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OBSERVING
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Report of Meetings of Experts and Equivalent Bodies

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ANNEXES

1. OPENING

The second session of the Ocean Observations Panel for Climate (OOPC) was hosted by the University of Cape Town, Cape Town, South Africa, 11-13 February 1997. John Field welcomed the Panel on behalf of the University and provided some history of the development of the University. He mentioned that the building we were in was once a jail in the 19th century.

Neville Smith, Chairman OOPC, also welcomed the participants. All members of the Panel were present except Gwyn Griffiths, and Ed Harrison. Harrison suffered an injury in Miami, Florida, en route to Cape Town that resulted in his cancelling out. Invited guests included M. Lefebvre, T Spence, Eugene Burger, Geoff Brundrit, Vere Shannon, and Mark Jury. The complete list of attendees is given in Annex II.

2. REVIEW AND ADOPTION OF THE AGENDA

Panel Members were invited to comment on the provisional agenda. The final adopted agenda is given in Annex I.

3. CHAIRMAN'S REVIEW

Smith gave his retrospective appraisal of the first meeting of the OOPC and events since. He saw a need for particular emphasis on sea ice and sea-ice observation technology and planned to focus on this next year. He believed that the OOPC was lacking expertise in this and other important areas such as the Ship of Opportunity XBT program. Steps would have to be considered to address this, perhaps by adding a new member or by arranging guest experts to attend meetings devoted to a specific subject area. In passing, Smith mentioned his hope to persuade J-GOOS to take a more active oversight/guidance role with all the Module Panels and to provide feedback to them. He noted the importance of modelling to all the modules.

Smith then briefly reviewed the action items arising from OOPC-I, and identified the key items in the agenda that he wanted to emphasize. Planning and organizing of the Time Series Workshop scheduled for March 1997 was moving along well. None of the planned "end-to-end" illustrative examples had been completed to brochure stage but there was growing evidence of their need. The success and high accuracy of TOPEX-POSEIDON clearly called for a revision of the OOSDP report on the impact and feasibility of its applications.

4. RELATED DEVELOPMENTS AND MEETINGS

4.1 J-GOOS

Neville Smith noted that J-GOOS was pleased with the fast start that OOPC had made and encouraged the Panel to move ahead with the strategy outlined in its report. The full report of J-GOOS-III had been made available to participants of this meeting some time earlier. Smith noted that J-GOOS had commissioned the preparation of a J-GOOS Plan by Peter Ryder. This plan, a sort of prospectus targeted to the stakeholders in GOOS, will explain GOOS in terms of why it is a good investment. It will also lay out a framework, address priorities and provide implementation plan guidelines with the aim of getting the stakeholders in GOOS entrained and on board as committed participants in realizing an operational GOOS.

4.1.1 Planning Meeting for the J-GOOS Plan

Arthur Alexiou explained that at different stages of its development, a small ad hoc Planning Group (including himself and representatives from I-GOOS, ICSU and NOAA) would meet to provide guidance to Peter Ryder during the course of his writing of the document. The first meeting was convened by John Woods in London, 24-25 November 1996. The background, scope and chapter outline were the chief agenda items. When a first draft is completed, the sponsors would be looking for feedback from implementing agencies to be incorporated in the final draft, thus making them partners in the preparation of the document. The current intention is to use the document in connection with a high-level “agreements meeting” being considered for next summer, perhaps at the ministerial level in connection with the “Year of the Ocean”, to have nations “sign on” to GOOS (see section 4.2).

4.2 I-GOOS

George Needler reported on the I-GOOS meeting held in Washington D.C. in December 1996. Discussions focussed on a survey of ocean and met services and the plan for a GOOS Priorities Agreements Meeting (initiated originally by the U.S.). This plan for this Priorities Agreements meeting was superseded by planning for the GOOS Agreements Meeting (see section 4.1.1) that will request nations to agree to a set of GOOS “principles” and to commit to implementation of selected elements of GOOS that could proceed immediately. The meeting was expected to take place within a year. Needler was one of several key contributors to the drafting of the principles.

4.3 GCOS JSTC

Spence reported on the GCOS JSTC-6 meeting in Canada and noted the discussions that related to the work of the OOPC. The JSTC reviewed the results of OOPC-I and fully supported the OOPC plans for producing the end-to-end “brochures”, commissioning reports and developing meetings. It was particularly gratified to see progress on the Time Series of Ocean Observations Workshop. Spence noted the JSTC provided encouragement to the OOPC to continue its efforts toward implementation through close cooperation with implementing groups/bodies.

4.3.1 Participating Countries Meeting

Spence reviewed the JSTC plans for a GCOS ”Participating Countries” meeting. He noted the central role of the OOPC in providing the ocean climate perspective in the overall climate problem. Based on the “Climate Agenda”, the meeting’s aim is to provide countries with opportunities to review and discuss GCOS, and to identify activities in support of the programme. Spence left the door open to GOOS participation if it was deemed warranted. The meeting will cover background (Climate agenda, etc.) the current state of observational capability, national perspectives, prioritized needs linked to products, and the way forward with conclusions. For this Spence expressed the need for the end-to-end illustrations being developed by the OOPC (see section 7.3). (Note. At the time of OOPC-II, the Particpating Countries meeting was tentatively scheduled for early 1998. By the time of the publishing of this report, a decision was reached to postpone the meeting to the indefinite future.)

4.3.2 Commission on Marine Meteorology (CMM)

Spence reported that the JSTC supported the concept of expanding the role of the Commission for Marine Meteorology to include ocean observations. He invited the OOPC to consider this concept and to provide advice. The OOPC strongly endorsed the concept of a joint WMO-IOC Technical Commission with ocean climate observations as a primary mission. If accompanied by appropriate rationalisation of other bodies (DBCP, GLOSS, IGOSS, etc.) the effectiveness of implementation would be greatly improved. The OOPC asked Spence to convey to the upcoming CMM meeting its strong endorsement of such an approach.

(Note. A meeting to further address this matter and other GCOS-GOOS implementation issues has been scheduled 3-6 March 1998 in Sydney, Australia -- see on the Web:
http://WWW.BoM.GOV.AU/bmrc/mrlr/nrs/oopc/implwshp.htm.)

4.4. OTHER JOINT GCOS-GOOS PANELS

4.4.1 Joint Global Observing Systems Space Panel (GOSSP)

Spence provided a brief update on GOOS-GCOS GOSSP. This Panel will represent the requirements of the observing systems to agencies and to the Committee on Earth Observation Satellites (CEOS). He emphasized the particular need for ocean climate input to the space panel and requested the participation of OOPC in preparing Version 2.0 of the space observations plan. He also asked the OOPC to review a list of ocean requirements compiled by the space panel. This would be handled off-line by Smith with assistance from Lefebvre and others.

4.4.2 Joint Data and Information Management Panel (JDIMP)

Spence reported that the JDIMP will focus on issues of data quality and data access. It will work with existing specialized ocean data management groups such as IODE. He and Smith described a GCOS Quality Control proposal and outlined some ideas for a joint project with JDIMP on assessing and quantifying the value added to data sets through the various stages of processing and attendant metadata. A draft of a proposal along these lines initiated by R.Keeley was made available to the meeting (see Annex III). The Panel commended the idea in principle, noting that the XBT data stream and the sea level data set provide good examples. A workshop examining several cases might be worthwhile. Lefebvre pointed out that the entire loop of data flow, the algorithms, the modelling, etc., had to be examined, not just the data processing stages, to arrive at a meaningful evaluation of the added value by these stages on the end product.

4.5 INTEGRATED GLOBAL OBSERVING STRATEGY (IGOS)

Spence reviewed recent developments related to the IGOS. A meeting of a group of representatives of the Sponsors for the three Global Observing Systems (GCOS, GOOS, and GTOS) met for the first time in January 1997, in Geneva. This group decided to participate in the development of the strategy and will support the activities of the G3OS (its suggested acronym for the three observing systems). Spence informed the Panel that CEOS has decided to take up the IGOS concept with Strategic Implementation Team (SIT) Projects. Some SIT-1 projects are closely related to OOPC interests (e.g., ocean colour and data assimilation) and some are not (ozone, land, upper atmosphere, etc.). Identification of SIT-2 interests will come later.

4.6 *IN SITU* OBSERVATIONS

Smith spoke briefly about the *in situ* Observations Meeting in September 1996 in Geneva. He described it as a positive meeting. Prioritization was approached in a common way making integration of the observation systems requirements easier. Details of this meetingcan be found on the GCOS web site for meeting reports: www.wmo.ch/web/GCOS/meeting. OOPC interests are documented in a report also on the Web: WWW.BoM.GOV.AU/bmrc/mrlr/nrs/oopc/insitu.

4.7 CLIVAR UPPER OCEAN

Smith reported on discussions with the CLIVAR Upper Ocean Panel (UOP). It was agreed that the UOP will plan on the basis that it will look after the sustained system required for CLIVAR's special needs (e.g., experimental, process studies) and the OOPC will look after the establishment of an adequate basic system for sustained long-term observations that underpin CLIVAR as well as other programs, e.g., LOICZ, etc.

4.8 CLIVAR DEEP CIRCULATION

W. Zenk briefed the Panel on the present state of CLIVAR planning regarding the Atlantic Thermohaline Circulation (THC), i.e., focus D4 of the DecCen part of the CLIVAR Scientific Plan. Fritz Schott and Jurgen Willebrand, IfM Kiel, are drafting this component for the implementation plan. D4 is one of 12 foci for which stand-alone implementation documents will be drafted. Schott and Willebrand have summarized the main objectives of D4 as follows:

- To determine the space-time characteristics of past DecCen variability that may be related to the THC;
- To determine the sensitivity of the THC to changes in the surface fluxes, in particular, those changes that cause sudden transitions of the THC;
- To understand those oceanic processes which are critical for the dynamics of THC changes;
- To investigate the coupling mechanisms between the THC and the atmosphere;
- To establish the degree of predictability arising from the influence of the THC variations on atmospheric climate.

Among the observational needs for an intensive study of the THC variability are the following:

- Standard sections at:
  - 55^o - 60^o N -- source region of North Atlantic Deep Water (NADW)
  - 48^o N -- exchange between subpolar and subtropical gyres
  - 24^o N -- oceanic heat flux maximum
  - 10^o S -- exchange between equatorial zone and subtropical South Atlantic
  - 30^o S -- inflow from southern source waters and export of northern source waters
- Monitoring northern ice and freshwater import through Baffin Bay and Fram Straits
- NADW export array at 48^oN
- Inventories of deep and intermediate water exchanges
- Time series stations at key locations
- Flux field observations
- Documentation of the climate change response to CO_2 signals

It was suggested that OOPC could help with the 24^o N section by persuading EuroGOOS to contribute to making this an operational section. It was considered important to try to get regional programs to undertake observations like this on an operational basis.

4.9 EUROGOOS

W. Zenk informed the Panel of recent developments in EuroGOOS. He outlined the structure of the non-governmental organization with its 24 Members and Associate Members (as of December 1996). The structure with its subsidiary bodies is shown in Annex IV. At present, the membership includes eligible agencies from 14 countries which are Members of the Council of Europe. Collaboration with university institutions, industry and multi-national bodies has been established. Abrochure is in preparation and will be published in 1997.

The aims of EuroGOOS were briefly presented as follows:

- Identify European priorities for operational oceanography;
- Promote development and transfer of technology for operational oceanography;
- Support regional GOOS projects by concerted European actions.

Scientific activities of GOOS are guided by a Science Advisory Working Group. Technological developments are overseen by a Technology Plan Working Group (TPWG). The latter met at Brighton in

March 1996; a report is under revision. The Plan will address sensors, instrument systems, platforms (including telemetry) and support systems (including navigation). Hydrographic, physical, optical, acoustical and chemical parameters have been identified. A number of requirements and problems for operational oceanography resemble similar findings in the OOSDP Final Report (e.g., intercalibration/compatibility, drift, maintenance, corrosion protection, data management, and training of personnel).

Zenk noted the existence of a Ferry Box Working Group, a subgroup of the TPWG. This working group is preparing a proposal for a Concerted Action for submission to the EU MAST Programme. Under its chairman, P. Koske of the University of Kiel, the Working Group aims to demonstrate the practicality of equipping ferry boats with an autonomous multi-sensor monitoring system, as a test case for a near-surface observational technique for European coastal waters. National contributions for this autonomous system, called a Ferry Box or Blue Box, are expected from Finland, France, Germany, Italy, Spain, Sweden, and the UK. The German contribution to the Blue Box will include components from MERMAID, an earlier European development project. In the operational mode, it is expected that the Box will be tele-linked to appropriate data acquisition agencies.

5. IMPLEMENTATION

Spence informed the Panel of the networks that GCOS has identified as contributions to the Initial Operational System (IOS). He urged the OOPC to identify candidate ocean observing components for similar network recognition.

5.1 Data Buoy Cooperation Panel (DBCP)

As background for this discussion the Panel was provided with a set of documents including comments prepared by Smith on drifting buoy implementation for the DBCP (see Annex V); from Eugene Burger, on Activities of the DBCP and regional action groups (see Annex VI); and from Peter Dexter, global buoy coverage charts (see Annex VII) and a draft proposal for the creation of a DBCP Global Implementation Programme. A later revised draft of that proposal is in Annex VIII.

Eugene Burger from SAWB opened discussions on the data buoy network and on how the OOPC might improve its working relationship with the Data Buoy Cooperation Panel which is seen as the main avenue for implementing requirements via drifters. The inter-sessional work of the OOPC was noted and further studies on the sensitivity of SST analyses to particular data types and the scales of bias corrections were encouraged. The OOPC encouraged the DBCP to continue to work toward a global implementation plan. In the meantime OOPC would continue working with the various implementation groups as far as possible. The OOPC also called for closer coordination between the CMM VOS and the DBCP.

Burger informed the Panel of the University's drifting buoy activity. Not much data is available in the South Atlantic, so they crave drifting buoy data. Efforts are being made to improve communications to reduce data delay. A receiving station is to be started up this year in Cape Town. The drifters being used have a problem with the barometer, otherwise they have an average lifetime of about a year. The majority of their drifters are air-deployed. Harrison's notes indicate there is a climate signal in the wind fields in the Southern Ocean but the SST does not pick it up.

5.2 SHIP OF OPPORTUNITY PROGRAMME (SOOP)

A report of the first meeting of the SOOP Management Committee (SOOP MC) in May 1996 was provided by Needler, who had attended on behalf of the OOPC. The meeting addressed mechanisms that needed to be put in place to maintain the SOOP program of XBTs on VOS as an operational system, rather than on the basis of scientist/operators (as was the case for WOCE and TOGA). One new wrinkle is of particular importance to the OOPC. While the SOOP MC and its subcommittee, the SOOP Implementation Panel (IP) will assess the resources available and plans of nations for maintaining the network, it will be the responsibility of the OOPC and the CLIVAR UOP to provide advice on the priorities for maintaining existing lines and establishing needed new lines where possible. Needler questioned whether the OOPC was set up to deal with questions of how to distribute XBTs. He believed a "principles" document would be useful as a basis for decision and suggested a small SOOP-OOPC-CLIVAR UOP executive group be formed to decide questions posed along these lines. This group would have to consider the role that other profile instruments being used now might play.

Implementation of SOOP was a major item on the agenda of the OOPC, in part due to the request from Peter Dexter to provide feedback on the optimal SOOP network which could be implemented with the projected available XBT resources for 1997 and beyond, and to decide which are the highest priority lines and optimum observation densities. Dexter had provided some SOOP tables and statistics that illustrated deficiencies between requirements and resources on the various lines and that overall the entire system is being degraded (see Annex IX). Dexter's request posed considerable challenges. Clearly, the OOPC is not staffed in sufficient numbers to provide expert advice in all cases, but it must work with groups like the SOOP MC and with the research groups who also have an interest in SOOP, to enable orderly and scientifically credible implementation plans to be formulated. Discussion yielded the following conclusions and recommendations:

- The OOPC should seek to augment its expertise in this area and, as circumstances dictate, arrange for SOOP IP representation at OOPC meetings. Consideration should be given to forming an ad hoc CLIVAR UOP, OOPC, SOOP IP group to decide science questions regarding, for example, initiating or terminating XBT lines.
- The available XBT statistics would provide a better basis for decisions if they could be related to impact, e.g., how does the existing XBT sampling affect ENSO prediction models.
- The difference between the required and actual sampling is now so large, it begins to call into question the usefulness of the TOGA/WOCE recommended sampling. A set of implementation guidelines that is part of the basis for deciding priorities, and an implementation plan that is more realistic should be drafted.
- The degrading of the system is worrisome; the scientific reason for the indicated oversampling in some lines needs to be clarified so that any surfeit of XBTs in these lines might be transferred to undersampled lines to provide some relief from the dwindling resources.

5.3 TRANSPAC

The issue of TRANSPAC sampling was raised and it was concluded that OOPC should seek an authoritative review of the science that has resulted from the TRANSPAC data in order to provide more substantial arguments for the continuation of this series. Gary Meyers and Kimio Hanawa agreed to have a look at it. Other factors have prevented much progress on this review. However, it remains the firm view of OOPC that such a review is quite critical for the continued support of this contribution to the SOOP network. The PX-26 (TRANSPAC) sampling is already substantially less than "needed". With new technology (e.g., altimetry), perhaps this is reasonable. On the other hand, we may be in the process of destroying one of our most valuable records. OOPC II reaffirmed its strong support for such a study.

5.4 SEA LEVEL

Christian Le Provost gave a presentation describing the PSMSL, GLOSS and WOCE networks for sea level observations and discussed the opportunities for producing new products from the now available high accuracy and complementary altimeter and tide gauge measurement techniques (see Annex X). He summarized the work undertaken over the last months on the definition of an optimal sea level network for climate monitoring and prediction.

This work is contributing to the revised GLOSS Implementation Plan which is to be discussed at a meeting of the GLOSS Group of Experts in March 1997 at the Jet Propulsion Lab (JPL) in Pasadena, California. The plan calls for a network of GLOSS stations, some selected for altimeter calibration (mostly islands), others to provide ocean circulation monitoring where the altimeter is insufficient (e.g., wide straits, choke points, polar coastlines). Le Provost and Smith will be attending this meeting; they are also involved in a related NOAA sea level review. A report to the GLOSS meeting has been prepared. Le Provost is developing material to produce a background paper for the OOPC, possibly under joint sponsorship by GLOSS. He is also working on an end-to-end illustration.

5.5 AIR-SEA FLUXES

Weller reported that analyses of recent process studies that included efforts to collect accurate time series of the air-sea fluxes (e.g., TOGA COARE, Subduction, and the Arabian Sea Mixed- Layer Dynamics Experiment), indicate significant, and at times large differences (up to 100 watts/meter^2), between measured fluxes and those available from atmospheric general circulation models (NCEP and ECMWF). Weller also showed data provided to him by Ed Harrison that indicated significant differences between model-derived winds and real data.

At the same time, Weller stressed that the tech0nology for making accurate measurements at modest cost has progressed. Self-contained sensor modules now exist that are battery powered, internally recording, and also capable of being linked to other sensor modules and a satellite transmitter. With such sensor modules one could equip a VOS with a hull-contact sea temperature sensor, an air temperature and relative humidity sensor module, incoming shortwave and longwave radiation sensor modules, a barometric pressure module, and a wind module. If equipped with a GPS receiver, the package could be independent of ship's navigation.

One could envision, as part of a global observing system, an ongoing effort to identify and motivate correction of errors in the surface meteorological flux fields using Volunteer Observing Ships (VOS) patterned after the VOS North Atlantic work done by Taylor and Kent. Another approach would be to establish at selected sites, time series stations for surface meteorology and air-sea fluxes. These time series would be used for validation and calibration of model outputs and remotely-sensed fields.

Weller pointed out that attention must also be paid to converting the knowledge gained by better observations into better performing models and thus show the value of the improved observations. He suggested that it would be useful to demonstrate with a pilot study the payoff of the investment in better measurements. Such a study would help focus attention on the need for both making better measurments and improving on how better surface meteorological and air-sea flux measurments and parameterizations are incorporated into operational models. The Panel agreed and requested that Weller write to the JSC Task Group on Air Sea Fluxes recommending that such a study be considered. Letters would also be written by Smith to the Director WCRP and to the Director of the CLIVAR IPO expressing the OOPC's continuing concern and offering to assist in whatever ways possible to address the discrepancies between measured and model derived fluxes.

5.6 SEA ICE.

The members agreed that a survey of the sea-ice community may be needed to determine priority needs. Depending on how matters develop in the next few months, it may be appropriate to take up polar observations in earnest at the next OOPC meeting and to invite Roger Colony as an expert participant.

6. INVITED SCIENTIFIC TALKS

6.1 LONG RANGE OCEAN CLIMATE SIGNALS FOR SOUTH AFRICA

Mark Jury gave a talk on Regional Ocean Signals for Long Range Climate Forecasts in Southeast Africa. In his effort to develop long range forecasts of rainfall he has investigated potential predictors based on statistical correlations. He is concerned with atmospheric convection over South Africa and its correlation to SST anomalies in the surrounding oceans. He has noticed that the central Indian Ocean seems to hang on to the ENSO signal after ENSO has degraded. Time-series 200 mb winds over South Africa reveal a thermal wind response to ENSO-correlated central Indian ocean SSTs with a 6-month lead time. Jury uses SST, winds, and other predictors , e.g., rainfall, river flows, for 3-month lead time predictions. He suspects that SSTs south of South Africa are important but data are too sparse to make solid conclusions. SST is not important for 4-month forecasts. The appearance of an Atlantic La Nina is a predictor but with too short a lead time to be useful. The development of an Atlantic La Nina prediction capability is needed to achieve a longer lead time forecast useful to farmers. Jury would like to have the sea level anomalies available from Hawaii on the Internet, especially for the Seychelles. He delivers his products by mail, fax and Internet to farmers and the press. See Annex XI for a synopsis of his talk.

6.2 BENGUELA ECOSYSTEM

Vere Shannon gave a talk on the Changing State of the Benguela Ecosystem, which includes the eastern South Atlantic. The South Atlantic experiences an El Nino-like warm episode of its own every 10 years or so. He alluded to such warm episodes in 1963, 1984, and 1995. The 1995 event was considered particularly intense. La Nina-like phenomena are also observed sometimes as intense upwelling which leads to high productivity. Extended cool periods in the tropical Atlantic have been known to be followed by oxygen-poor water and this sequence is a 2-3 year predictor for an Atlantic warm episode. Oxygen poor waters can have an extreme influence on fisheries; there was a catch collapse off Namimbia in 1993 that was attributable to low O_2. See Annex XII for a synopsis of Shannon's presentation.

6.3 ACOUSTIC THERMOMETRY OF THE OCEAN (ATOC)

Geoff Brundrit gave a talk titled 'The ATOC Programme: Where Are We Now?". ATOC has been in operation for 12 months and one can discern week-long events in the data. The signal of the barotropic tide can be seen. Changes are due to eddies moving in and out of the signal path at 800 metres. ATOC data can be used to derive volume change due to temperature change but not mass change, while the altimeter gives changes due to both. A rise of say a millimetre at the surface can be caused by different heat storage at different depths and ATOC has the ability to provide temperature information at different depths. Thus the two techniques are complementary and both are needed to monitor climate effects. The present sound source off California may be deployed off Perth Australia in 1998. Sources cost $1 million, receivers $20,000; 8 sources and 40-50 receivers would be needed for global coverage. ATOC is a particularly attractive option for monitoring in high latitudes. See Annex XIII for a synopsis of Brundrit's talk.

