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2nd Joint GOSUD/SAMOS Workshop

U.S.Coast Guard Base, Seattle, Washington, 10-12 June 2008

UNESCO 2008

2nd Joint Global Ocean Surface Underway Data (GOSUD)
Shipboard Automated Meteorological and Oceanographic System (SAMOS) Workshop

10-12 June 2008

U. S. Coast Guard Base at Pier 36
Seattle, Washington, USA

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Acknowledgements

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Executive Summary

On 10-12 June 2008, the NOAA Climate Observation Division sponsored the 2nd Joint Global Ocean Surface Underway Data (GOSUD)/Shipboard Automated Meteorological and Oceanographic System (SAMOS) Workshop in Seattle, WA, USA. The workshop focused on the ongoing collaboration between GOSUD and SAMOS and addressing the needs of the research and operational community for high-quality underway oceanographic and meteorological observations from ships. The SAMOS initiative is working to improve access to calibrated, quality-controlled, surface marine meteorological data collected in-situ by automated instrumentation on research vessels (primarily) and select merchant ships. GOSUD is an IODE project which focuses on the collection, quality evaluation, and distribution of near surface ocean parameters (for the moment mainly salinity and sea temperature) from vessels.

The workshop organizing committee (Shawn Smith, Mark Bourassa, Loic Petit de la Villéon, David Forcucci, and Phillip McGillivary) brought together a panel consisting of operational and research scientists, educators, marine technicians, and private sector and government representatives to address several key topics (see below). Participants from the U.S. government represented NOAA (AOML, COD, ESRL, NDBC, NODC, NWS, PMC, and PMEL) and the United States Coast Guard. CIRES, LUMCON, Florida State University, Moss Landing Marine Laboratories, Oregon State University, Scripps Institution of Oceanography, Stony Brook University, and the Universities of Delaware, Maryland, Miami, and Rhode Island represented the United States university community. A significant international presence included representatives from the Bureau of Meteorology (Australia); Environment Canada (Canada); LEGOS, IFREMER, and Meteo France (France); the University of Hamburg (Germany); the Directorate of Civil Aviation (Kuwait); the Nigerian Institute for Oceanography and Marine Research (Nigeria), University of Santiago de Compostela (Spain); and the NOCS (UK). Educators were present from ACT, IIRP, and MATE. Finally, Earth and Space Research, the RMR Company, and two consultants represented the private sector.

The workshop was comprised of invited and contributed talks, poster presentations, plenary discussions, and the SAMOS and GOSUD technical working group meetings. Broad topic areas included new opportunities for international collaboration, emerging technologies, scientific application of underway measurements, and data and metadata issues. New sessions included a technician's round-table discussion and developing educational initiatives.

Scientific discussion centered around the need for high-quality meteorological and thermosalinograph observations to support satellite calibration and validation, ocean data assimilation, polar studies, air-sea flux estimation, and improving analyses of precipitation, carbon, and radiation. Determining the regions of the ocean and observational parameters necessary to achieve operational and research objectives requires input by the scientific user community. The CLIVAR community should be one way to approach the scientific community. This input will allow SAMOS and GOSUD to target their limited resources on vessels operating in the high priority regions. The vessel operators and marine technicians were very supportive of the activities of SAMOS and GOSUD. They requested a clear set of guidelines for parameters to measure, routine monitoring activities, and calibration schedules. The operators also desire additional routine feedback on data flow and data quality. A clear need for training and educational material was noted by the technical community. The dissemination of best practices guides for existing techs and pre-cruise training for new techs were suggested. The result of the workshop was a series of action items (Appendix A) and seven recommendations.

Recommendations

1. Expand routine automated measurements on vessels participating in SAMOS to include precipitation; vessel speed relative to the water (speed log); and shortwave, longwave, and photosynthetically active radiation.
2. Vessels making automated weather observations should make every effort to augment these data with routine visual cloud (type, height), weather condition, sea state (waves, swell, period), and ice conditions.
3. Expand access to underway meteorological and TSG observations in remote ocean regions and marginal seas. The scientific user community must determine critical regions for increased monitoring.
4. Encourage efforts to develop new and make available historical upper-ocean and meteorological observations for use by developing nations.
5. Develop a global data discovery system to identify which research and select merchant vessels are participating in GOSUD/TSG, SAMOS, PCO_2, Radiation, and other underway ocean and atmospheric sampling programs.
6. Vessels providing underway TSG should routinely report both their intake temperature (sea temperature) and the salinometer temperature (used to calculate salinity).
7. Vessels making underway TSG measurements should collect daily bottle samples of water to monitor TSG performance.
8. Promote the recognition of underway sea water sampling (via GOSUD and AOML) as a critical component of the Global Ocean Observing System
9. Maintaining and distributing metadata for meteorological and TSG measurements (e.g., height/depth) is critical for all applications (e.g., data assimilation, satellite validation, etc.)
10. Build best practice guides and continuing education materials to support the needs of technical personnel on the front lines of data collection at sea.

Introduction

On 10-12 June 2008, the NOAA Climate Observation Division sponsored the 2nd Joint Global Ocean Surface Underway Data (GOSUD)/Shipboard Automated Meteorological and Oceanographic System (SAMOS) Workshop in Seattle, WA, USA. The workshop focused on the ongoing collaboration between GOSUD and SAMOS and addressing the need of the research and operational community for high-quality underway oceanographic and meteorological observations from ships. The SAMOS initiative is working to improve access to calibrated, quality-controlled, surface marine meteorological data collected in-situ by automated instrumentation on research vessels (primarily) and select merchant ships. GOSUD focuses on the collection, quality evaluation, and distribution of near surface ocean parameters (salinity and sea temperature) from vessels.

The workshop organizing committee (Shawn Smith, Mark Bourassa, Loic Petit de la Villéon, David Forcucci, and Phillip McGillivary) brought together a panel consisting of operational and research scientists, educators, marine technicians, and private sector and government representatives. A full list of attendees is presented in Appendix E.

The workshop was comprised of invited and contributed talks, poster presentations, plenary discussions, and the SAMOS and GOSUD technical working group meetings. Broad topic areas included new opportunities for international collaboration, emerging technologies, scientific application of underway measurements, and data and metadata issues. New sessions included a technician's round-table discussion and developing educational initiatives. The final agenda is included in Appendix D.

Loic Petit de la Villéon opened the workshop with an overview of GOSUD. GOSUD was established as an IODE Project at IODE-XVI -october 2000 – through Recommendation IODE-XVI/10 as the "Underway Sea Surface Salinity Data Archiving Project".In addition the JCOMM-1 meeting supported such a project urging that integration with other data collected at the same time be properly considered. It evolved from the WOCE sea-surface salinity DAC with a new component that focuses on near-real time data collection and transmission. The objective of GOSUD is to build a comprehensive archive of surface underway ocean data. At present, only SSS & SST have been taken into account. In 2007, a network of 14 research vessels and 28 merchant ships were reporting to GOSUD using a combination of delayed-mode and near-real time reports (21 ships via GTS and 17 ships report directly to the GDAC). The GOSUD data flow (figure 1) includes both real-time and delayed-mode components with all data finally residing in the GDAC. Data can be selected at: http://www.coriolis.eu.org/cdc/GosudSelection/cdcGosudSelections.asp.

Loic noted that GOSUD is still trying to establish the roles of science centers and their relationship to the GDAC. In addition, they are working to determine the relative role of GTS versus direct submissions (near-real time and delayed-mode) to the GDAC and they are interested in identifying new users of global underway SSS data. GOSUD plans to begin working closely with NOAA AOML and the NOAA vessels and is encouraging new providers to submit their data (e.g., Australia, VOS Nippon, etc.). GOSUD needs to address user requirements for both a new netCDF data format and how best to contribute to product development (e.g., objective analyses).

Shawn Smith provided an overview of the SAMOS initiative. The primary SAMOS objective is improving access to high quality underway meteorological and near-surface ocean data collected at high-temporal frequency (currently 1-min. averages) on research vessels and merchant ships.

These data are being collected to meet the scientific goals of a wide community (including air sea fluxes, satellites, and modeling). The SAMOS DAC has experienced a rapid increase of data providers in 2007. At the time of the workshop 15 vessels (up from 2 in early 2007) are sending routine data reports to the data center. The SAMOS data flow (Figure 2) occurs in near-real time, but uses an email (not GTS) protocol. GTS data transmission formats are too limiting to resolve the high precision of SAMOS data reports. The largest challenge facing SAMOS at present is the ability to routinely collect instrumental and ship-specific metadata.

The DAC has developed a series of web-based forms and is seeking input on ways to automated metadata transfers from ship to shore. Both automated and visual quality control procedures are now fully implemented; however, the DAC is developing additional automated QC to reduce the man-hours needed for visual data evaluation.

New web tools to plot cruises and allow access to data and metadata are available at: http://samos.coaps.fsu.edu/. The SAMOS DAC continues to work with NODC and NCAR to establish a permanent archive for SAMOS data. The portable seagoing air-sea flux standard has been successfully deployed on two SAMOS ships in 2007 and partners continue to investigate opportunities to improve the accuracy of observations through airflow modeling and educational initiatives.

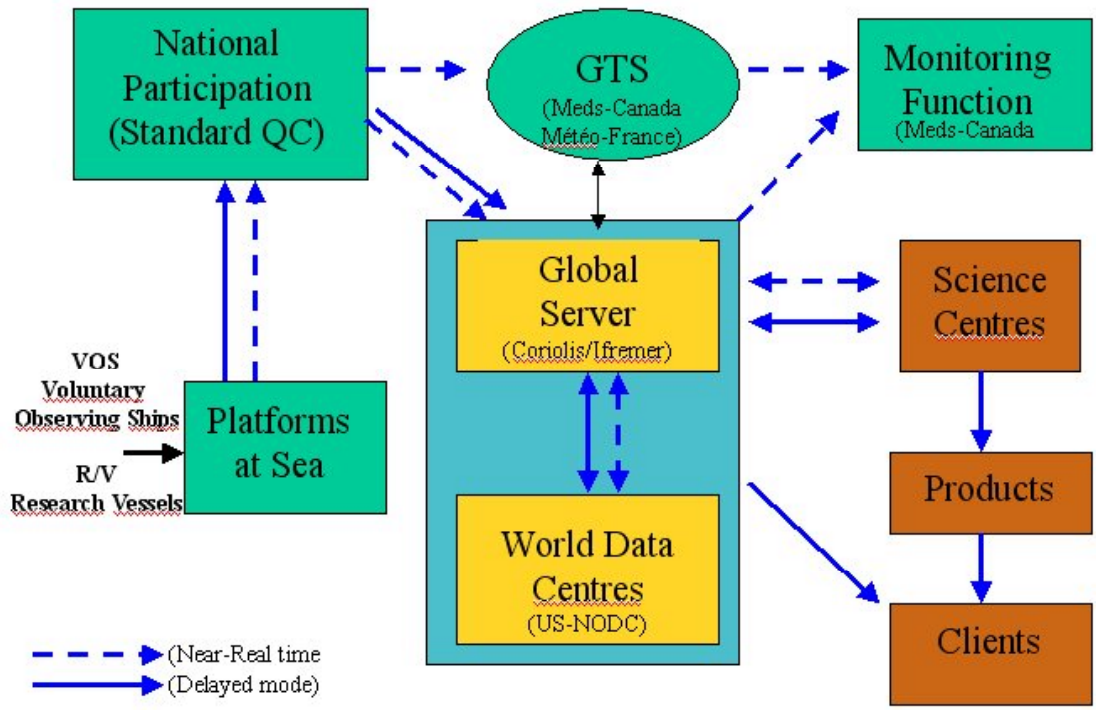

Figure 1: GOSUD data flow

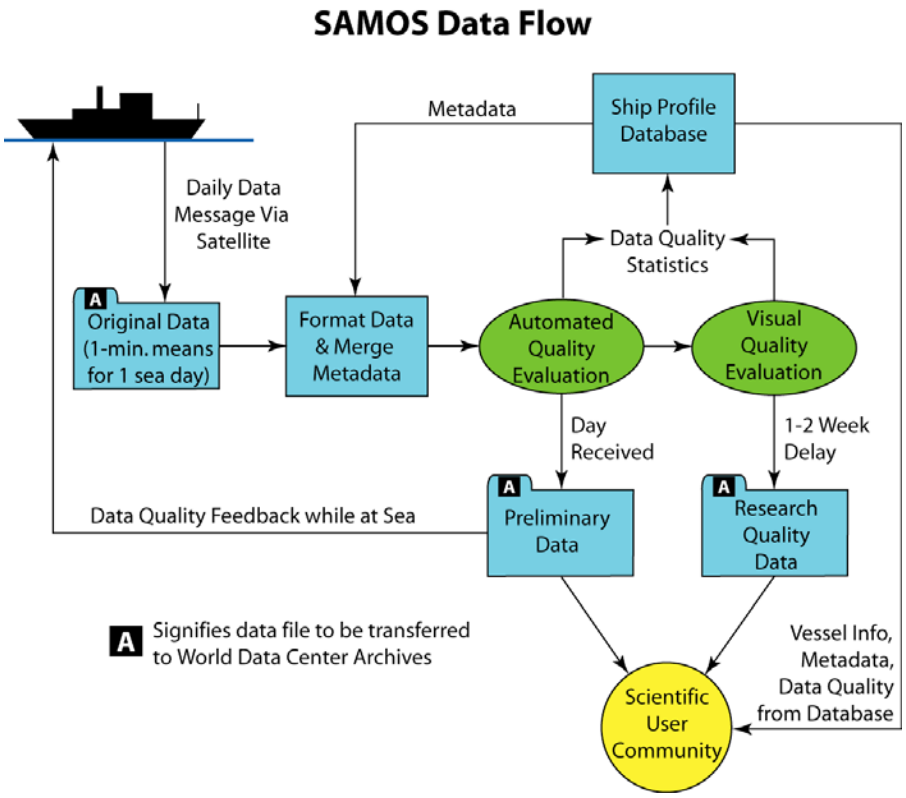

Figure 2: SAMOS data flow.

The introductory session concluded with the chairmen outlining the goals of the workshop (see Appendix C) and describing the plan for the SAMOS and GOSUD working group meetings on Tuesday afternoon (see Appendix D). In addition, outcomes of the workshop were to include a full workshop report (this document), a short report in EOS or a similar publication, and a series of recommendations and action items (Appendix A).

New Opportunities

Several invited and contributed talks focused on new opportunities and technologies that could contribute to advancing the goals of GOSUD and SAMOS. The keynote talk by Detlef Stammer will also be discussed under this section since the topic was very relevant for new opportunities. Detlef was unable to arrive until Wednesday, so his talk was not within this session.

Detlef Stammer presented an overview of the evolving underway data management for the large German research vessels and introduced the upcoming OceanObs09 meeting (for which he is a co-chair). The German data management centers on the philosophy that research vessels are very capable platforms for conducting routine underway data collection. The approach being developed will ensure that a standard set of instrumentation is switched on and collecting data whenever the engines of the large R/Vs are running. Primarily the focus is systems that are automated but may require some routine calibration (water samples) and maintenance (radiometer dome cleaning) during each cruise.

A small investment in resources will greatly reduce the underutilization of the instrumentation installed on the German R/Vs. Detlef noted that they would like to see this initiative expanded to other EU countries and it could serve as a model for the U. S. and elsewhere.

The main issues raised for the German R/V program include data quality control (e.g. water samples for TSG), data delivery (some real-time feed to GTS, rest delayed mode), enhancing sensors, and diplomatic permits. The concept involves all sensors being switched on by the vessel crew (not the scientists) outside of respective countries exclusive economic zones (EEZ). The instrumentation would include meteorology, TSG, ADCP, bathymetry, among others. SST and SSS are routinely collected now, but the SSS requires much more routine QC. The *Polarstern* is the role model for SSS in Germany, with a person dedicated to collecting daily water samples. These samples are used on land for post cruise QC, making the TSG data of high value for calibrating the ARGO float salinity and for future satellite validations (e.g., SMOS and Aquarius). For ADCP, the recommendation is to have two systems continuously operating different frequencies. This will provide both high spatial sampling in the upper ocean and extended depth sampling at lower spatial sampling. If the ADCP are running, they can provide a wealth of useful data (if properly evaluated). Bathymetric measurements are essential in shallow shelf regions and in the Arctic, though operational challenges remain. They are exploring using gravimeters on ships for bathymetry. Additional parameters of interest for routine sampling include:

- Precipitation – multiple sensors needed on all ships
- Oxygen – Will need water samples for QC
- Acidity/Ph
- Radiation – with full spectral resolution

Detlef noted that some sensor development might be needed to allow routine automated collection of some of these parameters. The need for interested scientist to be involved in the QC and data collection process cannot be overstated. This involvement ensures high data quality.

Diplomatic obstacles are still a huge issue when research vessels enter the EEZ of different countries. Acoustic sensors seem to prove the most problematic. There is a need for international agreement to remove such obstacles. Recent discussions at the International Oceanographic Commission (IOC) have raised the visibility of the issue and a working group is currently looking at the issues. Hopefully some agreement can be reached in the future.

Detlef concluded with an introduction of OceanObs09, a major ocean observation system meeting to be held in Venice, Italy from 21-25 September 2009. One goal is to demonstrate the usefulness of the existing observing system. Where possible, there is a desire to show the societal and economic benefit of the observing system and to place dollar figures on the benefit. A series of white papers will be developed for presentation by keynote speakers. The SAMOS and GOSUD community are encouraged to attend the meeting and to provide input from the observer perspective to the white papers.

Eric Schulz introduced the Australian IMOS project. IMOS plans to provide routine underway measurements from two research vessels, the *Aurora Australis* and *Southern Surveyor*, and two short run ferries (primarily TSG). Eric's goal for these vessels is to conduct routine data quality evaluation and develop air-sea flux estimates. Through an agreement with SAMOS, the underway data will be provided to the SAMOS DAC. The DAC will conduct its own QC and compare to the evaluation conducted by Australia. The SAMOS DAC will be able to distribute the IMOS observations and will provide the data to GOSUD and world archive centers. Eric and Shawn have met to discuss IMOS adoption of the SAMOS netCDF format and our strategies for data exchange.

Eric was strongly in favor of withholding SAMOS and IMOS observations from the GTS to maintain their use for validation studies. Eric also noted that IMOS is a research project (not operational) that is considered a precursor to an Australian Integrated Ocean Observing System.

Vinciane Unger provided an overview of the automated weather system (BATOS) deployed on the majority of the Voluntary Observing Ships (VOS) recruited by Meteo France.

