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Newsletter of the international Argo project

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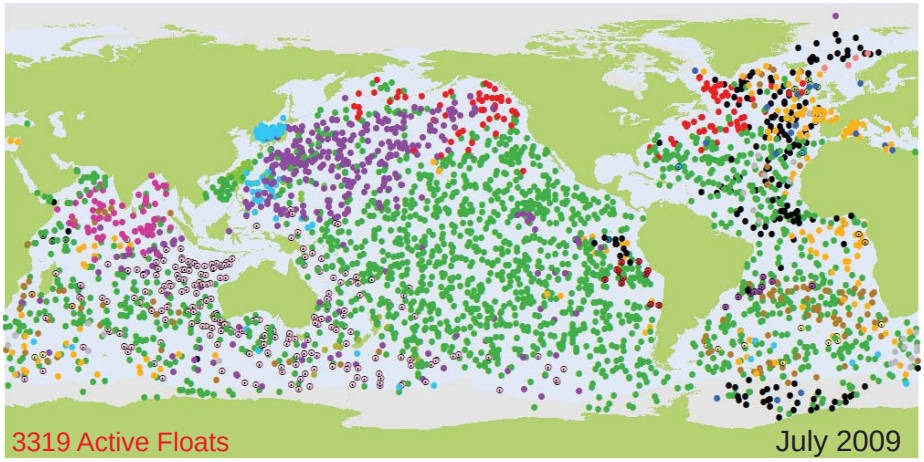


Notes from the Editor

Since the July 2008 Newsletter, Argo has focused on listening and responding to its user community as well as expanding users of Argo data in different parts of the world. One issue that was brought to Argo's attention by the Argo UW program is the problem of negative pressure sensor drift exceeding specifications. This newsletter contains a message to the Argo user community from the Argo Steering Team as well as a description of the pressure offset problems by Steve Riser of the Argo UW program. While this issue is not yet completely resolved, much work has been done to isolate the problematic sensors and replace them. When more information is available, it will be posted on the Argo web sites.

This past spring, the Chinese Argo program hosted the Third Argo Science Workshop (ASW3) and the tenth Argo Steering Team meeting. Eleven Argo countries were represented in the various talks and posters, with several more in the audience. This successful forum provided direct feedback to the Argo Steering Team which helps to plan Argo's course of action for the next several years. Please read H. Freeland's article in the newsletter on the ASW3 for more details.

There is also a summary of the AST-10 meeting in the newsletter. The main focus of the AST-10 meeting was evaluating how well Argo has met its initial targets and planning how to meet or improve current and new goals. Additionally, much work has been done by Michel Ollitrault to improve the quality and the consistency of the trajectory files at the Coriolis DAC. Since the meeting, Ollitrault has moved on to working with both the AOML and JMA DACs to improve the trajectory files there. Thank you again to our Chinese Argo hosts for providing a beautiful venue and wonderful hospitality.

Over the course of the past year, two training workshops have taken place to help users better understand and use Argo data. The first workshop, which took place in Nadi, Fiji in September 2008, focused on training specialists in a variety of marine data, including Argo data. The second workshop in Lagos, Nigeria was part of the South Atlantic Argo Regional Center's activities. At this workshop in March 2009, scientists from AOML worked with Nigerian scientists to teach them how to manipulate ocean related data to produce statistics and plots. There are articles on both workshops in the newsletter.

As often occurs in the newsletter, there is an article on float technology. This time the article is an update on the new Arvor floats including data from two of ten floats that have been deployed in the Indian Ocean.

The list of Argo-related papers published this year is included in this newsletter as well as known papers in press. I am working on building up the Argo bibliography and providing more statistics on it such as the number of papers published by each country. While every effort is made to find all the Argo-related papers published each year, I am sure there are some missing from the Argo bibliography. Therefore I request that if you publish a paper using Argo data or know of one published, please send argo@ucsd.edu an e-mail with the citation to ensure that it is included in the expanding list. This provides an important resource to many seeking Argo funding.

Producing delayed mode data files continues to be a high priority of the Argo Program and progress has been made in reducing the backlog of files for delayed mode. The Argo Data Management Team is exploring several options to help diagnose potential problems with data before the delayed mode process in order to ensure the best quality data is available for users. In the meantime, users are directed to the editorial in the newsletter on Argo data quality and global-change research as well as to the summary of the ADMT-9 meeting.