7. OOPC INITIATIVES

7.1 GLOBAL OCEAN DATA ASSIMILATION EXPERIMENT

Neville Smith and Michel Lefebvre led a discussion of a new initiative for a Global Ocean Data Assimilation Experiment (GODAE). The fundamental objective is a practical demonstration of real-time global ocean data assimilation in order to provide a regular, complete depiction of the ocean circulation at time scales of a few days, space scales of several tens of kilometres, and consistent with a suite of space and direct measurements and appropriate dynamical and physical constraints. The Panel had been provided with a draft proposal beforehand and reaction to the proposal from the members was solicited to determine whether the OOPC should move forward and seek a much wider range of opinion from the broader ocean community. Lefebvre noted that, just prior to the meeting, the CEOS Strategic Implementation Team (SIT)had adopted the proposal as one of its main projects.

All Panel members expressed some reservations, ranging from its scope to the reasons for doing it (i.e., the “deliverables”). Lefebvre was convinced that an institution is needed to bring observations and models together to produce weekly realizations and predictions of the eddy-resolved global circulation. WOCE will be counted on to provide guidance on what measurements must be made. The weakness in using TOPEX/POSEIDON data is in modelling and assimilation -- at present it can’t be done on time scales of a week and at eddy-permitting space scales. Weller offered a different slant. He believed better understanding of the physics was the key to progress at this time not simply more powerful models, and he proposed more emphasis on observations and assimilation. John Field stated that biological models aren’t ready to be run operationally. GLOBEC and JGOFS have some goals aiming towards this but the effort is sparse and will remain so until a persuasive proposal makes the case that we need weekly forecasts of biological processes. Walter Zenk agreed that a purpose must be clear for undertaking the preparation of weekly products. Haugan cautioned that assimilation is not the same for all modelling applications. Some case can be made for non-eddy-resolving applications and he wondered whether climate needed these kinds of time and space scales. Masaki believed more experience is needed with deep layer assimilation. He noted that there is not much data but the data that do exist are exciting in that they are not consistent with prevailing assumptions. At the end of the discussion, however, there was a unanimous belief that this experiment was worth doing, that it would provide context for regional developments, and that it would provide a needed framework for developing process studies.

The project was seen as a way of focussing and consolidating satellite and *in situ* resources for a common aim: it would provide the purpose and proof of concept for global ocean observing systems. No one doubted the enormity of what was being proposed or the considerable challenges that would lay ahead, but all agreed it was a step that had to be taken now. The members were asked to suggest some 40-50 names as reviewers. Smith and Lefebvre agreed to revise the proposal in light of the discussion and to prepare a 2-page summary for the benefit of CEOS and to seek initial comments from the list of reviewers by 21 March 1997.

Should GODAE gain wide acceptance, it will be a major initiative of the OOPC over the next 5-10 years. It will require commitments on the scale of FGGE and will pose theoretical and logistical problems that will require novel and innovative solutions. It will be important that productive partnerships are quickly established with CEOS and the research community, particularly CLIVAR and WOCE, since the success of the experiment is dependent on them for continuing improvements in knowledge, computing capabilities and satellite and direct observational coverage.

7.2 TIME SERIES WORKSHOP

Peter Haugan briefed the members on progress concerning the organization of the Time-Series Workshop. All seems to be moving along well. SCOR has offered to act as host at Johns Hopkins University in Baltimore, 18-20 March 1997. The list of invited participants has been established and a draft program has been circulated. Funding is assured by the Sponsors that now include GCOS, GOOS, SCOR/JGOFS and WCRP. Haugan hoped the workshop would provide justification for time series as a climate tool and guidance for the future of time series by addressing questions such as: since they have limited impact on gridded products, do we need time series? What suffers if we lose them? Who are the customers that would cry for the data?

This workshop will be followed up next year by a companion activity being organized by Gerold Siedler as a session of the EGS in Nice in April 1998. The EGS session will provide a forum for following up the assessment and recommendations of the OOPC workshop.

7.3 END-TO-END DEMONSTRATIONS

OOPC I committed itself to drafting a suite of end-to-end demonstrations of the value of certain data streams to the goals of the ocean observing system for climate. Little progress was made on these intersessionally but as a result of Spence's request there is now a firm commitment to have such brochures available for the "participants" meeting of GCOS (see section 4.3.1). The OOPC agreed to work with GCOS JPO in designing end-to-end illustrations for some of the main OOPC themes (e.g., SST, upper ocean thermal data, sea level, etc.). This would form part of the OOPC contribution to the GCOS Participating Countries Meeting. It is likely the GLOSS implementation group will cooperate with OOPC on the preparation of an end-to-end type brochure expounding the value of sea level data for monitoring long-term climate change. SOOP IP may wish to cooperate on one for XBTs or upper ocean thermal data in general.

8. SATELLITE SYSTEMS

Michel Lefebvre and Christian Le Provost briefed the Panel on JASON, the TOPEX POSEIDON (T/P) follow-on,) the Gravity Recovery and Climate Experiment (GRACE) and other important ocean oberving satellites in the pipeline. Lefebvre provided updated satellite launch schedules for the meeting. These are contained in Annex XIV along with information on the GRACE mission.

8.1 ALTIMETERS

Lefebvre stated that the fundamental objective of JASON is to provide, on a continuous basis for a period 20 years, a continuation of the T/P high accuracy altimetric measurements for ocean circulation and surface elevation requirements. It will repeat the T/P orbit. It will incorporate a CNES 2-frequency altimeter derived from the single frequency POSEIDON, and a NASA 3-frequency microwave radiometer to provide data to correct for water vapor, non-raining clouds and wind-induced changes in the sea surface emission. The expected satellite mass is about 500 Kg in contrast to the 2500 Kg for T/P. JASON will mark the transistion to operational systems designed to ensure continuity of service with the best compromise in terms of performance and cost. JASON is now budgeted at $15 million/year for ten years.

8.2 SCATTEROMETERS

Christian Le Provost reported on the performance of the NSCAT scatterometer. Launched August 17, 1996 on the ADEOS space platform, it had been operating since September 11, 1996. The first calibration/validation meeting was held in Honolulu, January 20-25, 1997. From this meeting it was determined that NSCAT largely matched the initial requirements of the mission. The daily coverage was determined to be far better than ERS-1 because of the double swath coverage, the orbital period, and its constant operating mode. Daily surface wind products are now realizable from observations. Preliminary studies of the impact of NSCAT data on ocean surface analyses and numerical weather predictions indicated a significant impact in the southern hemisphere, where wind observations are sparse to non-existent, but not in the northern half of the globe.

Scatterometer winds are of considerable interest for ocean studies because they represent a direct observation of the source of ocean momentum for the ocean, not contaminated by biases in wind estimates provided by prediction centres. Furthermore, mesoscale wind patterns appear to be resolved in NSCAT products, in particular in the eastern regions of the basins and near islands. Resolving these mesoscale features has been shown to impact the solutions of the OGCMs. At present, NSCAT resolution is 50 x 50 km cells; improvement to 6 x 25 km cells is a possibility. Accuracy is $\pm$ 2 m/s for wind speed in the range 3 - 20 m/s, and $\pm$ 20 ^{o} in direction in the wind speed range of 5 - 20 m/s. Coverage is quasi- synoptic and quasi-global. (Note. NSCAT ceased operating in June 1997 when ADEOS abruptly went dead.)

9. TECHNOLOGY

As Gwyn Griffiths was unable to attend this meeting, discussion was purposely limited with the view that it will be taken up at the next meeting. Brief descriptions were presented of the Japanese Triton Buoy which will be deployed by Japan in the waters east of Japan and in the extension of the TAO array in the Indian Ocean (see Annex XV), and the EuroGOOS "ferry box" mentioned in section 4.9.

Technology will be a major focus of OOPC-III. This is an important dimension for achieving efficiency in observations. Candidate techniques for salinity measurements at high latitudes need to be evaluated then. The figure of 0.15 practical salinity units is lately being considered as feasible for remote sensing precision. The idea surfaced for a background report to which pages could be added at each meeting on particular technologies (e.g., floats, gliders, etc.).

10. UNDERWAY EXPERIMENTS

10.1 THE KUROSHIO

Masaki Kawabe described his study of the Kuroshio. He has found it useful to consider the Kuroshio as having three stable states: meandering, non-meandering and partly meandering. A transition from one state to another takes about 4 months. High transport is related to non-meandering flow. Estimates are rough and improved monitoring is a main objective. Data from tide gauges between the coast and small islands off Japan can be used to determine the meander state of the Kuroshio. Kawabe has developed an index based on the ratio of the difference in sea level between Nakano-shima and Nishinoomote, to the difference between Naze and Nishinoomote, that describes the North South movement of the Kuroshio. Surface velocity can be roughly measured by sea level differences between Naze and Nishinoomote. JMA has been measuring volume transport for years using sea level differences between these stations and a third at Odomari. They make a good time series. Another objective is to monitor air-sea heat fluxes; they get good data from ships. Summer fluxes are steady. Winter annual fluxes are more variable. Anomalies show more heat loss in recent years but the data quality and grid are not the best. Kawabe mentioned that K. Taira is installing echo sounders to measure volume and there is hope to measure transport with submarine cables in some places. See Annex XVI for details of Kawabe's work.

10.2 THE LABRADOR CURRENT

George Needler addressed the area of the 50^{o} W section and the Newfoundland Basin. He noted the large interannual changes in the Labrador Current. The appearance of relatively small amounts of very cold-water transport through the section make for a colder climate than large amounts of less-cold water transport This is a case where data describing the eddy field needs to be known and made available to the model in order to correctly model the circulation. Needler discussed the compilation of phenomena that have some known predictability (greater than one month or more) from indicators, basically boundary currents. He suggested that coastal people should look at indicators that have a shorter than one month utility.

10.3 JGOFS.

John Field noted that the time lines for most JGOFS activities end in 2001 (see Annex XVII). A number of new CO_2 measurement techniques have been developed under JGOFS, some of them suitable for buoy operation. At present, a project tentatively called the Surface Ocean - Lower Atmosphere Study (SOLAS - not to be confused with Safety of Life at Sea) is being considered as a follow-on to JGOFS. SOLAS is an outgrowth of an earlier proposed project that was under consideration by the IGBP to either complement or follow JGOFS. That project was known as the Global Ocean Euphotic Zone Study (GOEZS). Where GOEZS, as it was formulated, was model-driven, i.e., questions to be studied would be generated from models, SOLAS would be cast in terms of hypotheses. The focus for SOLAS is envisioned to be marine biochemistry as it affects, and is affected by the climate. In addition to carbon fluxes, other radiatively active gases such as nitrous oxide and dimethyl sulphide would be central to the project. By focussing on biological issues, SOLAS would fill a critical gap in the plans of IGBP and WCRP.

10.4 MERCATOR

Le Provost briefly described MERCATOR, a French project for operational oceanography. It is aimed at the development of operational oceanic models for real-time monitoring and forecasting. The goal is to develop a simulation tool for the global ocean circulation, assimilating ocean observations under preoperational constraints. It has a modelling component, an assimilation component, a data component, and a driving unit. A high-resolution ocean GCM, being developed under the French CLIPPER project, will be coupled with high resolution regional models and with an atmospheric GCM under the modelling component. The objective of the driving unit is to develop the system architecture for driving the three components together. MERCATOR is seen as an important contribution to GODAE. For more detail on MERCATOR and CLIPPER see Annex XVIII.

10.5 THE NORTH ATLANTIC

W. Zenk reviewed the unusually large scale of current observational work being pursued in the North Atlantic.

10.5.1 The Atlantic Circulation and Climate Experiment (ACCE)

Zenk reported that the ACCE will wrap up the WOCE observational phase in the North Atlantic. Special emphasis was given to float deployments in this ocean basin between 1996 and 1999. The Panel took note of the coming cruise (no.39) of the German research vessel METEOR, April-Sept 1997 (App. X2). WOCE lines A1 and A2 at nominal latitudes of 55° N and 48° N will be reoccupied between Greenland and the Irish shelf, respectively between the Grand Banks and the British shelf. In addition extensive hydrographic and tracer data will be collected in the Island and the Irminger Basins as well as in the Labrador Sea. Mooring work in surface and deep boundary current regions is scheduled at the Mid Atlantic Ridge, off Greenland and off Labrador. Float seedings are planned in the eastern basin (RAFOS) and in the Labrador Sea (ALACE) where a tomography array will also be installed.

10.5.2 Eurofloat

Since October 1996, the international initiative called Eurofloat has been fully operational. This effort is a joint programme of five laboratories (Southampton, Liverpool, Brest, Madrid, Kiel) funded by the EU. The scientific target of Eurofloat is the mean circulation and its eddy-enhanced mixing of Mediterranean and Labrador Sea Water in the northeastern North Atlantic. This Lagrangean experiment uses French MARVOR and German RAFOS floats at a nominal depth of 1000 m, embedded in an array of sound sources provided by both nations. Additional observations with MARVOR floats are underway by the French Navy under the acronym ARCANE at the somewhat shallower depths of the North Atlantic Central Water in the Western European Basin. The chart of the Eurofloat sound source array and the first displacement vector diagram of MARVOR floats are shown in Annex XIX.

10.5.3 U.S. WOCE

Information about the US WOCE North Atlantic activities presented by Zenk was provided courtesy of P. Chapman of the U.S. WOCE Office. The US WOCE programme in the North Atlantic includes a modelling component, hydrographic cruises, XBT operations on VOS, and the deployment of a large fleet of RAFOS and ALACE floats (order 500). The scientific rationale and its general strategy are summarised in the document "U.S. Contribution to WOCE and ACCP: A Program Design for an Atlantic Circulation and Climate Experiment (ACCE)" issued by the US WOCE Office (1995). The US implementation discriminates between three foci: variability of the subpolar gyre, meridional overturning circulation, and the tropical surface layer. Geographically, they are bounded between 5° S and 60° N.

10.5.4 Panel Conclusions

The Panel clearly recognised the potential of the European and American float observations in the North Atlantic and anticipated that follow-on programmes in operational oceanography will build on the ACCE work begun to provide in-situ data on oceanic variability of the meridional overturning circulation. There were some concerns raised by Panel members about a possible lack of information exchange as well as adequate coordination among the various groups operating in the North Atlantic. It was agreed that OOPC should seek to facilitate better coordination since, potentially the various group efforts provide a "pilot experiment" for *in situ* sampling. Zenk was requested to update the information he had provided to the meeting and to compile as complete an inventory as possible on all available information of on-going or intended campaigns (1996-1999) using Lagrangean techniques. This inventory is part of Annex XIX.

11. RECAPITULATION OF ASSIGNMENTS FOR THE INTERSESSIONAL PERIOD

(i) Completion of the end-to-end brochures for:
XBT - Neville Smith
SST - Robert Weller
Winds - Robert Weller
Carbon cycle - P. Haugan and John Field
Deep Circulation - George Needler, Peter Haugan
Sea Level - Christian Le Provost

(ii) Background documents:
TRANSPAC - Gary Meyers, Ed Harrison, Warren White
Sea Level - Christian Le Provost (for GLOSS)
Boundary currents and climate forecast indicators - George Needler
Global Ocean Data Assimilation Experiment (redraft proposal) - N. Smith, M. Lefebvre
Technology - Gwyn Griffith

(iii) Letters to be written:
To Roger Colony (invitation to next meeting) - Neville Smith
To CMM encouraging a Joint WMO-IOC Technical Commission - Neville Smith
To Peter Dexter on drifting buoy experiment and VOS interaction - N. Smith
To Task Group on Air Sea Fluxes (suggesting study) - R. Weller
To WCRP (cc CLIVAR) on observed and GCM fluxes discrepancies - N. Smith
To Funding agencies for North Atlantic Projects about coordination - N.Smith

(iv) For VOS - SOOP:
Need to develop a set of agreed principles for deciding where resources go - N. Smith to talk to Rick Bailey about an approach.

(v) For JDIMP:
Develop an outline re value added and meta data contributions to end products - N. Smith

(vi) Satellites:
Need to go over the lists (WMO, ESA, etc. parameters) where the ocean is mentioned and provide detailed text to support their being on the list. The point needs to be made that the thread gets lost between a parameter and the reason for its need when combining needs into simple integrated lists - Lefebvre and colleagues.

12. NEXT MEETING

It was decided to accept the invitation from CERGA (Centre d'Etudes de Recherche de Géodynamique et Astronomie) and hold the next meeting 6-8 April 1998 in Grasse, France .

ANNEX I

AGENDA

1. OPENING

2. REVIEW AND ADOPTION OF THE AGENDA

3. CHAIRMAN'S REVIEW

4. RELATED DEVELOPMENTS AND MEETINGS

4.1 J-GOOS

4.1.1 Planning Meeting for the J-GOOS Plan

4.2 I-GOOS
4.3 GCOS JSTC

4.3.1 Participating Countries Meeting
4.3.2 Commission on Marine Meteorology (CMM)

4.4. OTHER JOINT GCOS-GOOS PANELS

4.4.1 Joint Global Observing Systems Space Panel (GOSSP)
4.4.2 Joint Data and Information Management Panel (JDIMP)

4.5 INTEGRATED GLOBAL OBSERVING STRATEGY (IGOS)
4.6 *IN SITU* OBSERVATIONS
4.7 CLIVAR UPPER OCEAN
4.8 CLIVAR DEEP CIRCULATION
4.9 EuroGOOS

5. IMPLEMENTATION

5.1 DATA BUOY COOPERATION PANEL (DBCP)
5.2 SHIP OF OPPORTUNITY PROGRAMME (SOOP)
5.3 TRANSPAC
5.4 SEA LEVEL
5.5 AIR-SEA FLUXES
5.6 SEA ICE.

6. INVITED SCIENTIFIC TALKS

6.1 LONG RANGE OCEAN CLIMATE SIGNALS FOR SOUTH AFRICA
6.2 BENGUELA ECOSYSTEM
6.3 ACOUSTIC THERMOMETRY OF THE OCEAN (ATOC)

7. OOPC INITIATIVES

7.1 GLOBAL OCEAN DATA ASSIMILATION EXPERIMENT (GODAE)
7.2 TIME SERIES WORKSHOP
7.3 END-TO-END DEMONSTRATIONS

8. SATELLITE SYSTEMS

8.1 ALTIMETERS
8.2 SCATTEROMETERS

9. TECHNOLOGY

10. UNDERWAY EXPERIMENTS

10.1 THE KUROSHIO
10.2 THE LABRADOR CURRENT
10.3 JGOFS
10.5 THE NORTH ATLANTIC

10.5.1 The Atlantic Circulation and Climate Experiment (ACCE)
10.5.2 Eurofloat
10.5.3 U.S. WOCE
10.5.4 Panel Conclusions

11. RECAPITULATION OF ASSIGNMENTS FOR THE INTERSESSIONAL PERIOD

12. NEXT MEETING

ANNEX II

LIST OF PARTICIPANTS

OOPC PANEL MEMBERS

John FIELD (Prof.)
Dept. of Zoology
Univ. of Cape Town
Rondebosch 7701
SOUTH AFRICA
Tel: (27 21) 650 3612
Fax: (27 21) 685 3937
E-mail: jgfield@pop.uct.ac.za

Peter Mosby HAUGAN
UNIS (University Courses on Svalbard)
P.O. Box 156
N-9170 Longyearbyen
NORWAY
Tel + 47 79 02 33 38 (direct)
Fax: + 47 79 02 33 00 (UNIS)
Fax: +47 79 02 3301
E-mail: peter@aurora.unis.no

Prof. Masaki KAWABE
Ocean Research Institute
University of Tokyo
Minamidai 1-15-1, Nakano-ku
Tokyo 164
JAPAN
Tel:
Fax: 81-3-5351-6418
E-mail: kawabe@ori.u-tokyo.ac.jp

Michel LEFEBVRE
8 Avenue Cugnaux
31270 Villeneuve Tolosane
FRANCE
Tel: (33) 61 92 06 09
Fax: (33 5) 61 92 94 69
E-mail: milef@calvanet.calvacom.fr

Christian LE PROVOST
LEGOS-UMR CNES/CNRS/UPS
Observatoire de Midi-Pyrenees
Groupe de Recherche en Grenoble spatiale
18 avenue Edouard Belin
31055 Toulouse Cedex
Tel: (33 05) 61 33 29 23
Fax: (33 05) 61 25 32 0
E-mail: Christian.Le-Provost@cnes.fr

George NEEDLER
Bedford Institute of Oceanography
PO Box 1006, Dartmouth, N.S. B2Y 4A2
CANADA
Tel: (1 902) 426 3145
Fax: (1 902) 426 7827
E-mail: g_needler@bionet.bio.dfo.ca

Neville R. SMITH (Chair)
BMRC
150 Lonsdale St., Box 1289K
Melbourne, Vic. 3001
AUSTRALIA
Tel: (61 3) 9669 4434
Fax: (61 3) 9669 4660
E-mail: N.Smith@bom.gov.au

Robert WELLER
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
USA
Tel: (1 508) 289 2508
Res: (1 617) 759 9255
Fax: (1 508) 457 2181
E:mail: rweller@whoi.edu

Walter ZENK
Institut fur Meereskunde
an der Universitat Kiel
Dusternbrooker Weg 20
24105 Kiel
GERMANY
Tel: (49 431) 597 3892
Fax: (49 431) 597 3891
E-mail: wzenk@ifm.uni-kiel.de

OOPC MEMBERS NOT ATTENDING

Gwyn GRIFFITHS
Southampton Oceanographic Centre
Empress Dock
Southampton SO14 3ZH
UNITED KINGDOM
Tel: (44) 1703 596004
Fax: (44) 1703 596149
E-mail: Gwyn.Griffiths@soc.soton.ac.uk

D.E. (Ed) HARRISON
PMEL/NOAA
7600 SandPoint Way
Seattle, WA 98115
USA
Tel: (1 206) 526 6225
Fax: (1 206) 526 7644
E-mail: harrison@rascal.pmel.noaa.gov

IOC SECRETARIAT

Art ALEXIOU
Senior Assistant Secretary IOC
IOC-UNESCO
1, rue Miollis
75732 Paris Cedex 15
FRANCE
Tel: (33 1) 45 68 40 40
Fax: (33 1) 4568 5812
E-Mail: a.alexiou@unesco.org

INVITED EXPERTS

Geoff BRUNDRIT (Prof.)
Oceanography Dept.
Univ. of Cape Town,
Private Bag, Rondebosch, 7701
SOUTH AFRICA
Tel: +27 21 650 3277
Fax: +27 21 650 3979
E-mail: brundrit@physci.uct.ac.za
or shirley@physci.uct.ac.za

Eugene BURGER
South African Weather Bureau
Private Bag x97
Pretoria 0001
SOUTH AFRICA
Tel: (27 12) 309 3024/5
Fax: (27 21) 309 3020
E-mail: burger@cirrus.sawb.gov.za

Vere SHANNON
Oceanography Dept
Univrsity of Cape Town
Rondebosch 7701
SOUTH AFRICA
Tel: +27 21 650 3625
Fax: +27 21 650 3979
E-mail: vshannon@physci.uct.ac.za

Tom SPENCE
Director, GCOS Joint Planning Office
c/o W.M.O
P.O. Box 2300
1211 Geneva 2
SWITZERLAND
Tel: (41 22) 730 8401
Fax: (41 22) 740 1439
E-mail: GCOSJPO@gateway.wmo.ch

M. R. JURY (Prof.)
University of Zululand
c/o Geography Dept.
P.B. X1001
KwaDlangezwa 3886
South Africa
Tel: 27 0351 93911 Ext. 2626
Fax: 27 0351 93420
E-mail: mjury@pan.uzulu.ac.za

ANNEX III

GCOS QC DRAFT PROPOSAL

OBJECTIVE

To quantify the added value in a collection of data resulting from quality assessment and data management practices.

INTRODUCTION

In the last few years data quality assessment has become formalized in projects such as WOCE and the GTSPP. These particular projects have started from different sources and so assessment techniques and conventions for indicating problems in data are not the same. Also, whereas WOCE has defined protocols and instrumentation standards, GTSPP has not (simply because it cannot). In both projects, there is some assembly of information about the data collection techniques, instrumentation, processing, etc. (the metadata). Both data quality assessment and metadata of data collections are required to archive data properly so that the data will be meaningful to future users. Without this information, subtle signals in data may be lost in the noise of changing measurement practices, or accumulated errors in the data files. Given the work that has been done in these and other projects, it is time to assess the added value imparted to data collections by these activities.