Automated weather systems (similar to the SAMOS on R/Vs) are becoming more common on VOS and the SAMOS chairman feels that now is the time to consider the possibility of including select VOS AWS into the SAMOS initiative. The BATOS system is designed to report air and sea temperature, pressure, humidity, and wind speed and direction at hourly intervals to support marine weather forecasting and NWP. The BATOS sensors can sample at up to 10 sec. intervals, but these data are currently not logged on the ship. It is worth noting that the BATOS software also allows the inclusion of visual observations (e.g., clouds, sea state, etc.). The BATOS is one of three systems used in the Meteo France VOS program. The program is well organized and consists of the Port Meteorological Officers, a maintenance team, the technical department, a network manager, and a quality control department. Meteo France has a centralized calibration facility for all BATOS sensors. Overall, the number of vessels in their VOS fleet is not increasing, but the use of AWS has resulted in a four-fold increase in observations between 2001 and 2007.

Opportunities for expanding collection of underway salinity measurements (via TSG) were discussed by Gustavo Goni and Gael Alory. These observations are generally made under the WMO ship of opportunity program (SOOP) and can be made either by research or merchant vessels. Gael introduced one of the French TSG observing services, which is a primary contributor to the GOSUD data server at CORIOLIS. Their quality controlled salinity data are available from: http://www.legos.obs-mip.fr/observations/sss/. Gustavo's group at AOML is focusing on TSG data from the NOAA fleet of research and fisheries vessels. Gustavo noted that TSG measurements could provide along track spatial resolution that cannot be achieved using ARGO floats. The TSG must be considered complementary to ARGO and the GOSUD and SAMOS community should work to improve the image of TSG data as a critical resource for scientists. We need to show the strength of TSG measurements for a wide range of applications and should push for underway measurements to be included in summaries of the global ocean observing system. Clearly the applications of TSG measurements are many. Gael showed several examples including SSS trend analysis, contributions of local forcing on SSS variability, and ENSO related SSS variations. Both Gael and Gustavo noted the future role of TSG measurements for validation of the upcoming satellite salinity observations by Aquarius and SMOS.

Phil McGillivary provided another informative (and entertaining) discussion of what is new in autonomous vehicle technology. Vehicles include everything from small robo-jellies, which can hold their position for monitoring ocean frontal zones, to full size robotic sailing vessels. These new technologies are now becoming viable systems to provide ocean surface and atmospheric measurements. Robo-kayaks continue to be one of the more cost effective autonomous surface platforms, with the ability to measure winds and even carry a winch for conducting ocean profiles. In addition, Phil brought us up-to-date on the latest in autonomous aircraft. These offer a great opportunity to extend the spatial coverage around vessels (from which they can be deployed); however, their deployment near land is still limited due to Federal Aviation Administration policies. Phil also showed some new versions of wave energy generators that are used to run aids to navigation. This technology is becoming efficient enough to power more extensive ranges of sensors on mooring (or other autonomous platforms).

Radiation measurements are a critical component of the air-sea exchange. The relative magnitudes of the surface flux components was introduced by R. Michael Reynolds and he noted that shortwave irradiance (downwelling shortwave), longwave irradiance (downwelling longwave), and the sea surface temperature (upwelling longwave) are critical to properly measure. Currently it is rare to have either longwave measurement being made on vessels. Mike introduced a system developed in partnership with Peter Minnett that converts the output of the standard Eppley PIR and PSP sensors into a single NMEA string (system is ~$10K). This should be very useful for most SAMOS operators (that do not have longwave radiation from a PIR) as they typically are working with NMEA output from their sensors. Mike also outlined some of the important consideration for instrument calibration and issues associated with downwelling longwave and shortwave measurements. Radiometric SST measurements are costly to make. Mike introduced the ISAR system that employs a scanning sensor that looks at the sky, water, and two internal black bodies to ensure accurate measurements. This system still runs ~$60K and, though it is autonomous, will likely need to be deployed on high-value ship tracks for the foreseeable future.

Discussions focused on the need to take advantage of the international collaborations and the evolving technology. One item that was clear was the need to set priorities for which ship tracks have high scientific value for both oceanography and meteorology. Resources will not allow instrumentation of all vessels to the fullest extent. In addition, there is a need for more coordination between programs. Whenever possible, multiple sensor systems should be deployed on a single vessel to allow simultaneous meteorological, radiative, and upper ocean sampling. Stammer noted that research vessels are ideal multi-use platforms, but we should take full advantage of VOS and merchant SOOP. The coordination across different observing programs and identifying high-value regions for additional observations are likely to be addressed at OceanObs09 and the SAMOS/GOSUD communities should contribute to this meeting. It was also suggested to contact the CLIVAR community to obtain scientific input to help define the scientific priorities for underway data collection by SAMOS and GOSUD.

Another suggestion asked the SAMOS DAC to undertake a pilot project with Meteo France to identify one or two high-science value lines on which Meteo France would collect one-minute BATOS observations. These data could be collected when the vessel reaches port and then be shipped to SAMOS for processing. In addition, SAMOS and GOSUD should encourage collaboration with the German large R/V effort and IMOS. Whenever possible, agreements should be made to standardize data formats to ensure ease of interoperability between countries and programs. As noted by Gustavo, all of these international partners should work to raise the visibility of underway-automated meteorological and oceanographic measurements from ships as vital to the ocean observing system. Finally, we should encourage the use of the emerging technologies and work towards the routine deployment of additional radiation sensors. These topics were addressed during discussions later during the workshop.

SAMOS working group report

The SAMOS working group convened to discuss technical issues related to the continued advancement of the goals established in the first three SAMOS workshops (http://www.coaps.fsu.edu/RVSMDC/Workshops/). The group meeting began with status reports from active SAMOS projects and continued throughout the afternoon with open round-table discussions led by the SAMOS chairman.

Topics of discussion included future deployment of the PSAFS, metadata acquisition, data archival, expanding parameters measured by SAMOS vessels, seawater temperature requirements, international collaboration, participation at upcoming meetings, and future funding.

Shawn Smith reported on the status of the SAMOS data assembly center (DAC) activities. Since the workshop in 2006, the DAC has expanded routine data collection from 2 to 15 research vessels. A full suite of automated and visual data quality control procedures are now implemented and applied to all data received by the DAC. Intermittent feedback to the vessel operators has proven quite valuable to resolve instrument and data transmission problems. Recruitment of additional NOAA vessels and the LUMCON vessel *Pelican* are underway. The *Oceanus* and several NOAA vessels are utilizing compact sensor packages for their measurements. In the case of the *Oceanus*, there are concerns that this system may not be as robust as the IMET system. In addition, it is rare for these compact systems to be deployed in conjunction with their previous system, violating one of the GCOS climate monitoring principles that states that an overlap should exist between new and old data observing systems (to allow comparison of performance). The other major problem continues to be the acquisition of metadata (primarily the instrument metadata). For some vessels, the initial metadata is never received, while instrument changes are rarely reported to the DAC. The DAC has developed web-based forms for use by the vessel operators to upload metadata, but these may not be the only solution (see discussion below).

The advancement of the DAC activities (including the ingestion of additional data formats) continues to be hampered by funding limitations. We are looking for a more diverse funding base to advance our activities. Several suggestions were made. First we should try to take advantage of interns or visiting data managers to assist with the data quality evaluation at the DAC.

Possibly we could retain an intern (e.g., from MATE), a data manager from NODC, or someone from NOAA Corp to allow them to learn about the issues related to data quality evaluation, while the DAC receives assistance with our data quality workload. Another idea that is still requested by the operators is for an "offshore SAMOS ambassador". This person would visit vessels to collect metadata and help with shipboard decisions regarding sensor placement. Regarding funding, the suggestion was made to try to meet the needs of operational ocean and weather forecast centers which may lead to additional operational resources. It was suggested that it is important to have SAMOS recognized by agencies and programs outside of NOAA and NSF (e.g., POGO, NASA, etc.). This may provide leverage for future funding.

Tom Stepka provided the status of SAMOS data transmission for NOAA vessels. Currently 12 ships in the NOAA fleet are using the SCS 4.0+ to transmit data to the SAMOS DAC. Several additional vessels (*Okeanus Explorer*, *Oregon II*, and *Albatross*) are in the recruitment process. Tom noted that the feedback from the DAC to NOAA vessels has been highly valuable to identify problems and weaknesses for NOAA OMAO to address. The result is higher quality observations from the NOAA vessels. Smith emphasized that a letter from NOAA/OMAO describing some of the perceived benefits (with cost estimates if possible) would be of great help to justify the SAMOS initiative. Suggestions to improve the collaboration between NOAA OMAO and SAMOS include (1) OMAO providing routine cruise metadata to allow the DAC to know when a vessel is at sea, (2) OMAO filling out instrument metadata forms for each individual vessel, and (3) the DAC providing routine quality reports and sensor feedback to NOAA to help justify new instrument acquisition. At this point there was a brief discussion of whether or not SAMOS data could be displayed on NOAA vessels (does this option exist in SCS).

In addition, the question was again raised as to the possible value of QC'd SAMOS data being distributed via the GTS to compliment the instantaneous values currently provided via GTS through the SEAS system.

David Forcucci provided an update on the SAMOS data flow from the USCG vessels. Currently data are routinely transmitted from the *Healy*. David noted that bringing SAMOS on board the *Healy* has had benefits, including data quality evaluation, identifying sensor problems, providing suggestions for sensor locations, and ensuring the data will be archived at NODC. The suggestion was made that additional graphical displays of the SAMOS data (with flags) would be useful for use by onboard technicians. In addition, the David Hassilev suggested the provision of routine quality reports would be very helpful. Protocols for this type of reporting will need to be developed by the SAMOS DAC along with methods of providing this feedback to the vessels. One suggestion was for some form of subscription service.

An update on the portable shipboard air-sea flux standard (PSAFS) was provided by Dan Wolfe. In 2007, the system was deployed on the *Knorr* in the North Atlantic and the *Healy* for a short North Pacific cruise. Details can be found in Dan's poster. The PSAFS interfaces well with the NOAA SCS system, but does require a rider from NOAA Earth System Research Laboratory (ESRL). Future improvements will include wireless communications, tilt-stabilized radiative flux measurements, and MATLAB-based data processing. At present, no new cruises are scheduled, but new opportunities are welcome. Since the system is a NOAA resource, deployment on NOAA vessels is not a problem. In addition, vessels participating in SAMOS (a NOAA funded project) should be able to work out deployment opportunities. Advance planning with ESRL (Chris Fairall, lead investigator) is definitely needed. Participants suggested several scientifically interesting deployment opportunities including a three-way comparison with a WHOI mooring to be deployed south of Australia in 2009 (Eric Schulz contact) or on the *Lawrence M. Gould* transiting the Drake Passage. Mark Bourassa also suggested that comparisons with some of the Gulf of Mexico moorings would be beneficial for satellite validation.

Following the updates from ongoing SAMOS activities, the discussion turned to the difficult problem of metadata acquisition. Currently, most SAMOS metadata is received via email as Word documents. This has proven to be only partially successful, with the tracking of sensor changes being the most problematic. In addition, there is not a clear relationship between SAMOS metadata and the metadata being provided for VOS (e.g., WMO Pub. 47 metadata). In some cases, the VOS and SAMOS observations are collected using different instruments, so the Pub.

47 metadata should differ, but more SCS equipped vessels are now transmitting both VOS reports via SEAS and SAMOS reports via email using the same scientific instrument systems. To improve SAMOS metadata collection, the DAC has developed a set of web-based forms for metadata collection, which are now ready for use by participating vessels. The participants noted that access to the web is not always possible at sea and any web forms still require technician time to complete. An alternative suggestion was to develop some form of ASCII or XML formatted metadata that could be transmitted from ship to shore on a regular schedule. This would allow rapidly changing metadata (e.g., for instruments) to be loaded a single time into the ship's computer system (e.g., SCS) and then automated metadata messages could be generated to provide the information to shore-side locations (possibly both for SAMOS and Pub. 47). Some vessel metadata (including digital imagery) will need to be transmitted either via email or a web-based system. Clearly multiple methods of metadata acquisition should be considered and the participants agreed that a subcommittee should be formed to address these issues. The primary focus of the subcommittee would be development of an automated method to transmit metadata from ship to shore.

The need for better cruise metadata was also discussed. Currently there is no organized system to determine which research vessels have or are planning to conduct underway meteorological, TSG, carbon, radiation, or other measurements. Current sites created by POGO and the University of Delaware are not meeting this need (likely because this was not considered in their design). There are initiatives underway in UNOLS to improve the access to cruise metadata and it is possible that JCOMMOPS may play a role in this effort. The panel encourages the University of Delaware to play an active role in improving access to cruise activity metadata.

A brief discussion focused on the archival of SAMOS data. At a subgroup meeting on Monday 9 June, members of the GOSUD, SAMOS, the AOML TSG group, and the NODC met to review plans for data archival. It was clear that some comparisons of the data flow for NOAA vessels to NODC are necessary. The members agreed that using data from the NOAA vessel *Ronald Brown* would be a good test case for developing an archival strategy at NODC. NODC, GOSUD, SAMOS, and AOML need to resolve differences between the data collection strategies. SAMOS receives one-minute average data from NOAA vessels, while NODC and AOML receive 30-second spot values. AOML then creates 5 minute median values that they QC and return to NODC. An archival strategy is needed to ensure user access to the best quality meteorological and oceanographic measurements.

SAMOS data flow in 2008 is greatly increased compared to previous years; however, most vessels are currently providing only the basic navigation and standard meteorological parameters (winds, pressure, air temperature, and humidity). The user community is interested in receiving additional parameters to achieve their scientific goals. The discussion of parameters to add to routine SAMOS data collection included:

- **Shortwave and longwave radiation** – According to Michael Reynolds the key parameters to measure are downwelling shortwave, downwelling longwave, and upwelling longwave radiation. The cost of a single set of downwelling shortwave and longwave sensors is ~ $10K. The upwelling longwave (basically the sea surface radiative temperature) is a more costly prospect. The ISAR system developed by Reynolds and his colleagues costs ~$80K, but requires less maintenance than other comparable instruments (e.g., MAERI). Clearly, deployment of the ISAR will be limited to select vessels and the choice of vessels must be driven by high priority science. Deployment of at least a single set of downwelling shortwave and longwave sensors seems a practical next step for SAMOS vessels. Requirements for onboard maintenance must be spelled out (though they are listed in the Marine Handbook).
- **Photosynthetically Active Radiation (PAR)** – PAR is a critical component to many biological studies over the ocean and the satellite and biological communities desire direct measurements. The sensors for measuring PAR are relatively low cost and SAMOS vessels are encouraged to include this measurement in their routine data stream.

There are some issues related to the units conversion from a photon flux (typical of the in-situ PAR sensors) to the more commonly used energy flux (W/m^2) used by the satellite community; however, if the PAR sensors are deployed and provide data from well documented sensor (using known units), the PAR community can work through the issues to take advantage of these measurements.

- **Carbon (CO_2)** – Although carbon measurements are a critical component of the climate problems, there is an entire research community focusing on these measurements. The participants agreed that the role of SAMOS in carbon observations should be one of providing high quality meteorological measurements on ships equipped with carbon sensors, but not necessarily be directly involved with the collection and evaluation of the carbon measurements. To be effective, the carbon and SAMOS programs must improve our dialog. One step is to ensure that the carbon community looks at SAMOS vessels as potential platforms to deploy their instruments and SAMOS should work to recruit vessels that currently have carbon sensors. The participants suggested that it would be helpful to have someone compile the meteorological requirements for the carbon community and some information regarding the priorities for which ships are instrumented with carbon sensors (and subsequently SAMOS data collection).
- **Speed log** – Measures of the fore/aft and port/starboard components of the vessel's motion relative to the water mass are of great interest to groups focusing on wind stress and air-sea heat fluxes. The speed log data provide the opportunity to subtract the ocean currents from the true wind observations to determine an ocean-relative wind, which is the desired measurement for flux calculation. The participants recommend that any SAMOS vessel equipped with a speed log should routinely report these data. It was recommended that the DAC investigate whether or not the upper gate data from an ADCP would satisfy the speed log requirement. The DAC will make inquiries with the ADCP data center at the U. of Hawaii.

During the discussion of future parameters to include on SAMOS vessels, it was noted that the preference is to provide observations from redundant sensors whenever possible. The marine handbook recommends that each vessel carry at least two different sensors for each parameter deployed at separate locations on the vessel. The reality is that funding rarely provides for this level of redundancy. Current policy from the SAMOS DAC is to request data from the "best" exposed sensors on the vessel, but the operator is encouraged to transmit multiple measurements for each parameter whenever multiple sensors are available. The DAC emphasizes that the SAMOS ASCII transmission format and all our data quality processing is designed to handle multiple values for each parameter.

Another key data dissemination issue is the measurements of the seawater temperature collected by the vessels flow water system. Participants noted that most vessels take a water temperature near to the ship's intake and another temperature in the tank for the TSG. The former temperature is the best estimate of the actual sea temperature while the latter is the temperature used to calculate salinity. At present, SAMOS vessels provide a variety of these measurements (often with incomplete metadata). The panel recommends that the SAMOS DAC receive both the intake and tank temperature from ALL vessels. GOSUD currently uses both temperatures as part of a QC procedure to evaluate the flow rate through the water system (as most ships do not provide a flow rate measurement). A similar approach may be adopted by SAMOS.

A new direction for SAMOS is to collaborate directly with international partners to obtain additional underway-meteorological observations. A pilot project has been established with the Australian IMOS project. The Australians plan to provide their observations to SAMOS in the SAMOS netCDF format. They will be conducting their own version of the SAMOS QC which can be compared to the FSU SAMOS processing. Another potential candidate for additional underway measurements is data collected by AWS on VOS. Meteo France is operating 50+ VOS that are equipped with BATOS system. Although the BATOS currently report only hourly data to support NWP, they are capable of providing one-minute observations in delayed-mode (no mechanism for real time data transmission).

The panel agreed that data from the BATOS equipped vessel might benefit the science community; however, the move to include them into SAMOS should be approached carefully. We first must determine which AWS VOS would provide the highest value data to achieve science goals. One suggestion was to focus on vessels that follow the XBT lines.

The preliminary plan is to develop a pilot project where SAMOS would select 1 or 2 of the French BATOS vessels that run on lines of high scientific value (possibly the North Pacific XBT lines). A dialog between Meteo France (Unger), AOML (Goni), and SAMOS (Smith) is underway and will continue over the upcoming months. Other candidates for international collaboration include:

- German Large R/V effort (Stammer)
- Two new icebreakers in Korea and Japan (McGillivary)

The discussions of furthering international collaboration raise the question of upcoming meetings at which SAMOS may want to be present. The INMARTECH 2008 will be held in France in October. SAMOS will seek a representative to "raise the SAMOS banner" at this workshop, possibly providing a poster for the meeting. In addition, the participants suggested making a presence at the International Research Ship Operators Meeting in January 2009. Travel funds may limit direct participation by the SAMOS DAC at these meetings. The chairman also noted that FSU (and the SAMOS DAC) would be hosting the 2008 UNOLS RVTEC meeting from 28-30 October 2008.