Megan Scanderbeg

A review of recent problems with float CTD units and Druck pressure sensors

Stephen Riser [riser@ocean.washington.edu]

Deployment of Argo profiling floats has been largely suspended since early 2009 due to a problem with the Druck pressure sensors that are employed in conjunction with the SeaBird CTD units that are used on nearly all Argo floats. This problem is manifested by large, negative drifts in pressure that typically begin to appear within the first 20 profiles after deployment. The negative drifts are made evident by the fact that the measured pressure at the sea surface should be no more than a fraction of a decibar; in floats that show this problem, the surface pressure will continue to drift towards negative values on each profile, even when the surface pressure is reset to zero. The cumulative effects of this drift can be as high as 50 decibars on some floats before the pressure sensor finally fails altogether, effectively ending the useful life of the float.

The problem can be seen graphically in Figure 1, where the uncorrected pressures from 474 Webb/Apex floats deployed since 2004 are displayed as a function of time; about 80% of the data shown in this figure were derived from floats constructed at the University of Washington, with the remainder originating at CSIRO in Australia and Bundesamt für Seeschifffahrt und Hydrographie (BSH) in Germany. These floats were chosen for analysis since they all used the APF9 Apex controller, which allows negative values of pressure to be transmitted; the same behavior has been found in SOLO and PROVOR floats, and it is surely also present in Apex floats with the APF8 controller although the APF8 cannot transmit negative pressure values.

The green points in Figure 1, originating from floats with good Druck pressure sensors, show that over the lifetime of floats, the surface pressure generally varies by less than ±1 decibar. Changes of this magnitude are consistent with what would be expected from variations in atmospheric pressure and nonhydrostatic effects such as surface waves. The red points in Figure 1, originating from floats with defective Druck sensors, show the drift towards large negative pressure values that often begins in the first 10-20 profiles and eventually kills the float. The blue points in the figure are from floats that are seemingly tending to the large negative drift stage but have not yet exceeded the -1 decibar threshold.

Figure 2. Photographs of the upper end of a normal Druck pressure sensor (left) and one with a deformed titanium diaphragm, indicative of the microleak problem (right).

The use of Druck pressure sensors with SeaBird CTD units began in 2003, and the incidence of the problem shown in Figure 1 was apparently very low for several years thereafter (an unrelated defect in Druck sensors, the "snowflake problem", was identified and fixed in 2004). The first documented evidence of the problem in Figure 1 came from a group of UW floats deployed in the Antarctic in January 2008; nearly 18% of the floats in this group showed the large negative drifts. Later in 2008, nearly 28% of a suite of 100 Apex and SOLO floats jointly deployed by UW and SIO showed the problem, and BSH and CSIRO floats showed an incidence of 15-20% early in 2009. As of mid-2009, it was estimated that 20-25% of Druck sensors produced since mid-2006 will exhibit these symptoms, and the problem was considered severe enough that SeaBird suggested that further float deployments should be suspended until the problem could be isolated and fixed.

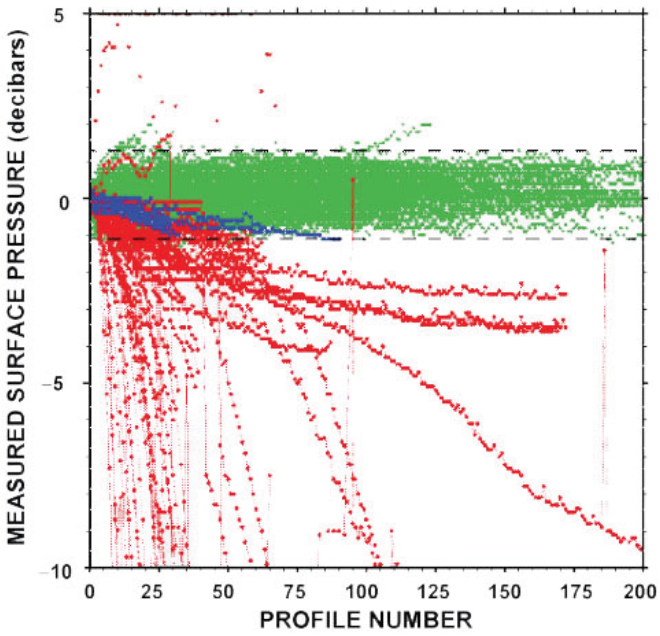


Figure 1. Surface pressure as a function of profile number from 474 Apex/APF9 floats deployed between 2004 and 2009. The green points are from floats considered to be operating normally, with surface pressure variations usually less than ± 1 decibar over the lifetime of the float. The red points are from floats that exhibit the "microleak" problem, showing large negative pressure drifts that typically begin during the first 20 profiles after deployment. The blue points are from floats that appear likely to show the microleak problem at some point later in their lives.

