Report of the Argo Science Team 4th Meeting (AST-4)

March 12-14, 2002, CSIRO Division of Marine Sciences Hobart, Tasmania Australia

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Summary

The fourth meeting of the Argo Science Team (AST-4) was held in Hobart, Tasmania, Australia from March 12-14, 2002. International commitments to the Argo project continue to increase. More than 10% of Argo has now been deployed, with about 340 floats presently active. The number of active floats will increase rapidly over the coming year - over 1500 floats have now been funded, with additional proposals over the next three years averaging nearly 900 floats per year. In consideration of the steep increase in float deployments, AST-4 considered areas needing attention for successful large-scale Argo implementation. These include completion of the data management system, technical aspects of float performance, a regional float deployment planning mechanism, and the need for rapid utilization of Argo data. Another objective of the meeting was to encourage float providing nations to increase deployments in the Southern Hemisphere - and to that end a Southern Ocean Science Symposium was held in joint session with the CLIVAR Southern Ocean Panel.

A second meeting of the Argo Data Management team was held in Brest in October 2001. Formats for exchange of Argo data have been agreed, and direct exchange of data between national and global data centers (GDACs) will occur soon. Argo profiles are presently published on the GTS and distributed via the Internet by the IFREMER/Coriolis GDAC. An improved user interface is being implemented at Coriolis and a second GDAC will soon be operating. Plans for scientific quality control of Argo data were discussed – including a semi-automated step as described by the PMEL center, and final examination by the principal investigator. It was agreed that by September 2002, the scientifically reviewed Argo data should start becoming available.

Technical issues relevant to the Argo array were reviewed. A major development is the availability later this year of the Iridium system for improved communication bandwidth, two-way capability, and decreased surface time for Argo floats. Continuing successes with stable salinity sensors were also reported. Several technical problems (and solutions in some cases) were described by individual groups - including surface pressure drifts, rapid battery drain due to a controller failure, and salinity offsets in some recently deployed floats. It was noted that the Argo technical forum has not been a useful mechanism for information exchange and a technical workshop should be staged at an appropriate time.

A formal mechanism has been established for iteration and web publication of regional plans for float deployment. For each ocean basin a deployment coordinator is identified as well as points of contact for all float-deploying groups. After communication with the float providers, the coordinator will publish plans extending approximately 12 months in advance, and these plans will be updated at least every 6 months. A number of other issues related to large-scale implementation of Argo were discussed. Possible activities and participants for the regional data centers were identified. A mini-symposium was held describing early scientific results from Argo data and it was agreed to emphasize Argo results in future meetings. The next meeting, AST-5, will be held in Hangzhou, China around March 2003.

1. Introduction

The implementation phase of Argo has begun, with over 300 active floats now in the water. Argo data are available on the GTS and from the global IFREMER/Coriolis data center. The pace of float deployments is rapidly accelerating and international commitments to the Argo array continue to grow. Prospects for achieving a complete 3,000 float array by the end of 2005 are strong. With Argo entering a steep growth phase, the Argo Science Team's objectives for the present meeting are:

- Stimulate southern hemisphere float deployments. The majority of active floats are in the tropics and the North Atlantic and North Pacific. With 2/3 of the global ocean being south of the equator, Argo must begin to seriously address southern deployments. A joint session (science symposium) of the AST with the CLIVAR Southern Ocean Panel will focus on the scientific value of Argo in the Southern Ocean and will lead to an implementation plan for that ocean.

- Provide feedback to the Data Management team on the DM system as presently described. Reach consensus on procedures for salinity calibration and delayed mode QC, and on the roles of regional data centers.

- Design a process and designate focal points for regional deployment coordination. As the Argo array reaches a substantial fraction of its nominal density in some regions, it is necessary to formalize the regional deployment planning process. To help initiate this, the AST will produce a snapshot of regional deployment plans for all oceans.

- Describe the present technical status of profiling floats, ongoing problems, and planned technical enhancements. Improve lines of communications for problem identification and for sharing of information between float providers and

- Determine how the AST can encourage rapid exploitation and broad use of Argo data. Argo's continuation, beyond the initial global implementation, will depend on demonstrations of high value in both scientific and operational applications. Argo's acceptance by many coastal nations will similarly require that those nations see value in information from the array.

Presentation - Argo: Some User Perspectives and Needs (N. Smith)

OceanObs '99 provided a view of a multipurpose ocean observing system, with the focus on scientific products for climate change, climate prediction, operational ocean services and weather prediction, among others. In this view, *Argo* is a contributor to the "content" of the observing system and does not by itself reach to the end user. Another user perspective focuses on the (many) end users (agriculture, fishing, etc.) and in this case the "content" above are part of the input.

It is convenient to break the discussion down in terms of services:

- Global Change services - Greenhouse; long-term changes and variability
- Climate services - ENSO prediction; climate monitoring
- Ocean services - Ocean prediction; the marine environment
- Data services - General use; climatologies and baselines;
- Knowledge services - Contributions to research: processes, physics

Each of these services has slightly different priorities in terms of data though there are no order one differences. For example, quality is critical for climate issues whereas timeliness is paramount for ocean services. For ENSO prediction, the tropical moored buoy network remains the key element and Argo largely provides complementary data. Argo *may* be asked to do more where the TMBN approach is logistically untenable. Ocean services target safety and risk management in the marine environment, shipping and transport, boundary conditions and inputs to coastal services and management, among things. GODAE is providing the lead as operational services are developed. The Pacific Workshop proposed by *Argo* is one element of the strategy. There are also regional and coastal activities that will be important in the development of services.

It is important to retain focus on the scientific rationale and design. The user perspective is important but the priorities and requirements at that level are hard to translate into constraints on the design or implementation. The broad user base potentially provides robustness and stronger advocacy. It is also important to develop *Argo* within the context of the integrated observing system; Argo needs the rest of the observing system as much as it needs *Argo*. The discussion noted that it is important *Argo* is able to advocate its role to the different user communities. It is also clear that the ocean community is working better as advocates for the integrated observing system and recognizing the valuable individual contributions from the networks. GODAE and others responsible for scientific products (e.g., analyses and model predictions) must also take an advocacy role and establish dialogue with the end-users. The links to regional and coastal communities are difficult but it appears, through Coastal GOOS and GODAE that the links are becoming stronger.

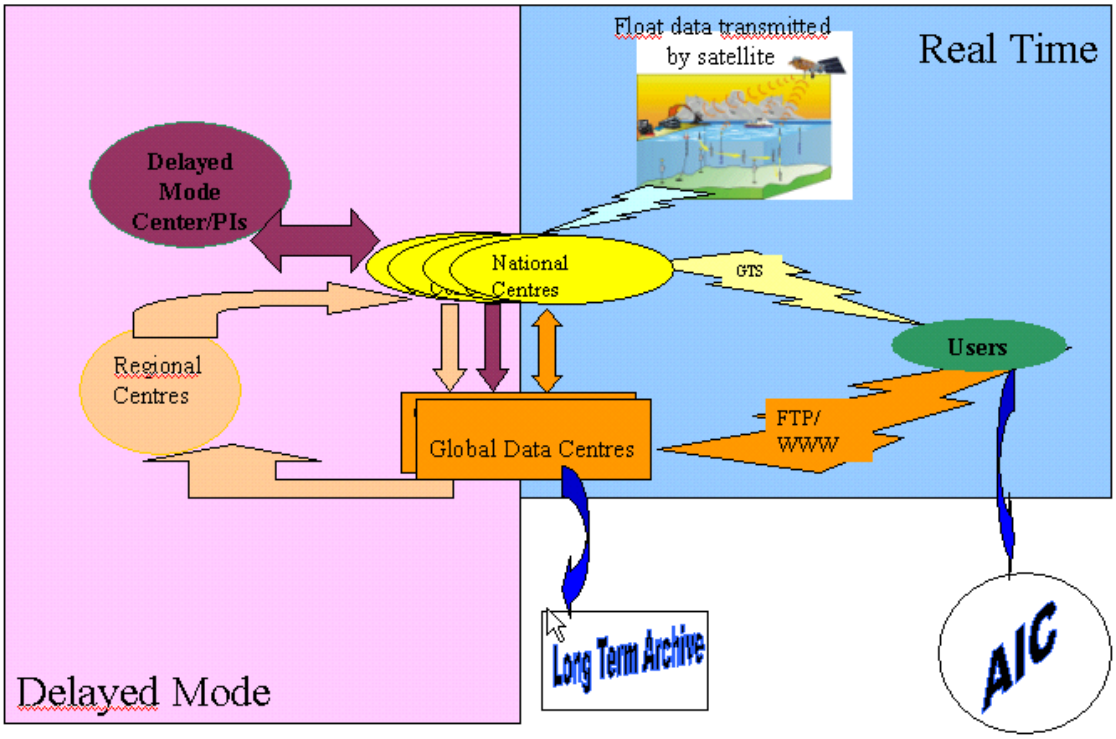
2. The Argo Data System

2.1 Report on the 2nd Data Management meeting (S. Pouliquen, R. Keeley)

The co-chairs of the Data Management Team, Sylvie Pouliquen and Bob Keeley, presented a summary of the progress made in designing and building the Argo data system.

- Real-time data circulating on the GTS are presently being served up by the French GDAC. In early March about 75% of the Argo data are being posted to the GTS within 24 hours of observation.
- The format for data exchange with GDACs was settled last November and some national centres are close to sending data in this format to the GDACs.
- Documents describing the data format, Argo Handbook, automated QC procedures and GDAC operations are in final daft stage or complete.
- The French GDAC has the ftp site built and ready for data. They are testing functionality of the WWW site. The US GDAC is setting up the ftp site this month with WWW functions to follow soon after.
- The AIC is restructuring the web site to include more information about the data system including documentation, implementation progress tracking, monitoring tools for float operations in addition to existing functions.

At the meeting we agreed to the following data flow between the different actors of the Argo program



In the coming months work will focus on the following activities.

- Implementing real-time data transfers from national centres to GDACs
- Working with the IAST to define standardized delayed mode QC procedures.
- Developing monitoring tools to show the performance of the data system and the Argo program.
- Defining in consultation with the AST the role and data flow to the Regional Centres.
- Defining the role of the long term archive for Argo.
- Defining the necessary components in BUFR to report data in this format on the GTS.

The following points came out of the discussion.

- The trajectory data are not yet available from the GDACs. There was a desire to have these data served as well. They will be available on FTP by June 2002 and Coriolis WWW server should provide them during summer.
- It is important to distinguish data at the GDACs derived from GTS as opposed to those directly uploaded from national centres.
- Floats deployed before Argo but still operating that abide by Argo principles should be treated with equal status as Argo equivalent floats if the Pis want to make these data available through their national centers.
- Caution was expressed regarding web sites that require high bandwidths for presentations of information since such bandwidths as not globally available.
- Graphics should be available for export at resolution of at least 300 dpi.

2.2 PMEL salinity drift correction (A. Wong, G. Johnson), testing (Y. Desaubies)

Progress since AST-3

The delayed-mode salinity correction system at PMEL has been running in trial automatic mode since AST-3. Our aim during the past year has been to accumulate as many time series in as many regions as possible, so we can diagnose how well our system performs under various circumstances, and then initiate improvements accordingly. The gathering of knowledge on the behavior of these floats and how our system responds to the various float behavior over time and space are vital in achieving a good sensor drift correction, and this task can only be accomplished by involving the Argo community as a whole. To that end we have decided to broadcast our results, however preliminary they might be, on the WWW for anyone to browse, have made our software publicly available for anyone who cares to use it, and have tried to describe every detail of our system in a scientific article. Needless to say we have received much valuable feedback over the past 12 months that has refined our estimation of regional climatology and calibration errors.

Present status

At present PMEL is monitoring sensor salinity drifts in all the US Argo floats. These 157 floats are located in the Pacific, the Atlantic, and the Bering Sea. Based on a very preliminary visual inspection: for 76 of them we would probably recommend using the float data as they are without correction, either because no significant trend has been detected relative to the climatology, or because the recommended correction is within the calibration errors; for 12 of them we would have an approximately 0.01 (PSS-78) correction applied to them; 16 would have corrections between 0.02 and 0.04; 8 would have > 0.05 correction; 27 have too short a series (< 10 profiles) to determine any trends; 14 are problematic in that float data are jumbled or unexplainable; 4 need to have their series broken up for calibration (parts of the series are good). Some of the corrections are problematic because they tend to artificially spread the θ-S envelope.

