WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

SCIENTIFIC AND TECHNICAL WORKSHOP OF THE JCOMM SHIP OBSERVATIONS TEAM

Presentations at the first session of the Ship Observations Team (Goa, India, 26 February 2002)

WMO/TD-No. 1118

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JCOMM Technical Report No. 16

NOTE

FOREWORD

A Scientific and Technical Workshop was held as a part of the first session of the Ship Observations Team (Goa, India, 25 February - 2 March 2002), to provide an opportunity to exchange information related to observations on board ships, communications facilities and technology, and the applications of ship-board observations. The workshop concept and structure were modelled on the very successful workshops which have been conducted for a number of years now as an integral part of the annual sessions of the Data Buoy Cooperation Panel (DBCP).

The workshop took place during the second day (26 February 2002) of the session, when 15 papers were read to more than 50 participants. Extended abstracts/ power point presentations/abstracts of the papers presented are included in this JCOMM Technical Report, which is published only electronically, as agreed by the meeting. In all cases, the papers/presentations have been included as received, without any editorial intervention.

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AGENDA FOR SCIENTIFIC AND TECHNICAL WORKSHOP
OF THE SHIP OBSERVATIONS TEAM

VENUE … Goa, India
DATE … 26 February 2002

Workshop chairman: Dr G. Narayana Swamy

Session 1 **New Programmes** (Chair: Dr G. Narayana Swamy)

1. PRACTICE OF OCEAN CO2 OBSERVATIONS USING TRANS-OCEAN CARGO SHIPS

Yukihiro Nojiri, Carbon Cycle Research Team, National Institute for Environmental Studies
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ABSTRACT:

CGER-NIES (Center for Global Environmental Research belonging to National Institute for Environmental Studies) started monitoring of oceanic CO_2 and related parameters utilizing North Pacific cargo ships from 1995. The activity was combined with existed atmospheric sampling program using Japan-Australia line container ships. Summary of the history is shown in Table 1.

The daily operation of on board CO_2 instruments is one of most important and difficult issues for the long-term maintenance of VOS observation. Even by the advanced technologies, suction of seawater into the ship is indispensable for the accurate measurement of oceanic CO_2 parameters, such as partial pressure of CO_2 (pCO_2), total dissolved carbon (DIC), pH and alkalinity. The measurement of pCO_2 is most practical and popular CO_2 measurement as an underway mode. Because the measurement uses seawater in the ship, safe installation of the intake and exhaust system for surface seawater and care during the cruise are truly necessary. A complete automatic system may not be enough safe. Asking a regular seaman to watch the water system is usually very difficult under the recent trend of reducing number of crew on board.

In the history of CGER-NIES CO_2 monitoring program using Pacific VOS, the on board system operator was changed from laboratory technicians to a seaman, employed by the research budget. Seaman employment can save the operational cost of the monitoring work. Ship operator also can have benefit of addition of a seaman sharing his working hours. The on board seaman can be responsible about the safety of on board monitoring system, especially for safety of the seawater use.

We made effort for automation of on board CO_2 system, and data networking of equipments, such as air CO_2 system at ship bow, ocean pCO_2 system at ship bottom, and navigation/meteorological system at bridge. On board operator can remotely watch the measurement results at bridge through on board LAN by our update instrumentation. Less necessity of daily on board maintenance facilitates operation by seaman without scientific carrier. The similar type of pCO_2 system has recently been installed on board a North Atlantic VOS under cooperation with Institute für Meereskunde, Germany and NIES.

The oceanic pCO_2 measurement needs SST and SSS information. A thermosalinograph is usually operated simultaneously with the pCO_2 system. The CO_2 VOS program can cooperate with the continuous surface SST and SSS measurement network by VOS.

The integration of global data set of oceanic CO_2 parameters, assurance of analytical accuracy is also an important issue. About DIC and alkalinity, Scripps CRM (certified reference material) is playing a great part. Unfortunately CRM is not so useful for accuracy control of pCO_2. Inter-calibration of on board pCO_2 system and common use of certified CO_2 system are recommended. We are also making effort for the quality control work in this field.

Table 1. History of NIES VOS monitoring including air and ocean CO_2 measurement

North Pacific VOS monitoring (Japan-US/Canada west coast line)						
Ship	Flag	Started	Ended	Air CO_2	Ocean. CO_2	System operation
Skaugran	Norway	1995/03	1999/10	hourly	minutely	on board technician
Alligator Hope	Liberia	1999/11	2001/05	10 sec.	10 sec. dual system	employed seaman
Pyxis	Panama	2001/11	active	10 sec.	10 sec. (2002/06-)	employed seaman
Western Pacific VOS monitoring (Japan-Australia line)						
Ship	Flag	Started	Ended	Air CO_2	Ocean. CO_2	System operation
Hakuba	Japan	1992/06	1996/01	flask	none	unmanned
Southern Cross	Japan	1996/03	2001/05	flask	none	unmanned
MOL Golden Wattle	Liberia	2001/05	active	10 sec.	10 sec. (2002/10-)	employed seaman

2. COORDINATION OF VOS AND SOOP PROGRAMMES MEASURING OCEAN CARBON AND RELATED PARAMETERS

Maria Hood, Intergovernmental Oceanographic Commission of UNESCO, Technical Secretary, SCOR – IOC Advisory Panel on Ocean CO_2
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ABSTRACT:

The SCOR-IOC Advisory Panel on Ocean CO_2 has recently created an email and web-based communications forum for scientists making measurements of ocean carbon and related parameters. (http://www.ioc.unesco.org/iocweb/co2panel) In October 2001, the Panel initiated the development of an inventory of programmes and principle investigators to determine the routes and measurements being made, and to share this information with the wider community. To date, the Panel has identified 21 programmes (8 Atlantic, 9 Pacific, 1 Atlantic-Pacific, and 4 Indian and Southern Ocean) measuring a wide range of ocean and atmospheric variables, including SST, SSS, pCO_2, fluorescence, pigments, optical properties, Total CO_2, Alkalinity, and atmospheric CO_2, ^{13}C, ^{14}C, ^{18}O, CH_4, N_2O, O_2/N_2, O_3, air temperature, humidity, solar radiation, and wind velocity and direction. The vessels used are approximately 50% research or resupply vessels, and 50% industry vessels. Countries sponsoring programmes include Norway, Germany, UK, Spain, US, Japan, Australia, Canada, and France. A number of these programmes work together to create combined data sets and products. There is a need, expressed by several of the principle investigators, for greater communication between these programmes to improve the coordination and data sharing, and for intercalibration exercises, standardization of techniques, and agreement on and use of certified reference materials and data formats. The Panel discussed the way forward at its 2nd Session meeting, 9-10 February, 2002. The initial inventory and plans for continued coordination and communication with this group of investigators will be presented.

3. BIOGEOCHEMICAL MEASUREMENTS OF SHIPS OF OPPORTUNITY- ONGOING PROGRAMMES AND FEASIBILITY

Yves Dandonneau, Laboratoire d'Oceanographie Dynamique et de Climatologie, Universite Pierre et Marie Curie, Paris

ABSTRACT:

The marine ecosystems that control the biological carbon sink are complex, including primary producers, grazers, predators, and bacteria, and produce a large variety of dead particles and dissolved organic matter. Their study implies measurements of many kinds of biomass and fluxes, and is possible only during devoted cruises onboard of oceanographic research vessels. Hence, only a limited number of such studies can be made, and these are generally organized in provinces where carbon fluxes are important and over which the dominant processes are considered to be homogeneous and can be predicted.

On the other hand, sea color sensors on satellites deliver data that can be converted into chlorophyll concentration, making it possible to obtain weekly global maps of chlorophyll concentration at the sea surface, i.e., information that is very close to the carbon flux which corresponds to gross photosynthesis.

Between these two approaches, there is a large gap, as global chlorophyll fields derived from satellites cannot be used accurately for the determination of global biogeochemical fluxes unless we know how the ecosystems operate these fluxes in all provinces. Ships of opportunity can help to describe the variability of the ecosystems which is mostly at large scale (regional, seasonal). Programs already exist that are based on sampling by ships of opportunity and that address oceanic biogeochemistry. They can be divided into two categories according to their objectives. Some of them aim to improve the estimates of surface seawater chlorophyll content from reflectance measured at the top of the atmosphere. For this, atmospheric correction represents 90% of the signal, making it a major difficulty. In order to validate the algorithms that estimate the seawater reflectance from reflectance at the top of the atmosphere, measurements of the former must be repeated in many places, covering the wide variability of aerosols and atmospheric conditions. For these measurements, three difficulties must be solved: avoiding the sun glitter, avoiding the white caps, and avoiding surfaces where the irradiance field is affected by the ship. The two last ones are especially difficult to solve. Two radiometers have been developed: the SIMBADA (Laboratoire d'Optique Atmosphérique in Lille, France) is a portable easy to use radiometer, that has 11 wavelengths near or close to those of SeaWiFS or MERIS sea color sensors and can be operated by the officers of ships of opportunity, and the Shadow Band Radiometer, developed at Brookhaven (New York), that is fully automatic and additionally measures the radiation from the sky (without direct sun radiation) using a rotating screen (the 'shadow band'). Other ones aim to describe the variability of biogeochemical conditions at sea, and can include the measurement of a very large number of parameters. Among these, photosynthetic pigments are especially interesting : they offer a way to validate the products of sea color satellite sensors, and they make it possible to characterize the ecosystems, because many of these pigments are indicators of phytoplankton groups. Great care must be taken for the sampling of photosynthetic pigments, especially for storage that must be done at temperature less than minus 40°C. Depending on the measurements to be made, presence of a scientific observer onboard of the ship is often necessary. Examples of such programs are the Atlantic Meridional Transect (AMT) managed from Plymouth, England, and the Geochemistry, Phytoplankton and Color of the Ocean project (GeP&CO) operated from LODyC, France.

Session 2 Observational equipment and telecommunication facilities (Chair: Ms Sarah North)

4. AN AUTOMATED OCEAN AND WEATHER MONITORING SYSTEM FOR USE ON VOLUNTARY OBSERVING SHIP (VOS)

Tom Houston, Geoffrey K Morrison, Cynthia Moore, and Rod G. Zika, International SeaKeepers Society
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ABSTRACT:

The International SeaKeepers Society has developed an autonomous ocean and weather monitoring system. Systems are currently deployed on private superyachts, and commercial cruise ships, which participate in the Volunteer Observing Ship (VOS) program. Wind speed and direction, air temperature, barometric pressure, relative humidity, and sea surface temperature (SST), along with ship's position, are reported automatically to the United States National Weather Service via INMARSAT C email at regular intervals.

In addition to its "weather sensors", the SeaKeepers system is designed to accommodate a wide variety of oceanographic sensors as well. At present all participating vessels carry a suite of ocean sensors that measure, log and transmit data on SST and salinity. Other aqueous sensors such as dissolved oxygen, pH and Eh and optical sensors for chlorophyll and CDOM fluorescence and turbidity are being developed for inclusion in the system and are currently completing field tests. Sensors for pCO_2, total CO_2 and trace metals are also in development. A nutrient monitoring package is also planned.

This process represents a unique collaboration between:

The International SeaKeepers Society, a not for profit organization
The National Oceanographic and Atmospheric Administration, US government
The University of Miami, Rosenstiel School of Marine and Atmospheric Science
General Oceanics Inc. a US corporation
Idronaut Srl an Italian manufacturer

SeaPoint Corporation a US corporation
WS Envirotech a UK manufacturer

5. RELIABLE WIND DATA FROM SHIPBOARD AWS

R Caplikas, Manager, Vaisala Melbourne, Australia
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ABSTRACT:

Truly representative information about wind direction and speed at sea cannot be obtained by observing the weather on the coast. Australia's Bureau of Meteorology has installed a small number of Automatic Weather Station (AWS) on its Australian Volunteer Observing Fleet (AVOF) ships to assist in obtaining maritime weather observations. These ships report generally on a three hourly Synoptic schedule, and relay the conventional weather parameters such as wind speed and direction, pressure, temperature and humidity.

An INMARSAT-C satellite transmitter with an internal GPS receiver is used to transmit observations back to the Bureau's network. The GPS receiver provides information on the ship's position and speed and its course over the water. A laptop PC on the bridge displays real-time information on the AWS measurements. It also enables manual entry of observations such as visibility and sea state.

Data transmission costs from the AVOF ships is an important consideration. For this reason, the standard Synop message is converted to a short binary report prior to transmission and then decoded back to the standard Ship Synop code at the Bureau. This enables the use of very short data transmissions. The benefits are two-fold, observations can be made as frequently as once per hour, and costs are significantly lower compared with other communication options.

AWS data from these ships will significantly contribute to improve accuracy of marine forecasts. For example, the first Ship AWS was fitted to the Spirit of Tasmania to assist in the study of wind patterns across Bass Strait, as part of an effort to enhance the Bureau's computer derived forecasts and improve forecasting for Bass Strait.

At present the Bureau has installed this system on five AVOF ships and is currently planning to install a further five to ten over the next three years. In summary, the Ship AWS system provides automatically accurate, around the clock, information on the marine weather situation. The weather information collected is proving to be an extremely useful contribution for forecasts, and model input both in the Australian area, and also for input into the worldwide NWP models.

6. DEVELOPMENTS IN VAISALA'S ASAP EQUIPMENT

Erkki Jarvinen, Vaisala
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ABSTRACT:

This presentation introduces the Vaisala ASAP Product. Product is based on DigiCORA III MW21 based radiosounding equipment. DigiCORA III sets new standards for upper-air sounding operations due to its open software architecture, flexibility, telecommunication and networking capabilities.

Several improvements have been made to GPS-derived upper air wind measurements. These improvements have been implemented in the Vaisala radiosonde design and its associated computation algorithms. The effect of these improvements has been analyzed for performance and reliability and compared with collected operational data from the field.

This presentation will also consider "Data as a product" -concept: Discussion about one possibility to accelerate the increase of the ASAP-observations over the oceans. Vaisala could consider furnishing ASAP-installations and providing data for GTS.

7. DEVELOPMENT OF BEOGEOCHEMICAL AND PHYSICAL DATA ACQUISITION SYSTEMS FOR USE ON MERCHANT VESSELS

Rick Bailey (CSIRO/BMRC JAFOOS Australia), Roger Francey, Bronte Tilbrook, John Parslow (CSIRO Australia)
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8. REPORT ON THE DEVELOPMENT OF CO2 MONITORING SYSTEMS TO BE INCLUDED IN AN AUTONOMOUS DATA GATHERING SYSTEM

Geoffrey K Morrison, Frank Millero, Flavio Graziottin, Walter Varda, Regis Cook, Richard Wood and Rod G. Zika, International SeaKeepers Society
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ABSTRACT:

The development of two specialized sensors for monitoring air-sea CO_2 flux is described: 1) A pCO_2 continuous-flow system utilizing a miniature shower head equilibrator and 2) a continuous-flow differential pH system for monitoring total inorganic carbonate (TCO_2). The initial development of these instruments was funded by an NSF STTR grant. The second phase of the development is now being funded by an NSF Phase II STTR grant. The two sensors are being designed so that they can be easily installed, together with other ocean and atmospheric sensors, in the SeaKeepers Ocean & Atmospheric Monitoring System currently being deployed on ships, buoys and piers around the world. After being fully field tested, the two CO_2 instruments will be deployed worldwide by the non-profit International SeaKeepers Society to analyze CO_2 absorption by the oceans as a contribution to the research on the role of CO_2 in global warming.

9. IMPROVING THE FREQUENCY AND RELIABILITY OF GLOBAL METEOROLOGICAL OBSERVATIONS AT SEA

Ron Fordyce, PMO Manager, Environment Canada, Hamilton, Canada
Tom Vandall, Director, AXYS Environmental Systems, Victoria, Canada
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ABSTRACT:

The Voluntary Observing Ships' (VOS) meteorological reports provide essential data to meteorologists and climatologists. Currently these observations are collected, corrected (true wind, magnetic variation, pressure etc.) and transmitted manually using the standard WMO format. Until recently, over 20% of the observed data in Canada's VOS program was being rejected by failing automated quality control (QC) tests, or being lost by complications in the data routing pathways to the GTS. Commonly, data was rejected due to errors in the observed wind speed and direction or errors with the observed position.

The manual nature of VOS data collection introduces an inherent risk for observation bias and/or input error. In addition, the frequency of data reporting is inconsistent and often not carried out in extreme weather conditions when the data is most important. Other limitations include the wide variety of uncalibrated instruments that are in use. In an effort to improve Canada's VOS program, Environment Canada contracted AXYS Environmental systems to develop the Automated Voluntary Observing Ships AVOS™ system to transmit fully automated VOS observation reports. This system was based on the successful Watchman™ based buoy payloads in use in the Canadian Weather Buoy Network. Today AVOS™ reports include GPS position, UTC time, vessel identification, 3 hourly ship speed made good, course speed made good, pressure tendency, true wind speed and direction, pressure, air temperature, wet bulb temperature and sea surface temperature. The system uses standardized, calibrated climate quality sensors, which are in use in the National Weather Buoy Network. Early data return rates for AVOS™ have been excellent with automated region detection algorithms supporting reporting modes for Synoptic (6 hr.), Intermediate Synoptic (3 hr.) and Data Sparse (1hr.) regions. As a result the frequency of measurements has risen dramatically with automatic region detection and automatic reporting of STORM and SPREP conditions also taking place.

Through the use of image rich touch screen technology and an intuitive software interface, manually observed data such as cloud height and type, present and past weather, wave conditions and ice and icing can be added to the VOS report. Automated quality control protocols ensure that manual observations are correctly entered. Corrections for elevation and magnetic variation are made automatically using region detection algorithms. PMO's have been very enthusiastic about the simple installation and ease of use with AVOS™ which is helping them to promote the VOS program.

To date Environment Canada has purchased 13 AVOS™ systems and plans to outfit 75 vessels in the Canadian AVOS fleet over the next few years. Ships outfitted with AVOS™ have generated a ten fold increased in the average number of VOS reports. It is apparent that this system will significantly help Canada improve the frequency and accuracy of VOS observations.

10. THE NEW OBSJMA

Tadashi Ando, Japan Meteorological Agency
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(see extended abstract)

11. ARGOS SYSTEM APPLICATIONS AND ENHANCEMENTS

Christian Ortega , CLS/Service Argos
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(see extended abstract)

12. NEW INMARSAT MARINE SAFETY AND COMMERCIAL SERVICES IN 2002

Vladimir Maksimov, Inmarsat Ltd.
Email: vladimir_maksimov@inmarsat.com
(see extended abstract)

13. AUTOMATIC VOLUNTARY OBSERVING SHIPS' SYSTEM BRIDGE TOUCHSCREEN INTERFACE

Tom Vandall, AXYS Environmental Systems, Victoria, Canada
Email: tvandall@axys.com

ABSTRACT:

AVOS™ automatically samples, processes, displays, logs and transmits weather data from VOS ships in the universal FM 13-XI code to VOSCLIM (VOS Climate Project) standards.

Automated parameters include GPS position & UTC time, 3 hourly ship speed made good, course made good & pressure tendency, true wind speed & direction, air temperature & wet bulb temperature, barometric pressure, sea surface temperature, and vessel identification. Through the use of touch screen technology and an intuitive software interface, manually observed data such as cloud height and type, present and past weather, wave conditions and ice and icing can be added to the FM13-XI ship report. Automated quality control protocols ensure that manual observations are correctly entered.

Corrections for elevation and magnetic variation are made automatically using region detection algorithms. Region detection also supports automated reporting modes for Synoptic (6 hr.), Intermediate Synoptic (3 hr.) and Data Sparse (1hr.) reporting regions when required. STORM and SPREP conditions are also automatically detected and transmitted. AVOS Bridge Touchscreen Interface will be demonstrated.

Session 3 Evaluation (Chair: Mr Steve Cook)

14. RESULTS OF FIELD TESTS OF THE NEW XCTD-2

Tomowo Watanabe[1] and Michio Sekimoto[2]
[1] Tohoku National Fisheries Research Institute
[2] Tsurumi Seiki Co., LTD
Email: trade@tsk-jp.com

ABSTRACT:

The eXpendable Conductivity, Temperature, and Depth profiler for temperature and salinity observations to a depth of 1,850 m (XCTD-2) was tested during the MR01-K04 cruise of the research vessel R/V MIRAI in the summer of 2001. The new, deep–water probe was recently developed by the Tsurumi-Seiki Co., LTD. Field tests of the XCTD 2K are indespensible for determining the depth-time equation for practical use. On the cruise, 12 probes were launched during CTD up-casts at 11 CTD stations. Successful observations were collected to a depth of 1800 m by 9 of the 12 tests. By using the 9 pairs of XCTD and

CTD profiles, the depth-time equation was estimated as $D = 3.4005t - 3.2x10^{-4}t^2$, where D is the depth in meters and t is the elapsed time after the probe hits the sea surface. The temperature and salinity differences from CTD observations in the deep layer of 1000m to 1500m were -0.001^0C and -0.008psu respectively. Standard deviations were 0.018^0C and 0.013psu. These values indicate improvement of the XCTD system.

15. EVALUATION OF DATA FROM A PILOT FIELD EXPERIMENTT UTILIZING SEAKEEPERS AUTOMOATED DATA COLLECTION AND TELEMETRY SYSTEMS ON A GROUP OF VESSELS

Geoffrey K. Morrison, Edward J. Kearns, Christine Caruso-Magee and Rod G. Zika,
InternationalSeaKeepers Society
Email:geoffmorrison@bigfoot.com

16. THE ACCURACY OF VOLUNTARY OBSERVING SHIPS' MARINE METEOROLOGICAL OBSERVATIONS

Elizabeth C. Kent and Peter K. Taylor, Southampton Oceanography Centre, U.K.
Email: elizabeth.c.kent@soc.soton.ac.uk

ABSTRACT:

Typically the merchant ships of the Voluntary Observing Ships scheme are recruited by a Port Meteorological Officer at a port which the ship frequently visits. The observing practises and meteorological instruments provided depend on the recruiting country and are often very basic. Indeed, the VOS system was primarily designed to aid weather forecasting, while climate change studies require higher quality data. A better understanding of the error characteristics of the VOS data is now needed for both data assimilation and climate studies.

Using sea and air temperatures as an example, this talk will show how the large random errors present in the data can be quantified. Determining the smaller, systematic biases is more difficult because correlations exist between the different variables and their respective errors. For example, the error in SST data measured using buckets is likely to depend on the air - sea temperature difference, and hence on both sea and air temperatures. Surprisingly the scatter in the air temperature data seems to vary with how the SST is measured, probably because the observing practises strongly depend on recruiting country. By transforming the data to form new variables which are uncorrelated, the systematic errors can be properly estimated and then transformed back in terms of the observed quantities. The results suggest that, while SST data from engine room intake (ERI) thermometers are very scattered, any mean bias is small. In contrast, while bucket SST data is less scattered, it is biased cold in regions of high heat flux. Previously it had been assumed that ERI data were biased warm.

Improving the quality of future VOS data requires fuller information on instrumentation and observing techniques, and the implementation of good observing practises. These are goals of the WMO sponsored VOS subset for climate (VOS-Clim). Eventually it is hoped to introduce better instrumentation. For example, hull contact SST sensors installed with acoustic data transmission rather than cables. The IMET project at Woods Hole Oceanographic Institute and the AutoFlux system (developed by SOC with European partners) are prototypes for future VOS instrumentation systems.

17. EVALUATION OF XBTs AND XCDTS IN SEA TRIALS

Rick Bailey, Lisa Cowen, CSIRO/BMRC JAFOOS
Ken Ridgway (CSIRO)
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Session 4 Scientific and operational applications (Chair: Mr Jean-Paul Rebert)

18. APPLICATIONS OF UPPER OCEAN THERMAL DATA

Rick Bailey , CSIRO/BMRC JAFOOS
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19. EUCOS, AN OCEAN OBSERVATION STRATEGY OVER THE NORTH ATLANTIC

François Gérard, Météo-France
Email: francois.gerard@meteo.fr

ABSTRACT:

The European meteorological services member of EUMETNET have established a strategy for the definition, implementation and operations of the surface based observation systems of interest for weather forecast over Europe. From 1999 to 2001, the EUMETNET Composite observing system (EUCOS) implementation programme has worked on network evolution scenarios to implement the strategy. The presentation will present the oceanic part of the scenario adopted at the end of the EUCOS programme. It will be shown that the use of sensitivity tools enable to issue clear requirements for the operation deployment of marine platforms like ASAP ships, VOS and buoys, in order to target the observation over the main sensitive areas. The fesibility of such targeting will be shown through the results of an experiment performed in September 2001with the European ASAP ships.

CO_2 Panel

Scientific Committee on Oceanic Research

VOS / SOOP Measurements of Carbon and Related Variables – the SCOR – IOC CO_2 Panel Initial Survey (http://www.ioc.unesco.org/iocweb/co2panel)

Yukihiro Nojiri, Carbon Cycle Research Team, National Institute for Environmental Studies
Email: nojiri@nies.go.jp

Email / web-based communications forum for the VOS / SOOP community.

Inventory of programs, funding agencies and dates of operation, routes, ships, measurements made, principle investigators, contact information, web information.

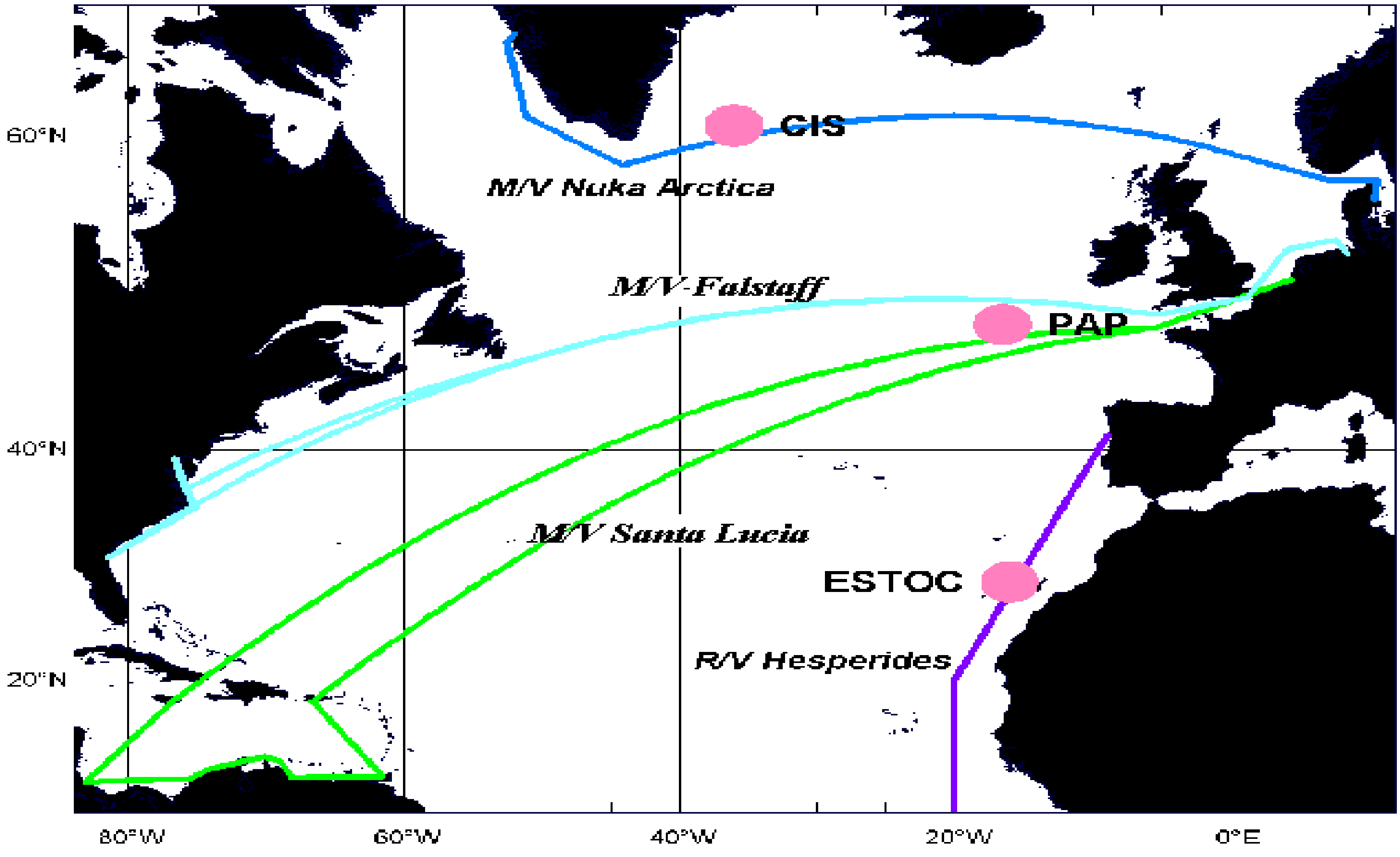
21 Programs / Routes : 8 Atlantic, 9 Pacific, 1 Atlantic-Pacific crossing, and 4 Indian and Southern Ocean . Countries sponsoring programs include Norway, Germany, UK, Spain, US, Japan, Australia, Canada, and France.

Measurements : SST, SSS, pCO_2, fluorescence, pigments, optical properties, Total CO_2, Alkalinity, and atmospheric CO_2, ^{13}C, ^{14}C, ^{18}O, CH_4, N_2O, O_2/N_2, O_3, air temperature, humidity, solar radiation, and wind velocity and direction.

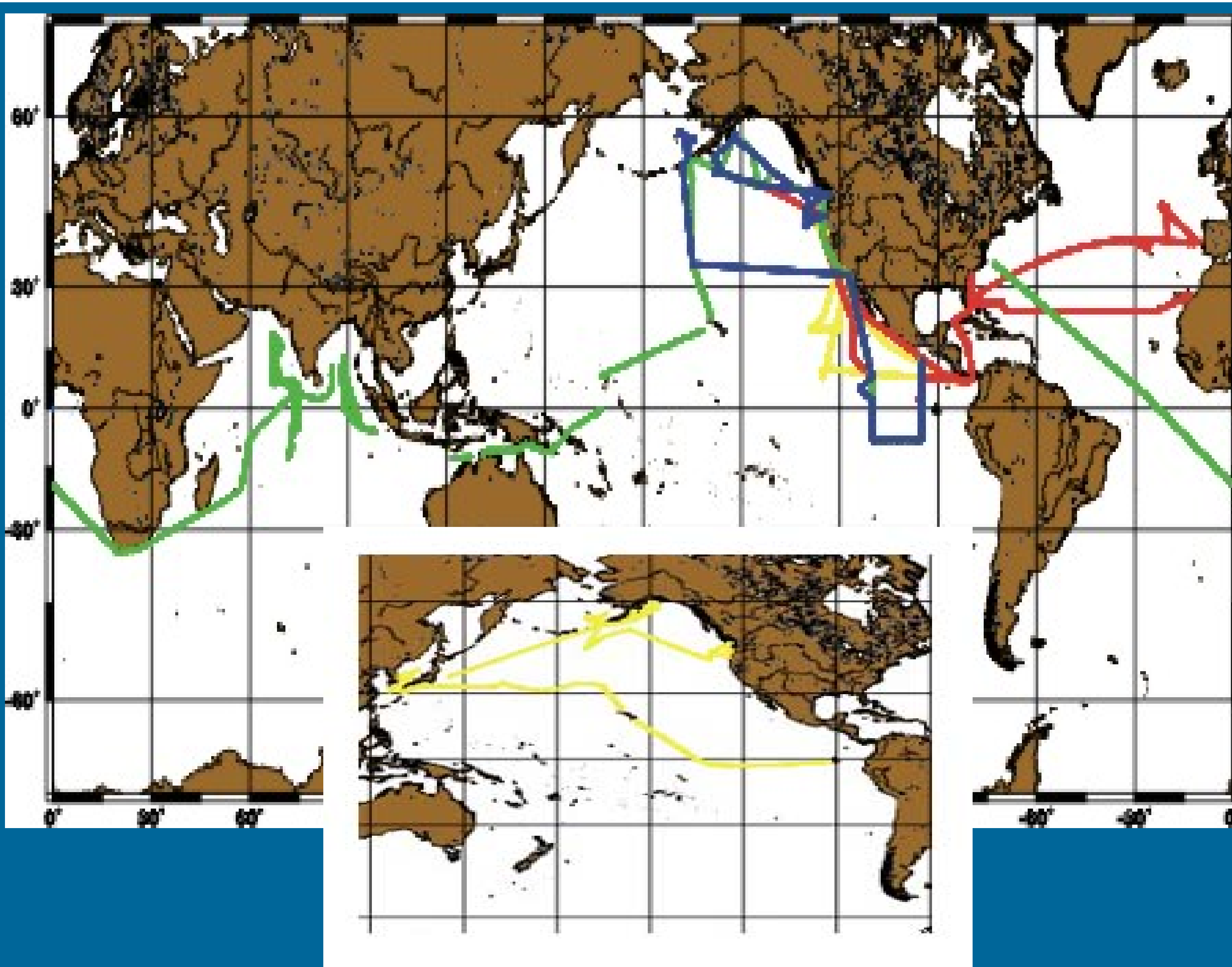
Vessels: approximately 50% research or resupply vessels, 50% industry vessels.

<u>Carbon Variability Study from Ships of Opportunity (CAVASSOO)</u>

EC funding 2001-2003; University of Bergen, Kiel, East Anglia, and Instituto de Investigaciones Marinas, Spain.

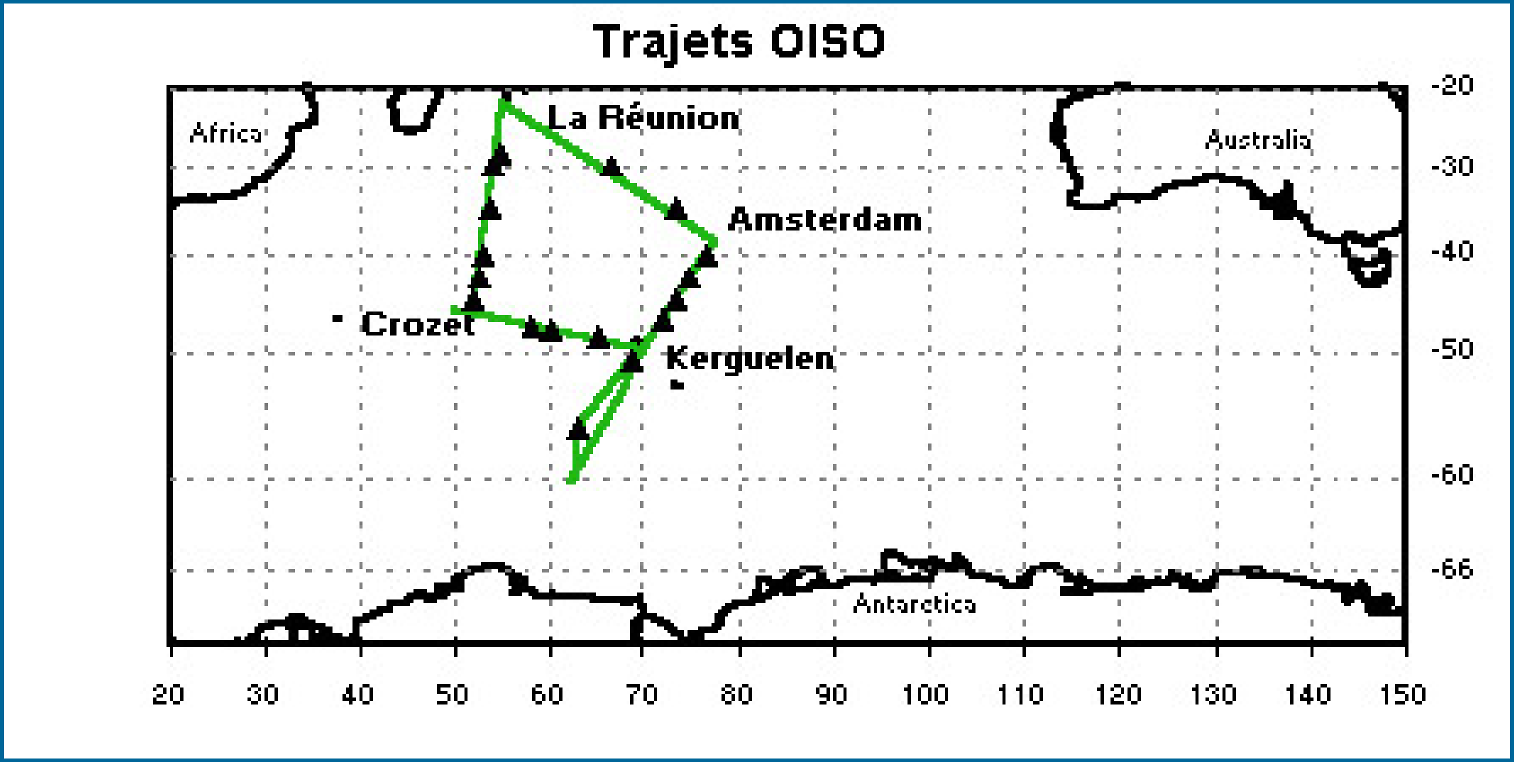


<u>NOAA Underway pCO_2 Programs</u> – Atlantic Oceanic and Meteorological Laboratory and the Pacific Marine Environmental Laboratory



Océan Indien Service d'Observation (OISO)

Institut National des Sciences de l’Univers, Institut Francais pour la Recherche et Technologie Polaires, Institut Pierre Simion Laplace, et University Pierre et Marie Curie.