The first clues as to the cause of the problem came from a recovered float and laboratory simulations. As can be seen in Figure 2, a titanium diaphragm covers the upper end of the Druck pressure sensor, and this diaphragm is normally relatively flat. In floats that exhibit the large negative drift, however, the diaphragm is deformed downwards. The cause of this deformation can be seen schematically in Figure 3. The Druck sensor operates by sensing the deflection of the diaphragm; when seawater pressure increases, the diaphragm is deflected downwards, causing an increased pressure in an oil-filled chamber, which induces a voltage in a silicon sensor located in the chamber. The sensor is connected via small wires through glass elements into the interior of the float (held at a vacuum) and the CTD electronics. In this scenario, as the float descends, the diaphragm should deform downwards and should return to a flat surface at the end of the ascent phase. This apparently worked as designed on sensors produced at the Druck factory through mid-2006. However, between mid-2006 and early 2007 a change in the manufacturing procedure was initiated wherein an electron-beam weld was added between the threaded adapter that held the sensor and the titanium sensor housing. The result of this added weld was to weaken the seal between the titanium housing and the glass conduit holding the connection wires in some sensors. When the seal was weakened, some of the oil in the chamber was pushed along the glass conduit at the site of the glass-metal seal. As a consequence, the volume of oil in the sensing chamber decreased over time, and the diaphragm was unable to return to its flattened position. This resulted in a long-term negative drift to the pressure measured by the Druck sensor. Eventually, as more and more oil leaked out of the chamber, it became possible for the diaphragm to

continued on page 3

continued from page 2

actually make contact with the connecting wires, thus causing an electrical short and effectively rendering the sensor inoperative.

This problem with some Druck pressure sensors, now known as the "microleak problem", was diagnosed at the Druck factory in mid-2009, and manufacturing procedures were changed in order to eliminate the leak in the glass-metal seal caused by the E-beam weld. A new batch of sensors built using these modifications will be available at SeaBird in the autumn of 2009. In the meantime, SeaBird has been conducting a screening program in order to identify defective sensors before they are deployed, and they now have an inventory of more than 200 sensors that are considered reliable. These screened sensors will be used to replace the sensors on some of the floats that have been returned to SeaBird this year since the problem was first identified, so that some Argo deployments can be resumed before the end of 2009. By early 2010 it is hoped that the production of Argo CTD units at SeaBird will be back on schedule, using exclusively the new batch of Druck pressure sensors.

Information concerning the return of float CTD units to SeaBird and product warranties related to the microleak problem can be found at the SeaBird Electronics website, http://www.seabird.com.

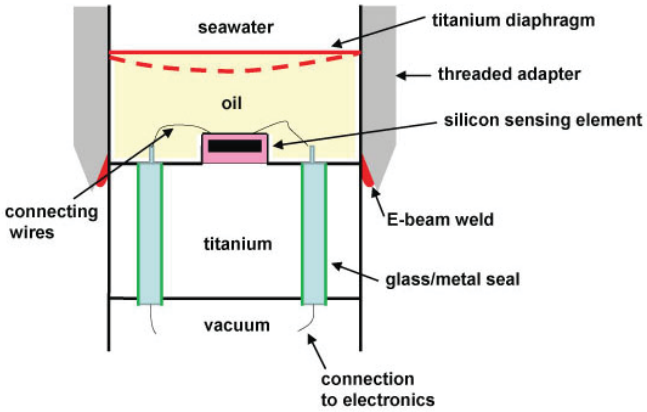


Figure 3. A schematic drawing of a cross-section through a Druck pressure sensor. The upper titanium diaphragm is normally flat at atmospheric pressure, as shown by the solid red line. For floats with the microleak problem, the diaphragm is deformed downwards (as shown by the dashed red line) even at atmospheric pressure. This is caused by a slow leak of oil from the sensing chamber past the glass/metal seal. The cause of this leak is the addition of the E-beam weld during the manufacturing process, beginning late in 2006.

Argo data quality and global-change research

The Argo program provides the highest achievable quality in profiling float data through expert examination of all profiles and by comparisons of these with nearby high quality measurements, including well-calibrated shipboard CTD data. Each of these delayed-mode quality control (DMQC) profiles includes estimates of measurement errors.

For the particular application of using Argo to understand global-change, (such as the calculation of changes of ocean heat content or of changes in the hydrological cycle), large-scale (up to global) averages are needed of seasonal-to-interannual temperature and salinity variations. For these large-scale averages, systematic (or bias) errors can become more important than the reported random error (which becomes small under mass averaging).