In summary, about 50% of floats at present are returning good data that do not need correction, 10% have problems that may not be correctable, and the remaining 40% (or less if the θ-S spread problem is taken into account) are correctable by relatively simple methods.

This is a delayed-mode calibration system simply because of the need to accumulate a time series of float profiles. From our experience we maintain that about 10 profiles on either side of a sample are needed to diagnose a trend.

Likely improvements and the issue of including contemporaneous data

The areas we can improve on are regional isolations of marginal seas and more accurate estimation in the North Atlantic. The improvements in these areas will benefit future floats in the Southern Ocean, since the Southern Ocean is more variable than the Pacific and the main areas around Antarctica such as the Weddell Sea and the Ross Sea should be treated separately. We would also like to address the problem of the calibration artificially spreading the θ-S envelope, thus introducing spurious drifts.

In recent months Yves Desaubies' group has been rigorously testing the effect of including recent CTD data in the database for climatological estimation of the North Atlantic. We are slowly coming to terms with the fact that even though inclusion of recent data will improve climatological estimates, the nature of a climatology dictates that there will always be some degree of smoothing and filtering. Hence if an in-situ cast is performed during deployment of a float or near the path of a float, ideally there should be a constraint that will anchor the

calibration of those float profiles to that exact in-situ cast without involving climatological θ-S relations. This is future work to be discussed.

Testing at IFREMER

Implementation in the NE Atlantic has shown the need to tune the algorithm to proper scales (in space and time) of variability. As a way to tune the method, it has been implemented using well-calibrated CTD profiles as if they were float profiles. The output indicates that the algorithm proposes corrections of the order of 0.01 psu, or less, with variance of $(0.015)^2$. Argo data are intended for assimilation into numerical OGCM or as input for inverse models or objective mapping; error bars are necessary inputs for those applications. The estimated variance depends on mapping error, which in turn depends on signal variance. The conclusions from the implementation of the PMEL algorithm at IFREMER are that it is easy to run; it needs to be tuned before implementation in a particular oceanic region; great care must be taken in choosing the signal variance and the correlation lengths; whenever possible the estimates are improved if recent CTD data can be added to the database; there are particular cases (fronts, meanders, or near coast lines) where PI expertise is necessary to evaluate the results.

Future salinity correction systems

One could in fact envision a system for the highly variable basins such as the North Atlantic, whereby floats and contemporaneous CTD casts were compared to produce a consistent data set. We envision an automated version building on Bacon et al (2001). Applying this scheme to more than 5 floats will require significant algorithm development. Also, in order to accomplish this task more experience in float behaviors (stability of conductivity, drift rates, etc) will have to be gained in more quiescent regions.

Need for feedback, data flow

The success of any scientific correction system relies on the communication between float PIs and the centers that perform the correction, since sharing of ideas and experience is the only way to achieve a high data quality. We will continue to work with other centers that wish to modify our routines to suit their particular regions. PMEL will perform delayed-mode salinity drift correction on all US Argo floats, as well as assist JAMSTEC (proposed Pacific regional center) to qc other Pacific floats as needed. We also encourage continuing feedbacks from PIs on our proposed corrections. We hope any data flow scheme will encourage this feedback.

AST Discussion

The AST agreed that it is essential for all Argo data to be subjected to equivalent procedures for scientific quality control, and that datasets used for comparison to float data should be kept uniform. The PMEL salinity drift correction system has been tested by several partners and found to be very promising. It was agreed there should be further testing and development in the coming 6-month period. At that time (September 2002), a decision will be made about the use of this drift correction system Argo-wide, and scientifically QC'ed data should begin to become available. It may take some additional time for data from all floats to begin moving through the system. Some nations may reassign the automated QC function to partners or regional data centers. Similarly, floats without identified PIs may be "adopted" by experts at national or regional data centers. The operating principle is that while national Argo programs take responsibility for the quality of Argo data, functions within the data management structure may be appropriately reassigned to improve Argo's final data quality and its efficiency.

2.3 Plans for and roles of regional data centers (Discussion)

Activities that are envisioned for regional data centers include:

- Determining the internal consistency of the Argo dataset by comparing Argo data from different sources in the region and through comparison with ongoing hydrographic cruises. A mechanism for feedback to PIs will be essential.
- Comparing Argo data with model output and with assimilated fields. Understanding why specific data are rejected by assimilations (model inconsistencies, systematic data errors)
- Preparing and distributing Argo data products and services.
- Providing scientific QC as a service to national programs without such capabilities.
- Coordinating Argo float deployment plans for the region. Providing advice/guidance on regional deployment needs.
- Developing new real-time quality control tests if appropriate for the particular region.
- Assembling best available recent CTD/hydrographic data for real-time and delayed mode calibration purposes.

Regional data centers may be contributed by a single national data center or may result from collaborations among two or more groups. Collaborative efforts might target different sub-regions or contribute different areas of expertise. Argo national programs (and institutions) interested in forming or participating in regional data centers are listed below. The first one listed for each ocean is designated as the lead institution, to work with the others in developing a regional data center.

Atlantic Ocean – France (IFREMER/Coriolis), U.S.A. (AOML)
Pacific Ocean – Japan (JAMSTEC), U.S.A. (PMEL), U.S.A.(IPRC)
Southern Ocean – U.K.(BODC), Australia (CSIRO/BOM)
Indian Ocean – India (INCOIS), Australia (CSIRO/BOM), U.S.A.(PMEL), U.S.A. (IPRC)

2.4 Role of the AIC in data management (M. Belbeoch)

Participation of the AIC in Argo Data Management is through the following actions:

- Real-time QC implementation at CLS-ARGOS, based on the AST requirements and AOML existing software. CLS-Argos is evaluating the developments required to include the QC in their GTS system. A plan will be proposed in the next two months.
- Participation in BUFR group
- Development of G/DACs status application. The application is on-line and used by G/DACs managers to inform the community on the status of their developments. This application has been designed and built from a list of milestones, and the AIC asks the users (G/DACs managers) to send feedback to improve it.
- Metadata: engineering data are important for the program monitoring; the AIC needs this information to produce some statistics on the network. This should be easy to access when the NetCDF format is implemented.
- QC Feedback application. The goal of this application is to relay information on data quality, from data users (e.g. GDACs) to data producers (i.e. Argo operators). This application would be integrated within JCOMM to include data buoys (DBCP), XBTs (SOOP) and profiling floats (Argo). The AIC which is acting as a focal point for Argo data, is in good position to identify owners, to propose tools to automatically relay

information and to extract information regarding specific float operators from monitoring reports and relay these sub-sets to them. The information should be relayed via email and web page(s) for float operators to sort out quality information collected by the AIC.

3. Science symposium: The Value of Southern Hemisphere Observations.

This symposium was held jointly with, and organized by, the CLIVAR Southern Ocean Panel. Its purpose was to elucidate the scientific rationale for Argo floats in the Southern Ocean, thereby stimulating increased commitments and early deployments. The following presentations were made:

Introduction: Argo in CLIVAR (Gould)
The Southern Ocean's role in climate (Rintoul)
Southern Ocean response to climate change (O'Farrell)
Carbon uptake and accumulation in the Southern Ocean and sensitivity to change (Sabine)
Modes of variability in the atmosphere-ocean system of the southern hemisphere (Simmonds, Reason)
Observed changes in the southern hemisphere oceans and the need for an expanded observing system (Bindoff)
Southern Ocean water mass transformation and connections to lower latitudes (Speer)
How to extend Argo into the high latitude Southern Ocean (Fahrbach)
Ocean state estimation and operational oceanography: the need for southern hemisphere observations (Smith)

Discussion: challenges and opportunities for Southern Ocean Argo (Rintoul, Roemmich)

There are a small number of floats in the Southern Ocean at present, but with increasing deployments planned for the 2002-2003 austral summer, good communication between Argo and its scientific user community will be needed soon. K. Speer was identified as the CLIVAR Southern Ocean panel's point of contact with Argo. S. Riser volunteered to coordinate and publish deployment plans (see section 6.) for the Southern Ocean.

4. Technical issue updates

4.1. Iridium communications (S. Riser)

Roof tests: data has been sent regularly at speeds 1600--2200 bps, using combination of Iridium, land lines, and internet connections. Handshaking can take up to 30 seconds. At present, we are using electronics from disassembled Iridium phones. UW has been able to buy 17 reconditioned phones at this time. Commercial Iridium modems suitable for ARGO float use will be available in the near future.

Cost issues: Iridium cost is $1.68/minute presently (at 200 bytes/sec, this is $0.14 per kilobyte). At 2 dbar sampling (similar to WOCE shipboard CTD), one ARGO profile to 2000 m would consist of about 7000 bytes; the data could be sent in approximately 7000/200 = 35 seconds. Cost: $1.00 + handshaking, or <$2.00. Additional advantages include 2--way communication and short surface time.

Antenna design by UW Department of Electrical Engineering. Prototype design: quadrafilar helical antenna, operating for both GPS and Iridium. Present cost is about $500; likely less in quantity. Other designs are possible.

We hope to deploy a surface drifter in an ARGO float hull in the Gulf of Alaska soon to test the characteristics and survivability of this antenna, as well as 2--way communication capabilities.

Goal this year: an operational Iridium float in the water before the end of 2002.

4.2. Problem with pressure sensors (D. Roemmich)

Pressure sensors presently installed on SeaBird CTDs exhibit slow systematic drift. On Scripps SOLOs, drifts of 2-3 dbar are typical, with about 10% of instruments showing drift of 5 dbar or greater. In such cases, the CTD pump continues to run as the CTD passes through the air-sea interface. These instruments have shown much greater salinity drift (0.1 psu or greater in some cases) than instruments having pressure drift < 5 dbar, presumably due to coating of the conductivity cell by surface contaminants. The problem in the SIO instruments has been addressed with controller software. SeaBird is testing a new (Druck) pressure sensor that it hopes to use in the near future.

4.3. Salinity offset problem with PROVOR/METOCEAN (N. Shikama)

The performance of thirty-nine PROVOR/METOCEAN floats was reported, equipped with SBE-41CP CTD sensors and deployed by JAMSTEC from October 2001 to February 2002.

Regarding the initial survivability after deployment, two floats died without transmitting any profile data from their designated depth, 2000m, and one died after transmitting the profile data of its second cycle. Three floats shifted to emergency ascent mode after the seventh to ninth cycle, and have been continuously transmitting technical messages on the sea surface without observing CTD profiles. After this trouble, the software has been upgraded so that the float recovers to the predetermined cycle and observes the CTD profiles after its emergency ascent. Other floats have been working well.

When we compared the profile data from thirty-seven floats with those from CTD casts conducted at deployment locations or with nearby historical data or with nearby APEX float data, we found that four floats show salinity offset less than 0.01 psu and seventeen floats 0.01-0.02psu, eleven 0.02-0.03psu, one 0.03-0.04psu, one 0.04-0.05psu, and three 0.05-0.06psu. All salinity offsets are lower than comparison data. JAMSTEC, METOCEAN and Sea-Bird are making the best effort to solve this salinity offset problem.

4.4. Estimating “up” and “down” times (K. Kim)

Most previous profiling-floats do not provide the times when floats dive and surface. In this case it is difficult to estimate subsurface currents at parking depths due to large uncertainty in surface drifts before the first fix and after the last fix by satellites. A new reliable method is found to estimate "up" and "down" times within a few minutes, taking advantage of repeat cycles. Application of this methods for 1800 cycles for 25 floats in the East(Japan) Sea for a period from August, 1999 to June, 2001 shows that it is possible to estimate subsurface currents within an

error of 20 % in magnitude and 15 degrees in direction.

4.5. Termination and recovery of Argo floats (K. Mizuno)

A float-termination and recovery method will be used for the Japanese Argo project in connection with their domestic law. Float missions will be terminated at the sea surface after a certain number of observations. The behavior of terminated float is anticipated and it is shown that the floats are able to stay at the surface over a long period of time. A significant fraction of them will be stranded and can be recovered. It is also shown that retrieving of floats at sea is practicable in the case of calm sea state, and the retrieved float is very useful for evaluation of the salinity sensor stability. In fact, a retrieved 10-months old float showed almost no bio-fouling and good salinity stability.