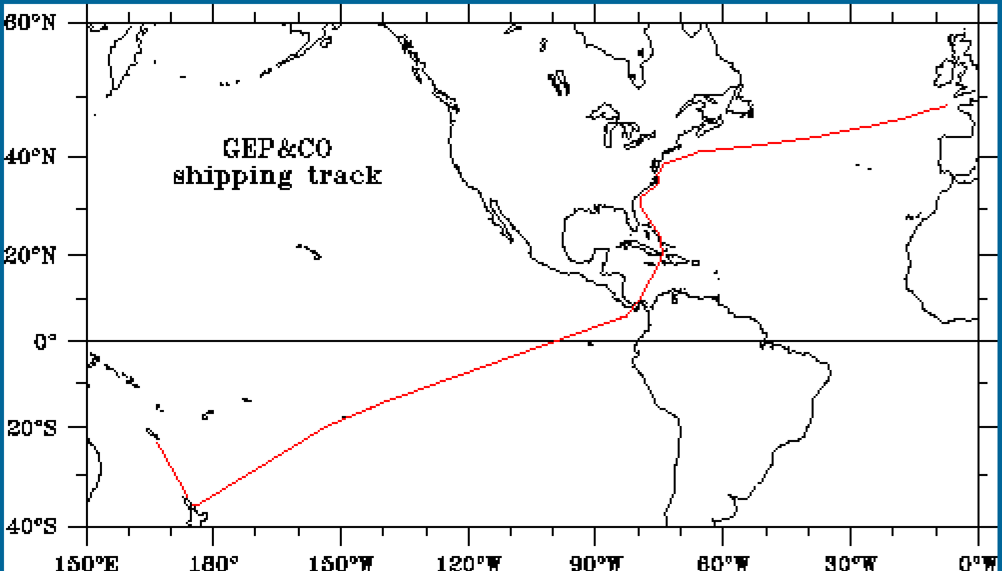
Geochemistry, Phytoplankton and Color of the Ocean (Gep&Co)

Objectives: To describe the space and time variability of the composition of the phytoplankton over a wide range of oceanic conditions; To understand how oceanic conditions control this variability; and To build a database of field observations for the retrieval of some main phytoplankton groups using sea color detected from satellites.

Ship: Merchant ship Contship London

Route: Le Havre (France) to Nouméa (New Caledonia) via New York, Panama, Tahiti and Auckland, every three months.

Status: Gep&CO started in November of 1999, and was scheduled for 3 years. At present, 10 cruises have been made, and the last two are scheduled in April and July of 2002.



Panel Projects for VOS / SOOP

To complete the initial inventory of carbon and related measurements from VOS / SOOP;

To bring these groups together into a ‘virtual’ forum to exchange information and data;

To develop intercalibration projects and agreements on the use of certified reference materials where needed;

To encourage the closer coordination of VOS / SOOP measurements with other observation programs such as hydrographic sections and time series stations;

To encourage the further development of automated measurement techniques for a suite of ocean carbon and related variables, including ocean color.

An Automated Ocean and Weather Monitoring System for Use on Volunteer Observing Ships (VOS)

Tom Houston, Geoffrey K. Morrison, Cynthia Moore and Rod G. Zika
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www.seakeepers.com

The International SeaKeepers Society has designed an autonomous oceanographic and meteorological monitoring system which can be deployed on a wide variety of platforms to collect data for marine weather forecasting and oceanographic research. The compact modular system has been deployed on yachts, cruise ships, commercial vessels, research ships and piers. Low energy-demand systems are being developed for use in buoys, in partnership with the National Data Buoy Center of the National Oceanographic and Atmospheric Administration (NOAA). These are expanding the VOS network with reliable, timely and accurate reports every three hours by INMARSAT Standard C telemetry, and collecting data on oceanographic conditions, stored every minute. The system carries a standard suite of sensors, and can accommodate specialized sensors for focused research problems. The society has invited instrument manufacturers, academic faculty , government agencies and other organizations to design sensors and experiments utilizing the SeaKeepers capabilities for low-cost world-wide environmental research..

The monitoring system, shown in Figure 1, is housed two NEMA-4 stainless steel enclosures to facilitate installation in a variety of configurations. The smaller module contains the computer, the INMARSAT transceiver and the power supplies. The second module has the pump, a distribution manifold, and mounting brackets for up to five instrument packages. The modules are each 16 inches wide, 10 inches deep and 18 inches/30 inches high.

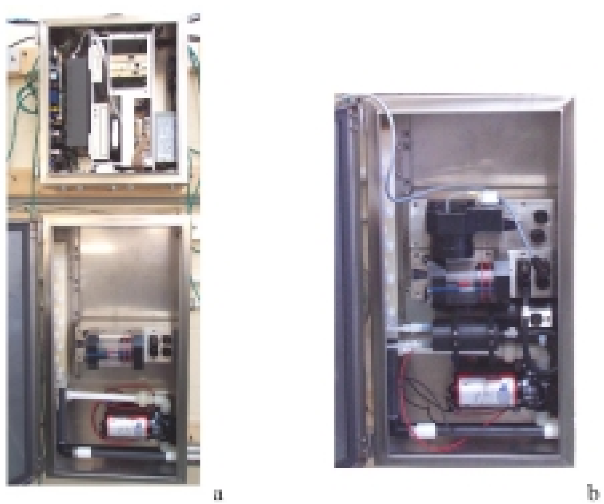


Figure 1. The Ocean and Weather Monitoring System. The standard system is shown in figure a, and the instrument module with an expanded suite of sensors in b.

The meteorological station illustrated below (figure 2) comprises components manufactured by R M Young Inc. In most applications all of the sensors are mounted on a single mast.

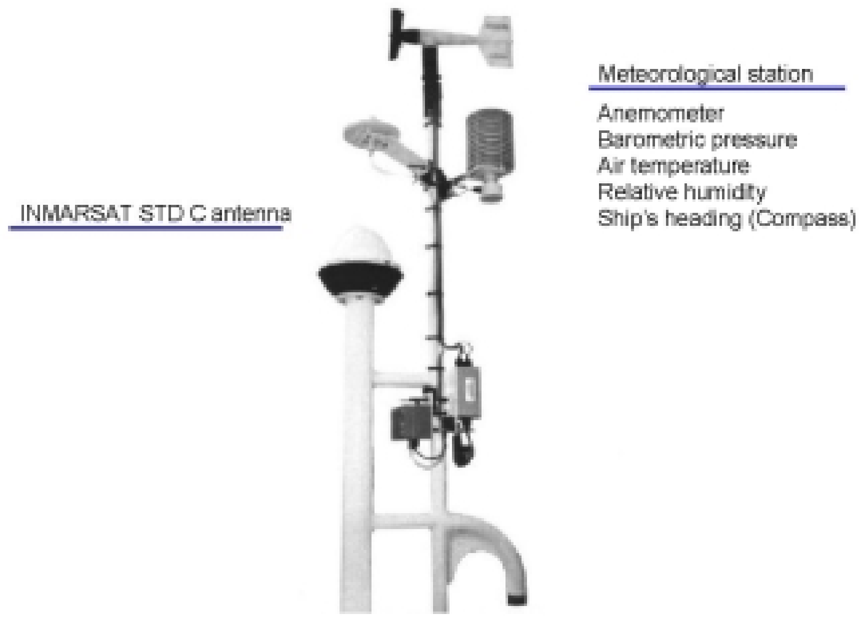


Figure 2. The meteorological sensor suite comprises wind speed and direction, a fluxgate compass, barometric pressure, air temperature and relative humidity.

The standard SeaKeepers installation has a multi-parameter sensor for oceanographic measurements which includes temperature, conductivity, dissolved Oxygen, pH and Eh. A platinum resistance thermometer mounted outside the hull at the water intake measures sea surface temperature (SST). Solid-state optical sensors have been developed for Chlorophyll-a and dissolved organic material (DOM) fluorescence and Turbidity. A new sensor suite is under development by SeaPoint Sensors, Inc. that will incorporate Turbidity, Chlorophyll and CDOM in one package. Toxic metal sensors are being developed by Idronaut Srl Italy to fit into this system. A nutrient sampling package has been developed by WS Envirotech in the UK and will shortly be undergoing sea trials.

A phase II NSF Tech. Transfer grant has been awarded to General Oceanics Inc. in conjunction with The University of Miami and NOAA AOML scientists to assist in the development of a miniaturized pCO_2 monitoring system that will be suitable for SeaKeepers use and later unattended buoy operation. Details of this system are reported in a paper: Kearns, E. et al., “Report on the development of CO_2 monitoring systems to be included in an autonomous data gathering system.” also presented at the JCOMMs meeting in Goa, India.

The modular design of the SeaKeepers Ocean monitoring system makes it possible to deploy many sensors, if they are designed to fit the required footprint. Submodules for mounting electronics and components can be supplied by the society.

One of the advantages of utilizing yachts as one component of the VOS network is the opportunity to sample less frequented ocean regions. Figure 3 illustrate the cruise tracks of 30 SeaKeepers member vessels for 2001. The number of vessels equipped with the Ocean Monitoring system continues to grow.

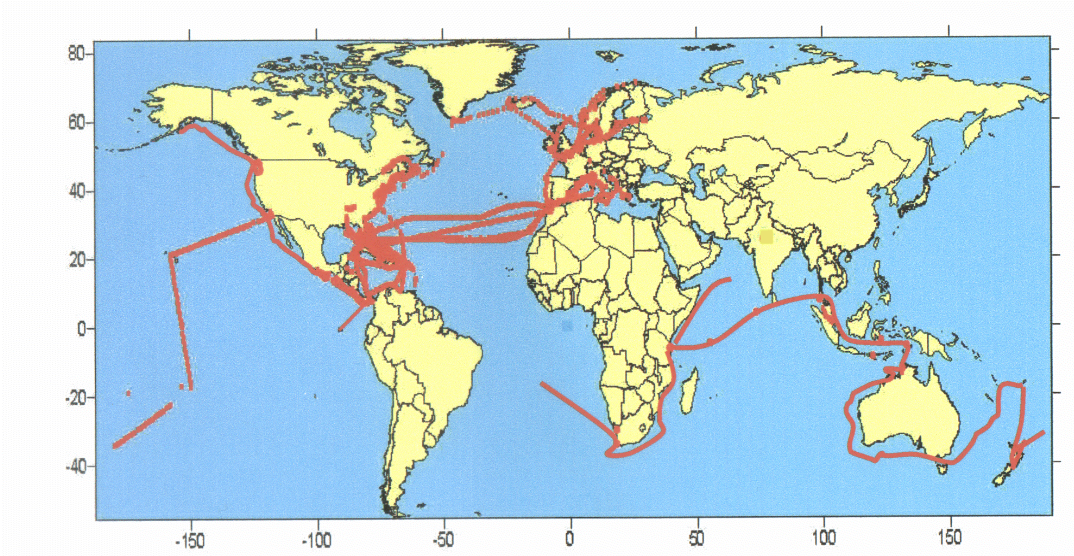


Figure 3. *Cruise tracks year 2001*

Figure 4 illustrates in a cartoon how the data is transferred and handled at the University of Miami prior to distribution to the US National Weather Service via GTS. As the data volume increases we anticipate requiring a full time group of data managers in this area.

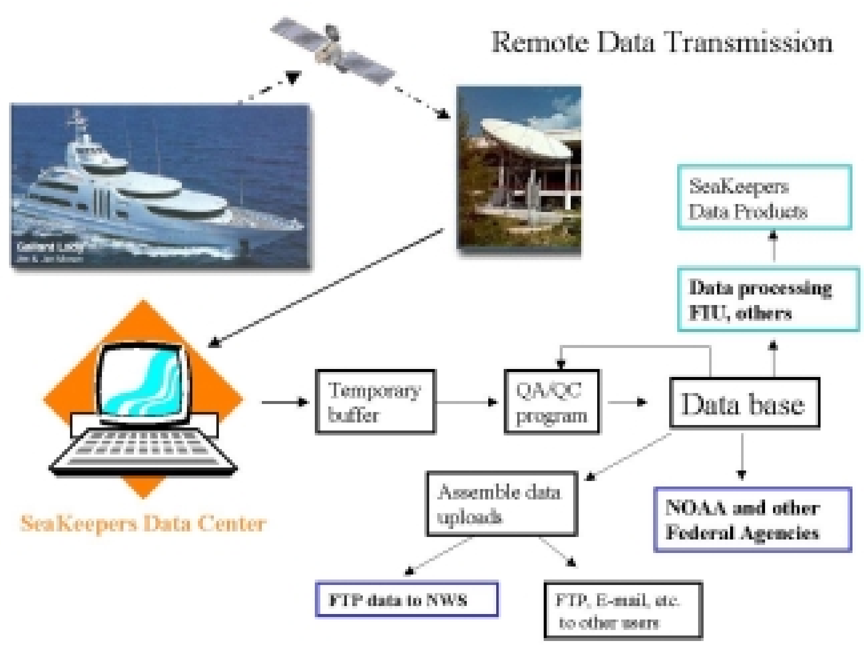


Figure 4. Data handling

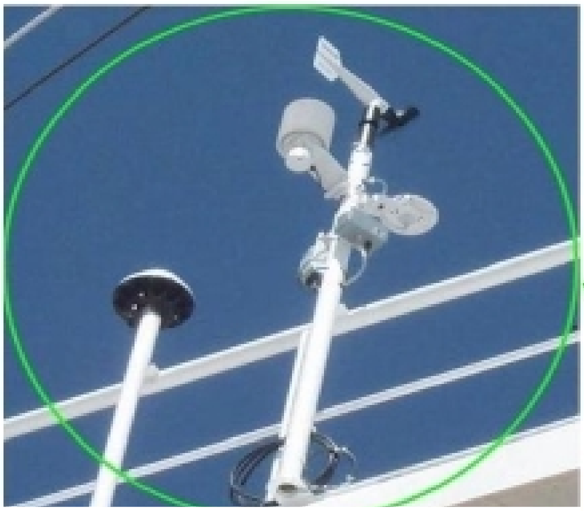
A spin off from the above system is the creation of an automated weather station that can be readily installed upon any vessel and will fulfill and exceed the VOS ship requirements while logging a high resolution data set for later use. In an effort to develop another source of funding for the Society, the Society is now offering an Automated VOS station which is described in the attached brochure. As well as providing 8 3 hourly observations per day this system will telemeter observation times and positions, while providing an elegant display on the vessels networked computers.

This project represents as unique collaboration between:

The International SeaKeepers Society, a not-for=profit organization
The National Oceanographic and Atmospheric Administration, US government
The University of Miami, Rosenstiel School of Marine and Atmospheric Science
General Oceanics Inc., a US corporation
Idronaut Srl, an Italian manufacturer
SeaPoint Sensors Inc, a US corporation
WS Envirotech, a UK manufacturer

The International SeaKeepers Society has proved that a small determined group of people can make a significant impact on the volume and frequency of marine observations.

The International SeaKeepers Society Automated Volunteer Observing Ship (VOS) Meteorological Station.



Met sensors and INMARSAT C antenna

Avoid time-consuming manual data collection and transmission

Eliminate transcription errors

Improve marine weather forecasting

Generate a permanent record of weather conditions on all voyages

Collect data to the quality required by the National Weather Service World Meteorological Organization, and Global Ocean Observing System

Data Transmissions will always be made automatically without involvement by the ship's crew

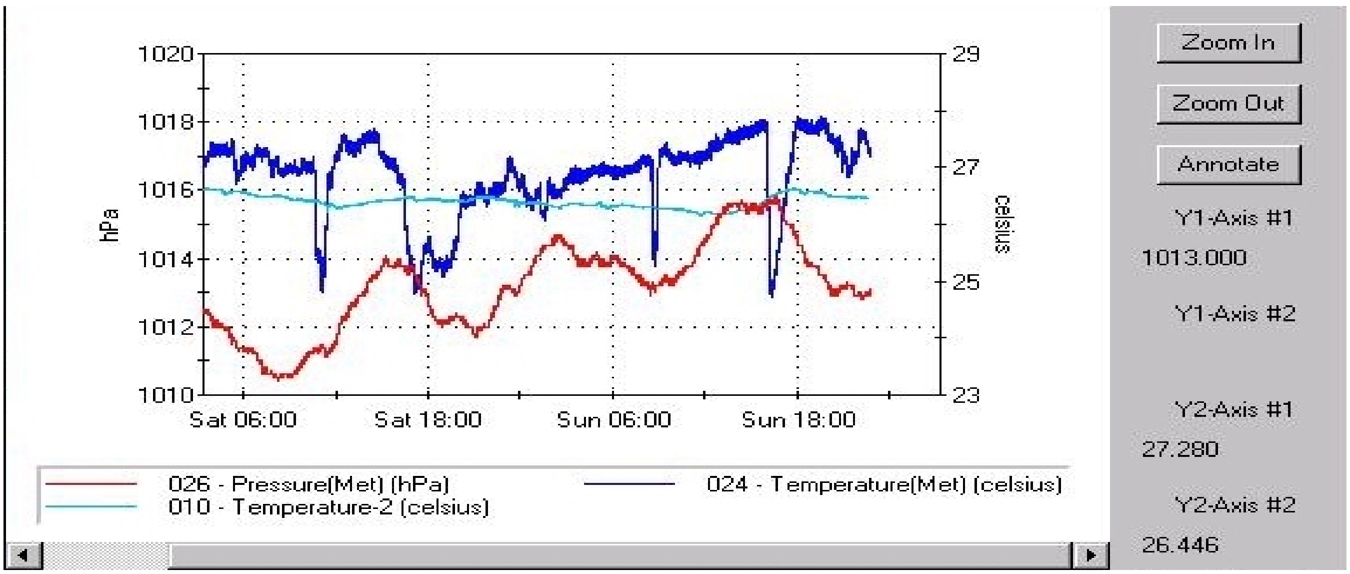
Data transmissions include vessel position and course over the ground, which may be utilized to facilitate better fleet planning. The automated VOS meteorological station which is based upon the International SeaKeepers Society's Ocean monitoring module has been extensively field tested for the last three years; providing data of exceptional quality.

The package includes the weather station, a NEMA4 enclosed computer, INMARSAT C transceiver and a sea surface temperature probe. Simple installation requires running a coaxial cable to the antenna, and 0.25 inch diameter cables to sensor locations both on the mast and to the sea surface temperature probe on the hull. An additional cable is required to connect the system the vessel's computer.

As an option, system can also provide bi-directional email capability (INMARSAT C) for the crew with true global coverage.

Utilizing the vessels computer network any connected computer can access user-friendly data displays.

The system further provides a continuous history of weather conditions during the voyage that can be displayed on the ship or sent to headquarters



A plot of barometric pressure, air temperature and water temperature from Saturday at 0300 until Sunday at midnight

Sensor specifications

Variable	Units	Range	Accuracy	Resolution
Sea surface temperature	° Celsius	-3 to 50 °C	± 0.01 °C	0.001 °C
Air temperature	° Celsius	-50 to +50 °C	± 0.3 °C	0.1 °C
Relative humidity	%	0 to 100 %	± 3 %	0.1 %
Wind speed	Knots	0 to 120 Knots	± 1 Knot	0.1 Knots
Wind direction	Degrees	0 to 355 Degrees	± 3 Degrees	0.1 degree
Barometric pressure	h Pascals	800 to 1100 hPa	± 2 hPa	0.1 hPa
Course over ground	Degrees	0 to 359 Degree	± 3 degrees	1.0 degree
Speed over ground	Knots	0 to 100 knots	±0.5 knot	0.1 Knot
Latitude	Degrees	-90 to +90	<±0.001min	0.0001min
Longitude	Degrees	-180 to +180	<±0.001min	0.0001min
UTC time	HH:MM:SS	0 to 24 hours	±0.013 sec	0.001 sec

Ship Automatic Weather Stations

R Caplikas, Manager, Vaisala Melbourne, Australia
R Hibbins, Instrument Engineering, Bureau of Meteorology, Australia
Email: robert.caplikas@vaisala.com

Vaisala experience

- First Ship applications during 80’s
- From 1986 to 1992, Vaisala supplied thirteen Ship AWS’s to Canada.
- Some 27 Ship AWS’s have been supplied to DWD in Germany during 90’s.
- 4 full automatic AWS with optical sensor to Norwegian Coast Guard in 2001
- Total installed base of over 80 systems.
  - Research ships, Icebreakers, Cruise Ships, ASAP Ships, Military Ships
  - Finland, Germany, Sweden, Russia, USA, Norway, Spain, France, China, Italy, Ireland

Ship AWS features

- Interfaces for GPS navigation and ship’s LOG system.
- True wind calculations.
- Automatic message coding and transmission via satellite (Meteosat, GOES, GMS, Inmarsat-C).
- NMEA compatible input / output.
- Reliability in a demanding environment.

Technology

Vaisala Milos AWS

- Flexibility of the system
  - third party hardware
- Flexibility of the software
  - calculations, reports, serial interfaces
- Worldwide support
- Quality / Standards
  - international standards (CE, IEC, MIL)
- Proven performance
  - > 2000 systems in operation

Overall system

Automatic measurements

- Pressure
- Temperature and Humidity
- True wind speed and direction
- Sea temperature (if fitted)

Manual input

- Cloud and visibility
- Sea state, Ice etc.
- Present/past weather

Overall system options

Optional automatic measurements

- Cloud base
- Present weather
- Precipitation
- Several Solar radiation
  - Global, Albedo, UV, IR
- Precipitation
- Rain Duration
- Sunshine duration
- Multiple wind sensors

Australian Bureau of Meteorology Ship AWS

Vaisala Melbourne

Project Goal

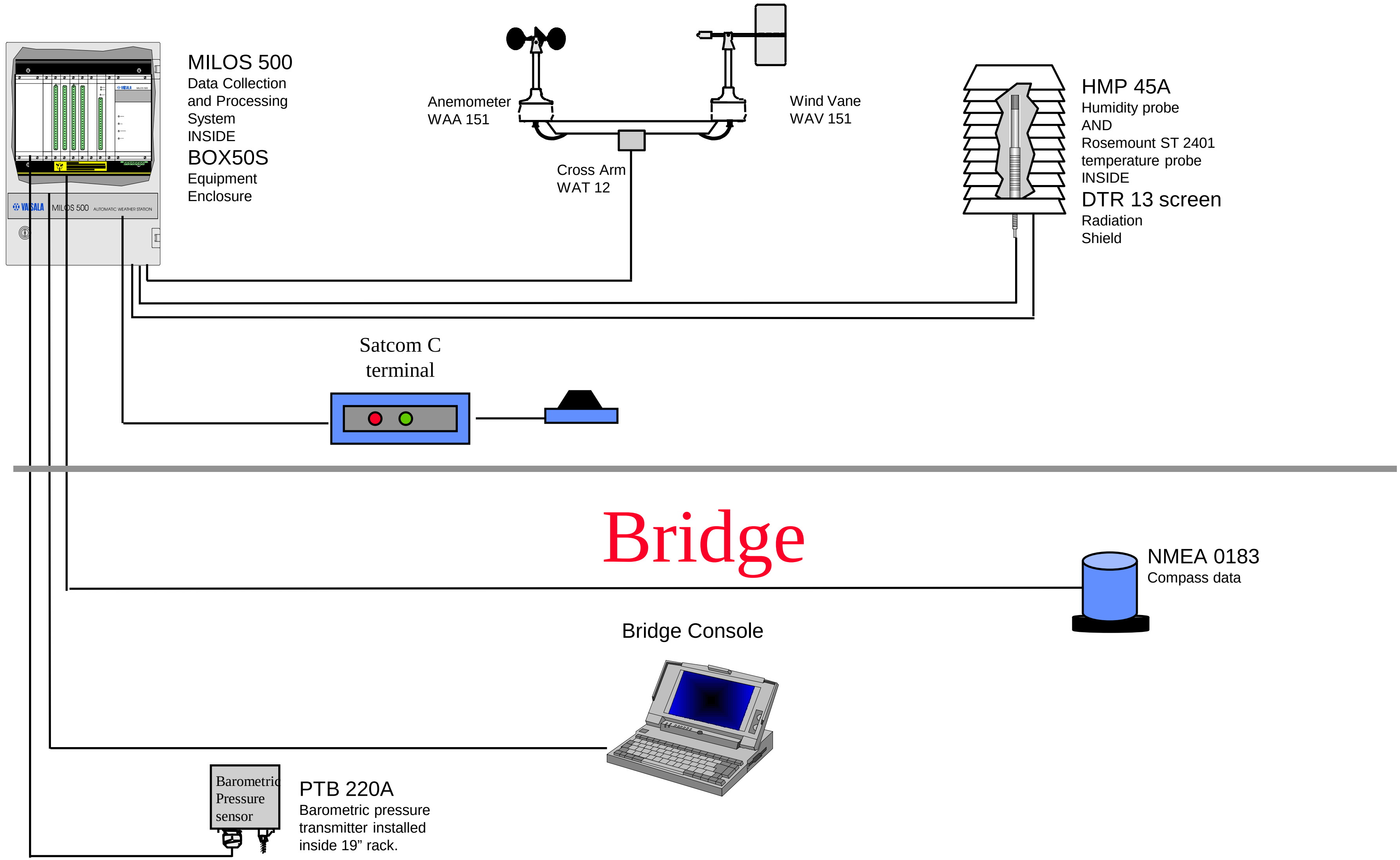
- In 1997 Vaisala and Bureau of Met jointly commenced work on Ship AWS.
  - Initially developed to collect Weather information across Bass Strait.
- To provide a cost effective alternative to existing platforms
- Identify a cheaper method of transmitting Met data
- To transmit the data back real time to the regional forecasting centre.
- To send all Met data via the same communication structure.

System Features

- Automatic measurement of Wind, Pressure Temperature and Relative Humidity
- Calculation of True Wind, Wet Bulb Temperature, 2 minute & 10 minute statistics
- Local display of Real Time data
- Automatic Coding of SYNOP message
- Local storage of SYNOP & 10 minute data
- Cost effective Transmission of SYNOP message via satellite

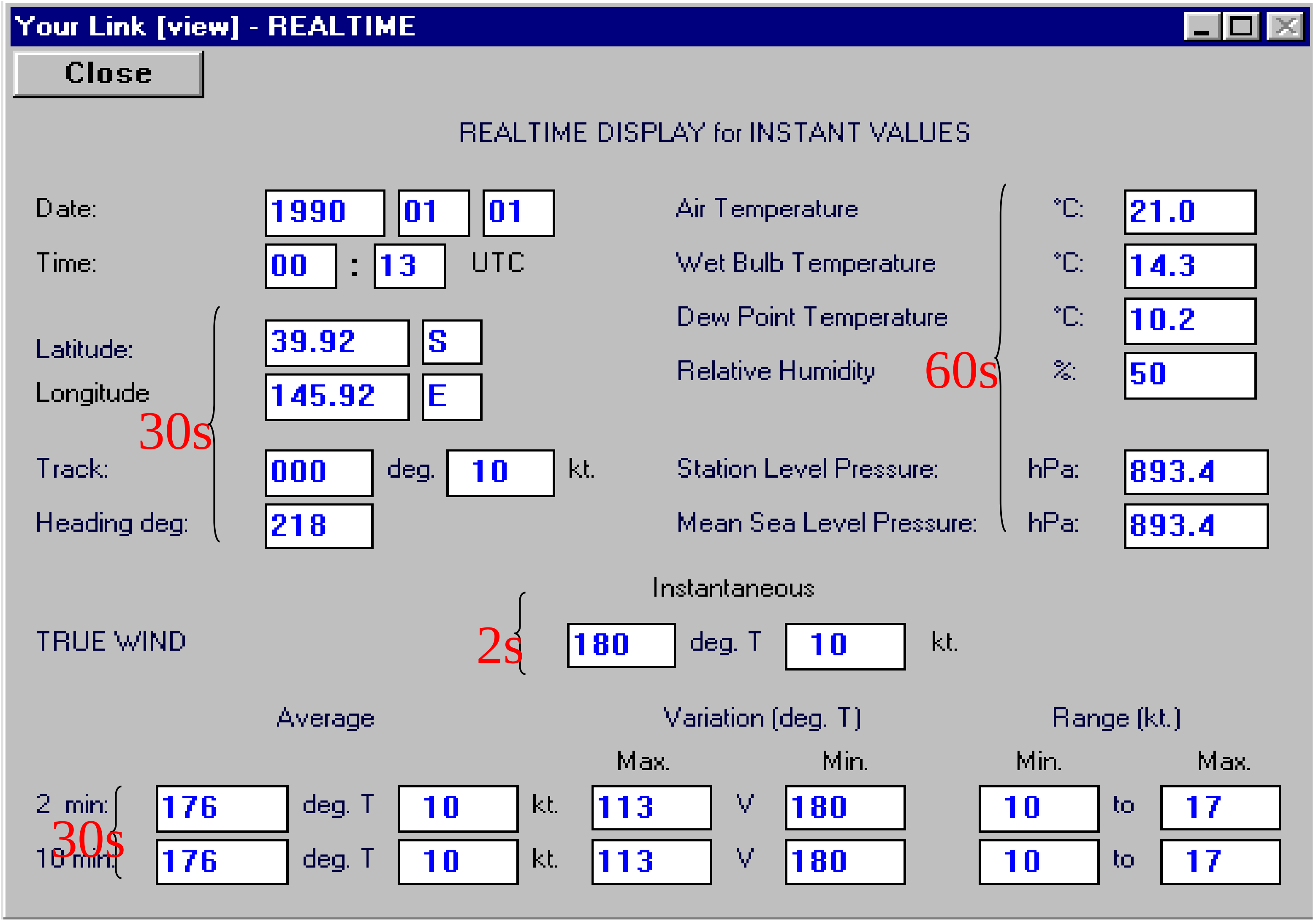
VAISALA

System Layout In Met Bureau applications



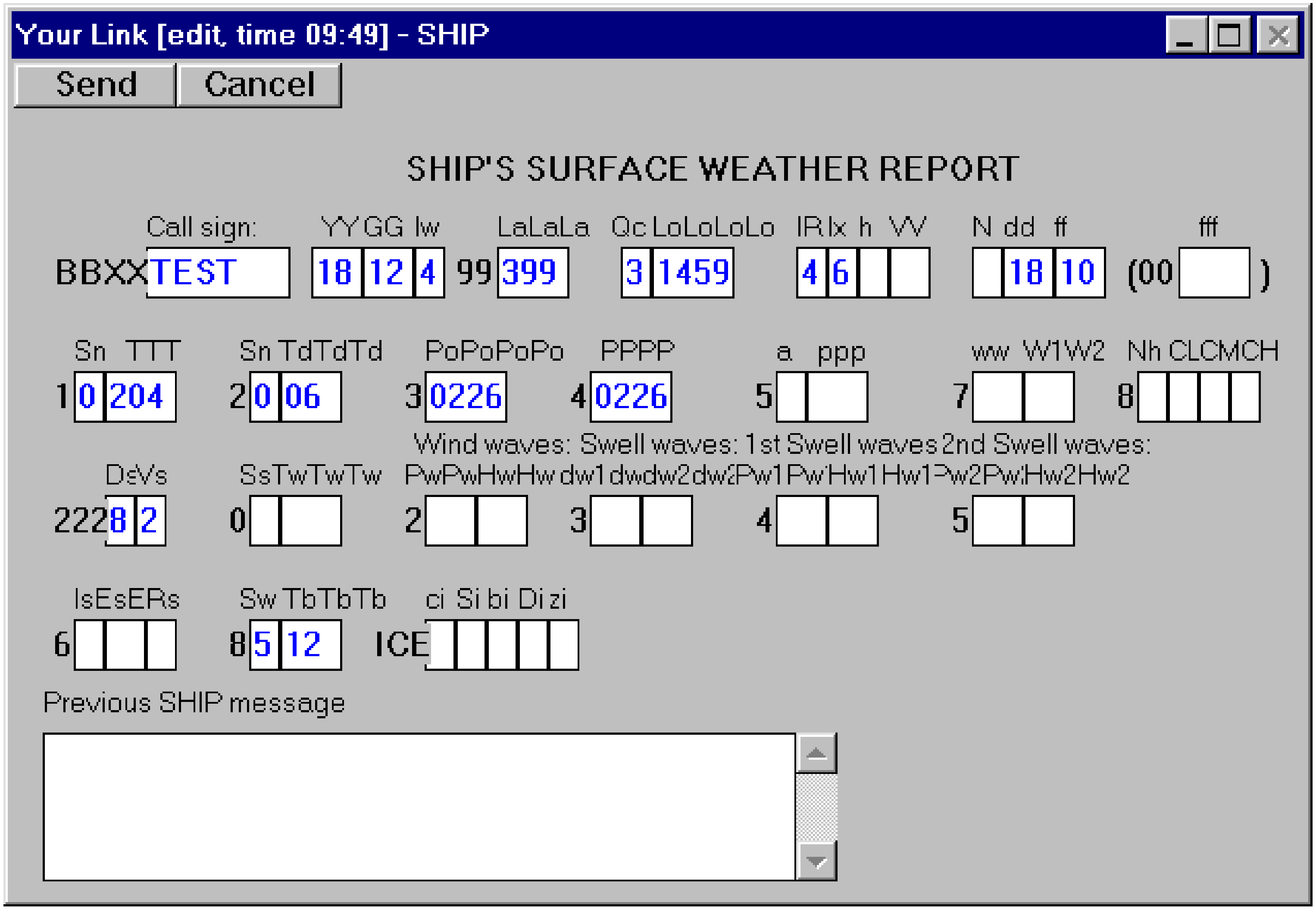
VAISALA

Displays - Real-time View



VAISALA

Displays - Editing Template



Sample messages

- **BBXX VLST 24174 99383 31448 46/// /0124 10118**
  20094 30202 40233 52008
  22224 85105

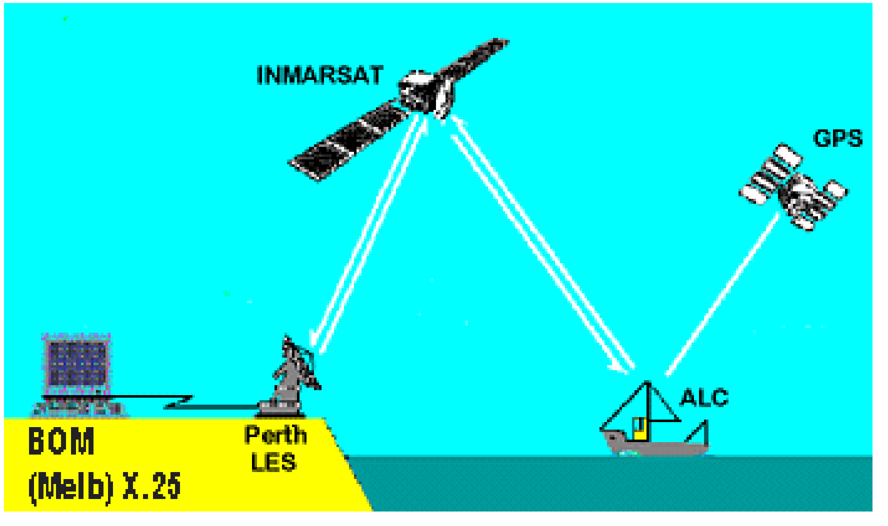
- **BBXX VLST 24184 99381 31449 46/// /0123 10117**
  20088 30203 40234 52010
  22284 85101

- **BBXX C6CN4 25214 99183 31678 46/// /0514 10238**
  20220 30076 40099 52017
  22243 85225

- **BBXX C6CN4 26034 99198 31677 46/// /1807 10233**
  20213 30059 40082 57019
  22243 85219

Communications

- Satcom C (Data reporting mode)
  - Cost effective, Global Coverage
  - Ability to send a full ships Obs. message.



