

Editorial	1
R/V Kaharoa "Small ship - big challenge"	2
Predicting the growth of the Argo array	3
Calendar	3
Delayed-mode data now available	4
News in Brief	
Profiling float in the Kuroshio Extension	4
Argo China web site	4
Float recoveries	4

Changes in German Argo	5
Argo at the CLIVAR conference	5
A strategy for Global Earth Observations	6
Argo in South America	6
Argo-GODAE session - Cairns August 2005	6
Changes to the Argo web sites - www.Argo.net	6
UK Argo users group	6
New Argo papers	7



Density of Argo array in July 2004 (% of the target 3° x 3° coverage). SIO, USA

# Editorial

It has been a long time since the last Argonautics was issued and much has happened in the intervening months. Although it was only late last year that we celebrated the milestone of 1000 floats in the water, the latest count shows that total is now (end-August) 1340 floats, almost 45% of the final 3000 float array. The future growth in numbers is dependent on two factors - the rate at which floats are deployed and the rate at which floats already in the water "die". Based on presently known commitments to float deployments and the present rate of mortality (about 0.9 floats/day) we should have 1700 floats operating by the end of 2004. The half way point is now in sight.

Argo is growing to be a big project and any such project needs appropriate "tools" that will enable the Project Office and the Steering Team to "manage" the project in the sense of assessing what progress has been made and knowing how well Argo is doing in meeting its objectives. The most fundamental measure of progress is the one mentioned above - the rate at which the array size is increasing.

We are taking steps to improve the reliability of information needed to project array growth. On page 3 of this Newsletter we address the issue. We discuss float survival rates and new ways to assess them. We also highlight the need for co-operation on publicising float deployment plans and on streamlining the float notification process.

#### Argo STEERING Team meeting

The AST met in Brest in February 2004. The full report of the meeting can be found at www.argo.ucsd.edu under Argo Steering Team.

The main decisions of the AST (many of which are reflected in articles in this Newsletter) were :-

• Change its name from Science to Steering to reflect the group's broader responsibilities

• Agreed procedures for Delayed-Mode Quality Control and started implementation (See page 4)

• Decided on new methods to estimate float performance (See page 3)

• Agreed to take steps to collect temperature and salinity data during submerged drift

• Agreed to improve Argo web sites. (See page 6)

• Decided to hold an Argo workshop in South America (See page 6)

• Welcomed Andreas Sterl as the AST representative of the Netherlands

The Argo Steering Team Executive will meet early in 2005. A full AST meeting will be held later that year.

# R/V Kaharoa Small Ship - Big challenge

Filling the remote South Pacific with floats was always going to be a big challenge. It is rarely visited by research ships, lies far away from major shipping routes and much of it is outside the range of aircraft deployments. Yet, without floats in this area Argo would be failing in its global objectives.



# R/V Kaharoa in Wellington

The US Argo consortium made global deployment of floats a high priority but needed a deployment mechanism for the South Pacific. A novel solution to the problem was suggested by New Zealand's National Institute of Water and Atmospheric Research (NIWA). NIWA operates a small research vessel, *R/V Kaharoa*, with deep-sea capabilities (28m 300 tonnes, http://www.niwa.cri.nz/rc/vessels/kaharoa). It was proposed to use this vessel to deploy Argo floats in remote regions under a partnership arrangement, with U.S. Argo bearing most of the operating cost, but with a significant participation by NZ. Argo. The moderate cost and long range of the Kaharoa made this an attractive option.

When you receive this newsletter in August 2004 the *Kaharoa* will be in the middle of its second deployment cruise. The first cruise, which took the vessel from New Zealand to Chile and back in February/March 2004 deployed 61 floats (Scripps Institution SOLOs and University of



The deployment tracks for Kaharoa's 2004 Argo voyages. Blue - February/March, Red July/August) .



Dean Roemmich presenting a float deployment certificate to Captain Ron Palmer



The crew of Kaharoa with Dean Roemmich (3rd from left) and Steve Riser (4th from left)

Washington APEX floats) of which all but 2 are working successfully after 15 cycles. The second voyage is now deploying a further 83 floats in the Tasman Sea and the southern tropical Pacific.

As the photograph opposite shows, a 20ft freight container full of floats virtually fills the working deck of the Kaharoa. Additional floats are stored in the hold. SOLO floats are deployed in their biodegradeable cardboard packing container for protection against damage (the ship experienced 50 knot winds and 7 m swell during the February/March

> crossing). APEX floats are deployed as bare instruments. In either case, the ship slows for deployments, which are carried out by a NIWA marine technician trained in float deployment. Prior to the ship sailing, all instruments were carefully checked out at NIWA to make sure they were in working order after shipment.