Addressing these issues requires the cooperation of scientists and data managers who have been involved in the problem. Their experience and judgment is needed to design a process that will provide a fair evaluation and quantification of the value added by data quality assessment and metadata. It is proposed to convene a workshop to tap into this experience to initiate and plan the project.

DATA QUALITY ASSESSMENT / METADATA WORKSHOP

Evaluating the impact of data quality assessment and metadata in contributing to the value of a data collection is not straightforward. It is important to focus on those aspects of these practices which can result in an objective (quantitative) valuation.

Goals:

l. Identify the quality assessment procedures and metadata that can be evaluated.
2. Identify the procedures to be used to quantify the added value imparted by data quality assessment and metadata.
3. Develop techniques to identify objectively the added value.
4. Identify the people who will undertake the work.

Derived from a draft proposal by R. Keeley (MEDS) for the GCOS DIMP, 4 Sep 96

A tentative annotated agenda for the Workshop follows. It is expected that 3 days will be sufficient to define the project. A meeting report will be prepared and circulated to participants afterwards.

Day 1: - Welcome; Introductions; Approval of Agenda; Discussion of goals and strategy

The meeting needs to determine if the goals are sensible and can be met. Once goals are set, the strategy to accomplish the goals needs to be decided. This includes whether to tread data quaqlity assessment and metadata separately, if both can be addressed, what type of data to consider, etc.

Day 2: - Write goals and strategies
- Commit to paper the decisions of the previous day
- Define the evaluation criteria

This should document exactly what techniques will be used and how results will be measured for evaluating the added value needs to be proposed.

Day 3: - Write evaluation criteria
- Commit to paper the decisions of the previous day
- Share out the work

These discussions should define who will carry out what work and the timetable for completion of the work. As much as possible, commitments should be made at the meeting and recorded in the meeting report.

Venue and date: No location is proposed, but I would hope somewhere in the US. November, December, 1996 is proposed for the time. I will work with GCOS DIMP to see what can be arranged.

In order to start the discussion, a paper has been attached as a strawman. It is proposed that this be the starting point of the Workshop discussions. I have also attached excerpts from Neville Smith's thoughts about the problem.

EVALUATING THE IMPACT OF DATA QUALITY ASSESSMENT AND METADATA

INTRODUCTION

Data quality assessment and assembling metadata are considered important to good data management practices. However, there is no objective measure of the impact of these practices on the value of data collections or products derived from the collections. It is argued that subtle (perhaps not so subtle) changes in climate will be masked by errors in data collections or by lack of knowledge of changes in measurement techniques, instrumentation and so on. There are examples in the literature of long time series that have been assembled and of efforts made to 'clean' them up by removing the influences of such changes and errors. This paper is a strawman proposal that suggests a framework for how to quantify the value of data quality assessment and metadata

Both data quality assessment and assembling metadata have a role to play. It will be important to be sure a clear distinction is made between what is considered data quality assessment and what is metadata This definition need not be universally true, but should be used for the work carried out under this project.

DEFINITIONS

For the purposes of this project, data quality assessment is considered to be the practice that results in well defined markers being attached to data collections that are intended to inform the user of the reliability of the data. Within WOCE and GTSPP standard definitions of quality flags has been agreed to. Other data assemblages, such as the World Ocean Atlas published by WDC-A Oceanography) have a different scheme. It is both the process and the results (the flags) that are considered in the domain of data quality assessment.

Metadata is a more difficult term to define. For the purposes of this project, all other information about a data collection, beyond data quality assessment, is considered to be in this domain. Generally, it is information such as instrumentation used, when it was last calibrated, the measurement technique, the potential appropriate uses of the data and so on. It will be necessary to tighten up this definition in the context of the project before any progress can be made.

DATA QUALITY EVALUATION

The first step is to agree on the data quality practices that can be evaluated. Many data centres and originators are in the practice of attaching data quality flags to observations. This is the practice in the WOCE programme and in the GTSPP. It is also the practice of the World Ocean Atlas published by WDC-A. The first point to consider is what information must these flags impart to be useful? Should the flags indicate only the quality of individual observations, of composite observations (such as complete profiles), of the entire data collection, or the uses to which the data should or should not be put?

A debate began about the purposes/use of quality flags in the GTSPP. The present scheme attaches a flag to every observation. The flags are as follows.

0 = No QC done
1 = QC done and value appears to be correct
2 = Qc done and value appears to be probably correct.
3 = QC done a value appears doubtful.
4 = QC done an value appears to be wrong.
5 = QC done and value has been changed.

In addition, there is a flag used to characterize the quality of the entire profile. This flag is set to be the lowest quality of any observation in the profile. It was proposed that the value of this flag should be related to the uses of the data. So, if a profile has insufficient points for a mixed layer depth calculation, the overall flag would be '4' to indicate that as far as this product is concerned, the data are unusable. This proposed usage was not adopted by GTSPP. Nevertheless it does indicate the interest in a product view of QC flags.

It is proposed that the quality assessment evaluation should consider only the flagging that indicates the reliability of the observations.

Another view has been that a flag be used to indicate every test on every observation that was failed. Given 20 tests one could imagine every observation of a profile having multiple flags attached. This certainly is a complete representation and documentation of the quality of the data, but may be overkill from the viewpoint of a user.

It is proposed that data quality flags be used only to decide on the inclusion or exclusion of the observations from the final product.

Different programmes have all developed different schemes to flag data. In some cases (e.g.. WOA96) the type of test failed is indicated while in others (GTSPP) only the reliability of the observation is indicated. It may be that in deciding to use data for a product there will be some ambiguity because of the flagging scheme employed. If this is the case, the evaluation report should be sure to highlight this or any other difficulties encountered with any of the flagging schemes employed.

It is proposed that if the interpretation of a data quality flag is ambiguous, the evaluation be carried out as if the flag indicated the data be excluded from the analysis. It is suggested that, if possible, a re-analysis using the data flagged ambiguously be included in the product and a comparison made to the first instance.

QUANTIFICATION OF VALUE ADDED BY QUALITY CONTROL

We must decide how to quantify what value is added as a result of quality control. The evaluation results should ideally be objective and reproducible so that to the degree possible, subjectivity is removed. To this end, the following considerations are proposed as the basis for determining value added.

Value is added to a data set as a result of quality control when spurious values and data redundancies are removed from the data and data product so that true signals are better resolved. The quantification of value added then becomes finding the means to show that true signals in the data are enhanced by the quality control process, and spurious signals are reduced.

It is proposed to start with a list of products that are of general value and are broad enough to cover the interests of much of the -user community. The list could include the following. Note that in every case, it will be necessary to identify the type of data that will be used, the product or results that will be used in the evaluation, and the valuation procedure.

1. ENSO Prediction

The data to be used are mostly real-time but with some high resolution data as can be assembled in the time frames needed for this process. The product to be evaluated must be identified. We propose to assemble the data, and to pass them through quality control processes at a number of volunteer sites. At each stage, the product is generated, and a 'signal to noise ratio' determined. Some characterization of the data sampling (real-time versus high resolution) will need to be factored in the results.

2. MIXED LAYER DEPTH AND HEAT STORAGE

The data to be used are exclusively real-time data. The product is that produced as at IOS (Canada) and distributed by MEDS. The same evaluation process would be used as for 1) above.

3. CLIMATE CHANGE

The data to be used are exclusively high resolution data. The product needs to be defined. The same evaluation process would be used as for l. above.

METADATA EVALUATION

Metadata is a vague term. It is necessary to clarify what are those practices that are important and should be considered in this project. I include a list of information that might be considered for evaluation here. This list is not exhaustive.

(i) The type of instrument used to make the measurements (e.g. XBT, CTD, tide gauge).
(ii) The measurement technique (e.g. profiling instrument, towed body, acoustic).
(iii) Calibration information (e.g. when done, precision and accuracy, XBT fall-rate).
(iv) Known deficiencies (e.g. for XBTs, measurements from top 3.7m are suspect).
(v) Sampling information (e.g. interval, design).
(vi) Analysis information (e.g. if chemistry, how was the measurement made).
(vii) Measurement units (e.g. Sl or something else).
(viii) Processing history (e.g. processes or software that have passed the data).
(ix) Positioning information (e.g. accuracy, precision, how done, resolution reduction).

It is proposed that those practices to be considered should be amenable to quantification of their effects on the value of a data collection. Candidates would be the application of the new or old fall rates to XBTs, and the inclusion of the upper 3.7m from XBTs.

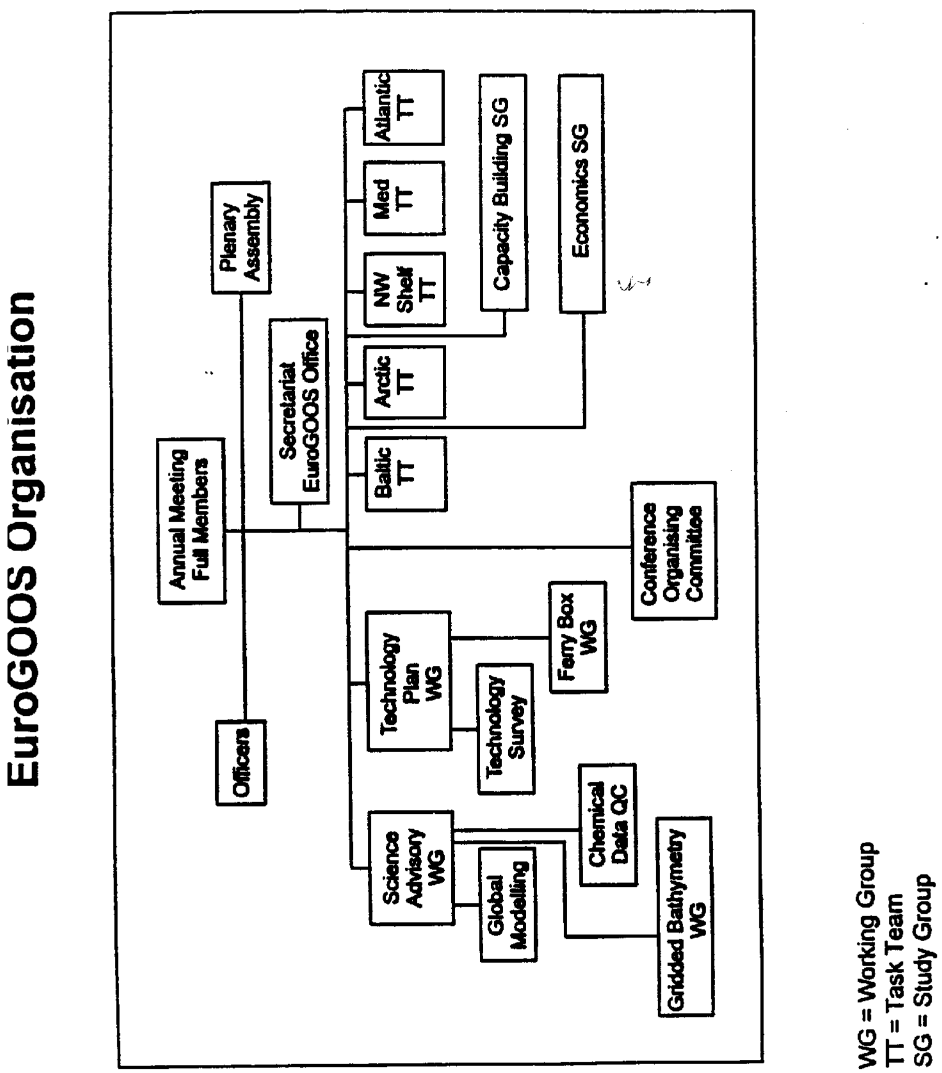
Having decided the metadata that will be considered, it will be necessary to develop the process that will allow for a quantification of the impact of the metadata. A possible evaluation would be to determine if a sea surface temperature product which uses the upper 3.7m of XBT data has a quantifiable lower value than one that does not? Is this dependent on the oceanographic region or time frame under study? In this example, it should be possible to use similar techniques as proposed for the data quality assessment discussed earlier.

A more difficult example would be to determine the impact of having processing history information. The questions to be addressed here would be, what is the effect on a user of having the processing history? Does it decrease the amount of work they would do to use the data? What processing information is most important to a user? All of these are more difficult to quantify, but if at least some information, such as the impact of a resolution " reduction (converting CID profiles to TESACs, for example), can be assessed, this is important.

It is proposed that having decided the metadata that can be quantified, that a similar evaluation process as used for data quality assessment be employed.

ANNEX IV

EUROGOOS STRUCTURE



ANNEX V

COMMENT ON DRIFTING BUOY IMPLEMENTATION FOR DBCP SESSION XII

by Neville Smith
(Chair, Ocean Observations Panel for Climate and member of the CLIVAR Upper Ocean Panel)

The following are some comments on work of the Ocean Observations Panel for Climate (OOPC) in relation to drifting buoys and SST, and the relevance of some recent developments in CLIVAR to the work of the DBCP (the DBCP may be being briefed separately on CLIVAR activities). Note that while I am speaking on behalf of the OOPC, some of the comments probably reflect personal views on the subject.

1. The first session of the OOPC was held in Miami, 25-27 March 1996. The OOPC devoted a session to consideration of SST and how it might improve the design and implementation of plans related to climate (in effect the Ocean Observing System Development Panel Report of 1995). The OOPC noted improvements were needed in several areas:

- improve *in situ* observations south of 45°S where data density is sparse to zero.;
- advise on where to put drifters to improve the SST product;
- improve the quality of existing SST observations by getting rid of the mix of bucket temperatures, ship intake temperatures etc., and moving toward hull-contact sensors.

2. The OOPC noted that the implementation of the OOSDP recommendations has been hampered by lack of detail, lack of advice in a form that can be readily understood by agencies, as well as a scarcity of resources. The OOPC proposed an on-going programme of direct interactions with whatever groups are involved in implementation. For SST, the OOPC would seek to interact with WMO, the DBCP and other groups involved with implementation of *in situ* SST measurements. In particular, the OOPC would investigate better methods for advising on the required distribution of *in situ* observations from hull-mounted sensors and drifters, based on where OOPC believes enhanced *in situ* sampling is warranted.

3. Strategies for SST sampling have also been considered by the CLIVAR Upper Ocean Panel (UOP), though not in detail. In terms of the general oversight of the drifter program, the following recommendations of the CLIVAR Scientific Steering Group (CLIVAR SSG V, Sapporo, Japan June 1996) should be noted:

3.1 Recommendation

CLIVAR should use existing bodies as much as possible for management of its observing systems and data flows and therefore looks to strengthen relationships with WWW, GCOS and GOOS.

3.2 Recommendation

Regarding the surface velocity drifter programme, the SSG looks to the UOP to provide primary scientific oversight for this programme. Sampling requirements will be developed in the context of preparation of the CLIVAR implementation plan. The OOPC will provide technical advice on SST and MSLP measurements. The CLIVAR SSG supports the SVPPC-X recommendation that operational aspects of the drifter programmes be co-ordinated by the Drifting Buoy Co-ordination Panel (DBCP).

In the context of the future work of the DBCP, the latter recommendation is, I think, an indirect endorsement of the idea to move toward a Global Implementation Programme. Both the research (e.g., CLIVAR) and operational (e.g., GCOS/GOOS OOPC) groups most concerned with the application of drifter data (particularly SST and surface drift) would, I think, agree that a single implementation program would be more effective in terms of implementation of plans and interaction with scientific groups. As Chair of the OOPC, I think it is a concept that is welcome.

4. One of the actions recommended by the OOPC was to seek a better specification of the requirements for *in situ* SST measurements in support of climate applications. The method proposed aimed to (i) quantify the accuracy (estimated error) of the *in situ* bias corrections applied to satellite data in the operational systems running at NCEP, BMRC and other places, (ii) quantify the individual contributions from the VOS and buoy programs to these analyses, (iii) use these analysis systems to understand the sensitivity of the *in situ* analysis to (a) the distribution of data and (b) the (assumed) accuracy of the data, and (iv) seek a better understanding of the biases in the satellite data which lead to the need for *in situ* corrections in the first place. Action (iv) is to be taken up by Reynolds and Harrison.

Both NCEP and BMRC assume drifter data are more useful (accurate) than ship data (for BMRC, the relative impact is around 1.7:1; for NCEP it is somewhat higher). Research on the North Atlantic VOS system suggested hull-contact sensors could greatly reduce the errors associated with ship data. These facts suggest that the sampling strategy could be approached in (at least) two ways. For areas where the analysis error is below standard, implementation of hull-contact sensors on ships might be sufficient to reduce the analysis error to the required standard. Improved VOS could be traded off against drifter deployments; alternatively, if an existing drifter program was already achieving the required standard, then the case for adding hull-contact sensors to VOS is much reduced. For completely data void regions there are at present no alternatives to drifters.

The work on this task that is included here is only preliminary but it should at least give an impression for the sort of product that could be made available routinely. The enclosed figures show (1) Australian Bureau of Meteorology SST analysis and the SST anomaly for the week ending 13 October 1996, (2) the estimated error of the *in situ* analysis used to correct possible bias in the satellite data (note that satellite data are only changed where the estimated error is considered to be of an adequate standard), and (3) estimates of the *in situ* "information density" for (a) all *in situ* data, (b) just ships, and (c) just buoys. There are some problems with the way these experiments were set up but they do not affect the message being put here. Note also that while the following are based on the Bureau of Meteorology National Meteorological Centre (BoM NMC) analysis system, the NCEP(Reynolds) analysis system employs a very similar strategy and so the results should be equally applicable there as well.

Generally the BoM NMC *in situ* analysis aims to apply corrections on spatial scales of around 750 km and with accuracy better than 0.3-0.4°C. This is being achieved for a substantial part of the globe (for a monthly analysis estimate this translates to 0.2-0.3°C over the same scales). In theory, the information density should be around or greater than 1 everywhere if we were meeting the standard (see top panel of the 3rd figure). For reasons which are not immediately obvious, the ship data are only reaching this standard in a few places (middle panel); the decreased weight for ships is certainly a factor in this but the lack of impact appears much less than might be expected. The lower panel shows the impact of the drifters (it appears the BoM decoder is not accepting the TAO data at the moment). There is a considerable contribution through many regions of the global ocean. The notable gaps are, as might be expected, the Southern Ocean, the tropical Atlantic (perhaps less expected and a little worrying) and parts of the Indian Ocean. There is a great deal of redundancy with the ship data in the North Pacific and North Atlantic, but useful synergism in parts of the Indian Ocean and the South Atlantic.

The aim is to make access to this information routine (i.e., weekly maps and monthly/annual maps would be produced as part of the operational system. Moreover, the OOPC would like to push it a little further so that rudimentary observing system experiments could be undertaken by implementors. For example, the mapping in the tropical Atlantic could be tested for improved VOS and improved drifter deployments in order to choose an optimum mix of these sampling strategies. The assumed error characteristics of instruments used in the analysis could be altered to test the impact of improved/degraded sensors. This work will continue over the next year (contact myself for more information).

5. One general (personal) comment on the proposed implementation strategy. One of the difficulties in implementing any observational strategy is to maintain focus, by which I mean keeping the implementation consistent with the operational and/or scientific objectives which ultimately drive the program. In fact, I think it is impossible to provide proper prioritisation and rationalisation of the system if this is not done. So I think it is critical that the proposed GIP do more than just aim to provide global coordination, etc. (laudable as those aims are), but it should demand from the groups responsible for setting objectives and providing designs clearly articulated objectives for the drifting buoy contribution. The scope and implementation are then directly driven by the objectives. Without such clear articulation of the purposes for implementing the buoy program, the analysis of system performance just comes down to pages of numbers without context.

I look forward to the revised Draft of this GIP plan. It is my plan at the moment to devote some time at the next OOPC meeting (Cape Town, 11-13 February 1996) to consideration of some of the issues I discussed above. The Panel could provide comment on the GIP plan if you wish.

ANNEX VI

ACTIVITIES OF THE DBCP IN THE SOUTH ATLANTIC AND INDIAN OCEANS

Eugene Burger (SAWB)

Preface

Data buoy's have become an indispensable component of meteorological and oceanographic data gathering from remote areas. Drifting buoys are now an essential component of the marine observation system of the World Weather Watch (WWW), the Global Ocean Observation System (GOOS), the Global Climate Observation System (GCOS) and the Integrated Ocean Services System (IGOSS). Many other operational meteorological and oceanographic programmes also make use of buoy data.

The DBCP

The Drifting Buoy Co-operation Panel was set up in 1985 by the World Meteorological Organization and the Intergovernmental Oceanographic Commission. It is a mechanism for co-ordination and co-operation in the implementation of drifting buoy deployment programmes. It is also a forum for discussing technical problems related to buoy operations. At its 8th session in Paris, October 1992, the DBCP decided to change its terms of reference to include all ocean data buoys on the high seas. Hence its name was changed to Data Buoy Co-operation Panel. The DBCP employs a full time coordinator, based in Toulouse, France, to provide appropriate technical support to the buoy community.

The DBCP meets annually. The last meeting was in Henly on Thames, and the next meeting will be hosted by Meteo France in la Reunion. A data buoy technical session is held two days before the panel's annual meeting. Here presentations on a technical nature with regards to buoy development and buoy data usage are presented.

The DBCP has been a catalyst in creating better ways of utilising buoy technologies. An example of this is the development of the SVP barometer drifter by SIO, under the auspices of the DBCP. The DBCP has also set out and implemented quality control measures for buoy data being disseminated onto the GTS. The DBCP has an Internet web site located at http://dbcp.nos.noaa.gov.

QC Measures

Data from drifters are checked by various centres against the first guess field's of numeric models. Information on faulty drifters are then sent via Internet to buoy-qc@vedur.is in fixed format messages, from where they are sent to the various buoy programme officors in charge. These messages are also archived. These measures have over the past two years resulted in a steady decline in the continuous dissemination of faulty data onto the GTS.

Regional Action groups

With the proliferation of buoy deployments, regional action groups were started to better coordinate buoy activities in particular regions. The following action groups have thus far been accepted by the DBCP (with respective www sites).

1. European group on Ocean Stations EGOS

2. International Arctic Buoy Programmeme IABP

3. International Programme for Antarctic Buoys IABP

4. International South Atlantic Buoy Programme ISABP
(http://dbcp.nos.noaa.gov/l isabp.html)

5. International Buoy Programme for the Indian Ocean IBPIO
(http ://www. shom.fr/meteo/ibpio)

These action groups have to submit annual reports to the DBCP on their activities.

As I have direct involvement in both the ISABP and IBPIO, these two actions groups will be discussed in more detail.

A Brief History

The first preparatory meeting of the ISABP was held in Buenos Aires during December 1993. This was followed by the first programme meeting. The ISABP was accepted as an regional action group of the DBCP meeting in La Jolla, in October 1994. At the same time the first deployment of 25 SVP-B drifter supplied by the USA and SAWB was taking place in the South Atlantic Ocean.

The success shown by the ISABP, prompted the formation of a similar action group for the Indian Ocean. This need resulted in the first preparatory meeting for the IBPIO taking place in Goa, India last year, with the IBPIO being accepted as an action group in the DBCP meeting held in Henley during October 1996.

Programme Objectives of these action groups

Maintain a data network over the Indian/Atlantic ocean using *in situ* ocean platforms, and in particular drifting buoy’s. This network has to satisfy the needs of the different contributors to the programme, but also has to take into consideration of GCOS, GOOS and the WWW. The WWW currently is the only well defined requirement available, and is widely used.

Make arrangements, as necessary, for data collection, dissemination and quality control.

Distribute basic meteorological and oceanographic data from the network on the GTS. All participants of these action groups are encouraged to disseminate the data from their drifters onto the GTS.

Arrange for archival of the data from the network. MEDS, in Canada, and AOML, Miami, serve as principal archival centres for the ISABP and IBPIO.