Systematic errors in Argo temperature versus pressure measurements are most likely to derive from pressure. A recent example due to sensor drift is described on the Argo web site, (see http://www.argo.ucsd.edu/Acpres_drift_apex.html) and in the above article. Systematic errors affecting the Argo dataset at the 1 dbar (regional or global average) level are possible and are difficult to detect. A 1 dbar depth-independent error in pressure is equivalent to about 0.01°C error in 0 – 2000 dbar average temperature, or about 5 dyn mm in steric sea level (0/2000 dbar). The quality control needed to detect and correct errors at this level requires the acquisition and analysis of a substantial body of other high quality measurements for comparison with Argo.

Users are therefore cautioned that:

(1) For applications requiring the highest quality data, it may be necessary to wait a period of years, beyond the initial DMQC interval, for data "maturity" through final quality validation. Users requiring this high level of accuracy need to become familiar with Argo technology and sensors and are well-advised to initiate quality checks of their own.

(2) Long time-series with known error bounds are required for the unambiguous detection of global change. Trends become visible above the level of small systematic errors only by accumulating long series.

The Argo Program places the highest priority on improving data quality and on sustaining the array. Through its international collaborating researchers, Argo is developing and applying innovative techniques for the detection and correction of systematic errors. Nevertheless the process takes time and, as experience is gained, we expect to detect and make efforts to correct new biases and errors in the data. Meanwhile, it is essential that Argo data be made public from the time of collection, to enable a wide variety of real-time operational applications as well as research studies not dependent on a climate-quality data stream.

A conflict exists for studies needing the highest quality data and yet being subject to high competitive pressure for rapid publication of results. Users must ensure that the standard of quality control in the dataset they are analyzing is appropriate for the problem being addressed. For data user support, contact support@argo.net.

The Argo Steering Team

Argo News in Brief

Argo has a YouTube Channel

The Argo Project Office has created a YouTube Channel called "argoproject". To view videos uploaded to the channel and to subscribe to it, visit http://www.youtube.com/argoproject. The movies include several float deployments, animations both of the float cycle and float trajectories, etc. This is designed to be both a resource for Argonauts and a place where the general public can go to learn more about Argo. If you have a video that you would like included, email argo@ucsd.edu. All videos are also available on the AIC ftp: http://argo.jcommops.org/FTPRoot/Argo/Movies/

Argo gridded datasets

Many centers are now producing gridded fields based on Argo data. There are both global and regional fields that are either a combination of Argo and non-Argo data or are solely based on Argo data. A brief description of these different fields can be found at: http://www.argo.ucsd.edu/Gridded_Fields.html.

If your center is creating a product that fits the criteria for inclusion on this page, please email argo@ucsd.edu with all the necessary information.

The Third Argo Science Workshop

Howard Freeland, AST Co-chair [Howard.Freeland@dfo-mpo.gc.ca]

The first Argo Science Workshop took place in Tokyo in November 2003 with the second being in Venice in March 2006. It was with great pleasure that the Argo Steering Team accepted the generous offer from China-Argo to host the Third Argo Science Workshop (ASW-3) at the Zhejiang Hotel in the beautiful city of Hangzhou, 25-27th March, 2009. The Argo Steering team thanks all of our Chinese hosts for the smooth and efficient organization of this meeting, and especially for arranging for the deployment of a very large Chinese Argo float in the West Lake during the meeting. That must have been very hard to arrange.

A view across the West Lake showing an Argo float about to make its first dive with the deploying vessel showing to the left

The Zhejiang Hotel in Hangzhou

The focus of this meeting was the OceanObs meeting in the autumn of 2009 in Venice. To prepare for OceanObs'09 we needed to consult with our user community, find out what worked in the design of Argo and what needed improvement to develop a community sense of what changes one might consider making to the general design of Argo. Scientists were invited to present talks on any aspect of ocean science provided that substantial use was made of Argo data. Speakers and poster presenters were also asked at some point to address the sufficiency of Argo from the point of view of their own research. Specifically we wanted to know if Argo was perfect for the project reported or if some changes in design might have made Argo work better in some way.

We anticipated that there might be a call for more rapid sampling in some areas of the ocean, or perhaps a perceived need for more floats, or a subsample of floats sampling abyssal waters etc. Suffice it to say, my instructions to the authors were addressed and we did receive the input we requested. In that respect, the result we hoped for from the meeting was addressed and we have material that will be used in the Community White Paper on Argo addressed to OceanObs'09.

