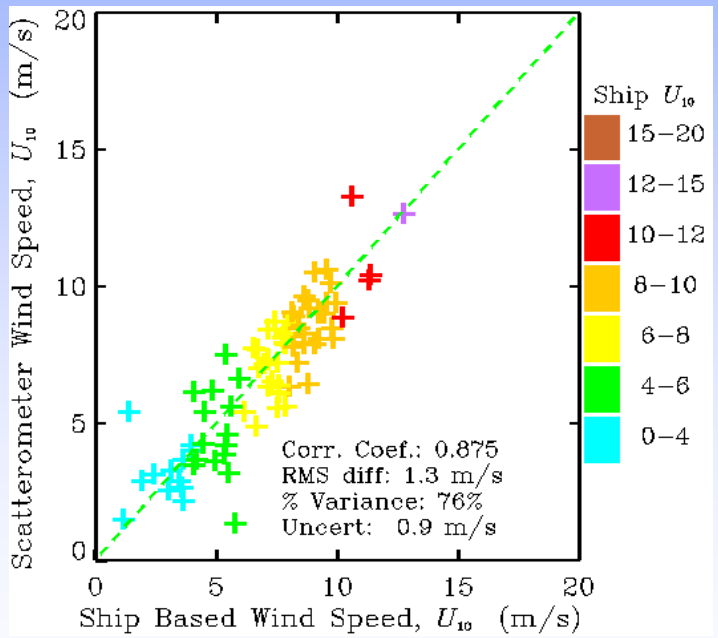
- R/V SAMOS observations are ideal for validating satellite sensors (e.g., Bourassa et al., 2003, *J. Geophys. Res.*)

SeaWinds on Midori

Wind Direction



Wind Speed



Workshops

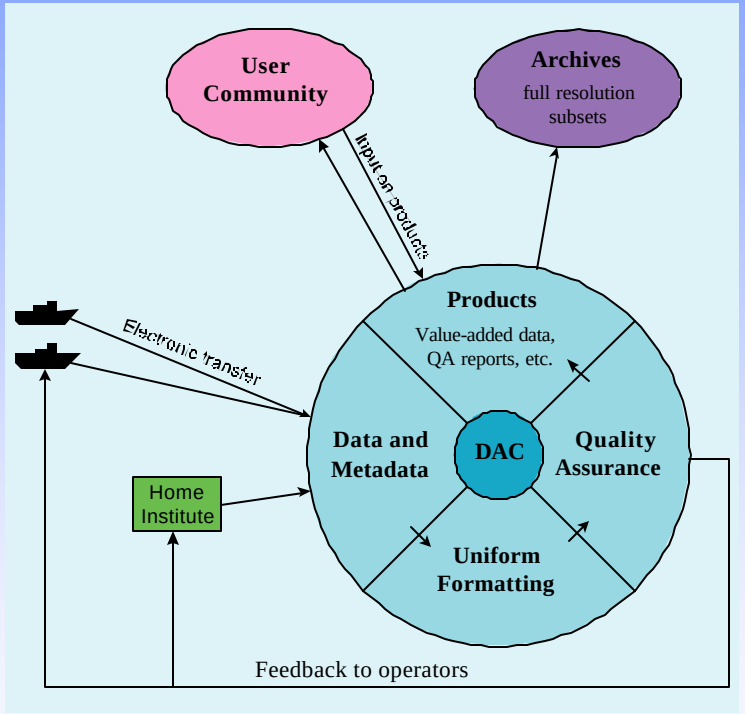
- Convened in Tallahassee, FL (March 2003) and Silver Spring, MD (April 2004) to outline initiative to make high-quality SAMOS data routinely available to the research and operational communities
- Attendees included members of the university, government, and international community involved with SAMOS design and deployment, data collection, quality control, archival, and funding of these programs.
- 1st Workshop resulted in 13 recommendations focusing on:
  - Overall Observing System, Data Stewardship, Data Accuracy, and Training
- 2nd Workshop focused future initiatives on research vessels and VOS equipped with SAMOS
- Workshop reports and recommendations are available at: http://www.coaps.fsu.edu/RVSMDC/Workshops/