4.6. Anomalous energy consumption in APEX floats (S. Riser)

Observations: Many floats (approximately 20% of the total number of APEX floats, and the predecessor PALACE-R1 floats), show a rapid discharge of the alkaline batteries at times of 30--50 profiles after deployment. This discharge causes the battery voltage to fall below 8.5 volts; below this level, the float is unable to pump against the pressure of seawater and will not reach the sea surface, effectively ending the float mission. This occurs well before the estimate of 150--200 profiles that should be possible, based on laboratory tests under pressure.

Causes: We have identified 2 likely causes of this problem.

(1) For cases when the rapid discharge occurs after 30 profiles, the problem is related to a bad solder mask on the main controller board in the float, leading to a short on the board in the presence of moisture. The source of moisture is water vapor that accumulates in the float due to the chemical properties of alkaline batteries. Over time, the concentration of water vapor builds up in the float until it is high enough to cause a short across the controller board on affected floats. When this short occurs, there is a high current drawn which rapidly discharges the batteries. Fix: A more reliable vendor has been found for the controller boards.

(2) For cases where the discharge occurs early in the float mission (<10 profiles), the problem is related to a design flaw in the board; in this case several resistors on the board are too large. This causes a current loop in a portion of the circuit where there should be no current drawn, leading to a rapid discharge of the batteries. Fix: The circuit has been redesigned with smaller values of the resistors at the relevant places.

4.7. Ancillary measurements - drift temperatures (submitted by S. Gille)

Combined analyses of temperature and velocity (for example for eddy heat flux v'T' calculations) depend on knowledge of the parking temperature. Moreover, if parking temperatures differ significantly from profile temperatures they can provide additional information about oceanic variability. When a float crosses a deep front, such as the subantarctic front, near the time of the profile, then the profile temperature (an instantaneous value) is quite different from the parking temperature (an average value over the parking period). Using P-ALACE data from the Southern Ocean during the 1990's, 9326 pairs of parking and profiling temperatures were compared. Probability density functions of temperature difference showed long (non-Gaussian) tails. Outlier values (2^{o}C or more difference between

parking and profile temperature) were associated with events when floats crossed frontal boundaries, and may have significant impact on v'T' analyses.

5. Status of Argo Implementation

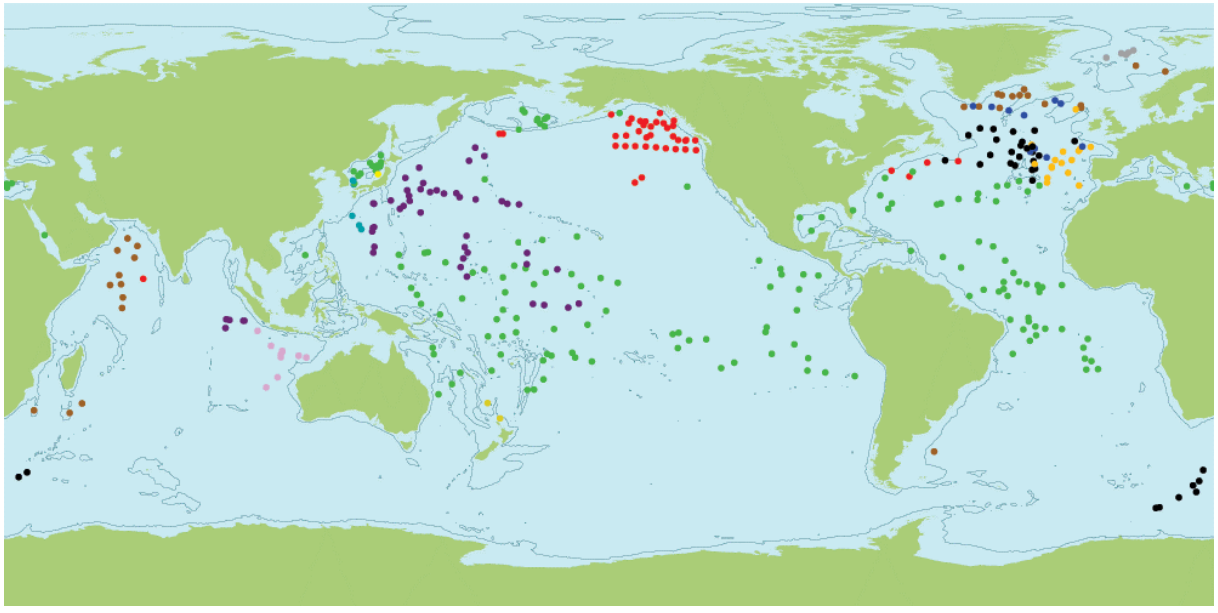
5.1 National Reports

Beginning with AST-4, National Reports are presented in written versions only in order to conserve meeting time. The AST agreed to continue this practice at future meetings. National Reports are included in Appendix 2.

5.2 Status of the global array, AIC float tracking (M. Belbeoch)

The Argo Coordinator presented the status of the global array, indicating how to track the floats on the AIC website. The discussion focused on the way the Argo floats are listed on various websites, and agreed that the AIC would be the reference. Floats itemized by the AIC are active (it was agreed that an active Argo float should have transmitted data in the last month), are officially declared as Argo floats by their PIs, and respect the Argo data policy. Argo equivalent floats (not strictly funded under the Argo label) will stay included in this status, indicating clearly this difference.

Today about 10% of the network has been achieved (358 active floats). The picture below represents the network, coloured by country, as of 9 March 2002:



- Australia (CSIRO, BOM) 10
- Canada (MEDS, IOS) 41
- Denmark (NBIA) 5
- France (**Coriolis**: IFREMER, SHOM, IRD, METEO FRANCE, IFRTP, CNES, CNRS) 16
- European Union (**Gyroscope**: FRANCE, GERMANY, SPAIN, UK) 10
- Germany (BSH, IFM, AWI) 0 + 33

- Japan (JAMSTEC, JMA, Japan Coast Guard) 48
- New Zealand (NIWA) 2
- Korea, rep. Of (METRI, KMA) 6
- Russian Fed. (Hydromet, JAERI, FERHRI) 0 + 1
- United Kingdom (UKMO, SOC, BODC, UKHO) 25 + 2
- United States (SIO, AOML, WHOI, Univ. of Washington, Navoceano + PMEL) 150 + 9

Total 313 + 45 = **358** Active Floats, as of 9 March 2002
(Additional numbers represent Argo equivalent floats)

5.3 International commitments of floats to Argo (S. Wilson)

The table below reflects the year in which funds are provided for floats; it takes a year or more until such floats are available for deployment.

Number of Floats by Country	Argo Funded FY99	Float Equiv's FY99	Argo Funded FY00	Float Equiv's FY00	Argo Funded FY01	Float Equiv's FY01	Argo Funded FY02	Float Equiv's FY02	Proposed over next 3 years	Prop Float Equiv's over 3 yrs
Australia	10				13		7		93	
Canada	10		42		20		25		75	
China					10		8		105	
Denmark						5			30	
European Comm.			10		70					
France		8	3		50		95		160	
Germany				18		22		42	115	
India							31		119	
Japan			24	4	76	8	90		300	
New Zealand			2		2		2		6	
Republic of Korea					19		30		90	
Russia		1		2		2	2	1	6	
Spain									30	
United Kingdom			13		50	5	45	12	150	40
U.S.A.	55		132	51	174	43	275	7	1238	75
TOTALS	75	9	226	75	484	85	610	62	2517	115
TOTALS BY YEAR	FY99 = 84		FY00 = 301		FY01 = 569		FY02 = 672		Ave/Yr = 877	

To achieve a global array of 3,000 operating floats—assuming that 90% of the floats have an average lifetime of four years (the other 10% fail early)—it is necessary for the international community to provide floats at a sustained rate of 825 per year.

A “Float Equivalent” is defined as a float—while not funded under the Argo Program— whose data are available consistent with the Argo Data Policy and provides the information equivalent to one Argo float.

This table and the accompanying annotation (Appendix 3) were reviewed and approved by the International Argo Science Team at its meeting in Hobart, Australia March 12-14, 2002.

6. Deployment planning mechanism

The AST agreed that deployment plans for each ocean basin should be published, with updates made public at least every 6 months and plans made about 12 months in advance. A deployment coordinator for each ocean basin will collect plans and communicate among basin float providers to inform them of gaps or crowding problems. Published plans should include (1) a map of planned deployment locations, also showing presently active floats, (2) an Argo coverage map for present plus planned floats and (3) a listing of planned deployment locations, including country/ship/month/latitude/longitude for each float. The deployment coordinators are Y. Desaubies (Atlantic Ocean), D. Roemmich (Pacific Ocean) and K. Radhakrishnan (Indian Ocean). For the Southern Ocean (south of 40^{o}S), S. Riser is deployment coordinator, with K. Speer the point of contact on the CLIVAR Southern Ocean Panel. As soon as deployment plans are ready for public release, links to the appropriate sites will be provided at the AST and AIC internet sites.

7. Implementation issues

7.1 Status of Argo Information Center development (M. Belbéoch).

The Argo Coordinator presented the web based information system implemented at the AIC. A complete information system, including a relational database, a geographic information system (GIS) and a web server have been implemented. The database has been modelled, loaded and is maintained in conjunction with the JCOMMOPS co-ordinator, as it can deal with Argo, DBCP and SOOP platforms, programs, etc. The complete system (hardware + software) has cost about 20 000 US$ and is independent from the CLS computing network. An additional contribution from the DBCP helped to preserve this independence, as the logistic contract could not cover all the expenses. All dynamic web developments have been implemented and are maintained by the Argo Coordinator. This has taken 50 % of the working time as specified in the terms of reference. The architecture is now completely operational.

The Coordinator focused first on emergency needs required by the IOC Resolution: Notification mechanism and Monitoring System. The AIC web site is now being re-designed, focusing on the “Information” aspect and on the integration of the developed applications in a homogeneous site. The team agreed that this was the priority.

A summary of some dynamic applications developed was presented. Next upgrades will permit to users, to download ASCII files generated “on the fly” from database queries, for both UNIX and Win platforms. About the monitoring system (interactive map) the team insisted on the need to provide some maps centred on the Pacific Ocean. The system should be improved by including more layers (ice cover, deployment opportunities, etc.) The team agreed that the Coordinator could assist in the future, in the implementation of the global array by providing a web tool able to deal with the network status, deployment opportunities and regional plans. There is no urgency for providing such a tool. A new monitoring system should be deployed soon for high bandwidth users, providing higher resolution maps (java applet and vector map streaming). Regarding the Data Centre Gateway application, the team insisted on the necessity to emphasize the access to the GDACs. Concerning the maps provided for publication use, the team asked to provide some formats (eps) readable by both UNIX and Win platforms.

The final Argo Label, to put on each Argo float was presented. As soon as a free phone number will be obtained the production will start and some stickers will be sent to manufacturers, and engineer teams for final tests. After that manufacturers/engineers will order stickers directly from the company.

A last discussion was held about the design or re-design of the Argo logo and the CSIRO team proposed to redraft the logo.

7.2 Regional implementation – Pacific Applications Workshop (S. Wilson)

A workshop is to be held in Nadi, Fiji, Oct 4, 5, and 7, 2002, to review the potential applications in the Pacific Islands of Argo and other ocean data, and to identify data product and timeliness requirements that are needed for each of these applications. Applications to be considered include seasonal-interannual forecasting, sea level change, operational ocean services, health of coral reefs, fisheries applications, basic oceanographic research, and secondary and tertiary education. The workshop will include experts in the applications areas from inside and outside the region, with attendance expected to be 30 to 40 individuals in all.

7.3 Capacity building - SEREAD update (submitted by J. Hall and W. Erb).

SEREAD (a teaching resource utilizing Argo data and being developed for Pacific secondary schools – see AST-3 report) has developed significantly in the past year. The Steering Committee has met twice, an outline for the teaching material has been prepared and some of the teaching units have been drafted. A brochure promoting SEREAD has been printed and distributed throughout the Pacific, and Than Aung has visited schools and made contact with the Ministries of Education in Tonga, Fiji and Samoa to discuss and promote the programme. A number of schools have expressed a keen interest in being involved in piloting the programme. The development of teaching resources is now underway for New Zealand schools. Keith Hartle, a senior science teacher with extensive experience in developing resources is using part of his time as a Royal Society Science, Technology and Mathematics Teacher Fellow to work with staff at the National Institute of Water and Atmospheric Research (NIWA) to develop this resource. He will work collaboratively with those developing the SEREAD Pacific resource material. The development of the web site to support the teaching material will be taken forward when Mathieu Belbeoch visits both New Zealand and Fiji in the next two weeks.