The final topic addressed in the SAMOS working group meeting was the future funding of the SAMOS initiative. Clearly budgets are tight at the moment, but the demand for the SAMOS data are growing. The DAC needs examples from any group that is currently using SAMOS or other underway research vessel meteorological data in their research to provide support for this activity. Suggestions for improving funding include:

- Expanding access to SAMOS observations to support NWP and operational meteorology/oceanography (thus relating to GTS issues).
- Further internationalization.
- Exploring possible linkage with IOOS, COOS etc. (targeting coastal data issues).
- Targeting funding for expanded radiation measurements

GOSUD working group report

The GOSUD working group did not formally meet since the 1st joint SAMOS-GOSUD workshop (Boulder 2006). Considering the small amount of time available for this splinter sessions, it was agreed to have a quick review of the actions decided in Boulder and then to focus on the following themes. The 2006 actions list will be distributed again in addition to this meeting actions list. The following themes were addressed:

- Network status
- Importance to enlarge the GOSUD network
- Improve the delivery of data
- Data management
- Develop educational and training capabilities

Gustavo Goni proposed two more points:

- Importance that GOSUD and TSG to be officially recognized as part of the global Ocean Observing System
- Need to have scientific inputs and to get recommendations on transects on which GOSUD must establish a priority

Network status

It is reported that in 2007, 38 vessels are reporting data to the GDAC. Fourteen research vessels report their data regularly and 24 merchant ship send their data to the GDAC. The number of platforms reporting TSG data decreased between 2006 and 2007, but now many ships report higher resolution data. The role of the GTS was discussed. Seventeen ships report their data directly to the GDAC and 21 ships send their data to the GTS where there are retrieved by the GDAC either by the way of MEDS-Canada or Meteo-France. It was also noticed the importance to have more than one link to the GTS to retrieve as much data as possible from the GTS. The data of the ships from the Seakeepers Society (reporting their data on the GTS under KSxxxxx identification) were shown as an example of data circulating through the Meteo-France node of the GTS and not through MEDS. Joaquin Trinanes noted that only one French research vessel (*Marion Dufresne*) is presently reporting data on the GTS. Loic Petit de la Villéon confirmed that all the French research vessels that are routinely collecting TSG data are supposed to report them on the GTS. The problem will be fixed up immediately. The participants agreed on the following recommendation: data must be transferred, each time it is possible, directly to the GDAC, but submission to the GTS must continue.

Presently very few delayed mode data are archived in the GOSUD GDAC. Most of them come from the WOCE Sea Surface Salinity dataset but they cannot be considered as a higher quality than the near real-time data collected during the WOCE period. A discussion followed on the GOSUD delayed mode dataset but, as it is also linked to the on going discussion on new format and to the method developed by IRD to elaborate such a DM dataset, it will be reported in the data management section of this report.

Importance to enlarge the GOSUD network

Some contacts have already been taken to have more contributors to the project. The first priority is to integrate the TSG data from the NOAA vessels. Goni and Trinanes reported that the data were ready to be transmitted and that they were waiting for specifications (format, sampling rate, etc.) from the GDAC. Goni reported that AOML could contribute with local datasets. He also advised that NOAA would soon operate a ship doing the WOCE line PX26 in the North Pacific (*cap Vandemen*).

An important potential source of data is the data collected by the ships selected by the Seakeepers Society. For the moment, the data from only a few vessels from Seakeepers are reaching the GDAC. Those data have circulated through the GTS and have not been sent directly to the GDAC. A discussion followed about the role that GOSUD wants to be played by the GTS. The GTS could be considered either as a way to transmit the data between the collectors and the GDAC or a way to identify the potential further direct contributions to the project. Conclusion was that because of the weakness in the meta-data circulating on the GTS, direct transmission to the GDAC should be preferred each time it is possible. Loic mentioned that some vessels might have been badly identified in the annual report (i.e., R/V *Miller Freeman*).

It was also mentioned that a simple ASCII format is available for submitting the data to the GDAC. This format must be considered as a recommendation and not as a mandatory format to be used to submit data to the GDAC.

Loic reported that the Japanese non-governmental agency VOS-NIPPON has contacted the co_chairs to provide the TSG data they collect. He also stated that VOS-NIPPON did not wish that their ships could be identified and that they want the call signs of their ships to be masked before any transmission to the GDAC or outside their project.

For the moment none of the VOS-NIPPON data have been submitted to the project but agreement must be found because they represent two interesting lines. Loic will re-contact this organization.

Japanese research vessels are potential important contributors. Loic proposed to contact the new JODC director to consider how Japanese data could be integrated in the GOSUD dataset.

Canada vessels were considered as potential contributors to the project. Bob Keeley, contacted by email, informed the project that the ferries that were cruising in the Gulf of Saint Laurent were not collecting TSG data on a regular enough basis to allow routine data transmission to the Project.

Loic informed the participants that an effort in being done at an European level to routinely collect and transmit TSG data that are measured on research vessels. The Spanish research vessel *Cornide de Saavedra* is reporting TSG data routinely in near real time directly to the GDAC. Middle size German research vessel *Poseidon* routinely is collecting TSG data, but they decided to provide their data to the GDAC through the GTS. From time to time, it may occur that one other German research vessels collect and report TSG data to the GDAC. For the moment it depends of the willingness of the chief scientist.

Detlef Stammer addressed the status of the German large research vessels later on in the plenary session. He informed the GOSUD/SAMOS participants that Germany is willing to participate in the world wide effort that is done to collect near surface measurements (including temperature, salinity and other parameters). He mentioned that the data would be provided to the WODC –Word Ocean Data Centre Mare in Hamburg.

Some other experiences have been attempted (i.e., R/V *Belgica*) but they could not provide a near real time routine service.

It was reported that, for the moment, none of the British research vessels report TSG data regularly to the GDAC. Before considering to transmit data regularly they have to demonstrate the demand to get funding. The action is pending but it is asked to contact BODC to consider how they could contribute to the GOSUD activities.

Contacts have been taken with Australia. They will be pursued during the inter-meeting period to organize the data transfer to the GDAC. During the plenary session, Eric Schulz from Bureau of Meteorology proposed to be the contact point between the Australian data originators and GOSUD.

Loic informed the participant that a FerryBox workshop would be held in Southampton (UK) in late September. He will present the GOSUD activities and will propose to integrate the FerryBox data in the GOSUD dataset.

Public relations and training capabilities

This item was addressed shortly during the splinter session but later on it was discussed during the plenary session. It was proposed that the co-chairs contact the Ocean Teacher educational program to consider whether it is possible to integrate a TSG data management part in their courses.

The discussion continued on the difficulty to enlarge the network and how to make the participants aware of benefits of joining GOSUD. Goni reported that, from its point of view, the work done on the *Oleander* is a perfect example of valuable effort and contribution to scientific goals (article in the Bulletin of the American Meteorological Society, EOS). He also informed that AOML is making public relation work. He also pointed out that it is important the international community should recognize our efforts and make TSG part of the Ocean Observing System.

The CLIVAR Office in NOAA and CLIVAR panels should be aware of TSG for climate studies. Goni emphasized the importance to have input from the scientific community. During the plenary session, it was decided that the co-chairs would contact the CLIVAR chairs. The question posed to the scientists will be in which areas do we have to put our efforts.

Requirements from the satellite community are also needed. John Gunn represented the Aquarius project. The European project SMOS was not represented and it is asked to contact them. It should be suitable that GOSUD should be represented at the next Aquarius workshop that will be held in Argentina early December 2008.

Loic noted that when most of the data are well quality controlled and populated with metadata, it would be easier to advertise the GOSUD data. He mentioned that it was one of the reasons that a new NetCDF format definition was proposed (see below).

Loic also informed the participants that the CORIOLIS data centre aggregates different data sources (ARGO, GOSUD, drifters, XBT) and distributes them on a daily basis. For CORIOLIS, TSG data is effectively part of the global observing system.

In summary, it was decided to increase our efforts to demonstrate the added value that could be brought by GOSUD to the global Ocean Observing System. The next objective is to highlight the GOSUD activities during Oceanobs'09 which will be held in September 2009.

The participants agreed it was not relevant to participate to the GODAE meeting. Loic informed also that he would have to report on the GOSUD activities during the next IODE meeting (May 2009).

Data Management

GDAC status: Steve Rutz (US NODC) informed the participants that US-NODC is continuously mirroring the content of the GDAC hosted by CORIOLIS at IFERMER in France. He also mentioned that US NODC will continue to provide the GOSUD data through an OpenDAP server, but since the latest security problems it has not been restored. He also reported that the US-NODC web pages provide links to the major projects contributing TSG data (GOSUD, AOML, CORIOLIS, etc.). A discussion followed on the opportunity to have the same data flow used by the Argo project (DACs feed either one of the GDACs or the 2 GDACs). Goni expressed that Argo is a bigger project and that the GOSUD data exchange structure should remain simple. He also informed that AOML was able to provide NetCDF files with quality controlled data in both near real-time and in delayed mode. Loic Petit de la Villéon reported that the GDAC hosted by CORIOLIS would continue to maintain its OpenDAP server.

A new NetCDF format proposition has circulated before the meeting. Because of lack of time, it has not been discussed in details during this splinter session but it will be discussed further on by email. Bob Keeley has already provided some comments by email. The main innovations of this format are:

1. one file contents the data from a unique voyage,
2. a voyage is considered as the time elapsed between the TSG sensors are changed,
3. metadata (i.e., calibration coefficients) are held in the same file than the data,
4. ancillary data (i.e., water samples) are hold in the same file than the data,
5. a file holds both near-real time data and the related delayed-mode data (best values).

It was decided to circulate again the NetCDF format proposition by the 3rd quarter of 2008 and that a small group should evaluate the metadata fields.

Developing a new format that fit better with the users requirements goes towards making the GOSUD data more used and more visible. This must be one of our priorities.

Quality control

Gael Alory made a presentation describing the method developed by IRD to elaborate a delay-mode dataset. Using the data received in near-real time or when the ship arrives in the port and with the help of the salinity samples taken with bottles, it is possible to evaluate the drift of the conductivity sensor and eventually to propose adjustments of the salinity values that could fit with the water samples. The software, using Matlab, is running as a prototype but some corrections must still be made before any wider distribution. The software is using as inputs/outputs the NetCDF format that has been proposed (see above). The software was also presented during the plenary session. Note: the recommendation is still to collect, when it is possible, water samples on a daily basis.

Goni reported that AOML compare the data against the NCEP reanalysis both in NRT and delayed mode. The values stay the same but the flags can change between the NRT and DM. For the moment AOML does not correct the bias.

Further discussion is needed and a way to continue could be the distribution of the software developed by IRD (see actions list below).

Products

The importance to continue working on integrated ocean products that could integrate TSG data was addressed. During the plenary session, the presentation prepared by Fabienne Gaillard (IFREMER) showed her plan to integrate TSG data and other surface data in an objective analysis.

Next meeting

The participants agreed that a period of 2 years between the meetings was too long. It is proposed to have a GOSUD meeting within one year and AOML proposed to hold it apart from the AOML annual meeting.

Science and Applications

Two sessions of talks focused on the scientific application of SAMOS and GOSUD observations. Topic areas included satellite calibration and validation, roughness length parameterizations, upper ocean variability, and air-sea fluxes of heat, momentum, and carbon.

John Gunn and Gary Lagerloff provided an update on the Aquarius satellite mission and the needs for underway salinity measurements to calibrate/validate the satellite measurements. Aquarius is a partnership between NASA and the Comision Nacional de Actividades Espaciales in Argentina. The current launch date is in May 2010. Aquarius uses three beams pointing towards the night side of the Earth (to avoid sun glint) and will provide global coverage in 7 days (with 4 repeat cycles per month). The authors provided an error analysis using ship observations and simulated Aquarius footprints. Their analysis showed a need to improve in-situ sampling of SSS in the Alaskan Gyre (a region of low salinity).

They also emphasized the need for additional sampling in regions of high salinity and strong gradients. They suggested that a member of the GOSUD community attends the upcoming Aquarius workshop in Argentina (December 2008).

Darren Jackson provided another example of the application of in-situ observations for developing satellite retrieval algorithms for air temperature and humidity. Air temperature and humidity are critical for determining surface heat fluxes. Shipboard measurements are ideal for this activity and they used data from research cruises in the tropical Pacific and Indian oceans to develop their algorithms. The initial validation work presented used temperature and humidity data from version 2.4 of ICOADS, not directly from SAMOS research vessels. The results showed a wet bias in the humidity retrievals from satellites as compared to ICOADS. Darren also noted that they are having problems with retrievals in regions with temperature inversions. They have devised a stability index to help with this problem, which results in better matches in inversion regions. Darren also noted that the height correction of buoys in ICOADS had a larger impact on the comparisons than the correction for ships.

Rachel Pinker presented a potential new application of SAMOS observations, in this case using the Photosynthetically Active Radiation (PAR) sensors. There is an active community working to improve radiative fluxes from satellites, including the PAR range of the shortwave spectrum (spanning 400-700 nm). There are several projects working on this problem, including the Surface Radiation Budget project and the Baseline Surface Radiation Network (BSRN). These (and other projects) have created shortwave radiation products that show large differences when compared to common AMIP2 model radiation estimates. PAR represents a subset of the shortwave radiation spectrum and is necessary to address the carbon cycle, estimating the evaporative flux from land-based vegetation, and primary productivity in the ocean. Rachel's research has been developing estimates of PAR globally using shortwave radiation measurements from satellites. Since direct PAR measurements are not common, the practice is to apply a conversion factor to estimate PAR from shortwave measurements. Analysis has shown that you cannot apply a single conversion factor across the globe. Validating the satellite-derived PAR estimates is still a problem due to limited in-situ observations. Shortwave radiation is measured at some buoy locations, but direct measurements of PAR are rare (especially over the ocean). This is where Rachel sees a unique opportunity to use research vessels and other ships of opportunity.

She noted that a combination of shortwave and PAR measurements from ships, along with visual cloud observations, would benefit the PAR community. Finally she noted that she is chairing the BSRN subcommittee on PAR and encourages SAMOS to collaborate with this panel.

Mark Bourassa focused on the issues related to adjusting in-situ measurements to account for varying observation heights. Adjusting in-situ data to a common height is a concern for computing turbulent energy and mass fluxes, when comparing in-situ and satellite data, and when using in-situ based climatologies for studies of long-term climate change. The choice of algorithm for making height adjustments does make a difference in the resulting value. Mark showed results of a comparison using five parameterizations of roughness length for temperature and moisture and two stability conditions. The different parameterizations have a greater impact on temperature and humidity height adjustments than they do for winds. Mark noted that biases due to height adjustment may not be consistent for upward (buoys) and downward (ship) adjustments and that this could have consequences for data assimilation and objective analyses. Observations collected by SAMOS vessels while they are near moorings (e.g., TAO) provide an ideal set of data to evaluate the height adjustment problems. The knowledge gained from research vessels can then be applied to a wider set of marine data (e.g., ICOADS) when creating marine climate analyses.

Fabienne Gaillard was unable to attend the workshop, so Loic Petit de la Villéon provided her presentation. Fabienne has created an in-situ analysis system to synthesize the SST and SSS data available at CORIOLIS to create a four dimensional T/S analysis. The method uses optimal interpolation after applying some basic climatology and spike elimination quality control tests to ARGO float data. The latest version (4.0) is a global research mode product (not yet operational). Comparisons have been made to the World Ocean Atlas (2005 version). Regional differences are noted at multiple depths, with the largest differences appearing in the North Atlantic and around the western boundary currents. Fabienne is now working to integrate TSG data into the analysis system with the goal of improving the upper ocean salinity fields.

Regina Folorunsho introduced the SAMOS and GOSUD community to the ongoing ocean research in the Gulf of Guinea (of the west coast of Africa). This region is dominated by a southward coastal current and receives a large amount of fresh water input from African rivers. Occasional current reversals and large interannual variability in coastal upwelling impact both the primary productivity and fisheries in the region. Currently there are limited resources for routine ocean observing in the region. They include a few PIRATA moorings and the ARGO floats. Limited ship observations exist and there is great interest among scientist in the region for improved access to historical oceanographic cruise data in the region. Other potential areas for collaboration include bringing the region's few scientists onto U.S. vessels or into U.S. oceanographic institutions for internship opportunities (possibly a way to conduct the data archeology for the region). Regina wished to remind SAMOS and GOSUD to consider the needs of African scientists and developing countries when expanding their observing systems.

The ongoing challenge of studying ocean-atmosphere interaction in the Southern Ocean was discussed by Janet Sprintall. Southern Ocean heat fluxes continue to be very poor and estimates are hampered by the lack of data. Janet showed a mixed layer depth product that clearly showed wintertime mode water formation just north of the Antarctic Circumpolar Front, but noted that imbalances in the heat budgets in the region are huge (> 100 W m^{-2}). The complete lack of data in the wintertime complicates efforts to reduce these imbalances. Sensitivity tests showed that the main contributors to the heat imbalances are the latent and sensible heat fluxes. The available flux products in the Southern Ocean have large differences and there is no consensus as to which product best represents the region. Overall, she emphasized the continued need for additional in-situ salinity and meteorological observations in the region (even during the winter). More data will help constrain the errors in the products and help derive more representative satellite-based products.

The final science and applications talk focused on carbon fluxes and was presented by Cathy Cosca. She focused on ongoing pCO_2 measurements on VOS and research ships. These measurements have existed

since 1992, but the interest in carbon measurements continues to increase as the community works to determine the magnitude of carbon uptake by the ocean. Estimating the carbon flux requires measuring the mole fraction of CO_2 from both the air and the ocean. Cathy's group at PMEL currently focuses on four vessels (*Ka'Imimoana*, *David Star Jordan*, *McAurthur II*, and the *Columbus Waikato*). Systems are semi-autonomous and transmit data on a daily basis. The data undergo shore-side QA/QC and are used to create carbon flux products for the tropical Pacific. Cathy presented recent work to relate pCO_2 directly to SST. This is a promising effort as SST is easier to measure (via satellites).

The discussions that followed the two science and applications sessions focused on the need for the science to drive where resources are allocated for additional in-situ observations.