Liaise on technical aspects of buoy development. This is done on a continual basis by participants.

Continually review the effectiveness of the programme in satisfying data requirements of users. At each annual meeting the performance of the programme, and problems encountered are discussed.

Drifter coverage of the Indian and Atlantic Ocean

Atlantic Ocean

The accompanying map is a snapshot of drifter coverage of the Atlantic ocean as on February the 3rd this year. As can be seen, the coverage over the Atlantic ocean is good, but the Tropical Atlantic is an area in need of more drifter deployments. Brazil will be deploying some drifters in this ocean. The NDBC last year arranged a successful deployment in the Tropical Atlantic before the Hurricane season. This was a blend of FGGE WSD drifters and SVP-B drifters. It is hoped that once the SVP-B WSD drifter has been developed, that more deployments will be done in this region.

Indian Ocean

The Indian ocean is well covered by SVP type drifters, with much fewer barometer drifters. The most of these barometer drifters are drifters that move into the Indian Ocean from the Atlantic Ocean. Some Barometer drifters were deployed near la Reunion before the recent Tropical Cyclone season.

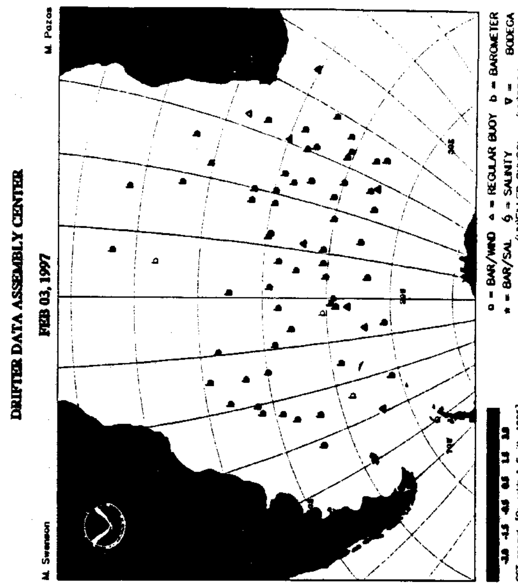
Future Prospects

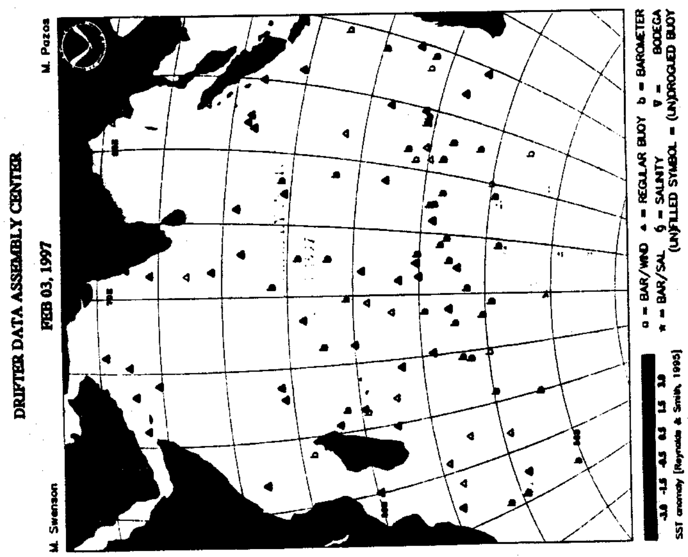
We are looking for more comprehensive guidelines of oceanic data requirements from
GCOS an GOOS

The Buoy community is looking forward to the development of the SVP-B/WSD drifter. This drifter makes use of acoustic technology by calculating wind velocity by “listening” to the noise generated by the wind blowing over the water.

It is hoped to establish some moored buoy’s in the Atlantic and Indian oceans.

More Argos receiving stations in the region wi11 decrease data delay’s, in improve data availability for synoptic purposes.


DRIFTER DATA ASSEMBLY CENTER
FEB 03, 1997
M. Swenson
M. Pazos
o = BAR/WIND △ = REGULAR BUOY b = BAROMETER
* = BAR/SAL ó = SALINITY ∇ = BODEGA
(UN)FILLED SYMBOL = (UN)DROGUED BUOY
SST anomaly (Reynolds & Smith, 1995)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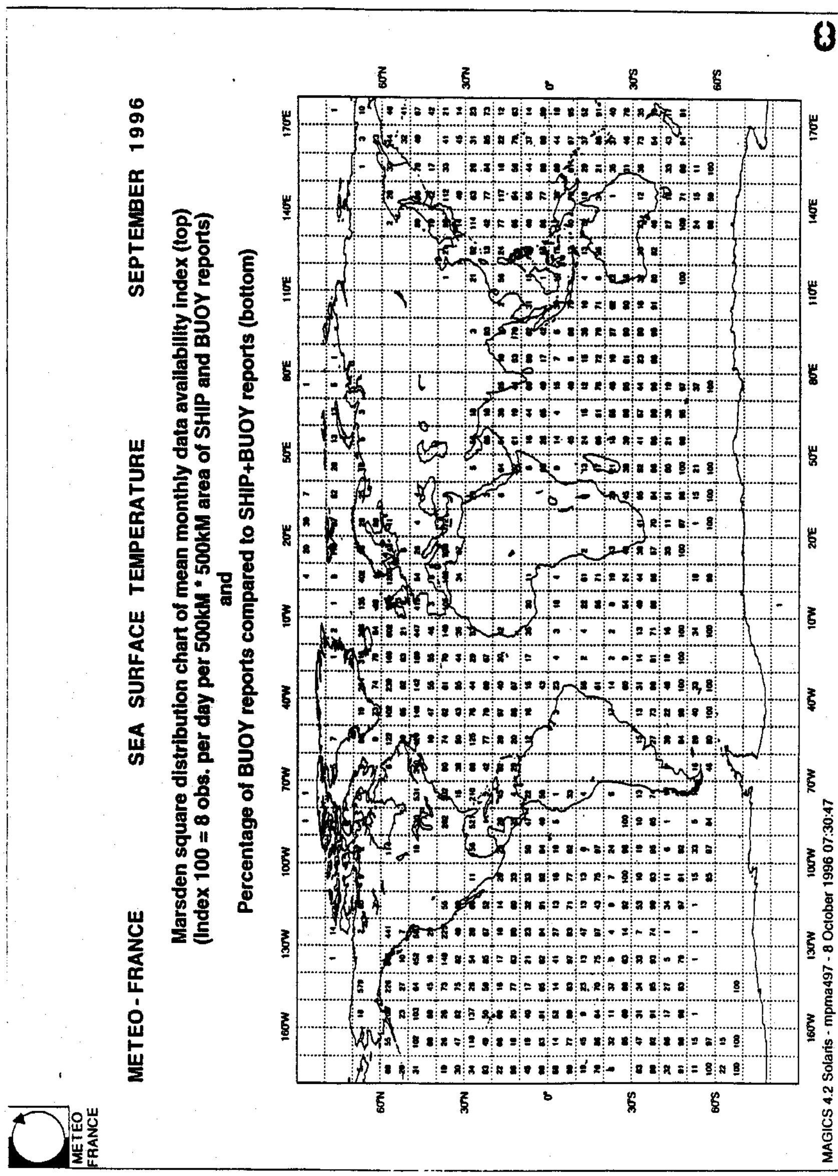
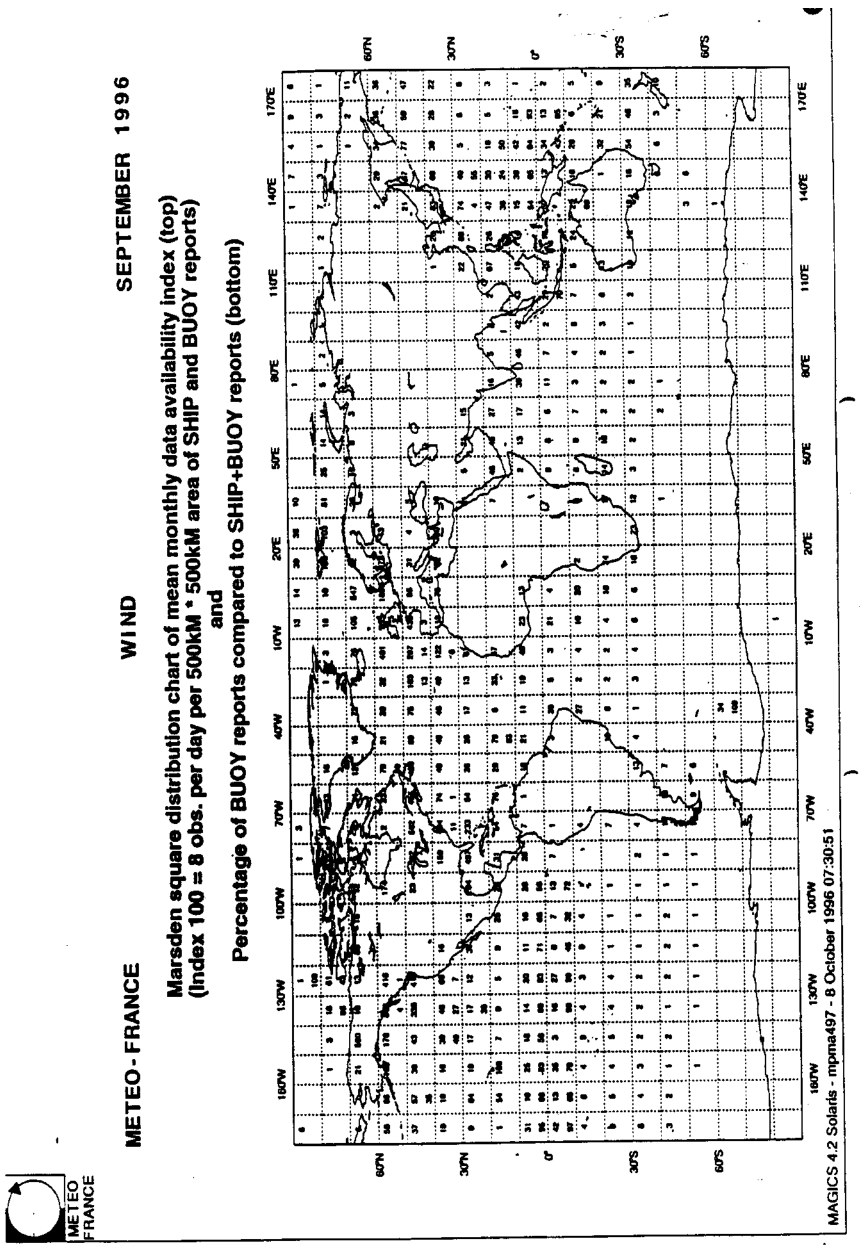
(UN)FILLED SYMBOL = (UN)DROGUED BUOY
SST anomaly (Reynolds & Smith, 1995)

ANNEX VII

GLOBAL COVERAGE OF BUOY AND SHIP REPORTS

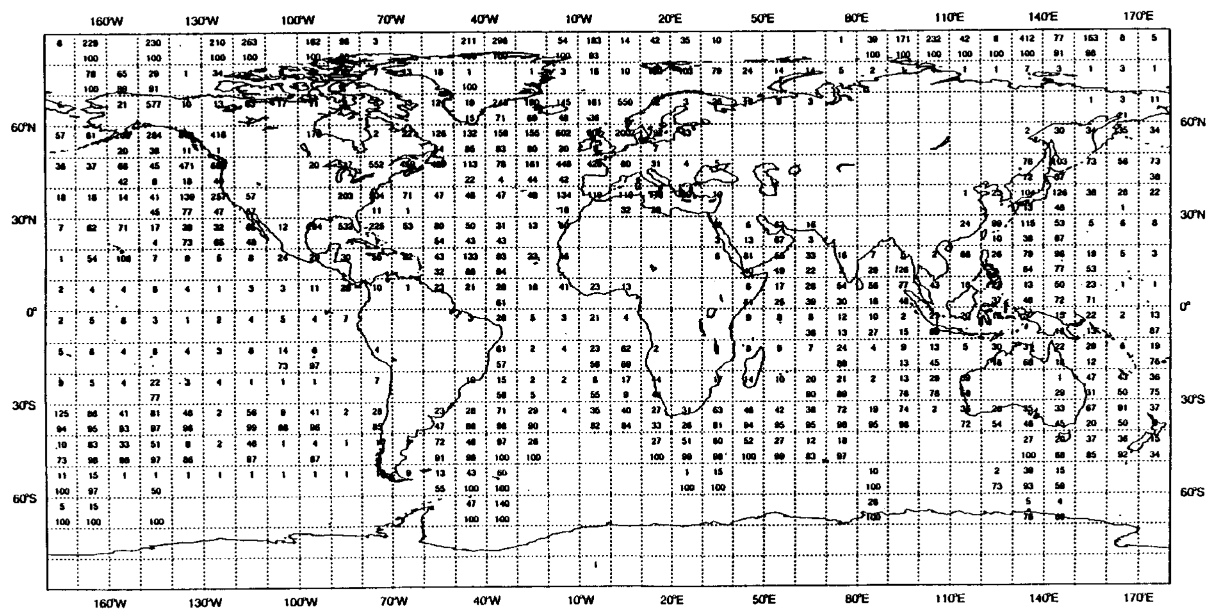



METEO-FRANCE
WIND
SEPTEMBER 1996
Marsden square distribution chart of mean monthly data availability index (top)
(Index 100 = 8 obs. per day per 500kM * 500kM area of SHIP and BUOY reports)
and
Percentage of BUOY reports compared to SHIP+BUOY reports (bottom)
MAGICS 4.2 Solaris - mpma497 - 8 October 1996 07:30:51
METEO FRANCE

METEO FRANCE

METEO-FRANCE **PRESSURE** **SEPTEMBER 1996**

Marsden square distribution chart of mean monthly data availability index (top)
(Index 100 = 8 obs. per day per 500kM * 500kM area of SHIP and BUOY reports)
and
Percentage of BUOY reports compared to SHIP+BUOY reports (bottom)



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ANNEX VIII
(REVISED DRAFT)

A PROPOSAL TO ESTABLISH A GLOBAL IMPLEMENTATION OBJECTIVE WITHIN THE DATA BUOY COOPERATION PANEL
A DBCP Contribution to GCOS/GOOS, CLIVAR, and WWW

Preface

Data buoys at or near the ocean surface are a principal source of information about the conditions and variability of the upper ocean, the surface marine atmosphere and exchanges at the air-sea interface. The present global array of buoys is a complicated blend of individual programmes serving a wide array of research and operational purposes. A new objective of the WMO-IOC Data Buoy Cooperation Panel is proposed to help integrate the individual programmes, harmonize their requirements and especially to coordinate their deployment/implementation strategies.

1. INTRODUCTION

A. Rationale Knowledge of the spatial and temporal variability of certain physical and biogeochemical parameters, including sea surface temperature , upper ocean temperature and salinity, and air-sea fluxes is essential to national and international efforts to improve weather prediction, to assess environmental changes and the state of fisheries and to describe, understand and predict climate variability and change.

Much of what we know today about the upper ocean and the air-sea interface has come from measurements collected by buoys at or near the ocean surface. In 1985 the WMO and the IOC jointly established the Drifting Buoy Co-operation Panel (DBCP), later to become the Data Buoy Co-operation Panel, to contribute significantly to the co-ordination and expansion of drifting buoy programmes in support of the World Weather Watch (WWW), the World Climate Research Program (WCRP) and other national and international meteorological and oceanographic programmes. The Second World Climate Conference, convened in Geneva, Switzerland, from October 20 through November 7 1990, issued a Conference Statement of Scientific/Technical Sessions which included the following:

> "There is an urgent need to create a Global Climate Observing System (GCOS) built upon the World Weather Watch Global Observing System and the Integrated Global Ocean Services System and including both space-based and surface-based observing components. ....Such a GCOS would be based on: (1) an improved WWW Programme; (2) the establishment of a global ocean observing system (GOOS) of the physical, chemical and biological measurements;........... The further development and implementation of the GOOS concept should be pursued with urgency, by scientists, governments and international organizations."

The existing and planned global data buoy programmes are essential elements of the emerging GOOS and their efficient implementation is vital to the success of GCOS. An international mechanism to link the programmes, harmonize their requirements, and especially to coordinate their plans and deployment/implementation strategies is needed to promote that efficiency.

B. Objectives. The DBCP was established in 1985 to, inter alia, coordinate activity on existing buoy programmes and to propose, organize and implement expansions on them or create new ones. The DBCP has been effective in broadly coordinating the wide array of international buoy programmes. However, a sharper focus on specific implementation issues and strategies is required to ensure that buoy deployments and operations are effectively and efficiently integrated. The DBCP is proposing to provide that focus. A new objective of the DBCP thus is:

To Facilitate the Implementation of Existing Data Buoy Programmes and Improve their Global Efficiency by Promoting Close and Frequent Interaction among the Programmes.

Strategies for deployment are a critical aspect of implementation for all data buoy programs. The DBCP will place early and strong emphasis on maximizing the efficiency of global buoy deployments. Joint planning of deployment strategies and sharing of deployment resources will be fostered with an objective of achieving better spatial and temporal coverage with the buoy arrays. This will enable the buoy programmes to better satisfy the ocean and surface marine measurement needs of the WWW, GOOS, GCOS and CLIVAR.

The DBCP recognizes that there are many buoy programme implementation panels and action groups already in existence. It does not intend to take the place of them but rather seeks to coordinate and harmonize their ongoing activities. There may come a time, however, when a single unifying Implementation Panel for data buoys may be appropriate. The DBCP will therefore seek the views of its members and action groups at DBCP 12, on the concept of a single panel and on whether an exploratory process to assess such an expanded role of the DBCP is warranted.

2. CONCEPT, SCOPE, ACTIVITIES AND OPERATING PROCEDURES

A. Concept. The DBCP is not a Programme that deploys buoys. It is a mechanism to provide global coordination of implementation activities for programmes that do. The concept of the new objective is that by assembling in one place detailed information about the implementation plans of the broad array of buoy programmes, analysing that information to assess potential areas for synergy among the programmes and feeding the conclusions back to the programmes for action, a more integrated and efficient global buoy program will result.

The DBCP will conduct this work within the DBCP and it will come under the oversight of one of the DBCP Vice-Chairs. Much of the work will be conducted jointly by the Technical Coordinator (TC) and the designated Vice-Chair in collaboration with the other action groups and national programs. The DBCP will not place additional demands on the current programmes or their implementation bodies but, rather, will use existing reporting mechanisms from those programmes as a primary source of the information needed to produce added value through integration and synergy.

B. Scope. The DBCP will seek to integrate the implementation of as many Action Groups and existing buoy programmes as possible. The scope of the DBCP will thus include but not be limited to: EGOS1, IBPIO1, ISABP1, IPAB1, IABP, TIP, GDC, National Buoy Programs (see Appendix for list of acronyms).

The responsibilities of the individual programs and the Action Groups will remain the same. They will continue to have their own objectives and to develop their own plans and strategies. The DBCP will act as an umbrella or virtual programme that will concentrate on encouraging interaction, integration and synergism among these ongoing efforts.

C. Activities. In specific terms, The TC and designated Vice-Chair working together will gather up-to-date information about the specific buoy programmes by attending the relevant implementation and technical meetings, reviewing implementation and planning documents and by regular interaction with those who are implementing the programmes. This information will be assembled into a continuously updated database and analysed to determine areas of potential collaboration nd resource sharing among the buoy programmes. The programmes will be informed of the results of these analyses by DBCP reports to them and they will be asked to report back to the Panel on any actions taken. Thus, new central functions of the DBCP are as follows:

(i) Actively participate in the deployment/implementation strategy planning sessions for individual programmes and promote, as appropriate, the international cross-fertilization of the strategies.

(ii) Maintain a database of program information in a uniform format for all buoy programs. The database will include: Program Description, Requirements, Customers, Participants, Implementation Mechanism(s), Deployment Strategies, Status and Plans. Make the database information available on the DBCP Web Server.

(iii) Analyse the buoy programme information to identify areas for collaboration and inform the programmes of the analysis results with recommendations for action.

(iv) Provide assistance as needed to strengthen individual programmes by promoting interaction among them.

A useful measure of the value of the data buoy programmes is the impact of the data collected by them on the operational analyses and forecasts. Although performing impact or sensitivity studies is beyond the scope of the new proposed DBCP activities, it can provide assistance in this area by helping to coordinate the impact studies that are underway and planned within the national programs and by acting as a clearinghouse for the results by making that information available on the DBCP Web Server.

D. Operating Procedures. The TC and the designated Vice-Chair will prepare an annual plan of work for the DBCP that is consistent with the above functions and submit it for approval to the annual meeting of the Panel. The work plan will include the schedule of meetings to attend, a list of specific tasks to be undertaken and the expected deliverables from those tasks. The TC and the designated Vice-Chair will meet informally on frequent occasions to review the tasks, assess progress and make any necessary course corrections in the work plan.

The success of the Programme will be evaluated regularly by the DBCP on the basis of written reports and verbal presentations at the annual meeting.

3. RELATIONSHIPS TO OTHER PROGRAM AND PANELS

A central issue for the DBCP is what is its role vis-a-vis other similar bodies like, for example, the TAO Implementation Panel. As it is initially conceived, the DBCP fully supports the continuation of the existing bodies and panels, their functions and their responsibilities. What the DBCP provides is a productive international framework through which the existing bodies can work together easily and more closely and which can produce an integrated global buoy programme that is greater than the sum of its parts.

It is likely that for the next several years the DBCP role will be limited to this type of coordination and it will not assume any of the functions or responsibilities of the existing implementation bodies or panels.

The international GOOS structure calls for a GOOS Technical Implementation Panel, although that has not yet been established. In fact, the Intergovernmental GOOS (I-GOOS) Committee is still considering the question of having a single Technical Implementation Panel versus a series of smaller "platform oriented" Panels. If the DBCP can demonstrate success in its work as outlined above then it would be a likely candidate to be a single panel that would eventually represent the implementation of all global data buoy programmes within the GOOS or I-GOOS structure.

4. ENDORSEMENTS AND APPROVAL

The plan described herein is a proposed DBCP contribution to GOOS/GCOS, CLIVAR and the WWW. Upon approval of the proposal by the DBCP (WMO and IOC), endorsement of these new activities will be requested from each of those Programs before they are formally implemented.