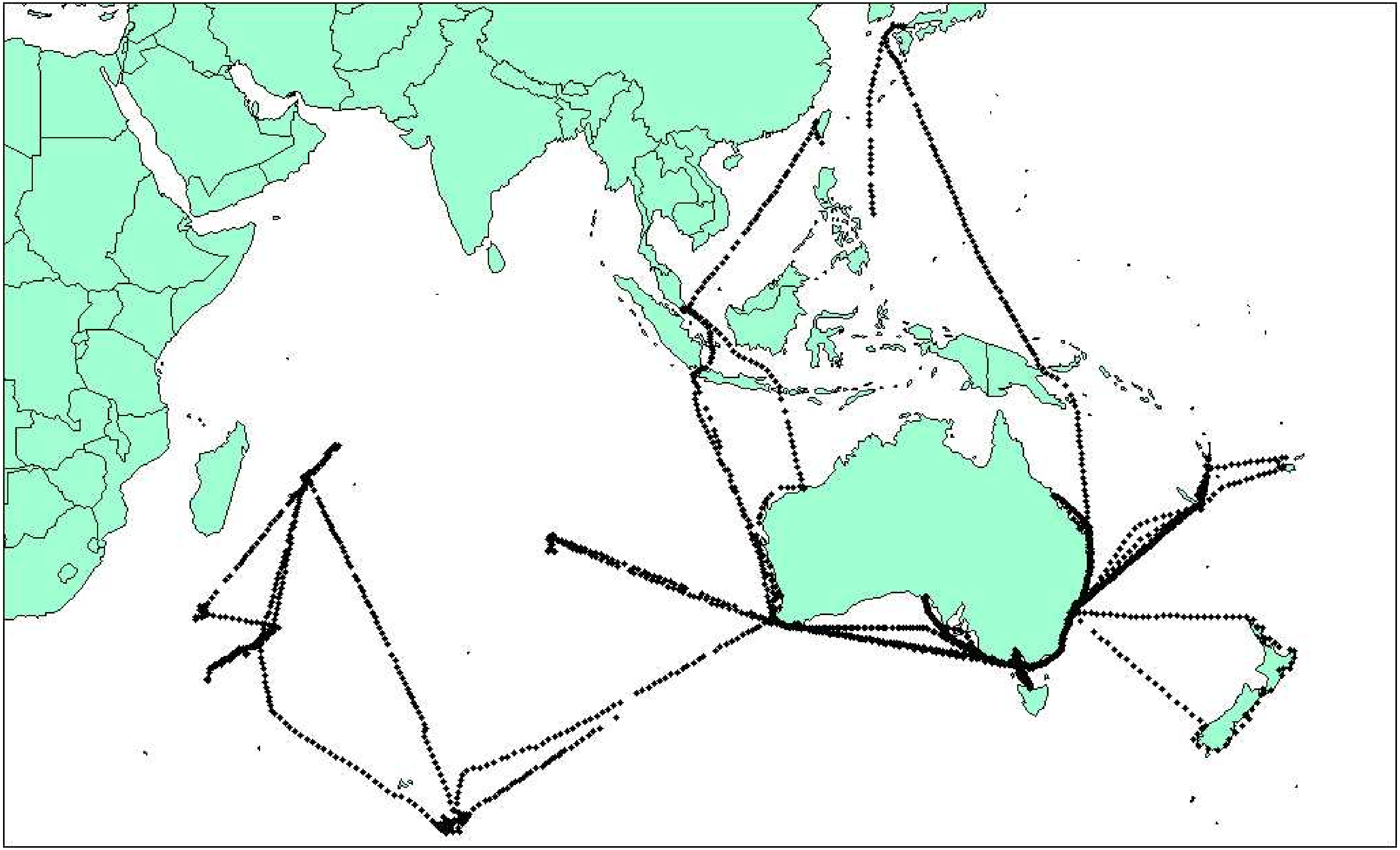
Current communications costs In Australia

- Data reporting mode costs 6 cents per packet
- Automatic observations use 3 packets (18 cents)
- Manual observations use 5 packets (30 cents)
- On average, there is usually one manual obs & 23 automatic ones daily (AUD$4.44 per day)
- Annual cost is about AUD$1620 for 8395 automatic messages and 365 with manual input

Bureau Installations

- Bureau currently has six systems in full operation.
  - Austral Leader (VNRA)
  - Iron Yandi (VNVR)
  - Ormiston (VJIK)
  - Pacific Sky (GYYP)
  - Portland (VNAH)
  - Spirit of Tasmania (VLST)

Bureau Installations - Observations



Spirit of Tasmania

Spirit of Tasmania

Pacific Sky

Ormiston

For Consideration...

- Real Time NMEA output to ships Map system
- Variable data transmission intervals
  - currently 1, 3 or 6 hour
  - position based
- Local storage of data for VOSCLIM requirements
- Data Delivery methods - e-mail etc
- Operation in other areas of the world
    - Global coverage

DEVELOPMENT IN VAISALA'S ASAP EQUIPMENT

2002-02-26
JCOMM / SOT
Scientific and Technical Workshop
Goa, India

Erkki Järvinen
Business Unit Manager, Sounding Equipment
Upper Air Division
Vaisala

Contents

- **Vaisala ASAP Equipment**
  - **ASAP Launcher**
  - **DigiCORA III features**
- **Windfinding methods**
  - **Automatic Loran-C Chain Selection**
  - **On the Windfinding Accuracy**
  - **GPS Performance Improvement**
- **RS90**
- **New concept for observations over the oceans**
  - **Data as a product**

Vaisala ASAP Equipment

ASAP Launcher

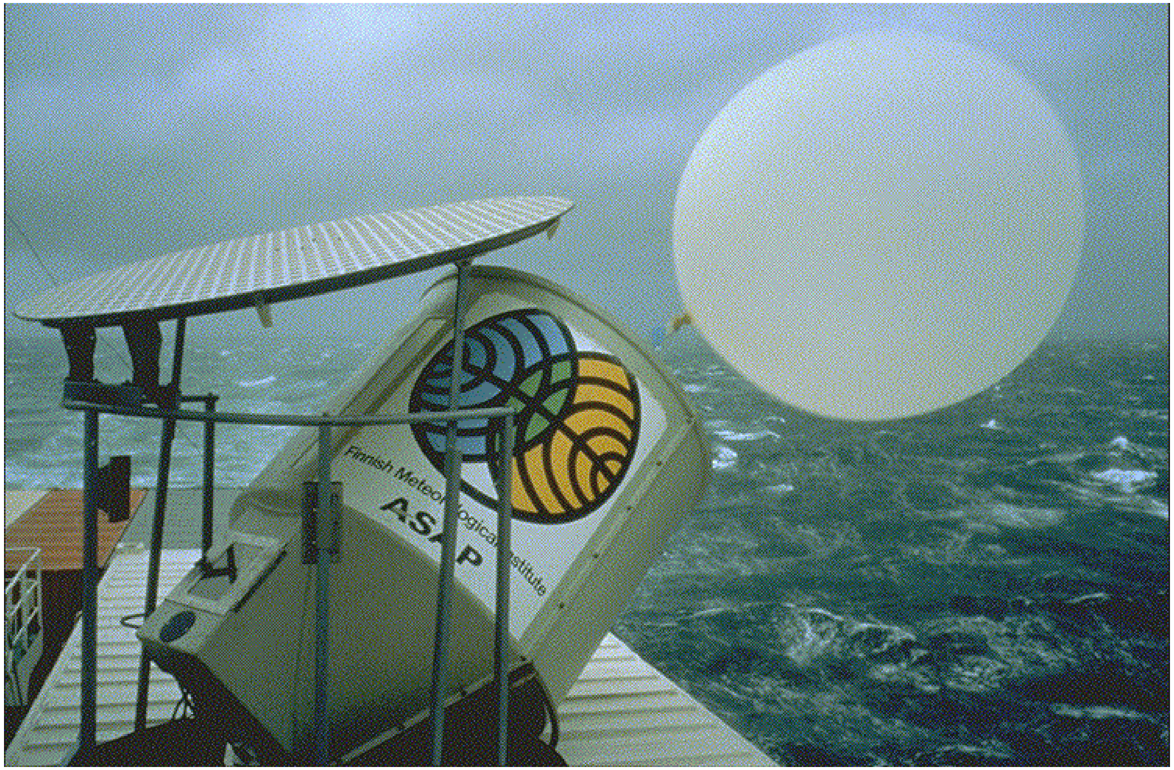
DigiCORA III features

VAISALA

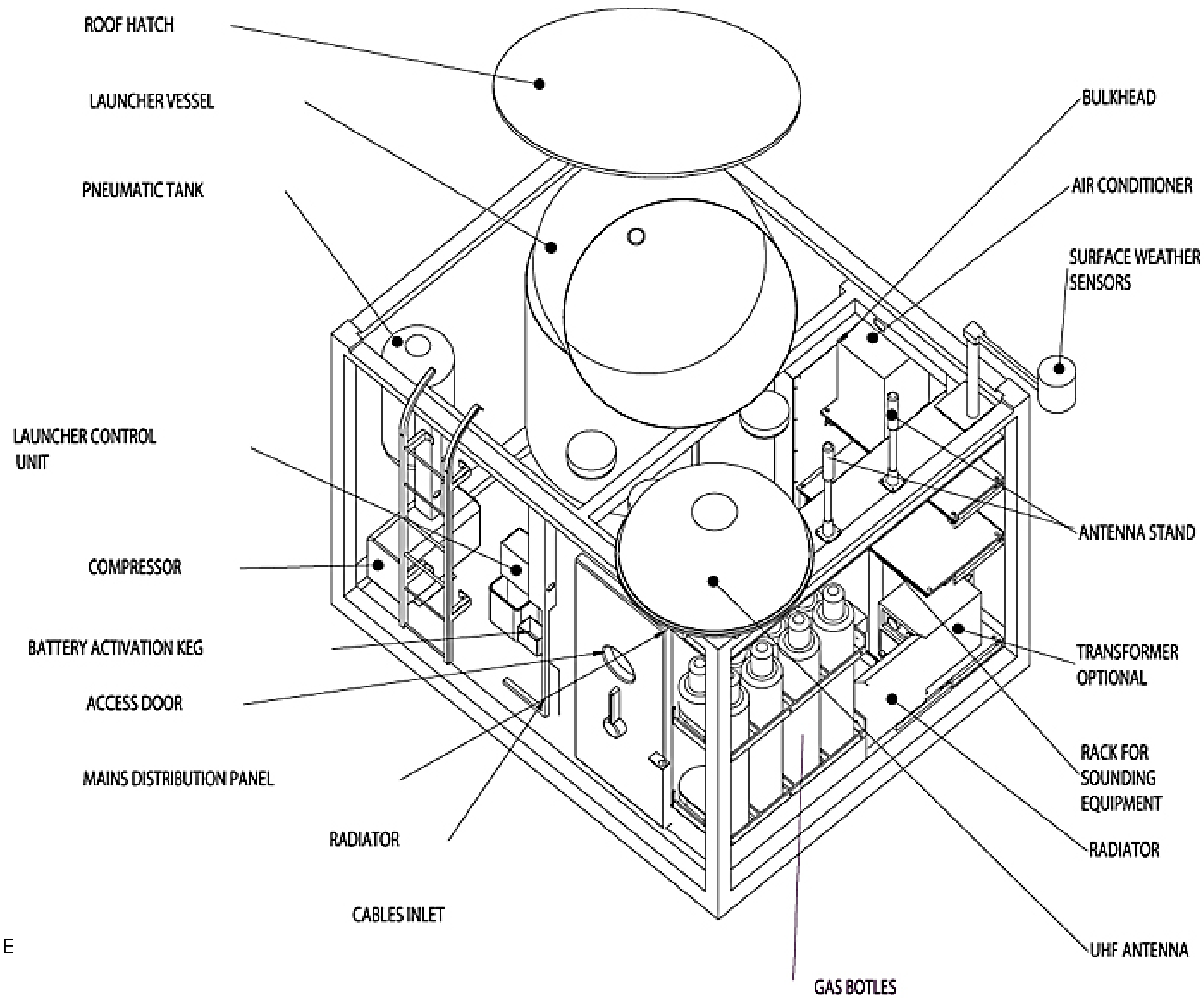
Vaisala's Experience in Sounding Automation

ASAP observation containers, more than 15 systems from 1984

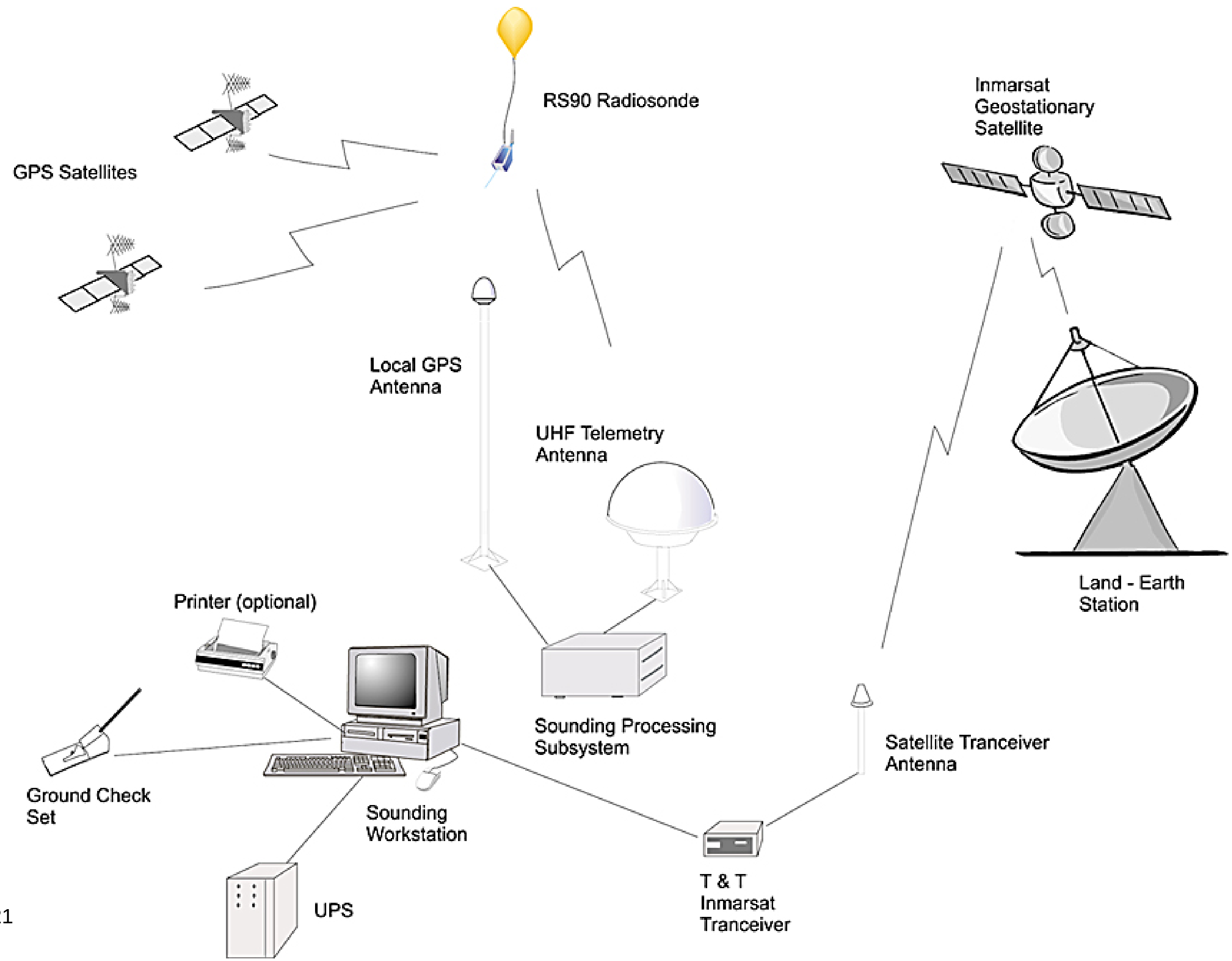
- Germany, Spain, Japan, Norway etc.



ASAP Launcher Construction



ASAP System Overview (GPS)



VAISALA

DigiCORA III Standard Software

- PTU and wind data collection, processing and archiving
- Message creation editing and delivery including:
  - TEMP, PILOT, BUFR,
  - CLIMAT TEMP
  - Inmarsat-C satellite transmission
- Access to software functionality according to user level
- All user prompts can be translated / localized
- Remote use: DigiCORA III with Windows operating system can be remotely controlled from another PC
- Stable and robust software design

DigiCORA III in ASAP

Easy to use compared to existing ASAP installation:

- **Automatic Loran-C chain selection**
- **Possibility to use Inmarsat C**
  - **Inmarsat C coordinates are fed to the system automatically**
  - **Compared to DCP, does not loose data in compression**
  - **Compared to DCP, the data transmission is 100% vs. 80%**
- **Various possibilities for messaging: TEMP, BUFR**
- **In next SW-releases:**
  - **Possibility to feed the surface pressure automatically, P-value from radiosonde or from AWS.**
  - **Even more versatile means for remote control and remote maintenance than currently.**
  - **CREX message format**

Windfinding methods

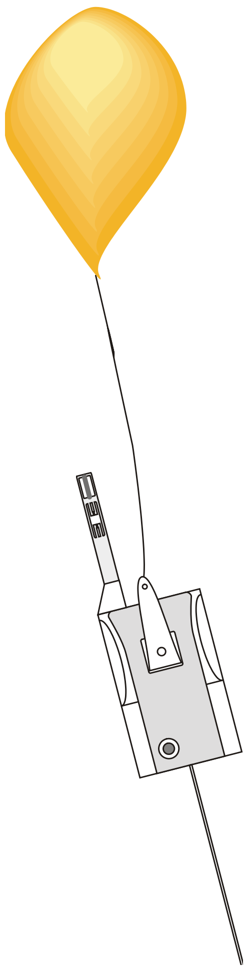
Automatic Loran-C Chain Selection

On the Windfinding Accuracy

GPS Performance Improvement Project

2002-02-21 / EEJ

Why Loran-C windfinding



Advantages

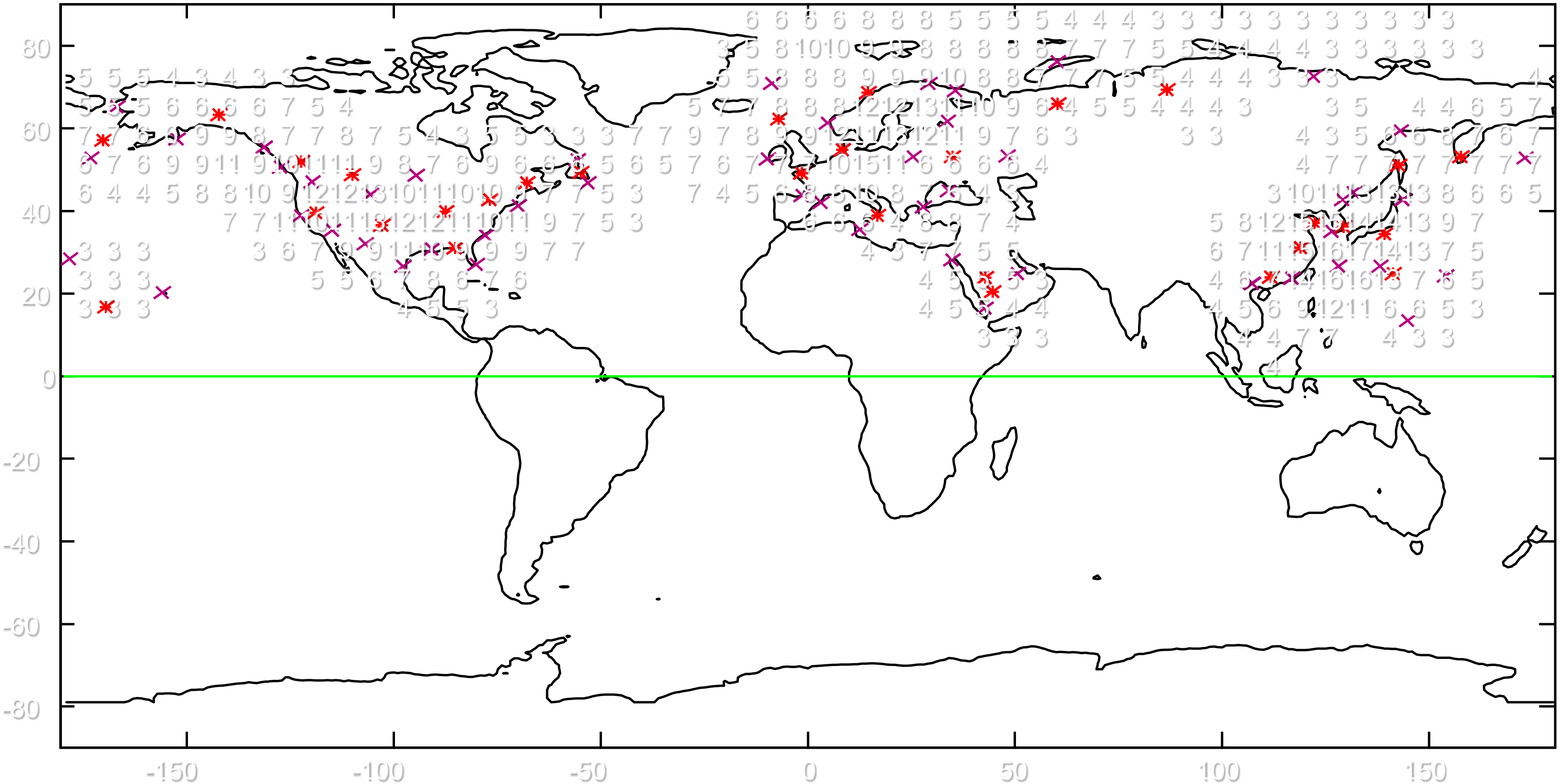
- Low cost radiosonde
- Accurate
  - Loran-C accuracy meets numerical forecast requirements
- Available in Northern Atlantic (evaluation with Sealand Achiever WPKD)

Limitations

- Regional coverage
- Sounding geometry must be taken into account: Automatic chain selection is the answer
- Future of Loran-C is at stake

VAISALA

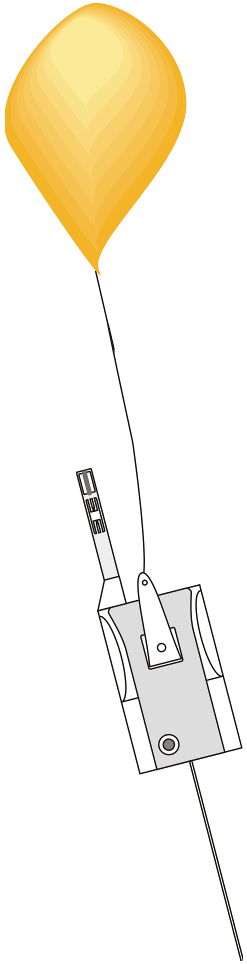
Loran-C and Chayka Coverage



Station Availability, accuracy -1+2 stations

NOTICE: This is an estimate of the expected coverage

Automatic Loran-C Chain Selection

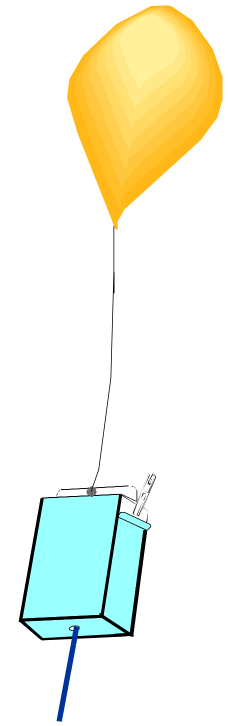


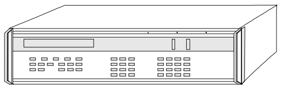
- Automatic Loran-C Chain Selection selects the best two chains out of four predefined alternatives to be used in the sounding before the sounding starts.
- The selection is based on station geometry and signal quality
- To get the best possible sounding geometry for each launch.
- To increase reliability of soundings.
  - Disturbances in signal quality (distant chains).
  - Unpredictable maintenance breaks.
- To simplify operator’s work.

Windfinding Accuracy, Summary

Windfinding accuracy

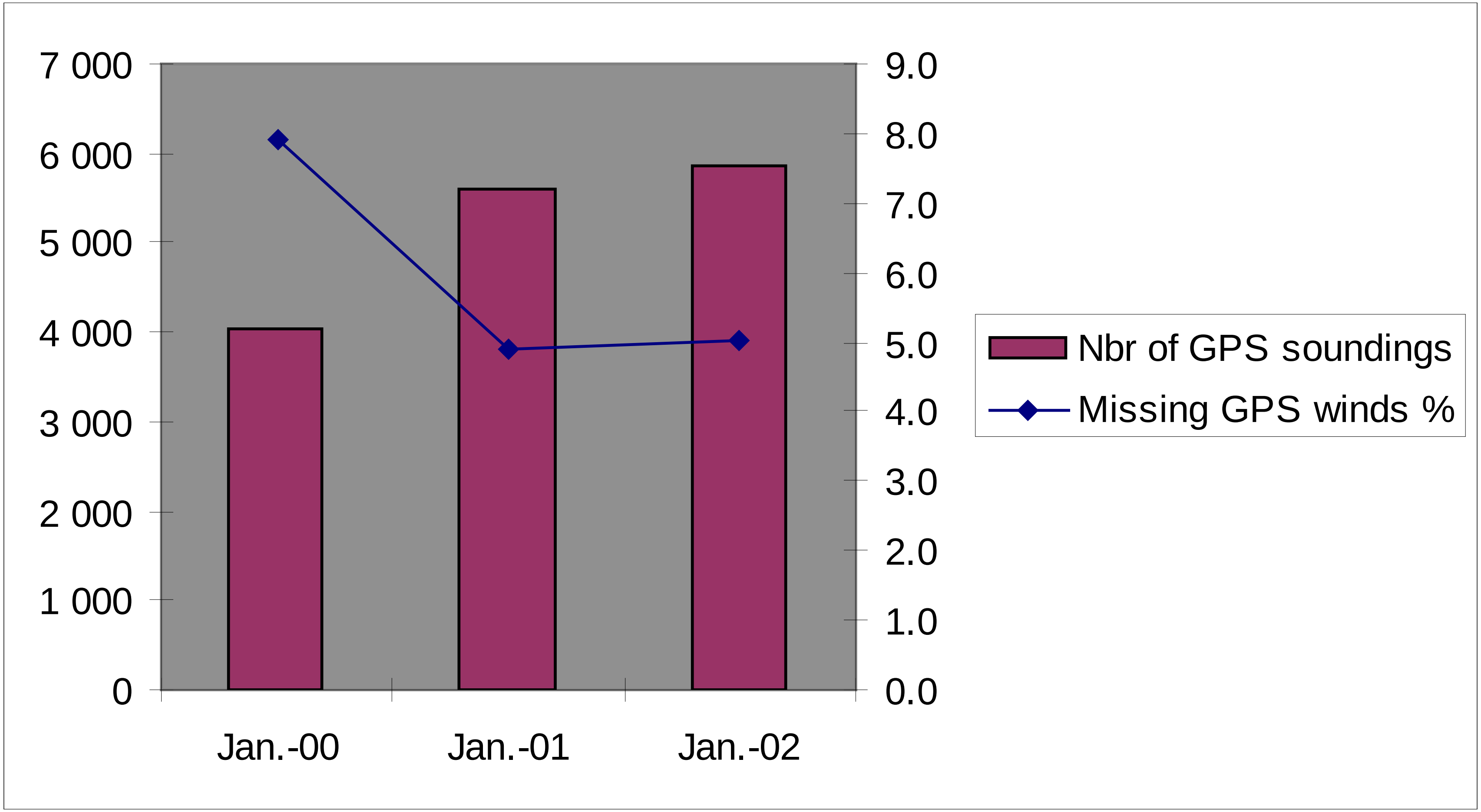
- **GPS** Vaisala RS80/RS90 GPS is a very accurate reference with error less than 0.3 m/s
- **Loran-C** Loran-C system provides about 1 m/s accuracy which degrades at ranges exceeding 150 km
- **Radar** Accuracy depends on the range. At short range (<60 km) more accurate and at long range (>130 km) less accurate than Loran-C.





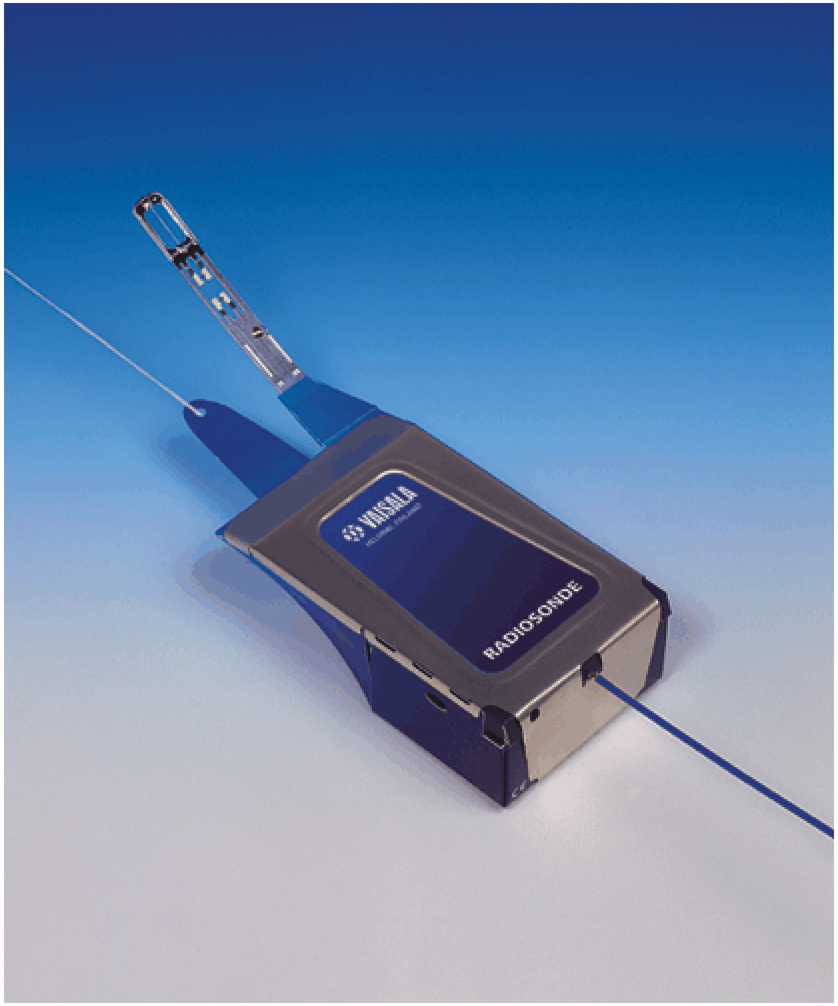
VAISALA

Sounding Performance - Synoptical Data



VAISALA

Vaisala RS90



2002-02-21 / EEJ

RS90 Improved Measurement Performance

- **Fast temperature sensor, F- THERMOCAP®**
  - **Accurate temperature sensor with fast response time and minimized solar radiation error**
- **Shock-resistant pressure sensor BAROCAP®**
  - **Silicon pressure sensor, shock resistant, and offers a fast temperature response**
- **Fast, defrosting humidity sensor heated HUMICAP®**
  - **Short response time, reduces condensation and icing**
- **Factory calibration covers a wide measurement range and includes also measurement electronics**

New concept for observations over the oceans

Data as a product

Obstacles for ASAP observations

Common understanding has been for long that more in-situ upper air observations over the oceans are needed.

Common interest and financial resources don't seem to meet in a timely manner;

- **There are difficulties to finance the investments like sounding equipment and automatic launchers.**

In addition, running the ASAP-operations - deployment of ships, training of crew, global maintenance etc. - may be slightly out of scope of National Meteorological Services ?

Silver Lining

There are promising efforts going on within E-ASAP program to increase the number of ASAP-ships, and to integrate the existing ASAP-systems into the same operation. The finance may still be uncertain.

There are promising efforts going on in order to increase the efficiency by integrating operations within JCOMM/SOT: But whether this leads to increasing number of upper air profiles over the oceans, remains to be seen.

VAISALA

Data as a Product

For the sake of discussion, there is one more possibility to accelerate the increase of the ASAP-observations over the oceans:

Vaisala could be the data provider from a fleet of 25+ ASAP systems, to include

- **furnishing ASAP-installations,**
- **taking care of logistics for supporting ASAP-operations,**
- **taking care of maintenance & refurbishment of ASAP equipment and**
- **providing meteorological messages for GTS for a fee.**

Such investment would require that there is a negotiating party or few parties with long-term commitment for such co-operation.

Discussion ?

Report on the Development of CO_2 Monitoring Systems to be Included in an Autonomous Data Gathering System.

Geoffrey K Morrison[1] , Frank Millero[1], Flavio Graziottin[2], Walter Varda[3], Regis Cook[3], Richard Wood[3] and Rod G. Zika[1]

The goal of this project was to miniaturize an existing pCO_2 monitoring system and it's attendant water gas equilibrator, for deployment on yachts, buoys and other platforms of opportunity as a component of the SeaKeepers Ocean and Weather Monitoring System. The requirements for the system were to develop a small, light weight, energy efficient instrument package that could be operated automatically for extended periods of time.

The objectives of the first phase, completed six months ago, were:

1. to modify a compact, less expensive commercial non-dispersive infrared detector (NDIR) CO_2 sensor to monitor pressure and temperature of CO_2.
2. to calibrate and make stability tests for the compact NDIR CO_2 sensor
3. to fabricate a miniaturized showerhead equilibrator
4. to perform laboratory bench tests of the new instrument against a reference unit
5. and to perform at sea tests of the new instrument against a reference unit

Figure 1 illustrates schematically the principal components of a pCO_2 sensor. A closed loop of air is passed through a equilibrating chamber, where water with the unknown CO_2 concentration is sprayed from a shower head to maximize surface contact between the water droplets and the air. This allows the CO_2 concentration in the air to equilibrate with the CO_2 concentration in the seawater. The air stream is then passed through a (NDIR) to measure the change in the CO_2 concentration in the air. The concentration of dissolved carbon dioxide in seawater is a function of temperature and salinity.

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[1] The International SeaKeepers Society, 4600 Rickenbacker Causeway, Miami FL 33149 USA
[2] Idronaut Srl, Milan Italy
[3] General Oceanics, Miami FL USA

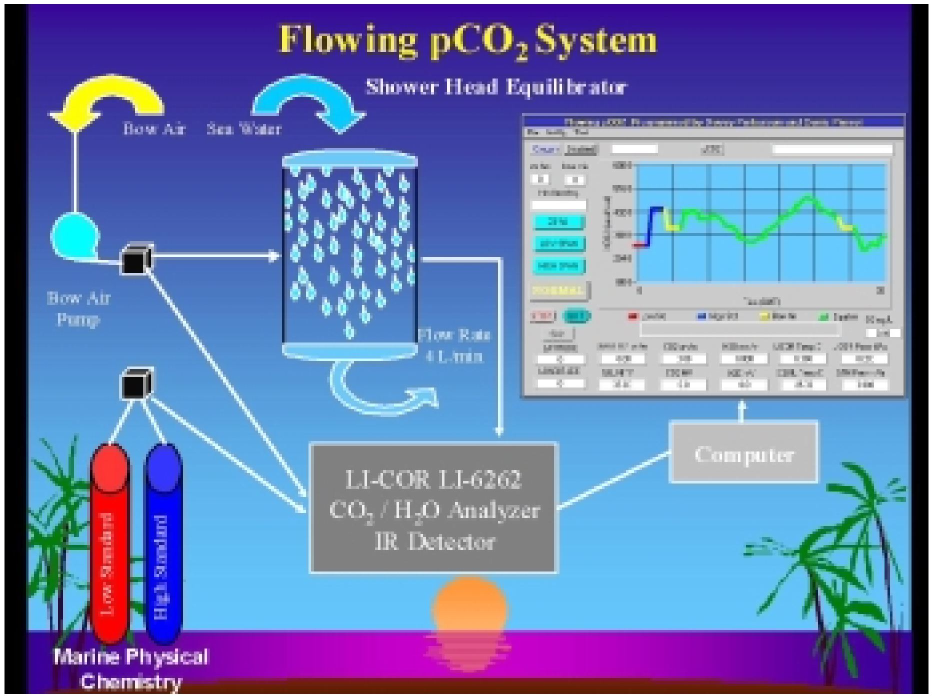


Figure 1. Generalized scheme for measuring pCO2 in seawater.