It was clear that the satellite community needs to make recommendations for in-situ observing on SSS, air temperature, humidity, winds, radiation (including PAR), and specialized measurements like pCO_2. The Aquarius community noted that there is a need for additional TSG data in the North Pacific (low salinity region), the subtropical gyres (high salinity regions), the Southern Ocean, and regions with large amounts of rainfall. Similarly, Darren Jackson noted that the Southern Ocean, South Pacific, and the subtropical gyres are of interest for additional air temperature and humidity observations to validate satellite retrievals. Regions with high winds are especially critical for those working on satellite flux studies. Sampling issues are not just spatial, but temporal as well.

There is a need for more in-situ observations during the winter in the Southern Ocean. Where possible ship observations should be collected and the SAMOS and GOSUD communities should collaborate with ongoing ocean observing system initiatives to deploy moored buoys in the Southern Ocean. Several action items were noted to address the need for input from the science community to the data collection projects (SAMOS, GOSUD, etc.).

A second discussion focused on the need for better coordination between the different shipboard in-situ observing programs. There is a clear need to know which vessels are conducting routine meteorological, TSG, PAR, radiation, pCO_2, and other underway measurements. The potential exists to consolidate these observations onto several ships to provide a "super-observing" platform. This may lead to an economy of technical and personnel resources needed to develop high-quality observations. In addition, the different projects can benefit by sharing their data from co-located sensor systems (e.g., when SAMOS and GOSUD data are available on a pCO_2 equipped vessel, the quality evaluated meteorology and TSG may benefit the pCO_2 analysis).

Poster Session

In addition to the oral presentations and associated panel discussions, a series of twelve invited and contributed posters were presented. The poster authors provided a brief oral introduction to their work at the beginning of the poster session. Topics of the posters included automation of marine measurements, air-sea flux studies, comparisons between marine data collection systems, and data stewardship.

The poster session showed that a lot of efforts are being done in different laboratories and that it is important that the meteorological and marine data that are acquired should be disseminated through projects such as SAMOS and GOSUD. It also highlights the importance to have a common approach in quality control the data and to use compatible procedures and formats. The posters that have been presented could be split in 3 groups. The first series of posters shows what is done to contribute to the global effort of collecting data. The second group of posters shows what is the present state of art on the quality control procedures for both meteorological and near the surface ocean data. In the third group one of the posters shows how to access TSG data as part of the integrated global ocean observing system that includes also moorings, Argo, XBT, CTD and drifters data, and the last poster suggests how the links between the ICOADS and the JCOMM projects should be strengthened to match the ICOADS requirements in terms of data and metadata.

A short summary of each poster follows:

Integrating the R/V Pelican's Underway Data into LUMCON's Environmental Monitoring System
Presenting Author: Ms. Brenda Babin (LUMCON)

The Louisiana Universities Marine Consortium (LUNCOM) has collected on board the *R/V Pelican* a 10 years time-series of meteorological and water quality environmental data. All those data are transmitted in NRT and integrated into the LUNCOM's environmental monitoring system before being transmitted to the SAMOS project. This is a good example of how a local effort to collect data can contribute to the global observing system.

Remote management of an autonomous shipboard scientific data using a wide area wireless network
Presenting Author: Mr. Thomas Wilson (School of Marine and Atmospheric Sciences)

As part of the SoundScience project, an autonomous data collection system was developed and has been operated since 2003 on board the *M/V P.T. Barnum*. The system allows the collection of climate-quality weather data and hydrographic data (including ADCP data). By using the commercial wide area wireless networks in the New York metropolitan area, the system allows sending of the one-minute-averaged data. The interesting innovation of this system is ability to control this data collection system from the shore. This allows more rapid troubleshooting and is of a great help to maintain a coastal ship based network when it is difficult to get time, when the ship is at the port, for maintenance.

In-situ wave measurements at Station Mike.
Presenting Author: Dr. Margaret Yelland (National Oceanography Centre, Southampton)

The poster presents in-situ wave measurements that have been collected at the station Mike. The Norwegian weather ship was equipped in 1978 to make measurements of the sea state. In 2006, the ship was equipped with a marine wave radar. Taken together, the two systems provide a comprehensive description of the sea state. Using the two systems allows cross comparison of the measurements.

High Wind Air-Sea Exchanges (HiWASE) - continuous air-sea turbulent flux measurements on the weather ship Polarfront.
Presenting Author: Dr. Margaret Yelland (National Oceanography Centre, Southampton)

The objective of the HiWASE project (part of SOLAS –Surface Ocean Lower Atmosphere project) is to improve the parameterizations of surface fluxes in terms of more easily measured mean variables. This study presents initial results that have been derived from data that have been collected on board the weather ship *Polarfront* and from a long time-series collected at station Mike.

Advancing Marine Climatology with GOSUD/SAMOS Data: Enhancing Linkages to ICOADS and JCOMM
Presenting Author: Mr. Scott Woodruff (NOAA/ESRL)

The International Comprehensive Ocean-Atmosphere Data Set (ICOADS) is the largest archive of historical surface marine data. Data and metadata are stored using the IMMA –International maritime Meteorological Archive format. The poster highlights the potential of high resolution GOSUD/SAMOS data to complement the ICOADS.

One specific goal from the 1st joint GOSUID/SAMOS meeting was to investigate an appropriate template for GOSUD/SAMOS combined data. This poster suggests completing that action through the implementation of IMMA "attachments" containing data and metadata provided by GOSUD/SAMOS that cannot be included in the IMMA core format.

Incorporating real – time GOSUD/SAMOS Data into the World Meteorological Organization's Voluntary Observing Ship (VOS) Program and VOS Climate (VOSClim) Project.

Presenting Author: Mr. Robert Luke (National Weather Service)

This poster shows the complementary nature between the JCOMM (and its subdivision SOT) programs (VOS, VOSClim, SOOP) and projects such as SAMOS or GOSUD. While the JCOMM programs provide an official structure to argue on which areas or lines the data originators must focus on, the programs like SAMOS and GOSUD provide recommendations on quality control procedures, formats description, and data management structure.

The Automatic Weather Observing System (AWOS) for the State of Kuwait (Marine Sites)

Presenting Author: Mr. Kasem Elfadli (Directorate General of Civil Aviation (Meteorological Department))

This poster is a good demonstration that all the countries can contribute to a worldwide observation system. Based on the AWOS (Automatic Weather Observing System) installed by the Australian company ALMOS, the network is able to automatically collect synoptic data, agro-meteorological data, and marine data. The data are shared through the GTS and SYNOP, SHIP, BUOY, and CLIMAT messages are regularly disseminated. Sea temperature and salinity are acquired at three different levels in addition to ocean currents and waves measurements. The poster highlights the importance to share quality-controlled data.

CORIOLIS: providing an ocean in situ data service for the needs of operational oceanography

Presenting Author: Mr. Loic Petit de la Villéon (IFREMER)

The poster represents the effort that has been developed at a French level to implement an in-situ data center dedicated to the needs of operational oceanography. The CORIOLIS data centre plays an important role in three major ocean in-situ projects: (i) Argo as one of the 2 GDACs, (ii) GOSUD as the GDAC, (iii) OceanSites as the GDAC for the management of open-ocean moorings. The first priority was dedicated to the near-real time data processing. Further on, they focus on delayed-mode data processing (Argo and GOSUD). They have reprocessed global datasets for the years 2002-2006 and it is planned to do the same for the years 1990-2007.

Quality Evaluation of Marine Meteorological Observations

Presenting Author: Mr. Jeremy Rolph (COAPS)

Since the WOCE experiment the Florida State University has developed a good knowledge in quality control the meteorological and near-surface data. The poster describes the different quality control steps that are applied and highlight the importance that the DAC provide feedback to the data originators to enhance the quality of the data that are collected.

Shipboard Meteorological Measurements: Interpretation and Quality Assessments

Presenting Author: Mr. Daniel Wolfe (NOAA/OAR/ESRL/PSD3)

This poster presents results derived from the data that have been collected on board the USCGC *Healy* and the Woods Hole research vessel *Knorr*. The results provide some feedback on how the instruments work but the most important thing is to notice how placement of the instruments on the ship and the design of the ship could affect the measurements.

Data Flow through the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Data Assembly Center

Presenting Author: Mr. Shawn Smith (COAPS)

First this poster gives an overview of the SAMOS project which aims to improve the quality of meteorological and near-surface oceanographic data and to select research vessels and merchant ships that could provide long time series of high resolution data.

But the poster describes in details the data flow that has been implemented in the project. This includes a data logger connected to meteorological and oceanographic sensors, quality evaluation procedures, data storage in a DAC (Data Assembly Centre), and free data distribution. The importance of the meta-data is highlighted. It is demonstrated that the final quality of the measurements depends on the sensor exposures so the characteristics of the installation of the sensors must be very well known.

Technicians round-table discussion

The technician's roundtable occurred for the first time at the 2nd Joint GOSUD/SAMOS Workshop. The goal was to provide the vessel operators, technical managers, and shipboard technicians a forum to raise issues, concerns, and ideas that would lead to improved data collection for both GOSUD and SAMOS. Ten shipboard technicians and six technical managers represented the technical community. The workshop chairmen and the session moderator, David Forcucci, were uncertain as to how well this session would be received, but we would have to say that it was a great success and we will allocate more time for this open dialog at future workshops.

The first discussion topic was the pros and cons for participating in the SAMOS or GOSUD projects. The majority noted that there are no fleet-wide standards for what instruments to deploy or parameters to measure in terms of underway meteorology or TSG. In addition, there are no standards for training of technical personnel. The participants noted that having programs like SAMOS or GOSUD to provide guidance and standards based on science needs was an advantage for the operators. Another comment made was the need for each operator to have a single point of contact (or champion) to implement the recommendations of GOSUD and SAMOS. This person would be in direct contact with the SAMOS and GOSUD data centers.

Sensor maintenance and calibration are a huge responsibility of the technical personnel on each vessel. Questions raised included whether or not SAMOS or GOSUD could set standards for calibration and sensors and whether or not the SAMOS/GOSUD metadata forms (web based or not) provide sufficient detail on calibration. Most scientists in the group felt that it was important to leave the calibration details up to the operators collecting the data and that it was sufficient to know when the calibration was last completed. It is very rare to have post cruise calibration completed (with the exception of TSG) and have this used to adjust previous measurements.

This may be a laudable goal for the future of SAMOS data collection, but we are not ready to reach for this goal. Several technicians noted that if SAMOS or GOSUD would like more frequent or additional calibrations (or calibration documentation), these suggestions should be presented as a clear request and then the operators could try to achieve the request (with new funding as needed).

How to achieve new or improved calibration schedules and practices on SAMOS/GOSUD vessels was addressed. There were several suggestions to take advantage of ongoing activities. The BSRN does have a protocol for calibration of radiation sensors and it would be advantageous to work with BSRN ocean observation team to distill this information to a level that is useful for the technicians and operators.

A suggestion to ensure that recommended calibration practices are followed would be to have them included in the NSF ship science inspections. It was noted that this would only help with the UNOLS vessels funded under NSF, but the lessons learned from this exercise could be extended to other U.S. and international operators. Dan Wolfe suggested that we might want to tie this activity into the American Meteorological Society instrument and observation committee. The question was raised as to whether or not this committee had a marine meteorologist and whether or not someone from SAMOS could serve that role. The final recommendation from this discussion was the formation of a SAMOS task team on calibration standards and practices. This committee would develop realistic schedules for calibration of the primary instrumentation required by SAMOS and GOSUD (including looking into routine water samples for TSG calibration). Tom Wilson volunteered to lead this task team and will be seeking members. There was some off-line discussion of having this team meet at RVTEC in October 2008.

The routine collection of meteorological and oceanographic observations and the accompanying metadata are the focus of both GOSUD and SAMOS. This activity is where the shipboard technical personnel are on the front-line of these programs. In terms of the actual data transmissions, most operators and technicians seem pleased with the current system using an email protocol and the SAMOS ASCII key:value pair format. There is always room for improvement, but the present discussion did not raise any issues. The primary problem area is the routine transmission of metadata, both related to the vessel and the instrumentation (which poses the greatest challenge). The discussion focused on ways to automate the transfer of metadata from ship to shore. Woody noted that SIO uses a configuration file within their logging system with one file for each sensor. Others use event log files to highlight when sensors are started or turned off. The question is how best to utilize this information and move it to a shore-side data center. Suggestions included sending daily ASCII text metadata documents or using sensor ML (or an alternative XML) format. Tom Stepka noted that it might be possible to expand the configuration file for SCS to include all desired SAMOS metadata. In the end, it became clear that metadata issues need to be addressed by a second SAMOS task team. Shawn Smith agreed to chair this task team and Toby Martin and Brenda Babin expressed interest in participating. Shawn will be seeking additional members and someone suggested contacting Jerry Miller at CORE. The task team will consider the issues related to static and dynamic metadata, setting some protocol for automated transfers (likely using one or more methods), and how to take advantage of existing configuration and event log files. An opportunity to meet may also exist at the UNOLS RVTEC meeting in October 2008.

In addition to the flow of data and metadata to SAMOS and GOSUD, a key component of the success of these programs is their feedback of information to the vessel operators and the shipboard technicians. There was general agreement that real-time feedback is very beneficial to the personnel at sea and the technicians made several suggestions for new information.

There was a suggestion to provide time series plots of the observations back to the vessels that include the QC flags. The current flag summaries and graphics are nice, but they do not clearly show the shipboard technician what observations are suspect and how they relate to other observations. Another suggestion was to provide a daily “trouble” report stating the time range and sensors that are exhibiting problems. If no problems exist, several technicians still noted it would be nice to know that the data were received and are OK. If possible, daily messages should be both script and human readable. Clearly some form of daily, weekly, or monthly data flow and data quality report is desired. The primary suggestion was for the SAMOS data center (not sure if this would also work for GOSUD) to establish a subscription service to a series of quality reports. The different operators could subscribe to the service to receive updates on their vessel.

Final thoughts on feedback to the vessel operators and personnel included establishing some form of email list services. This would include a forum for discussing problems throughout the vessels providing data to SAMOS. The service should be broken down by ship and operators and should include an overall list for all vessels operating within SAMOS. Lastly, there was agreement that some form of recognition program for vessels and shipboard personnel is desirable. This may be certificates, hats, etc. It was also recognized by the technicians that it is important for the scientists and data centers to inform them of why these data are important and how they are being utilized. These comments will also help raise awareness of the data and show their importance when operators submit their annual funding request for instrumentation and personnel.

Data Stewardship

The SAMOS and GOSUD data centers are involved in all aspects of data and metadata collection, quality evaluation, format specification, data distribution, and archival.

Gustavo Goni began this session with an overview of the TSG operations at NOAA AOML. Data arrive at AMOL via two primary systems: SEAS 2000 provided data from cargo and cruise vessels and the observations from the NOAA research fleet arrive via SCS.

These data are emailed to AOML where they undergo automated QC and are placed on the GTS. The QC system is based on the recommended GOSUD real time QC plus three additional tests (including a comparison to water samples). Guilherme Castelao provided a demo of the QC system. The system allows the user to attribute quality codes, show the ship trajectory, display the climatology, calibrate the TSG, and interpolate missing positions. The data may also be corrected with external data and can be augmented with metadata.

Data formats are a continual issue with any data project. Joaquin Trinanes described several of the traditional GTS data formats for ocean observations (BATHY, TESAC, BUOY, TRACKOB) and introduced a proposed BUFR template for TSG observations. The old formats date back to tape data transmission and hand encoding, so they were human readable, but very limited in terms of data precision and metadata. WMO has mandated a transfer from the legacy GTS formats to table driven formats (BUFR recommended for underway data) by 2012. BUFR is a binary format based on the needs of the NWP modeling community. It requires tables to define codes but offers the flexibility to define your own description (in the local section). Currently, AOML does BUFR encoding on the shore side, not on the ship. This issue is more one for transmitting data via the GTS to ensure data is useful for modeling centers. Currently AOML has code to translate XBT and TRACKOB data to BUFR. They will be attending a meeting in September 2008 to finalize the VOS BUFR format (for meteorological data) and may address the XBT and TSG templates at this time. Must be done now as approval process can take 2 years.

Steve Hankin followed the TSG data flow and format talks with an introduction to the Observing System Monitoring Center (OSMC). The OSMC is a tool for science managers to review the status of the global ocean observing system. In its current form, all information entering into the OSMC is provided through the GTS (including all the problems and limitations of the GTS data flow). The GTS works for operational observing systems, but Steve asked the question: How do we get data into the OSMC from climate quality observing centers that are primarily research funded at present (e.g., the SAMOS DAC and GOSUD GDAC). For simplicity, all the OSMC is looking for is the "footprint" of platforms making observations. It is necessary to know what type of observations are being collected and from what type of platform.

The possible solutions presented are to (1) push all SAMOS and GOSUD data to the GTS, (2) provide OSMC access to databases at the DACs, or (3) establish the link through an OpenDap server. Steve also noted that the latest version of the Live Access Server (LAS) would handle trajectory data sets (e.g., hydrographic cruises).

The discussion following the data stewardship was limited. One item of note for SAMOS was that Steve was willing to have a member of his staff travel to FSU (if needed) to help set up a new LAS/OpenDap server for the shipboard data. As a follow-up to the discussions in Seattle, a teleconference was recommended between the SAMOS DAC and PMEL to address developing an action plan to get SAMOS represented in the OSMC. One post meeting thought by the SAMOS chair was to consider whether or not assembling an international workshop on underway data assembly and stewardship would be useful? The idea would be to bring the community together to determine the feasibility of extending to other countries' fleets the German model of ensuring certain sensors were on-line and collecting data (and the necessary ancillary data and metadata) whenever an R/V is at sea.

Educational Initiatives

The initial SAMOS workshop in 2003 "strongly encouraged funding agencies to support human capital development through education and training". To address this long-standing recommendation, a session on educational initiatives occurred at the 2nd Joint GOSUD/SAMOS Workshop.

Lani Clough led off with an overview of the Marine Advanced Technology Education (MATE) center. MATE is a national partnership of community colleges, universities, research institutions, marine industries, and working professionals focused on increasing the number of highly skilled individuals who enter the marine technical workforce. MATE originated out of industry needs for a technically competent workforce.

In the days before MATE originated, the United States was great at developing new technology, but was not so good at providing the education and training necessary to maintain these high-tech systems. MATE evolved to bridge the gap between the high-tech marine careers and the few training programs that can provide hands-on at-sea experience. One focus of MATE has been their intern program that places students on research vessels and in labs or industry settings. The main problem MATE faces is that many of their interns do not understand the nature of marine technical work and equipment prior to their internship on an R/V. Several suggestions were made to better prepare students including providing more information on equipment or improving the curriculum to better prepare students for their at-sea experiences. To better prepare students, the MATE Center suggest an improved curriculum needs to

- be portable (online?)
- accommodate a variety of learning styles (e.g. streaming video with narration)
- clearly define the prerequisite knowledge and this knowledge could be gained in introductory courses (oceanography, computer science, meteorology, etc.,).
- directly connect to the student's at-sea experience so the learning is relevant
- provide knowledge and skills that UNOLS and the USCG find valuable
- reinforce basic math and science principles
- provide a foundation for a myriad of technical and science knowledge and skill sets that an employee would need in a at-sea position in research or in industry

At the end of her presentation, Lani described the ongoing development of a certification program for oceanographic professionals. She sought input of the workshop attendees through a survey she distributed after her talk.