APPENDIX
List of Acronyms

CLIVAR	Climate Variability
DBCP	Data Buoy Cooperation Panel
EGOS	European Group on Ocean Stations
GCOS	Global Climate Observing System
GDC	Global Drifter Centre
GOOS	Global Ocean Observing System
IABP	International Arctic Buoy Program
IBPIO	International Buoy Program in the Indian Ocean
I-GOOS	Intergovernmental GOOS
IOC	Intergovernmental Oceanographic Commission
IPAB	International Programme for Antarctic Buoys
ISABP	International South Atlantic Buoy Program
PMOC	Principal Meteorological or Oceanographic Centre - for QC of GTS buoy data
RNODC	Responsible National Oceanographic Data Centre
SVP DAC	Surface Velocity Program Data Assembly Centre
TC	Technical Coordinator
TIP	TAO Implementation Panel
WCRP	World Climate Research Program
WMO	World Meteorological Organization
WWW	World Weather Watch

ANNEX IX

XBT REQUIREMENTS VS DEPLOYMENTS STATISTICS

SUMMARY OF XBT RESOURCES & REQUIREMENTS

ATLANTIC

	1995		1996		1997	
REQ'D XBTs	NO. OF XBTS	NO. OF TRANS	NO. OF XBTs	% OF REQ'D NO.	NO. OF XBTs	% OF REQ'D NO.
11,260	7,895	294	7,230	64.21	6,000	53.29

INDIAN

	1995		1996		1997	
REQ'D XBTs	NO. OF XBTS	NO. OF TRANS	NO. OF XBTs	% OF REQ'D NO.	NO. OF XBTs	% OF REQ'D NO.
6,490	4,222	159	3,450	53.2	3,280	50.5

PACIFIC

	1995		1996		1997	
REQ'D XBTs	NO. OF XBTS	NO. OF TRANS	NO. OF XBTs	% OF REQ'D NO.	NO. OF XBTs	% OF REQ'D NO.
25,310	17,539	539	16,605	65.6	13,985	55.3

TOTAL

	1995		1996		1997	
XBTs	XBTS	TRANS	XBTs	REQ'D NO.	XBTs	REQ'D NO.
43,060	29,656	992	27,285	63.4	23,265	54.0

PACIFIC OCEAN

LINE	ROUTE	(a) XBTs NEEDED	(b) XBTs in 1996	DIFF (b-a)	(c) XBTs in 1997	DIFF (c-a)
PX01	California - Indonesia	860	865	5	865	5
PX02	Flores Sea - Torres Strait	320	80	(240)	0	(320)
PX03	Coral Sea	160	360	200	0	(160)
PX04	Japan - Kiribati - Fiji/Samoa	500	230	(270)	0	(500)
PX05	Japan - New Zealand	560	440	(120)	290	(270)
PX06	Suva, Fiji - Auckland	160	370	210	260	100
PX07	Auckland, NZ - Seattle		0		0	
PX08	Auckland - Panama	700	930	230	930	230
PX09	Hawaii - Noumea/Auckland	440	1075	635	1075	635
PX10	Hawaii - Guam/Saipan	440	980	540	980	540
PX11	Flores Sea - Japan	320	0	(320)	0	(320)
PX12	Tahiti - Coral Sea	370	630	260	0	(370)
PX13	New Zealand - California	770	815	45	815	45
PX14	Alaska - Cape Horn	1080	1530	450	1530	450
PX15	Ecuador - Japan	960	0	(960)	0	(960)
PX16	Peru - Hawaii	680	0	(680)	0	(680)
PX17	Tahiti/Mururoa - Panama	530	600	70	0	(530)
PX18	Tahiti - California	440	700	260	700	260
PX20	California - Panama	370	0	(370)	0	(370)
PX21	California - Peru	500	0	(500)	0	(500)
PX22	Panama - Valparaiso	360	0	(360)	0	(360)
PX23	Mexico - 115W	60	0	(60)	0	(60)
PX24	Panama - Indonesia	1200	0	(1,200)	0	(1,200)
PX25	Valparaiso - Japan/Korea	1320	0	(1,320)	0	(1,320)
PX26	TRANSPAC	5500	2000	(3,500)	2000	(3,500)
PX27	Guayaquil - Galapagos	120	80	(40)	120	0
PX28	Tahiti - Sydney/Auckland	240	0	(240)	0	(240)
PX29	Tahiti - Valparaiso	560	0	(560)	0	(560)
PX30	Brisbane - Noumea	120	20	(100)	0	(120)
PX31	Sydney - Noumea - California	880	380	(500)	340	(540)
PX33	Hobart - Macquarie Island	130	0	(130)	0	(130)
PX34	Sydney - Wellington	140	0	(140)	0	(140)
PX35	Melbourne - Dunedin	140	0	(140)	0	(140)
PX36	Christchurch - McMurdo	400	0	(400)	0	(400)
PX37	Hawaii - California	340	360	20	360	20
PX38	Hawaii - Alaska	320	540	220	540	220
PX39	Hawaii - Seattle/Vancouver	320	710	390	710	390
PX43	Hawaii - Marshall Is. - Guam	440	0	(440)	0	(440)
PX44	Taiwan - Guam	160	300	140	300	140
PX45	Surtropac (Noumea, N. Caldonia)		0	0	0	0
PX47	Alaska - California		0	0	0	0
PX49	Japan/Taiwan - Singapore		150	150	150	150
PX50	Valparaiso - Auckland	720	1720	1,000	1720	1,000
PX51	Taiwan/Mindanao - Coral Sea/New Caledonia	360	70	(290)	0	(360)
PX52	Japan - Fiji	540	100	(440)	0	(540)
PX53	Taiwan/Mindanao - Fiji	540	270	(270)	0	(540)
PX55	Melbourne - Wellington		0	0	0	0
PX56	Brisbane - Dunedin		0	0	0	0
PX57	Brisbane - Wellington		0	0	0	0
PX76	Costa Rica Coast	60	0	(60)	0	(60)
PX77	Peru Coastal	60	0	(60)	0	(60)
PX78	Peru Coastal	60	0	(60)	0	(60)
PX79	Valparaiso - 80W	60	0	(60)	0	(60)
	UNNUMBERED LINES:			0		0
(PX05)	Hong Kong - New Zealand		300		300	
	TOTAL PACIFIC OCEAN:	25,310	16,605	(9,005)	13,985	(11,625)

INDIAN OCEAN						
		(a) XBTs	*(b) XBTs*	*DIFF*	*(c) XBTs*	*DIFF*
LINE	*ROUTE*	*NEEDED*	*in 1996*	*(b-a)*	*in 1997*	*(c-a)*
IX01	Fremantle - Sunda Straits	240	0	(240)	0	(240)
IX02	Cape of Good Hope - Fremantle	520	575	55	575	55
IX03	Red Sea - Mauritius/La Reunion	240	390	150	0	(240)
IX06	Mauritius/La Reunion - Malacca Strait	340	440	100	770	430
IX07	Cape of Good Hope - Persian Gulf	480	575	95	575	95
IX08	Mauritius - Bombay	320	315	(5)	315	(5)
IX09	Fremantle - Persian Gulf	650	280	(370)	280	(370)
IX10	Red Sea - Malacca Strait/Singapore	310	270	(40)	160	(150)
IX11	Calcutta - Java Sea	320	0	(320)	0	(320)
IX12	Fremantle - Red Sea	700	0	(700)	0	(700)
IX14	Bay of Bengal	140	0	(140)	0	(140)
IX15	Mauritius - Fremantle	380	0	(380)	0	(380)
IX16	Mombasa - Singapore		0		0	
IX17	Mombasa - Karachi		0		0	
IX18	Mombasa - Bombay	220	0	(220)	0	(220)
IX19	La Reunion - Amsterdam/Kerguelen	240	0	(240)	0	(240)
IX20	Mauritius - Rodriguez		0	0	0	0
IX21	Cape of Good Hope - Mauritius	180	345	165	345	165
IX22	Fremantle - Timor Strait/Banda Sea	120	0	(120)	0	(120)
IX23	Hobart - Casey Station (Antarctica)	180	0	(180)	0	(180)
IX25	Mauritius - Karachi	360	0	(360)	0	(360)
IX26	Red Sea - Karachi	190	0	(190)	0	(190)
IX27	Mombasa - La Reunion		0		0	
IX28	Hobart - Dumont D'Urville (Antarctica)	180	260	80	260	80
IX29	Macquarie Island - Casey Station (Antarctica)	180	0	(180)	0	(180)
IX30	Hobart - Macquarie Island		0	0	0	0
IX31	Melbourne - Freemantle		0	0	0	0
	UNNUMBERED LINES:		0	0	0	0
	TOTAL INDIAN OCEAN:	6,490	3,450	(3,040)	3,280	(3,210)

ATLANTIC OCEAN						
		(a) XBTs	*(b) XBTs*	*DIFF*	*(c) XBTs*	*DIFF*
LINE	*ROUTE*	*NEEDED*	*in 1996*	*(b-a)*	*in 1997*	*(c-a)*
AX01	Greenland - Scotland/Denmark	160	60	(100)	160	0
AX02	Newfoundland - Iceland	200	400	200	400	200
AX03	Europe - New York	400	650	250	470	70
AX04	New York - Gibraltar/Lisbon	440	390	(50)	390	(50)
AX05	Europe - Panama Canal	650	0	(650)	0	(650)
AX06	New York - Dakar	420	0	(420)	0	(420)
AX07	Gulf of Mexico - Gibraltar	520	1290	770	1290	770
AX08	New York - Cape of Good Hope	960	910	(50)	910	(50)
AX09	Trinidad - Gibraltar	500	0	(500)	0	(500)
AX10	New York - Trinidad/Caracas	200	245	45	245	45
AX11	Europe - Brazil	560	710	150	300	(260)
AX12	Europe - Antartica	800	800	0	800	0
AX13	Rio - Monrovia (Liberia)	200	0	(200)	0	(200)
AX14	Rio - Lagos (Nigeria)	310	455	145	455	145
AX15	Europe - Cape of Good Hope	650	260	(390)	0	(650)
AX16	Rio - Walvis Bay	420	0	(420)	0	(420)
AX17	Rio - Cape of Good Hope	430	0	(430)	0	(430)
AX18	Buenos Aires - Cape of Good Hope	480	0	(480)	0	(480)
AX19	Cape Horn - Cape of Good Hope	480	0	(480)	0	(480)
AX20	Europe - French Guyana	440	480	40	0	(440)
AX21	Rio - Pointe Noire/Luanda	400	0	(400)	0	(400)
AX22	Argentina - Antarctica	220	0	(220)	0	(220)
AX23	Gulf of Mexico		0		0	
AX25	Cape of Good Hope - Antarctica	220	0	(220)	0	(220)
AX26	Lagos, Nigeria - Cape of Good Hope	320	0	(320)	0	(320)
AX27	Brazil - Cape Horn	400	0	(400)	0	(400)
AX29	New York - Brazil	360	580	220	580	220
AX32	New York - Bermuda	120	0	(120)	0	(120)
AX33	Boston - Halifax, Nova Scotia		0	0	0	0
AX34	Gulf of Guinea - Caribbean		0	0	0	0
AX35	Cape of Good Hope - Recife		0	0	0	0
	UNNUMBERED LINES:					0
	TOTAL ATLANTIC OCEAN:	11,260	7,230	(4,030)	6,000	(5,260)

XBT INVENTORY BY YEARS

AGENCY	1995 XBTs ATL	1995 XBTs IND	1995 XBTs PAC	1996 XBTs ATL	1996 XBTs IND	1996 XBTs PAC	1997 XBTs ATL	1997 XBTs IND	1997 XBTs PAC
CSIRO		2,452	1,086						
ORSTOM	917	158		1,150	500				
SIO			4,220			4,300		260	4,300
JMA.FSA		306	1,127		520	740		600	740
ORSTOM			2,743			2,660			
BSH	864			1,010			930		
NOS	6,114	1,306	8,363	5,070	2,430	8,825	5,070	2,430	8,825
TOTALS:	7,895	4,222	17,539	7,230	3,450	16,525	6,000	3,290	13,865

XBT INVENTORY BY OCEANS

AGENCY	ATLANTIC 95	ATLANTIC 96	ATLANTIC 97	INDIAN 95	INDIAN 96	INDIAN 97	PACIFIC 95	PACIFIC 96	PACIFIC 97
CSIRO									
ORSTOM	917	1,150		158	500				
SIO							4,220	4,300	4,300
JMA.FSA				306	520	600	1,127	740	740
ORSTOM							2,743	2,660	
BSH	864	1,010	930						
NOS	6,114	5,070	5,070	1,306	2,430	2,430	8,363	8,825	8,825
TOTALS:	7,895	7,230	6,000	1,770	3,450	3,030	16,453	16,525	13,865

ANNEX X

SOME PRELIMINARY IDEAS ON HOW TO MONITOR THE AMPLITUDE AND SPATIAL PATTERN OF LONG TERM SEA LEVEL CHANGE, AND WHAT PRODUCTS COULD BE MADE AVAILABLE

1. THE OBSERVATION NETWORK

For observing and monitoring the amplitude and spatial pattern of long term sea level change over the world ocean, we have now at our disposal complementary systems working in an operational mode.

1.1 PRECISION ALTIMETRY (TOPEX/POSEIDON TYPE)

High precision altimetry is a new and revolutionary observation technique made available only recently, with the launch of the TOPEX/POSEIDON (T/P) satellite mission , in 1992. The advantage of the new technique is that it allows the whole ocean to be observed with a resolution of a few tens to some hundreds of kilometers, with a time coverage of days to a few tens of days.

The principle of the altimeter measurement relies on the onboard radar altimeter which measures the altitude of the satellite above the instantaneous sea surface. The height of the instantaneous sea surface above a reference ellipsoid is the difference between the radial orbit component, computed independently (from precise orbit determination), and the altimeter measurement.

For T/P, orbit and altimeter accuracies are estimated to be 3.5 cm and 3.2 cm respectively, resulting in an absolute accuracy of 4.7 cm for the determination of the geocentric sea level (Fu et al, 1994). The global coverage of the T/P ground tracks is from 66° N to 66° S. The largest distance between two tracks is 250 km at the equator, with a time sampling repetitivity of 10 days. For ERS1-2, the resolution is 75 km at the equator, with a repetitivity of 35 days, and a larger coverage at high latitude: 82°. For Geosat follow-on, these numbers are : 160 km, 17 days, 72°.

For the next decade, T/P is supposed to continue operating up to 1999, followed by JASON1, and hopefully then JASON2. The expected life of ERS2 is beyond 2000, with ENVISAT to be launched in 1999. The US Navy Geosat follow-on will also be launched soon. This ensures at least 2 or 3 satellite altmeters flying together up to 2002-2003. Of course this will have to be continued on the long term, probably in an operational mode supported by ocean monitoring applications.

1.2 HIGH-QUALITY *IN SITU* NETWORK OF GAUGES

Measurements of sea level variations with tide gauges have been routine in harbours for shipping since the last century. Most of these data sets have been archived by the Permanent Service on Mean Sea Level, in Bidston, which constitutes a very valuable historical data base for long term sea level variation and trends studies. Over the last decade, efforts have been made in the research oceanographic community to develop high quality in situ sea level gauge networks, within the TOGA, WOCE and GLOSS programmes.

Several types of gauges are used for in-situ sea level measurements. Float tide gauges are the more traditional type of measurement technique, simple and well proven. Acoustic devices avoid the problems associated with moving floats and wires in the traditional gauge, but have their own calibration problems (e.g., temperature of the air). Pressure systems are used in hostile environment areas, but they require simultaneous measurement of atmospheric pressure and sea water density (possibly modelled), and they need particular care to ensure that the data level remains constant.

The accuracy is usually of the order or better than 1 cm, at all times. The accuracy of the referencing in the ITRF is still to be determined. Several networks are now operational.

The WOCE fast-delivery network operates nearly 100 tide gauges, telemetering the data which are made available within a month delay. Note that only a few number of these stations have more than 40 yrs of continuous data records. The data are made available at the fast-delivery center at Hawaii.
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The GLOSS operational network includes about 250 stations well distributed over the world ocean, on islands and along the coasts. Data are delivered with various typical delays of up to 1 year or more. The data are available at BODC in Bidston, UK.

1.3 GEOCENTRIC ABSOLUTE REFERENCING WITH NOW AVAILABLE SYSTEMS

For long-term monitoring of sea level variations and trends, it is necessary to observe the vertical movement of the land on which the gauge stations are settled. This is now possible with the use of the new positioning systems based on satellite techniques.

With the Global Positioning System (GPS), tide gauge bench marks can be fixed in a geocentric reference frame with a day to day repeatability of the order of 10 to 20 mm for the heigh component. Continuous GPS measurements show that over a period of 5-10 years, an accuracy of 1 mm/year can be achieved for the vertical rate of coastal deformation.

DORIS is another new positioning technique, closely related to satellite tracking (like GPS), and particularly important for some of the altimetric missions (T/P, JASON, ENVISAT) because tracking them for precise orbit determination relies on them. The DORIS beacon coverage is uniform over the world, with presently 50 stations positioned in the IERS system; 30 of them are collocated with nearby tide gauges.

2. SOME LEVEL 2 PRODUCTS

2.1 FROM ALTIMETERS

Routine algorithms make it possible to produce level variations at any given location of the world ocean, with the above given accuracy measured by T/P over the years between 1993 to 1997. After removing the high frequency contributions, due mainly to tides, intra-seasonal, annual and interannual variabilities are clearly visible on many typical examples, together with longer term trends.

Variations of the mean sea level on a global scale have also been produced, as measured by T/P between December 1992 and now, 1997. The mean trend adjusted over the 3 years of data is 1.3 mm/yr (result shown with the courtesy of A. Cazenave). The geographical distribution of the sea level trends over the period January 1993 to December 1995 by reference to the mean over the 3-year period is also a type of product which is available. Among the major features that can be observed are the sea-level rise in the western equatorial Pacific and sea-level lowering in the central and eastern equatorial Pacific, which are related to the 1994-1995 El Nino event.

2.2 FROM GAUGES

Sea level trends have been estimated by different investigators on the basis of historic tide-gauge archives (from PSMSL). A synthesis of these results reveals a large scatter, due to the different methods used to estimate the trends from the a priori same data base (choice of stations, methods to correct from the effect of post glacial rebound, etc.). The most probable number is 1.8 mm/year sea level rise since the end of last century.

2.3 POSITION REFERENCING

Already, time evolution of the 3-D coordinates of permanent GPS sites are available. The repeatability of the measurements for the vertical and latitudinal coordinates corresponds to the performances given above, and the coherence of the longitudinal displacement appears to be in agreement with the plate tectonic model (one example shown with courtesy of A. Cazenave).

3. MERGING OF THE PRODUCTS

3.1 THE COHERENCY BETWEEN TIDE GAUGE AND ALTIMETER MEASUREMENTS

The coherency between these two types of measurements has been shown by several researchers. The example of Kwajalein has been shown on the basis of a comparison of tide gauge values of daily mean sea level to T/P anomalies: the rms differences are around 4 cm (courtesy of Woodworth, 1996). Such comparisons can be performed at approximately 50 sites around the world, showing that T/P is indeed measuring with an approximately 4 cm accuracy for a single pass.

Combining the two sources of information provides a product that retains the benefits of both the long-term in situ record and the global coverage of the altimeter, giving useful information on long-term variability and trends, at large space scales. As an example, the understanding of the 90-day oscillations at Wake island given by Mitchum (1995) has been shown.

3.2 TIDE GAUGE NETWORK SHORT-DELAY MODE DATA

Tide gauges reporting on a short delay mode, offer an independent calibration/drift control system for an altimeter mission, and a way for intercalibration of simultaneous or successive missions.

Mitchum (1996) performed a study of the drift of T/P altimeter system, that contributed to revealing the existence of a clock correction error in the T/P data process, by using a subset of the WOCE sea level network station datasets.

3.3 TIDE GAUGE DATA AS AN INDEPENDENT CHECK OF LONG TERM VARIATIONS

Sea level variations associated with climatic changes in the ocean circulation can be independently confirmed with tide gauge long term observations. As an example, the demonstration of the interpentadal variability of the North Atlantic circulation between 1955-1959 and 1970-1974 (Ezer *et al*, 1995) has been shown. Such sea level variations are observable on the collection of tide gauges located along the east coast of North America, and will be observable from long-term satellite altimeter measurements, if any, over the next decade..

3.4 ASSIMILATION OF ALTIMETER AND TIDE GAUGE DATA WITHIN REGIONAL MODELS

Assimilating both types of data into regional models will make it possible to better understand both the signatures of coastal effects at some of the tide gauge locations and the aliasing of the high frequency signals in the altimeter measurements.

ANNEX XI

REGIONAL SIGNALS FOR LONG-RANGE CLIMATE FORECASTS IN SOUTHEAST AFRICA

Mark R Jury
Geography Department, Univ. Zululand, KZNatal, 3886

Recent advances in the understanding and prediction of climatic variability in southern Africa have been made by exploiting statistical relationships between sea surface temperatures (SST) and summer rainfall. The response of the atmospheric convection and circulation over southern Africa to SST anomalies over the adjacent oceans has been assessed using monthly field data in the period 1960-90. Teleconnections have been demonstrated for a convective dipole over Botswana and Mauritius and its associations with SST in the South Atlantic, central Indian Ocean, and the Agulhas Current region. Atmospheric responses include changes in zonal upper winds over the Atlantic and in monsoon convergence over the tropical SW Indian Ocean. The empirical evidence of ocean-atmosphere interaction gained from statistical studies has been corroborated by numerical modelling studies. These GCM experiments have simulated how the El Nino - Southern Oscillation signal is transmitted to SE Africa from an anomalously warm central Indian Ocean. The result is a strengthening of the mid-tropospheric high pressure cell over Botswana which inhibits mid- and late summer rainfall.

To further our understanding of regional ocean-atmosphere interactions, the observational network in the Indian Ocean and South Atlantic needs to be extended both for atmospheric and oceanic variables. Two focal points for such a network are Ascension Island and Seychelles. TOGA-type arrays and intensive experiments would serve a useful purpose to better monitor real-time adjustments in thermocline depth and low-level atmospheric convergence. Whilst the Indian Ocean generally cooperates in-phase with the global El Nino event, the tropical SE Atlantic undergoes El Nino type fluctuations of its own which impact rainfall over the Kalahari. It is concluded that expansion of the global observing system for coupled ocean-atmosphere processes would pay dividends in terms of more reliable long-range forecasts of summer rainfall and associated impacts. These forecasts are already operational but suffer from inadequacies from limited real-time upper ocean and marine atmospheric observations over the South Atlantic and Indian Oceans.

ANNEX XII

THE CHANGING STATE OF THE BENGUELA ECOSYSTEM

L. V. Shannon
Oceanography Department, University of Cape Town

The Benguela is one of four major eastern boundary current systems in the world. Although the oceanography of the western coast of southern Africa is dominated by a coastal upwelling system, like that off Peru, California and north west Africa, the Benguela is unique in that it is bounded on both its equatorward (14ºS) and poleward (37ºS) ends by warm water regimes, viz., the Angola and Agulhas Current systems respectively. With a western boundary approximating to the 0º meridian, the Benguela thus encompasses the coastal upwelling regime, the eastern part of the South Atlantic gyre and a complex system of fronts.

The high leve1 of primary productivity associated with the upwelling (typically 1.2 - 2.0 $gCm^{-2}d^{-1}$) supports an important global reservoir of biodiversity and biomass of fish, sea birds and marine mammals. Species assemblages, however, have many similar generic characteristics to other coastal upwelling systems. The near-shore sediments hold rich deposits of diamonds, phosphorite and diatomite as well as reserves of oil and natural gas.

The Benguela ecosystem displays substantial intra- and inter-annual and decadal variability, and this impacts on the harvested living marine resources, some of which are heavily exploited. Certain stocks have exhibited marked fluctuations and shifts in dominance as a consequence of the inherent natural variability and fishing mortality. Other forms of human activity, e.g., mineral exploitation, coastal development, pollution, are also increasingly impacting on the ecosystem.

There is a strong suggestion that the Benguela ecosystem is responding to large-scale changes in physical forcing. This view is reinforced by comparisons with other upwelling systems where a periodicity in abundances of dominant fish species of around 50 years is indicated from both the fishery and sedimentary record . Based on the available evidence, the following conclusions can be drawn.

(i) A regime shift is taking place in the Benguela ecosystem with an increasing abundance of sardine and a decline in anchovy, and that this is linked to changes in the large-scale wind field and changes in the plankton community structure.

(ii) There is an unexplained mismatch between changes in primary and secondary productivity and abundance of fish resources in the Benguela ecosystem.

(iii) While the ecosystem is well buffered against short term variability, sustained events, which fall well outside the optimal environmental window such as Benguela Ninos, system-wide cooling and Agulhas intrusions, are biologically very important.

(iv) Extreme events on decadal time scales such as Benguela Ninos, which occur on average every ten years, have a significant impact on the fish resources of the northern Benguela. They are predictable in form and in timing and this can be incorporated into resource management strategies.

(v) Extended cool periods are immediately followed by increased depletion of oxygen of shelf waters and precede Benguela Ninos by two to three years.

ANNEX XIII

THE ATOC PROGRAMME WHERE ARE WE NOW?

Geoff Brundrit
Department of Oceanography, University of Cape Town

The Acoustic Thermometry of Ocean Climate (ATOC) Programme exploits the temperature dependence of sound speed to measure water properties over ocean basin scales and thus to make a meaningful contribution to ocean climate predictions. Acoustic thermometry complements the observations from operational satellite altimetry and together they enhance the potential of data assimilation in ocean climate studies.