Stand-alone pCO_2 instruments have become common in oceanographic research on the total carbon cycle and its implications for global warming.. They typically have been large systems, requiring large volumes of continuously flowing seawater and high pressure cylinders of calibration gases. Efforts have been underway in our laboratory to reduce the size and complexity of the instrumentation. Figure 2 shows the equipment used by Millero to make these measurements on research vessels. The photograph does not show the 40-liter waterfall equilibrator, which is the active part of the system. Although smaller than those used by others, it is still considerably larger than the permitted SeaKeepers footprint or the space available in a monitoring buoy.

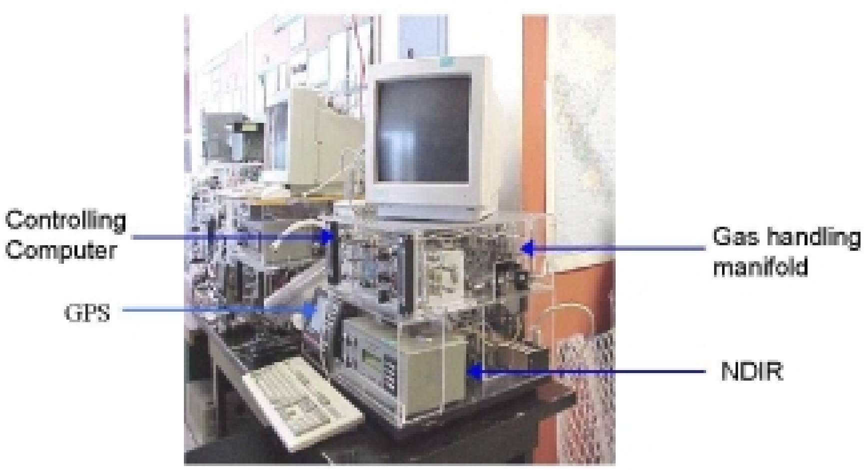


Figure 2. Research pCO2 monitoring system for field work.

The SeaKeepers modules were designed to provide a complete monitoring system in a compact modular format, so that sensors could be interchanged as research projects required. The system is contained in two stainless steel NEMA-4 enclosures, which are together 48 inches high, 16 inches wide and 10 inches deep. The enclosures can be separated and mounted in a variety of configurations to fit the available space. The instrumentation module has a manifold to support five discrete instrument packages in independent submodules of 4x8x12 inches (Figure 3). The ultimate goal is to develop a pCO_2. sensor that will fit in a submodule.

Figure 3. Instrument module with pump, manifold and 3 sensor submodules: Turbidity/CDOM, CTD (temperature, conductivity, dissolved oxygen, pH, Eh), and a prototype trace metals analyzer.

An inter-comparison between the “standard” detector (the Li-6262) and the smaller Li-800 gas analyzer proposed for this application is shown in figure 4. While it is clear that absolute calibration shifts are occurring, the similarity in the shapes of the curves and their response times are encouraging.

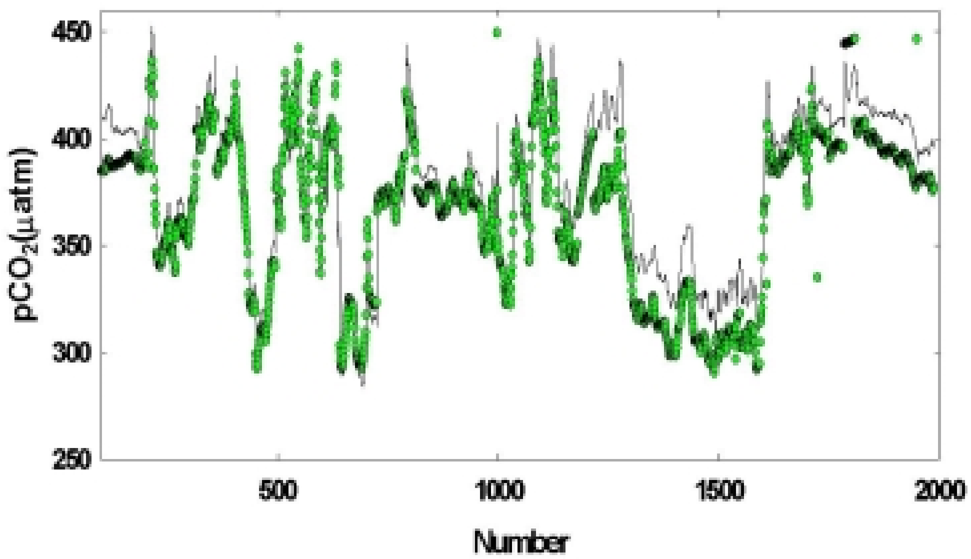


Figure 4. Intercomparison between the Li-6262 and the Li-800 NDIR detectors

A wide range calibration of the detector yielded a standard deviation of 4.3 micro-atmospheres, which indicates the possibility of achieving the research criterion of +/- 1 micro-atmosphere over the more limited ambient observed range.   Stability measurements made with the smaller detector gave a standard deviation of 1.06, which is again very encouraging.

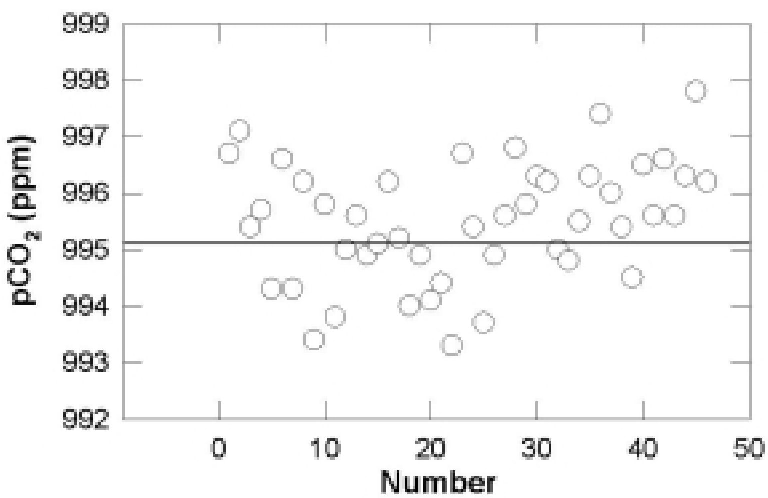


Figure 5. Li-800 stability with time. $\sigma = 1.08$

The Li-800 NDIR may be adequate for the intended use, and has the advantages of being smaller and less expensive than the Li.-6262

There remains an instrumental design problem to be resolved. Water is pumped through the system and returned to the source, while air of known concentration is pumped through the equilibrator (Figure 6). It is critical that the water level in the equilibrator remain constant, so the air circulation is a closed loop. If the liquid level drops in the equilibrator, the system can draw in outside air which can change the concentration of CO_2 in the air and the equilibrium values of the system, independent of the exchange with the sample water. On the other hand, if the water is allowed to overflow freely with little or no retention time, air will be lost as entrained bubbles. The air loss problem increases in severity and complexity as the volume of the equilibrator is decreased. It was decided to attempt to design a system which would continuously control the water level while using bubble traps to minimize bubble air loss.

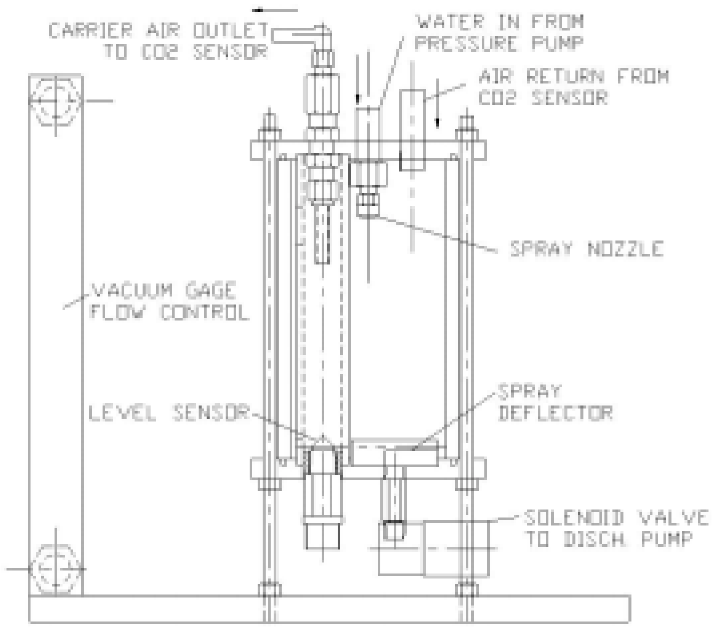


Figure 6. Schematic of the prototype pCO2 equilibrator.

Figure 7. Equilibrator and control system in SeaKeepers submodule

In a bench top comparison between the research grade instrument and the prototype, response and tracking appear to be in good agreement (Figure 8). There is a clear calibration offset and perhaps a systematic drift in the prototype that could be attributable to loss of equilibrated air and replacement with fresh air. The addition of a water level control in the next version may resolve these issues.

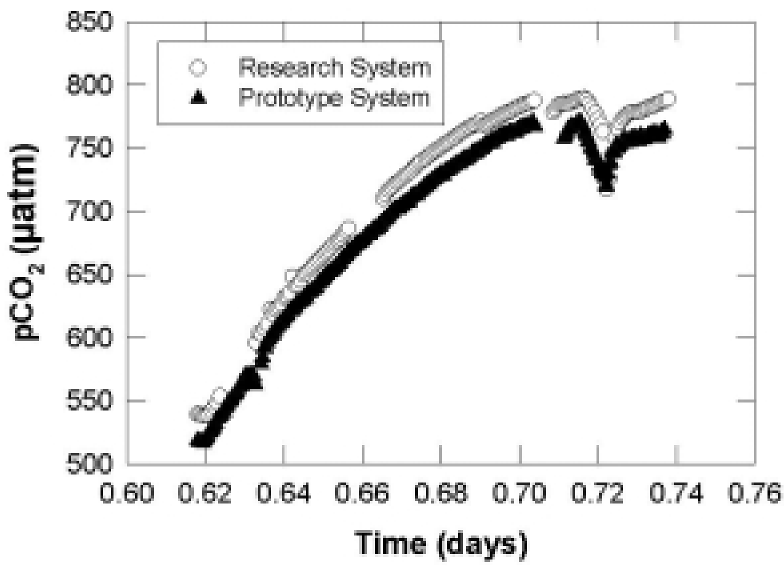


Figure 8. Bench top comparison of the two systems

During a one week cruise of the R/V F. G. Walton Smith, an informal inter-comparison was made between the research grade sensor and the prototype (figure 9).

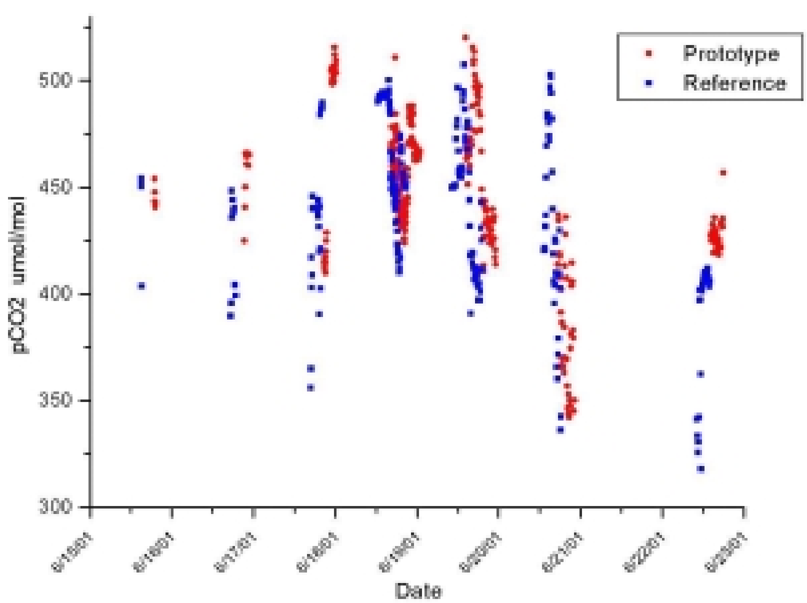


Figure 9. Field trial of the prototype, compared to a research system.

The results, while encouraging, are far from the desired accuracy of one micro-atmosphere. Additional funding was been obtained to further develop the miniaturized pCO2 analyzer and to deploy it on platforms of opportunity such as SeaKeepers member yachts, piers, buoys and commercial ships.

Another parameter, besides pCO_2, which is routinely measured to characterize the CO_2 system is total dissolved inorganic CO_2 (TCO_2). Currently, TCO_2 measurements involve acidifying the seawater sample with phosphoric acid and measuring the amount of CO_2 evolved by either coulometry or infrared detectors. A new and promising technique for measuring TCO2 has been developed in cooperation between Idronaut Srl, (Milan, Italy) and the University of Rome (figure 10). The system uses peristaltic pumps to fill a mixing chamber with an unknown sample of seawater. The differential pH sensors are normalized by passing this sample through both channels. A buffer solution is then added to the sample in one channel, stirred and the change in pH measured relative to the untreated sample. The volumes used of seawater and buffer are miniscule,

The differential pH sensors rely upon beautifully constructed capillary electrodes. Differential repeatability to the fourth decimal place has been observed. A unit in the third decimal place is equivalent to one micro-atmosphere.

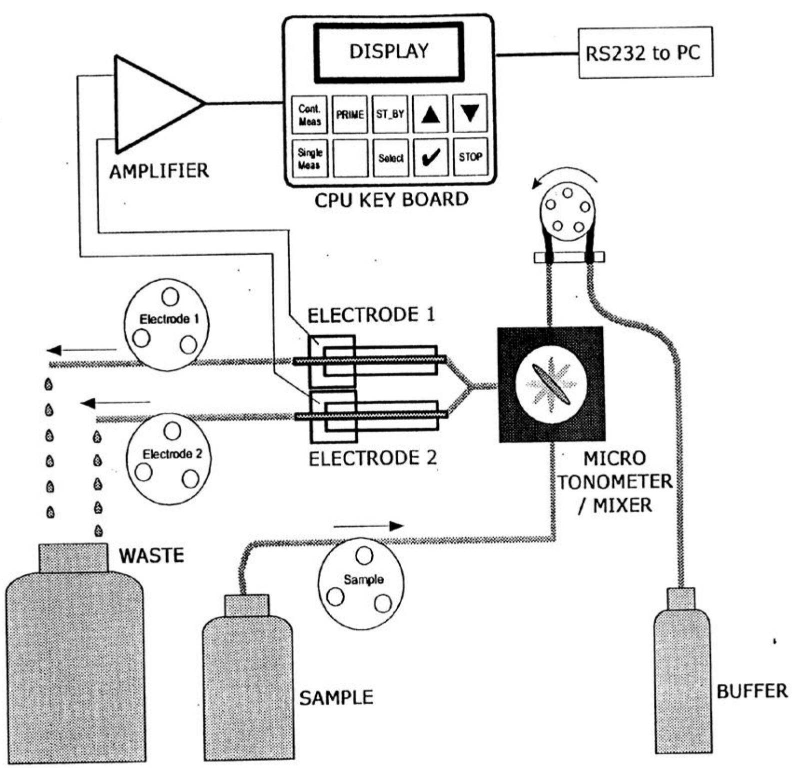


Figure 10. Prototype TCO_2 instrument

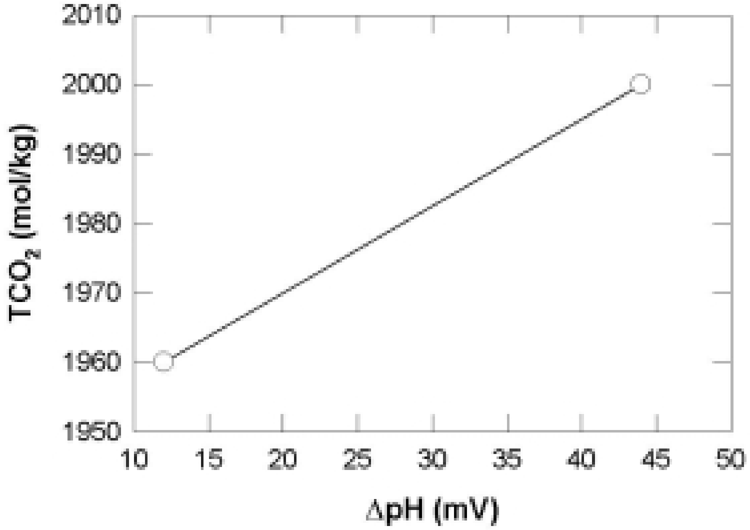


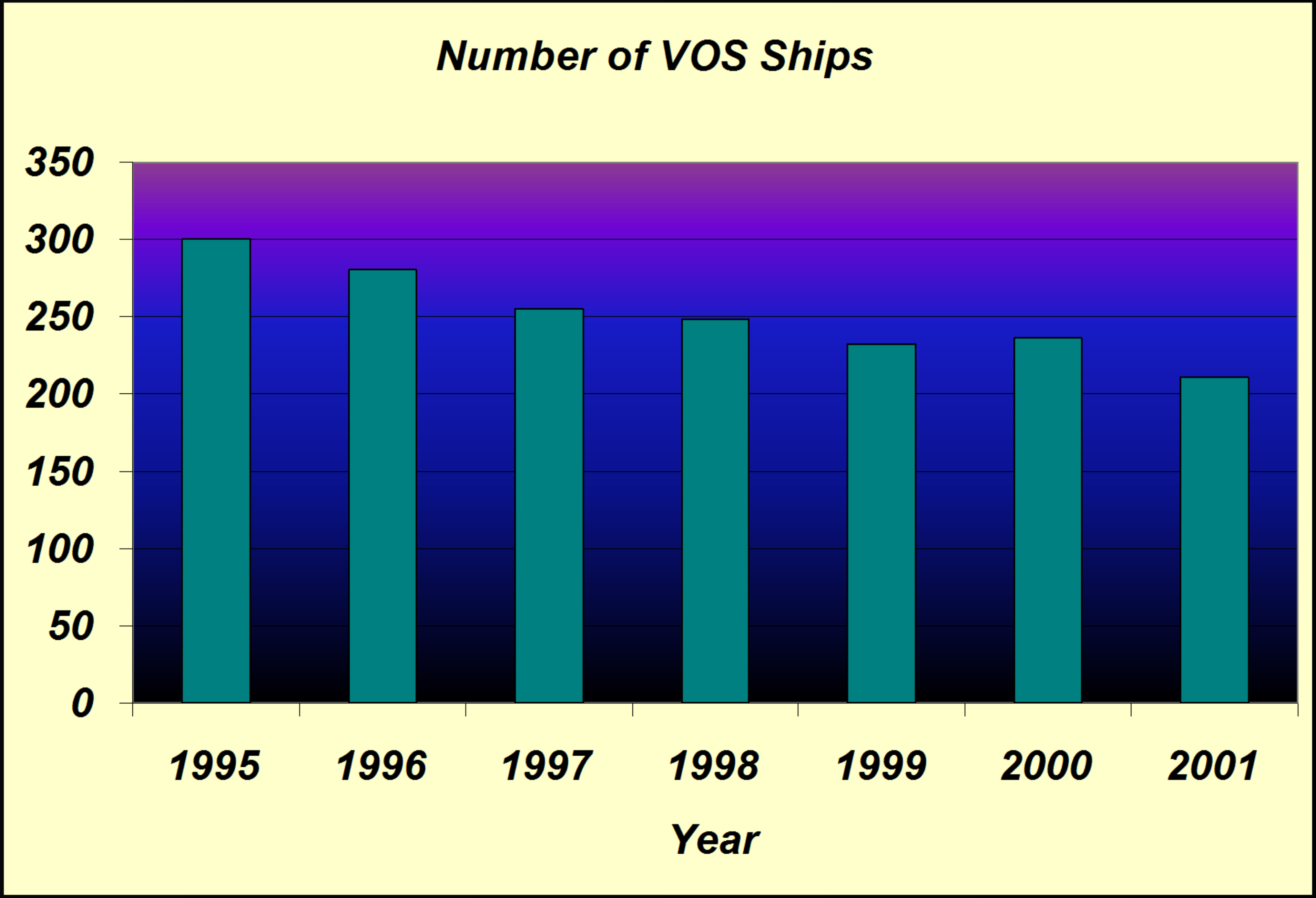
Figure 11. TCO_2 calibration curve

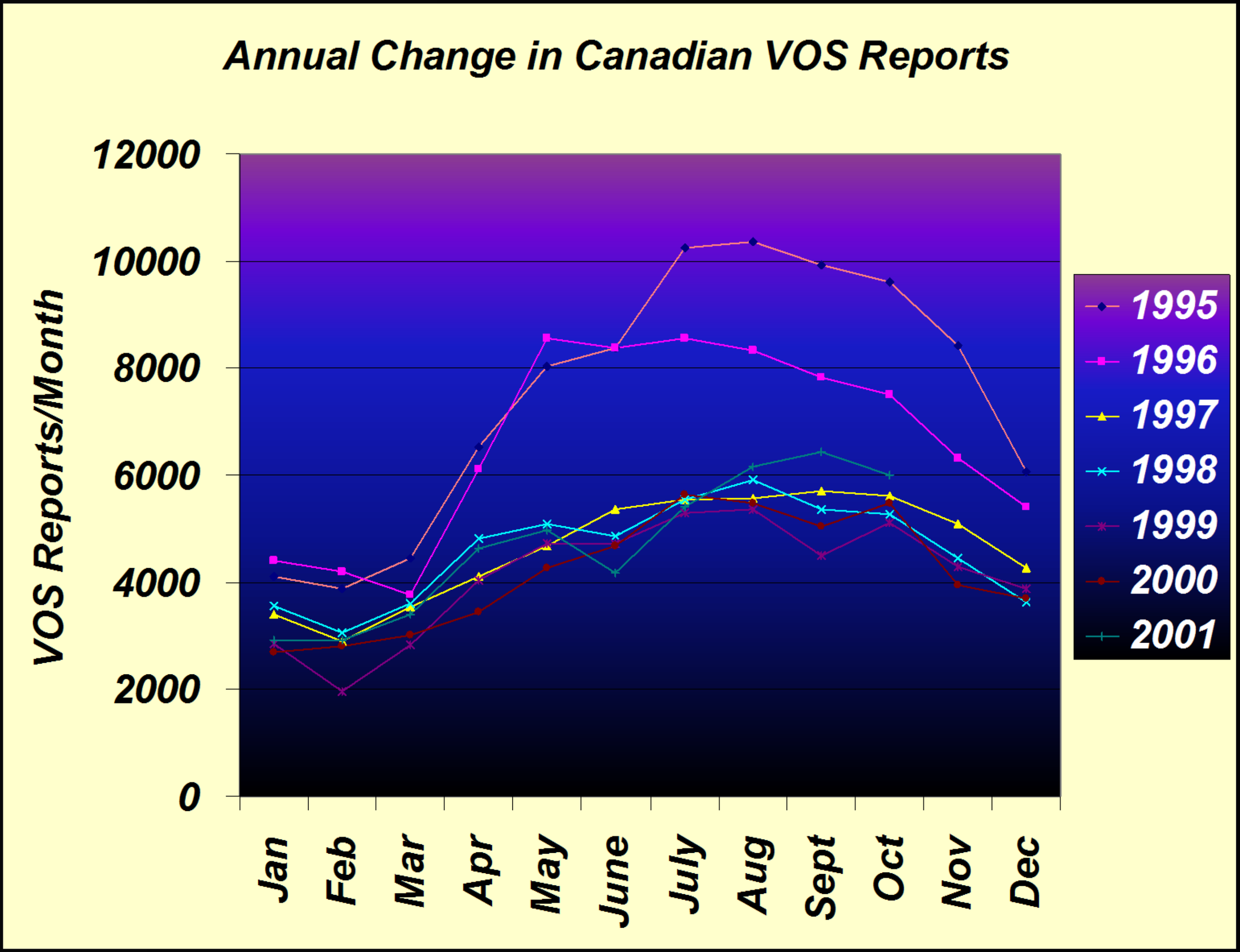
Improving The Frequency and Reliability of Global Meteorological Observations at Sea

by
Ron Fordyce
and
Tom Vandall

Canadian VOS Program…Challenges

Declining number of VOS ships (reports)
Smaller crews with higher workloads
Limited PMO resources to manage fleet
Requires system standardization to optimize operational support and increase data quality
Requires specialized training
Significant time commitment
Human error
QC failure rate of approximately 20%


Number of VOS Ships
350
300
250
200
150
100
50
0
1995
1996
1997
1998
1999
2000
2001
Year


Annual Change in Canadian VOS Reports
VOS Reports/Month
12000
10000
8000
6000
4000
2000
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
1995
1996
1997
1998
1999
2000
2001

Canadian VOS Objectives

Increase the frequency and reliability of VOS reports*
Decrease the number of ships
Standardize the fleet
Improve data quality
*Implement VOSCLIM**
*Minimize manual requirement**
*Reduce QC failure rate**
Enhance forecasting capabilities

Automation… Reliability… Watchman™…

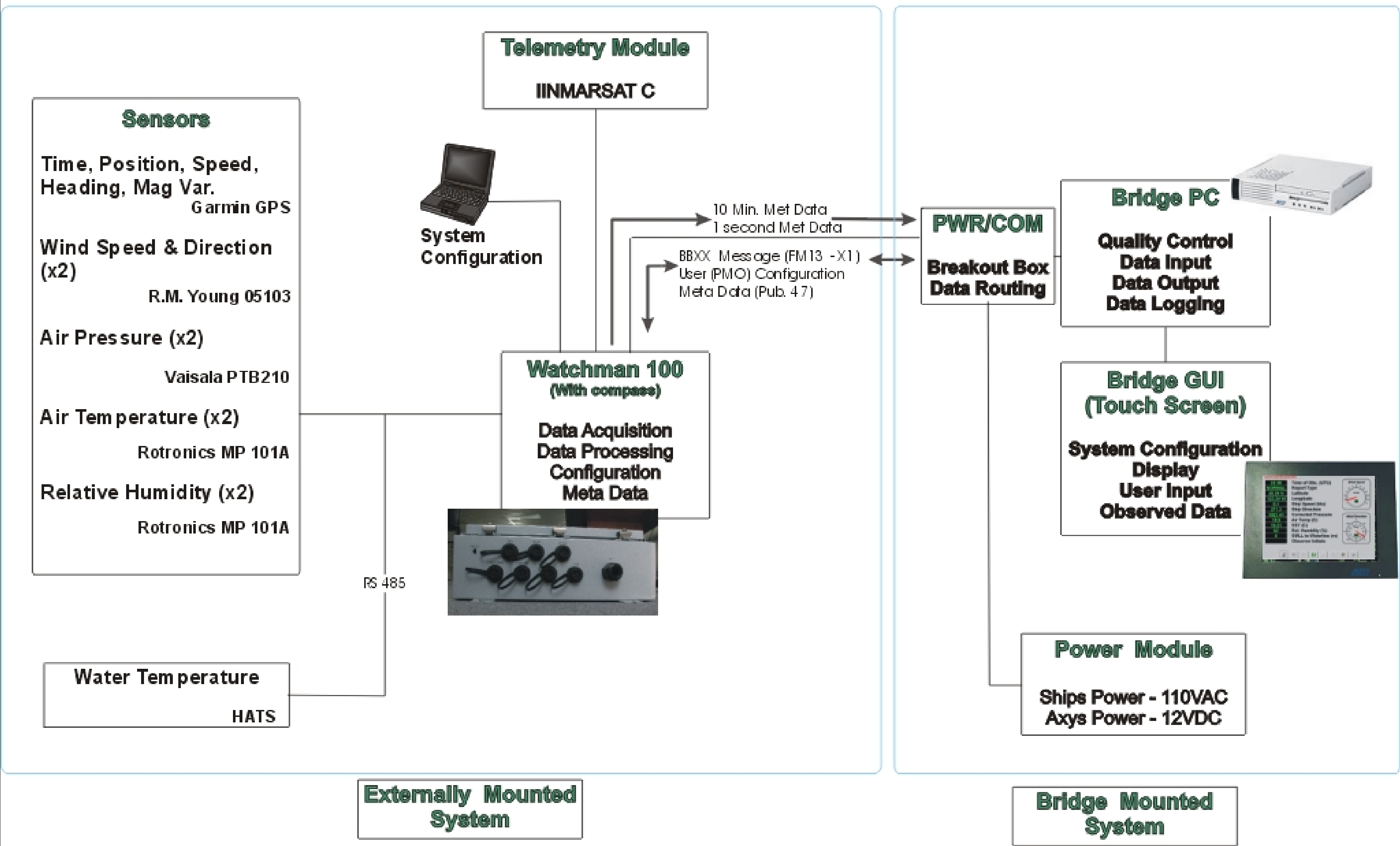
AVOS™

- *Automatic Voluntary Observing Ship's System*
- *Automated measurements, reports and telemetry*
- *Reliable Watchman™ based controller processor*
- *Intuitive image-rich touch-screen Bridge Interface*
- *VOSCLIM sensors*
- *Operates round the clock*

AXYS Environmental Systems

Environment Canada

Automatic Voluntary Observing Ships (AVOS) System



Sensors:

Parameter	Sensor Model	Range	Accuracy	Resolution
Wind Direction	RMY 05103	360°	±3°	1°
Wind Speed	RMY 05103	0 to 60 m/s	±0.3 m/s	0.1 m/s
Water Temperature	HATS	-10° to +50° C	±0.05°C	0.01°C
Air Temperature	Rotronics MP101A-T7	-40° to +60° C	±0.3°C	0.1°C
Relative Humidity	Rotronics MP101A-T7	0 to 100 %	±1%	1%
Air Pressure	Vaisala PTB210	500 to 1100 hPa	±0.15 hPa	0.01 hPa
Compass Heading	KVH C100	360°	Compass Swing score dependant	0.1°


AVOS^{TM} Controller Processor

Setup and configuration from Watchman^{TM} or Bridge Interface. Includes sensor calibrations (offset and scale factors)

Metadata – sensor type, model #, serial #, calibration due date, location, installer, country, date etc.

SST depth, barometer ht. above SMLL, corrected to SL anemometer(s) ht. above SMLL

Processing - Region detection (auto synoptic modes), pressure correction for elevation, ships speed and course made good (3hr.), true wind from apparent, auto SPREPS and STORM detection and reporting, cont.10 min avgs.



AVOS™ Power & Wiring

12VDC from ship mains, 5 day battery backup for AVOS Controller Processor

Bridge Interface ships mains with UPS

All sensors are mounted on AVOS mast (except SST) and powered by controller through communications wiring.

Three serial configuration ports with controller, terminal setup, bridge Interface, and real time winds

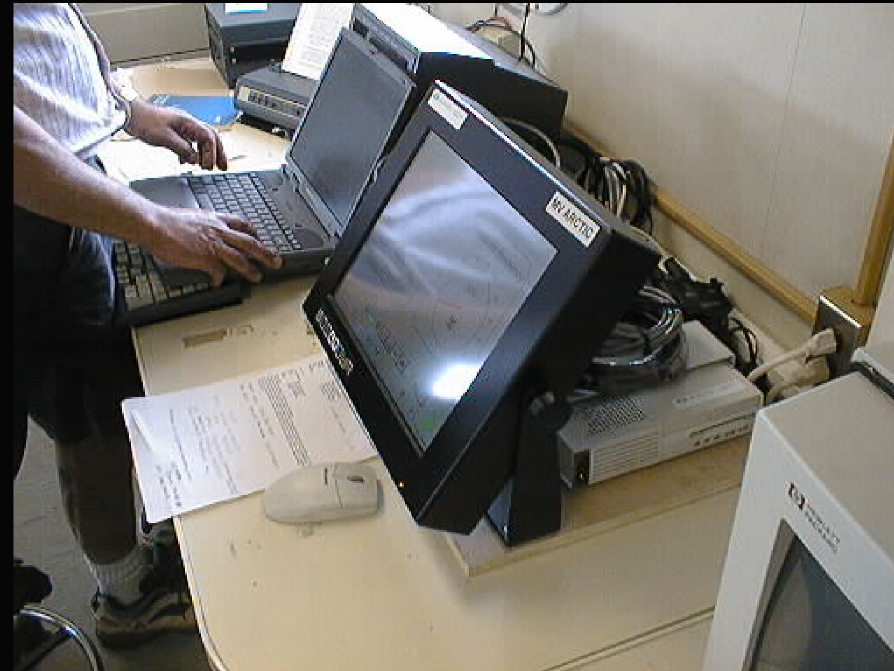
INMARSAT C, GPS are mounted on mast.