Ali Hudon introduced the activities of the Alliance for Coastal Technologies (ACT). ACT is a NOAA-funded partnership of research institutions, state and regional resource managers, and private sector companies interested in developing and applying sensor technologies for monitoring coastal environments. Several of the technologies applied by ACT are frequently used for underway observations on R/Vs. ACT is comprised of eight institutions around the country that work to test and document sensor technology. These institutions conduct a series of technology workshops that include instrument developers, academics, and technicians. The workshops facilitate a critical dialog between these parties to build a consensus on how to build useful tools for the topic area of the workshop (e.g., in-situ nutrient sensors, turbidity sensors, biofouling prevention, etc.). ACT also completes technology verification studies (ensuring sensors meet manufacturer's specifications) and technology demonstrations (using new technology before they go to market). The also provide some training opportunities (workshops) and have created a series of field guides. The field guides were of great interest to the R/V technicians at the GOSUD/SAMOS workshop.

Kathy Fearon outlined the expertise of the Institute for Instructional Research and Practice (IIRP) at the University of South Florida. They have extensive experience in developing testing programs and assessing the success of the tests. They also have experience in developing computer-based and computer-adaptive testing. They have worked on credentialing exams for laboratory technicians (among others) and could bring this experience to GOSUD/SAMOS for developing training programs for marine technicians.

An open discussion on potential educational initiatives followed these introductory talks. The chairman asked who provides most technical training for instrumentation on R/Vs. Most respondents stated that the training either comes from the manufacturers or simply is a matter of handing a technician the instrument manual and saying, "figure it out". NOAA AOML does run training on TSG systems (Is this open to anyone?). Typically marine technicians do not have too much problem when it comes to running the instrumentation; however, learning how to calibrate and maintain the sensors is more of an issue. Additional best practices guides, tailored to the technician's needs, would be helpful. Regina Folorunsho noted that developing simple flyers (1-2 page guides) of best practices for individual sensors could be very helpful (also easy to distribute).

During this session, an informal survey of the backgrounds of marine technicians was collected from the representatives of various countries at the workshop. Vinciane Unger stated that France has a school for marine technicians (a 2-yr program) and that most of their technicians come from an electronics background. In the UK, the marine technicians are often at a more mature level in their careers, with some being retired from the Navy. The shore-based technicians also tend to come from an electronics background.

Toby Martin noted that about half of the technicians in the U. S. are from the "nuts and bolts" hardware and electronics background while the other half come from the biological and geological sciences.

The discussion briefly focused on opportunities to develop interactive (computer based) modules to use for training prior to technicians going to sea. Ali noted that there is a corporation in St. Petersburg, FL that develops interactive modules for port security efforts. Shawn Smith suggested that it might be possible to develop interactive modules to show how meteorological observations change when sensors are well and poorly sited.

Another suggestion would be modules showing how true winds could be compromised by the failure to include one or more critical navigational parameters. It was suggested that there are many on-line physics experiments that may provide some examples to review. The development of these interactive modules may allow interns or students a chance to see the issues that occur with making underway observations, without having expensive hardware in their hands.

Of course, there is no substitute for hands-on experience. The discussion turned to how GOSUD and SAMOS could provide a "workshop" opportunity for marine technicians. The first question was whether or not there was a good time during the year for such an opportunity? Technician schedules are busy throughout the year, but in the U. S. the majority of the NOAA fleet has a winter lay-up period in December and January. This may provide an opportunity for a workshop. The possibility of a 1-2 day winter school, with hands-on training in best practices for meteorological and TSG systems, was suggested and recommended for investigation by GOSUD and SAMOS.

Clearly there are opportunities to take advantage of the coastal activities of ACT. They have developed several best practices guides that should be reviewed by the R/V technical community to see it they would meet some of their training needs. Another suggestion was for ACT to develop one or more workshops on PAR and other meteorological parameters that may benefit the biological community and ecological researchers.

Appendix A: Action items

Collaborative Actions: Determined during Plenary discussions

Item	Action	Who	When
1	Develop manuscripts, power points, and/or public relations material to show the value of underway TSG and SAMOS observations for science and operations	Goni, Smith, Petit de la Villéon	Initial material by end of August 2008
2	Satellite salinity community to provide written list (to Smith and Petit de la Villéon) of needs for underway SSS collection for cal/val. (including desired water sampling to validate TSG and ocean regions where expanded TSG sampling would support their mission)	Gunn, Lagerloff, SMOS representative	End of August 2008
3	Provide a list of focus regions where additional SAMOS-type underway Tair/Qair measurements are needed to support development/validation of satellite Tair/Qair retrievals (send to Smith).	Jackson, Wick	End of August 2008
4	Provide a list of needs for underway wind measurements that will support the activities of the satellite wind community (send to Smith).	Bourassa	End of August 2008
5	Engage the BSRN PAR working group to raise awareness of PAR measurements from SAMOS vessels and to ensure the sampling, units, and QC of underway PAR meet the requirements of the radiation and biological community	Smith, Pinker	
6	Cross link web resources for programs (e.g., GOSUD, TSG, SAMOS, PCO_2, Radiative SST, Ocean Radiation, and direct fluxes) making underway measurements on vessels	Smith, Goni, Petit de la Villéon, Cosca, Wolfe, Reynolds, Yelland	As possible
7	Provide recommendations to vessel operators for • What parameters to measure • Instrumentation (general, not by manufacturer) • Sensor redundancy • Sensor placement (for typical R/V deck profiles) • Calibration frequency, etc.	GOSUD, SAMOS data centers	
8	Investigate AGU science session focusing on application of automated underway ocean measurements from ships and autonomous vessels	Bourassa, Smith	Early 2009
9	Compile list of meteorological and surface ocean parameters needed to support high quality carbon observations from vessels. Provide to Smith.	Cosca	End of August 2008
10	Provide suggestions from the carbon community to Smith, Goni, and Petit de la Villéon on how SAMOS, GOSUD, and the carbon community could work to co-locate their activities on individual vessels.	Cosca	
11	Develop an article for a popular weather magazine that outlines the importance of visual cloud information and the concerns that these data will be lost due to automation	NOCS to lead?	
12	Investigate holding a “winter school” for marine technicians that focuses on “best practices” for making underway meteorological and flow water measurements.	Smith, Goni, Wolfe, others as interested	
13	ACT is requested to disseminate information regarding the ACT Technology on-line forum to the USCG, UNOLS, MATE, and other interested parties. (This forum allows techs to discuss, troubleshoot, and request	Hudon	As possible

	assistance/information regarding use of sensor technology).		
14	David Forcucci will forward ACT Technology Forum web site to UNOLS RVTEC.	Forcucci	August 2008
15	Smith will put ACT in contact with RVTEC chairman for the purpose of having Ali (or another ACT representative) attend the 2008 UNOLS RVTEC meeting in Tallahassee.	Smith, Hudon	Done

SAMOS Actions: From working group and plenary sessions.

Item	Action	Who	When
1	Provide a list of focus areas where additional SW and PAR measurements would support satellite PAR estimation	Pinker	August 2008
2	Begin routine transmission of speed log observations (fore/aft and port/stbd components) from SAMOS vessels (if necessary instruments are available)	All SAMOS vessels	As possible
3	Vessels equipped with vessel pitch/roll sensors should begin transmitting the following measurements: • Mean pitch • Standard deviation of pitch • Mean roll • Standard deviation of roll • Exact location of the pitch/roll sensor on the ship (use 3 axis measurement system used for other instruments in SAMOS) NOTE: Positive roll is port side upwards, starboard down. Positive pitch is bow upwards.	All SAMOS vessels	As possible
4	Establish a task team to discuss calibration frequency, practices, and standards for SAMOS	Tom Wilson to Lead	Summer 2008
5	Establish SAMOS task team to investigate and develop a protocol for instrumental metadata transfers for SAMOS vessels	Smith, Stepka, Babin, Martin	Summer 2008
6	Develop additional automated feedback to SAMOS data providers and a subscription service for these products	SAMOS data center	Fall 2008
7	Establish email list services for SAMOS data providers	SAMOS data center	August 2008
8	Provide to Smith a short list of how ocean weather service could take advantage of SAMOS observations in real time (6 hourly window). Bring forward the data requirements of ocean weather services, regarding observation type, timeliness, quality indicators)	Ji	August 2008
9	Explore methods to respond to needs of ocean weather prediction centers for SAMOS-type observations (possibly GTS transfers) or SAMOS QA/QC procedures.	Smith, Bourassa, Ji	Summer 2008
10	Investigate using a unique “masked” call sign for SAMOS ships to allow distribution via the GTS in a manner that would differentiate a SAMOS report from a VOS or VOSClim report for the same vessel.	Smith, Luke, Woodruff	Fall 2008
11	Provide contacts for POGO and other organizations that should be aware of the SAMOS activities (beyond NSF)	McGillivary	August 2008
12	Contact U. Hawaii ADCP data center and Fabriece Bofjen (?) at ERS (Bourassa to provide contact) to determine value of substituting upper ocean ADCP data for speed log. Send result of inquiry to operators.	Smith, Bourassa	August 2008
13	Send request to all SAMOS vessels to begin routine	Smith	July 2008

	transmission of BOTH temperature near the water intake (the sea temperature) and the TSG temperature (used to calculate salinity)		
14	Seek a representative for SAMOS that will be attending INMARTECH. The SAMOS data center can provide a poster and/or brochures.	Smith	July 2008
15	Develop a pilot project with Meteo France to exchange 1-minute AWS data. • Select one or two routine lines occupied by BATOS equipped vessels that also match TSG or XBT lines – Unger, Smith, Goni • Provide request for routine data collection at 1-min. intervals to Meteo France – Smith • Establish protocol to retrieve data and metadata from selected vessels and data transfer to SAMOS data center – Smith, Unger • Provide for QA/QC and feedback to Meteo France – Smith	Smith, Unger, with input from Goni	As possible
16	Explore possibility of a SAMOS presence at International Research Ship Operators meeting in January 2009, New Zealand.	Smith, White	Summer 2008
17	Provide a clear recommendation for siting a single sensor suite (wind, temp, rh, pressure, radiation) on research vessels using 2 or 3 common vessel geometries (e. g., block wheelhouse [icebreaker], stepped superstructure, etc.)	Smith, Moat, with input from others.	End of 2008
18	Provide to Smith a letter from NOAA OMAO describing some of the perceived benefits of your participation in SAMOS (emphasizing cost savings where possible).	Stepka	August 2008
19	Operators participating in SAMOS are asked to try using the web-based metadata interface and provide critical feedback to Smith. Rolph to send out instructions for system.	All operators, Rolph	August 2008
20	Update SAMOS netCDF format to make CF compliant • Include designator for QC system and version • Include “conventions” attribute • Move to have SAMOS units listed in CF conventions	SAMOS DAC	As possible

GOSUD Actions: Mostly from working group with some modifications from plenary

Item	Action	Who	When
1	**Actions to enlarge the network**		
a	Germany is a potential important contributor. Stammer as 1st contact for large vessels	Petit de la Villéon to contact Stammer	September 2008
b	Japan: contact JODC 's new director	Petit de la Villéon	September 2008
c	Japan: re-contact the VOS Nippon organization	Petit de la Villéon	September 2008
d	Contact BODC and British Ship operators.	Petit de la Villéon	October 2008
e	Approach the FerryBox community. Attend the next September workshop to be held in NOCS	Petit de la Villéon to attend	30 September 2008
f	Australian data transfer must be organized, through AOML if there are both met & ocean data at the same frequency otherwise directly to GOSUD	(Buttler, Schulz ,Petit de la Villéon)	December 2008
2	**Existing data and providers**		
a	Set up the data delivery from NOAA vessels to GOSUD	Goni, Petit de la Villéon	Sept/Oct 2008
b	Organize the transfer of the Seakeepers data (both historical and on going data)	Morisson, Petit de la Villéon	November 2008
c	Opportunity to submit a proposition for QC historical data	Goni, Petit de la Villéon	??
3	**Data management**		
a	Analyze the new format proposition (CF Compliant)	all	Summarize by the end of December 2008
b	Unique Id to be decided to match GOSUD & SAMOS data (cross SAMOS/GOSUD.	Smith, co-chairs	??
c	BUFR format template to be proposed	Trinanes	
d	Check meta data are consistent between the NetCDF format and the BUFR format	all	January 2009
e	Improve data delivery and clarify the role of the GTS	all, and ask Keeley	Long term action
f	Encourage national participants to provide their data directly to the GDAC instead on through the GTS. GTS should be considered as a way to track new potential providers	co-chairs and all	Long term action
g	Ask IRD if they could distribute their QC software	Alory, Petit de la Villéon	October 2008
h	Distribute the QC procedures (both NRT and DM) and highlight the differences	Goni, Petit de la Villéon	November 2008
i	Restart the French R/V TSG data for being inserted on the GTS (for the moment only one)	Petit de la Villéon	
j	Enhance the collection of the characteristics the ship installation details -possible because few ships	all to contact ship operators	
k	Advertise recommendations on sensor calibration frequency and more	co-chairs	
4	**Products**		
a	Identify existing products which integrate ocean surface data	all	
5	**Installation**		
a	Develop recommendations for the collection and routine	IRD, Petit de la	January 2009

	analysis of TSG water bottle samples that balances the need of science and the operational realities on participating vessels (i.e. need water samples on a daily basis)	Villéon, with input from SAMOS task team (SAMOS action 4)	
b	Advertise recommendations on TSG installation and on data collection procedure	IRD, Petit de la Villéon, SAMOS	January 2009
6	**Input from outside**		
a	To contact the CLIVAR chairs to have input from the scientific community Co-chairs	Keeley	As soon as possible
b	Which tracks? Which areas do we have to put our efforts first?	All	Long term action.
c	Inputs from the satellite community SMOS part to be contacted Attend the Aquarius workshop to be held in Argentina late 2008	Co-chairs (determine representative for workshop)	September 2008
7	**Public relations and training**		
a	Make the TSG data collection to be recognized as a full component of the Global Ocean Observing system. Very important.	Goni	By September 2008
b	GODAE : not relevant to be present	N/A	N/A
c	OCEANOBS 09 should be a better opportunity for advertising GOSUD	Co-chairs	February 2009
d	IODE Spring 2009. China. To be confirmed	Petit de la Villéon	4-5 May 2009
e	Propose Ocean Teacher to include GOSUD data in their courses	Petit de la Villéon	January 2009
8	**Next meeting**		
a	Proposed next meeting : AOML June 2009 in association with the AOML annual meeting (due to GOSUD desire to meet on annual basis)	Co-chairs, Goni	
9	**Look into the next steps to have GOSUD as a permanent program instead of pilot project**	**Keeley**	

Appendix B: Abstracts (in alphabetical order)

Monitoring Sea Surface Salinity in the Global Ocean from Ships of Opportunity: the French SSS Observation Service

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Sea Surface Salinity (SSS) observations are needed to improve our understanding of the earth's water cycle and climate variability. SSS has proven to be valuable for improving estimates of evaporation minus precipitation budgets, describing and understanding climate variability at seasonal to decadal time scales, testing physical processes, assessing numerical model performances, improving mixed layer representation by assimilation techniques used in operational oceanography, quantifying the role of salinity on sea level change, and improving El Nino prediction lead time. The importance of SSS in the climate system has motivated the development by European and USA/Argentina space agencies of dedicated satellite missions (SMOS and Aquarius) to enhance global observations. This presentation focuses on the French SSS Observation Service (www.legos.obs-mip.fr/observations/sss/), its strength and potential improvements. This service aims at collecting, validating, archiving and distributing in situ SSS measurements derived from Voluntary Observing Ship programs, both for climate research and for operational oceanography through the CORIOLIS data service (www.coriolis.eu.org). Details will be given about instruments and softwares used, management of real time data transmission, validation processes for real time and delayed mode data, with a special focus on a new validation software for delayed mode data, derived products, climatic indices and recent scientific results.

Integrating the R/V Pelican's Underway Data into LUMCON's Environmental Monitoring System

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The addition of HiSeasNet on the R/V Pelican provides LUMCON the opportunity to transmit data to shore in real-time. LUMCON is working to in transmit the MIDAS Underway data from the vessel to its facility via FTP. This data will then be integrated into LUMCON's Environmental Monitoring System and displayed online at weather.lumcon.edu. Mapping tools will not only display the ships location but also various water quality values along its course. Interpolated surface plots will also be available. This integration project is taking place alongside of the R/V Pelican's participation in SAMOS.

The Influences of Differing Temperature and Moisture Roughness Length Parameterizations on Height Adjustment and Turbulent Surface Fluxes

Dr. Mark Bourassa (COAPS/FSU), bourassa@coaps.fsu.edu
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Height adjustment of winds has been considered reasonably insensitive to the choice of roughness length parameterization. However, there are much greater differences in roughness length parameterizations for temperature and moisture.

We examine roughness lengths based on a smooth surface, and more elaborate models (Liu et al. 1979; Clayson et al. 1996; Zilitinkevich et al. 2001; and COARE3.0). The functional forms of these parameterizations are quite different, resulting in different roughness lengths. Consequently, there are systematic (not random) changes in height adjusted values, turbulent fluxes, and atmospheric stability, which can also cause changes in the stress. We demonstrate that height adjustment of potential temperature and humidity are substantially dependent on the parameterization of their respective roughness lengths. Furthermore, these parameterizations influence the magnitude of surface turbulent fluxes. Differences in height adjusted potential temperature can exceed 1.5C and humidity differences can exceed 2 g/kg. The resulting relative biases are quite substantial. They will change spatial/temporally due to regional differences in roughness lengths, and change temporally due to changes in observation height. Plans to adjust observations to a uniform height should consider this issue prior to provided adjusted data to the community.