SAMOS Components

- Achieving SAMOS goals requires broad collaboration
- Components include:
  - Partnership with shipboard data collectors
    - Two way flow of information that benefits both parties
  - A central data assembly center (DAC, funded by NOAA OCO)
  - A portable reference standard (partially funded)
    - Includes state-of-the-art flux measurement system and a set of individual sensors that will be used for side-by-side comparison to the R/V's SAMOS.
    - For onboard, at-sea comparison with existing SAMOS
  - Airflow modeling for ships
    - To improve sensor location and apply corrections to observations
  - Training documents and workshops (partially funded)
    - A handbook of "best practices" for marine meteorological measurements is under development

Role of DAC

- DAC established for U.S. research vessel SAMOS data at the Florida State University
- DAC will:
  - plan for near-real-time (daily) data transfer from R/Vs to the DAC
  - complete immediate QA prior to distribution
  - notify (via email) R/V and home institution when problems identified
  - ensure SAMOS data are placed in permanent archives
  - act as liaison with data collectors and the user community (to provide desired products).



DAC collaboration with UNOLS

- DAC wishes to establish routine data transfer from UNOLS vessels
  - Vision includes receiving full resolution (1 minute averages desired) navigation, meteorology, and TSG on a daily basis
  - Pilot plan has data transferred as compressed email attachments
  - Expect transfer method will change as broadband becomes available
- Automation of data transfer and quality control requires DAC and UNOLS to adopt some standards
  - Draft data and metadata specifications are available for comment
  - Data specification broken into primary and secondary parameters
  - Extensive metadata for each participating vessel to be stored at DAC

Time Line

- FY2004
  - Survey UNOLS fleet and seek input on design standards
  - Through pilot project, initiate daily transfer with 2-3 vessels
  - Refine data flow, QC, and two way communication
  - Test first portion of portable standard
  - Draft marine handbook
- FY2005
  - Expand daily data transfer up to 10 vessels
  - Refine procedures
- FY2006
  - Continue to add vessels as resources allow
  - Seek expansion to include international research vessels

Benefits to UNOLS

- Participating in the SAMOS initiative would provide:
  - Uniform, near real-time quality control of SAMOS data
    - Feedback to vessel technicians while at sea
    - Scientist would be able to upload QC'd data before end of cruise
  - Wide distribution of data collected at a large cost
    - Value added to funding agency technology investment
    - Once data are readily available, scientist will want more
  - Routine archival of all observations with national data centers
  - International exposure and recognition for data collection efforts
    - Data will play role in international climate studies
    - R/Vs will be recognized as part of a Global Ocean Observing System

Final Thoughts

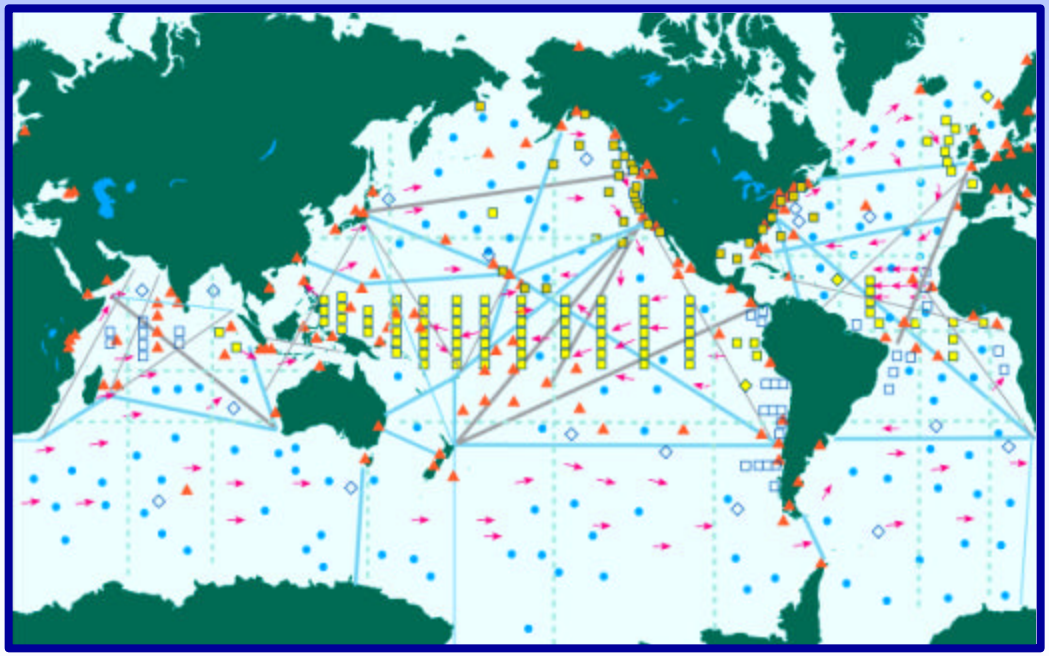
- Wish to emphasize that SAMOS initiative seeks a partnership with UNOLS
- Anticipate that additional funding will be required
  - Through UNOLS survey determine resources needed to:
    - Transfer data on daily basis
    - Enhance sensor suites on UNOLS vessels
  - To start airflow modeling of UNOLS vessels
  - Expand training and onboard sensor comparisons
- Key item needed now: Point of Contact for each vessel for survey, etc. (need to know details of SAMOS deployed)
- Please address comments and questions to smith@coaps.fsu.edu

