Recommendations from the High-Resolution Marine Meteorology Workshop

3-5 March 2003

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

www.coaps.fsu.edu/RVSMDC/marine_workshop/Report.html

Foreword

- A new initiative is underway to insure routine delivery (real-time and delayed) of calibrated, quality assured, surface meteorological data collected using automated weather system on research vessels, VOS, and additional moored buoys.
- The initiative resulted from the recommendations of the High-Resolution Marine Meteorology Workshop.
- Workshop participants noted that high-quality surface observations are ideal for validating model-derived fields
  - (e.g., Smith, S. R., D. M. Legler, and K. V. Verzone, 2001: Quantifying uncertainties in NCEP reanalyses using high quality research vessel observations. *J. Climate*, 14, 4062-4072.)
- A need for further collaboration between the in-situ observing and modeling communities was raised by the workshop participants.
- The recommendations are being presented to the JOSS PSG stimulate interest in this initiative and to open the door for future collaboration.
  - Interested parties are encouraged to talk with James J. O'Brien at the JOSS PSG meeting or to email Shawn R. Smith (smith@coaps.fsu.edu).

Participants

Co-chairs: Shawn R. Smith (FSU/COAPS), R. Michael Reynolds (BNL)

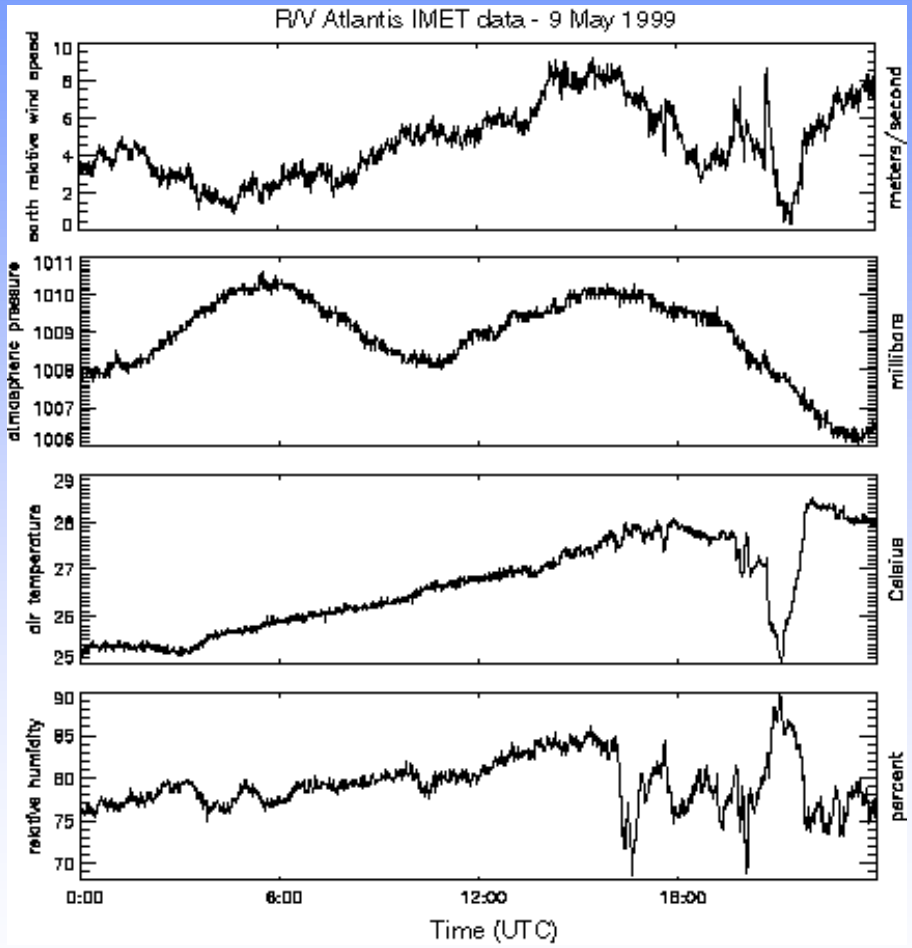
Sponsor: Michael Johnson (NOAA OGP)

Host: James J. O'Brien (FSU/COAPS)