7.4 Argo in the Indian Ocean: resolving Intraseasonal Oscillations (G. Meyers)

The CLIVAR Asian-Australian Monsoon Panel (AAMP, September 2001, Reading) identified the Intraseasonal Oscillation (ISO) as a key issue for monsoon research in CLIVAR because it is the building block of seasonal to interannual Monsoon variability, one of the key challenges for prediction research.

The ISO is a weather phenomenon that develops in the western equatorial Indian Ocean, propagates eastward in the 10N-10S band, splits into northeastward and southeastward streams in the Bay of Bengal sector and ultimately affects rainfall over Asia and Australia. The event evolves over a period of about two weeks and involves large changes in rainfall, winds and SST. Large changes can occur at a fixed point within five days. Research to date suggests ISO is a coupled ocean atmosphere process requiring coupled GCM's for simulation.

Large changes have also been observed in the ocean during process experiments (JASMIN, BOBMEX) involving currents, depth of the thermocline, structure of the barrier and mixed layers and surface heat fluxes. Understanding the role of the ocean in the ISO requires:

- Description of the changes in barrier and mixed layers during an event
- Understanding the process (e.g. role of currents) in the changes
- Incorporating processes into ocean models and validation of coupled models.

AST considered enhanced temporal Argo sampling as part of an integrated observing system to observe the ISO. The integrated observing system could involve floats, moorings, process studies and other elements. Within a year or so Argo communications will be improved - allowing cycle time to be adjusted during float lifetime. Also, gliders will become available, capable of rapid sampling at a fixed location. Individual PI's might consider the possibility of an early test of rapid sampling with an existing float and communication system.

AAMP should work with AST to design an appropriate integrated observing system for ISO.

7.5 The Asia-Pacific Data-Research Center (P. Hacker)

During the past year the International Pacific Research Center (IPRC) at the University of Hawaii has established the Asia-Pacific Data-Research Center (APDRC, http://apdrc.soest.hawaii.edu). The IPRC's research effort requires easy availability to the substantial atmospheric, oceanographic, air-sea flux and satellite data sets and products. The vision of the APDRC is to link data management and preparation activities to research activities within a single center, and to provide one-stop shopping of climate data and products to local researchers and collaborators, the national climate research community, and the general public. The APDRC has four main activities: Data Server System (DSS) implementation and development; data management and archive building; value-added, data-intensive research projects; and coordination and collaboration. The web-based serving and use of Argo data are viewed as top priorities.

The APDRC plans to contribute to Argo implementation plans as a participant in the linked regional data centers. Specifically, the APDRC plans to: help define and implement regional data center activities for the Indian Ocean and Pacific Ocean; and encourage the rapid use and demonstrate the value of Argo data through web-based data and product serving and by contributing to SEREAD and other outreach activities.

The AST welcomed the APDRC effort and others like it in support of Argo, and noted the importance of having Argo users obtain data from GDACS through appropriate use of links from subsidiary sites such as the ADPRC.

8. Membership changes. Next meeting.

The committee agreed that the co-chairs of Data Management team, S. Pouliquen and R. Keeley, should be added to the Science Team. It was further agreed to accept the kind invitation of the Second Institute of Oceanography (SIO,Hangzhou) and the Key Lab of Ocean Dynamic Processes and Satellite Oceanography (LOPSO,Hangzhou), to host AST-5 in Hangzhou, China about March of 2003. Further details will be provided on the Science Team web site around September 2002. The meeting closed with a series of 10-minute presentation on early scientific uses of Argo data, and it was agreed to place greater emphasis on Argo results in upcoming meetings.

Appendix 1: Agenda, International Argo Science Team, AST-4
CSIRO, Hobart, Tasmania
March 12-14, 2002

Tuesday March 12 9:00 am

1. Welcome and Introductory Remarks – Nan Bray

   Local arrangements
   Discussion of agenda
   Implementing Argo to meet the needs of users (Smith)

2. The Argo Data System –

   Report on the 2nd Data Management meeting, discussion: (Pouliquen, Keeley)
   Delayed-mode QC, report and discussion of procedures (Wong)
   Plans for and roles of regional data centers
   Proposed integrated (JCOMM) QC feedback mechanism (Belbeoch)

Tuesday March 12 1:30 pm

3. Science symposium: The Value of Southern Hemisphere Observations. (joint with CLIVAR Southern Ocean Panel)

Introduction: Argo in CLIVAR (Gould)
The Southern Ocean's role in climate (Rintoul)
Southern Ocean response to climate change (O'Farrell)
Carbon uptake and accumulation in the Southern Ocean and sensitivity to change (Sabine)
Modes of variability in the atmosphere-ocean system of the southern hemisphere (Simmonds, Reason)
Observed changes in the southern hemisphere oceans and the need for an expanded observing system (Bindoff)
Southern Ocean water mass transformation and connections to lower latitudes (Speer)
How to extend Argo into the high latitude Southern Ocean (Fahrbach)
Ocean state estimation and operational oceanography: the need for southern hemisphere observations (Smith)
Discussion: challenges and opportunities for implementation of Southern Ocean Argo (Rintoul, Roemmich)

Tuesday March 12 6:00 pm Reception at CSIRO

Wednesday March 13 9:00 am

- continuation of item 2 – The Data System

4. Technical issue updates –

    Iridium communications (Riser)
    Problem with pressure sensors (Roemmich)
    Salinity offset problem with PROVOR/METOCEAN (Shikama)
    Estimating “up” and “down” times (Kim)
    Termination and recovery of Argo floats (Mizuno)
    Problem with rapid battery drain (Riser)
    Ancillary measurements - drift temperatures (submitted by S. Gille)
    Carbon biomass SOLO-Explorers (submitted by J. Bishop)

Is a technical issues workshop needed (including engineers from float building groups and commercial reps from float, sensor, and communications companies)?

Wednesday March 13 1:30 pm

5. Status of Argo Implementation

    Acceptance of National Reports - presentations are written only
    Report on the Indian Ocean Implementation Meeting – (Radhakrishnan, Wilson)
    Status of the global array, AIC float tracking (Belbeoch)
    Argo coverage mapping
    Update summary table of international commitments (Wilson)

(If possible, Item 6 will be started Weds p.m.)

Wednesday March 13 7:30 p.m.

Dinner at Meadow Bank Winery, Coal River Valley

Thursday March 14 9:00 am

6. Implementation planning mechanism

Working groups to produce updated deployment plans by regions/years for
2002/2003: Ind (Ravichandran), Pac (Takeuchi, Roemmich), Atl (Desaubies), SO
Mechanism for updating and reporting specific deployment plans

Thursday March 14 1:30 pm

7. Implementation issues

Argo Information Center (Belbéoch). Status of AIC development, float labels, etc.
Regional implementation – Workshop on "Potential applications of ocean observations for the Pacific Islands" (Wilson)
Capacity building - SEREAD update (submitted by Erb, Hall).
Argo paper for GODAE symposium (Roemmich)
Other implementation issues…(Danchenkov)

8. Membership changes. Next meeting. Adjourn.

9. Following the formal meeting, time permitting, anyone with early science results from Argo should show them (10 minute presentations). This is not finished work, but a glimpse at what is being done initially with Argo data. Signup sheet Thursday am.

Appendix 2: National Reports

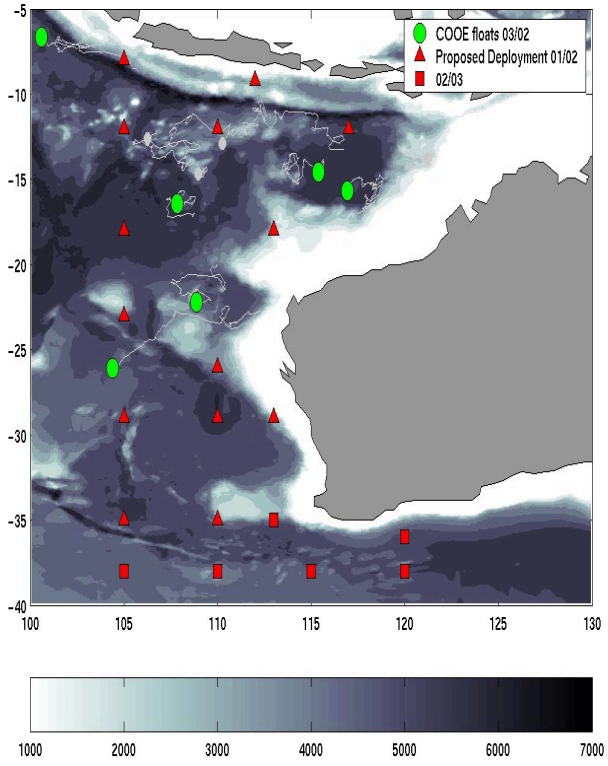
A.2.1. Australia (S. Wijffels)

Introduction:

The Australian contribution to Argo is through collaboration between the Bureau of Meteorology and CSIRO Marine Research via the Joint Australian Facility for Ocean Observing Systems (http://www.bom.gov.au/bmrc/ocean/JAFOOS/contents.html)

Floats Deployed:

Australia has deployed 10 floats as part of a pilot array in 1999-2000, all of which are still operating. These are all the 'old style' R1-PALACE floats manufactured by Webb Research Corporation, working on a 10-day duty cycle and drifting and parking at 2000m.



Floats to be Deployed:

Australia aims to deploy a further 19 floats starting in June 2002. These will be deployed in the eastern South Indian Ocean (see map) to both reseed the pilot array, which covers the outflow area of the Indonesian Throughflow, and then to extend the array to the south. We are entering talks with colleagues in Indonesia for joint deployments of several floats south of Java and Sumatra.
The new floats will be largely APEX-SBE 260cc from Webb Research Corporation, will be operated on a 10 day duty cycle and be parked to drift as close to 2000db as conditions allow.

Future:
The Bureau of Meteorology has funds in hand for ongoing float purchases of between 6-7 floats per year. Proposals will be submitted to supply a further 7 per year from CSIRO Marine Research equipment funds. Additional float requests will be made as part of a renewal bid for an Antarctic Cooperative Research Center.

Data:
All Australian data is published in near real-time on the GTS and is also available on the web through an interactive explorer at:
http://www.marine.csiro.au/~waring/cooe/

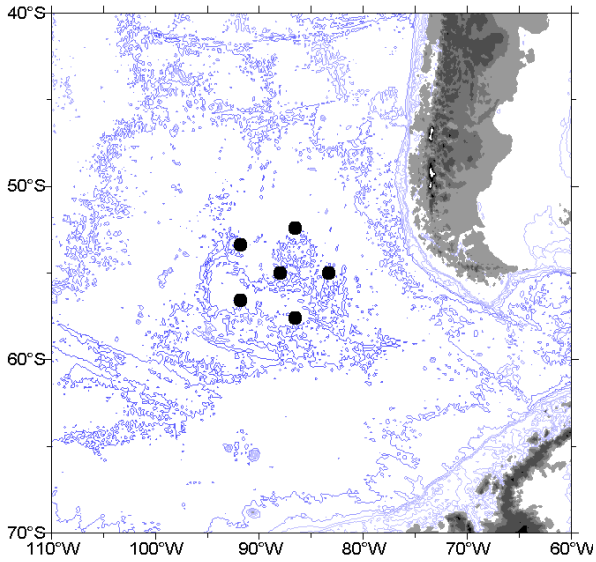
A.2.2. Canada (H. Freeland)

Preface:
The Canadian fiscal year starts April 1st and finishes on Mar. 31st of the following year. In all of the following FY01/02 refers to the fiscal year starting in 2001 and finishing in 2002. The Canadian plan is to purchase floats in one fiscal year for deployment in the following one, thus the number of floats available for deployment in FY02/03 is known, the number available for deployment in FY0304 depends on purchases in FY02/03 and is unknown.