> In recognition of the outstanding work of the Kaharoa, it was the first ship to receive a certificate of recognition from Argo. Other ships will be receiving certificates in the coming weeks.

We wish Kaharoa calm seas and a safe return to New Zealand in October and thank them for their important contribution to Argo.

# Predicting the growth of the Argo array

We have undoubtedly made enormous progress in building the array over the past year as the two maps below and the figure on Page 1 clearly demonstrate.



An important "tool" for managing Argo is an ability to predict the array's growth. That growth is dependent on two factors:-

- How many floats are deployed and
- How long these floats remain active and give good data.

### Deployments

Float deployment plans are shown on three web sites Pacific http://www.argo.ucsd.edu/FrDeploy.html Atlantic http://www.coriolis.eu.org/english/ deployment/argo\_atlantic.htm Indian http://www.incois.gov.in/website/ futureextended/viewer.htm

Each site has a map of recent and planned deployments and provides access to text files describing the likely time and location of the deployments. These plans are scheduled to be updated at least twice per year. **Notification** 

Floats that are deployed only appear in the AIC's monitoring system after the deployment has been notified. The notification process provides the AIC with the appropriate metadata so that the float can be uniquely identified and so that subsequent anomalies in its behaviour can be immediately recognised.



# Float performance

Floats do not last for ever. Some reach the end of their battery life (typically after about 200 10-day cycles) and then have insufficient energy to surface. Some may fail prematurely due to external damage (for instance being crushed in sea ice) and some may develop an electrical/electronic or

Argo array growth. When will it reach 3000?

mechanical fault that prevents the float from surfacing or transmitting data.

Argo has developed a model that allows the performance of floats from a particular production batch (or deployed in a particular year) to be monitored. This model has been used to demonstrate how float reliability has improved as design problems have been identified and then corrected in new production batches. Floats being deployed now are significantly more reliable than those deployed 2 years ago.

Since the object of Argo is to collect good temperature/salinity and velocity data, a 3rd factor is data quality (number of floats alone is not necessarily a measure of success!)

## Lessons and actions

- 1. Essential to keep information on float deployment plans up to date.
- 2. Float deployments need to be notified to the AIC promptly and accurately and identified as deployed on the deployment planning sites.
- Float performance affects the array growth. This has to be monitored globally and nationally to detect and diagnose premature failures and to help manufacturers to identify and correct problems.
- 4. We need to monitoring the quality of the data provided by the array

# Why does the number of active floats sometimes seem to decrease ?

On to the Argo Information Centre web site, the first thing you see is a global array map and the number of active floats. Over the months this number increases, but sometimes over a week or so the numbers decline. Why is this?

Well, the number is taken from the AIC's data base of active floats - floats that have been notified and entered into the system by Mathieu Belbéoch and that are delivering data. But Mathieu is sometimes away at meetings (or even on vacation) and during that time he is not able to enter new floats into the data base. So, existing floats, "die" and if new floats are not entered the numbers will decrease. So now you know!

Sep 29 - Oct 1	Southampton, UK	Argo Data Management - 5	www.bodc.ac.uk/projects/argo/adm2004/	
Oct 15 - Oct 23	Honolulu, Hawaii	PICES-XIII	www.pices.int	
Oct 18 - Oct 22	Chennai, India	DBCP-XX	www.niot.res.in/dbcp/	
Nov 1 - Nov 3	St Petersberg, Florida	2nd GODAE Symposium	www.bom.gov.au/GODAE/Symposium II/	
Nov 8 - Nov 10	Boulder, Colorado	CLIVAR Reanalysis Workshop	www.clivar.org/organization/gsop/	
Nov 29-Dec 1	Brest, France	POGO-6	ocean-partners.org	
Feb 14 - Feb 16	Brussels, Belgium	Earth Observation Summit	earthobservations.org/	
Feb 14 - Feb 18	Perth, Australia	Indian Ocean Mar. Env. Conf.	www.imarest.org/events/IOMEC2005/	
April 26 - 28	Silver Spring, MD	NOAA Climate Obs Workshop	www.ogp.noaa.gov/mpe/co/	
April 25 - 29	Vienna, Austria	EGU	www.copernicus.org/EGS/EGS.html	
August 22 - 26	Cairns, Australia	IAPSO - IAG - IABO	www.dynamicplanet2005.com	

# Timetable of Argo-relevant meetings

# Delayed-mode data now available

A great deal of effort has been expended over the past year in developing and implementing the Argo delayed-mode quality control (DMQC) procedures. This process is needed because the calibrations of the float salinity sensors drift during the floats' life due primarily to biofouling.