Combined Attendees: Workshop 1 and 2

- BNL
  - R. Michael Reynolds (co-chair 1st workshop)
- CSIRO, Australia
  - Frank Bradley
- FSU/COAPS
  - Mark A. Bourassa
  - Ruth Pryor
  - James J. O'Brien
  - Shawn R. Smith (chair)
- FSU/Meteorology
  - Carol Anne Clayson
- LDEO/Columbia
  - Val Schmidt
- NOAA/AOML
  - Steven K. Cook
  - Gary Soneira
  - Rik H.Wanninkhof
- NOAA/CDC
  - Scott Woodruff
- NOAA/ETL
  - Christopher W. Fairall
- NOAA/NCDC
  - Richard Reynolds
- NOAA/NODC
  - Donald Collins
  - Steven Rutz
- NOAA/NWS/NCEP
  - Glenn White
- NOAA/OCO/OGP
  - Michael Johnson (Sponsor)
  - Todd Pearce
  - Diane Stanitski
  - Sidney Thurston
- NOAA/PMEL
  - Paul Freitag
  - Michael McPhaden
- NRL
  - Jeff Reid
- NSF
  - Alexander Shor
- OSU/COAS
  - Linda Fayler
- SOC, UK
  - Elizabeth C. Kent
- UCSD/SIO
  - Carl Mattson
  - Woody Sutherland
- U. Miami/RSMAS
  - Edward J. Kearns
  - Peter Minnett
  - Elizabeth Williams
- U. S. CLIVAR Office
  - David M. Legler
- U. S. Coast Guard
  - Phil McGillivary
- WHOI
  - Frank K. Bahr
  - David S. Hosom
  - Robert A. Weller

Recommendations: System

- Develop a sustained system of calibrated, quality-assured marine meteorological observations built around the surface flux reference sites, drifting buoys, research vessels (R/Vs), and volunteer observing ships (VOS) to support science objectives of national and international climate programs.
- Improve global data coverage, especially from important but data sparse regions (e.g., Southern Ocean), by working with and making use of national and international observing efforts, research programs, and infrastructure development initiatives.



Recommendations: Stewardship

- Establish a data assembly center (DAC) for U.S. R/V (e.g., UNOLS, NOAA, Navy, Coast Guard) meteorological observations to unify data collection, quality assurance (QA), and distribution. The DAC will also provide for permanent data archiving and long-term availability of data at national archive centers.

- Establish standards for sensor calibration and data collection on ships and moorings, including accuracy and resolution, sampling rates and averaging periods, data acquisition and display software, data transmission, recommended instrument sites, and provision of metadata.

- Recommend that certain ship data not currently logged be made available to the research crew (e.g., pitch/roll, heading, currents, speed of ship in water). These data should be routinely recorded to improve flux calculations and QA.