The ASW-3 meeting was sponsored by PICES (The North Pacific Marine Sciences Organisation) who assembled the abstracts and program volume and gave considerable advice on how to run a meeting like this. It was also sponsored by:

- The Ministry of Science and Technology.
- The State Oceanic Administration.
- The Second Institute of Oceanography
- The State Key Laboratory of Satellite Ocean Dynamics

The meeting was also assisted with contributions towards an evening banquet event from the following industrial exhibitors:

Aanderaa data systems *JFE Alec Co. Ltd*
Laurel Scientific *NKE Instrumentation*
Rockland Scientific *Teledyne Webb Research*
Optimare *The Yichang Institute of Testing Technology*

I would like to thank them all for their generosity and support.

Madam Yue Chen, Deputy Director-General of the Department of International Cooperation, SOA welcomes delegates to ASW-3

Following the obligatory opening ceremonies and speeches from our sponsors, we began the science program with reviews of the current state of Argo (Dean Roemmich) and a review of the current state of the data system (Sylvie Pouliquen). These were necessary to ensure that everyone attending understood the current status of the program. The remaining talks were roughly divided into five general themes:

1. Heat and salt budgets on global to regional scales
2. Estimation of circulation fields on global to regional scales
3. The role of Argo in constraining ocean data assimilation models
4. Seasonal to interannual variability as seen by Argo
5. New technology

Talks were fitted only loosely into these themes. We wanted to hear from as many speakers and poster exhibitors as we could and so decided against strict adherence to categories.

An innovation was a decision to conscript two wise people, Stan Wilson and Kimio Hanawa, to lead a guided discussion at the end of each day. The concept here was that these are two people who are knowledgeable about Argo but have not (at least not for many years) been central elements of the Argo Steering Team. They were therefore qualified to offer opinions as informed outsiders. The task set to them was to highlight important items that they had heard each day and comment on conclusions achieved. The intention was to create a medium for discussion and debate at the end of each day. I was pleased with the level

Science in action at ASW-3

of discussion and debate that took place, and this was a relief to everyone who knew that they had contributions to a “Community White Paper” to write.

As one of the organizers of this event I was surprised firstly by the level of interest in the meeting. I was frequently in touch with Jianping Xu and Renqing Liu and there was a palpable sense of panic developing in the weeks immediately prior to the meeting that just perhaps the meeting might be too popular and we might have more people attending than we could easily accommodate in the meeting hall. It is easier to deal with that problem than the opposite problem. I always knew that there would be some people who agreed to present talks and then would be unable to attend. But in fact, after the program was assembled there were only two people who dropped out. For a meeting of this size this is a very surprisingly small number. I was very grateful to have Denis Gilbert and Mathieu Belbéoch graciously agree to step in at the last moment with well prepared talks.

Eleven Argo nations were represented in poster and oral presentations and several more were represented in the audience, ensuring a good cross section of the international Argo community.

Science inaction at ASW-3

In conclusion, Argo has existed now for 10 years and is engaged in a process that will affirm the direction that it has taken or lead to changes in the design of Argo. As the title suggested, ASW-3 was designed to be an important step along the way to the next 10 years, the Future of Argo, and the Argo Steering Team had high expectations from the meeting. ASW-3 met and surpassed those expectations. I cannot possibly list everyone who was important to making this meeting a success. I assume you all know who you are, thank you to all.

There are 108 people showing in this picture, which includes most of the attendees, identifications are as follows:

Row-1: (seated) Megan Scanderbeg, Fei Gao, Mathieu Belbéoch, Jianping Xu, Yongyue Yu, Yue Chen, Dean Roemmich, Jilan Su, Xian’en Zhang, Haisheng Zhang, Howard Freeland, Zhigao Qiu, Jiqing Hong, Dake Chen, Sylvie Pouliquen, Zhigang Zhou, Jon Turton.

Row-2: Yuhua Pei, Jingsong Xu, Igor Yashayaev, Liying Wan, Weifeng Zhou, Lixiao Xu, Stephanie Guinehut, Qinyue Liu, Cécile Cabanes, Virginie Thierry, Timothy Liu, Sylvia Garzoli, Pierre-Yves Le Traon, Sally Close, Anh Tran, Sindhu Parampil, Xunqiang Yin, Qilong Zhang, Candyce Clark, Mikio Miyake, Xiaodong Li, Guihua Wang,Huizan Wang, Zhaohui Sun