- CSIRO, Australia
  - Dr. Frank Bradley
- FSU/COAPS
  - Dr. Mark A. Bourassa
  - Ms. Ruth Pryor
- FSU/Meteorology
  - Dr. Carol Anne Clayson
- NOAA/AOML
  - Mr. Steven K. Cook
  - Dr. Rik H.Wanninkhof
- NOAA/ETL
  - Dr. Christopher W. Fairall
- NOAA/CDC
  - Mr. Scott Woodruff
- NOAA/PMEL
  - Mr. Paul Freitag
- NRL
  - Dr. Jeff Reid
- OSU/COAS
  - Ms. Linda Fayler
- SOC, UK
  - Dr. Elizabeth C. Kent
- UCSD/SIO
  - Mr. Carl Mattson
  - Mr. Woody Sutherland
- U. Miami/RSMAS
  - Dr. Edward J. Kearns
  - Dr. Peter Minnett
- U. S. CLIVAR Office
  - Dr. David M. Legler
- U. S. Coast Guard
  - Dr. Phil McGillivary
- WHOI
  - Mr. Frank K. Bahr
  - Mr. David S. Hosom
  - Dr. Robert A. Weller

Definitions

- High-resolution meteorological data
  - Sampling rates 1-60 minutes
  - Collected by continuously recording automated weather station (AWS)



Definitions

- Platforms of primary interest
  - U. S. sponsored research vessels (R/Vs)
  - Volunteer Observing Ships (VOS) equipped with AWS
  - Operational and Research moorings with AWS

Workshop Objectives

- Identify science objectives addressable with high-resolution (HR) marine meteorology
- Provide current status of U. S. sponsored HR marine data collection
- Identify technical issues related to instrument accuracy, calibration, and inter-calibration
- Outline a plan to insure routine delivery (real-time and delayed) of calibrated, high quality surface meteorological data consistent with science objectives
- Determine areas where sustained HR observing system can evolve to meet science objectives in future
- Identify areas where collaborative and joint activities would increase quantity and quality of data

Where We Are Today

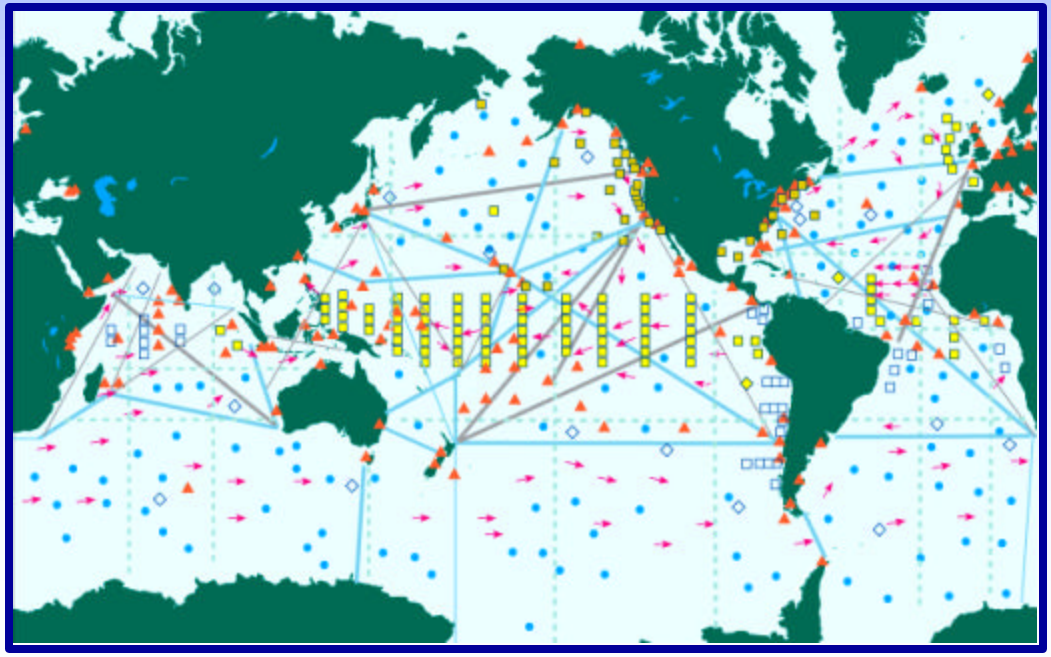
- U. S. currently supports
  - Dozens of R/Vs (Universities, Navy, Coast Guard, etc.)
  - Initiatives to install AWS on VOS
  - Mooring arrays (e.g., TAO)
  - Network of operational moorings
- Each vessel/array generally operates independently
  - Data collection, calibration, distribution methods differ
  - Quality control may or may not exist
  - Long term archival lacking in some cases
- Although R/Vs provide far-reaching platform, they are generally under-utilized for meteorological observations