In most cases the drift can be corrected by comparison of the float data with potential temperature/salinity climatologies based on well-calibrated ship-based data using a method described by Wong, Johnson and Owens, (2003)\*. (WJO) The DMQC process is then completed by the inspection of the WJO output by a scientist responsible for the particular float and experienced in the oceanography of the area in question.

This process was formally adopted following a workshop held during the Argo Steering Team meeting in March 2004 and is now being implemented.

The first data sets that have been subjected to DMQC are now available at the Argo Global Data Centres (GDACS). They consist of data that have been processed at Scripps Institution of Oceanography in the USA and at the Institute of Ocean Sciences, Pat Bay in Canada. All 7000 of these profiles are from the Pacific and are divided equally between the low latitudes and the Gulf of Alaska. The data replace earlier versions at the GDACs and are designated by D rather than R (Real time) in the DATA\_MODE field.

The WJO corrections are applied to a 12 month-long sequence of float profiles and so, as the name implies, Delayed-Mode data will always appear with a significant delay. For some regions of the ocean where seasonal and interannual variability even at depth are great, the WJO process has to be modified.

There is a large backlog of data remaining to be QC'd but we expect the process to accelerate as float groups gain experience.

# Data needed by the DMQC process

The recent focus on delayed-mode quality control also highlights the need for the global temperature/salinity climatologies to be kept up to date by the regular addition of new, high quality ship-based observations. Here Argo has a partnership with CLIVAR and the Global Carbon Co-ordination Project sponsored by IOC. These projects maintain a list of high-quality CTD sections that have been occupied during and since the 1990-98 World Ocean Circulation Experiment and that are planned in the coming months and years. A list of these sections can be found at http://www.clivar.org/carbon\_hydro/. Planned sections are shown below.





Argo DM QC needs high quality shipbased CTD data such as from the Global Carbon project

It is planned that details of recently occupied sections will be compiled by the Argo Information Centre and displayed on the AIC web site. Here we need your help. Not all the hydrographic data that would be useful to Argo (WOCE-quality temperature and salinity, profiles to 2000m or more) are collected by CLIVAR or the Carbon project - so - we would be interested to know of any other sections not listed at the CLIVAR site. (Station locations, dates, name of responsible scientist).

\*Wong, A.P.S., G.C. Johnson and W.B. Owens, 2003: Delayed-mode calibration of Autonomous CTD profiling float salinity data by Theta-S climatology. Journal of Atmospheric and Oceanic Technology, 20(2), 308-318.

# Profiling floats in the Kuroshio Extension

The University of Hawaii deployed 20 profiling floats (Argo Equivalents) in late June 2004 as a contribution to the Kuroshio Extension System Study (KESS). The goal of KESS is to study the dynamic and thermodynamic processes that govern the variability and interaction between the Kuroshio Extension and the recirculation gyre. KESS involves several institutions in the USA and Japan.



# NEWS IN BRIEF

The University of Hawaii component aims

- to quantify the horizontal structure and temporal variability of the Kuroshio Extension and the recirculation gyre using satellite altimetry
- to quantify the temporal evolution of the upper ocean temperature and salinity fields (including the subtropical mode water and intermediate waters) in the recirculation gyre using profiling temperature/salinity (Argo-type) floats
- to evaluate the upper ocean heat and salt budgets in the recirculation gyre region.

The 20 APEX floats (some on 5 day and some on 10 day cycles) are funded by the National Science Foundation. At mid-August all floats are still working.

For further information on the KESS profiling floats contact Peter Hacker (phacker@hawaii.edu) or see http://www.po.gso.uri.edu/kess/

# Argo China web site http://www.argo.org.cn

The Chinese Argo programme has just announced a new web site describing its national programme and giving information on the international aspects of Argo. The site has both Chinese and English language pages that include photographs taken on a number of float deployment cruises

## Float recoveries

Inevitably a small number of floats will be picked up at sea by fishermen or washed up on the coast. We can often learn a great deal of useful information about the performance of these floats

- Why they failed
- How their calibration had changed
- Whether they had grounded and picked up sediment

In recent months we have recovered floats from Tuvalu and Australia (Scripps SOLO floats), Sri Lanka (a NAVOCEANO APEX float) and from the Phillippines (a Chinese APEX). (see http://www.argo.org.cn/ English/float\_recovered.htm). Another float came ashore in Peru. This raises some important issues that we are addressing; particularly how to ensure that the Argo Information Centre, the Argo Project Office and float operators are informed as soon as possible about the float's location and condition and also how we can make sure that the person who finds the float knows how to handle and store the float safely until it can be returned for inspection.