Despite unfortunate delays in its implementation, ATOC is now forging ahead. The quasi-regular 260W acoustic source located on Pioneer Seamount off California has been operating throughout 1996 with receptions detected routinely throughout the north east Pacific. Analysis of the data is providing climatically relevant information on ever increasing temporal scales; seasonal information at various levels along the transmission paths is now beginning to emerge. There is every expectation that the Kauai source will shortly be deployed, greatly expanding coverage of the north Pacific.

Satellite altimetry on its own possesses inherent limitations as it integrates heat storage in the vertical. The ability of acoustic thermometry to provide information at various depths means that ATOC and satellite altimetry are complementary and both are needed to monitor climate effects. A recent study in the Mediterranean showed how a combination of modelling, altimetry and acoustic tomography combine to provide consistent results for seasonal heat storage. With either altimetry or tomography removed, the results were greatly diminished. As a first step towards the demonstration of a complete system, heat content estimates from ATOC measurements in the north Pacific have been compared with those obtained by constraining the MIT ocean circulation model with Topex Poseidon altimeter data.

ATOC measurements have also been made on an intermittent basis in the western Pacific and in the Arctic Ocean. Acoustic measurements in 1994 across the Arctic showed a significant warming of Arctic Intermediate Water. Arctic Ocean temperature change is impossible to obtain with satellites and is difficult and expensive with ice breakers and submarines. Plans are being made to repeat the measurements in the Arctic and to commence routine measurements in the Indian Ocean in 1998. The latter will bring ATOC into the southern hemisphere and start to provide information from the climatically important Southern Ocean frontal regions. The hope is that, eventually, there will be a fully operational system of global underwater acoustic monitoring.

ANNEX XIV

SATELLITE SCHEDULES

Gravity Recovery and Climate Experiment (GRACE) is a mission with expected launch date in mid 2001. It is a collaboration among the University of Texas at Austin, the Jet Propulsion Laboratory of the California Institute of Technology, the GeoForschunsZentrum-Potsdam, and Space Systems/Loral, Inc. Several other commercial partners are involved, including ONERA-France who would provide accelerometers and the platinum-rhodium proof mass developed for GRADIO.

The mission will consist of two satellites, some 100 to 500 km apart, in low Earth orbit, 450 to 250 km, with amicrowave link between them to measure their relative motion. The whole experiment is planned to last 5 years: the satellites would be placed in the higher orbit, and allowed to decay slowly to the lower altitudes over that time period.

The scientists involved in the mission believe that it will yield the following:

- The geoid derived from GRACE, substracted from TOPEX/Poseidon altimetry, will reduce the uncertainty in estimates of heat flux in the southern oceans by about 30-40 %, and in the North Pacific by 30 %. Elsewhere, the impact will be small.

- When used on ERS-1 and GEOSAT orbit recomputation, the GRACE gravity field will improve the orbit height estimate in those missions to the 1-2 cm error of Topex, which will improve their altimetric residuals and allow multi-year comparisons of sea level across satellite missions.

- The biggest scientific payoff is expected from measuring the time-varying gravity field, about once every 20 days for 5 years. Among these:

- Over the oceans, GRACE will measure changes in ocean bottom pressure (the sum of asmospheric and water columns), whose gradient gives ocean bottom currents. The resolution for useful accuracy is expected to be 2000km

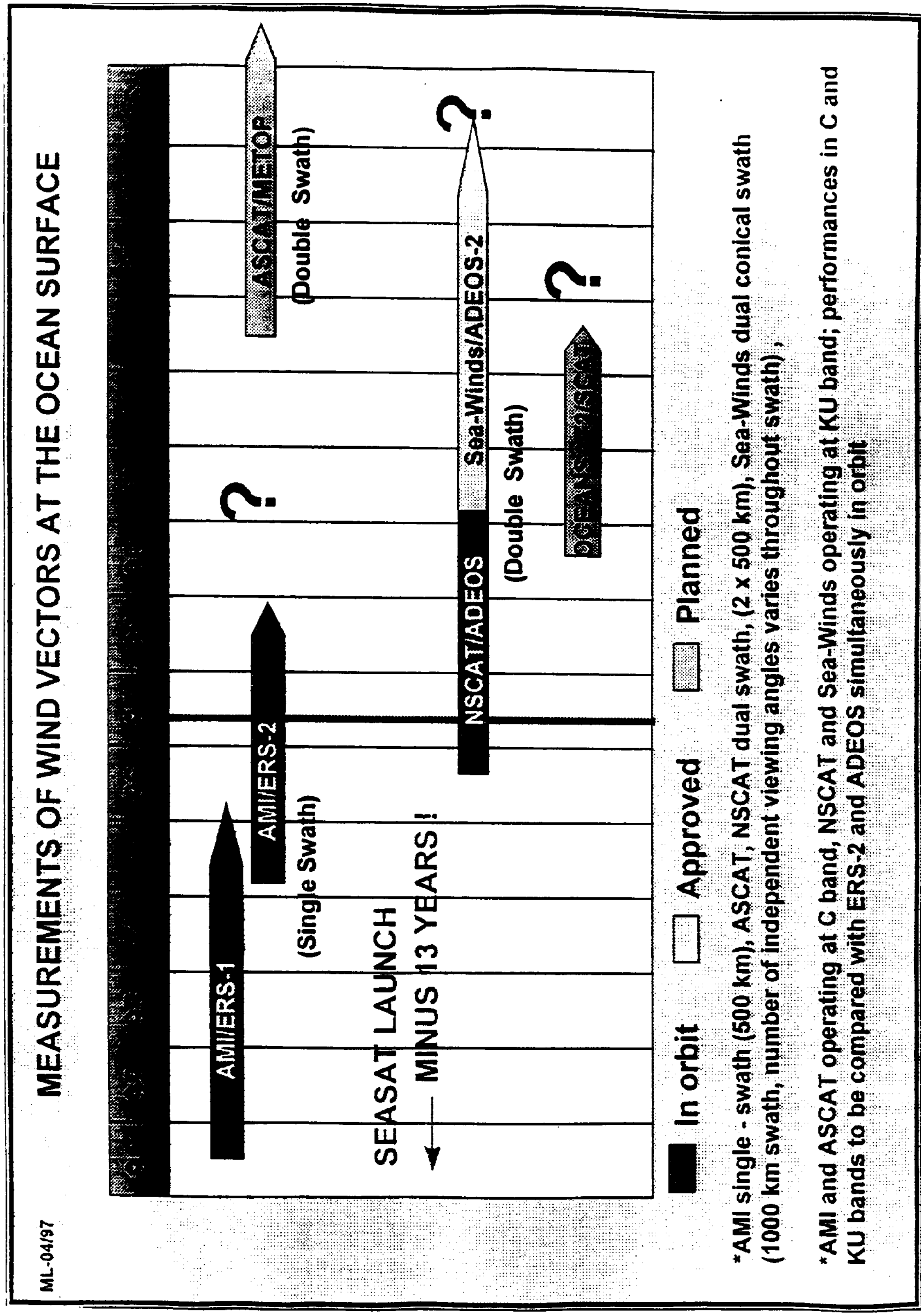
- In Hydrology GRACE will measure the residence time of precipitation remaining in a broad region. Combined with independent estimates of precipitation and runoff, we will compute evapotranspiration averaged over broad continental regions. The measurement resolution is 2.5 cm over 10 days for a region 1/3 the size of the continental US.

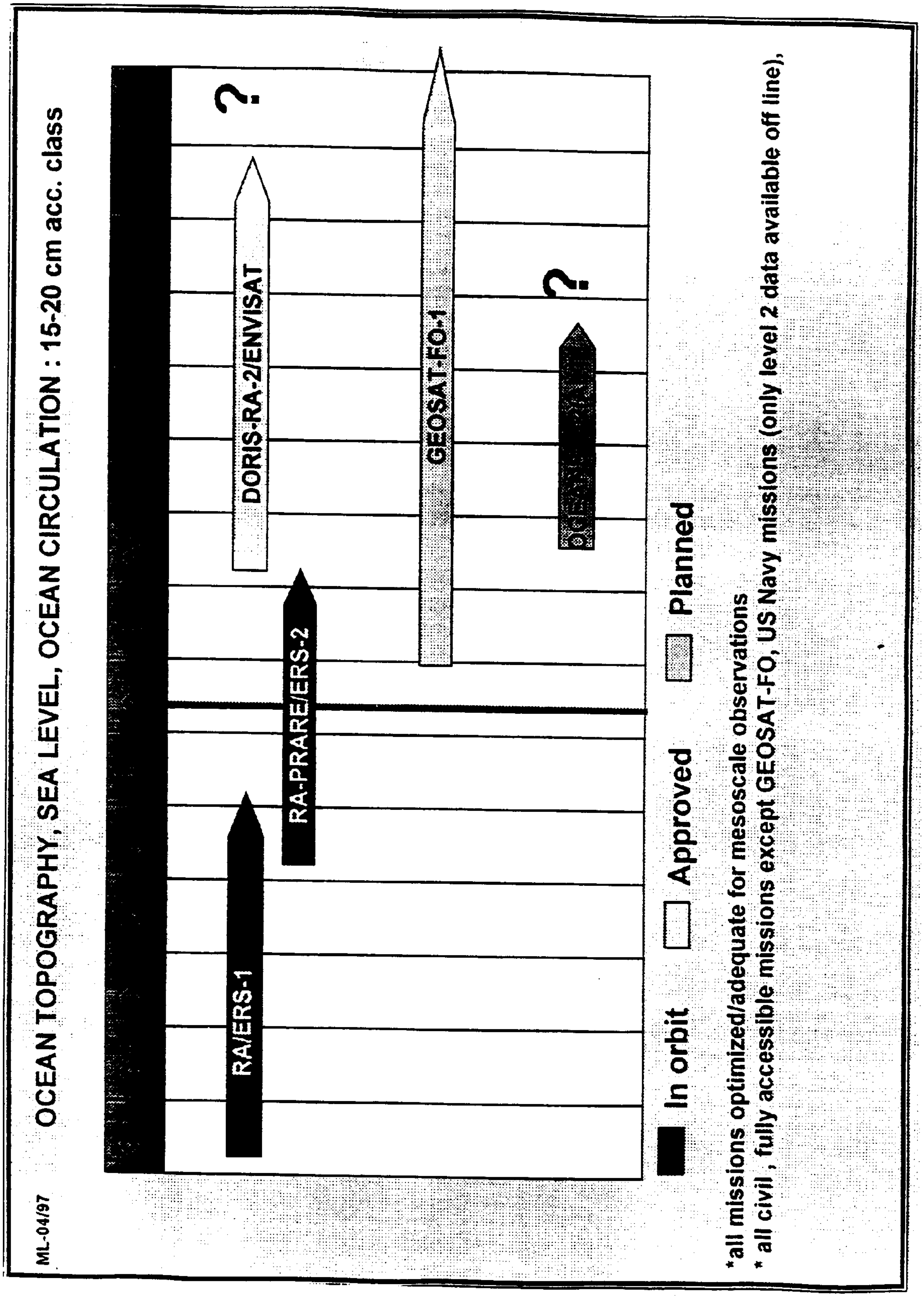
- Seasonally-varying snow volumes can be determined to about 9 cm of snow.
- Glaciology: GRACE will be able to detect secular changes in ice thickness over Antarctica of 0.4 mm/yr; over Greenland: 2 mm/yr.

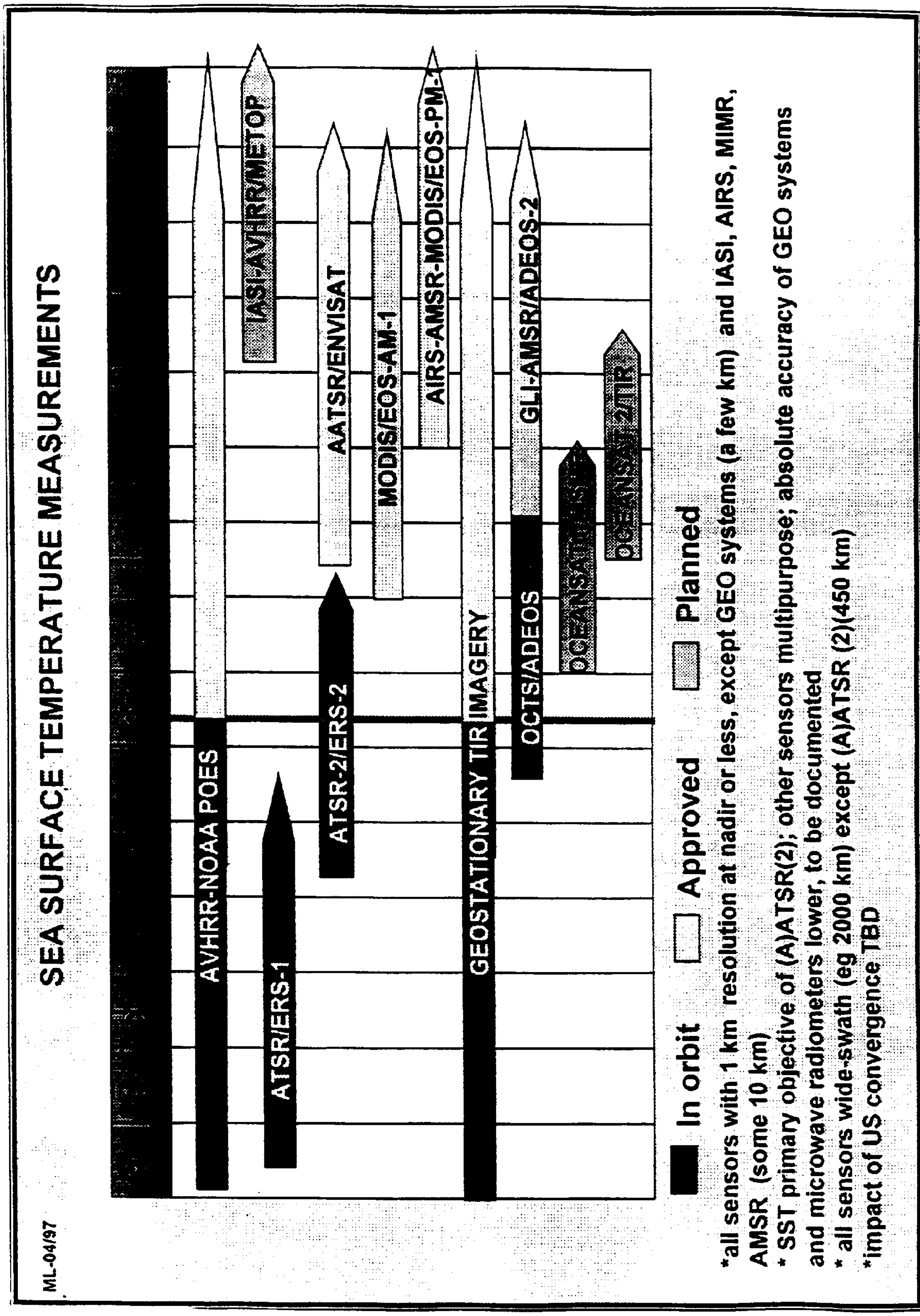
- Solid Earth: GRACE accuracy for the time-averaged gravity field is 1 cm over 200 km, much better than the 20 cm over 1000 km needed to address questions of the trajectory of subducted slabs, and visco-elastic response models following the last ice age.

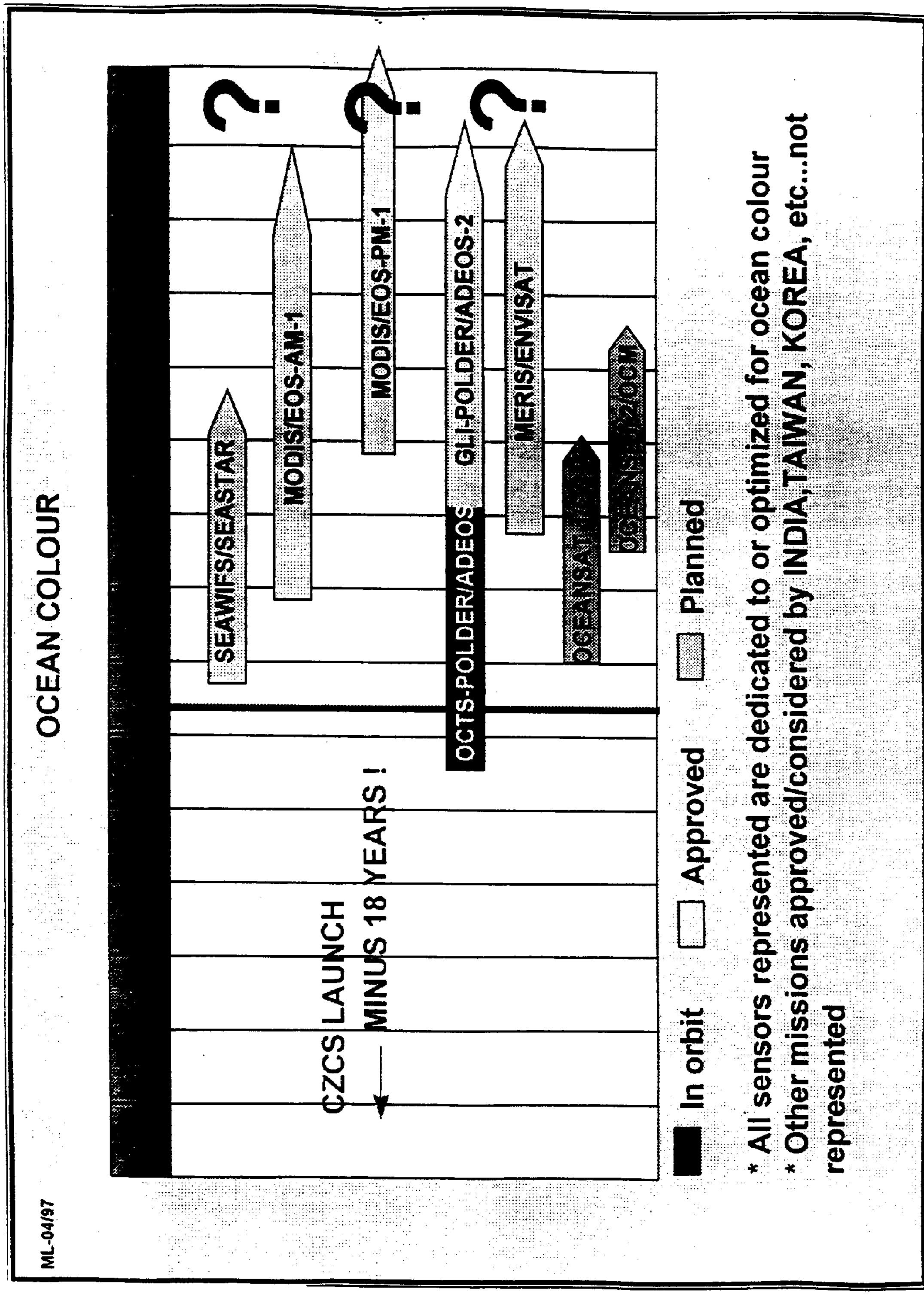
An additional experiment on GRACE is GPS occultation: since GPS receivers are aboard both satellites, GRACE will provide atmospheric temperature profiles with sub-Kelvin, sub-km vertical resolution by GPS limb sounding techniques.

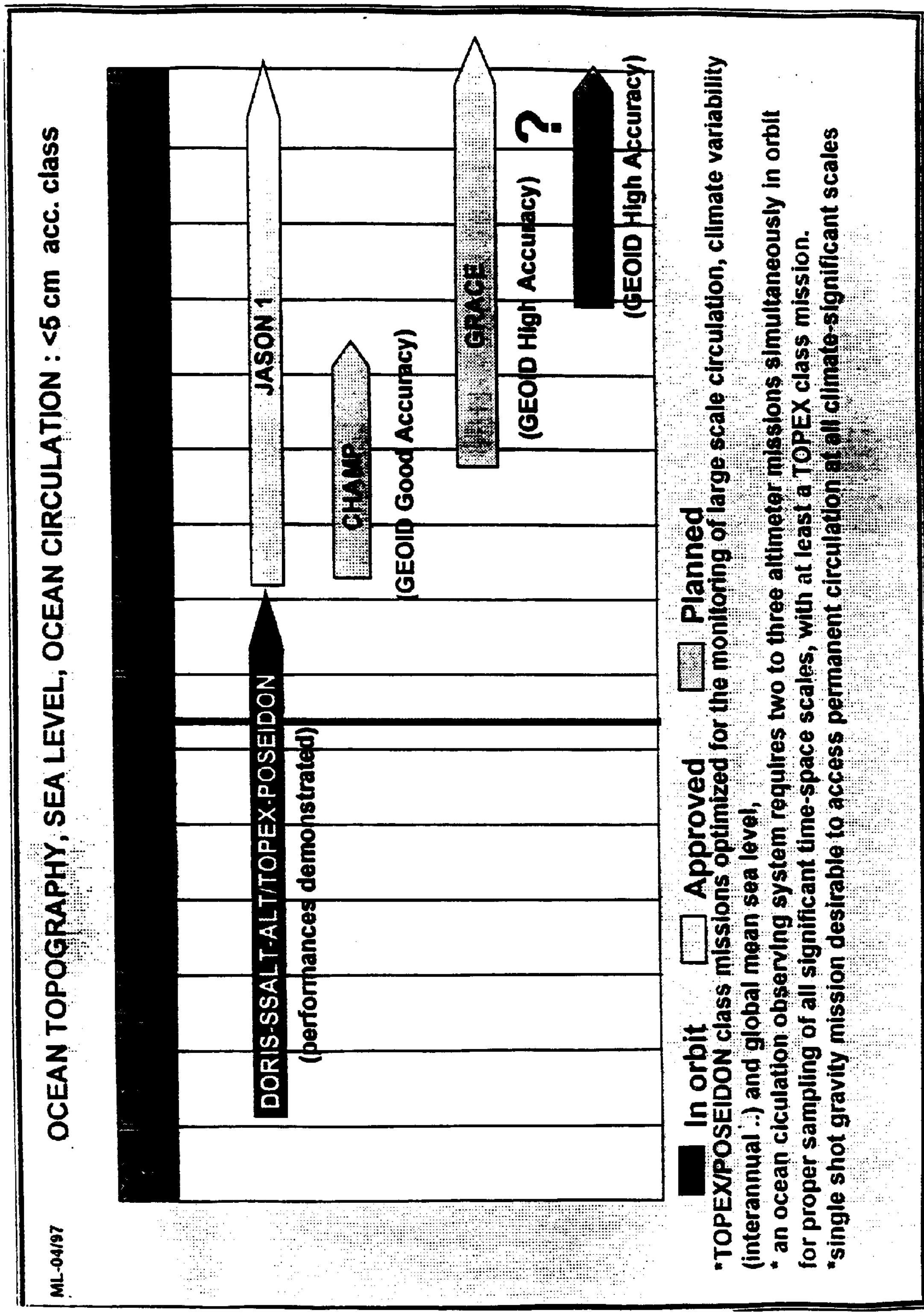
The US team is headed by Prof. Byron Tapley, U. Texas. The European team is headed by Dr. Chris Reigber, GFZ-Potsdam. The Project Manager is Mr. Ab Davis, JPL.