Installation about 2 days

AVOS™ Bridge Interface Software

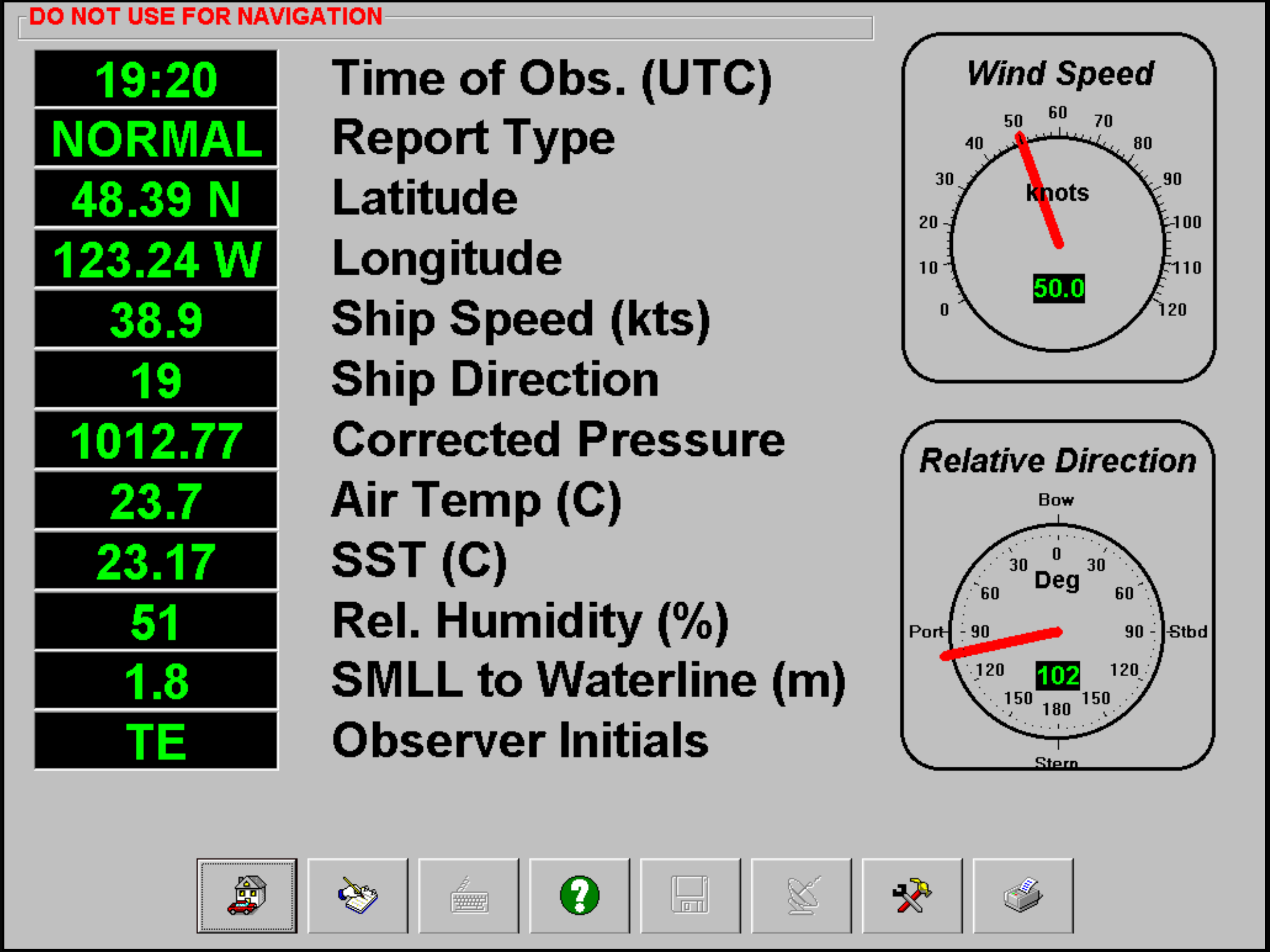
The AVOS™ Display Software performs six main functions:

- *configuration of the AVOS™ payload,*
- *display of AVOS™ payload data,*
- *input from users for observed data,*
- *data quality control,*
- *data archiving, and*
- *data transfer to the AVOS™ payload.*


MV ARCTIC


MV ARCTIC

AVOS[TM] BRIDGE INTERFACE



AVOS^{TM} TELEMETRY

INMARSAT C

FM 13-X Format

Synoptic Hours 0000,0600,1200 and 1800 UTC always sent

Intermediate Synoptic within 200 mile zone 0300,0900,1500 and 2100 UTC

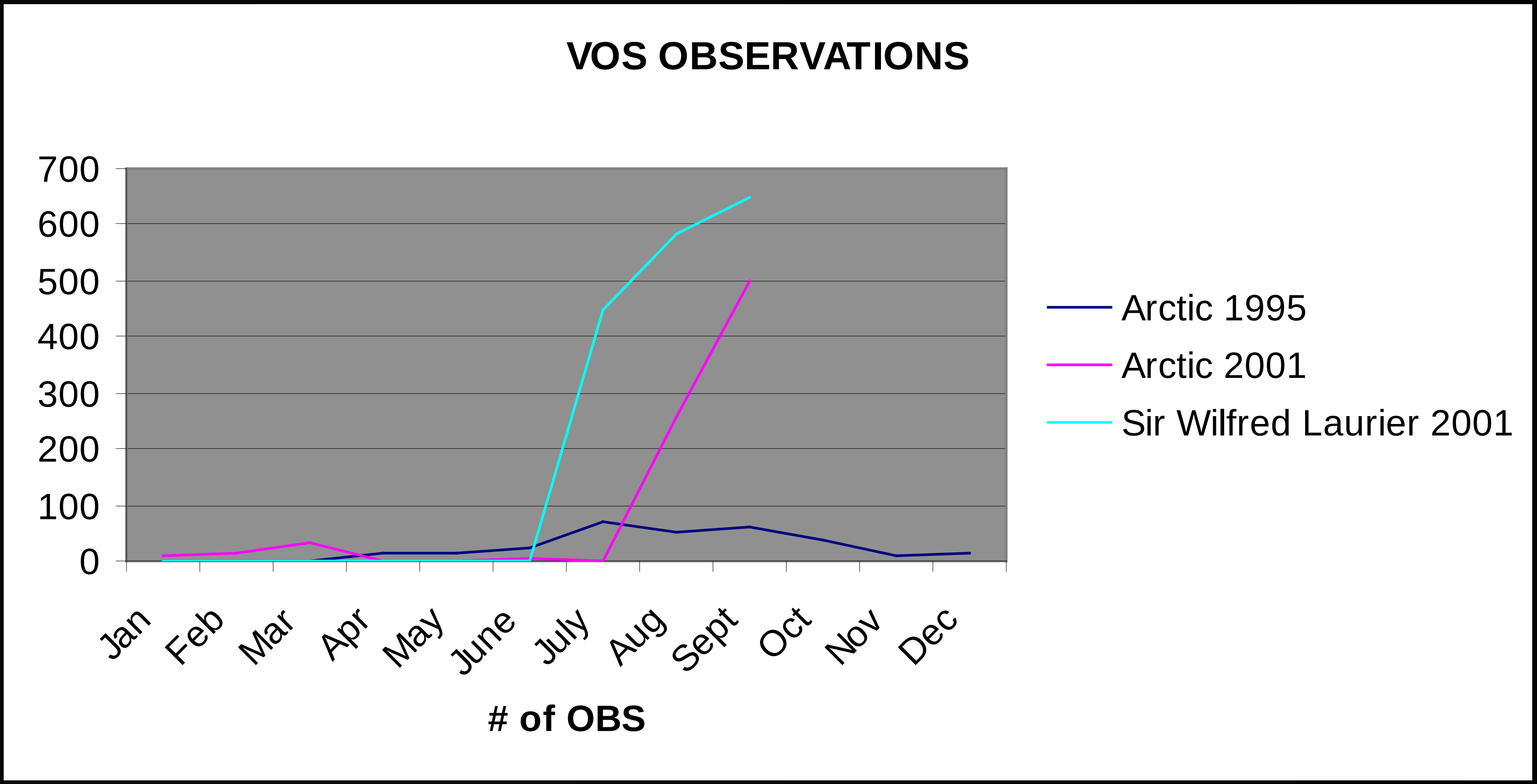
SPREP – sent immediately always when significant weather changes are detected.

STORM – wind over 48 kts sent every hour

AXYS ENVIRONMENTAL SYSTEMS

Environment Canada

IMPACT OF AVOS™



IMPACT OF AVOS™

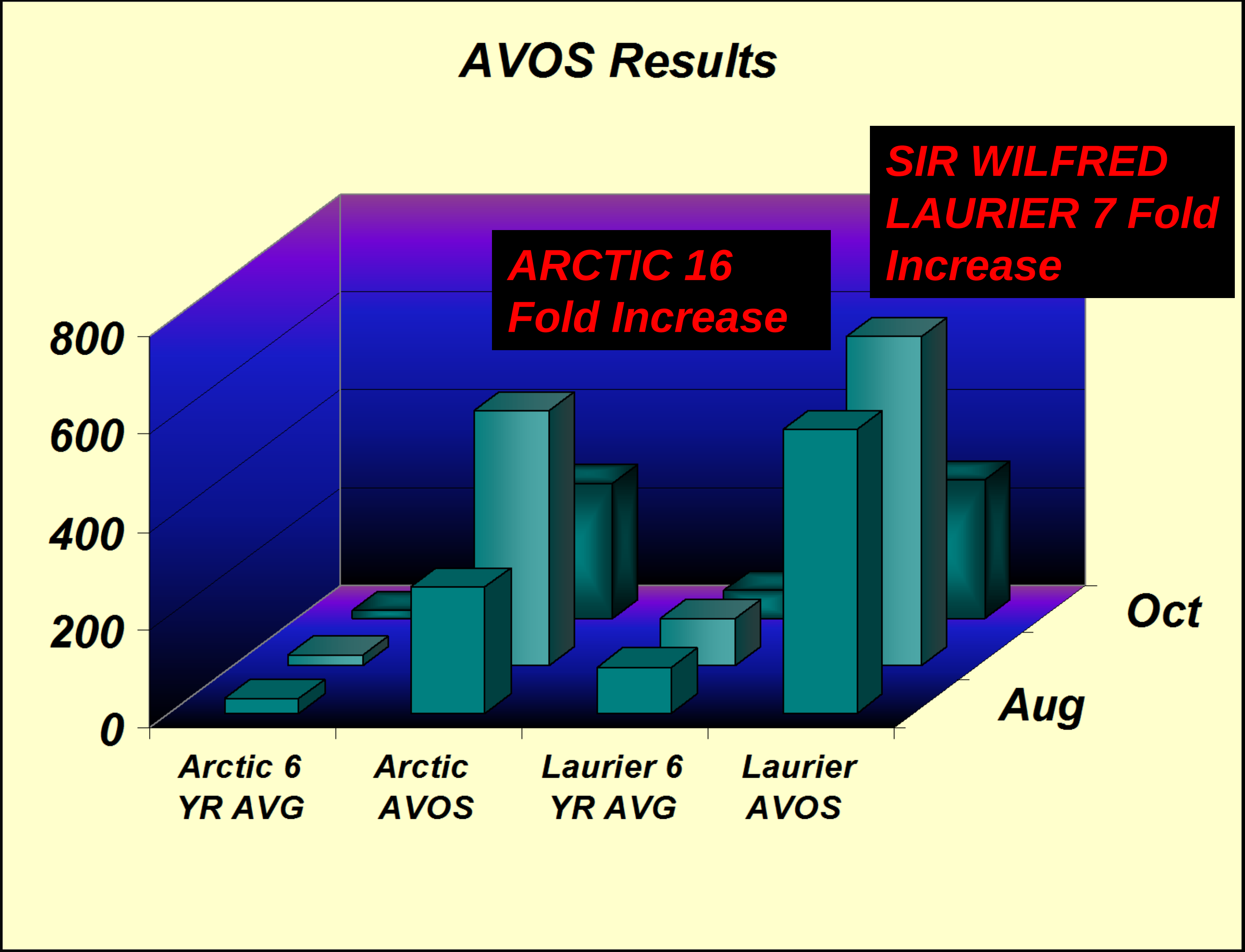
The Sir Wilfred Laurier made 1681 VOS reports in the first 3 months of use.

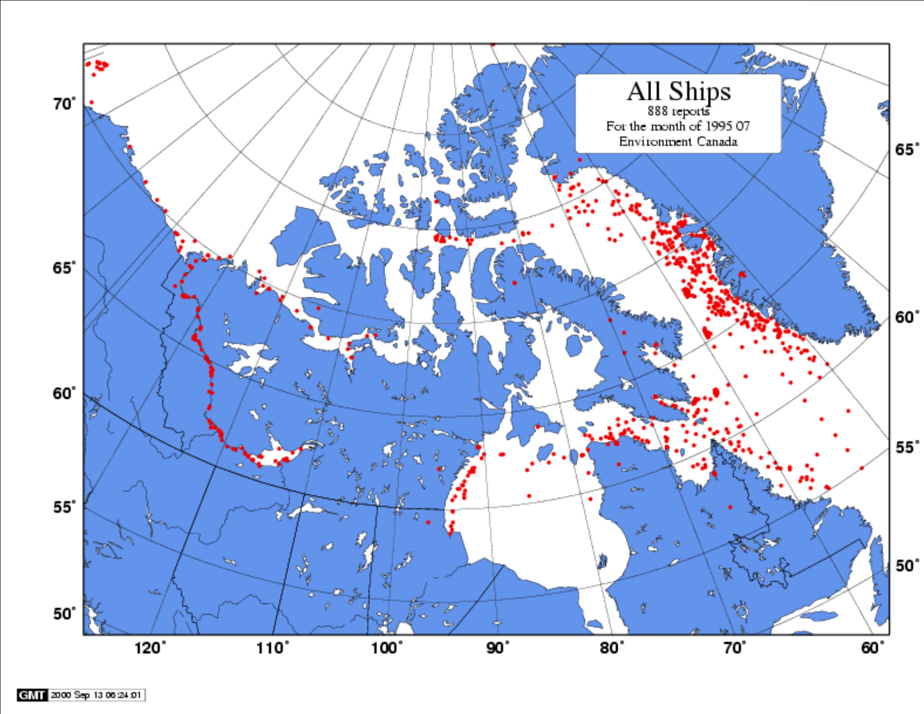
Only 3 Canadian VOS ships have reported over 1600 VOS reports in a 12 month period.

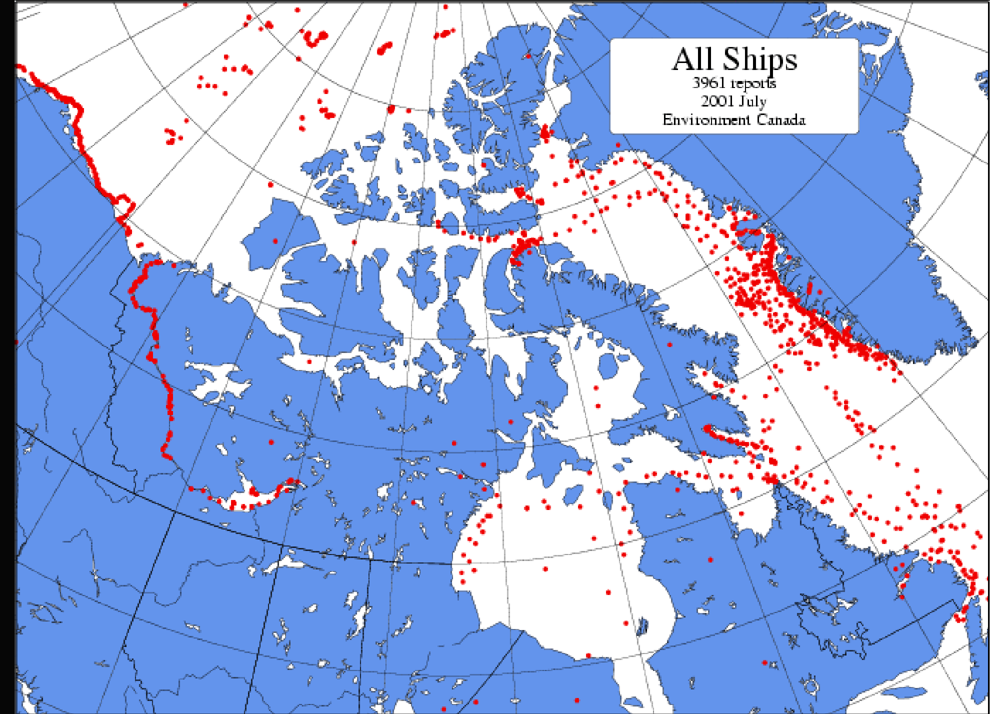
Out of 820 observations on the Arctic in 2001 92% have been made since the recent installation of AVOS™.

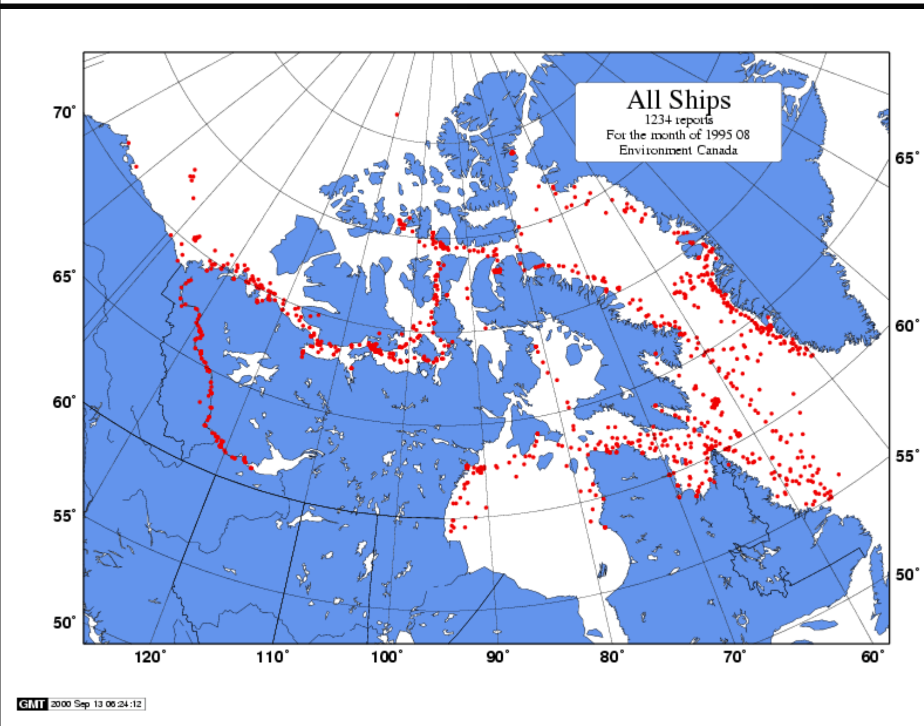
Historically 20% of Canada's VOS observations have been discarded by QC errors.

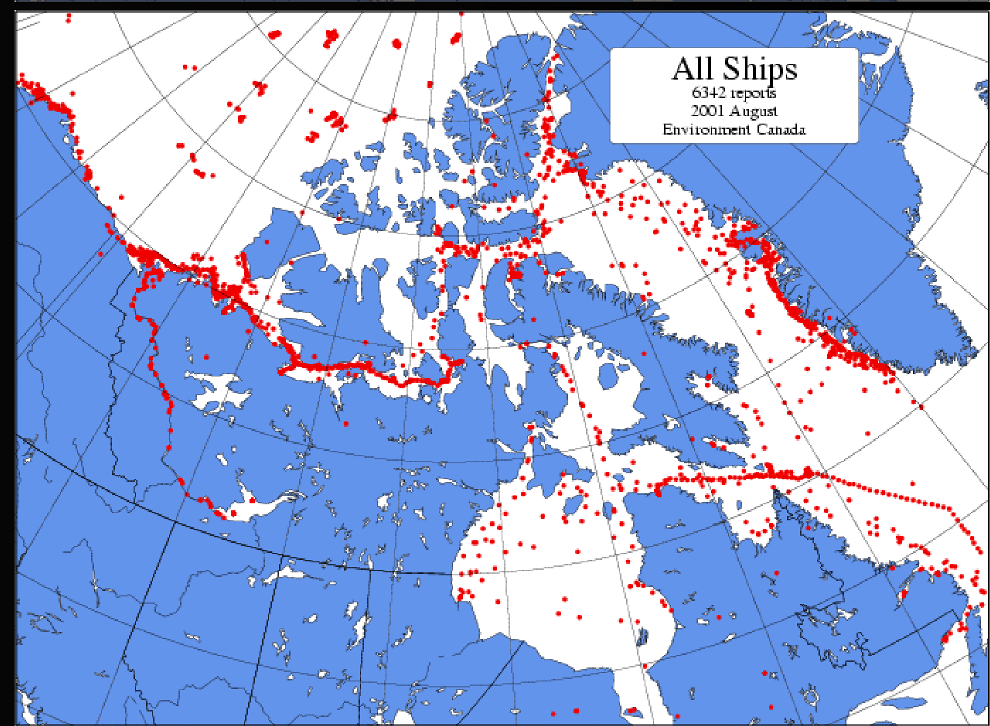
No AVOS™ messages have been discarded due to QC


AVOS Results
SIR WILFRED LAURIER 7 Fold Increase
ARCTIC 16 Fold Increase
800
600
400
200
0
Oct
Aug
Arctic 6 YR AVG
Arctic AVOS
Laurier 6 YR AVG
Laurier AVOS


All Ships
888 reports
For the month of 1995 07
Environment Canada
70˚
65˚
60˚
55˚
50˚
65˚
60˚
55˚
50˚
120˚
110˚
100˚
90˚
80˚
70˚
60˚
GMT 2000 Sep 13 06:24:01


All Ships
3961 reports
2001 July
Environment Canada


All Ships
1234 reports
For the month of 1995 08
Environment Canada
70˚
65˚
60˚
55˚
50˚
65˚
60˚
55˚
50˚
120˚
110˚
100˚
90˚
80˚
70˚
60˚
GMT 2000 Sep 13 06:24:12


All Ships
6342 reports
2001 August
Environment Canada

VOS

In the last few years 92% of the Canadian VOS data was collected by approximately 100 ships.
450 reports annually per ship on average.
50,000 reports a year.

AVOS™

75 AVOS ships, 500+ reports a month
500,000 reports a year
VOSCLIM

13 systems in Canada

Canadian VOS Objectives

Increase the frequency of VOS reports

50,000 – 500,000

Decrease the number of ships

211 - 75

Standardize the fleet

AVOS™

Improve data quality

VOSCLIM

Minimize manual requirement and reduce QC failure rate

AVOS™ Reliability

Enhance forecasting capabilities

The new OBSJMA

Tadashi ANDO (Japan Meteorological Agency)

1. Introduction

The Japan Meteorological Agency (JMA) developed a software package on meteorological report compilation for voluntary observing ships (VOSs) named "OBSJMA" in 1997. JMA is now upgrading the OBSJMA and plans to distribute it among Japanese VOSs. In this report, the present status and future plans on OBSJMA are introduced.

2. Current OBSJMA

JMA developed OBSJMA in 1997 for easy and accurate compilation of weather reports and marine meteorological logbooks recording by using a personal computer. After trial use by several ships, JMA has distributed OBSJMA and its operating manuals to about 500 ships. At every opportunity, JMA has been making efforts to appeal to VOSs for using OBSJMA: e.g. an article introducing OBSJMA in a JMA's magazine "The Ship and Marine Meteorology".

However, the current OBSJMA has become to be rather old-fashioned because the software was developed on MS-DOS base. For example, keyboard is the only device for data input (i.e. mouse pointer is not available), and it was designed to work on only floppy disk so that relevant visual images, such as types of clouds and sea condition, could not sufficiently be included.

Under these circumstances, the current OBSJMA is not popular among Japanese VOSs. Only 30 or less VOSs have regularly been using the OBSJMA for submitting the meteorological logbooks (Figure 1).

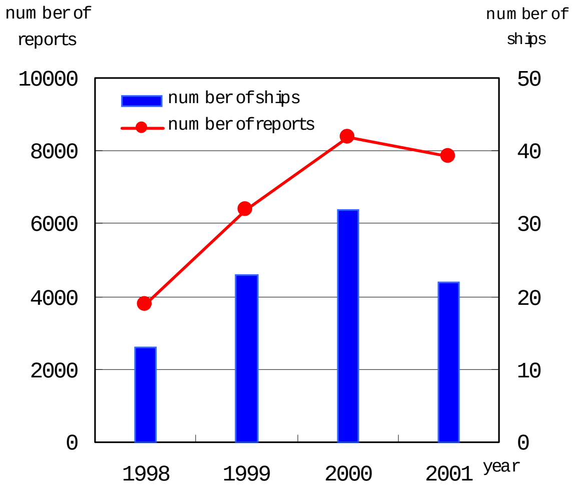


Figure 1. Number of ships using OBSJMA and reports made by OBSJMA

3. The OBSJMA for WIN

The JMA is now upgrading the OBSJMA to Windows edition. The new OBSJOM is called "OBSJMA for WIN". One of the major characteristics of the software is that the main screen is designed to be similar to the "Sheet for Marine Weather Observations" regularly distributed to VOSs by JMA. Observers on board can easily enter weather data on the screen using the mouse pointer. Figure 2 shows examples of screens of the OBSJMA for WIN.

The system requirements, functions and the way of distribution of the OMSJMA for WIN are as follows.

(1) System requirements
a) Operating System: Windows 95, Windows 98, Windows Me, Windows 2000 and Windows NT 4.0 for Japanese.
b) Memory: 64 MB RAM
c) Hard disk: 50 MB
d) Distributing media: CD-ROM

(2) Functions
The operation of the OBSJMA for WIN is in principle based on that of the current OBSJMA for MS-DOS. The following functions are added.
a) Mouse pointer is available.
b) Many color images, such as cloud types, are prepared in the "help" screen.
c) All the screens are alternative of Japanese or English and are changeable by clicking.
d) Data are archived in IMMT-2 format.
e) Meta-data for VOSClim could be input.

(3) Distribution of OBSJMA for WIN
The OBSJMA for WIN will be completed in March 2002, and JMA will distribute it to Japanese VOSs. JMA is to write an article to introduce the software package on the magazine "The Ship and Maritime Meteorology" and the JMA's web page for VOSs. In addition, Port Meteorological Officers are to demonstrate the OBSJMA for WIN when they visit VOSs.

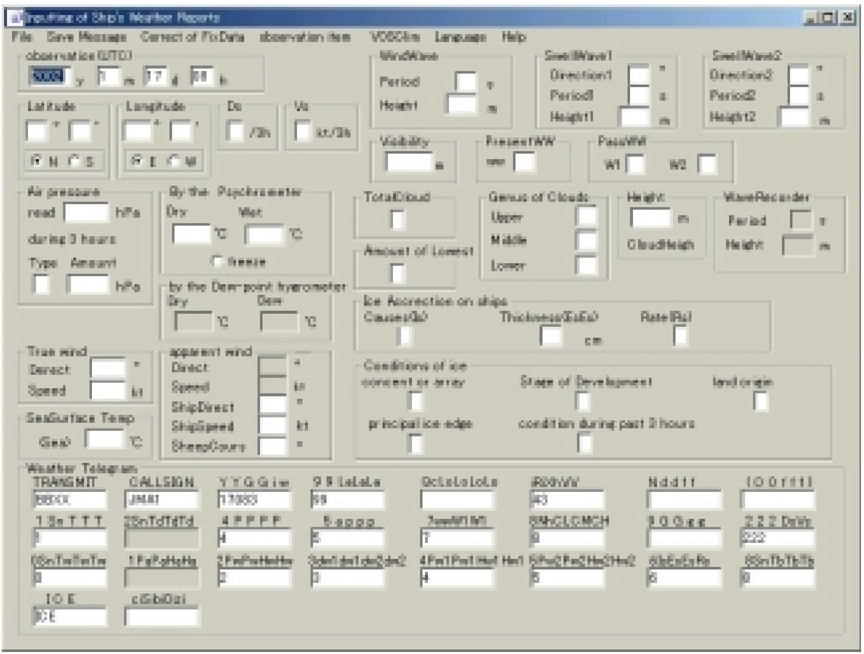
4. Future Plan
Unfortunately the number of submitted meteorological logbooks are decreasing in Japan. The difficulty of weather observation and the decrease of officers/crews are considered to be a major reason for the decreasing of meteorological reports. JMA expects that the OBSJMA for WIN will contribute to reduce the officers/crews' works of making meteorological reports. JMA will constantly keep on revising the OBSJMA for WIN duly reflecting user's comments as much as possible.

Recently almost all the shipping companies and many of ships can use internet. JMA plans to make VOSs available to download the OBSJMA for WIN and relevant documents on meteorological observation/reports via internet.

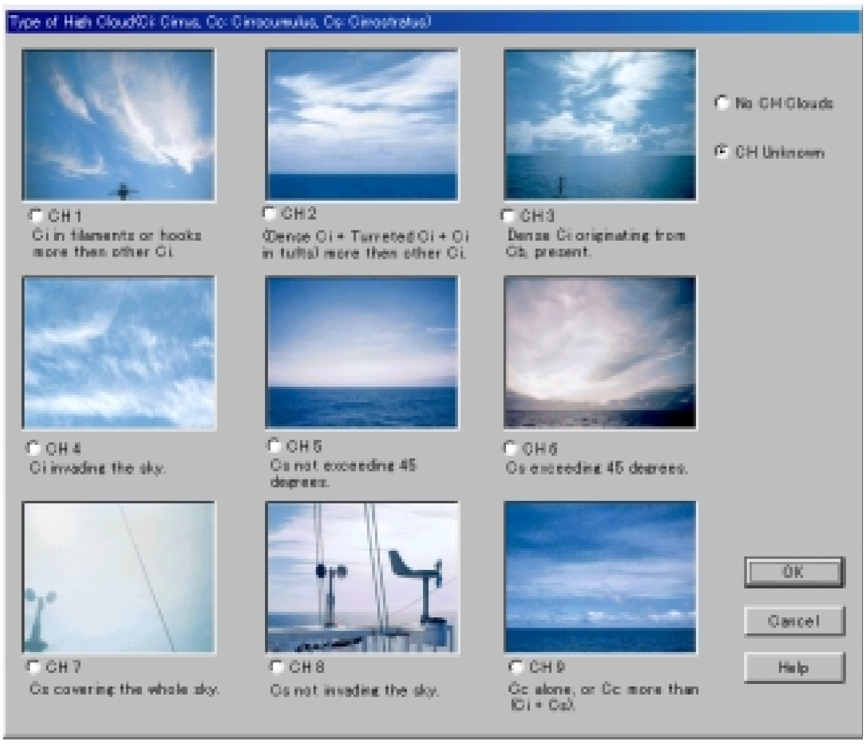
In connection with the near future use of the Table Driven Codes CREX/BUFR, JMA is considering to add a function to migrate the SHIP messages to CREX/BUFR in the future OBSJMA without any modification of data entry procedure by officers/crews.

Figure 2. Screens of the OBSJMA for WIN

Data entry screen



Help screen for cloud type



ARGOS SYSTEM, APPLICATIONS & ENHANCEMENTS

February 2002
Christian Ortega
CLS
Collecte Localisation Satellites, 8 – 10 rue Hermès,
Parc Technologique du Canal, 31526 Ramonville, France
tel: +33 561 39 47 20 / fax: +33 561 39 47 97 / email: ortega@cls.fr

ARGOS SYSTEM OVERVIEW

The Argos data collection and location system was established in 1978 by the National Oceanic and Atmospheric Administration (NOAA, USA), the National Aeronautics and Space Administration (NASA, USA), and the French space agency (CNES, France). Argos, was developed specifically for scientists to study the environment.

Argos can locate any platform carrying a suitable transmitter, anywhere in the world, and collect data from sensors connected to the transmitter.

The Argos system is operated and managed by:
- CLS, a CNES subsidiary in Toulouse, France
- Service Argos, Inc. (SAI), a CLS subsidiary in Largo, MD, near Washington, DC, USA
- worldwide subsidiaries

Over the last 20 years, Argos has evolved continually to keep pace with the needs of scientific research and applications dedicated to observing, monitoring and protecting planet Earth.

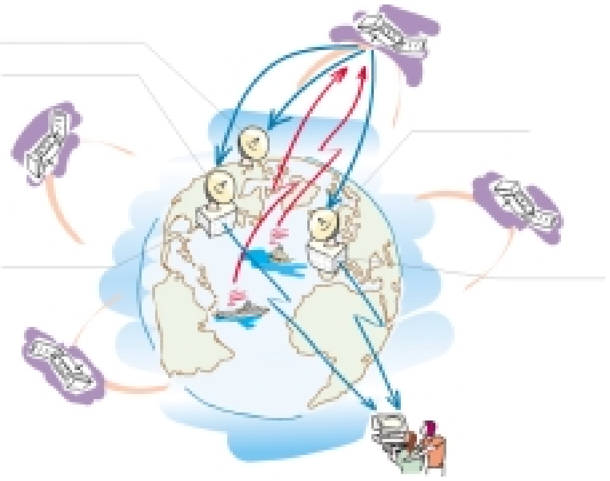


Figure 1: Argos is flown onboard the NOAA polar orbiting satellites (5 satellites as of today), and will also fly on NASDA and EUMETSAT polarorbiting satellites.

ARGOS APPLICATIONS

Half of the Argos system capacity is used for ocean, climate research applications. Many of these data are also used as input for operational meteorology and, as progress is made towards an observing system for the oceans, for operational oceanography. Argos applications also include animal tracking , oil spill tracking, monitoring equipment at sea, hydrology, fish stock management and hazardous cargo monitoring.

OCEAN APPLICATIONS

In the last six years, 5,000 drifting buoys, 1,500 deep floats, and 300 moored buoys and fixed stations, fitted with Argos transmitters, have measured the ocean currents and sent millions of measurements of atmospheric pressure, wind speed and direction, sea temperature and more. They have been important components of the operational WWW and WCRP programs, through TOGA, WOCE and now GOOS/GCOS, CLIVAR and GODAE programs and experiments.

ARGOS ON SOOP AND VOS

Argos have been used on ships since 1987 to collect SHIP and XBT observations.
Today some 20 ships equipped by French IRD and Australian BOM-CSIRO are fitted with Argos systems, of which 10 to 12 relay profiles every month. Temperature profiles data are validated by the shipboard software, inflexion points are calculated and coded in an Argos message. Messages are processed, quality controlled by the Argos GTS sub-system and sent to MeteoFrance for GTS insertion. In December 2001, 322 XBTs were inserted onto GTS.

Similarly, 4 PAB units from the BOM are sending SHIP observations. These units combine automatic measurements of atmospheric pressure, air and sea temperature, and manually-input observations. These data are validated in Argos centers, coded in SHIP and relayed to the GTS.

MeteoFrance has developed a basic weather station for VOS called Minos, which collects atmospheric pressure and air temperature. As a major advantage, this low-cost station can be installed in a couple of hours.

Figure 2: Minos : self-contained Argos telemetry station with atmospheric pressure, air temperature sensors, GPS, and data display unit for crew members.

ARGOS ENHANCEMENTS

Most fundamental changes are in the satellite segment and are planned years in advance. Two important decisions have been taken regarding the future of the Argos space segment:

- CNES has given the go-ahead for development of a third-generation Argos instrument to enter service in 2005. This instrument will offer significant enhancements, including better sensitivity, faster data transmission, and increased data collection capacity.
- CNES and NOAA are consolidating the Argos system's global reach by extending their partnership agreement to include two new major partners: Japan, represented by its national space agency NASDA, and Europe, represented by EUMETSAT. Partnership agreement with the Brazilian space agency, INPE, is on its way too.

The current launch schedule for the satellites carrying the Argos instruments is:

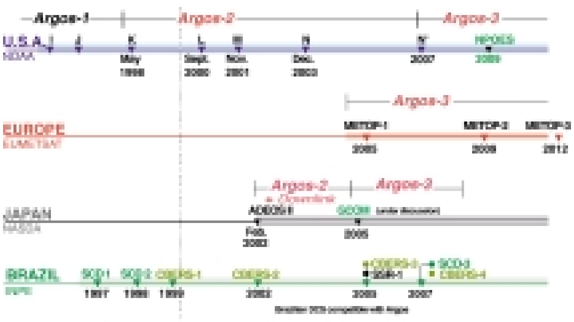


Figure 3: New satellites launches for the Argos system are already planned until 2012.

TWO-WAY COMMUNICATION

Two-way communication with Argos transmitters, also known as downlink messaging, will start with the ADEOS-II satellite, from late 2002.

Typical applications will be switching a transmitter on or off, or modifying a sensor sampling rate.

Users will connect to Argos servers via the web, and program the information they want their platforms to receive. The downlink will also provide uplink message acknowledgement.

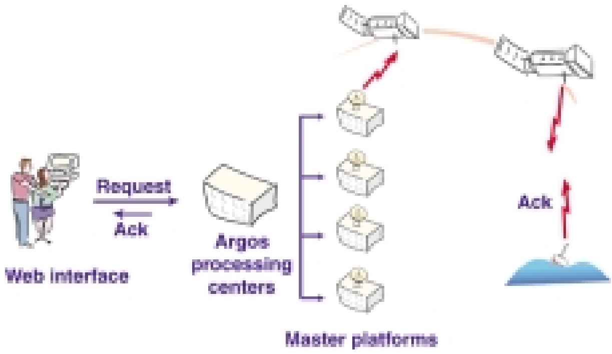


Figure 4: Argos users will send command to their platforms through a web interface and the satellite link.

INCREASING DATA BANDWIDTH

The Argos-2 generation, now flying on NOAA-15 & 16, can receive greater than three times more platform messages simultaneously than previous satellites. The improvement is due to a doubling of the number of Data Recovery Units on board the satellite and a tripling of the Argos frequency bandwidth.

The Argos system in use today includes redundant transmissions to increase the probability of error-free data receipt by the satellite. The two-way communication capability outlined above will enable the number of repetitive messages to be reduced by a factor 2 by including an "Acknowledgement" signal which will indicate when the data has been successfully received by the satellite.

The Argos-3 generation will feature a 4800 bps high data rate channel, ten times more data transfer than the current channel. This will, for example, match the ARGO float data relay requirements in a single satellite pass.

NEW USER INTERFACE, MORE PROCESSING CAPACITY

New data processing and management systems for the Argos processing centers are being phased in. These will provide:

- a more open system that lets users access and modify platform processing, program characteristics and access to results, on line
- easier access to results via an improved user interface.

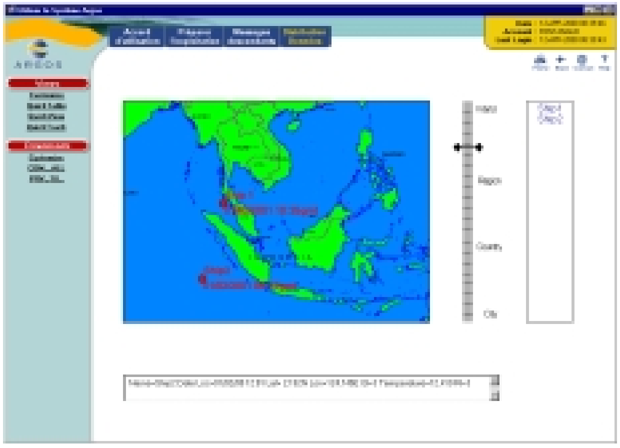


Figure 9: By mid-2002, Argos users will easily access their results on customized charts through a web browser, to see the most recent position or tracks along a number of days. Users can also download their results in spreadsheet.

REALTIME COVERAGE

Argos onboard equipment provides both global coverage of the earth through the store-and-forward mode and real time regional capability through a "bent-pipe" direct readout mode. CLS and SAI are shortening throughput time for operational needs, by installing regional stations worldwide. In January 2002, there were 28 S-band stations relaying Argos data in real-time.