Floats Deployed in FY01/02:
Canada has deployed 42 floats so far in FY01/02, it is possible that another 2 may be deployed before the end of March, but I will assume not. The 42 deployments are distributed between the Indian Ocean (1 jointly with India), the N. Atlantic (4 with a possible 2 more) and the remainder in the Gulf of Alaska. We entered the FY with an inventory of 52 floats, thus 10 remain on our inventory awaiting deployment. 10 of the floats deployed in the Gulf of Alaska were older 180 c.c. displacement floats ballasted for 1500 dbars, the remainder were all 260 c.c. displacement floats and are drifting at 2000 dbars, all are on a 10-day duty cycle.

Floats Acquired in FY01/02:
A total of 16 additional floats were purchased during FY01/02 thus creating a total inventory of 26 floats awaiting deployment as we enter FY02/03. Currently all floats on the Canadian inventory are APEX-SBE floats.

Deployment Plans in FY02/03:
Of the 26 floats available for deployment at least 8 will be deployed in the N. Atlantic, but the specific strategy has not been determined at the time of writing. We intend using 6 of the inventory to be deployed as part of an international study of the formation of intermediate water in the southern ocean. Initially these would be deployed in a 300 km radius circle as shown to the right, but this would fairly rapidly be dispersed and the floats contributing to more generic mapping in the southern hemisphere. A ship-board opportunity for deployment has been identified for February 2003.



The 12 floats remaining will be used first to fill gaps arising in the Gulf of Alaska array, then possibly to replace failures or fill gaps in the N. Atlantic.

Floats to be Acquired in FY02/03:
No funds have been identified yet for the acquisition of floats in this fiscal year. However, based on previous experience and support for the program it seems likely that Canada will purchase between 10 and 15 floats this FY for deployment in FY03/04. No firm commitment can be made at this time.

Data Acquisition:
Canada has created a real-time data processing facility based at MEDS (Marine Environmental Data Service, Ottawa) and this is working efficiently. Data are being posted on the GTS within 12 hours of acquisition and data are being exchanged with the Coriolis web site.

Funding:
Capital funding for the acquisition of hardware is *ad hoc* and needs to be addressed on a year-by-year basis. However, secure funding exists for operations and maintenance for 4 years. Continuation of this funding will need to be addressed during FY04/05.

Use of data:
In the spirit of Argo Canada puts no restrictions on the use of data acquired by Canadian Argo floats by any scientists. Within the last few months several proposals have been written in Canada to make energetic use of the Argo data sets. At the Institute of Ocean Sciences we are interested in using the Gulf of Alaska data in the immediate future to simulate sampling along our long time series, Line-P at 10-day intervals. As of February 2002 there is now data sufficient to do this. Also, Ocean Station Papa will be the site for a dye injection and iron-enrichment experiment during the spring-summer of 2002, it is our intention to calculate velocity fields around the dye patch and use the Argo data set to monitor the likely movement of the centre of mass of the dye patch and the likely stretching of the patch by the background strain field. This will help scientists return to the enriched and dyed water mass for sampling after the plankton bloom has finished

A.2.3. China (J. Xu)

China has formally decided to participate in the Argo Project and its implementation. The State Oceanic Administration (SOA) is responsible for the implementation of the China's Argo project, along with other agencies including China Meteorological Administration (CMA), Chinese Academy of Sciences (CAS).

During the year of 2002-2005, China plans to deploy 100-150 floats. Additionally, we will deploy 20-30 floats every year to maintain the array running regularly.

The deployment area designed is the northwest Pacific, within the area which is surrounded by connecting lines of 6 points, i.e. ($0^oN,130^oE$), ($15^oN,125^oE$), ($23^oN,125^oE$), ($30^oN,130^oE$), ($30^oN,145^oE$), ($0^oN,145^oE$). According to the deployment principle of the International Argo Program, 100 floats will be progressively launched. Depending on the progress of the project, another 50 floats could be deployed in the Indian Ocean and the Southern Ocean.

At the end of 2001, we got fund from the MOST and 2-3 floats will be deployed in the Northwest Pacific area (2 floats) and Indian Ocean area (1 float) in March of 2002. Another deployment of 8-10 floats is planed in the next half year.

With the floats deploying, China will set up the Argo data center to meet the need of data accessing, processing and distributing.

With financial support of POGO (the Partnership for Observing the Global Oceans) and under the assistance of NOAA, SOA sent 2 young oceanographers, in January 2002, to participate in a training course on Argo float technology and data processing method in University of Washington and NOAA'S Atlantic Oceanographic and Meteorological Laboratory (AOML).

The Second Institute of Oceanography (SIO,Hangzhou) and the Key Lab of Ocean Dynamic Processes and Satellite Oceanography (LOPSO,Hangzhou), would like to host the 5^{th} AST in Hangzhou in March of 2003.

A.2.4. France (Y. Desaubies, S. Pouliquen)

French contributions to ARGO proceed along several lines : the development and operation of the CORIOLIS data centre, active involvement in the data management committee, the procurement and deployment of profiling floats, technological developments, the leadership of the EU – funded project GyroScope, and related scientific activities.

1. The CORIOLIS data centre

The Coriolis Data centre is involved in Argo Data network at two levels. First it is a National Data Centre in charge of collecting, processing, archiving and distributing the float data for the floats deployed by French Pis and also some European ones (i.e. Germany, United-Kingdom and Denmark). Secondly it is one on the two Global Data Centres for Argo distributing to the user community, on Internet, all the data provided by the National Data centres.

1. 1 Coriolis : The French ARGO National Data Centre

The seven French agencies concerned with ocean research are developing jointly a strong capability in operational oceanography based on a triad including satellite altimetry (JASON), numerical modelling with assimilation (MERCATOR), and in situ data (CORIOLIS).

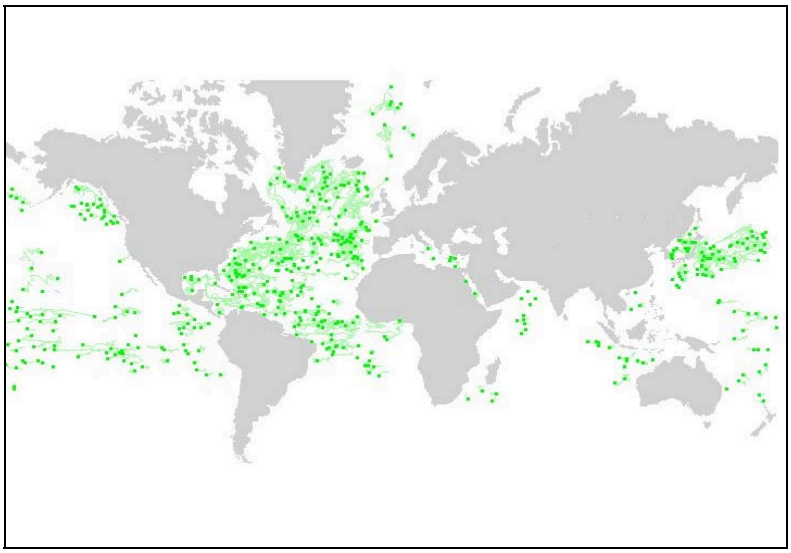
The CORIOLIS project aims to build a pre-operational structure to collect, validate and distribute ocean data (temperature/salinity profiles and current speeds) to the scientific community and modellers; it is also the French contribution to the ARGO network for the GODAE experiment, able to provide quality-controlled data in real time and delayed modes.

Initially designed on the GTSPP (Global Temperature Profile Programme) experience in order to provide services to users end of 2000, Coriolis Data Centre has evolved in time to provide services tuned to the needs of operational oceanography users, in terms of data distribution timeliness, quality control procedures and products. Since early 2001 the Coriolis data centre is providing operationally to the French ocean modellers all available Temperature and Salinity data, first on a weekly, and now on a daily, basis.

The main functions developed at the Coriolis data Centre are:

- *in-situ* data collection (from various instruments such as XBT, CTD, XCTD, surface moorings, thermo-salinographs and vessel mounted ADCP);
- data archiving and cataloguing;
- quality control;
- instruments technical support;
- data and products dissemination to final users.

CORIOLIS Data Centre is presently running in version 1; a new version under development will be available by mid 2002. Version 2 will include a new version of the database and a completely redesigned web site with new access functionalities such as visualisation and sub-setting tools according to time/period/parameters criteria. This news interface is implementing the recommendations of the Argo data management committee. A prototype of the interface will be presented at the AST4 meeting.



Argo 2001, global coverage : 491 floats, 12 517 profiles

1.2 Coriolis a Global Data Centre

As a recommendation of the 1st Argo Data Management meeting (held in Brest in October 2000), Coriolis has been asked to set up together with the US GODAE Centre in Monterey/USA, one of the Global Data Centres for the ARGO program.

First part of 2001, has been devoted to designing the concepts of data sharing in Argo (data flow, data formats). By summer Coriolis was providing the first version of the Global Argo FTP site. At the last Data management meeting (November 2001), the data management committee made recommendations that will be completely implemented in March 2002. The National data centres are setting up the mechanisms to feed the Global data Centres; this should be in place progressively first semester 2002. For the time being this server is fed by the data processed by Coriolis as well as data collected on GTS. The impact is that most of the profiles are available on the Global Data centre, except the trajectories, the metadata and the technical information.

1.3 Coordination of Argo Data Management Activities

The Coriolis team is an active participant in the Argo data Management activities:

- Co-chairing the Argo Data management Committee
- Coordination of the definition of standard Argo data formats
- Coordination of the data flow within the Argo network

Formats specification

The Coriolis Data Centre is an active participant in the ARGO Data Management Team and is the leader of the ARGO formats specification. During the latest ARGO data Management meeting (Brest, November 2001) the standard format for profile, trajectory, metadata and technical information have been finalized. Description of these formats is available on the Coriolis Web site: http://www.coriolis.eu.org/coriolis/cdc/argo_rfc.htm .

Designing the Argo Data Management network

As a Global Data manager, the Coriolis team has coordinated the elaboration of the design of the data flow within the ARGO network which lead to the description below and is fully described in the Argo Data management User Handbook available at the following address http://www.coriolis.eu.org/coriolis/cdc/argo.htm

2. Float procurement and deployments

Because of the funding cycle, there is a long delay between programme funding, orders, delivery and deployment. The table below lists the floats to be purchased and deployed in the few years to come. Most funding for floats comes from Ifremer, with smaller contributions from SHOM and CNRS. Only floats active at the time of this report are listed. In addition, SHOM has funded 20 Temperature-only PROVOR floats, 9 of which are active, and 11 to be deployed (2002) in N. Atlantic. Only floats that are very likely are listed here; those that are sure are **bold face**.

Summary of float purchases and deployments

	2000	2001	2002	2003	2004	2005
	Number to be purchased					
GyroScope at Ifremer		**40**				
Ifremer		**50**	**60**	**30**	50	50
SHOM	**3**		**15**	**15**	**15**	?
CNRS			**20**			?
Total funded or to be funded	**3**	**90**	**95**	**45**	65	50
	Number to be deployed					
Subpolar gyre, N. Atlantic			**15**			
Subtropical gyre, N. Atlantic	**1**	**6**	**35**			
Other, Atlantic				50		
Indian			**15**	**25**		
Total	**1**	**6**	**65**	75	75	75

3. Technological developments

Some time has been devoted to final testing and evaluation of the PROVOR float equipped with FSI Excell CTD cell, which is the reason why there is some slight delay in our deployment plans. Nevertheless, some 65 floats will be deployed in 2002. Meanwhile, development is proceeding on the PROVOR equipped with a SeaBird cell, for which the first sea tests are scheduled in the summer 2002. A similar version, but with different electronics and software is available from Metocean since the summer of 2001.

4. The GyroScope project (2001 – 03)

In previous reports this project has been listed separately. It is partially funded (50%) by the EU Commission and the participating laboratories (France : Ifremer, CNRS, SHOM, CLS; Germany : IFM; UK: SOC and UKMet Office; Spain : IEO, ULPGC, ICM). Funding has been obtained for 80 floats to be deployed by Ifremer, SHOM, IFM and IEO in the North Atlantic.

	2000	2001	2002
Number purchased	**10**	**70**	
Number deployed		**11**	**69**
Where			
Subpolar gyre		**10**	**25**
Subtropical		**1**	**44**

Other contributions to the project include the CORIOLIS data centre, technical evaluation of the array, and scientific activities : water mass characteristics, heat budgets, inverse modelling, comparison of the data with numerical model outputs, studies of the information content of the floats.