Row-3: Xiaofen Wu, Youmin Tang, Xianyao Chen, Shigeki Hosada, Toshio Suga, Ariel Troisi, Bill Woodward, Muthalagu Ravichandran, C. Gnanaseelan, Disheng Wu, Jiping Xie, Zhenyu Sun, Pedro Vélez Belchi, Eugenio Fraile-Nuez, Steve Diggs, Yu Zuojun, Norge Larson, Steve Riser, Moon-Sik Suk, Yaochu Yuan, Esmée van Wijk, H. Abe

Row-4: Renqing Liu, Xidong Wang, Stan Wilson, Jiancheng Kang, Huiyong Lin, Baogang Jin, Patrice Brault, Xinping Chen, Fabrice Hernandez, Clement de Boyer Montégut, Xinyao Rong, Jingzhi Su, Hiromichi Ueno, Kanako Sato, Harold Rohr, Pil-Hun Chang, Michele Ollitrault, Taiyo Kobayashi, Anders Tengberg, Hua Li, Juncai Zeng, Zhongjie He

Row-5: Qing Zhang, Jinshun Chen, Hua Tan, Shenglong Yang, Jiaxun Li, Denis Gilbert, Dan Webb, Matt Martin, Hiroshi Yoshinari, David Lindo, Eitarou Oka, Katsuro Katsumata, Shusaku Sugimoto, Steve Piotrowicz, Gilles Larnicol, Liang Sun, Fabian Wolk, Kazuhiko Hayashi, Zenghong Liu, Ling Huang, Yann Bernard, Xuefeng Zhang, Wei Li

Argo, GODAE and GODAE OceanView

P.Y. Le Traon [Pierre.Yves.Le.Traon@ifremer.fr]

Over the past 10 years, GODAE has demonstrated the feasibility and utility of global ocean monitoring and forecasting and has made significant contributions to the development of global operational oceanography infrastructure. Global ocean analysis and forecasting systems are now routinely assimilating *in situ* and satellite data to provide an integrated description of the ocean state. Products and services have been progressively developed to serve a wide range of applications. GODAE as an experiment ended in 2008. Its final symposium (Nice, November 12-15, 2008) allowed us to review the key achievements of the last 10 years and to discuss the future of operational ocean analysis and forecasting and proposals for its international coordination (see GODAE final symposium proceedings available at http://www.godae.org). A special issue on GODAE achievements will also be published this fall in Oceanography Magazine.

Argo and GODAE have maintained strong relationships over the past 10 years. Argo has had a major impact for GODAE and is now the single most important *in situ* observing system for operational oceanography. Most global and regional modeling and data assimilation systems are using Argo data. Argo is strongly complementary with satellite measurements (in particular satellite altimetry) to constrain models through data assimilation. Argo also provides outstanding data for model validation both at low (climate) and high (eddy resolving) resolutions.

GODAE Final Symposium, Nice, November 2008

Although there are still major challenges to face, global operational oceanography now needs to transition from a demonstration to a permanent and sustained capability. Most GODAE groups have or are now transitioning towards operational or pre-operational status. GODAE systems are also evolving to satisfy new requirements and must benefit from scientific advances in ocean modeling and data assimilation. In order to ensure the required long-term international collaboration and cooperation on these issues, an international program on ocean analysis and forecasting systems called GODAE OceanView has been set up. Through its science team, GODAE OceanView will provide international coordination and leadership in:

- The consolidation and improvement of global and regional analysis and forecasting systems (physics)
- The progressive development and scientific testing of the next generation of systems covering bio-geochemical and eco-systems and extending from the open ocean into the shelf sea and coastal waters.
- The exploitation of this capability in other applications (weather forecasting, seasonal and decadal prediction, climate change detection and its coastal impacts, etc).
- The assessment of the contribution of the various components of the observing system and scientific guidance for improved design and implementation of the ocean observing system.

GODAE OceanView science team will provide a forum where the main operational and research institutions involved in global ocean analysis and forecasting can develop collaborations and international coordination of their activities. It will include scientists from the main operational systems as well as scientific experts on specific fields and representatives of key observing systems. Its core activity is related to modeling and data assimilation. Some of the GODAE OceanView objectives will be pursued through a series of Task Teams (e.g. Intercomparison and Validation, Observing System Evaluation, Coastal Ocean and Shelf Seas, Marine Ecosystem Monitoring and Prediction, etc). These teams will address specific topics that require active collaboration with international research programs (e.g. OOPC, CLIVAR, IMBER, WCRP). Operational aspects related to product harmonization and standardization will be carried out by the JCOMM Expert Team on Operational Oceanographic Forecasting Systems (ET-OOFS).