Issues

- Need to consider individual platforms (R/Vs, VOS, moorings) as part of a global data system
  - Build partnerships to develop instrumentation, data and communication systems, calibrations methods, etc.
- Improve data quality
  - A key concern to achieve flux accuracy desired by international climate programs
  - Better calibration methods
  - Uniform metadata
  - Regular evaluation of both instrument systems and data collected
- Improve data access for research and operations
  - Include data streams not readily available
  - Collect all necessary parameters to estimate quality air-sea fluxes

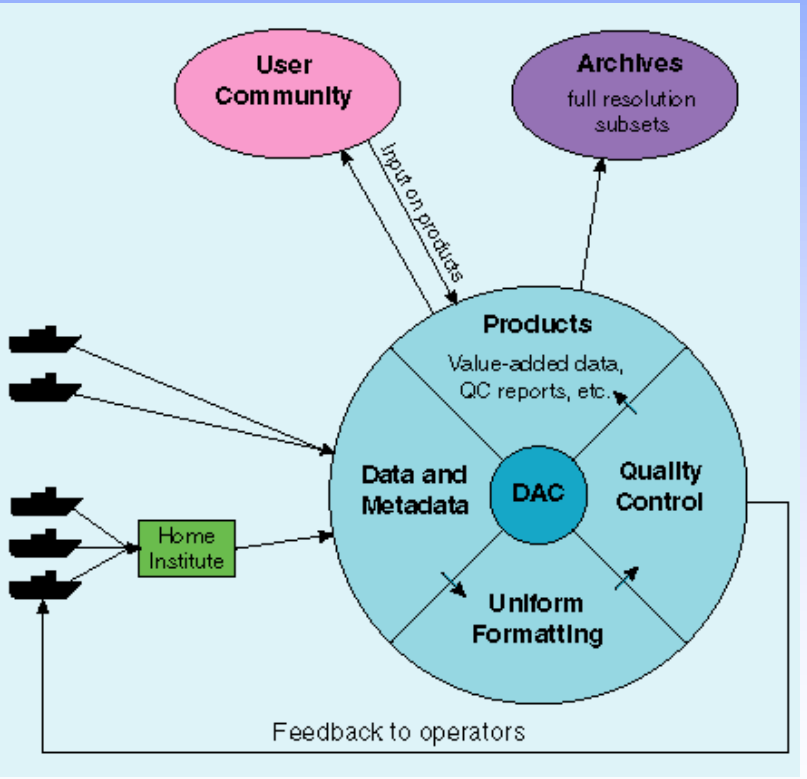
Recommendations

- 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

- 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.
  - R/V data currently lacking unified data system
  - Real-time and delayed-mode data from multiple sources would receive common formatting and QA
  - Providers would be notified when problems are detected
  - DAC would provide service to user community and be responsive to user needs



Recommendations

- 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 siting, and provision of metadata.
  - Standards essential to achieve science goals set by climate initiatives
  - Plan to work with existing programs to set standards (e.g., VOSClim, GOOS)
- Produce a reference manual of best procedures and practices for the observation and documentation of meteorological parameters in the marine environment. The manual will be maintained online and will be a resource for marine weather system standards.
  - Flexible reference manual essential to disseminate standards, recommendations, and procedures to marine technicians, system designers, and scientists