In the course of this project we are evaluating the salinity measurements, by implementing the algorithm of Wong et al (2002). So far, all indications are that the FSI sensors on the PROVOR perform well, to within the mapping error of the method.

The first GyroScope annual report is available on http://www.ifremer.fr/lpo/gyroscope

5. Scientific activities based on ARGO data

As the deployment of the array progresses, several scientific projects are developed around the ARGO data base. The MERCATOR project is well-known and proceeds according to planning. The CNRS has issued a call for proposal, based on ARGO data, for which two projects in the Indian ocean are under evaluation (and likely to be funded). The OVIDE project, a contribution to CLIVAR, is partially based on the use of ARGO data. Likewise for the EGEE project in the Eastern Tropical Atlantic.

6. Perspectives beyond 2003

The EU Commission and the European Space Agency are launching a new initiative called Global Monitoring for the Environment and Security (GMES), for which funding will be available through both agencies. The European Union support would come through so-called Large Integrated Projects, for which calls for proposals will be issued in 2003. One of the sub-projects under those programme will concern in situ observations, for which continuing funding for ARGO will be sought. Several French agencies will be actively involved in those projects, in co-operation with their European partners.

A.2.5. Germany (U. Send)

National ARGO (115 floats proposed):
A joint proposal of three research groups at the AWI (PI's: Boebel, Fahrbach), at BSH (PI's: Mittelstaedt, Koltermann and Sy) and IFM-Kiel (PI's: Fischer, Schott) for a German ARGO component was sent to the funding agencies early 2002. This proposal has three components, each with a requested number of 35 floats in the Southern Ocean Atlantic Sector (AWI), in the western tropical Atlantic (IFM-Kiel) and in the subpolar North Atlantic (BSH). This program is planned for a three year funding period beginning spring 2002. Funding prospects are uncertain.

German part of EU ARGO (10 floats operating, 30 planned), IfM Kiel (Send, Zenk):
As part of the EU ARGO project Gyroscope, IfM Kiel is responsible for a total of about 40 floats. Of these, 10 have been deployed in 2001 in the Iceland/Irminger basins. 10 more will be deployed on the French OVIDE cruise from Spain to Greenland in 2002. Another 8 will complement the BSH section coverage along 48N in 2002 (eastern and western extension). Further, 6 will be deployed in 2002 on a cruise from Newfoundland to Iceland (Labrador Sea, Irminger Sea). The final 6 are planned for a 2002 cruise between Iceland and Ireland.
All data are received from ARGOS by Coriolis, where the real-time QC and dissemination is handled.

Various non-ARGO projects exist in Germany which contribute floats to the overall system as float equivalents. These are listed in the following.

Subpolar North Atlantic (5-6 floats operating), IfM Kiel (Schott, Fischer):
Within the framework of a special research program (SFB460) at IFM-Kiel, Germany, profiling floats were lauched in the western subpolar North Atlantic since early 1997 (subprogram A4, "Variability of Water Mass and Circulation in the Western Subpolar North Atlantic"). The general objectives of this subprogram are the quantification of deep water pathways, transports and their variability in relation to the variability of water mass formation and distribution in the subpolar western North Atlantic. A variety of observational methods, among which is the deployment and analysis of profiling floats (PALACE, APEX), are used to achieve this goal. Floats are generally seeded into the deep western boundary currents (Deep Labrador Current, Fischer and Schott, 2002, JPO, 32, 573-584) drifting at 1500 dbar within the core of the Labrador Sea Water. From previous deployments, 2-3 temperature-only floats are still alive, these are not being processed in real-time and are not going on the GTS.

Seven floats of a newer genearation (APEX) were launched in May/June 2001 at three loacations, off the tail of the Grand Banks, north of Flemish Cap and at the exit of the Labrador Sea (FIG. 1). These floats drift at 1500 dbar, profile from 2000 dbar up to the surface at a ten day schedule. 5-6 of them are still alive. The data are transferred via ARGOS to the Coriolis data center and from there distributed to the GTS and the internet.
(see http://www.ifm.uni-kiel.de/fb/fb1/po1/research/sfb460/a4/sfb-a4.html)

Tropical Atlantic (11 floats operating), IfM Kiel (Schott, Fischer):
Within the framework of the German Clivar program profiling floats play an important role for the determination of the warmwater circulation that couples the subtropical regions with the tropics through shallow thermohaline circulation cells. In the southern hemisphere this cell consists of westward flow in the interior by the South Equatorial Current (SEC), northward flow along the western boundary with the North Brazil Current (NBC), and retroflection into zonal eastward flow of the equatorial current system.

Ten APEX-SBE floats (FIG. 2) were deployed in the western tropical Atlantic during March/April 2000 and an additional five floats were deployed in November 2000. ARGO runs these floats as ARGO-equivalent and their data are not found on GTS. All floats are programmed to drift at shallow depths (200 and 400 m) with the tropical/subtropical warm water circulation. In regular 10-day intervals the floats descend to 1500 m depth from which they subsequently rise to the surface and collect temperature and salinity profiles measured by a Sea-Bird CTD module. The floats which were launched near the Brazilian coast revealed the swift advection by the NBC with current speeds up to 60 cm/s. Farther downstream of the NBC, float 116 apparently entered the NBC retroflection and drifted eastward, presumably within the eastward equatorial current branches (NEUC/EUC). Some floats were deployed farther offshore in the SEC regime near 5 S first drifted westward and were then entrained in the NBC .

It is planned to include these floats into the ARGO data flow via Coriolis (ARGO equivalent floats). (see http://www.ifm.uni-kiel.de/allgemein/research/projects/clivar/ta/floats.html).

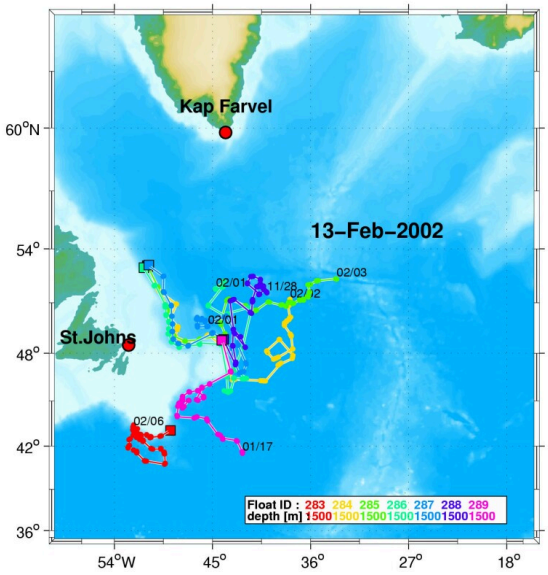


FIG. 1: Trajectories of the floats deployed deployed in subpolar North Atlantic (SFB 460)

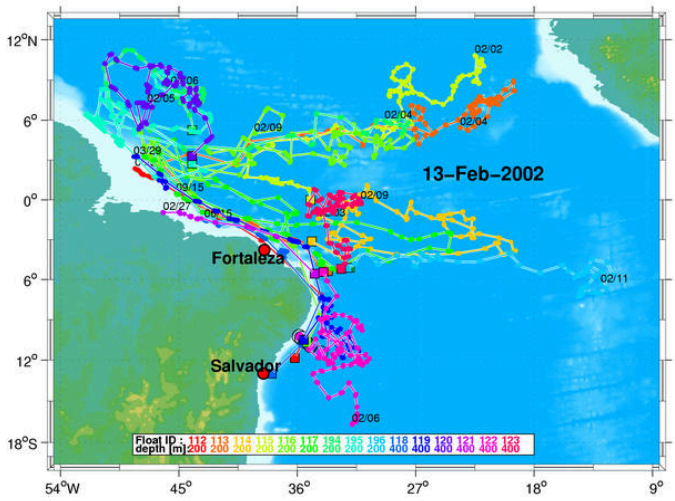


FIG. 2: Trajectories of Apex-floats in western tropical Atlantic (CLIVAR)

North Atlantic 48N (18 floats operating, 7 planned), BSH (Koltermann):
A total of 23 T/S floats have been deployed in 2000 and 2001 along 48N between 20W and 35W, of these 18 are alive. Another 7 will be deployed along the section between 15 and 35W in 2002. All are decoded and posted on the GTS by Service Argos, from where Coriolis also retrieves the data or gets a copy.

Southern Ocean,Weddell Gyre (9 operating, 10 planned), AWI (Fahrbach,Boebel):
In December 2001, 9 T/S floats were launched in the eastern Weddel Gyre, see FIGURE3. Drift depth 750m, profile depth 2000m, 7 day cycle. Another 10 floats are planned for deployment in same region for December 2002. If the German national ARGO proposal is successful, these 10 will be part of the 35 requested. Else, internal AWI funding will be sought for the 10 floats. All floats are received and processed in real time at Coriolis.

11 older T-only floats still operate in the region, and there not plans to disseminate them in real-time. If this is of interest though, no objection exists to making them available.

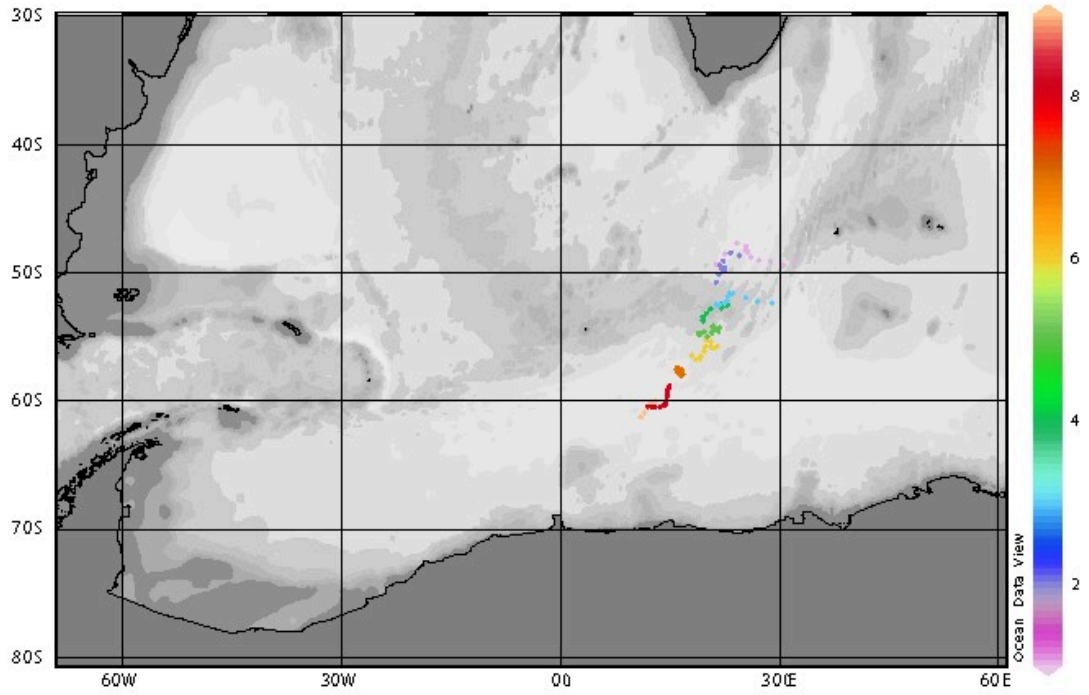


Figure 3: Deployment positions and initial drift of AWI floats from December 2001.

Western Mediterranean Sea (8 floats operating), IfM Kiel (Send):

Of 17 floats deployed in the western Mediterranean since 1998, 8-9 are still operating, see FIGURE 4 for the trajectories of the floats alive. The drift/profile depths are 1300 and 1900m, 8 day cycle. Of these, 5 are T/S profilers, the others T only. The data are not currently disseminated via GTS and data centers, but no objection exists if there is interest.