During this new sustained phase, more efforts will be given to the evaluation of the global ocean observing system. This is an area where international coordination and cooperation is a very high priority. Ocean analysis and forecasting systems are an appropriate and powerful means to assess the impact of the observing system, to identify gaps and to improve the efficiency/effectiveness of the observing system. Through the development of applications and users, these systems are also essential to contribute to the long-term sustainability of the ocean observing system. GODAE OceanView will liaise with major observing system programs (e.g. OOPC, CEOS, GOOS, GCOS) and science teams (e.g. Argo, Ocean Surface Topography, GHRSST) on observing system issues. In particular, active collaboration with the Argo Science Team is expected on the evaluation and evolution of the global Argo array and of its core mission.

Report on the Tenth Argo Steering Team Meeting

Megan Scanderbeg [mscanderbeg@ucsd.edu]

The 10th meeting of the international Argo Steering Team was held in Hangzhou, China on March 22-23, 2009 and was hosted by the Second Institute of Oceanography. AST-10 focused on Argo reviewing its current status, objectives and future evolution. Dean Roemmich opened the meeting with a discussion on how well Argo has met its core mission goals, including a more detailed look at exactly how many floats are needed in both hemispheres in order for Argo to fully reach its intended target of one float per three degrees latitude. Argo also needs to address the timeliness and the quality of the data based on the original design and how it might meet these targets better. Additionally, Argo needs to address new concerns as the dataset grows and expands to possibly include new sensors and new sampling domains. The consensus developed at the meeting on these issues, and others, is included in the OceanObs09 white paper entitled "Argo – a decade of progress". Many other topics were discussed and highlights from the meeting included:

Implementation issues

The Argo Technical Coordinator reported that things are stable at the AIC now and that there is a new IT resource to help with coordinating web site and other technical needs. The TC urged the AST to investigate a more formal relationship with JCOMM.

P.Y. Le Traon reported that Euro-Argo is progressing in its preparatory phase through mid 2010. Float technology is being tested and a new long-term governance and legal structure for Euro-Argo has been proposed. This structure will coordinate float procurement on a European level. Efforts will also be made to hold meetings with users to strengthen the user community and their understanding of how to use Argo data.

The Argo core activity statement was discussed and D. Roemmich noted that the actual number of floats needed was 3200 based on the one float per three degrees latitude. Currently, many floats are in areas outside the original Argo mission, including high latitude and marginal sea floats, but deployers of these floats should not feel excluded from Argo. It was suggested that a proposal be made to OceanObs09 on how to cover the high latitude regions with Argo floats.

Peter Dexter, co-president of JCOMM, gave a short presentation on what JCOMM is and what might happen if Argo were to formalize its relationship with JCOMM. Some potential benefits include direct access to governments through WMO and IOC, Secretariat support for Argo, enhanced direct coordination with users such as GODAE OceanView, and a full coordinated, intergovernmental, *in situ* ocean observing system. Potential disadvantages include more reporting requirements and negative impacts on existing funding arrangements in some countries.

Data management issues

S. Pouliquen reported that overall, the data system is functioning well. Most real-time files are available within 24 hours and 100,000 delayed mode files were processed in the past year. DMQC-3 was held in September 2008 where scientists from every country attended. Progress was made towards being more consistent throughout the delayed mode quality control process. Experts on different regions presented their decisions and newer dmoders were able to learn the reasons why experts were making such decisions on quality control. A discussion of how to correct pressure sensor offsets occurred and it was generally agreed that offsets should be removed during delayed-mode processing. Given the manpower challenges for dmode processing and the fact that some bad data pass through real time quality control, it is becoming more important to use other tools to detect bad data before dmode quality control.

Additionally, M. Ollitrault has been working on cleaning up the trajectory files, DAC by DAC, starting with Coriolis. He has moved onto AOML and JMA now. When a DAC has reformatted their entire trajectory dataset, all files will be uploaded in one batch.

S. Diggs presented the status of the reference database for Argo and showed progress in obtaining several cruises in the past year that can be included in the reference database. It was stressed once again that high quality, recent data is needed to ensure the quality of the Argo dataset.

Technical issues

S. Riser presented work done on an APEX float where unpumped temperature measurements were taken all the way to the sea surface. The results looked promising, and with very little energy cost to the current set up using ARGOS communications.

Both Provor and SOLO have new floats being developed that aim to improve upon the current float models. The Arvor is smaller, more energy efficient, uses Iridium and has performed well so far in test deployments. See the article on Arvor in the newsletter. The SOLO-II is also smaller, more energy efficient and will be able to sample to 2000 m anywhere in the world ocean. A prototype will be deployed soon.