NOAA/AOML TSG Operations: Data quality control and transmission

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The contribution of NOAA/AOML to GOSUD includes the transmission of TSG data in real- and delayed-time, from ships of the Ship Of Opportunity Program (SOOP) and ships of the NOAA fleet, in collaboration with NOAA/NMFS, NOAA/AMAO, the University of Virginia\\\'s Semester At Sea Program and the University of Miami. The transmission in real-time from ships of the SOOP is done using SEAS software, while from ships of the NOAA fleet is done using SCS. The data approved by the quality control checks recommended by GOSUD are transmitted in real-time to the GTS. During the QC process, ship measurements are also compared with the following datasets - the WOA05 climatology, the NCEP weekly analysis and simultaneous observations from XBT and Argo floats. These three additional quality control checks optimize the calibration schedules and helps to early identify sensor problems by analyzing trends and continuous biases in the data, therefore, further increasing the reliability of the system.
Procedures to generate real-time reports of the data flow are under development to summarize the information required to track the status of the system, to facilitate the identification of hardware or transmission problems. Future plans include the distribution of the delayed-time quality controlled data to NOAA/NODC and transmission of data in BUFR format. More information on the AOML/TSG operations can be obtained at www.aoml.noaa.gov/phod/tsg.

MATE Technical Internship Program: Preparing Students for Future Careers in Marine Technology and Science

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The Marine Advanced Technology Education (MATE) Center is a national partnership of community colleges, universities, research institutions, marine industries, and working professionals focused on increasing the number of highly-skilled individuals who enter the marine technical workforce. MATE's marine technical internship program helps prepare undergraduate students for ocean-related occupations. Since its inception, the program has placed 194 students in at-sea and shore-based internship positions. To date, more than two-thirds of the interns have gone on to work in a marine related science or technical field or continued their education in a marine-related discipline. The program targets community college students in marine technology programs and university students interested in marine technical careers.

This internship program is in partnership with the University National Oceanographic Laboratory System (UNOLS) and the United States Coast Guard (USCG) and is funded by the National Science Foundation. The need for qualified technical professionals to support ocean activities has never been greater. However, technical training programs that prepare students for these careers are few, mainly because it is prohibitively expensive for most programs to offer substantial time at-sea and time working with state-of-the-art equipment. The MATE internship program helps bridge this gap. In discussions with UNOLS and the USCG, we are looking for ways to better prepare our students for these at-sea technical experiences. We feel there is a need for a curriculum that can help prepare these students. From the standpoint of the MATE Center and its academic partners, the curriculum needs to: • be portable • accommodate a variety of learning styles • directly connect to the student's at-sea experience so the learning is relevant • provide knowledge and skills that UNOLS and the USCG find valuable • reinforce basic math and science principles • provide a foundation for a myriad of technical skills that an employee would need in a at-sea position in research or industry

Underway fCO2 Observations from VOS Ships in the Tropical and Subtropical Pacific Ocean

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As part of a multi-year effort to quantify the flux of CO2 between the ocean and atmosphere under the Climate Observations and Analysis Program of NOAA, underway CO2 systems are being placed on volunteer observing ships (VOS) in the Atlantic and Pacific oceans. After a collaborative design effort with U.S. scientists involved in shipboard measurements of underway fCO2, PMEL acquired four newly designed CO2 systems with the measurement criteria of fCO2 ± 2 µatm, temperature ± 0.01°C, and pressure ± 0.5 mB.
These systems are currently installed on four different VOS ships in the Pacific Ocean. For inter-comparison purposes, each of our four systems have the same hardware components, are running the same software programs, and each are currently providing a return rate of approximately 96%. The fCO2 measurements from the equatorial Pacific compliment our extensive database of fCO2 measurements in this region dating back to 1982, and show high seasonal and interannual variability.

The Automatic Weather Observing System (AWOS) for the State of Kuwait

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The Automatic Weather Observing System (AWOS) for the State of Kuwait is recently installed by the Australian company (ALMOS) it consist of fully automatic data collection units (DCU). Each DCU has a Oceanographic sensors that are tailored to its specific application. The DCU units read the sensors in real time and partially process the raw values into meaningful, quality checked one minute values. These values are then communicated back to a Central Data Acquisition System (CDAS), where the values are further process into hourly, daily and monthly statistics and then processed values are displayed on a Graphical User Interface at the Meteorological and Display Working Places and are also used to generate standard WMO messages such as SYNOP, SHIP, BUOY and CLIMAT. There are three basic types of reports: 1. Synoptic Data 2. Agro-meteorological Data 3. Marine Data. Similar Daily and Monthly reports exist for each type. We will be focusing on Marine Data for our presentation in the workshop. The total number of marine stations is 10 distributed in several marine sites. The following information is given in Marine Reports. Daily reports contain the given information for each of the 24 hours and monthly reports give information for each of the days of the month. Surface Temperature Average.

Sea Temperature Average at each of the potentially 3 levels (lower, middle and top third of ocean).Conductivity Average at each of the potentially 3 levels. Salinity Average at each of the potentially 3 levels. Sea Current Speed Average at each of the 3 levels. Sea Current Direction Average at each of the 3 levels. Tidal Height Average. Ocean Wave Direction Average for Sea, Swell and Total. Ocean Wave Height Average for Sea, Swell and Total. Ocean Wave Period Average for Sea, Swell and Total.

Potential Contributions of IIRP/ARI for Identifying Training Needs and Developing, Delivering, and Assessing Shipboard Technician Training Resources

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The Institute for Instructional Research and Practice/Institute for At-Risk Infants, Children, Youth, and Their Families (IIRP/ARI) operates within the University of South Florida's College of Education. The institutes specialize in the development, delivery, and assessment of instructional materials and programs.

We have extensive experience in developing, administering, and scoring several credentialing examinations for the State of Florida. The early stages of development include conducting literature reviews and convening groups of content area specialists to identify and reach consensus on program goals and objectives. Online surveys are developed, administered, and analyzed as a means of external validation. Groups then determine best practices and sound educational strategies, as well as appropriate delivery methods, depending on the needs of the client and the learners. Our facilitators train content specialists according to industry standards to write test specifications and test items to produce reliable, valid assessments. We have developed and scored paper-based multiple-choice tests, performance-based assessments, computer-based tests, and computer-adaptive tests.

Recent projects include designing and evaluating online training modules.

This institutes' expertise will enable us to customize the development, delivery, and assessment of resources for shipboard technician training.

Strategies for better understanding of Salinity/Temperature Regimes in the Gulf of Guinea through GOSUD/SAMOS cooperatives Activities

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Changes in oceanic conditions over the Gulf of Guinea (GOG) in terms of Sea surface temperature and Sea surface salinity in the last decade has been linked to the variability in both the upper ocean temperature and the mixed layer depth over the tropical Atlantic. On seasonal scales these changes have been observed to generally affect the water mass properties in the tropical Atlantic especially in upwelling areas of the GOG. These changes are also known to affect plankton production and the seasonal migration of fish and weather patterns which comprise of dry and wet seasons. However, there is paucity of temperature and salinity data to allow the spatial and seasonal understanding of upwelling and weather parameters in the GOG. While several sea surfaces temperature observing stations like in-situ moored buoys, research cruises and individual programmers have collected temperature data in the region over time, most of the data lack regional and long-term series mode. The GOSUD/SAMOS programme is a new programme that could provide a long term and spatial coverage of the region and hence ensure better understanding of upwelling, weather and other related metocean processes. Such a programme could improve the paucity of data and lead to a better understanding of upwelling, and seasonal changes in weather parameters like rainfall and air temperature in the region.

The region has existing institutional framework which could be enhanced by the GOSUD/SAMOS cooperative activities and thereby lead to the better understanding of these important oceanographic parameters and climate.

Observation of near ocean surface variability: data synthesis and analysis

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The recently set up ARGO array for the global observation of the ocean gives access to the temperature and salinity variability of the upper 2000 meters on time scales ranging from weeks to years, and space scales above 300km. Strong near surface variability occur at smaller time and space scales that can be explored by underway opportunity measurements as promoted by GOSUD and SAMOS. The analysis system ISAS was originally designed to synthesize the vertical profiles obtained mainly with ARGO but also CTD or moorings and produce gridded fields. It has been extended to incorporate underway measurements. We will show the first results of a global analysis of the near surface variability exploring the seasonal cycle, but also intraseasonal to interannual variations. The gain of information brought by the underway data is explored over the North-Atlantic on a specific dataset. The systematic use of such data relies on the availability of complete and reliable datasets. An operational system is building up at CORIOLIS for thermosalinometer data and should soon become available. This effort contributes to GLOSCAL, a cal-val project for the future SMOS mission.

Southern Ocean Surface Measurements: Improving Air-Sea Flux Estimates

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Southern Ocean air-sea mixed-layer exchanges are a potentially important component of the global climate system. A conceptual model of the global meridional overturning circulation suggests that water flows southward at mid-depth into the Southern Ocean where it is upwelled to the surface and carried northward through Ekman processes. While at the ocean surface, water mass properties are transformed as water in the mixed layer interacts with the atmosphere. Despite the central role that Southern Ocean surface processes play in global circulation, the exact size and spatial structure of air-sea fluxes are not well known. A mixed-layer heat balance in the Southern Ocean is examined by combining remotely sensed measurements, in situ observations and various reanalysis air-sea heat flux products, and the biggest contributor to the surface heat budget error are found to be the air-sea heat fluxes. Only limited Southern Hemisphere data are available for the reanalysis products, and hence these fluxes have large uncertainties. For example, available surface flux estimates in the Southern Ocean from NCEP/NCAR and ECMWF can differ by 100 W m2 or more on any given day, compared with typical values of 150 to 250 W m2. Limitations of the existing data sets and the desired spatial and temporal resolution that may lead to improvement in their application to scientific analysis will be discussed. In addition, we will present possible strategies for increasing the number of quality air-sea observations in the Southern Ocean, with particular reference to potential acquisition of ship-based meteorological measurements during the 2008-2009 International Polar Year.

NOAA/AOML TSG Operations

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NOAA supports the collection of SST and SSS data from TSGs installed in ships of the Ship Of Opportunity Program (SOOP) and of the NOAA fleet. The SOOP-TSG program at AOML is in support of the NOAA pCO2 program. Some elements of the NOAA/AOML TSG operations are a collaborative effort with several other NOAA laboratories and universities. We present here the status of the operations where a TSG is maintained and NOAA/AOML is involved in at least one element of their operations. A brief description is presented on TSG maintenance; data transmission, quality control and insertion into the GTS from each ship of this operation. Two additional presentations on AOML TSG operations will provide the details of data quality control and transmission, and on the AOML work to implement BUFR format in the transmissions.

The Aquarius/SAC-D Sea Surface Salinity satellite measurements and the application of GOSUD thermosalinograph data for in situ validation

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The Aquarius/SAC-D mission, scheduled to launch in May 2010, will utilize various types of near-real time in situ data to validate the satellite remote sensing sea surface salinity (SSS) measurements. The validation data will include SSS data from the GOSUD thermosalinograph (TSG) database as well at Argo floats, moored buoys and surface drifters. Each data type will require data-specific processing to optimize the comparison with the surface-focused satellite measurement. We have made an initial evaluation of the application of the GOSUD TSG data, considering the temporal and spatial variability scales and how best to process it to make optimal comparisons with the satellite data. We present some results of that comparison as well as recommendations to improve our application of this data to the satellite mission.

The Alliance for Coastal Technologies: Supporting the Technical Education & Training Needs of Tomorrow's Ocean Observing Workforce

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The Alliance for Coastal Technologies (ACT; see http://act-us.info) was established to foster the development and application of new coastal ocean sensor technologies to address the needs of a wide range of coastal decision makers and provide the Integrated Ocean Observing System (IOOS) with information required for the deployment of reliable, cost-effective networks.
New sensor technologies are required to make observations of biological and geochemical parameters that are needed to address many management issues in a long-term, sustained, environmentally relevant manner. ACT facilitates the transition of new sensor technologies from research to operations through technology-specific workshops and verification trials of emerging technologies. ACT workshops are designed to aid resource managers, coastal and ocean observing scientists, and private sector companies by building consensus on the steps needed to develop useful tools.

Recent workshops include wave sensor technologies, passive acoustic hydrophones, and conductivity temperature sensors. ACT technology verifications are rigorous evaluations of emerging and commercially available instruments to verify manufacturers' performance claims under diverse environmental conditions. Recent verification trials include dissolved oxygen sensors, chlorophyll fluorometers, turbidity sensors, and nutrient sensors. These capacity-building activities result in, among other things, an increased technical understanding of how to deploy and operate a variety sensor technologies in a wide range of coastal and ocean environments. ACT is currently working to develop these experiences into a series of technology-specific "Best Practices Guides" for use by field technicians, resource managers, and operational oceanographers. ACT also actively supports the development of undergraduate and graduate-level curricula in Ocean Technology. To this end, ACT's Gulf of Mexico partner, the USF College of Marine Science is working to prototype an Ocean Technology graduate degree/certificate program that can be offered at ACT's eight academic Partner Institutions.

Application of Near-surface In Situ Oceanic Observations for Improved Satellite-based Retrievals of Near-surface Temperature and Humidity

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Accurate and high-resolution observations of near-surface temperature (Ta) and humidity (Qa) observations are considered essential for determination of turbulent sensible and latent heat fluxes at the ocean surface. Satellite retrievals provide an advantage over in situ observations for they can provide near global oceanic coverage of turbulent heat fluxes over less than one day. In this presentation we will describe our latest satellite Ta and Qa retrievals methods, compare our method to previous satellite methods, and validate our method with the latest version of ICOADS data. Current methods of satellite-based retrievals use regression techniques relating in situ observations and satellite radiance to derive retrievals of Ta and Qa. However, these methods are subject to significant systematic and random bias due to inhomogeneous global distribution of the in situ training data set, limitations inherent to the satellite observations, errors caused by matching satellite footprints to point observations, and uncertainties with the in situ observations. Unrepresentative global distribution of in situ observations will be shown to adversely affect the original version of the satellite retrieval, and recent improvements to the satellite retrievals are a result of a better distribution of matched satellite and in situ data. A seasonally-dependent regional bias at high latitudes will be examined and shown to be caused by large scale temperature and humidity inversions that go undetected by satellite sensors. Corrections for this bias that utilize sea surface temperature will be discussed. Uncertainties with the in situ measurements will also be explored as they can affect both the regression and validation of the satellite retrievals. The in situ uncertainties to be discussed include varying measurement heights, differences in hygrometer types, and artificial solar heating of daytime observations.

Incorporating real – time GOSUD/SAMOS Data into the World Meteorological Organization's Voluntary Observing Ship (VOS) Program and VOS Climate (VOSCLIM) Project

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The Voluntary Observing Ship (VOS) program and the VOS Climate (VOSCLIM) project are an integral part of world's commitment in oceans. Most GOSUD and SAMOS personnel are well aware of the World Meteorological Organization's Joint Commission for Oceanography and Marine Meteorology (JCOMM) and its sub division of the Ship Observation Team (SOT). The three prongs of the SOT trident's objective are meteorology, oceanography, and the atmosphere. While the Ship Of Opportunity Program (SOOP) covers oceanographic data, and the Automated Shipboard Aerological Program (ASAP) concerns itself with atmospheric conditions, VOS's main objective is meteorological data from the oceans.

This data is sent into the national Weather Service's Telecommunications gateway (NWSTG) for routing to the Ocean Prediction Center and the Tropical Prediction Center as well as shared to other national Meteorological Agencies for their real-time modeling efforts. The data is then shared with the National Climatic Data Center (NCDC) and the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) for data archive and climatological use.
Traditional VOS participants are the transiting merchant vessels that follow the standard trade routes. GOSUD and SAMOS vessels are a prime interest to the VOS data collection efforts, as these ships tend to operate in non-traditional routes and have the potential to provide an important high-resolution complement in real-time and climatological processes. The traditional VOS ships are predominately-manual observers that only provide observational information once to twice per day while underway. By incorporating the current automated meteorological sensor suites onboard GOSUD and SAMOS ships with the communication capability of VOS, increased real-time coverage in data sparse areas of the ocean can be achieved.

A Review of Recent Technology Innovations for Enhancing Marine Meteorological Measurements

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Recent policy and technology developments are reviewed which have the potential for improving collection of marine meteorology data. These developments include new measurement technologies, improved accuracy of existing sensors, and several technologies which facilitate improvements in spatial resolution and temporal continuity of measurements. One interesting new technology is an air-sea heat flux sensor intended for inclusion as part of the network of vertically profiling ARGO ocean observing floats, which makes measurements during periodic emersion of the floats at the sea surface. The air-sea heat flux sensors can also be deployed independently, or as part of surface buoy systems, thus remaining at the sea surface to provide continuous measurements. In addition to the ongoing improvements in the ARGO float program, the major recent development in marine policy has been planning for a network of ocean observatories. One potential component of these observatories is autonomous sensors which would provide marine meteorological data. Plans for several observatories include use of glider-type autonomous underwater vehicles. We review the recent addition of marine meteorological sensors added to these vehicles, which like ARGO floats make measurements and report data during periodic exposure at the sea surface. Progress has also been made in the development of several new types of 'smart buoys' which include capabilities for marine meteorological measurements. These capabilities are described for autonomous surface vehicles, such as Robo-kayak and WaveGlider, and a novel autonomous flying buoy, called Flying Fish. Autonomous aircraft are also finally beginning to be used from research vessels, although mostly outside US waters. These aircraft, including Manta, ScanEagle, Silver Fox and Malolo, can extend shipboard marine meteorological measurements vertically. Preliminary results from these deployments are reviewed. Developments in autonomous shipboard marine meteorological systems are also reviewed, as these systems become more widely used on research, private and commercial vessels under both public and private funding. In addition to measurement of traditional marine meteorological parameters, we review several commercially available sensors for air-sea gas fluxes (mainly CO2 and methane) now being incorporated in autonomous shipboard and buoy-based marine meteorological sensor systems to provide data for global carbon flux and climate studies. Power systems which can harvest energy from ambient wave environments are described which enable sustained deployment of autonomous sensor platforms for improved spatial and temporal data collection. Harvesting of ambient marine power also facilitates long-term use of new low-power wireless communication protocols using recently available commercial communication products. These new communications protocols and hardware can be used to reliably send data ashore from ships or ocean buoys across much greater distances than previously possible. Finally, we reaffirm that a top priority for global climate studies is improving collection of high latitude marine meteorological data, including air-sea heat, moisture and gas fluxes, to determine how these parameters are being affected by rapidly changing sea ice and glacial runoff into the sea.