Recommendations

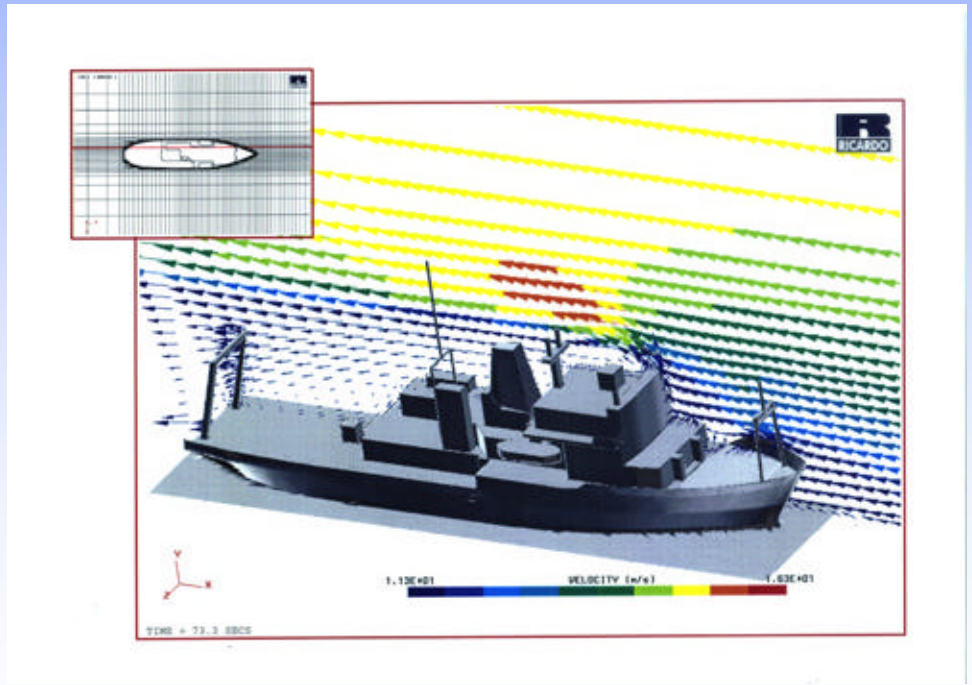
- Develop a portable, state-of-the-art, standard instrument suite and implement on-board inter-comparison between the portable standard and shipboard instruments to improve R/V and VOS automated meteorological observations.
  - A big step towards onboard inter-calibration of vessel's instrumentation
  - System envisioned to include:
    - Flux instrument suite optimally mounted to evaluate ship's operational system
    - Set of individual standards to be sited next to ship's instruments for direct sensor-to-sensor comparisons
  - Envisioned to be deployed on vessel for a period of days to weeks
  - System technician will work with R/V technician to evaluate inter-comparison in the field and recommend improvements to R/V AWS

Recommendations

- 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.
  - Measurements from remote and severe environments (e.g., Southern Ocean) are key to understanding air-sea interactions and are essential to future climate studies.
  - Icing, severe platform motion, large seas all contribute to the challenge.
  - Current technology does not allow adequate sampling in these regions and resources are needed to improve sensor and platform design.

Recommendations

- Implement a program in computational fluid dynamics (CFD) modeling of the wind flow regime over ships to determine optimal wind sensor siting, wind correction factors, and effective measurement heights.
  - Distortion of air flowing over a ship impacts most atmospheric measurements
  - CFD modeling allows corrections factors to be determined for each vessel
  - CFD models should be run as part of the design process for new research vessel to ensure optimal instrument siting



Recommendations

- Encourage (i.e. fund) R/Vs to schedule meteorological inter-comparisons with surface flux reference sites and, where appropriate, with one another.

- TOGA/COARE and EPIC have shown the advantages of inter-comparing observations from ships and buoy
- Take advantage of repeat hydrographic lines when placing surface flux reference sites
- Vessels should be encouraged to spend at least one diurnal cycle at reference site
- With early cruise scheduling, may be possible to have several vessels near reference site for multi-platform inter-calibration

Recommendations

- 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.
  - Many measurements are made with AWS that are not part of standard meteorology report.
  - Where possible, these data should be made available.

Recommendations

- 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 points 3-6 above.
  - Opportunity to rethink policy, provide funds not only for hardware, but also maintenance and data management.
  - Funding agencies are in a good position to influence data management practices.
  - By setting some requirements on data collected with agency funded instruments, the agency will add value to their investment (in the form of high-quality, user accessible data).

Recommendations

- Establish sources/contacts where expertise can be obtained by operators and made available for QA development.
  - Technical expertise desired to ensure that sensors are properly installed, sited, and calibrated
  - Sources needed for various parameters to aide the design of QA techniques
  - Resources will be provide and updated using the online manual

Recommendations

- Strongly encourage funding agencies to support human capital development through education and training.
  - Marine technicians are heavily tasked to maintain oceanographic and atmospheric instrumentation
  - Current shipboard priorities often limit time spent monitoring atmospheric instruments
  - Technicians concerned with the need for improved training related to siting, calibration, and desired accuracy for marine weather systems
  - Marine technicians are on the front lines of data collection, agencies need to invest resources to educate technicians

Benefits

- Increase access to high-quality, high-resolution marine meteorological data to
  - Anchor surface flux fields
  - Validate new satellite sensors
  - Evaluate numerical ocean and atmosphere models
- High-quality estimates of fine spatial and temporal resolution variability
  - Critical knowledge for data assimilation
- Vessels operators and technicians will have access to timely feedback
  - Instrument malfunctions
  - Inadequate placement of instrumentation

Next Steps

- Disseminate recommendations to scientific, observational, and programmatic communities to build support
- Seek resources for ocean reference sites, building R/V portable standard instrument suite, and establishing R/V data assembly center.
- Work with existing programs to establish data collection, calibration, distribution, and archival standards

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