The task of identifying a float is greatly helped if it is well marked. Of the present array of floats only 42% carry the official IOC label (many were launched before the label was introduced).

Argo would like to express thanks to all who helped in the recovery and identification of these floats and particularly :- Dr.E.M.S.Wijeratne, National Aquatic Resources Research & Development Agency (NARA), Sri Lanka: Dr. Cesar Villanoy and Ms Jayvee, University of the Philippines, and Mr Willy Tevali, Police Commissioner, Tuvalu.

The paper by Eitarou Oka (okae@jamstec.go.jp) "Long-term Sensor Stability of Argo Profiling Floats" Submitted to *Journal of Oceanography* (See back page) gives a good example of what can be learned about the drift of float salinity sensors when a float is recovered.

#### Changes in German Argo

Germany has for many years been contributing to Argo but has never had an officially-funded national Argo programme. It has deployed nearly 100 Argo-equivalent floats of which about 40 are still operating.

This situation has changed and Germany now has a national Argo program funded for calendar years 2004, 5 and 6. The programme has three partners:

- Bundesampt für Seeschiffart and Hydrographie (BSH), Hamburg focusing on the subpolar North Atlantic,
- Liebnitz Institut f
  ür Meereskunde Geomar, Kiel in the tropical Atlantic and
- Alfred Wegener Institut für Polarforschung (AWI), Bremerhaven in the Southern Ocean.

Each partner will deploy about 30 floats spread over the next 2-3 years.

In addition, there will be several Argo equivalent floats deployed in contributions to research projects. (16 float equivalents from AWI funding, 7 float equivalents from IfM Geomar and a further 10 float equivalents from IfM Hamburg). Germany would also play an additional role in EU funded float projects.

The data from German Argo floats are among the many data sets processed and fed to the GTS and GDACs by the Coriolis center in Brest. (see http://www.coriolis.eu.org/cdc/scientific\_projects.htm)

Each of the German partners has a three-year postdoctoral researcher position. AWI has devoted 80% of a scientist to Argo, and is funding a half-time position at a commercial company for float data analysis. Argo data analysis at IfM Hamburg is done within pre-existing Arctic projects.

The new leader of the German Argo programme is Dr. Juergen Fischer (jfischer@ifm-geomar.de) who will join the Argo Steering Team and replace Dr Uwe Send who has now moved to Scripps Institution of Oceanography in the USA. We thank Uwe for the important role he has played in the AST.

# Argo at the CLIVAR Conference

CLIVAR, one of Argo's co-sponsoring organisations (the other is GODAE) held its First Science Conference in the Baltimore Convention Center June 21-25 2004. The conference was well attended (640 scientists from 56 countries) and took the usual format for many such recent large meetings – invited plenary talks and poster sessions.



Argo was prominent in both and was particularly highlighted in the introductory address by Dr David Carson, (see picture above), Director of the World Climate Research Programme, as a good example of international collaboration on ocean observations. The posters and plenary talks can be accessed via the conference web site (http: //www.clivar2004.org/). 16 poster abstracts mentioned Argo specifically and many others, particularly those dealing with data assimilation were of clear relevance to Argo.

# A strategy for Global Earth Observations

In July 2003 the first Earth Observations Summit was held in Washington, DC. That meeting highlighted the importance of monitoring the earth's, atmosphere, oceans, land and human activities for the well-being of the planet and its inhabitants. That Summit started a process that is now reaching an important point.

Any strategy for earth observations must build on the existing activities for in situ observations (like Argo), satellite remote sensing, data management and international infrastructure. Thus it is seen as a Global Earth Observation, System of Systems (GEOSS)

In recent months an initial ten year implementation plan for GEOSS has been produced. It focusses on the observations needed to address nine main areas of impact :-

• Disasters • Health • Energy • Climate • Water • Weather • Ecosystems • Agriculture • Biodiversity

In its present form this is a 130 page GEOSS 10-year Implementation "Technical Blueprint" that has just been subjected to general review. This document contains specific references to Argo as an example of a project in which international collaboration has achieved a truly global impact.

After revision the 10-year Implementation Plan will form the basis of a much shorter document that will be negotiated by governments at the GEO summit in Brussels in February 2005.

To download the blueprint and find more about GEO go to http://earthobservations.org/

# Argo in South America

The coming months will see a flurry of activities based in South America. The Canadian Argo programme (led by Howard Freeland) has had a productive relationship with scientists in Chile for the deployment of floats on the southeastern pacific Ocean.