THE MISSION CONTINUES

Argos has been serving users for more than 20 years, in a spirit of worldwide cooperation. The best example of this is the way the system continues to evolve as a partnership between its users and operators. The enhancements described above will enable the Argos user community to satisfy increasingly difficult data relay needs with a proven, reliable and robust data collection system as Argos continues its Earth observation and monitoring mission into the next century.

WEB SITES

Argos system description:
http://www.cls.fr/
http://www.argosinc.com/

30th January 2002

NEW MARITIME SAFETY AND COMMERCIAL SERVICES IN 2002

JOINT WMO/IOC TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE
METEOROLOGY (JCOMM) SHIP OBSERVATIONS TEAM.
25 February- 2 March 2002, Goa, India

Brief notes on existing services

Inmarsat operates four communication systems Inmarsat A, Inmarsat B, InmarsatC, Inmarsat mini-M and Inmarsat E distress alerting system which are the right choice for safety at sea and commercial communications.

Inmarsat A is the original analogue Inmarsat satellite communication system that provides voice, telex, fax, data (9.6 kbit/sec) and high speed data (56/64 kbit/sec) services. The system is GMDSS compliant and provides telephone and telex distress calling to a Rescue Coordination Centre.

Inmarsat B is a digital successor to Inmarsat A and offers similar capabilities but with more efficient use of the resources and low call charges. The system is also GMDSS compliant and provides telephone and telex distress calling to a Rescue Coordination Centre.

Inmarsat C is a cornerstone of the GMDSS supporting 5 out of 9 communication functions defined in the IMO SOLAS Convention, Chapter IV. It is a packet data communication system providing store and forward messaging including e-mailing, distress alerting and distress priority messaging to associated Rescue Coordination Centres, reception of maritime safety information via the International SafetyNET service, data reporting and polling service. It is also very important that Inmarsat C is used to send messages to a short code or two-digit address, e.g. sending meteorological reports, navigational hazards and warnings, request for medical advice and medical assistance, requests for search and rescue assistance and sending ship position reports to shore authorities.

EGC SafetyNET provides an efficient and low-cost means of transmitting maritime safety information to vessels at sea and is used by meteorological, hydrographic, search and rescue and coastguard co-ordination authorities. Messages are addressed to ships at sea using IMO defined NAVAREAs/METAREAs, coastal areas or sea areas defined by a circular, e.g. area around vessel in distress or rectangular area.

Inmarsat mini-M is a the smallest, lightweight and cost effective satellite communication system that provides high quality voice, data, fax and e-mail services at the speed of 9.6 kbit.sec. It operates via Inmarsat spot beams in four ocean regions like a cellular phone with maritime coverage. The system is small in size and low weight and can be easily installed on smaller maritime users. Inmarsat Mini-M is not GMDSS compliant and does not support safety services.

Inmarsat E is an Emergency Position Indicating Radio Beacon (EPIRB) system which provides distress alerting capability via Inmarsat satellites. Distress alerts are handled automatically and received at associated Rescue Coordination Centres within, typically, two minutes after activation. Inmarsat E EPIRBs have built-in Global Positioning System (GPS) receivers, which provide accurate distress position information and are small and lightweight enough to be installed on smaller vessels. Two Land Earth Stations in each out of four Inmarsat ocean regions give 100% redundancy in case of failure or outages associated with any of the LESs.

The Inmarsat E system supports “Float Free” EPIRBs which incorporate the following features: integrated GPS receiver which is accurate to within 200 metres; automatic activation when the EPIRB is hydrostatically released by “floating free”; remote activation and information input from vessels bridge or other manned situation; optional Search and Rescue Radar Transponder (SART); optional 121.5MHz locator beacon; high intensity, low duty cycle flashing light.

WHAT IS NEW

Inmarsat Fleet

Inmarsat Fleet F77, unveiled at Europort exhibition in November 2001, is the first in new family of Inmarsat services for the maritime industry in eight years and brings a new dimension to maritime safety. Fleet F77 is the only service that meets the International Maritime Organisation’s latest requirements – IMO Resolution A.888(21) “Criteria for the provision of mobile satellite communication systems in the Global Maritime Distress and Safety System (GMDSS)”, by providing voice prioritisation and pre-emption.

This essential new prioritisation function comes as standard on Fleet F77 and allows the interruption and clearing of lower priority communications and routine calls to give way to voice communication for high priority distress, urgency and safety needs. The Resolution A.888(21) states that any system being designed for use in the GMDSS after 1 February 1999 should be able to recognise the four levels of priority in both ship-to-shore and shore-to-ship directions:

- Distress;
- Urgency;
- Safety; and
- Other (general/routine) communications

Rescue authorities calling a vessel equipped with Fleet F77 will always be able to contact a ship, even if the voice or data channel is in continuous use at a lower priority. Not only will pre-emption work seamlessly, it will always work in a hierarchical manner:
Distress priority P3 call will pre-empt all other communications;
Urgency priority P2 call will pre-empt both safety P1 and routine P0 calls; and
Safety priority P2 call will pre-empt a routine P0 call.

The introduction of Fleet F77 to the Inmarsat communications portfolio reinforces their continued commitment to the provision of international maritime safety. In addition, Inmarsat consistently exceeds the minimum IMO requirement for 99.9% system availability for ship-shore distress alerts.

The new IMO criteria were formulated following a maritime rescue incident in November 1994. The passenger liner "Achille Lauro" caught fire and sank off the coast of Somalia. The majority of the passengers (930) were subsequently rescued by the tanker "Hawaiian King", and the tanker "Chevron Perth" rescued a further 133. Upon being rescued, the survivors were keen to contact family and friends to let them know they were safe and well. In addition, the world's press was also keen to talk to survivors, to get first-hand accounts of the incident.

The subsequent increase in usage of the Inmarsat A terminal onboard the "Hawaiian King" prevented the Maritime Rescue Co-ordination Centre (MRCC) from contacting the ship. The situation was safely resolved by the MRCC using additional Inmarsat safety equipment, Inmarsat C, to alert the "Hawaiian King" to clear the voice channel on their Inmarsat A for safety communications.

Fleet F77 was at the design stage at the same time that the Resolution A.888(21) was being drafted. Once the new requirements were made clear, Inmarsat incorporated these into the design of Fleet F77. Provision of pre-emption in both directions also means that Inmarsat land earth station operators (LESOs), which provide Fleet F77 services, are capable of offering this valuable safety service.

In addition to an advanced safety service, Fleet F77 will also deliver a wide range of commercial communications needs; voice, fax and data services at speeds of up to 64 kbit/s, including mobile ISDN and mobile packet data service (MPDS), where users are charged for the amount of information sent and received rather than the time for which they are connected. This will enable mariners to send and receive information on real-time basis, rather than the traditional practice of logging on once or twice a day.

Selection of mobile ISDN or MPDS depends on what a maritime user wants to send or receive. As a general rule, the mobile ISDN service is best used when transmitting large files or if a data speed or of the utmost importance. The MPDS can be more efficient for applications that are interactive in nature such as e-mail, web or Intranet access.

Fleet F77 supports a range of powerful new applications through its high speed data capability which include secure access to information online, image transfer, video and digital image communications. Fleet77 also delivers e-mail, Internet and Intranet access plus a choice of two fax services. Some of maritime specific applications include graphical ocean charts and weather displays, navigational chart updates, database queries, accessing online safety information, telemedicine, vessel's telemetry transmission.

Inmarsat mini-C

Inmarsat mini-C is a low-power and compact communications solution for small vessel markets such as fishing vessels, yachting, inland waterways. Mini-C is an evolution of the existing Inmarsat C technology and supports all standard services combined with a significantly reduced level of power consumption. Low power consumption also offers the possibility of using a solar-fed battery power source where required.

Inmarsat mini-C offers two-way messaging and e-mailing, position reporting and polling, ship-to-ship communications. This makes mini-C an ideal portable and inexpensive solution to fulfill basic messaging, tracking and security communications requirements for small maritime users.

Mini-C provides ship-to-shore and shore-to-ship telex and e-mail communications, position reporting and tracking applications, short access code address messaging for maritime safety services such as sending meteorological reports to meteorological centers, sending navigational hazards and warnings, request for medical advice and assistance, sending position reports to shore authority.

In future an enhanced Inmarsat mini-C model, to be available in early 2002, will also provide emergency alerting for non-SOLAS ships and reception of maritime safety information via the EGC SafetyNET service. In the merchant marine sector, it can also deliver commercial information for shipping and transport companies, fishing and merchant fleet data applications, anti-piracy and navigation aids. Inmarsat mini-C can also be installed as supplementary terminals for crew communications, to complement existing communications services onboard.

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RESULTS OF FIELD TESTS OF THE NEW XCTD-2

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ABSTRACT

The eXpendable Conductivity, Temperature, and Depth profiler for temperature and salinity observations to a depth of 1,850 m (XCTD-2) was tested during the MR01-K04 cruise of the research vessel R/V MIRAI in the summer of 2001. The new, deep–water probe was recently developed by the Tsurumi-Seiki Co., LTD. Field tests of the XCTD-2 are indispensable for determining the depth-time equation and evaluating instrument accuracy. On the cruise, 12 probes were launched during CTD up-casts at 11 CTD stations. By using the pairs of XCTD and CTD profiles, the depth-time equation was estimated as $D = 3.4005t-3.2x10^{-4}t^2$, where D is the depth in meters and t is the elapsed time after the probe hits the sea surface. The temperature and salinity differences from CTD observations in the deep layer of 1000m to 1500m were -0.001^0C and -0.008psu respectively. Standard deviations were 0.018^0C and 0.013psu. These values indicate that the XCTD-2 is a useful addition to the XCTD system.

Introduction

The expendable conductivity temperature depth profiler (XCTD) system was developed in the 1990’s and was released for general use for 1000m observation in 1997 by Tsurumi Seiki CO. LTD (TSK). At an early stage, a positive salinity bias and slow adjustment just after launch were recognized as points which should be improved (Mizuno and Watanabe, 1998). TSK has addressed these issues with significant design changes to the original XCTD observation system. TSK also received requests for development of a new model for deeper use and initiated development of an XCTD probe for 2000m observations (XCTD-2).

Field experiments of the XCTD-2 were conducted in the summer of 2001, taking advantage of participation in the MR01-K04 cruise of R/V Mirai conducted by

Japan Marine Science and Technology Center (JAMSTEC). This allowed comparison of profiles observed by XCTD-2 with high precision CTD profiles. The cruise was conducted to revisit the WHP-P17 and high precision CTD observations from the sea surface to the bottom were successfully performed at each station. The purposes of the field tests were to develop a depth-time equation for the new XCTD probe and to evaluate the accuracy of XCTD-2 observations.

Design of the XCTD-2 system

The basic structure of the XCTD-2 probe is very similar to the current model for 1000m-observation (XCTD-1) as shown in Mizuno and Watanabe (1998). The major differences are wire length and the wire diameter. The diameter of the wire is 0.07mm, which is 0.02mm thinner than that of the XCTD-1. The length of the wire stored in the canister and the probe are 1200m and 1900m, respectively. TSK estimated that the available observation depth was 1830m at 3.5 kt of ship speed. A highly efficient digital filter was installed in the MK-100 XCTD digital converter, in order to cope with the increased noise introduced by longer data transmission distances.

In-situ comparison tests

The MK-100 converter with revised ROM and a PC were placed in a room behind the ship wheelhouse. A hand launcher was installed at the stern, about 50m from the CTD. In order to make XCTD-CTD concurrent observations, the XCTD probes were launched when the CTD-sonde reached a depth range of from 500m to 300m during up-casts.

The tests were performed at CTD stations including two training points and nine WHP-P17 revisit stations along the 135°W meridian as shown in Figure 1. The information and results of the observations are summarized in Table 1.

Nine of the 12 tests were successful. One failure was due to operator error, one to hand launcher malfunction, and one to a wire break caused by the ship propeller.

Data processing

The software for the XCTD observation was a version of the current program revised to allow deeper profiles. Initially, the depth-time equation for the XCTD-1 was used. Later, using the XCTD and CTD profiles obtained at the first training station at 39N, 179W, a temporary depth-time equation was determined according to the method adopted by Hanawa et al. (1995).

Finally, all of the profiles were converted with the temporary depth-time equation and were then compared with CTD profiles. Again using the method adopted by Hanawa et al. (1995), the final depth-time equation was developed utilizing a comparison to the CTD standard gradient profiles to eliminate temperature errors. The method is based on minimizing the differences between the CTD and XCTD temperature gradient profiles at the center of fixed depth-window intervals. The least squares method was then used to determine the quadratic equation coefficients for each window and the mean of all the values was calculated to determine the general coefficients.

Depth-time equation

The depth-time equation is in the form, $D = at + bt^2$, where D is the depth in meters and t is the elapsed time in seconds after the probe hits the sea surface. The depth-time equation obtained for each test is shown in table 2. Averaged values of coefficients a and b were adopted for the general equation as described in the section above. The depth-time equation for XCTD-2 was then determined to be:

$$D = 3.4005t - 3.2\times10^{-4}t^2$$

Figure 2 shows the depth difference of each equation from the averaged equation. The standard deviation of the depth difference at 560 sec (about 1800m by averaged equation) is 14m and difference at 305 sec (about 1000m) is 4.2m.

Temperature/salinity comparison

Temperature and salinity profiles for all XCTD-2 data were calculated by using the depth-time equation. Each profile is shown in Figure 3 with the corresponding CTD profile and T-S diagrams are shown in Figure 4. As seen in figure 3, the XCTD-2 profiles follow the CTD profiles well. The temperature and salinity differences averaged for the deep layer from 1000m to 1500m were calculated and summarized in table 2. The mean value of differences was –0.001℃ for temperature and –0.008psu for salinity. The standard deviations were 0.018℃ and 0.013psu, respectively. These values are better than the initial evaluation of model XCTD-1 by Mizuno and Watanabe (1998). These statistical values meet the specification presented by the manufacturer.

The temperature and salinity sections observed by XCTD-2 along WHP-P17 line from 30°N to 41°N were constructed and are shown in figure 5 and 6. The CTD sections and the difference between the XCTD and CTD observations are attached for comparison. The detailed structure of subsurface temperature fields are captured quite well by the XCTD-2. As to the salinity field, the structure of the water mass distribution can be evaluated by XCTD salinity section. However, the influence of the variation in accuracy of each probe within the range +/-0.02 appears as an unnatural undulation of the 34.5 psu contour line in the deep layer. The salinity field in the deeper layer where the vertical gradient is small should be interpreted with careful consideration of the accuracy of the salinity measurement of the XCTD.

Acknowledgements

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References

Hanawa, K., P. Rual, R. Bailey, A. Sy and M. Szabados (1995): New depth-time equation for Sippican or TSK T-7, T-6, and T-4 expendable bathythermographs (XBT). Deep Sea Res., 42,1423-1451.

Mizuno, K. and T. Watanabe (1998): Preliminary Results of in-situ XCTD/CTD comparison test. J. Oceanogr. 54,373-380.

Table 1 XCTD-2 test stations

Station	Date (UT)	Time	Latitude		Longitude		S/N	Depth
TR01S02	2001/07/31	04:43	39-03.19	N	179-49.52	W	#01075609	1823
TR02S02	2001/08/04	16:03	31-01.88	N	150-01.40	W	#01075619	-
P17C26	2001/08/06	21:55	30-00.06	N	134-59.81	W	#01075620	1047
P17C23	2001/08/07	13:12	31-31.94	N	135-00.12	W	#01075618	1824
P17C21	2001/08/08	00:01	32-36.53	N	135-00.71	W	#01075615	405
P17C21	2001/08/08	00:11	32-36.59	N	135-00.74	W	#01075616	1819
P17C18	2001/08/08	15:48	34-04.47	N	134-59.78	W	#01075612	1810
P17N29	2001/08/09	02:49	34-59.36	N	135-01.01	W	#01075617	1824
P17N32	2001/08/10	01:26	36-30.01	N	135-00.68	W	#01075613	1842
P17N35	2001/08/10	18:18	38-00.34	N	135-00.99	W	#01075614	1803
P17N39	2001/08/11	15:03	39-37.17	N	135-01.20	W	#01075610	1833
P17N46	2001/08/13	00:29	40-58.83	N	134-58.60	W	#01075611	1824

Table 2. Depth-time equation for XCTD-2 and temperature and salinity differences between XCTD-2 and CTD observations averaged for the depth range 1000-1500m.

Station	Time-Depth Equation	Temp. dif.	Sal. Dif.	S/N
TR01S02	D = 3.40316t-0.00029t^2	-0.010	0.001	#01075609
TR02S02	----------------------	-------	--------	#01075619
P17C26	----------------------	-------	--------	#01075620
P17C23	D = 3.43509t-0.00044t^2	0.002	-0.001	#01075618
P17C21	----------------------	-------	--------	#01075615
P17C21	D = 3.44297t-0.00043t^2	0.004	-0.027	#01075616
P17C18	D = 3.40269t-0.00039t^2	0.021	-0.030	#01075612
P17N29	D = 3.37367t-0.00032t^2	0.018	-0.005	#01075617
P17N32	D = 3.40348t-0.00025t^2	-0.039	-0.010	#01075613
P17N35	D = 3.38351t-0.00027t^2	-0.012	0.013	#01075614
P17N39	D = 3.36603t-0.00023t^2	0.001	-0.017	#01075610
P17N46	D = 3.39365t-0.00030t^2	0.004	-0.017	#01075611
Mean	D = 3.40047t-0.00032t^2	-0.001	-0.008	
S.D.	(0.02565)(0.00008)	(0.018)	(0.013)	

Figure caption

Figure 1

Location of CTD/XCTD stations for XCTD-2 tests (●) and MR01-K04 stations (˙).

Figure 2

Difference from averaged depth-time equation.

Figure 3

Vertical temperature and salinity profiles of XCTD-2/CTD.

Figure 4

T-S diagrams for XCTD-2/CTD.

Figure 5

a) Vertical temperature section along 135W observed by XCTD-2.

b) Vertical temperature section along 135W observed by CTD.

c) Temperature difference section along 135W, XCTD-2 – CTD.

Figure 6

a) Vertical salinity section along 135W observed by XCTD-2.

b) Vertical salinity section along 135W observed by CTD.

c) Salinity difference section along 135W, XCTD-2 – CTD.

Figure 1

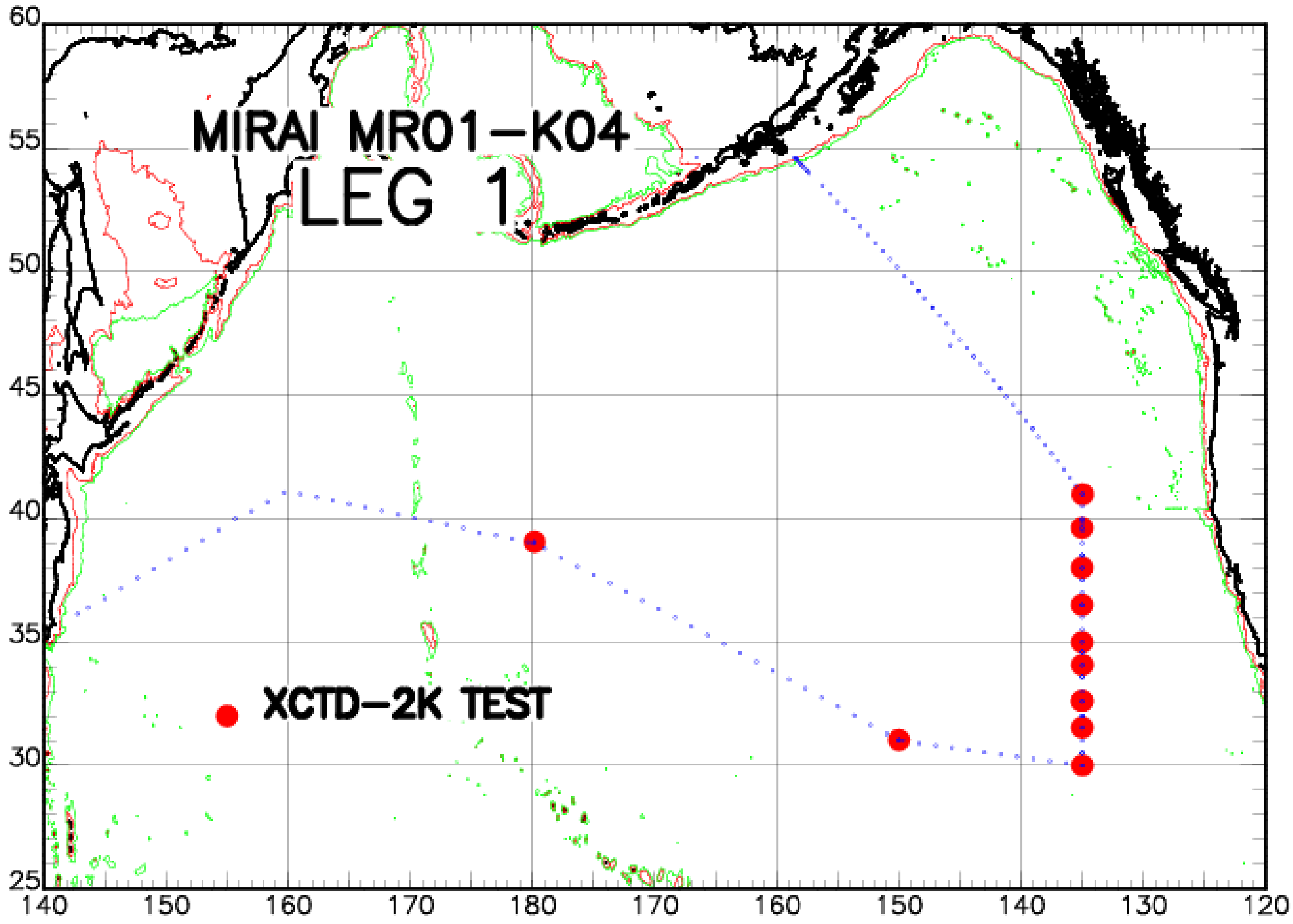

MIRAI MR01-K04
LEG 1
XCTD-2K TEST
60
55
50
45
40
35
30
25
140
150
160
170
180
170
160
150
140
130
120

Figure 2

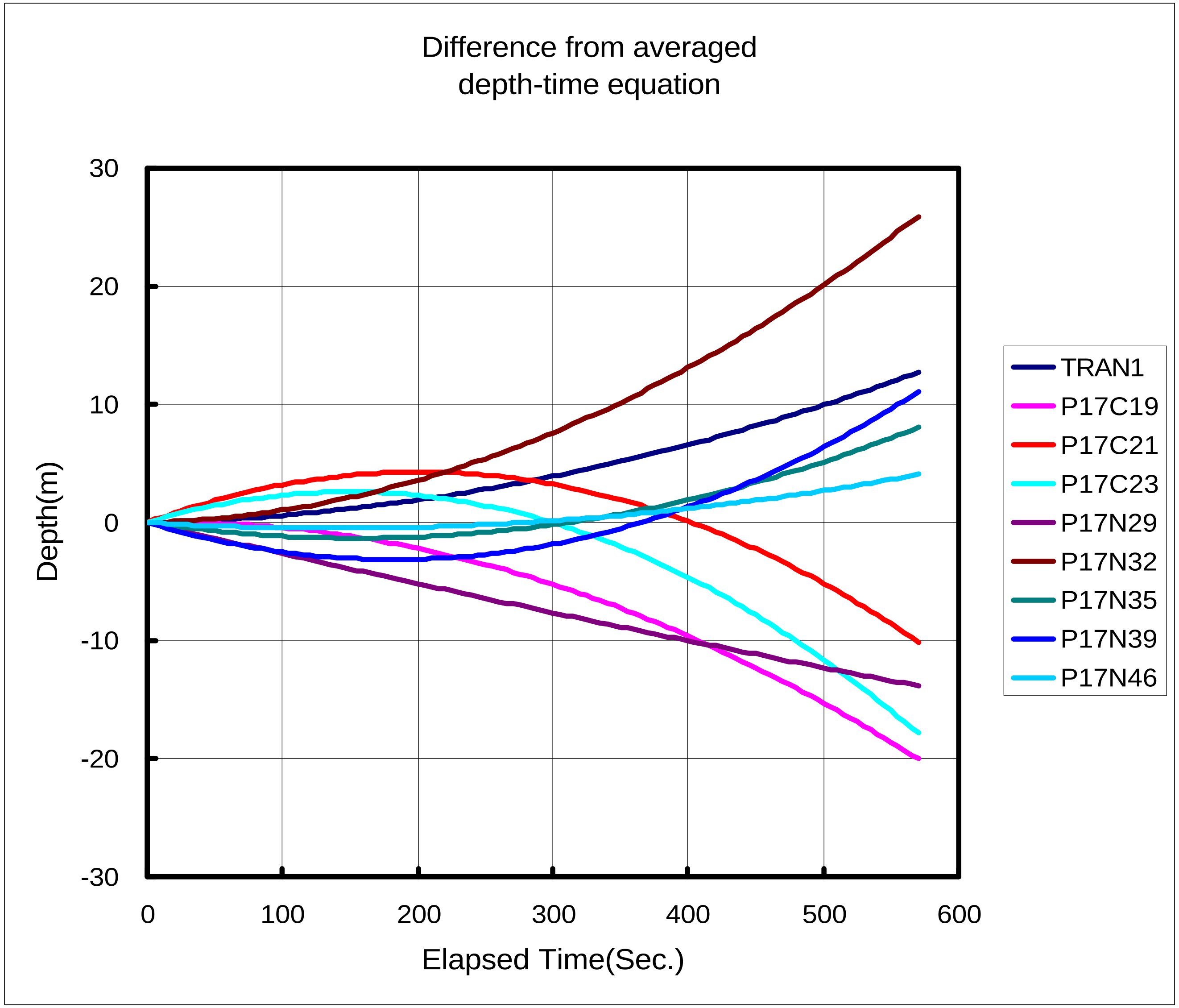

Difference from averaged
depth-time equation
30
20
10
0
-10
-20
-30
Depth(m)
0
100
200
300
400
500
600
Elapsed Time(Sec.)
TRAN1
P17C19
P17C21
P17C23
P17N29
P17N32
P17N35
P17N39
P17N46

Figure 3

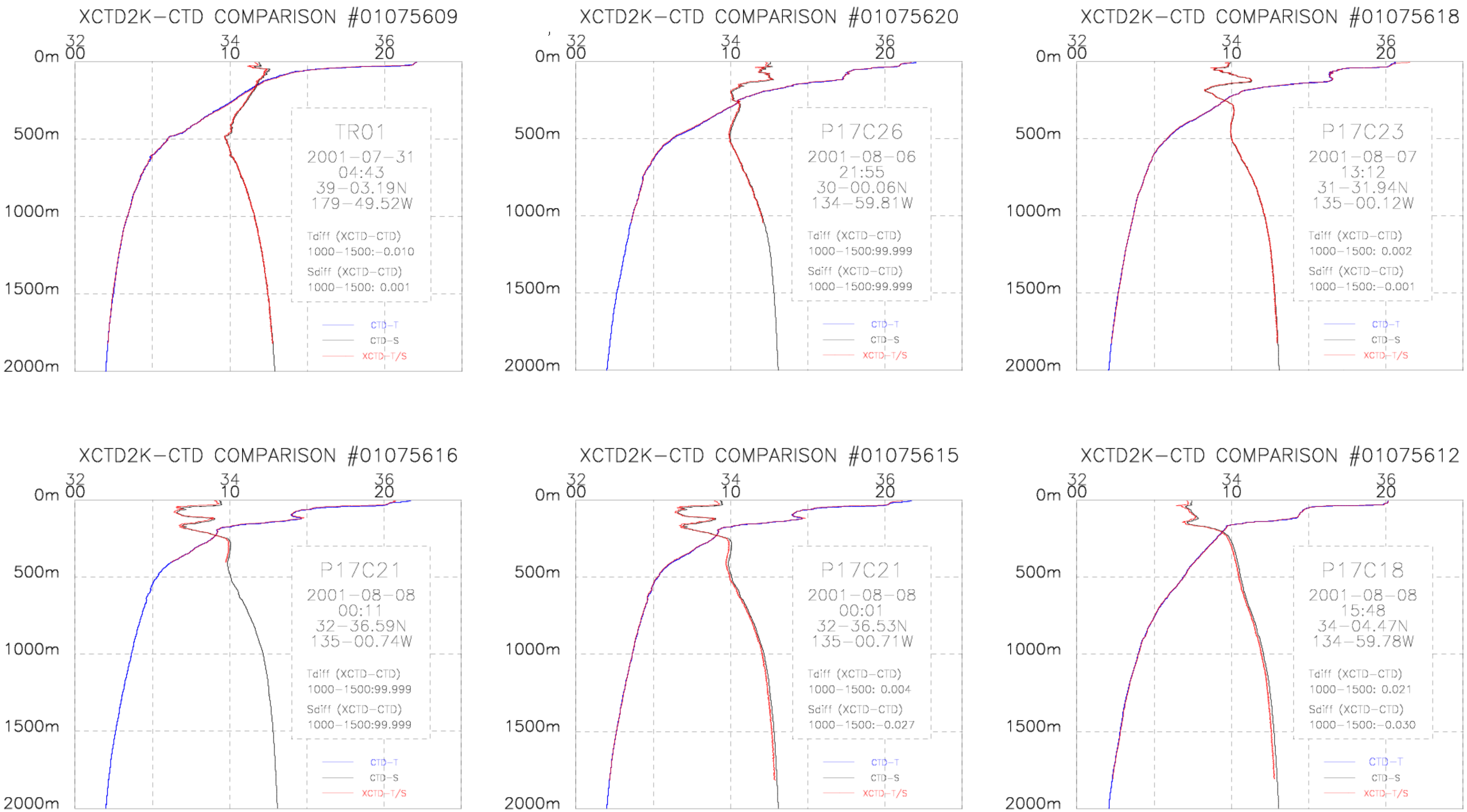

XCTD2K−CTD COMPARISON #01075609
TR01
2001−07−31
04:43
39−03.19N
179−49.52W
Tdiff (XCTD−CTD)
1000−1500:−0.010
Sdiff (XCTD−CTD)
1000−1500: 0.001
XCTD2K−CTD COMPARISON #01075620
P17C26
2001−08−06
21:55
30−00.06N
134−59.81W
Tdiff (XCTD−CTD)
1000−1500:99.999
Sdiff (XCTD−CTD)
1000−1500:99.999
XCTD2K−CTD COMPARISON #01075618
P17C23
2001−08−07
13:12
31−31.94N
135−00.12W
Tdiff (XCTD−CTD)
1000−1500: 0.002
Sdiff (XCTD−CTD)
1000−1500:−0.001
XCTD2K−CTD COMPARISON #01075616
P17C21
2001−08−08
00:11
32−36.59N
135−00.74W
Tdiff (XCTD−CTD)
1000−1500:99.999
Sdiff (XCTD−CTD)
1000−1500:99.999
XCTD2K−CTD COMPARISON #01075615
P17C21
2001−08−08
00:01
32−36.53N
135−00.71W
Tdiff (XCTD−CTD)
1000−1500: 0.004
Sdiff (XCTD−CTD)
1000−1500:−0.027
XCTD2K−CTD COMPARISON #01075612
P17C18
2001−08−08
15:48
34−04.47N
134−59.78W
Tdiff (XCTD−CTD)
1000−1500: 0.021
Sdiff (XCTD−CTD)
1000−1500:−0.030
CTD−T
CTD−S
XCTD−T/S
0m
500m
1000m
1500m
2000m
32
34
36
00
10
20

Figure 3

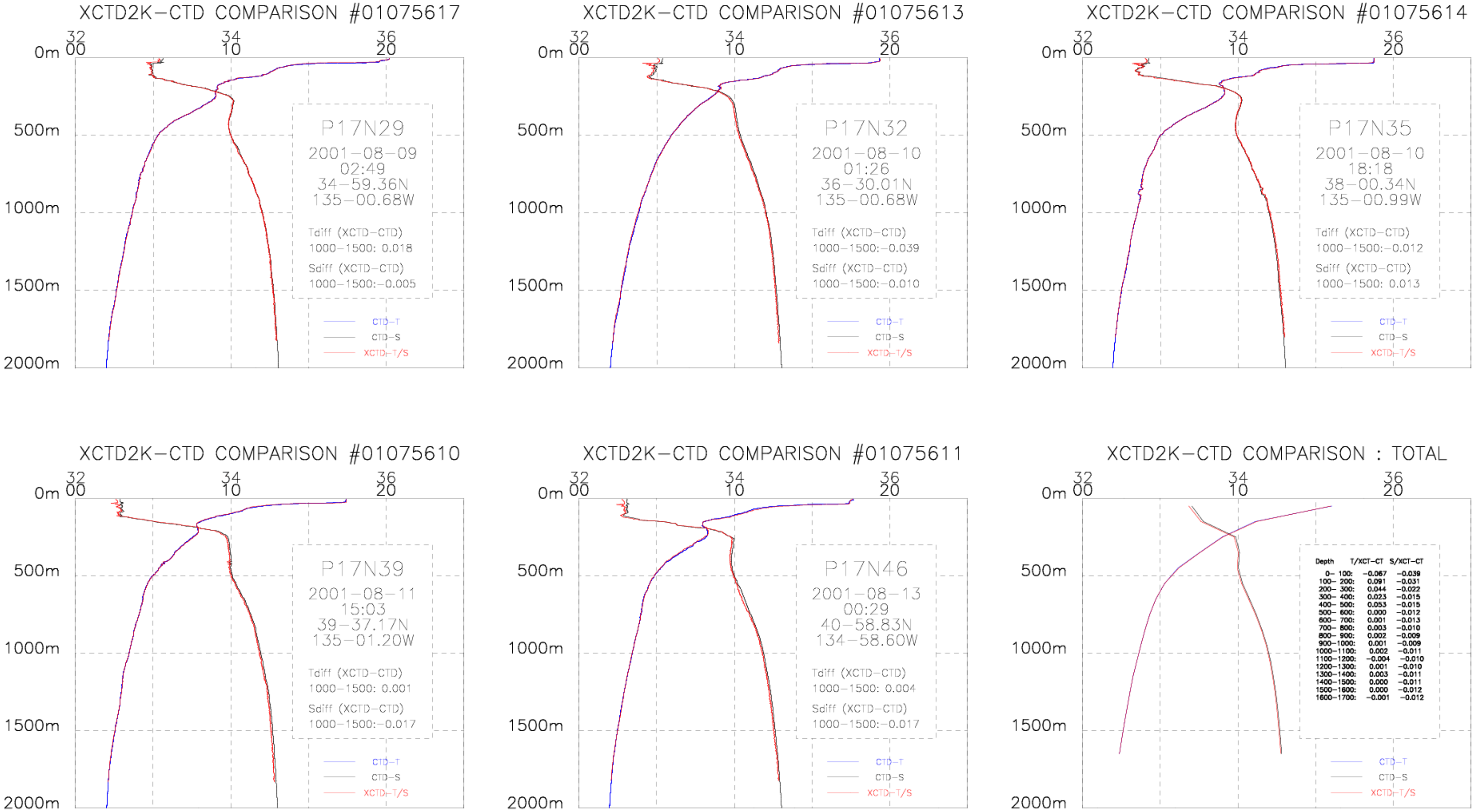
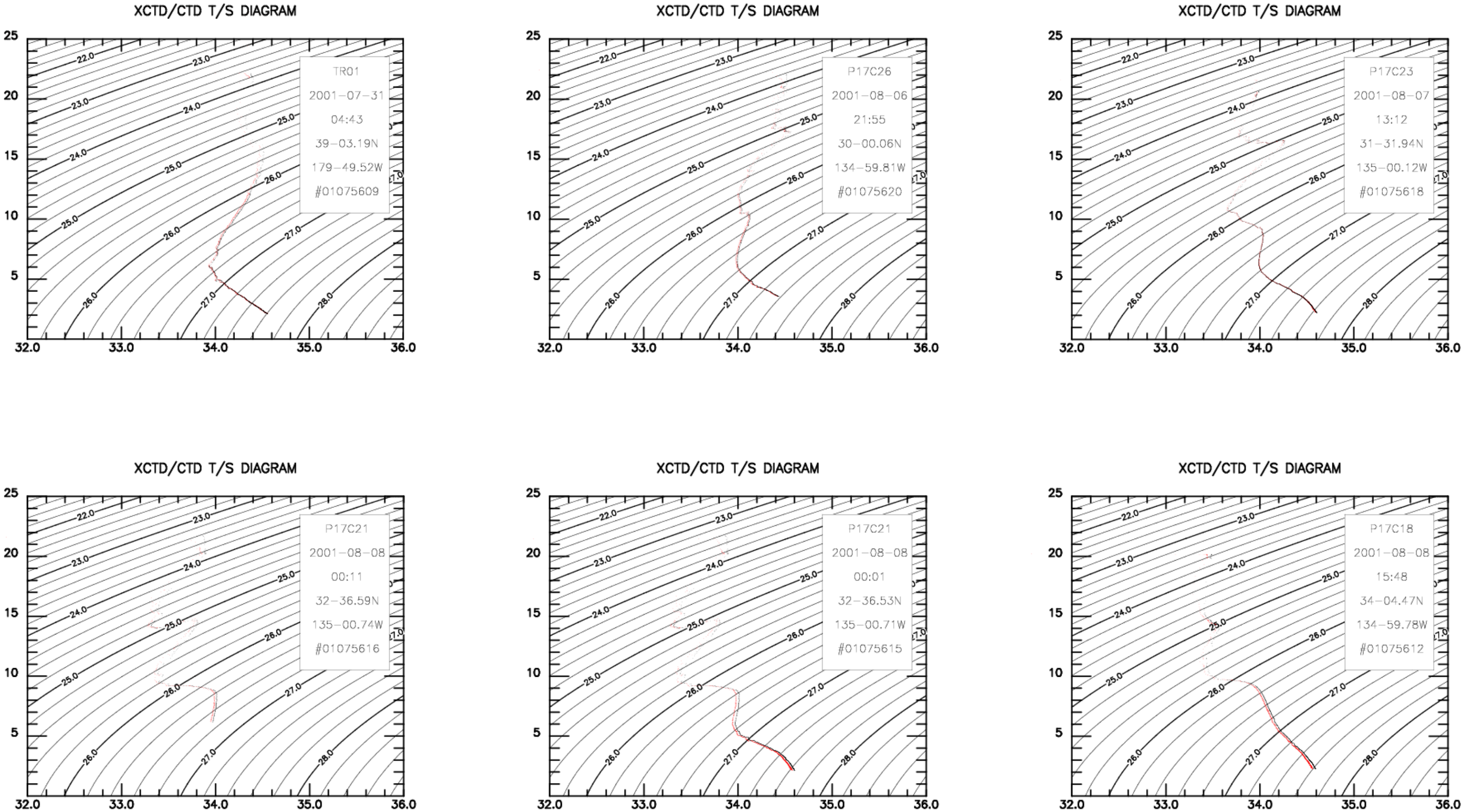