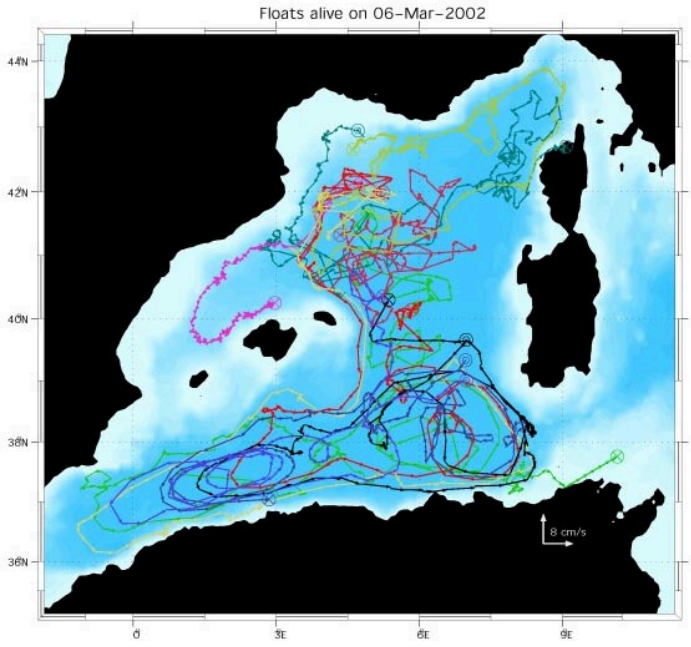


Figure 4: Floats alive in W.Med

Indian Ocean (15 floats funded), IfM Kiel (Schott,Fischer):

A new float program, "Circulation and Climate of the Indian Ocean (CICIO)", is funded for a two year period (FY 02/03) with 15 APEX floats to be deployed in the southwestern Indian Ocean. These

floats will drift at shallow horizons (200 and 400 m) but will profile down to 2000m. This program (PI's F. Schott and J. Fischer) is a contribution to ARGO and as such, the data will be available through the usual ARGO pipelines. Deployment of the floats is not fixed yet.

National data center and quality control:

All “public“ German floats are handled via Coriolis at present, i.e. the data are received there, real-time QC applied, and disseminated/archived. No procedures exist yet at any labs listed above for routine delayed-mode QC and for re-submitted the final QC´d data to the data centers. No national data center exists for this, and the P.I. groups do not have staff yet to carry this out on a routine basis (even though it is done for ongoing research work). All German groups would have no objection if Coriolis expanded its capacity to provide this service and thus act as a national data center for also the German floats deployed (ARGO or ARGO equivalents).

A.2.6. India (K. Radhakrishnan)

The Indian Argo Programme is funded by Department of Ocean Development (DOD) and implemented by the Indian National Center for Ocean Information Services (lead), National Institute of Ocean Technology, Center for Ocean and Atmospheric Sciences of Indian Institute of Science along with National Institute of Oceanography and 6 other academic/R&D/operational institutions

Progress since the AST-3

- The Indian Ocean Argo Implementation Planning Meeting was held in Hyderabad, India during July 26-27, 2001. The highlights of the meeting are brought out separately in the meeting report. India was identified as the Regional Co-ordinator and Regional Data Centre for the Indian Ocean region.

- An Argo float, provided by Canada, was deployed on December 22, 2001 in the South West Arabian Sea and thereby gained experience in float deployment. This float (2900193) has already given seven cycles of data.

- Data from the North Indian Ocean floats is being archived at INCOIS and this is being made available to other Indian Users.

- Argo float programme has found a prominent position in the Ocean Observation component of the Tenth Five year plan that is being finalized now by the Government. Process for investment approval is underway.

- The Indian commitment continues to be 150 floats in the Indian Ocean north of 10° south. The revised deployment schedule envisaged is 31 floats in 2002, 50 floats each in 2003 & 2004 and 19 floats in 2005.

- Argo Data Centre is being setup at INCOIS, Hyderabad, India.

- A study to assess the usefulness of Argo data in furthering the understanding of the physical processes in the Indian Ocean is in progress. It is expected that this analysis will bring the hitherto unknown spatio-temporal scales and variability of the hydrography and circulation in the Indian Ocean.

Capacity building on Data Assimilation and Modelling is imperative for effective utilization of Argo data in this region.

A.2.7. Japan (K. Takeuchi)

1. Deployment

JAMSTEC/FORSGC deployed, 24 floats in the calendar year 2001, and 29 floats in the first three months of the calendar year 2002, with cooperation of JMA, Japan Coast Guard, Univ. of Tokyo and so on. Except for 5 floats deployed in the western tropical Indian Ocean in October 2001, all the floats are deployed in the western North Pacific Ocean. The total number of floats deployed by Japanese Argo project reaches to 57 at the end of February 2002. Among them, 50 floats are still working. One float is recovered, in order to check the sensor drift and so on. Among the floats launched in the last two years, 21 of them are APEX floats with Seabirds sensors, one is a APEX float with a FSI sensor and the rest are PROVOR float manufactured by Met-Ocean with Seabird sensors.

Recently, we found that the PROVOR floats show offset in salinity, 0.01 to 0.06 lower than nearby CTD observations. JAMSTEC is now investigating the cause of this problem, and stops the deployment operation of Provor until the problem is fixed.

The first prototype floats developed by TSK will be put in the water adjacent to Japan during a Mirai (JAMSTEC) cruise in March 2002.

JMA deployed 4 Argo floats in FY 2001, added on 8 floats deployed in FY 1998-2000. Among the 12 floats, 6 floats are still working.

2. EEZ problem

The Ministry of Foreign Affair of the Russian Federation refused to give permission to the oceanographic observations by R/V Mirai (JAMSTEC) in June 2001, including deployment of floats in the Russian EEZ east of Kamchatka Peninsula.

The Ministry of Foreign Affair of China did not give EEZ clearance in time to the deployment of a part of floats along 137E by Ryofu-Maru (JMA) in Feb. 2002, which have a slight possibility to enter Chinese EEZ in four years.

3. Data Management

At present, JAMSTEC receives float data and decodes and transmit them to JMA as a P.I. of Japanese Argo floats and JMA delivers the data through the Global Telecommunication System(GTS). JMA will establish a real-time data processing system to quicken this distribution of float data to GTS by decoding data in JMA by the end of March 2002. Both JMA and JAMSTEC started to provide Japanese float data at each websites from April 2001.

Global and regional float coverage maps made from GTS TESAC messages and all TESAC messages are displayed on the JMA website (http://argo.kishou.go.jp/). JMA will start real time data transfer to the Global Data Centers by the end of March 2002 as the national real-time data center of Japan.

The JAMSTEC website (http://www.jamstec.go.jp/ARGO/J_ARGOe.html) will also show Float Coverage Maps of Pacific and Indian Oceans.

The JAMSTEC FTP server should be ready by the end of March 2002, which is to be used for mirroring the global data centers in FNMOC and IFREMER and providing data of Japanese floats in the standard data format (netCDF, Ver.2.0).

JAMSTEC is examining the method of delayed mode QC, and constructed high quality databases for the North Pacific and Indian Ocean, to be used for delayed mode QC. The database is edited in the same way as Hydrobase, using high quality historical data.

4. Deployment plan for FY 2002

JAMSTEC/FORSGC is planning to put about 100 floats in the water in FY2002. The main area of deployment is the Western North Pacific, but several floats will go to the Western Tropical Indian Ocean and the Southern Ocean.

A.2.8. Korea (K. Kim)

In 2001 Korea deployed 17 floats equipped with CTD; 8 in the East/Japan Sea, 8 in the western Pacific and 2 in the southern Pacific. Floats were provided by the Korea Meteorological Research Institute and Ministry of Marine Affairs and Fisheries through the Korea Ocean Research and Development Institute. KAS represented by major oceanographic and meteorological institutes and universities coordinates national plans of the Argo Program in Korea.

In 2002 25-30 floats are planned for deployment; 10 in the East/Japan Sea, 15 in the western Pacific and the rest elsewhere if available.

A.2.9. New Zealand (P. Sutton)

New Zealand (P. Sutton)

Argo is being implemented and supported in New Zealand by the National Institute of Water and Atmospheric Research (NIWA). The contact person is Philip Sutton.

Two floats were deployed north of New Zealand in September 2001:

32° 20.97'S	170° 00.14'E	3820m	16 September 2001
31° 27.23'S	171° 00.56'E	2943m	17 September 2001

There is approved funding to purchase 2 further floats in mid 2002. It is hoped to continue to purchase and deploy two floats per year for the foreseeable future. The floats will be deployed in the New Zealand region, with the initial deployments being in the Tasman Front / East Auckland Current areas north of New Zealand. Later deployments may be in the New Zealand subantarctic zone: 44°-55°S, 160°E-175°W.

New Zealand's largest contribution to Argo is likely to be in terms of logistical support. NIWA's 72m research vessel, "Tangaroa", can be used as a platform for Argo deployments, and routinely covers most of the New Zealand EEZ with occasional transits to Antarctica/Ross Sea.

In addition, New Zealand is able to supply logistical support for other South Pacific deployments. This support could take the form of supplying or training personnel, float delivery, preparation and maintenance, and the promotion of Argo throughout the South Pacific.

A.2.10. Russia (M. Danchenkov)

Introduction

The Russian ARGO activity is conducted by Far Eastern Hydrometeorological Research institute (FERHRI) with support of Hydrometeorological Agency (ROSGIDROMET), Japanese Atomic Energy Research Institute (JAERI, Japan) and School of Oceanography, University of Washington, USA. Director of FERHRI was pointed as coordinator of ARGO project in Russia.

Full-scale funding of Russian ARGO has not began due to "the absence of international agreement on ARGO".

Floats

In cooperation with JAERI had deployed 4 PALACE floats (Webb Co) in 1999-2000, two of which are still operating (level of drift- 600m, cycle- 10 days). Two of them drift at the surface from the beginning.

Floats that have to be deployed in 2002

Russia (FERHRI) will deploy 2 PALACE floats in 2002. Place for the deployment is not chosen yet. Probably it will be the northern Japan Sea.

Future

Without international agreement (program) on ARGO any work on it in Russia could be funded in small volume (on account of scientific program) only.

Data

All data is published in GTS and on the Russian ARGO web-site:

//rus.hydromet.com/~argo/

Russian Delayed Mode ARGO Data Center is being setup in FERHRI (Vladivostok).

Issues

Russian vessels could be used for deployment of foreign floats in south ocean.

Danchenkov M.A.
Email: danchenk@fastmail.vladivostok.ru

A.2.11. U.K. (J. Turton)

The UK's contribution to Argo is being funded by the Department of the Environment, Food and Rural Affairs (DEFRA), the Ministry of Defence (MoD) and the Natural Environment Research Council (NERC), and is co-ordinated by the Met Office with support from Southampton Oceanography Centre (SOC), the British Oceanographic Data Centre (BODC) and the UK Hydrographic Office (UKHO).

UK Argo Project

The UK Argo Project was initiated in 2000 with the aim of establishing the capacity to procure and deploy about 50 floats each year, to apply all real-time float data in operational ocean forecasting, and to process UK float data in delayed mode for climatological and hydrographic purposes. Funding for the UK Argo Project has been agreed to end March 2003. A phase 2 project, through to 2006, is being proposed, but as yet funding has not been confirmed.

Float deployments during the last year

During the last year (since March 2001) we deployed 25 floats (with 2 failures) in a wide range of different geographic areas; 4 floats in the Irminger Sea (north-west Atlantic), 3 in the north-east Atlantic, 2 in the Norwegian Sea, 5 in the south-west Indian Ocean, 10 in the north-west Indian Ocean and 1 in the south-west Atlantic. 25 of these are designated as UK Argo floats with 2 additional 'research' floats. The floats include 2 MARTEC PROVORs deployed in the Irminger Sea. Together with the 5 Irminger Sea floats deployed in January 2001, the total number of UK floats that has been deployed to date is 30.

Around 36 floats (33 UK Argo plus 3 research floats) are scheduled for deployment in spring 2002. 2 more floats are due to be deployed in the south-west Atlantic in early March, 25 floats will be deployed during March/April along the 32 °S section in the southern Indian Ocean, 2 more floats in the north-west Indian Ocean in April, 3 more floats in the Norwegian Sea in May, and around 4 more floats (including 3 research floats) in the Irminger Sea in March.

Climate simulations made by the Hadley Centre for Climate Prediction and Research have suggested that a freshening in the southern Indian Ocean and Arabian Sea intermediate waters (in the top 500 m) is a signal of man-made climate change. Hence these are regions on which we are focusing our early float deployments.