CORIOLIS: providing an ocean in situ data service for the needs of operational oceanography

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Seven French research agencies involved in ocean research and ocean predictions are developing together a strong capability in operational oceanography bases on three components including altimetry (Jason), numerical modelling with assimilation (Mercator) and in situ data service (CORIOLIS). The CORIOLIS data centre aims to distribute worldwide ocean data in both near real-time and delayed mode for assimilation and validation purposes. Further on, the CORIOLIS data centre is able to deliver products such as T & S fields and reference datasets. To be able to deliver such a global dataset, the CORIOLIS data centre plays an important role in three major projects: - The ARGO project where the CORIOLIS data centre acts as both one of the two global data centres. The comprehensive Argo dataset is available through the CORIOLIS servers. This dataset holds the data from 3129 active profiling floats. - The GOSUD project which aims to process and distribute sea surface data collected by both research vessels and merchant ships when they are underway. For the moment, only T & S surface data are taken in account but the objective is to extend the project to other parameters such as oxygen, fluorescence or PCO^2. The CORIOLIS data centre is one of the two GOSUD global data centres. Since the beginning of 2008, forty ships have sent their surface data to the CORIOLIS data centre - The OCEANSITES project which collects and processes data from open ocean moorings. Data from 60 different deep sea moorings are centralized in the CORIOLIS data centre which acts as one the two global data centres In order to complement the data set collected in the projects mentioned above, two connections to the GTS –the WMO network for data exchanges- have been implemented to retrieve any of the ocean data which were not part of the three projects Argo, Gosud and OceanSites. From the complete data set, value added products are regularly delivered. The reprocessing of the 2002-2006 period is a global and annual delayed analysis of the content of the database and an additional validation of the dataset collected in real time and delayed mode during this 5 years period, which provide T and S weekly gridded fields and individual profiles both on their original and interpolated levels. It is planned to reprocess 1990-2007 data in 2008.

Dialogue on the Use of Oceanic Observations for Improving Large Scale Estimates of PAR to Meet the Needs of the Oceanic and Climate Modeling Communities

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Oceanic biological processes control the transfer of carbon between the oceans and the atmosphere. The total daily net carbon fixation as well as the relative role of the oceans as compared to those of terrestrial ecosystems are is not well known. Factors that play a key role are: distribution of phytoplankton in the oceans and the distribution and characteristics of Photosynthetically Active Radiation (PAR). PAR is usually approximated as 50% of the surface shortwave radiation (SW), if available. Information on PAR and its direct and diffuse components can improve global scale modeling of light absorption in the oceans and the carbon budget. There is also a need to better understand the relationship between PAR and SW. It has been demonstrated that it is possible to derive global scale SW and PAR fluxes from satellite observations. Extensive evaluations of SW fluxes have been made over land; evaluation over oceans is much more limited and was done against observations from buoys. Observations of PAR over oceans are almost non-existent. There is a need to better understand what type of meteorological and near surface oceanographic observations can be provided by the oceanic observational community from automated sensors on ships, as well as to specify the accuracy required by the satellite community for validation purposes.

It is hypothesized that ship observations might have an advantage over buoy observations due to better scale compatibility between the surface observations and the satellite footprint. As yet, this hypothesis has not been tested due to the lack of such observations. Application of SAMOS and GOSUD observations could be instrumental for addressing these issues as well as for the evaluation of satellite PAR products over a wide range of oceanic conditions.

Shipboard Oceanographic and Radiometric Autonomous Instrumentation for VOS Applications

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This presentation will discuss developments and deployments of a variety of instrumentation for measurement of atmospheric radiation and sea-surface temperature from ships. Work on these applications has been coordinated largely through the Division of Meteorology and Physical Oceanography of the School of Marine and Atmospheric Science (RSMAS) at the University of Miami. The Marine Atmospheric Emitted Radiance Interferometer (MAERI) has been operated for many years in a satellite validation program. A new design for M-AERI will result in a much more compact and robust instrument. The ISAR, developed jointly by NOCS and RSMAS, is a single-channel scanning radiometer that is used primarily to measure the sea surface skin radiative temperature (SSST). ISAR is fully autonomous and incorporates an optical rain gauge to actuate closing a protective shutter. It has been operating routinely on commercial ships in the Atlantic, Pacific, and North Sea. Data are available in real time via Iridium SBD. Broadband short and long wave hemispheric irradiance are crucial components in the air-sea flux budget. The Radiometer Analog to Digital smart interface (RAD) integrates short and long wave radiometers into a single package that combines measured thermopiles and thermistors and computes actual irradiance in units of W/m^2. The NEMA output string is ingested by shipboard data systems. Quality is improved dramatically by real time computations.

Quality Evaluation of Marine Meteorological Observations

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The Florida State University has been operating a data assembly center (DAC) to collect, quality evaluate, and distribute marine meteorological and near surface oceanographic data since the 1994. From our origins in the World Ocean Circulation Experiment through the present Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative, the DAC has developed an expertise in the quality evaluation of observations collected by automated observing systems on research vessels, moorings, and fixed platforms. We will present an overview of the current state-of-the-art for automated and visual data quality evaluation, with a focus on SAMOS activities. The poster will provide examples of common problems identified in shipboard meteorological and oceanographic data. We will also describe the challenges related to data and metadata acquisition. A routine dialog between the DAC and vessel operators is critical to the success of the QC operations and we will provide examples of how this has resulted in improvements in data quality.

An Australian contribution to SAMOS and GOSUD

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The routine observation of the oceans around Australia has been significantly enhanced by the creation of the Integrated Marine Observing System (IMOS). A part of IMOS is devoted to the enhancement of meteorological systems on two Australian research vessels: the Southern Surveyor (SS) and Aurora Australis (AA). This will enable the routine estimation for "climate quality" bulk fluxes. The SS is the Marine National Facility and performs research voyages in the tropical and mid-latitude oceans and coastal seas surrounding Australia The AA is the Australian Antarctic Division research and resupply vessel, and operates between Antarctica and Australia. Near real-time data will be provided to SAMOS. The Bureau of Meteorology also operates the Australian Volunteer Observing Fleet (AVOF). A subset of the AVOF (approximately 10 vessels) currently carries automatic weather stations, which will be augmented with IMOS hull contact sea surface temperature (SST) sensors. The 1-minute meteorological data (including SST and surface salinity) from SS and AA will be submitted to SAMOS. The 3-hour AVOF SST data stream will undergo quality assurance and placed on the GTS and can also be provided to GOSUD. The Bureau of Meteorology is an operational centre and is investing resources into developing data quality assurance systems. There is potential to collaborate with international programs in this area.

Data Flow through the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Data Assembly Center

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The Florida State University has been operating a data assembly center (DAC) to collect, quality evaluate, and distribute Shipboard Automated Meteorological and Oceanographic System (SAMOS) observations since 2005. SAMOS typically are a computerized data logging system that records underway meteorological and near-surface oceanographic observations collected on research vessels. The authors note that the SAMOS initiative does not provide specific instrumentation for vessels, but instead takes advantage of science quality instrumentation already deployed on most research vessels. The SAMOS initiative provides vessel operators with desired sampling protocols and metadata requirements that will ensure the DAC receives a consistent series of observations from each vessel. The status of the SAMOS data flow from 2005-2008 will be described. The DAC and its partners in U. S. National Oceanographic and Atmospheric Administration (NOAA), the University National Oceanographic Laboratory System, the U. S. Coast Guard, and the U. S. Antarctic Program have implemented a series of daily data transmission from ship-to-shore using an email protocol. A set of observations recorded at one-minute intervals for the previous day arrive at the DAC soon after 0000 UTC and undergo automated quality evaluation. A trained data analyst reviews data and responds directly to vessels at sea when problems are identified. All quality-evaluated data are freely available to the user community (via http://samos.coaps.fsu.edu) and are distributed to national archive centers. As of April 2008, 12 research vessels are providing routine data transfers. The authors will describe current recruiting activities within the U.S. and International communities. Plans to improve metadata retrievals from vessels, expand data distribution, and advance data quality evaluation will be provided.

Incorporating SAMOS/GOSUD data into the Observing System Monitoring Center

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Other Authors: Steve Hankin (NOAA/PMEL), Kevin O'Brien (UW/JISAO)

The Observing System Monitoring Center (OSMC, www.osmc.noaa.gov) system is an information gathering, decision support, and display system for the National Oceanic and Atmospheric Administration\\\'s (NOAA) Office of Climate Observations (OCO). It is an essential component of the sustained Ocean Observing System for Climate, that permits many discrete components to be visualized and managed as a system. The OSMC system displays current and historical status of globally distributed meteorological and oceanographic data collection systems. The OSMC system provides data visualization tools to identify the coverage of any given collection of platforms and parameters. These visualization tools are available via the internet and can be used to present information from OSMC to other NOAA centers, national partners, and international partners. This presentation will provide a brief overview of the capabilities of OSMC as well as some comments as to how SAMOS/GOSUD data can be incorporated into OSMC and why that might be beneficial to both programs.

Managing Underway Measurements from Large German Research Vessels

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Research vessels are an essential asset for obtaining high-quality near-surface observations of physical and bio-geochemical variables from all parts of the world ocean. Yet, their use as observing platform was seriously neglected in the past. To remedy this problem, a pilot activity was started in Germany, concerned with routine and ongoing measurements of temperature, salinity, velocity and meteorological data from large ocean-going research vessels, their quality control at land and their delivery to global data centers. The talk will summarize the activities and also address diplomatic obstacles which if removed would easy the use of research vessels for routine near-surface observations over shelf regions and in coastal waters tremendously. The reported activity is part of an IOC initiative to oversee development of an international agreement and standards for routine set of ocean observations to be taken by research vessels as a contribution to the global ocean observing system.

NOAA/AOML TSG Operations: BUFR and metadata plans

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Current near-real-time transmissions of surface salinity data into the GTS use the FM 62 VIII Ext. TRACKOB code form. This format includes a limited set of metadata fields to report the averaging period for temperature, salinity and surface current measurements. But additional metadata could provide valuable information on other processes influencing the quality of the measurements and the different steps the original data passes through before being eligible for public distribution. In a related activity, one action item proposed at the JCOMM/SOT 4th session (Geneva, 16-21 Apr 2007) encourages AOML to develop and test the encoding of XBT data into BUFR, using ad-hoc templates that have been specifically designed to serve operational needs. This format also provides compression and an overall better file size reduction over the standard ASCII form. A similar approach is underway to migrate TSG data to BUFR. This effort seeks to improve the future migration from the traditional alphanumeric codes (TACs) to table-driven code forms (TDCFs),as required by WMO.

The testing will provide the feedback necessary to detect, identify and correct problems that can arise in the migration process, providing a robust framework for near-real-time collection, quality control and distribution of TSG data. The current pre-operational BUFR template for TSG data (descriptor 308010) is a literal translation of the TAC TRACKOB structure and therefore lacks the flexibility and extensibility to accommodate additional data/metadata fields required for operational activities. Future templates for TSG data have to address these issues and should be able to provide descriptors that allow users to assess the quality of the data and to determine if it fits the intended use. Within the general context of TSG operations carried at NOAA/AOML, we present here preliminary results and recommendations on migrating TSG data into BUFR.

MeteoFrance automated VOS network

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This presentation provides an overview of the MeteoFrance observing VOS network. The organization of the network will be described, as well as the equipment and sensors used, and the maintenance and calibration applied to the sensors. Meteo France has developed a sea-surface observation network based on drifting buoys, moored buoys and ships of opportunity. Ships are recruited to take, record and transmit weather observations whilst at sea. The administration of the ship network is based on a technical instrumentation service who appoints, sets up, checks and maintains the equipment, and Port Meteorological Officers (PMOs) with maritime experience who recruit voluntary observers and assist them in their meteorological work. The PMOs are always located at the main ports. Priority is given to vessels traveling the North Atlantic and Mediterranean Sea, but world wide, Indian Ocean or Pacific Ocean vessels are also selected. The main observing systems installed onboard are automated weather stations, while simple standard (manual) instruments are less frequently used. Since 2007, 70 vessels has been recruited, about 50 of them are automated weather stations, making measurement of pressure, temperature, humidity, wind speed and wind direction, and sea surface temperature. Calibration of the pressure, humidity and temperature sensors are made by the Meteo France “Metrology Laboratory” , which is an independent and accredited service. Pressure and humidity sensors are checked and fitted regularly (every one or two years), and a daily monitoring allows to detect any measurement error on all parameters.

Remote Management of an Autonomous Shipboard Scientific Data System Using a Wide Area Wireless Network

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Since 2003, the SoundScience project has operated an autonomous scientific data collection system aboard the M/V P.T. Barnum, a 91-meter car/passenger ferry that crosses central Long Island Sound between Port Jefferson New York and Bridgeport Connecticut. The system includes weather instruments, hydrographic sensors, and an ADCP. The availability of commercial wide area wireless networks (WWAN) in the New York Metropolitan area has always allowed the SoundScience system to send one-minute averaged data to shore. Data is provided in real time to the National Weather Service, the National Data Buoy Center, and to the public via a website at www.stonybrook.edu/soundscience. Recent speed upgrades of WWAN networks now enable complete “over the air” system access and control. Use of Dynamic DNS address services and port forwarding allow direct connections from shore to all devices on the ship’s LAN. Remote control software permits access to shipboard computer GUIs. Web enabled switches and watchdog circuits can power cycle any device in the system in response to operator commands or automated monitoring processes.

This increased ability to access the system from shore allows more rapid troubleshooting. In many cases problems are now resolved without a site visit, resulting in significantly decreased operating costs. Lessons learned and design paradigms used on the SoundScience project should prove more broadly useful as WWAN geographic coverage expands.

Shipboard Meteorological Measurements: Interpretation and Quality Assessments

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Quality shipboard meteorological measurements are critical for understanding air-sea interactions over the oceans. Several of the main goals of the SAMOS (Shipboard Automated Meteorological and Oceanographic System) program are to identify meteorological sensors installed on various research ships that are reliable and accurate, to improve data collections systems eliminating problems encountered in the past, and to improve access to quality assured data. NOAA's Earth Systems Research Laboratory (ESRL) has developed a shipboard flux standard and been tasked with evaluating how well the UNOLS and NOAA research vessels providing data to the SAMOS program are working, ESRL's flux standard was recently deployed on the USCGC *Healy* and the Woods Hole Research Vessel *Knorr*. Results from these deployments will be shown and discussed. Some of the critical areas to be addressed include not only how well the different instruments worked, but how placement on the ship and the actual design of the ship may effect these measurements, As stated in Bradley and Fairall (2007), without 'thoughtful location', the best instruments may still have measurement errors due to the influence of the measurement platform itself. During a short *Healy* test cruise, particular attention was paid to the numerous wind sensors and how they performed based on operational characteristics of the sensors, location of the sensor on the ship, and wind direction relative to the ship. Preliminary data from the ICEALOT cruise on board the *Knorr* includes short and long-wave radiometer, sea surface temperature and precipitation measurements. These results will show that the data collected are of a high quality but still requiring a careful understanding of how the data were taken. Such information should be included in a Metafile as it becomes available.

Advancing Marine Climatology with GOSUD/SAMOS Data: Enhancing Linkages to ICOADS and JCOMM

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The International Comprehensive Ocean-Atmosphere Data Set (ICOADS) is the world's largest archive of historical surface marine data (icoads.noaa.gov). Data and metadata are stored in the extensible International Maritime Meteorological Archive (IMMA) format, being developed in close coordination with the Joint WMO/IOC Technical Commission on Oceanography and Marine Meteorology (JCOMM). Voluntary Observing Ships (VOS) provide a relatively consistent foundation for marine meteorological reports in ICOADS throughout the period of record (presently 1784-2007). High-quality VOS data including enhanced metadata became available starting in 2001 from the VOS Climate (VOSClim) project, but are not yet blended. However, for recent decades ICOADS has been augmented with data (some at high temporal frequency) from moored and drifting buoys, and near-surface (i.e., $\leq$3m depth) oceanographic profile temperatures from the World Ocean Database.

Moreover, as part of Release 2.5 (planned for 2008) we will be blending Research Vessel (R/V) data from Russia (1936-2000) and from the Center for Ocean-Atmospheric Prediction Studies (1990-98). While GOSUD/SAMOS data hold the potential to provide an important high-resolution complement in ICOADS to other established JCOMM datastreams, much more needs to be done to improve consistency and commonality in how these data and metadata are managed and archived. One specific goal from the first GOSUD/SAMOS workshop was to investigate an appropriate template for combined GOSUD/SAMOS data using the International Maritime Meteorological Archive (IMMA) format (or possibly WMO's Binary Universal Form for the Representation of meteorological data (BUFR)). This poster will suggest completing that action through the implementation of IMMA "attachments" containing data and metadata provided by GOSUD/SAMOS that cannot be accommodated in the IMMA core and existing attachments. Additional information is likely to include sea surface salinity, currents and extensive metadata. The incorporation of data and metadata from R/Vs into ICOADS has thus far been achieved in an ad hoc manner and with considerable delay. There has never been a systematic attempt to recruit to the VOS R/Vs using their own instruments, rather than WMO certified instruments. Such recruitment would allow existing data flow mechanisms to be exploited but in the past the lack of a systematic approach to instrument quality, maintenance and calibration on many R/Vs failed to provide the continuity required for an operational program. Some R/Vs make VOS "bridge" reports (ref. Smith 2006, A Comparison of SAMOS and Bridge Observations on Research Vessels), but the relationship of these data to the science data is often unclear due to insufficient metadata. Proposed enhancements to ship-based data and metadata management and quality control within JCOMM, (e.g., exploring synergies between VOS/VOSClim and GOSUD/SAMOS) may in the longer term lead to more streamlined flows of GOSUD/SAMOS data and metadata into climate archives.

In-situ wave measurements at Station Mike.

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As part of a UK-SOLAS project "HiWASE" (High Wind Air-Sea Exchanges) the National Oceanography Centre has instrumented the Norwegian weather ship Polarfront with the directional wave radar "WAVEX". The Polarfront occupies Station Mike (66 N, 2 E) year-round, with only one 8-hour port call every 4 weeks. The WAVEX system complements the Polarfront's existing ship borne wave recorder (SBWR). NOC also equipped the ship with a) two digital cameras to record whitecap fraction and b) the autonomous air-sea flux system "AutoFlux", to obtain direct measurements of the air-sea fluxes of momentum, sensible heat, latent heat and CO2. The NOC systems were installed in 2006 and will operate continuously for the 3 years. For real-time data and more information see http://www.noc.soton.ac.uk/ooc/CRUISES/HiWASE/index.php It is believed that, until now, the WAVEX and SBWR systems have never been deployed together for more than brief periods. The SBWR provides reliable wave height data but no directional information, whereas the wave radar provides excellent directional wave spectra but does not measure wave heights reliably. In combination the two systems provide the most comprehensive in-situ information on sea state, located in a region of the world's oceans which experience a wide range of sea states including extreme events (e.g. 3-hourly significant wave height of 15.5 m in November 2001). "Sea spikes" in the raw wave radar images will be related to wave breaking. Both wave breaking and estimates of whitecap coverage (from the digital camera images) will be related to wind and sea-state conditions. Initial results from the two systems show that they are in good agreement for wave period, but that the wave height estimate from the WAVEX can be poor, particularly in mixed seas where swell dominates the wind sea.