Recommendations: Accuracy

- Develop a portable, state-of-the-art, standard instrument suite and implement on-board inter-comparison between the portable standard and shipboard instruments to improve R/V and VOS automated meteorological observations.
- Endorse development of robust sensors for use in severe environments to improve data accuracy and allow accurate data to be collected from data sparse regions.
- Implement a program in computational fluid dynamics (CFD) modeling of the wind flow regime over ships to determine optimal wind sensor sites, wind correction factors, and effective measurement heights.
- Encourage (i.e. fund) R/Vs to schedule meteorological inter-comparisons with surface flux reference sites and, where appropriate, with one another.

Courtesy WHOI

Recommendations: Training

- Produce a reference manual of best procedures and practices for the observation and documentation of meteorological parameters, including radiative and turbulent fluxes, in the marine environment. The manual will be maintained online and will be a resource for marine weather system standards.

- Establish sources/contacts where expertise can be obtained by operators and made available for QA development.

- Strongly encourage funding agencies to support human capital development through education and training.

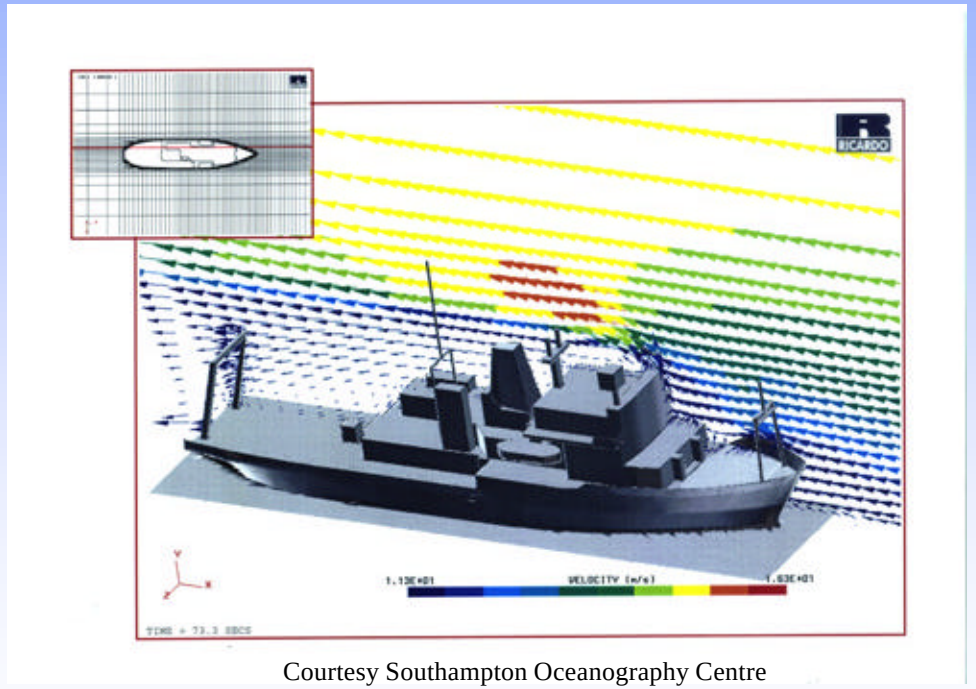
- Encourage funding agencies to require that new shipboard meteorological instrumentation purchased within research grants be installed and operated, and the measurements distributed and archived according to the principles embodied in these recommendations.

Implementation

- Chris Fairall (NOAA ETL) and Bob Weller (WHOI) plan development of a portable calibration standard SAMOS, an on-line reference manual, technician training, and possible CFD modeling.

- The portable standard is envisioned to include a state-of-the-art flux measurement system and a set of individual sensors that will be used for side-by-side comparison to the R/V's SAMOS.

- The on-line reference and future training workshops will improve access to accuracy requirements, calibration techniques, etc. for R/V technicians.



Courtesy Southampton Oceanography Centre

SAMOS Data Application

- Quality processed R/V SAMOS data are ideal for evaluation of global reanalysis fluxes (e.g., Smith et al., 2001, *J. Climate*)
  - Sampling rates allow accurate estimation of 6 hourly integrated fluxes