Plans are now being made to broaden South American involvement in Argo. The Spanish Argo programme has generously provided three PROVOR floats to be deployed that will be deployed by Costa Rica (2) and by Mexico (1). These deployments should be completed during 2004.

The Argo Steering Team supported a proposal by Howard Freeland to hold an Argo Workshop in South America so as to inform scientists in the region about the technical and scientific aspects of Argo and to encourage wider participation.

CLIVAR (one of Argo's sponsor's) is planning a workshop in Chile on the role of the South Pacific in global and regional climate in the first half of 2005 and discussions are being held about how the Argo and CLIVAR might hold their meetings together (perhaps also with a discussion of other ocean observation issues). No final decision has yet been made about time and location but this seems to present a great opportunity to widen the awareness of South American scientists in Argo.

# Argo-GODAE session in Cairns, Australia, August 2005

The International Association for Physical Sciences of the Ocean (IAPSO) is holding a Conference (together with the International Association for Geodesy and the International Association for Biological Oceanography) under the general title of "Monitoring and understanding a dynamic planet with Geodetic and Oceanographic Tools".

One symposium in the meeting is "Argo and GODAE - global and regional partners" The first call for papers will be issued later this year.

By the middle of 2005 we expect there to be many examples of Argo data being used to define the state of the ocean on regional and global scales and this meeting will present a timely opportunity for scientists involved in Argo and GODAE to come together to share results.

> Changes to the Argo web sites. Coming soon - www.argo.net

In the first half of 2004 a lot of work has been done to improve the main Argo web sites - and that work will continue.

The site maintained by Scripps (www.argo.ucsd.edu) has been completely redesigned to provide a straightforward introduction to the Argo project particularly aimed at newcomers to Argo but still retaining most of the information from the old site. Further changes are now underway.

The AIC site is also being redesigned and streamlined so that it and the Scripps site complement one another and so that the detailed information that is available from the AIC data base will be more easily accessible. This redesign is being aided by a student who will be working in the AIC for 2 months.

As a further step we hope soon to be using www.argo.net as a single entry point to the AIC, Scripps and Argo data sites.

# UK Argo users group

As Argo data, both real-time and delayed mode, become more abundant so the potential for a wide variety of uses of the data will grow. In recognition of this fact the UK Argo programme held a 1-day Argo users workshop in May 2004 under the auspices of the UK Inter-Agency Committee on Marine Science and Technology (IACMST). UK Argo is funded by two government departments (Department of Environment, Food and Regions and the Ministry of Defence) and by the Natural Environment Research Council.

The meeting, although relatively small (40 people) included 5 from the commercial sector and about a dozen potential new users of Argo data.

Since the thrust of a "user" meeting needs to look at applications, the keynote talk was given by Howard Freeland from IOS, Canada who showed how Argo data had played the primary role in determining large-scale changes in the Gulf of Alaska during 2002/3. (See the paper by Howard in the bibliography page 7 of this Newsletter).

Topics covered by other speakers included the assimilation of Argo data into ocean models, the impact of Argo data on model predictions, the potential for detection and attribution of oceanic climate change, detection of salinity changes in the Indian Ocean (that are believed to be a fingerprint of anthropogenic climate change), and the role of British Oceanographic Data Centre in the processing and supply of UK Argo data.

Several topics emerged from the final discussion. Members of audience drew attention to the opportunities that could be provided by the next generation of floats incorporating new sensors, using new communication techniques and being able to work under ice. A decision was made to establish a UK Argo User Group that could for example help with the provision/exchange of software tools and set priorities for deploying UK floats. The group is expected to hold its first meeting in October.

# How to acknowledge Argo data

A unique feature of Argo is the open access to data by anyone. As the project develops we expect to see an ever widening community of Argo data users, many from research groups and countries not directly involved in Argo float deployment or data management. The Argo Steering Team felt that it would be appropriate to encourage the use of a standard acknowledgement in papers or reports that used Argo data. The form of words suggested is

"These data were collected and made freely available by the International Argo Project and the national programmes that contribute to it. (www.argo.ucsd.edu, argo.jcommops.org). Argo is a pilot programme of the Global Ocean Observing System".

Furthermore people using Argo float data are encouraged, as a courtesy, to contact the person responsible for the floats used and to outline the type of research or analysis that they intend to carry out.



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Please inform us of any papers not yet listed in *Argonautics*. or at www.argo.ucsd.edu

Argonautics is the Newsletter of the international Argo project.

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cludes information about the present (and past) distribution of Argo floats. Argo data may be downloaded from the Global Data Centres

www.usgodae.org/argo/argo.html and www.ifremer.fr/coriolis/cdc/argo.htm