High Wind Air-Sea Exchanges (HiWASE) - continuous air-sea turbulent flux measurements on the weather ship Polarfront.

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HiWASE is a UK-SOLAS project to improve the parameterisation of the air-sea fluxes of CO2, momentum, sensible heat and latent heat, under high wind speed conditions. Although the momentum flux is reasonably well understood there is debate over the influence of sea-state. The heat fluxes are less well known, with debate about any wind-speed dependence of their transfer coefficients. The CO2 flux is poorly understood, with parameterisations of the gas transfer velocity differing significantly for winds of 7 m/s or more. In 2006 NOC staff instrumented the weather ship Polarfront with the air-sea flux system "AutoFlux", a directional wave radar and two digital cameras. These complement a range of sensors (including a ship borne wave recorder) which have long been run by the Norwegian Met Office, plus an underway delta pCO2 system run by colleagues at BCCR. The AutoFlux system includes a Solent R3 sonic anemometer, a MotionPak motion sensor and two Licor-7500 sensors. Each Licor is shrouded in turn for one month at a time and then run without a shroud for the following month. This is done in order to obtain corrections for distortion of the sensor head. The AutoFlux system produces momentum and latent heat fluxes automatically using the inertial dissipation method. Near real-time (24 hours) summary data are transmitted from the ship via iridium and displayed on a project web page under http://www.noc.soton.ac.uk/ooc/CRUISES/HiWASE/index.php. The Polarfront occupies Station Mike (66 N 2 E) year round, with only 8 hours in port per month. The instrumentation all operates continually, and will do so at least until the end of the project in late 2009. Continuous operation allows data to be obtained under a wide range of wind speeds and sea states: to date the maximum 10 minute mean wind speed is 28 m/s. Initial results will be presented.

Appendix C: Workshop Objectives

1. Determine the status of a sustained SSS observing network (data collection, assembly, QC). The CLIVAR and Satellite communities wish to know who is making quality-evaluated SSS data routinely available.

2. Develop a clear plan for routine delivery of ship and instrument metadata for SAMOS and GOSUD activities (a criticism raised by SOT).

3. Outline a plan to integrate observations from parallel efforts in Australia and the EU, including the potential expansion to include a subset of AWS equipped VOS, into GOSUD/SAMOS. Should also consider contributions of developing countries.

4. Identify methods to better link GOSUD and SAMOS data and metadata.

5. Develop an education and training component to SAMOS/GOSUD. Identify needs and plan for proposal to support activities. What additional activities can be developed to support the personnel making observations at sea (e.g., recognition programs, certificates).

6. Determine how GOSUD/SAMOS can support ongoing or future research and operational efforts. What new user communities exist (e.g., pCO_2, PAR, ocean biology, etc.)? What products are desired by the user community?

Appendix D: Final Agenda

Tuesday 10 June 2008

0800 Coffee

0815 Introductory session – Plenary in Ranier Room (45 min)
Welcome (local hosts), logistics, intro talks, workshop outcomes
- Mr. Loic Petit de la Villéon, IFREMER – GOSUD overview, status (15 min)
- Mr. Shawn Smith, COAPS/FSU – SAMOS overview, status (15 min)
- Goals, charge to group, and desired outcomes (co-chairs)

0900 New Opportunities – Plenary in Ranier Room (1 hr, 30 min)
Moderator: Shawn Smith
- Dr. Eric Schulz - Australian Bureau of Meteorology (20 min)
  An Australian contribution to SAMOS and GOSUD
- Ms. Vinciane Unger - MeteoFrance (20 min)
  MeteoFrance automated VOS network
- Dr. Gustavo Goni – NOAA/AOML (15 min)
  NOAA/AOML TSG Operations
- Dr. Gael Alory – LEGOS (15 min)
  Monitoring Sea Surface Salinity in the Global Ocean from Ships of Opportunity: the French SSS Observation Service

Panel Discussion (20 min)

1030 Break (15 min)

1045 Technology/Future tech – Plenary in Ranier Room (1 hr)
Moderator: Shawn Smith
- Dr. Philip McGillivary – U. S. Coast Guard (20 min)
  A Review of Recent Technology Innovations for Enhancing Marine Meteorological Measurements
- Dr. Michael Reynolds – RMR Company (20 min)
  Shipboard Oceanographic and Radiometric Autonomous Instrumentation for VOS Applications

Panel Discussion (20 min)

1145 Plans for afternoon break-out sessions (15 min)

1200 Lunch (1 hr, 15 min)

1315 Begin GOSUD and SAMOS working group meetings (2 hr)
GOSUD meets in Olympic Room
SAMOS meets in Ranier Room

1515 Break (15 min)

1530 Continue working group meetings (2 hr)
GOSUD meets in Olympic Room
SAMOS meets in Ranier Room

1730 End sessions

Wednesday 11 June 2008
All sessions in Ranier Room

0800 Coffee

0815 Science and Application (1 hr, 45 min)
Moderator: Mark Bourassa

- Mr. John Gunn – Earth and Space Research (20 min)
  The Aquarius/SAC-D Sea Surface Salinity satellite measurements and the application of GOSUD thermosalinograph data for in situ validation
- Mr. Darren Jackson – CIRES (20 min)
  Application of Near-surface In Situ Oceanic Observations for Improved Satellite-based Retrievals of Near-surface Temperature and Humidity
- Dr. Rachel Pinker – University of Maryland (20 min)
  Dialogue on the Use of Oceanic Observations for Improving Large Scale Estimates of PAR to Meet the Needs of the Oceanic and Climate Modeling Communities
- Dr. Mark Bourassa – COAPS/FSU (20 min)
  The Influences of Differing Temperature and Moisture Roughness Length Parameterizations on Height Adjustment and Turbulent Surface Fluxes

Panel discussion (25 min)

1000 Break (15 min)

1015 Poster session (1 hr 45 min)
Moderator: Loic Petit de la Villéon
Each presenter will have 2 minutes to introduce their poster

- Ms. Brenda Babin - LUMCON
  Integrating the R/V Pelican's Underway Data into LUMCON's Environmental Monitoring System
- Mr. Kasem Elfadli – Directorate General of Civil Aviation
  The Automatic Weather Observing System (AWOS) for the State of Kuwait
- Mr. Robert Luke – NOAA/National Weather Service
  Incorporating real – time GOSUD/SAMOS Data into the World Meteorological Organization's Voluntary Observing Ship (VOS) Program and VOS Climate (VOSCLIM) Project

- Mr. Loic Petit de la Villéon - IFREMER
  CORIOLIS: providing an Ocean In situ Data Service for the Needs of Operational Oceanography
- Mr. Jeremy Rolph – COAPS/FSU
  Quality Evaluation of Marine Meteorological Observations
- Mr. Shawn Smith – COAPS/FSU

Data Flow through the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Data Assembly Center

- Mr. Thomas Wilson – Stony Brook University
  Remote Management of an Autonomous Shipboard Scientific Data System Using a Wide Area Wireless Network
- Mr. Daniel Wolfe (invited) – NOAA/ESRL
  Shipboard Meteorological Measurements: Interpretation and Quality Assessments
- Mr. Scott Woodruff – NOAA/ESRL
  Advancing Marine Climatology with GOSUD/SAMOS Data: Enhancing Linkages to ICOADS and JCOMM
- Dr. Margaret Yelland (invited) – National Oceanography Centre, Southampton
  In-situ wave measurements at Station Mike
- Dr. Margaret Yelland (invited) – National Oceanography Centre, Southampton
  High Wind Air-Sea Exchanges (HiWASE) - continuous air-sea turbulent flux measurements on the weather ship Polarfront

1200 Lunch (1hr, 15 min)
On own

1315 Science and Application (1 hr, 45 min)
Moderator: Mark Bourassa

- Ms. Fabienne Gaillard – LPO/IFREMER (20 min)
  Presented by Mr. Loic Petit De La Villéon (IFREMER)
  Observation of near ocean surface variability: data synthesis and analysis
- Dr. Regina Folorunsho – JCOMM (15 min)
  Strategies for better understanding of Salinity/Temperature Regimes in the Gulf of Guinea through GOSUD/SAMOS cooperatives Activities
- Dr. Janet Sprintall – Scripps Institute of Oceanography (20 min)
  Southern Ocean Surface Measurements: Improving Air-Sea Flux Estimates
- Catherine Cosca – NOAA/PMEL (20 min)
  Underway fCO2 Observations from VOS Ships in the Tropical and Subtropical Pacific Ocean

Panel Discussion (30 min)

1500 Break (15 min)

1515 Technicians round-table discussion (1 hr, 15 min)
Moderator: David Forcucci

This session will provide an opportunity for marine technicians and vessel operators to discuss ways that SAMOS and GOSUD can help observers improve data and metadata collection. Attendees representing the observers at sea are requested to discuss their experiences with what works and does not work when making underway meteorological and TSG measurements. Please raise any issues and concerns related to the SAMOS and GOSUD objective to uses R/Vs as a routine component of the ocean observing system.

1630 USCG Vessel Tours

1830 Reception (1 hr, 30 min)
Pyramid Ale House, Executive Room
Cash bar

Thursday 12 June 2008
All sessions in Ranier Room

0800 Coffee

0815 Keynote Speaker (45 min, including discussion)
- Dr. Detlef Stammer – University of Hamburg
  Managing Underway Measurements from Large German Research Vessels

0900 Data Activities
Moderator: Shawn Smith
- Mr. Guilherme Castelao – CIMAS/Univ. of Miami (15 min)
  NOAA/AOML TSG Operations: Data quality control and transmission
- Dr. Joaquin Trinanes - University of Santiago de Compostela (15 min)
  NOAA/AOML TSG Operations: BUFR and metadata plans
- Mr. Derrick Snowden – NOAA Climate Observation Division (15 min)
  Presented by Steve Hankin – NOAA/PMEL
  Incorporating SAMOS/GOSUD data into the Observing System Monitoring Center

Panel Discussion (15 min)

1000 Break (15 min)

1015 Data and Metadata discussion (1 hr, 30 min)
Moderators: Shawn Smith and Loic Petit De La Villéon
- Mr. Doug White – University of Delaware (10 min)
  International Research Vessels Site

Format issues, mutual data discovery, metadata reporting, topics from Tuesday's afternoon sessions

1145 Lunch
On own

1300 Educational initiatives (1 hr, 45 min)
Moderator: Shawn Smith
- Ms. Lani Clough – MATE Center/Monterey Peninsula College (20 min)
  MATE Technical Internship Program: Preparing Students for Future Careers in Marine Technology and Science
- Ms. Ali Hudon – Alliance for Coastal Technologies/Univ. South Florida (20 min)
  The Alliance for Coastal Technologies: Supporting the Technical Education & Training Needs of Tomorrow's Ocean Observing Workforce
- Ms. Kathy Fearon – IIRP/ARI, Univ. of South Florida (15 min)
  Potential Contributions of IIRP/ARI for Identifying Training Needs and Developing, Delivering, and Assessing Shipboard Technician Training Resources

Discussion: Focus will be on developing training materials, tools, continuing education materials to support making accurate underway observations.

1445 Break

1500 Wrap-up discussion
Reviewing priorities and new initiatives

New action items

1700 End Workshop

GOSUD Working Group Agenda (Prepared by Loic Petit De La Villéon, chairman)

The GOSUD session will address the following items, with a particular focus on general workshop goals 1 to 3.

1 Status report
- 1.1 Network status (Petit de la Villéon)
- 1.2 Report on GDACs activities (Rutz-Petit de la Villéon)
- 1.3 Adopt the annual report
- 1.4 Revue of the actions
- 1.5 Report on JCOMM meeting on quality control procedures

2 Network
- 2.1 How to enlarge the GOSUD network ?(all)
- 2.2 Ferry box
- 2.3 Canadian Vessels (input from Keeley)
- 2.4 German Research vessels
- 2.5 Seakeepers (Morrison)
- 2.6 NOAA vessels (Goni)
- 2.7 Australia (input from ??)

3 Data Management
- 3.1 New format proposition (Petit de la Villéon)
- 3.2 Adopt a simple format to submit data to the GDACs
- 3.3 Review of Near real time QC procedures
  - 3.3.1 IRD
  - 3.3.2 Ifremer/CORIOLIS
  - 3.3.3 AOML
- 3.4 Delayed mode QC procedure (Alory)
- 3.5 Metadata (ODAS-Meta-T to be linked with the format discussion
  - 3.5.1 Minimum requirement
  - 3.5.2 Opportunity to transmit meta-data to the GDACs prior sending the data

4 Products

5 Materials
- 5.1 Contribution to the GOSUD web site (all)
- 5.2 Opportunity of a poster / presentation for the next GODAE meeting
- 5.3 Opportunity of a poster/presentation for the next IODE meeting (early 2009, China)
- 5.4 Update the GOSUD booklet

6 Others
- 6.1 Next meeting

Seeking a volunteer to take notes ?
SAMOS Working Group Agenda (Prepared by Shawn Smith, chairman)

Status reports
- Overall data/metadata collection (Smith)
- Participating NOAA vessels (Stepka)
- USCG (Forcucci)
- Portable comparison standard (Wolfe)

Past Action Item review (Smith)

New vessel recruitment

The Metadata Problem (intro by Smith)
- How can we improve flow of ship and instrument metadata from SAMOS vessels?
- Should we track cruise level metadata?
- What additions should we include for TSG (e.g., flow rate (data), pipe length to sensor)
- Event logs from cruises (e.g., NOAA Snap files)
- Sensor calibration (Can a central calibration facility work?, minimum calibration metadata for SAMOS)

Enhanced data collection
- Radiation (SW, LW, PAR)
- Speed logs
- TSG (beyond sea temperature), relationship to GOSUD activities
- What is needed to expand SAMOS role in observing these quantities

Sustaining SAMOS program in tough budget climate
- Application of observations
- Seeking additional resources (leveraging within NOAA, NAVY, etc)
- Working with our international partners (IMOS, AWS-VOS, EU efforts)

Format issues
- Deciding upon format for international contributions to SAMOS (IMOS, EU effort)
- Can we decide on a format for archival (IMMA vs. BUFR issues, hourly vs. one-minute)
    - Expand upon pros/cons presented by Steve Worley

Mutual data cataloging and serving
- Not a small task on a limited budget
- Create a list of what would be needed (e.g., discovery metadata, ontologies, etc.)
- Need for a GOSUD/SAMOS task team to address these issues

Next meeting

Appendix E: Participants

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Appendix F: Acronyms

ACT	Alliance for Costal Technologies
ADCP	Acoustic Doppler Current Profiler
AOML	Atlantic Oceanographic and Meteorological Laboratory (NOAA)
ARGO	Free-drifting profiling float program
ASAP	Automated Shipboard Aerological Programme
BATOS	Automated weather stations used by French VOS program
BODC	British Oceanographic Data Center
BSRN	Baseline Surface Radiation Network
BUFR	Binary Universal Form for the Representation of meteorological data
CIRES	Cooperative Institute for Research in Environmental Sciences
CLIVAR	Climate Variability and Predictability program
CNRS	Centre national de la recherche scientifique (France)
COAPS	Center for Ocean-Atmospheric Prediction Studies
COD	Climate Observation Division (NOAA)
COOS	Coastal Ocean Observing System
CTD	Conductivity-Temperature-Depth recorder
DAC	Data Assembly Center
DM	Delayed Mode
EEZ	Exclusive Economic Zone
ESRL	Earth System Research Laboratory (NOAA)
EU	European Union
FSU	Florida State University
GCOS	Global Climate Observing System
GDAC	Global Data Assembly Centre
GODAE	Global Ocean Data Assimilation Experiment
GOSUD	Global Ocean Surface Underway Data project
GTS	Global Telecommunication System
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IFREMER	Institut français de recherche pour l'exploitation de la mer
IIRP	Institute for Instructional Research and Practice (Univ. of S. Florida)
IMET	Improved Meteorology system
IMMA	International Maritime Meteorological Archive
IMOS	Integrated Marine Observing System (Australia)
IOC	Intergovernmental Oceanographic Commission
IOOS	Integrated Ocean Observing System
IRD	L'Institut de recherche pour le développement (France)
ISAR	Infrared Sea surface temperature Autonomous Radiometer
JCOMM	WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM in-situ Observation Platform Support centre
JODC	Japanese Oceanographic Data Center
LEGOS	Laboratoire d'Etudes en Géophysique et Océanographie Spatiales
LUNCOM	Louisiana Universities Marine Consortium
MAERI	Marine Atmospheric Emitted Radiance Interferometer
MATE	Marine Advanced Technology Education
MEDS	Marine Environmental Data Services (Canada)
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction (NOAA)
NDBC	National Data Buoy Center (NOAA)
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOC(S)	National Oceanography Centre, Southampton (UK)
NODC	National Oceanographic Data Center (NOAA)
NRT	Near Real Time

NSF	National Science Foundation
NWP	Numerical Weather Prediction
NWS	National Weather Service
OAR	Office of Oceanic and Atmospheric Research (NOAA)
OCO	Office of Climate Observation (NOAA)
ODAS	Offshore Data Acquisition Systems
OMAO	Office of Marine and Aviation Operations (NOAA)
OSMC	Observing System Monitoring Center (NOAA)
PAR	Photosynthetically Active Radiation
PIR	Precision Infrared Radiometer
PIRATA	Prediction and Research Moored Array in The Atlantic
PMC	Pacific Marine Center (NOAA)
PMEL	Pacific Marine Environmental Laboratory (NOAA)
POGO	Partnership for Observation of the Global Oceans
PSAFS	Portable Seagoing Air-sea Flux Standard
PSD	Physical Sciences Division (NOAA/ESRL)
PSP	Precision Spectral Pyranometer
QC	Quality Control
RSMAS	Rosenstiel School of Marine and Atmospheric Science
R/V	Research Vessel
RVSMDC	Research Vessel Surface Meteorology Data Center
RVTEC	Research Vessel Technical Enhancement Committee (of UNOLS)
SAMOS	Shipboard Automated Meteorological and Oceanographic System
SCS	Scientific Computer System (NOAA)
SEAS	Shipboard Environmental data Acquisition System
SIO	Scripps Institution of Oceanography
SMOS	Soil Moisture and Ocean Salinity
SOOP	Ship of Opportunity Programme
SOT	Ship Observations Team (of JCOMM)
SSS	Sea-Surface Salinity
SST	Sea-Surface Temperature
TAO	Tropical Atmosphere Ocean project
TSG	Thermosalinograph
UCAR	University Corporation for Atmospheric Research
UNOLS	University - National Oceanographic Laboratory System
USCG	United States Coast Guard
VOS	Voluntary Observing Ship
VOSClim	WMO VOS Climate project
WHOI	Woods Hole Oceanographic Institution
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
XBT	Expendable Bathythermograph

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