XCTD2K−CTD COMPARISON #01075617
P17N29
2001−08−09
02:49
34−59.36N
135−00.68W
Tdiff (XCTD−CTD)
1000−1500: 0.018
Sdiff (XCTD−CTD)
1000−1500:−0.005
XCTD2K−CTD COMPARISON #01075613
P17N32
2001−08−10
01:26
36−30.01N
135−00.68W
Tdiff (XCTD−CTD)
1000−1500:−0.039
Sdiff (XCTD−CTD)
1000−1500:−0.010
XCTD2K−CTD COMPARISON #01075614
P17N35
2001−08−10
18:18
38−00.34N
135−00.99W
Tdiff (XCTD−CTD)
1000−1500:−0.012
Sdiff (XCTD−CTD)
1000−1500: 0.013
XCTD2K−CTD COMPARISON #01075610
P17N39
2001−08−11
15:03
39−37.17N
135−01.20W
Tdiff (XCTD−CTD)
1000−1500: 0.001
Sdiff (XCTD−CTD)
1000−1500:−0.017
XCTD2K−CTD COMPARISON #01075611
P17N46
2001−08−13
00:29
40−58.83N
134−58.60W
Tdiff (XCTD−CTD)
1000−1500: 0.004
Sdiff (XCTD−CTD)
1000−1500:−0.017
XCTD2K−CTD COMPARISON : TOTAL
Depth T/XCT−CT S/XCT−CT
0− 100: −0.067 −0.039
100− 200: 0.091 −0.031
200− 300: 0.044 −0.022
300− 400: 0.023 −0.015
400− 500: 0.053 −0.015
500− 600: 0.000 −0.012
600− 700: 0.001 −0.013
700− 800: 0.003 −0.010
800− 900: 0.002 −0.009
900−1000: 0.001 −0.009
1000−1100: 0.002 −0.011
1100−1200: −0.004 −0.010
1200−1300: 0.001 −0.010
1300−1400: 0.003 −0.011
1400−1500: 0.000 −0.011
1500−1600: 0.000 −0.012
1600−1700: −0.001 −0.012
0m
500m
1000m
1500m
2000m
32 34 36
00 10 20
CTD−T
CTD−S
XCTD−T/S

Figure 4



XCTD/CTD T/S DIAGRAM
TR01
2001-07-31
04:43
39-03.19N
179-49.52W
#01075609
XCTD/CTD T/S DIAGRAM
P17C26
2001-08-06
21:55
30-00.06N
134-59.81W
#01075620
XCTD/CTD T/S DIAGRAM
P17C23
2001-08-07
13:12
31-31.94N
135-00.12W
#01075618
XCTD/CTD T/S DIAGRAM
P17C21
2001-08-08
00:11
32-36.59N
135-00.74W
#01075616
XCTD/CTD T/S DIAGRAM
P17C21
2001-08-08
00:01
32-36.53N
135-00.71W
#01075615
XCTD/CTD T/S DIAGRAM
P17C18
2001-08-08
15:48
34-04.47N
134-59.78W
#01075612
32.0
33.0
34.0
35.0
36.0
5
10
15
20
25

Figure 4

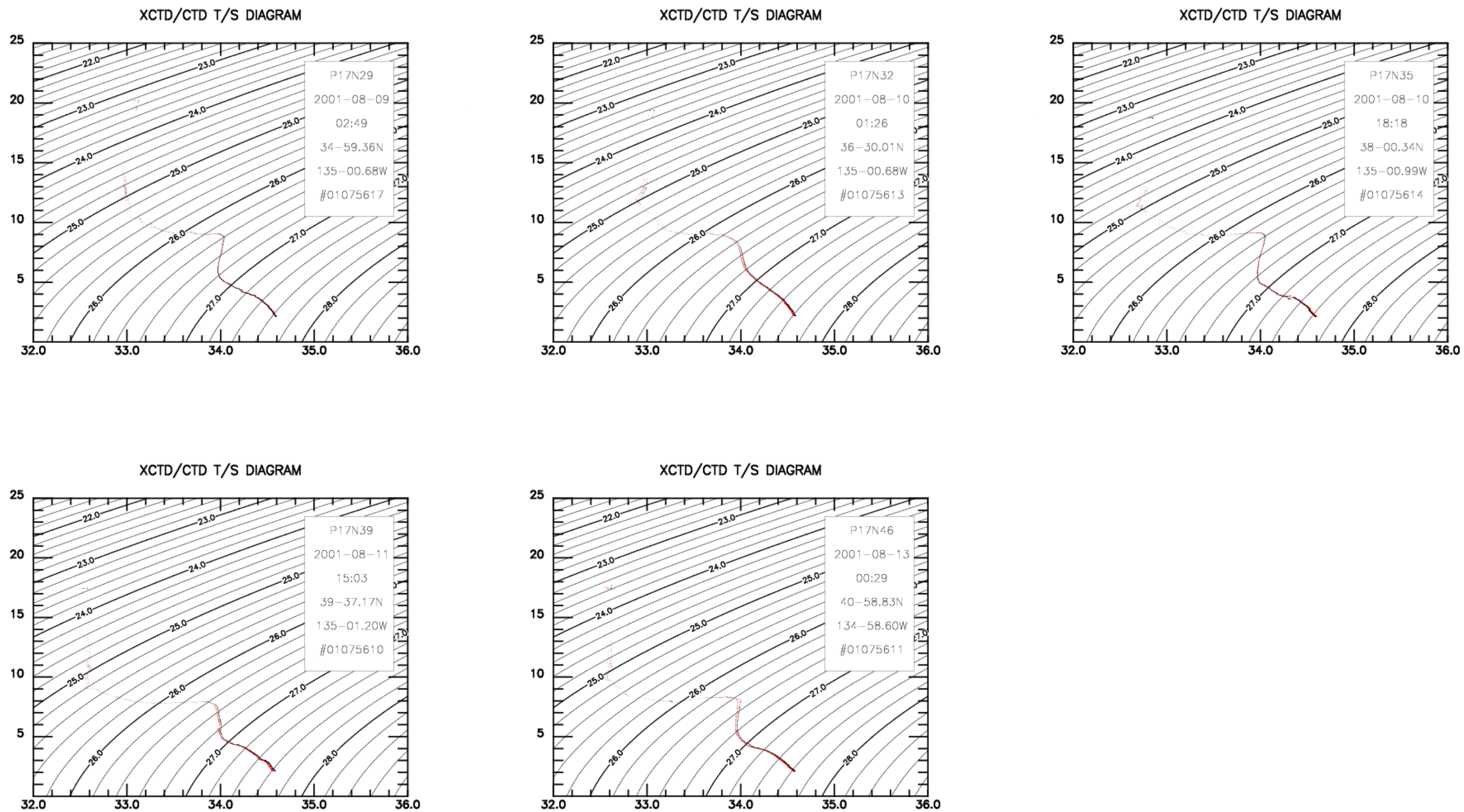
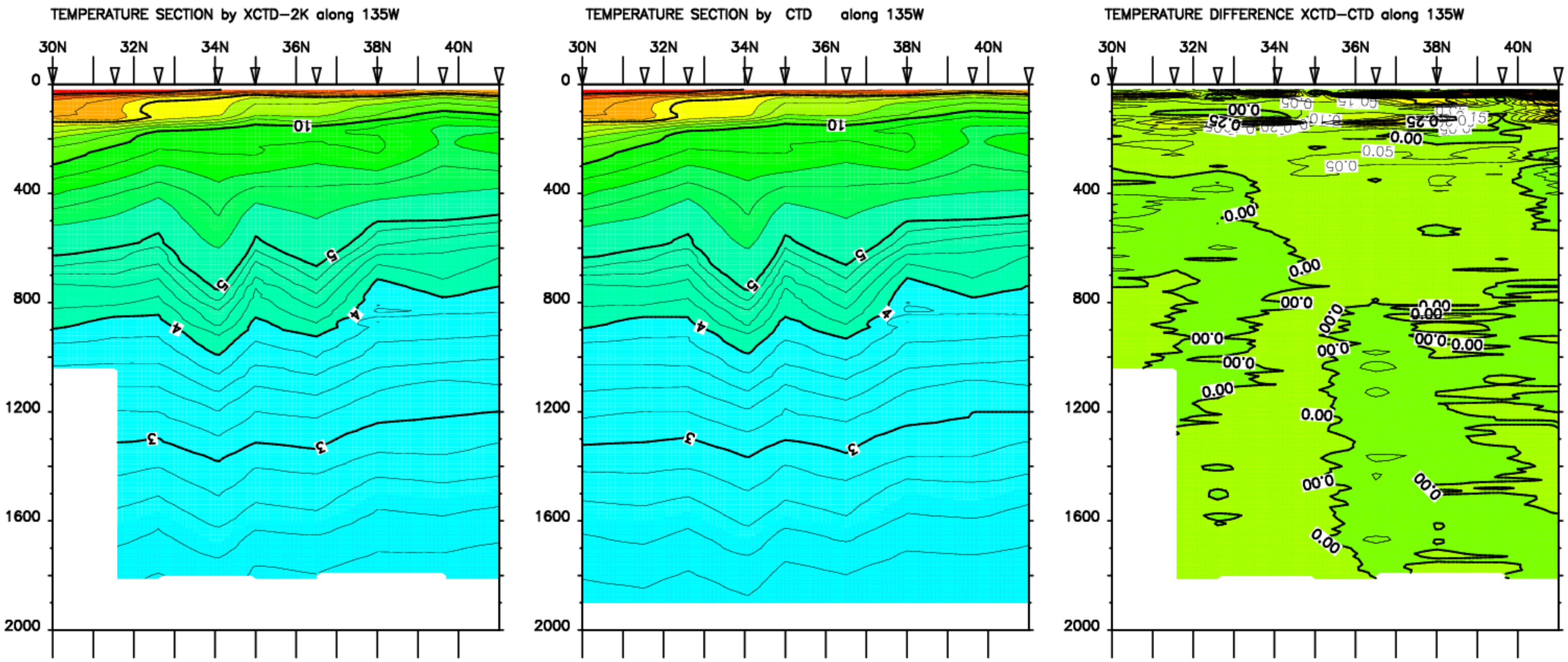
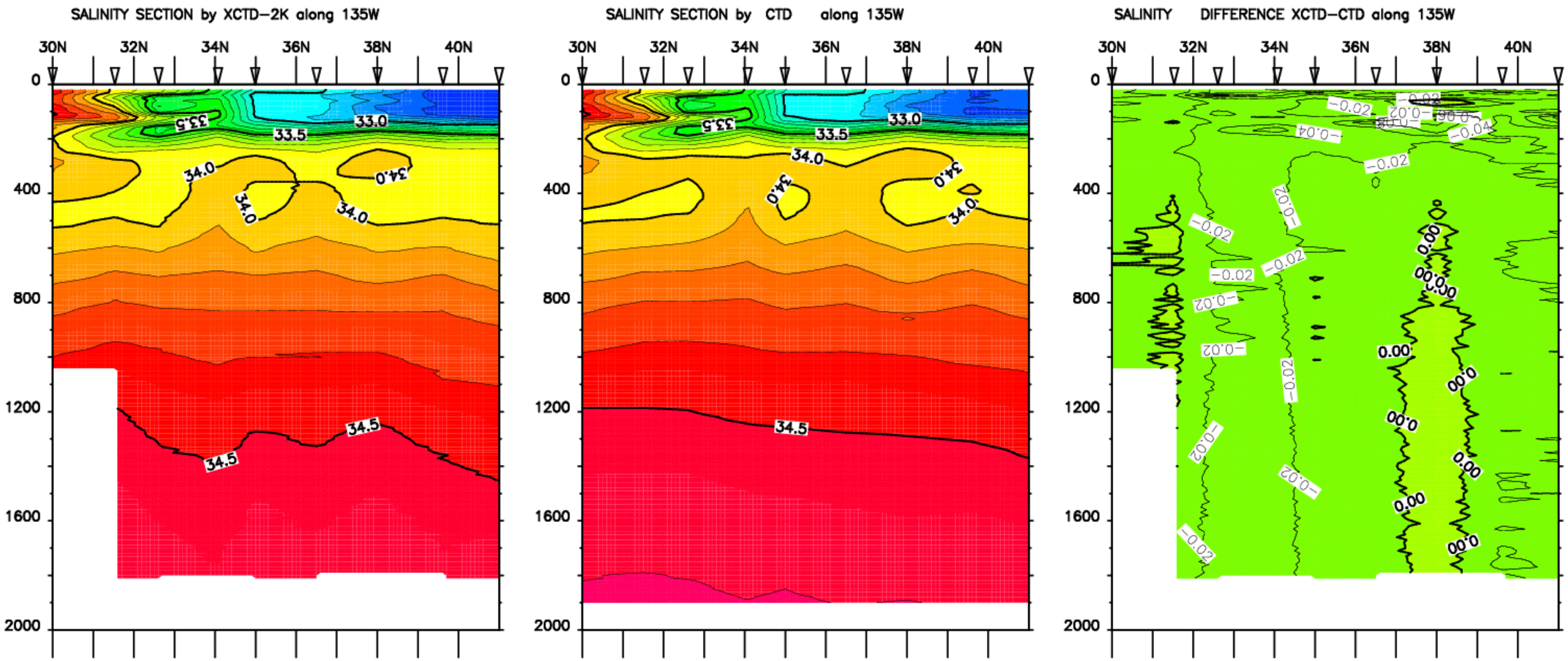

XCTD/CTD T/S DIAGRAM
P17N29
2001-08-09
02:49
34-59.36N
135-00.68W
#01075617
XCTD/CTD T/S DIAGRAM
P17N32
2001-08-10
01:26
36-30.01N
135-00.68W
#01075613
XCTD/CTD T/S DIAGRAM
P17N35
2001-08-10
18:18
38-00.34N
135-00.99W
#01075614
XCTD/CTD T/S DIAGRAM
P17N39
2001-08-11
15:03
39-37.17N
135-01.20W
#01075610
XCTD/CTD T/S DIAGRAM
P17N46
2001-08-13
00:29
40-58.83N
134-58.60W
#01075611

Figure 5



TEMPERATURE SECTION by XCTD-2K along 135W
TEMPERATURE SECTION by CTD along 135W
TEMPERATURE DIFFERENCE XCTD-CTD along 135W
30N
32N
34N
36N
38N
40N
0
400
800
1200
1600
2000
10
5
4
3
0.00
0.05
0.25

Figure 6


SALINITY SECTION by XCTD−2K along 135W
SALINITY SECTION by CTD along 135W
SALINITY DIFFERENCE XCTD−CTD along 135W
30N
32N
34N
36N
38N
40N
0
400
800
1200
1600
2000
33.0
33.5
34.0
34.5
−0.02
−0.04
0.00

Collection and evaluation of marine observations from the International SeaKeepers Society Autonomous VOS Fleet

Edward J. Kearns[1], Steven Browdy, Rupert Minnett, Christine Caruso-Magee, Geoffrey K. Morrison and Rod G. Zika

The non-profit International SeaKeepers Society was founded by environmentally minded owners of large yachts. They had a strong interest in the health of the oceans and waterways, and were willing to equip their personal vessels with instruments to contribute to scientific research. The autonomous Ocean and Weather Monitoring system collects and transmits weather information and sea surface temperature (SST) every three hours to NWSTG for use by the National Weather Service for forecasting. More extensive data: temperature, conductivity, dissolved oxygen, pH, and Eh, together with relative wind speed and direction, air temperature, relative humidity, barometric pressure, ships position, speed and heading are recorded to the computer hard drive every minute for later downloading to the SeaKeepers database. Today, with the continued support of our founding members, we are becoming involved in equipping commercial vessels, cruise ships, piers and buoys with autonomous ocean and weather monitoring systems.. The data described in this paper are heavily weighted toward cruise ships which operate 24 hours per day and 7 days per week.

The instrumentation installed upon all of these vessels and observing platforms is essentially Identical. Figure 1 shows the components of the system. The computer and instrument modules are stainless steel NEMA-4 enclosures, which can be mounted in a variety of configurations. An INMARSAT std-C transceiver is housed in the computer module. The software collects the data and automatically sends a data message which encodes the 10 minute average immediately before the transmission time for each reporting sensor and sends it to the SeaKeepers data center at the University of Miami.

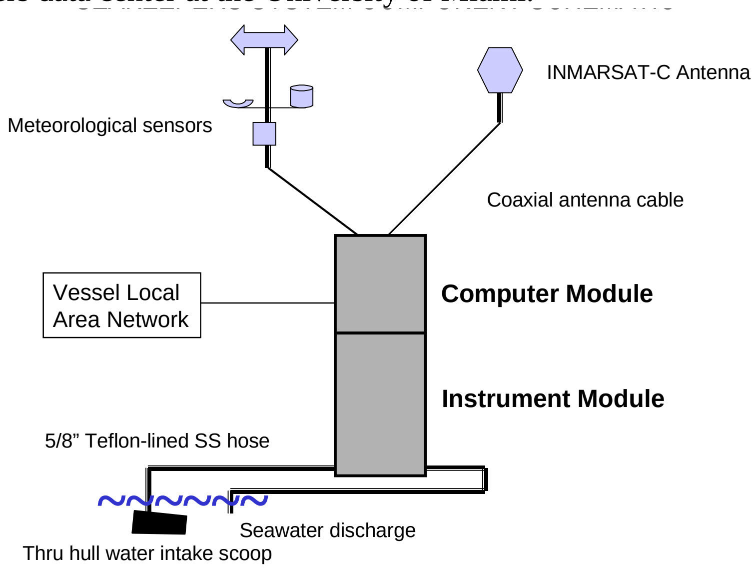


Figure 1. Schematic of the SeaKeepers Ocean and Weather Monitoring System.

[1] University of Miami, 4600 Rickenbacker Causeway, Miami FL 33149

From selected vessels (13 out of 40+ at the time of this report), a subset of these data are formatted in standard WMO FM-13 and FM-62 messages at RSMAS and sent to NWSTG, and then routed to GTS and other locations. Figure 2 shows the position for observations delivered to NWS during 2001. Other systems are being added to the reporting group as their software is upgraded and field tested. The vessels, and other SeaKeepers systems on fixed platforms, are assigned call signs in the format KS*nnn*, to preserve anonymity for the owners of superyachts. The full data set (averaged and high-resolution) will be available at SeaKeepers Web-based data server for use by scientists and educators.

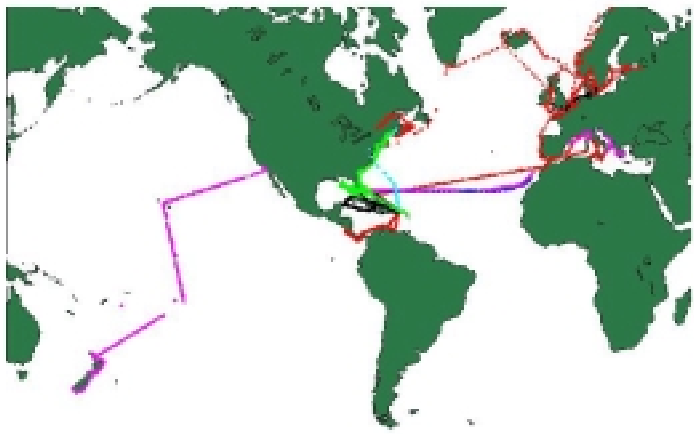


Figure 2. Map of SeaKeepers observations delivered to NWS during 2001.

Membership in the International SeaKeepers Society has continued to grow. Systems are operating on three cruise ships, two research vessels, 30 yachts, a pier, and are being installed in new yachts, commercial tankers. A low-energy version is being developed for fixed buoys, in cooperation with the National Data Buoy Center (NDBC).

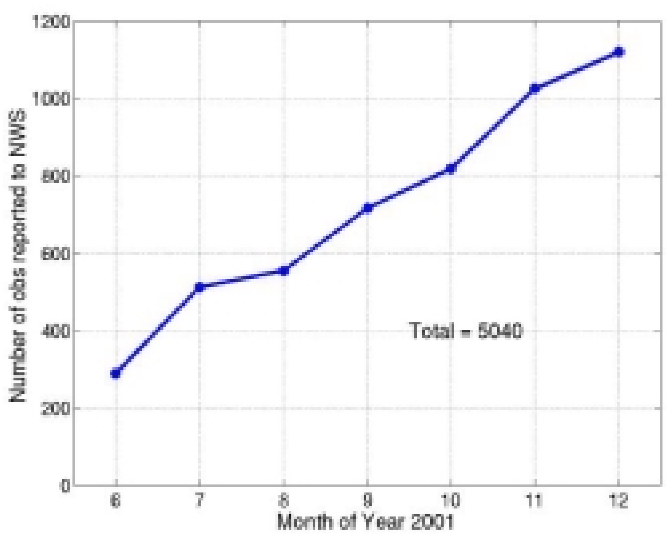
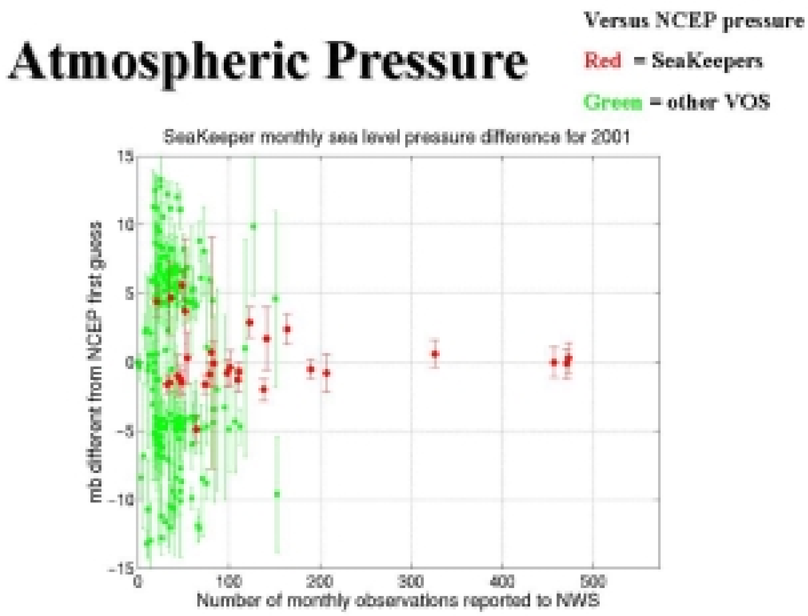


Figure 3. Number of weather observations reported from SeaKeepers vessels by month.

Data Analysis

Each point in the following series of graphs represents one vessel, the error bars represent the repeatability of the data from that vessel. The "Y" axis on each graph represents the average difference from the NCEP model, while the "X" axis indicates the number of observations reported from that ship.



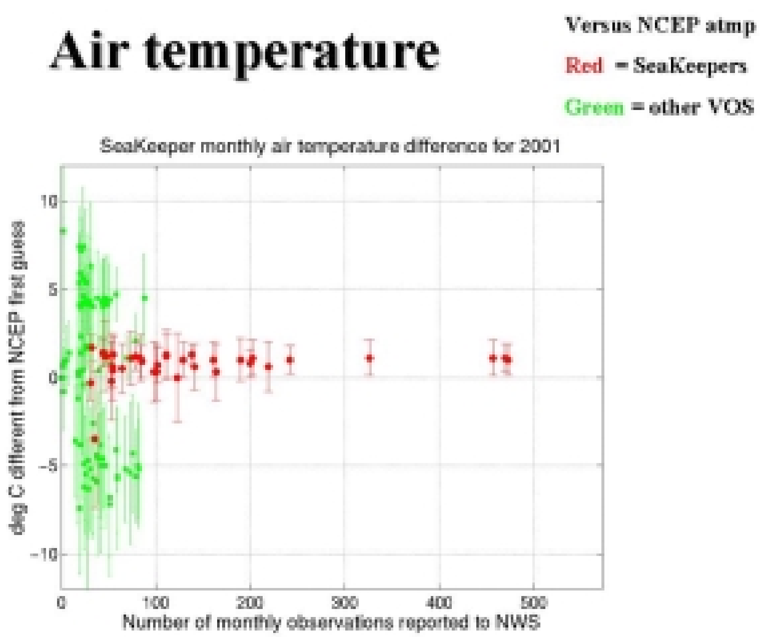


Figure 4. Comparison of SeaKeepers and VOS fleet data to the NCEP model predictions

It is immediately apparent that the SeaKeepers data shows excellent accuracy, data repeatability, and data quantity for atmospheric temperature and pressure (figure 4). Wind speed and direction observations (figure 5)are more difficult, and while the SeaKeepers data compares well with the entire VOS fleet, the quality is not as good as the pressure and temperature data when compared to the NCEP model. We believe that this problem is attributable to several different sources and we shall attempt to explore some of them here.

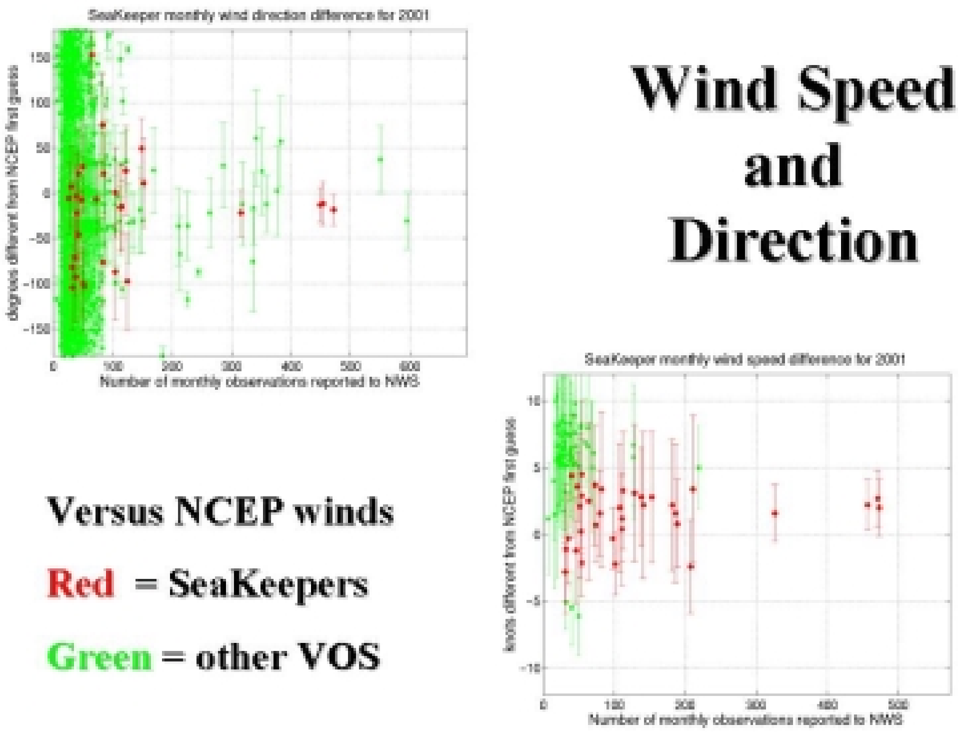


Figure 5. Comparison of SeaKeepers and the VOS fleet wind data to the NCEP predictions

With one or two notable exceptions, the wind speed and direction error rates are higher near shore, the area where one would expect the NCEP open ocean models to be least reliable (Figure 6)

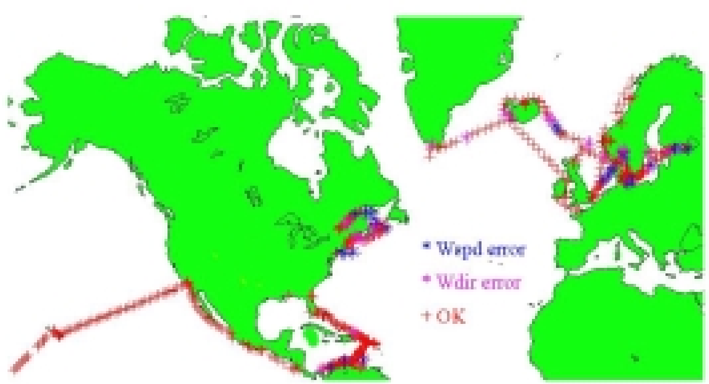


Figure 6. Topographic influence on gross wind error

There is a better correlation between the SeaKeepers data and QuikSCAT satellite winds and a strong inverse correlation between difference between the observed values and those predicted by the models with distance from the coast (Figure 7).

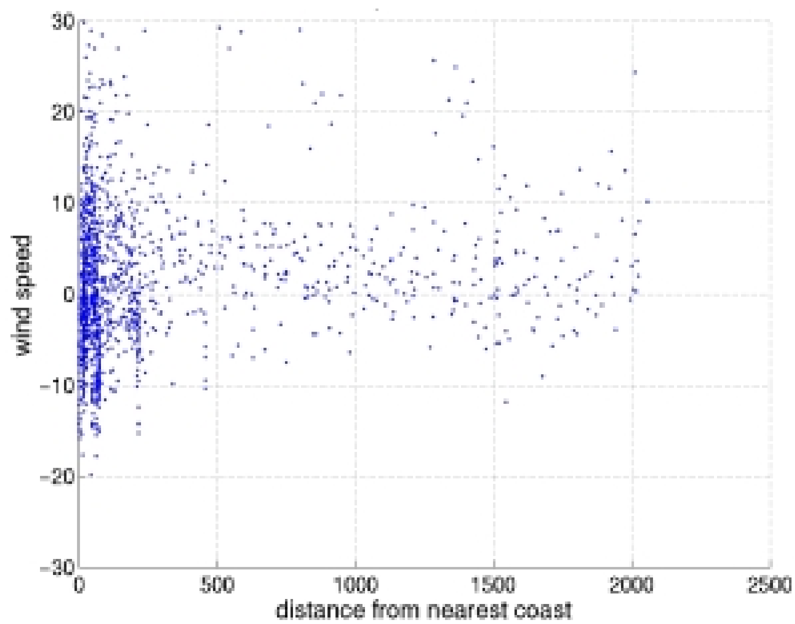


Figure 7. Wind Speed difference from QuikSCAT model predictions, for all SeaKeepers vessels

We have singled out one vessel, Carnival Triumph, whose repetitive course and apparent large measured differences have made us suspicious. The lowest quality is indicated wind direction , wind speed differences being localized to near the Cuban coast where presumably other sources of wind observation are limited. The high incidence of large direction differences on the southeasterly outbound leg of the Eastern Caribbean route led us to more closely examine the placement of the anemometer. There appears, from examination of wind speed and wind direction differences vs relative wind direction, to be a total absence of reported wind from 150 to 350 degrees relative to the bow of the vessel. A vessel steaming at 20 knots, as this one routinely does, would not be expected to report much in the way of relative wind from 90 to 270 degrees. The absence of incident winds in the 270 to 359 quadrant was surprising until we more closely examined the location of the wind sensor relative to a 4 inch diameter tripod mast which sits in exactly this quadrant relative to the wind sensor (Figure 8.). The anemometer will be repositioned and this type of data analysis repeated to quantify the effect.

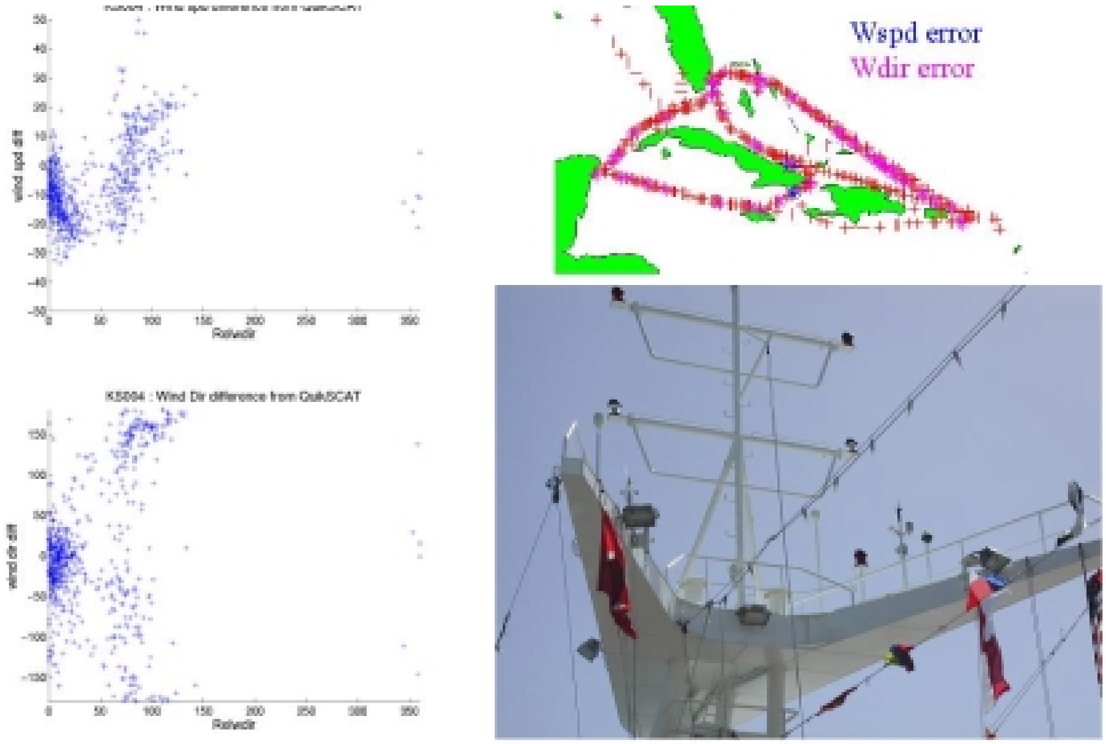


Figure 8. Wind bias in observations from Carnival Triumph

Generally the SeaKeepers Sea Surface temperature data is good and in excellent agreement with the NCEP model Figure 9). The small bias on the more numerous reporting ships could be an indication of the nonrepresentative depth of measurements on the cruise ships, typically 7 to 10 meters below sea level. For all high data volume vessels, the night time agreement is superior to the daytime data sets indicating that diurnal surface heating could be playing a significant role Figure 10)..