MEASUREMENTS OF WIND VECTORS AT THE OCEAN SURFACE
AMI/ERS-1
AMI/ERS-2
(Single Swath)
NSCAT/ADEOS
Sea-Winds/ADEOS-2
(Double Swath)
ASCAT/METOP
(Double Swath)
SEASAT LAUNCH
MINUS 13 YEARS !
In orbit
Approved
Planned
*AMI single - swath (500 km), ASCAT, NSCAT dual swath, (2 x 500 km), Sea-Winds dual conical swath (1000 km swath, number of independent viewing angles varies throughout swath) ,
*AMI and ASCAT operating at C band, NSCAT and Sea-Winds operating at KU band; performances in C and KU bands to be compared with ERS-2 and ADEOS simultaneously in orbit
ML-04/97


ML-04/97
OCEAN TOPOGRAPHY, SEA LEVEL, OCEAN CIRCULATION : 15-20 cm acc. class
RA/ERS-1
RA-PRARE/ERS-2
DORIS-RA-2/ENVISAT
GEOSAT-FO-1
?
?
In orbit
Approved
Planned
*all missions optimized/adequate for mesoscale observations
* all civil , fully accessible missions except GEOSAT-FO, US Navy missions (only level 2 data available off line).


SEA SURFACE TEMPERATURE MEASUREMENTS
AVHRR-NOAA POES
ATSR/ERS-1
ATSR-2/ERS-2
GEOSTATIONARY TIR IMAGERY
OCTS/ADEOS
IASI-AVHRR/METOP
AATSR/ENVISAT
MODIS/EOS-AM-1
AIRS-AMSR-MODIS/EOS-PM-1
GLI-AMSR/ADEOS-2
In orbit
Approved
Planned
*all sensors with 1 km resolution at nadir or less, except GEO systems (a few km) and IASI, AIRS, MIMR, AMSR (some 10 km)
* SST primary objective of (A)ATSR(2); other sensors multipurpose; absolute accuracy of GEO systems and microwave radiometers lower, to be documented
* all sensors wide-swath (eg 2000 km) except (A)ATSR (2)(450 km)
*impact of US convergence TBD
ML-04/97


OCEAN COLOUR
CZCS LAUNCH
MINUS 18 YEARS !
SEAWIFS/SEASTAR
MODIS/EOS-AM-1
MODIS/EOS-PM-1
OCTS-POLDER/ADEOS
GLI-POLDER/ADEOS-2
MERIS/ENVISAT
OCEANSAT
In orbit
Approved
Planned
* All sensors represented are dedicated to or optimized for ocean colour
* Other missions approved/considered by INDIA, TAWAN, KOREA, etc...not represented
ML-04/97


ML-04/97
OCEAN TOPOGRAPHY, SEA LEVEL, OCEAN CIRCULATION : <5 cm acc. class
DORIS-SSALT-ALT/TOPEX-POSEIDON
(performances demonstrated)
JASON 1
CHAMP
(GEOID Good Accuracy)
GRACE
(GEOID High Accuracy)
?
(GEOID High Accuracy)
In orbit
Approved
Planned
*TOPEX/POSEIDON class missions optimized for the monitoring of large scale circulation, climate variability (interannual ..) and global mean sea level,
* an ocean ciculation observing system requires two to three altimeter missions simultaneously in orbit for proper sampling of all significant time-space scales, with at least a TOPEX class mission.
*single shot gravity mission desirable to access permanent circulation at all climate-significant scales

ANNEX XV

THE TRITON BUOY

Relationship to International Programmes

The TRITON plan will be discussed at international forums and implemented by JAMSTEC with the cooperation of interested countries. The scientific goals of the TRITON project address the observational requirements of international research programme of CLIVAR (Climate Variability and Predictability), a major component of the World Climate Research Programme sponsored by the World Meteorological Organization, the International Council of Scientific Unions, and the Intergovernmental Oceanographic Commission of UNESCO. TRITON project will be a component of the CLIVAR observing system and also contribute to the development of the Global Ocean Observing System (GOOS) and the Global Climate Observing System (GCOS). TRITON implemenetation will begin in the western equatorial Pacific where it will be integrated with the existing TAO(Tropical Atmosphere Ocean) Array, which is presently maintained by the Pacific Marine Environmental Laboratory/National Oceanic and Atmospheric Administration of the United States, in cooperation with France, Chinese Taipei, Korea and Japan.

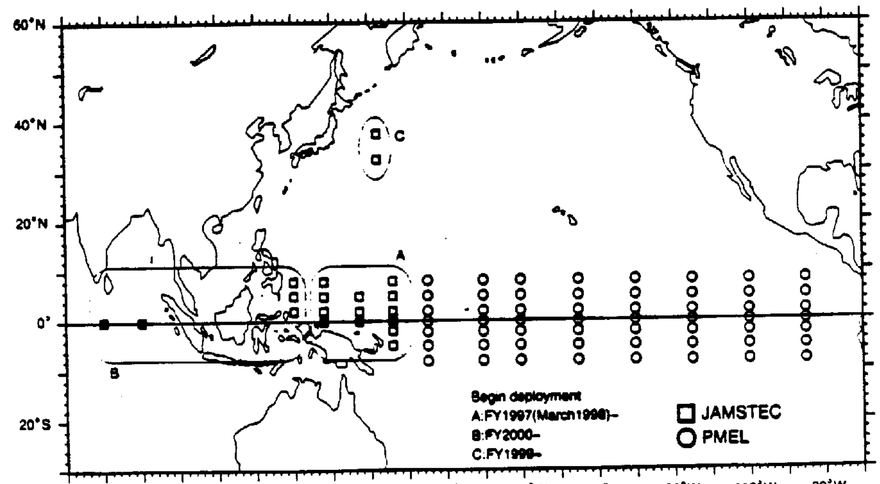
TRITON Development Schedule

FY1994: Conceptual buoy design.
FY1995: Basic buoy design and construction of the prototype buoy. Open sea trial of the low-latitude prototype buoy.
FY1996: "International Workshop on Ocean Climate Variations from Seasons to Decades with Special Emphasis on Pacific Ocean Buoy Network", in May 1996 at Mutsu. Continuation of the open sea trial of the low-latitude prototype buoy. Construction of the buoy maintenance building at the mother port of R/V "Mirai" at Mutsu.
FY1997: Launching R/V "Mirai". Open sea trial of mid- and high-latitude prototype buoy.

Deployment schedule

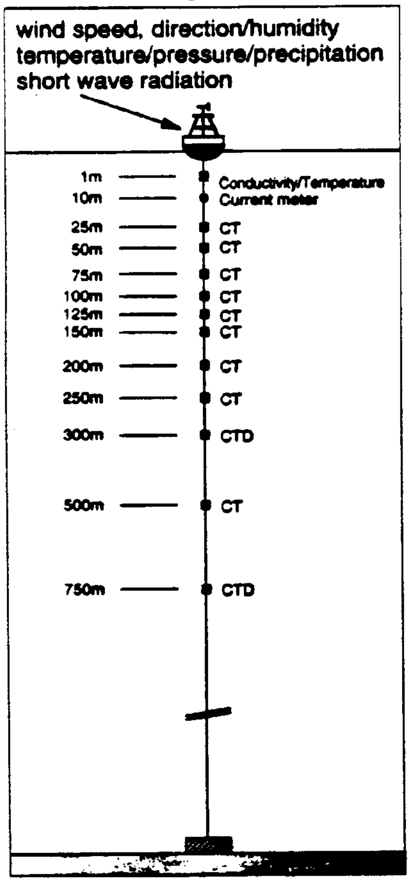
Region A: Begin deployment in FY1997 (Mar 1998) harmonized with TAO array and completed in FY1999.
TRITON buoys will enhance the capability of TAO buoys in the warm pool region by carrying salinity sensors down to 750m and full meteorological sensors, and be deployed in order to obtain long-term data for process studies on ENSO.
Region B: Begin deployment in FY2000.
TRITON buoys focusing on oceanic change and air-sea interaction associated with Asian monsoon in the far western Pacific Ocean and the eastern Indian Ocean.
Region C: Begin deployment in FY1999.
TRITON buoys focusing on intermediate water formation and air-sea interaction in the frontal region between the subtropical gyre and the subpolar gyre.

Proposed buoy array

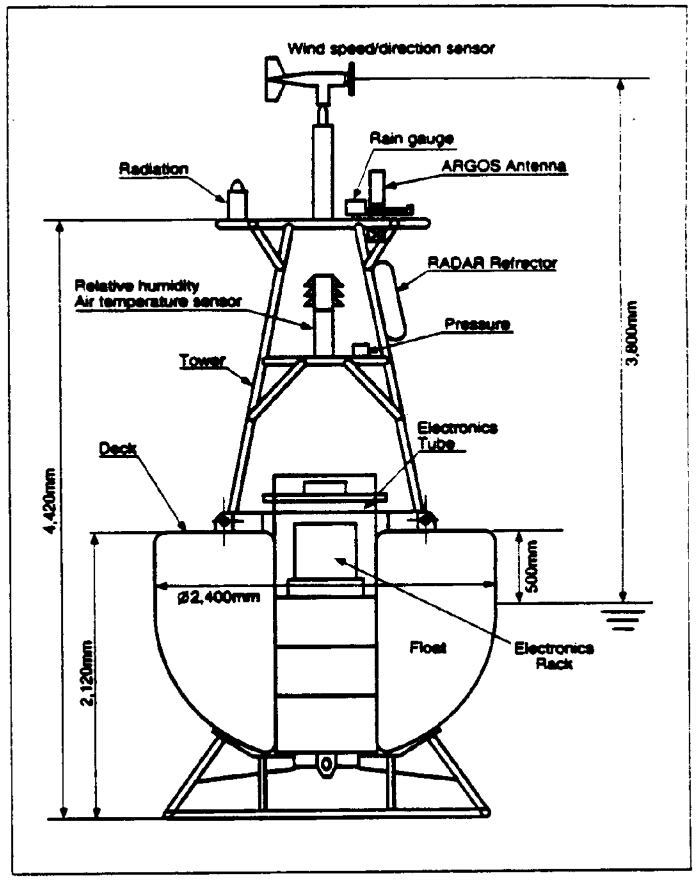


Buoy Specifications

Configuration of the low latitude buoy



Configuration of float



Sensor specifications

SENSOR		RANGE	RESOLUTION	ACCURACY
Wind speed		0~60m/s	0.1m/s	0.3m/s
Wind direction		0°~360°	0.7°	5°
Shortwave radiation		0~1400W/m²	0.1W/m²	0.5%
Relative humidity		0~100%RH	0.1%RH	1%RH
Air temperature		-20~+55℃	0.01℃	0.1℃
Precipitation gauge		0~500mm/h	0.001mm	5%
Barometric pressure		800~1100hPa	0.0038%	0.01%
CTD	Conductivity	0~70ms/cm	0.001ms/cm	0.003ms/cm
	Temperature	-3~+33℃	0.0006℃	0.002℃
	Depth	0~1,000psia	0.003% F.S.	0.15% F.S.
Current speed		0~1000cm/s	0.1cm/s	1%, 0.5cm/s

Data sampling and real time data transmission

Under water data transmission:

Inductivecoupling data communication method

Satellite data transmission:

ARGOS system.

The minimum sampling rate for all sensors will be every 10 minutes, and hourly averaged data be transmitted in real time.

ANNEX XVI

MONITORING OF THE KUROSHIO

by Masaki Kawabe

The Kuroshio, the western boundary current in the subtropical gyre of the North Pacific, flows in the East China Sea and the southern region of Japan with a large variability of current path and velocity (Fig. 1). Monitoring of the Kuroshio path is important for not only oceanography but also a practical aspect of fisheries, ship navigation, and so on. On the other hand, the Kuroshio carries a large amount of heat. The heat is converged in the current and partly supplied to the atmosphere. Monitoring of heat transport of the Kuroshio is important for climate research.

1. MONITORING OF THE CURRENT PATH

Tide-gauge data at the coast and islands of Japan in the Kuroshio region are very useful for monitoring the path of the Kuroshio (Kawabe 1985, 1995). In particular, the tide gauges at Kushimoto (Sta. 6 in Fig. 1), Uragami (Sta. 7), Miyake-jima (Sta. 8), and Hachijo-jima (Sta. 9) play a crucial role in the monitoring (Fig. 2). The difference in sea level between Kushimoto and Uragami is an excellent indicator of the large meander of the Kuroshio, and the sea levels at Miyake-jima and Hachijo-jima well indicate the path position over the Izu Ridge. Thus we can monitor the path of the Kuroshio using these sea levels shown in Fig. 4 along the procedure of Fig. 2, in terms of the three typical stable paths -- the large-meander path and the nearshore and offshore non-large-meander paths (Fig. 1) -- and their alternate transitions shown in Fig. 3. The north-south move of the Kuroshio in the Tokara Strait south of Kyushu, which is related to the path variations, can be monitored by the ratio of the difference in sea level between Nakano-shima (Sta. 2) and Nishinoomote (Sta. 3) to the difference between Naze (Sta. 1) and Nishinoomote (Kawabe 1995; Yamashiro and Kawabe 1996). The Kuroshio in this strait takes a northern position during the large meander, and the meridional shift leads to the formation and decay of the large meander by about four months associated with the transition process (Fig. 5).

2. MONITORING OF CURRENT VELOCITY AND TRANSPORT

Surface velocity of the Kuroshio main current is roughly monitored by the sea-level difference between Naze and Nishinoomote, and volume transport is by the combination of sea levels at Naze, Nishinoomote, and Odomari (Sta. 4) which is almost equal to the sea-level difference between Naze and Odomari (Kawabe 1995).

Climate research, however, requires a highly accurate estimate of heat transport of the Kuroshio and its long-term monitoring. Monitoring systems of volume transport of the Kuroshio are being studied in the Japanese GOOS program (1993-97), named "Basic Studies towards Establishment of GOOS" sponsored by the Ministry of Education, Science, Sports and Culture (Table 1). Studies on the estimate of absolute velocities and a construction of system for a long-term monitoring are progressed in this program, using moored current meters and acoustic Doppler current profilers as well as the TOPEX/POSEIDON altimeter data and producing a modified inverted echo sounder (IES), named a multi-path IES.

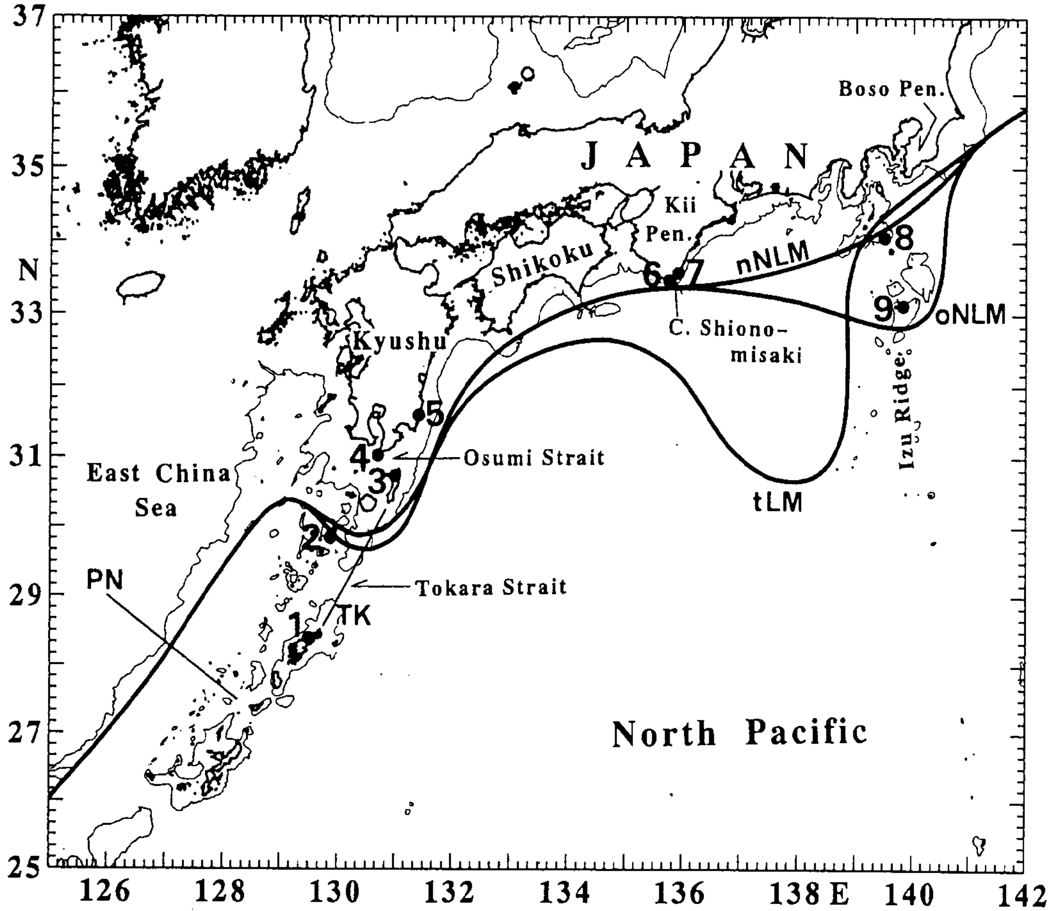


FIG. 1. Tide stations and the typical paths of the Kuroshio. Thin lines are 500-m isobaths. The lines of PN and TK are CTD lines of the JMA Nagasaki Marine Observatory's: 1) Naze, 2) Nakanoshima, 3) Nishinoomote, 4) Odomari, 5) Aburatsu, 6) Kushimoto, 7) Uragami, 8) Miyake-jima, 9) Hachijo-jima. nNLM is the nearshore non-large-meander (NLM) path; oNLM is the offshore NLM path; tLM is the typical large-meander (LM) path.

Kawabe (1995)

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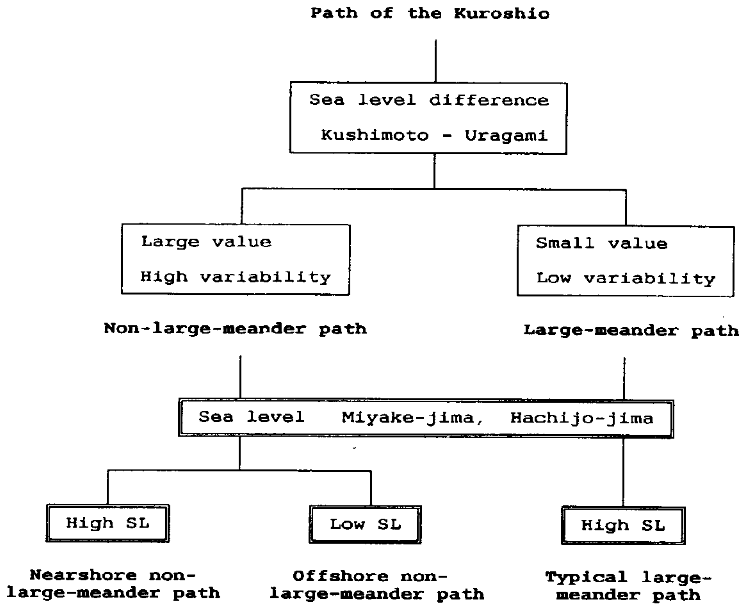

FIG. 2. Flow chart to classify and monitor the current path of the Kuroshio using sea level data. This figure is based upon Fig. 6 in Kawabe (1986b).

Kawabe (1995)

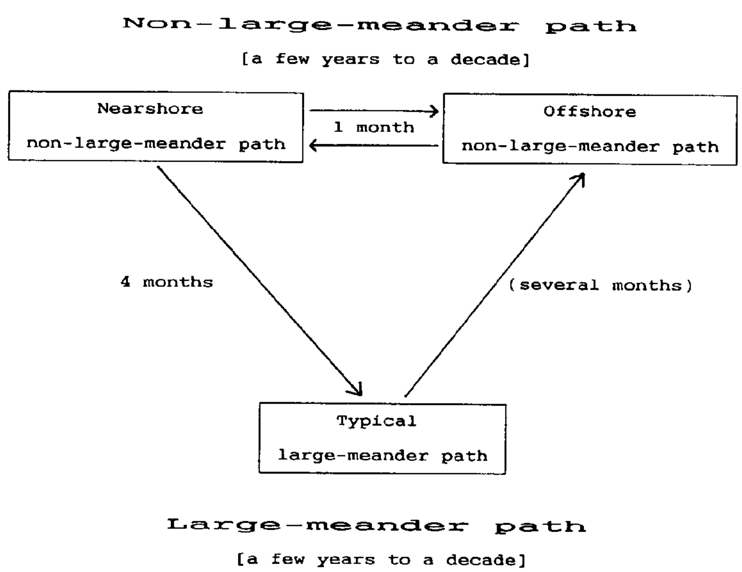

FIG. 3. Basic cycle of current path of the Kuroshio. This figure is based upon Fig. 11 in Kawabe (1986a).

Kawabe (1995)

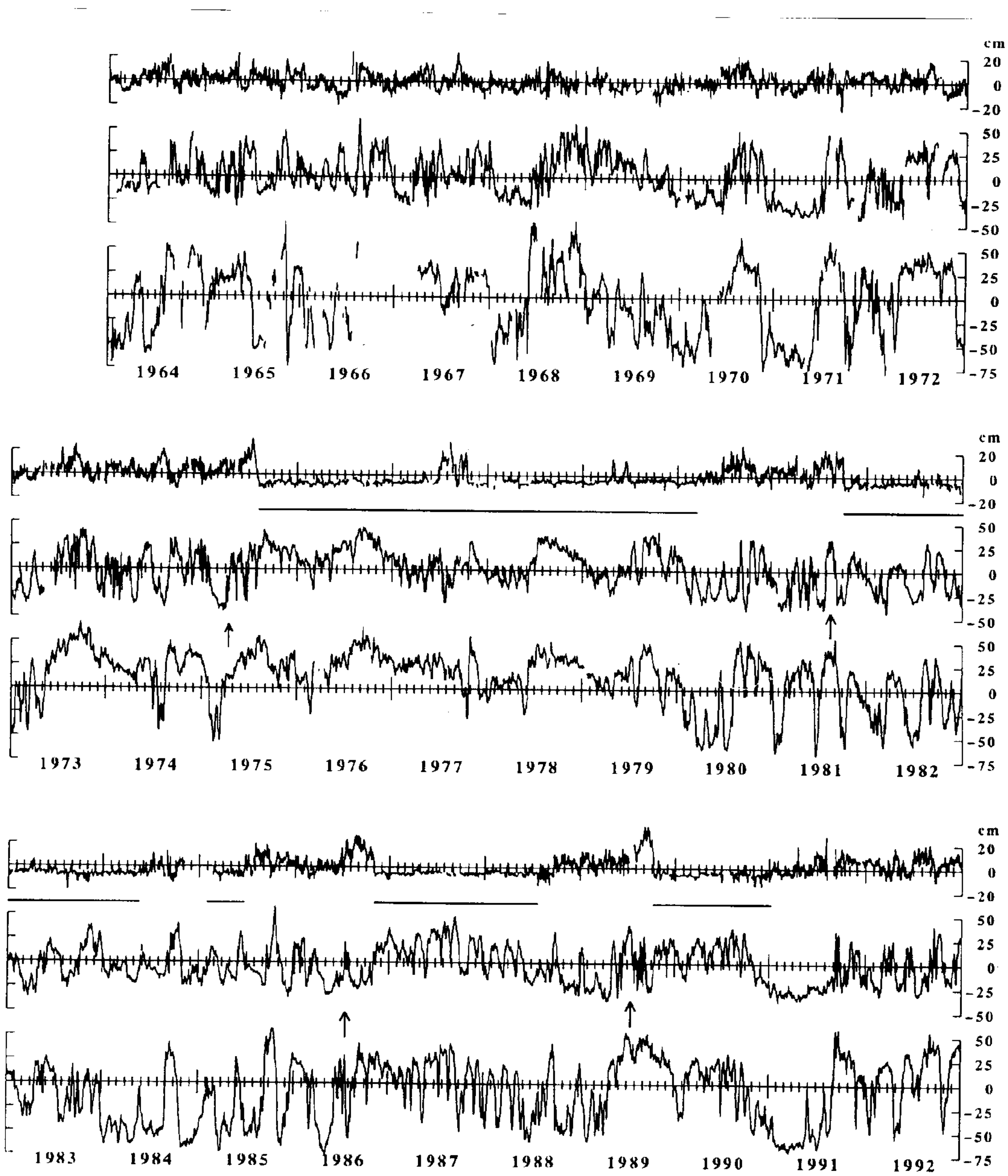

Fig. 4 FIG. 5. Time series of difference in daily mean sea level of Kushimoto minus Uragami (upper curve), and daily mean sea levels at Miyake-jima (middle curve) and Hachijo-jima (lower curve) from 1964 through 1992. The zero point is the mean of each curve during this period. The horizontal lines under the upper curves show the LM periods that are determined from the sea level difference between Kushimoto and Uragami. The arrows show the generation of small meander southeast of Kyushu.