Data processing

Real-time data. Data from all working UK floats are automatically placed onto GTS in WMO TESAC format by CLS/Meteo-France or (for our PROVOR floats) Coriolis. Since November 2000 the Met Office have monitored the real-time float data received over GTS. The number of floats received has increased from 214 (52 with salinity) in November 2000 to 371 (252 with salinity) in February 2002. Over twice as many floats are now reporting within 2 days. Full-resolution data from our UK floats is also available in near real-time from an ftp site, currently hosted by SOC. All real-time float data received over GTS are routinely assimilated into the operational Forecasting Ocean Assimilation Model (FOAM) run daily by the Met Office to produce analyses and forecasts to 5 days ahead of the temperature, salinity and currents of the deep ocean.

UK Argo 'Delayed-Mode' Data Centre. UK delayed-mode data management will be a collaboration between BODC and the UKHO, utilising the expertise at SOC, especially during the early stages. BODC will operate an Argo 'Delayed-mode' Data Centre; funding for this has been agreed for an initial period of 4 years to summer 2005, i.e. to the end of the Pilot Phase of Argo. The activity will be reviewed in late 2004 when the requirements for its longer term operation will be assessed. The Data Centre will act as a) the 'delayed-mode' data centre for UK floats in the Argo programme regardless of their location and b) as the international Argo 'delayed-mode' data centre for the Southern Ocean. The Data Centre will collaborate with the UKHO in the validation of 'delayed-mode' data and ensure the timely delivery of such data to UKHO for inclusion in their databases. Data will be delivered to the Global Argo Data Centres once the BODC system is operational and exchange formats have been fully defined.

The Met Office has a set of web pages describing the UK Argo project (www.metoffice.com/research/ocean/argo), linking to the SOC ftp server for the data and to other Argo web sites (including the Argo Information Centre). During autumn 2001 a web-site (www.bodc.ac.uk/projects/argo) was established at BODC, at present this links to the SOC ftp site for access to the data, but from May 2002 the data should be available directly from BODC.

Plans for FY02/03

During FY02/03 we anticipate buying around 45 UK Argo floats, perhaps supplemented by as many as 12 'research' floats. Initial plans are to deploy these mainly in the South Atlantic, Indian Ocean and Southern Ocean (Atlantic and Indian Ocean sectors).

Issues

An important issue for the UK is the longer term future for Argo. Our expectation is that an initial global array should be in place by 2006. At that stage Argo should be ready to enter a transition phase towards becoming an operational system with nations committing longer-term funding. However, it will be essential for Argo to demonstrate real benefits and impacts for this to be justified. GODAE will be critical in providing a demonstration of, and quantifying, the benefits of Argo for real-time ocean analysis and forecasting. However, it will take rather longer to demonstrate the impact of Argo on seasonal forecasting and climate prediction.

A.2.12. U.S.A. (D. Roemmich)

Organization: The U.S. Argo Project is supported through the multi-agency National Ocean Partnership Program (NOPP). The project is carried out by a U.S. Float Consortium that includes principal investigators from six institutions (SIO, WHOI, UW, NOAA/AOML, NOAA/PMEL, LDEO). Float production, deployment, and data system functions are distributed among these institutions on a collaborative basis. Following 2 years of pilot activity supported by ONR and NOAA, U.S. Argo has begun a 5-year full implementation phase funded by NOAA.

Status: In the first two years of U.S. Argo (FY99, FY00) a total of 187 floats were funded, with about 1/3 of these yet to be deployed. During calendar 2002, we will deploy the remaining FY00 floats plus 172 floats funded in FY01. FY02 funds will provide at least 275 floats, to be deployed during calendar 2003. At present, 164 active U.S. floats are returning data through the Argo data system. These include 90 Argo floats and 74 floats funded through non-Argo sources: 10 PMEL floats, 12 NAVOCEANO floats, 13 AOML floats, 19 UW floats, and 20 SIO/CORC floats.

A major focus of U.S. Argo this year is technology improvement and development. The failure rate of U.S. floats has been unacceptably high so far. Efforts are being made to address all possible failure modes due to design, fabrication, and deployment. The relatively slow rate of deployments during the past 6 months is due to the concentration on improving float ruggedness and reliability. An additional aim of technology improvement this year is the testing of alternate communications systems – Iridium and Orbcomm.

The U.S. Argo Data Center is now in operation at NOAA/AOML. Real-time data from all U.S. Argo floats are presently being transmitted via the GTS. GTS transmission uses computers housed at Service ARGOS (U.S.) and operating round-the-clock, running software developed at AOML to implement internationally-agreed quality control tests. The AOML data center serves as the focus for data management by passing data to PIs and to the delayed-mode QC center at NOAA/PMEL, where a statistical system for salinity recalibration has been developed. The Data Center is transitioning to internationally agreed NetCDF Argo formats.

Priorities: Main target areas for U.S. Argo float deployments continue to be the tropical Pacific and the Atlantic Ocean. While building on these arrays during 2002, we will also deploy floats in the northeast Pacific and the tropical Indian Ocean, and will initiate Southern Ocean deployments during austral summer 2002-2003. Regional priorities for deployment of floats are set by the U.S. Argo Advisory Panel (C. Koblinsky and B. Owens, co-chairs). The panel is composed of float providers and representatives of the Argo user community, and its criteria are to:

- Build a global Argo array with international partners.
- Rapidly implement regional arrays that are high priority to users (e.g. the tropics and western subtropics)
- Build on existing (pre-Argo and early Argo) float arrays.

Appendix 3: Annotation for table of commitments of floats to Argo (Section 5.3)

Australia – FY02 starts Jul 1, 02 – funded by Commonwealth Scientific and Industrial Research Organization (CSIRO) and Bureau of Meteorology (BoM); FY03/04/05 funding includes proposals for 7 floats/yr from CSIRO equipment fund and an additional 24/yr year as part of renewal bid for Antarctic Cooperative Research Center

Canada – FY starts Apr 1 – funded by Dept. of Fisheries & Oceans with potential funding from Dept. of National Defense, Environment Canada, and others

China - FY starts Jan 1 - funded by Ministry of Science & Technology (MOST); implemented by State Oceanic Administration in collaboration with other organizations; 6-10 are proposed for FY02 and 80-130 for FY03/04/05

Denmark – Niels Bohr Institute for Astronomy, Physics and Geophysics is deploying 5 floats in the Greenland Sea and is proposing 30 for next three years

European Commission – Gyroscope proposal—submitted by France, Germany, Spain, and U.K.—has funded 80 floats, with 40 for Institute fuer Meerskunde-Kiel and 40 for Institut Francais de Recherche pour l' Exploitation de la Mer

France – FY starts Jan 1 – Overall coordination under the national Coriolis Project; most funding from Institut Francais de Recherche pour l' Exploitation de la Mer, with smaller contributions from Centre National de la Recherche Scientifique (20 proposed for FY02) and Service Hydrographique de la Marine (3 funded in FY00; 15 proposed per year for FY03/04/05); an additional 8 floats were funded as part of POMME

Germany – FY starts Jan 1 – Argo proposal for 115 floats submitted by AWI/BSH/IfM to Ministry for Research & Technology (BMBF). Other floats include: Bundesamt fuer Seeschiffahrt und Hydrographie (BSH) has funded 18, 5 & 7 floats in FY00, 01 & 02 for Mid-Atlantic Ridg; Alfred Wegener Institute (AWI) has funded 10 floats in FY01 and will fund 5-10 floats in FY02 for Southern Ocean; Deutsche Forschungs Gemeinschaft (DFG) has funded Institute fuer Meerskunde-Kiel (IfM) for 7 floats in FY01 for Lab. Sea and 15 floats in FY02 for Indian Ocean; and 15 BMBF-funded IfM floats deployed in Tropical Atlantic will be included in FY02 when data are reported on GTS

India – FY starts Apr 1 – funded by Dept. of Ocean Development; implemented by National Center for Ocean Information Services (lead), National Institute of Ocean Technology, Center for Ocean and Atmospheric Sciences along with National Institute of Oceanography and 6 other academic/R&D/operational institutions

Japan – FY starts Apr 1 – funded by Ministry of Education, Culture, Sports, Science & Technology and Ministry of Land, Infrastructure & Transport; implemented by JAMSTEC, Frontier Research Program, Japanese Meteorological Agency (JMA), and Coast Guard; out-year commitment proposed to ramp up to 100+ floats per year; an additional 12 floats funded by JMA, ½ with 1000-m and ½ with 2000-m depth, all 7-day sampling and reporting data via GTS

New Zealand – FY02 starts Jul 1, 02 – funded and implemented by National Institute of Water & Atmospheric Research

Republic of Korea – FY starts Jan 1 – funded by Ministry of Science & Technology/Korean Meteorological Administration and Ministry of Marine Affairs & Fisheries; implemented by Meteorological Research Institute (METRI) and Korea Ocean Research & Development Institute (KORDI) under supervision of Korea Argo Subcommittee of the Korea Oceanographic Committee

Russia – FY starts Jan 1 – 2 floats funded in FY02 by Hydromet; will be implemented by Far Eastern Regional Hydrometeorological Research Institute (FERHRI)

Spain – proposal submitted to Programa Nacional de Investigacion by Instituto Espanol de Oceanografia, Universidad de Las Palmas de GC, Instituto de Ciencias del Mar de Barcelona-CSIC and several other Spanish research institutions with decision ~ Feb 02

U.K. – FY starts Apr 1 – funded by Dept. for Environment, Food & Rural Affairs, Ministry Defence, and Natural Environment Research Council; managed and implemented by U.K. Met Office in collaboration with Southampton Oceanography Center, British Oceanographic Data Center and U.K. Hydrographic Office; out-year commitment to ramp up to 50 Argo floats per year, to be supplemented by 12 floats in research proposal currently under review and up to 40 additional floats over 3 years depending on successful bids for research funding

U.S.A. – FY02 starts Oct 1, 01 – funded by NOAA and Office of Naval Research via National Oceanographic Partnership Program; pending NOAA FY03 budget commitment to provide ½ of the global array; other contributions are from Naval Oceanographic Office (Navoceano, 16 in FY00, 20 in FY01) and NOAA via Consortium for Ocean Research & Climate (35 in FY00, 20 in FY01); an additional 75 equivalent floats by Navoceano are dependent on availability of funding; includes 3 equivalent floats funded by NOAA/OAR/Arctic Program Office for deployment in the Bering Sea in FY01 and 7 in the Bering Sea and subpolar N Pacific for FY02; 412 floats per year requires annual funding at a level of ~$10M

Appendix 4: AST-4 List of Attendees

Name and e-mail	Address	Phone	Fax
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John Gould wjg@soc.soton.ac.uk	ICPO SOC Empress Dock Southampton, SO143ZH, UK	44 2380 596208	44 2380 596 204
Graeme Brough G.Brough@bom.gov.au	Chairman DBCP Bureau of Meteorology GPO Box 1289K Melbourne 3001	61 3 9669 4163	61 3 9699 4168
Rick Bailey rick.bailey@csiro.au	Chairman JCOMM Ship Observations Team CSIRO/BMRC JAFOOS GPO Box 1289K Melbourne 3001	61 3 9669 4170	61 3 9669 4660
Jana Goldman jana.goldmann@noaa.gov	NOAA 1315 East-West Highway #11960 Silver Spring, Maryland 20910 USA	301 713 2483	301 713 4020
Mathieu Belbeoch belbeoch@jcommops.org	JCOMMOPS 8-10 Rue Hermes-Parc Technologique due Canal - 31526 Ramonville France	33 561 394730	33 5 61 75 10 14
Stephen R Piotrowicz S.Piotrowicz@ocean.us.net	Ocean US 2300 Clarendon Blvd Suite 1350 Arlington, Virginia USA 22201-3367	1 703 588 0850	1 703 588 0872
Kuh Kim kuhkim@ocean.snu.ac.kr	School of Earth & Environmental Sciences Seoul National Univ. Seoul, 151-742, Korea	82-2-880-6749	82-2-887 0210
Graham Jones g.jones@bom.gov.au	Chairman IBPIO Bureau of Meteorology GPO Box 1289K Melbourne 3001	61 3 96694167	61 3 9 699 4168

List of Attendees

Name and e-mail	Address	Phone	Fax
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