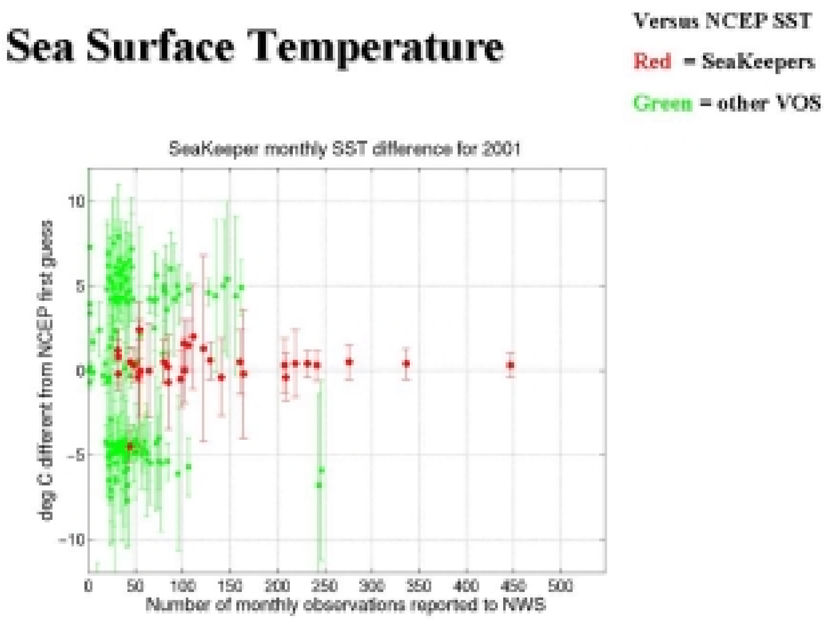


Figure 9. Sea Surface Temperature observations compared to the NCEP model

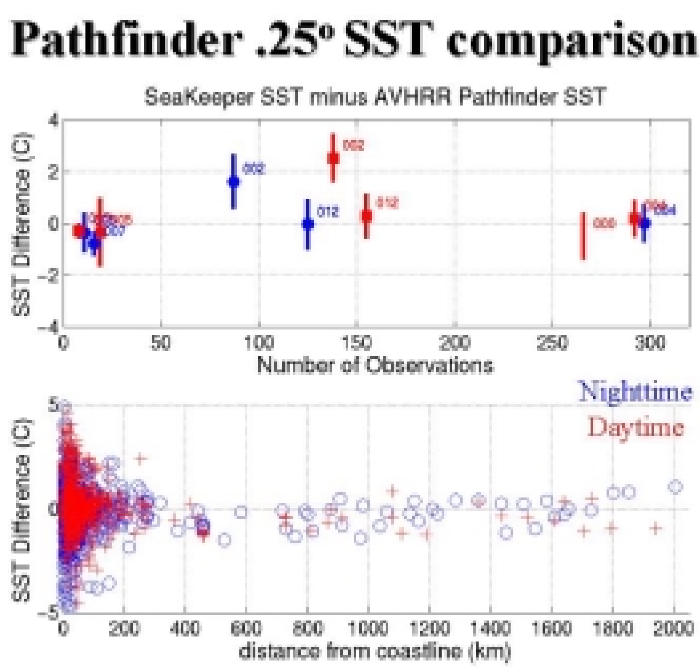


Figure 10. Day/night errors comparison. The numbers on the upper plot identify specific SeaKeepers vessels by call sign.

Future directions:

- Improve quality control procedures
- Expand the number of SeaKeepers systems reporting to the NWS.
- Deployments in coastal moored buoys and piers.
- Installations on more freighters and container ships, for routine continuous reporting.

Summary

The international fleet of SeaKeepers vessels are now routinely collecting large numbers of good quality meteorological and oceanographic measurements. The data are being delivered shoreside in real time. While the observations are “good” compared to the VOS fleet in general, these measurements can be made better by improved QA/QC procedures and identifying problems with particular vessels. Continued and expanded deployments of the SeaKeepers instrument system is warranted, and should provide a large database of world-wide oceanographic and meteorological observations. A particular value of the use of private yachts as volunteer observing platforms is the opportunity to collect data from less frequented areas of the oceans, away from shipping lanes and major commercial ports.

The Accuracy of Voluntary Observing Ships' Marine Meteorological Observations

Elizabeth C. Kent and Peter K. Taylor

Southampton Oceanography Centre, Southampton, UK

Abstract

Typically the merchant ships of the Voluntary Observing Ships scheme are recruited by a Port Meteorological Officer at a port which the ship frequently visits. The observing practises and meteorological instruments provided depend on the recruiting country and are often very basic. Indeed, the VOS system was primarily designed to aid weather forecasting, while climate change studies require higher quality data. A better understanding of the error characteristics of the VOS data is now needed for both data assimilation and climate studies.

Using sea and air temperatures as an example, this talk will show how the large random errors present in the data can be quantified. Determining the smaller, systematic biases is more difficult because correlations exist between the different variables and their respective errors. For example, the error in SST data measured using buckets is likely to depend on the air - sea temperature difference, and hence on both sea and air temperatures. Surprisingly the scatter in the air temperature data seems to vary with how the SST is measured, probably because the observing practises strongly depend on recruiting country. By transforming the data to form new variables which are uncorrelated, the systematic errors can be properly estimated and then transformed back in terms of the observed quantities. The results suggest that, while SST data from engine room intake (ERI) thermometers are very scattered, any mean bias is small. In contrast, while bucket SST data is less scattered, it is biased cold in regions of high heat flux. Previously it had been assumed that ERI data were biased warm. A report detailing the preliminary results of these studies can be downloaded from: http://www.soc.soton.ac.uk/JRD/MET/PDF/goa.pdf

Improving the quality of future VOS data requires fuller information on instrumentation and observing techniques, and the implementation of good observing practises. These are goals of the WMO sponsored VOS subset for climate (VOSClim). Eventually it is hoped to introduce better instrumentation. For example, hull contact SST sensors installed with acoustic data transmission rather than cables. The IMET project at Woods Hole Oceanographic Institute and the AutoFlux system (developed by SOC with European partners) are prototypes for future VOS instrumentation systems.

An observation stragegy over the Atlantic

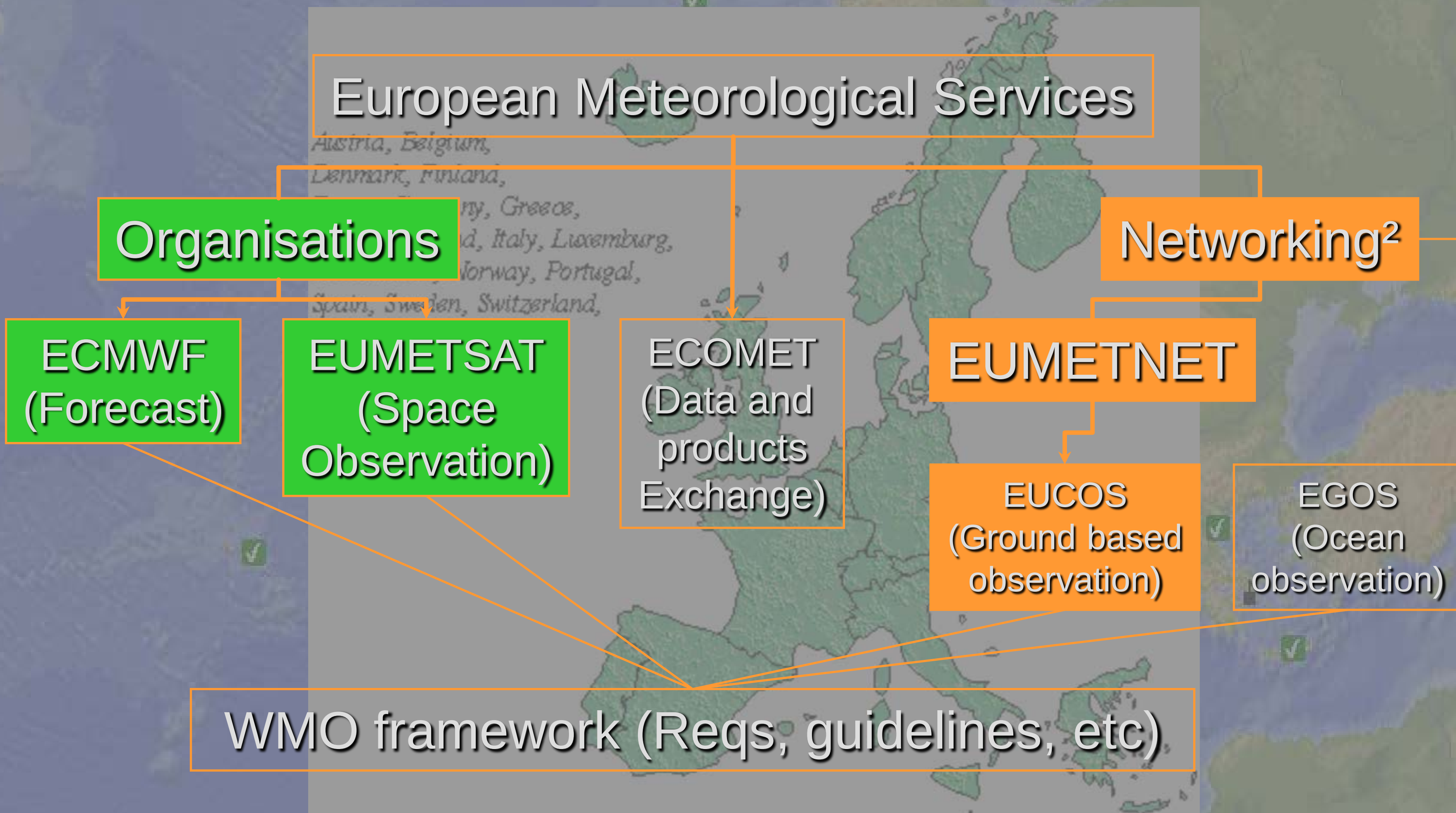
Presentation to SOT meeting

Goa, India 26 Feb 2002

By

François Gérard, Météo-France

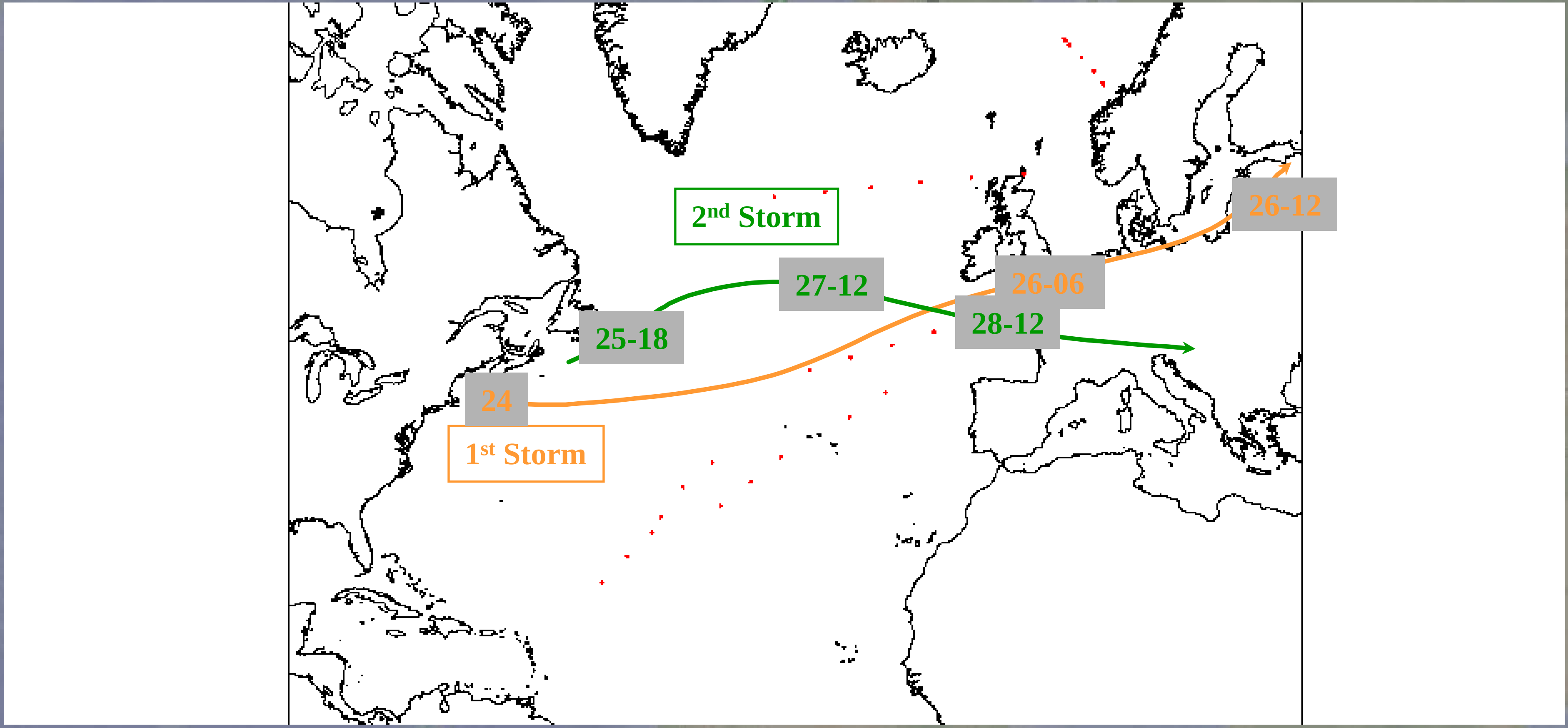
European Co-operations in Meteorology



What is EUCOS?

- **An observing system designed for the support of short-term GNWP (24-72h) over Europe ;**
- **An evolutive system ;**
  - Technical evolutions in ground based observation techniques ;
  - Expected space segment evolutions ;
  - Evolving requirements of GNWP
- **A mechanism for co-operative definition, implementation and operation of that observing system ;**
- **An implementation Programme (1999-2001) having led to the above through**
  - observing system experiments and sensitivity studies,
  - cost benefit assessments,

Present oceanic undersampling



EUCOS extension over sensitive areas

EUCOS-0.5
Extension
with new profile and level data
in areas sensitive for
weather prediction
over Europe

TO

Present system

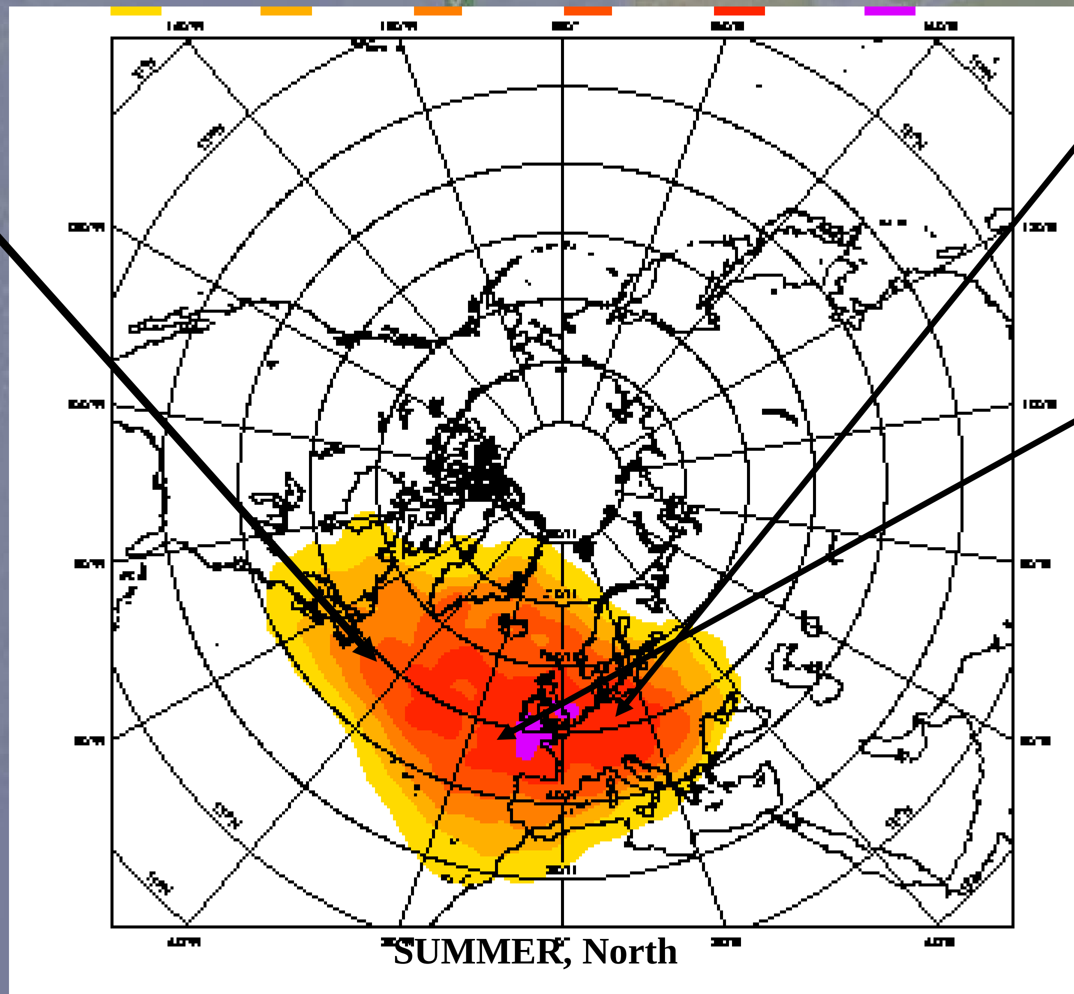
- HYPOTHESIS:
  - ✓ **Addition of profile or level data in sensitive areas may improve efficiency of the system.**
- TOOLS:
  - ✓ **Climatology of sensitive areas**
  - ✓ **Pilot projects (ASAP)**
  - ✓ **Ceiling : 5 M€/yr**

… Results for the North

Winter sensitivity maxima confirmed

Maximum sensitivity layer :

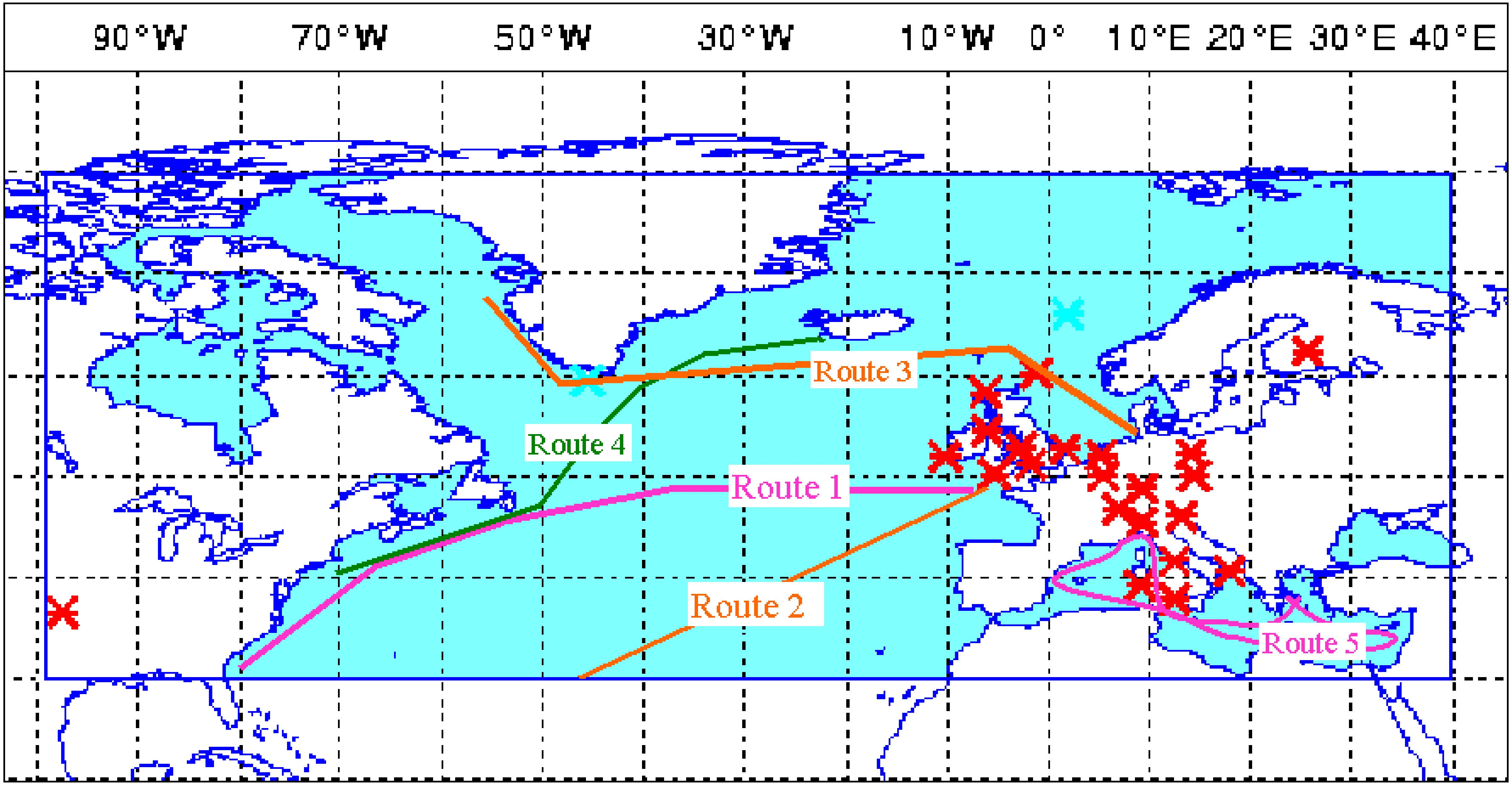
700 – 400 hPa



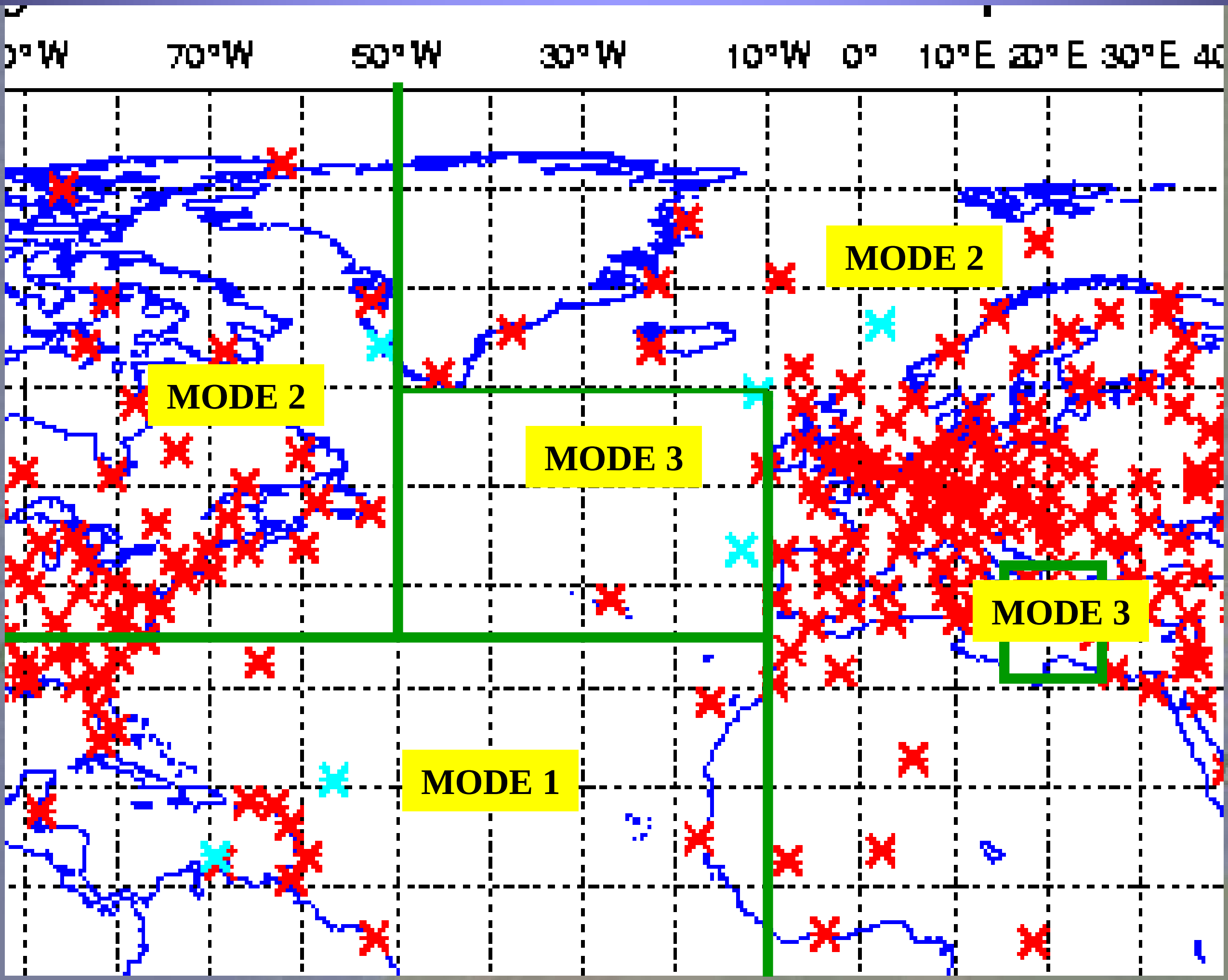
Europe is also a sensitive Area !!

Eastward shift of maximum sensitivity patterns in summer Towards an area also identified by case studies

Guidelines for EUCOS over the Ocean



Variable operation mode



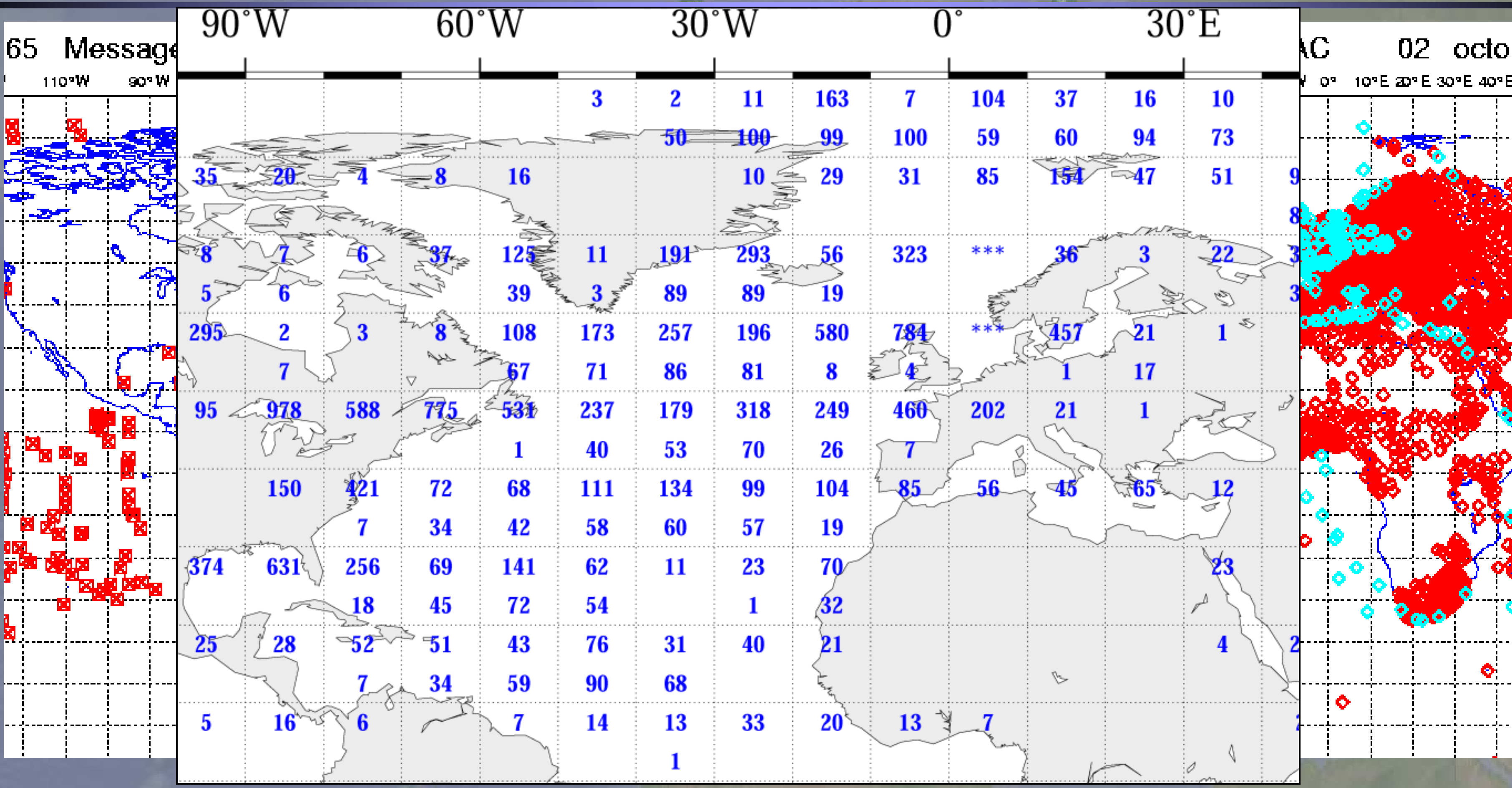
Results of the experiment

		Evolution : Sep-Oct / Jun-Jul				
Name	**Call Sgn**	**00**	**06**	**12**	**18**	**Total**
Hornbay	ELML7	-10	10	-3	9	6
Fort Royal	FNOR	5		-2	7	10
Fort Fleur d'Epée	FNOU	3		1	8	12
Fort Desaix	FNPH	-15		-3	6	-12
Douce France	FNRS	1	3	-2	8	10
Arina Arctica	OVYA2	-6	8	3	1	6
Nuka Arctica	OXYH2	-2	8	2	14	22
Peljasper	SWJS	3	6	4	9	22
Lagarfoss	V2XO	12	12	11	11	46
Sealand Achiever	WPKD	7	7	1	5	20
Canmar Pride	ZCBP6	4		-1	13	16
	Total	**2**	**54**	**11**	**91**	**158**

Conclusion of the experiment

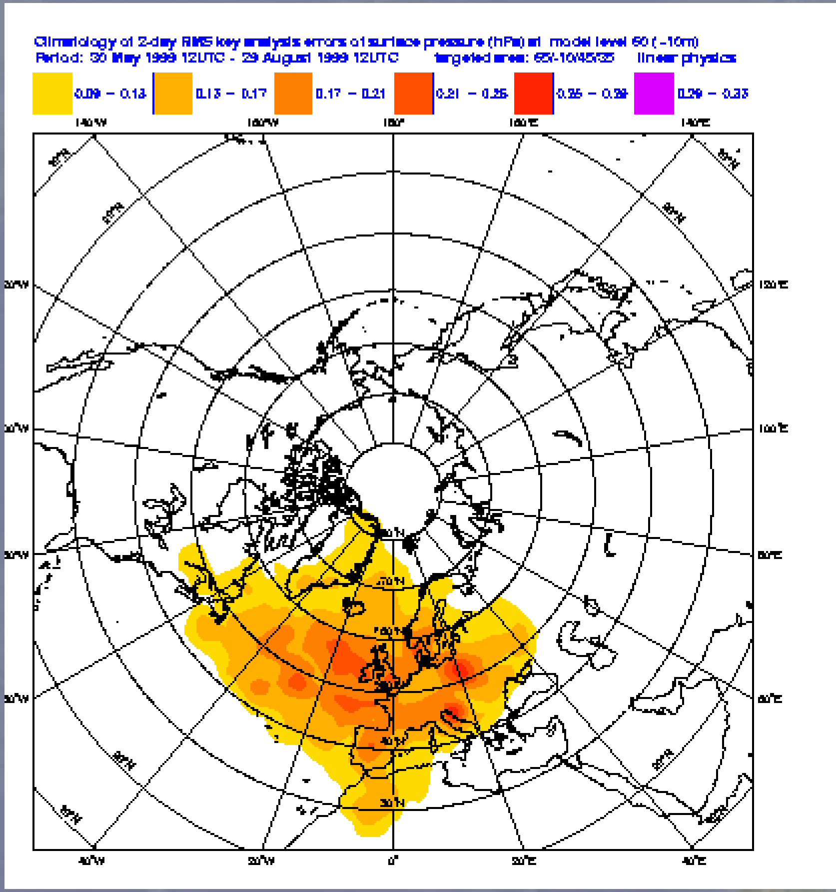
- **Implementing-location dependent operations is feasible and recommended;**
- **The E-ASAP ships are implementing this observation strategy;**
- **Next steps :**
  - ✓ Test a time dependent operations using targeting tools,
  - ✓ An experiment is planned under EUCOS for end 2002 or beginning of 2003

Surface observation today

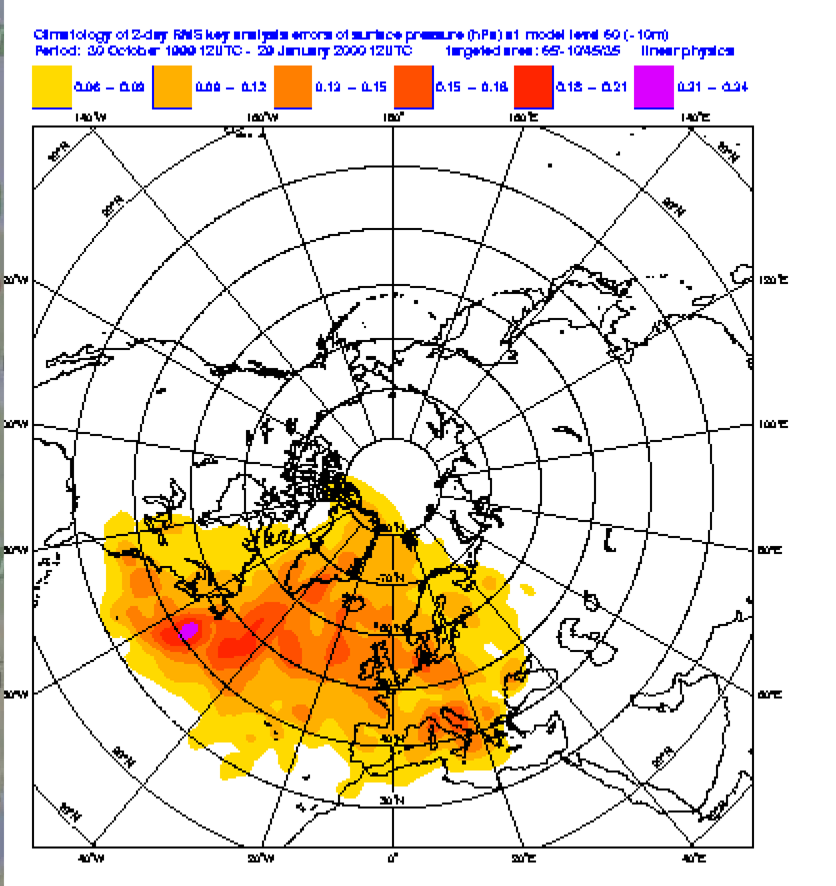


Need to co-ordinate and target surface observation

Surface Pressure sensitivity North



SUMMER



WINTER

EUCOS requirements…

- **From NWP requirements**
  - ✓ The signal of surface pressure is small on the average, but is likely to increase according to developments in data assimilation and physics modelling
- **Impact of data from buoys (and ships) on synoptic forecast is obvious on some cases**
- **Results call for developing targeted observation from buoys :**
  - ✓ Winter / Summer deployment ;
  - ✓ On request Activation / Desactivation ;
- **Targeted observation strategies to be developed**

CONCLUSIONS

- **Sensitivity and impact studies enable to identify where to increase the observation effort over the Atlantic;**
- **Implementing location-dependent observation from ships is feasible;**
- **Time-sependent targeting has still to be demonstrated :**
  - ✓ EUCOS studies programme;
  - ✓ THORPEX offers a framework;
- **Co-operation increases cost-efficiency of obs systems**

SCIENTIFIC AND TECHNICAL WORKSHOP OF
THE JCOMM SHIP OBSERVATIONS TEAM
Goa, India, 26 February 2002

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