Kawabe (1995)

4/69

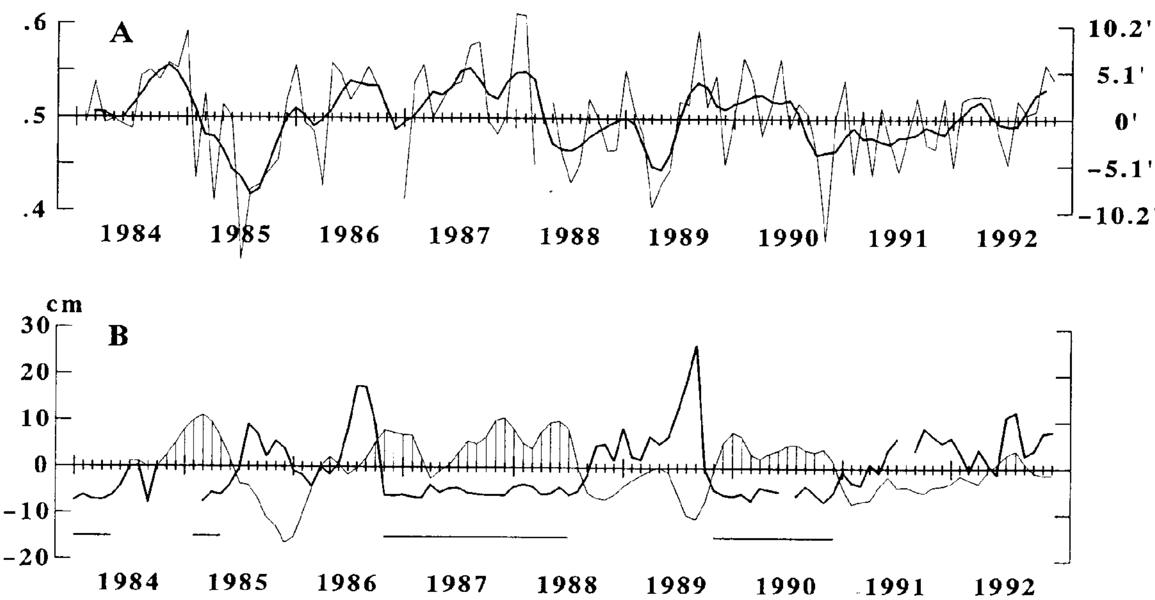

Fig.5 FIG. 12. (a) Monthly mean index of position of the Kuroshio in the Tokara Strait defined by Eq. (1), named the Kuroshio position index (KPI) (thin line) and its four-month running means (thick line) from 1984 through 1992. The ordinate on the right side shows the deviation of the Kuroshio current axis at the TK line from the mean position (29°48′N), which is converted from the KPI using its relation with the latitude of 17°C at a depth of 200 m at the TK line. (b) Difference in monthly mean sea level of Kushimoto minus Uragami (thick line) and four-month lag of the thick curve in panel A (thin line). The horizontal lines show the LM periods.

Kawabe (1995)

TABLE 1

STRUCTURE OF THE UNDERPINNING GOOS-RELATED PROGRAM IN JAPAN

(Each group is led by the person in parenthesis)

"Basic Studies towards Establishment of GOOS" (1993-97)

Subject 1
Evaluation of oceanic transports of heat and water mass in the North Pacific
- Group 1. Kuroshio off Shikoku (S. Imawaki)
- Group 2. Kuroshio over the Izu Ridge (K. Taira)
- Group 3. Alaskan Stream (1996-97) (K. Ohtani)
- Group 4. Turbulent process (S. Kanari)

Subject 2
Evaluation of fundamental elements of the oceanic processes (sea surface fluxes)
- Group 1. Satellite data (H. Kawamura)
- Group 2. Satellite data (R. Kimura)
- Group 3. Surface mooring buoy (K. Hanawa)

Subject 3
Design of ocean observing system with high-resolution models of ocean circulation
- Group 1. High-resolution OGCM (T. Yamagata)
- Group 2. Regional circulation model (T. Awaji)

Subject 4
Monitoring techniques for time series data of ocean environment (1994-97)
- Group 1. Chemical analysis techniques (S. Tsunogai)

Subject 5
Monitoring of ocean currents and biomass abundance by new techniques (1994-97)
- Group 1. Submarine cable (K. Rikiishi)
- Group 2. Shipboard ADCP (T. Sugimoto)
- Group 3. Satellite data (T. Saino)

The second phase of the Japanese GOOS program is being planned along the NEAR-GOOS (North-East Asian Regional GOOS) in the WESTPAC/IOC. The Kuroshio monitoring is a central theme again. The submarine cables between Taiwan and Okinawa, between Philippine and Okinawa, in the Tokara Strait, and on the Izu Ridge will be used for monitoring the Kuroshio transport.

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Kawabe, M. (1986a): Transition processes between the three typical paths of the Kuroshio. J. Oceanogr. Soc. Japan, 42, 174-191.

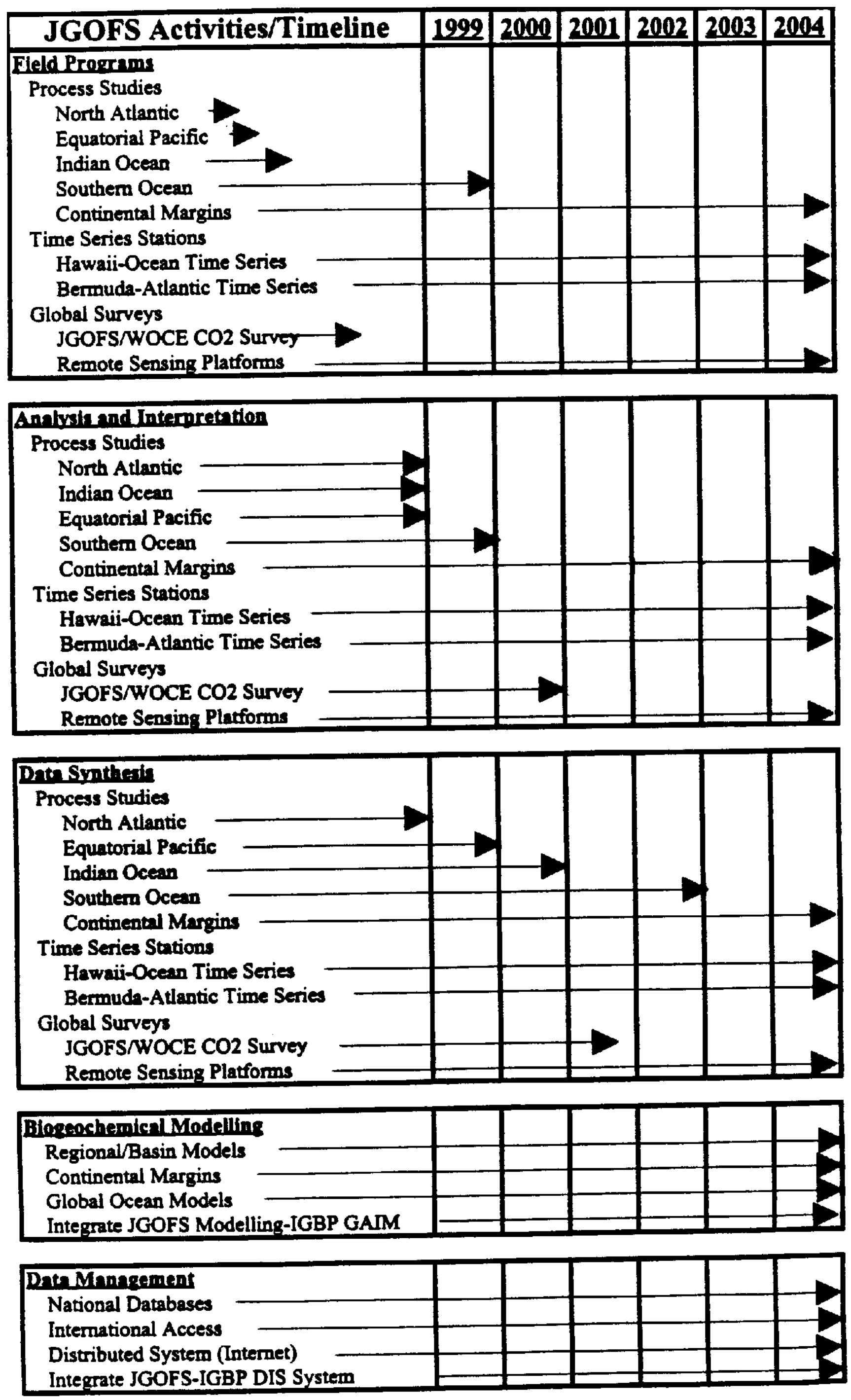
Kawabe, M. (1986b): Study on the Kuroshio and the Tsushima Current -- Variations of the current path. J. Oceanogr. Soc. Japan, 42, 319-331 (in Japanese with English abstract and legends).

Kawabe, M. (1995): Variations of current path, velocity, and volume transport of the Kuroshio in relation with the large meander. J. Phys. Oceanogr., 25, 3103-3117.

Yamashiro, T., and M. Kawabe (1996): Monitoring of position of the Kuroshio axis in the Tokara Strait using sea level data. J. Oceanogr., 52, 675-687.

ANNEX XVII

JGOFS SCHEDULING



ANNEX XVIII

THE MERCATOR AND CLIPPER PROJECTS

MERCATOR

Background

In June 1995, the French oceanographic community met in La Chapelle Aubareil (France) and discussed the opportunity of taking joint steps to develop a simulation tool of the global ocean circulation, by assimilating observation data under pre-operational constraints. The purpose was to combine skills among French laboratories to build together a common system useful to scientific applications and others.

In 1996, all the French organisms or institutes concerned with the development of oceanography decided to share the definition and the development of such a system and they launched the MERCATOR project.

At the beginning of 1997, the project passed a major step by entering the feasibility phase;: the participants involved showed their clear intentions of carrying MERCATOR forward.

Main goals of the MERCATOR project

The MERCATOR project aims to bring into play in the next 5 to 7 years, a system able to:

- simulate the global ocean circulation with a high-resolution primitive-equation model,
- assimilate satellite and *in situ* data,
- be used in a pre-operational mode, i.e., near-real-time routine operation handled by scientists or engineers.

MERCATOR will be designed to interface with local and global modules handling commercial and military applications. Climate applications as well as a fully operational forecasting capability are logical next steps in the longer term.

MERCATOR as a research tool

The MERCATOR system will be a useful tool for research activities. It will:

- provide a complete description of the ocean circulation, consistent with satellite and *in situ* data, atmospheric forcings and the dynamics and thermodynamics of the ocean,
- allow a diagnostic description of the climatic evolution of the ocean,
- provide 3-D ocean transport fields for bio-geochemical studies,
- help to describe some dynamical and thermodynamical processes of the ocean, including those implying resolving at the mesoscale,
- help to analyze data from the WOCE and CLIVAR programmes as well as from ERS, Topex/Poseidon, Jason and Met satellites.

MERCATOR, a pre-operational system and its applications

The MERCATOR system will be designed to support preoperationall applications. It will:

- contribute to open ocean military applications of the French Navy, such as the 15 to 30 day forecasting of mesoscale ocean dynamics, that will require a mesoscale and zooming capability,

- help to develop coastal ocean applications (where most industrial, commercial and environmental impacts can be found) by providing at least open ocean boundary conditions to coastal ocean models.

MERCATOR to prepare the future oceanography

The availability of the MERCATOR tool will clearly help to prepare the further developments of oceanography. It will:

- help to define and select the appropriate ocean observing tools. By specifying precise needs for a real operational observation system, MERCATOR is a french contribution to the GOOS programme.
- help to define climate models (coupled ocean/atmosphere models) of the second generation.

MERCATOR strategy of development

Three main components have been identified in the MERCATOR system : modelisation, assimilation and data flow handling. They give a structure to the main tasks of the development. Among each of them, when it was possible, the choices have been made to partly rely on research projects already existing or planned in laboratories. The MERCATOR project is clearly open to international cooperations.

*** the MODELISATION component**

The purpose of this component is to develop a high resolution Ocean Global Circulation Model (OGCM). Three sub-tasks can be distinguished:

- the development of an High Resolution OGCM with atmospheric forcing. It is currently being conducted within the CLIPPER project, the modelisation component of MERCATOR,
- the coupling of this OGCM with Very High Resolution Regional Models, that will rely on projects dealing with mesoscale dynamics or coastal applications,
- eventually, the coupling of this OGCM with an Atmospheric Global Circulation Model (AGCM), that will be tackled in the CLIPPER coupled experiments.

*** the ASSIMILATION component**

The purpose of this component is to develop a global assimilation scheme allowing near-real time operations. At least three assimilation schemes - simplified Kalman filtering, adaptative filtering and variational methods - will be considered alone or in a combination, taking into account the outcome of recent data assimilation projects (e.g. AGORA).

*** the DATA FLOW HANDLING component**

The purpose of this component is to develop the sub-system which will provide to the model the initialization, forcing, assimilation and validation data sets. The gathering of the data needed to initialize the MERCATOR model, as well as, to a certain extent, the data needed to validate it, mostly relies on research teams involved in the WOCE, TOGA, GOOS or CLIVAR programmes.

The procedures implemented to provide assimilation and forcing data have to bear near-real time and routine operation constraints. The implementation of the near-real time forcing data flow mostly relies on the competence of the French and European met centers,

The Jason or Envisat altimeter data will play an important role. The development of reliable methods to allow near-real time altimeter data acquisition and processing mostly relies on the DUACS European project.

CLIPPER

Clipper is a French programme on “High Resolution modeling of the Atlantic Ocean forced by or coupled with the atmosphere”

Project coordinator : C. Le Provost
Core Project Team : B. Barnier (LEGI-Grenoble)
G.Madec (LODYC-Paris
A.M.Tréguier (LPO-Brest)

Associate scientific investigators from the following laboratories :

LEGI Grenoble, LMC Grenoble, LPO Brest, LODYC Paris, La Mouette Toulouse,CLS-Groupe Océanographie Spatiale Toulouse, Centre ORSTOM Cayenne, Antenne ORSTOM Brest.

CLIPPER is a programme aiming to model the oceanic circulation over the whole Atlantic with a high resolution (1/6°), in order to resolve the mesoscale dynamics, and explicitly simulate its contribution to the control of the large scale ocean circulations. The goal is to run this model over the WOCE period and to use the WOCE data to validate the simulations. The model results will then help the analyses and the physical understanding of these *in situ* data. Additionally, a major scientific goal of the programme is to study the role of the mesoscale processes on the general circulation of the ocean over the Atlantic, on the heat and mass transports, and on the ocean-atmosphere exchanges. The model will resolve the seasonal time scale and short-term interannual variability in the tropics. Assimilation techniques will be developed and tested, with the aim to assimilate some of the WOCE data sets (especially the altimeter data) in the CLIPPER model after the prognostic experiments are run and analyzed. This programme is a French contribution to WOCE, and is intended to be continued within CLIVAR. It is also considered as a contribution to the development of the MERCATOR model aiming to establish a pre-operational system for ocean circulation simulations with data assimilation, for future operational oceanography.

Some technical details :

The modeled domain is voluntarily limited to the Atlantic, where the French oceanographic community put its effort during WOCE. This is in order to allocate the entire computer resources available to the high resolution and the possibility to run several sensitivity experiments.

Consequently, open boundary conditions will have to be managed, on the Southwest (Drake passage), Southeast (40°East), along the Gibraltar Strait, and on the North (70°N). For the Mediterranean Sea outflows and the exchanges with the Arctic Sea, buffer zones will be used. For the Antarctic Circumpolar Current inflow and outflows, radiative conditions will be combined with climatological open boundary conditions.

The model code will be developed from, basically, the Primitive Equation code of LODYC, on a massive parallel computer (CRAY-T3E). A special effort will be dedicated to the representation of the bathymetry (the model will possibly be developed in sigma-coordinates). The vertical resolution will have 30 to 40 levels, depending on the adequacy of the vertical discretisation to correctly include the different water masses. The horizontal resolution will be 1/6° longitudinally and 1/6° x cos (latitude) latitudinally (i.e., 13 km resolution at 45°).

The model will be initialized with a new climatology computed from the presently available hydrographic station data set, including some of the new WOCE sections. The model will be forced by wind fields and thermodynamic air sea fluxes issued from the ECMWF reanalysis. After a spin-up phase (of the order of 10 to 15 years) forced by mean monthly forcing, the model will be run with half daily forcing fields, over the period 1979-1996 (and further on).

Lagrangian floats will be included in the simulations.

A series of experiments will be run in a coupled mode with a global atmospheric circulation model (either the LMD model or the Arpege model). The SST over the other oceans (Pacific, Indian and Polar oceans) will be imposed, corresponding to the 1979-1996 period of the forced run.

The programme just started (January 1997), and will be carried over the next 4 years.

ANNEX XIX

NORTH ATLANTIC FLOAT CAMPAIGNS (1996-1999)

North Atlantic Anticipates Biggest Float Fleet Ever

Walter Zenk, Institut für Meereskunde, Universität Kiel, Germany.
wzenk@ifm.uni-kiel.de

In February 1997 the Ocean Observing Panel for Climate (OOPC) met at the University of Cape Town under its chairman Neville Smith. This group of experts was esrablished in 1996 jointly by the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS) and the World Climate Research Programme (WCRP). Its terms of reference are to monitor, describe and understand the physical and biogeochemical processes that determine the ocean circulation. Among other issues the Panel also reviewed future float experiments in the North Atlantic.

In preparation for the meeting I had collected information on all US and European float experiments in the North Atlantic started in 1996 or planned for 1997–1999. During the discussions in Cape Town it appeared that the list was incomplete. In the following weeks all potential experimentalists, who we thought would use floats, were asked to submit their plans by electronic mail. The community responded promptly which is highly appreciated. I had offered to circulate the results of my survey in return for the PI's helpful answers. Instead of individual answers I present the results here in Table 1 and Fig. 1.

The International WOCE Newsletter appears to be an excellent platform for the exchange of this comprehensive information on planned float experiments in the North Atlantic since the WOCE Float Planning Committee was disbanded before the major N. Atlantic experiments were started. This summary may serve as a reference for all float users inside and outside the WOCE community. (Those using RAFOS floats may contact Kevin Speer at IFREMER Brest (kevin.speer@ifremer.fr) for an up-to-date summary of moored sound generators in the eastern North Atlantic.)

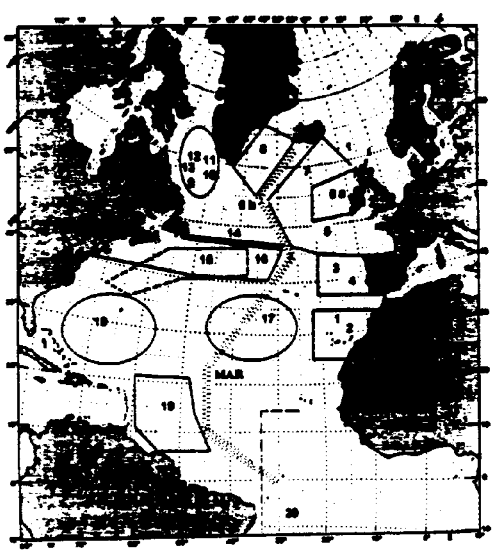


Figure 1. Regional distribution of experiments with various floats in the North Atlantic, 1996–99. Areas are numbered in accordance with column 1 in Table 1.

Table 1. Inventory of intended float deployments in the North Atlantic, 1996–99. Information was collected on the base of an electronic poll conducted in March 1997. It has been checked by B. Thompson from the WOCE Data Information Unit. The first column contains numbered areas which are reproduced in Fig. 1. The following abbreviations were used:

Instrumentation:	
R	RAFOS (Ranging and Fixing of Sound) float, passive
M	French MARVOR float, active
A	ALACE (Autonomous Lagrangian Circulation Explorer), active
P-A	profiling ALACE with temperature sensor
S/P-A	profiling ALACE with temperature and conductivity sensors
AGP	German 'Automatischer Profilierender Geratetrager', (Automatic Profiling Platform), prototype
Other:	
+	additional equipment is expected
?	information presently unavailable to the author
ACCE	Atlantic Circulation and Climate Experiment
ARCANE	a joint civil and military exercise in the eastern Atlantic by French institutions
ARI	Accelerated Research Initiative
CANIGO	European project 'Canary Island Azores Gibraltar Experiment'
MAR	Mid Atlantic Ridge
ONR	Office of Naval Research
PIRATA	Pilot Research Moored Array in the Tropical Atlantic
SAMBA	Subantarctic Motions in the Brazil Basin
SFB	German 'Sonderforschungsbereich' (Special Research Initiative)
SOC	Southampton Oceanography Centre

No.	PI/Project	Region/Coverage	Depth (m)	Float type	1996	1997	1998	1999	Sum
					Number of Intruments				
1	Knoll, Cantos/ CANIGO	Canary Basin	500	R		July/Aug 11			11
2	Zenk, Gould, Speer, Cantos/ EUROFLOAT	Canary Basin	1000	R	Oct'95 15	Jan 6			21
3	LeCann, Serpette, Speer/ARCANE ? French Navy ?	Iberian Basin	400	M	29	8?			37+
4	Ambar/CANIGO	Iberian Basin	800, 1000	R		June --> 14	10		24
5	Speer, Gould, Cantos/EUROFLOAT	Eastern Basin	1750	M	21				21
6 a,b	Richardson, Bower/ WOCE, ACCE	NE North Atlantic incl. east-boundary	$\sigma_0 = 27.5$	R	Oct/Nov 14	June 34 Oct 20			68
7	Zenk, Siedler, Mueller/ SFB Kiel	Iceland Basin	~ 1400	R		May 20	summer 20+		40+
8	Gould/SOC	Irminger Sea	1500	(S)/P-A	7				7
9	Schott, Send, Rhein/ SFB Kiel	Labrador Sea	1500	(S)/P-A		Jan 6+			6+
10	Davis, Owens/ ONR Conv. ARI	Labrador Sea	350 - 1400	S/P-A with vanes	31	20	20		71
11	Rossby, Prater/ ONR Conv. ARI	Labrador Sea	?	R					?
12	D'Asaro/ ONR Conv. ARI	Labrador Sea	?	special purpose					?
13	Freeland/ ?	Labrador Sea	?	P-A	fall 5				5
14	Koltermann, Knutz/ WOCE, ACCE	W of MAR, 47°N	1500	S/P-A APG-new		June 3 ?	3?		6+
15	Rossby, Carr, Prater/WOCE	Gyre Exchange N. Atlantic Current and on 38°W	$\sigma_0 = 27.5$	R from VOS		spring 80			80
16	Davis, Owens/ WOCE	N of 40°N 2x2 grid	600 (-1400)	(S)/P-A with vanes	fall 40	Feb/Mar 30	Jan/Feb 30		100
17	Leeman, Molinari/ ?	S of 40°N 600 km²	800 -1000	A and P-A		summer 19 fall 17	18		54
18	Riser/ ?	Sargasso Sea	1000	P-A		summer 20	30	20	70
19	Schmitt/ ?	6°N-16°N 600 km²	1000	S/P-A		summer 10	30		40
20	Ollitrault, Schopp, Servain, Vianna, McPhaden/ SAMBA, PIRATA	Equator 15°N to 10°S	partly ~ 800	M					?