T. Suga reported on three NINJA floats equipped with fluorometers to measure larval and juvenile sardine in the mixed layer water in the Kuroshio region. The floats and sensors operated well for over a year at a parking depth of 40 dbar and a profiling depth of 500 db.

Demonstrating Argo's value

M. Ravichandran reported on the Argo User's Workshop held at INCOIS in July 2008. The goals of the workshop included interacting with Indian Argo users to understand how Argo data is being used as well as how to improve temporal and spatial distribution of floats. Much valuable feedback was gained from the experience and it was noted that this type of workshop is very valuable and such activities should be linked to on the AST web site.

The AST web site is being updated to better reflect the current research uses of Argo data. New content on these topics will be added, as well as better documentation of meetings, meeting reports and the various media available. Argo gridded datasets and data viewers will be displayed on the web site to give users access to more diverse forms of Argo data.

M. Belbéoch and S. Diggs presented work being done to create a new Argo Google Earth kml file. This will include a tour following an Argo float on its profiling mission, information on each float and stories on select floats within the Argo dataset that showcase interesting themes in oceanography. M. Scanderbeg and J. Gould will also work on this Argo "layer" to add more views of Argo data and educational content.

The third Argo Science Workshop was held immediately following the AST-10 meeting where many talks and posters showcased much of what is being done currently with Argo data. See the story in the newsletter on the ASW-3 for more details.

The full report of the AST-10 meeting and the supporting documents are available on the AST web site at: http://www.argo.ucsd.edu/meeting_reports.html.

National Workshop on Data Analysis in Lagos, Nigeria

Claudia Schmid [Claudia.Schmid@noaa.gov]

The South Atlantic Argo Regional Center is collaborating with scientists in countries on both sides of the Atlantic Basin. The purpose of these collaborations is to advance the research on regional to global scales and to improve the data coverage in remote regions. As part of this collaboration two scientists from NOAA/AOML in Miami, Claudia Schmid and Rick Lumpkin, visited Nigeria to train African Scientists in the analysis of data from Argo profiling floats, expendable bathythermographs, surface drifters and Atlas Moorings during the "National Workshop on Data Analysis in Lagos Nigeria". The workshop took place from March 20 to March 26, 2009 at the Nigerian Institute for Oceanography and Marine research (NIOMR) and on board the USS Nashville. It was part of the African Partnership Station program of the US Navy, was coordinated by Augustus Vogel. The local organization was performed by Regina Folorunsho from NIOMR. Given the large demand for this workshop, 38 scientists participated, mainly from the University of Lagos and the NIOMR.

The workshop was started with a beautiful and interesting opening ceremony at NIOMR. The second day focused on an introduction to physical oceanography and the various measurement systems used to increase the understanding of the ocean, ocean-atmosphere interactions and climate variability. For the next four days the group was split in half, so that hands-on training could be done in two classrooms on board the USS Nashville. The participants learned how to load various data sets into a high-level software package, how to analyze the data and how to generate figures. The participants were very satisfied with the way the workshop was held and there are already plans to pass the knowledge acquired during the workshop on to other Nigerian scientists that were not able to attend due to logistical constraints. This is a very positive sign that such collaborations will open future opportunities for regional oceanography in the northern Gulf of Guinea. At the end of the workshop each participant received a certificate.

The success of this workshop will be beneficial for the international Argo project. To keep the momentum going the South Atlantic Argo Regional Center is continuously initiating new collaborations and expanding existing collaborations that frequently result in opportunities to deploy Argo floats in remote regions.

Opportunities to showcase your Argo research

Contribute to the next newsletter

If you are doing research on Argo floats that you think others would like to read about, let us know. We are always looking for news article submissions for Argonauts. The research can be on float technology, data assimilation, data analysis methods, or other aspects of Argo data. The next newsletter will be published in summer 2010, so please submit your article idea to argo@ucsd.edu by March 2010. We will let you know soon after if your article idea has been accepted for the upcoming newsletter.

Float of the Month featured on AIC web site

Every other month a float of the month is featured on the AIC web site with text and graphics explaining the data. May's float, a Canadian float equipped with an oxygen sensor, depicts a crossing of the Gulf Stream. March's float, one of the Dutch floats, was caught in the Agulhas current region for several months. This feature is a great way to learn about floats contributing to the Argo program around the globe. Their data are explained in a direct, easy to understand manner. If you would like to contribute a float to this feature, e-mail argo@ucsd.edu.

Summary of 9th Argo Data Management Team meeting

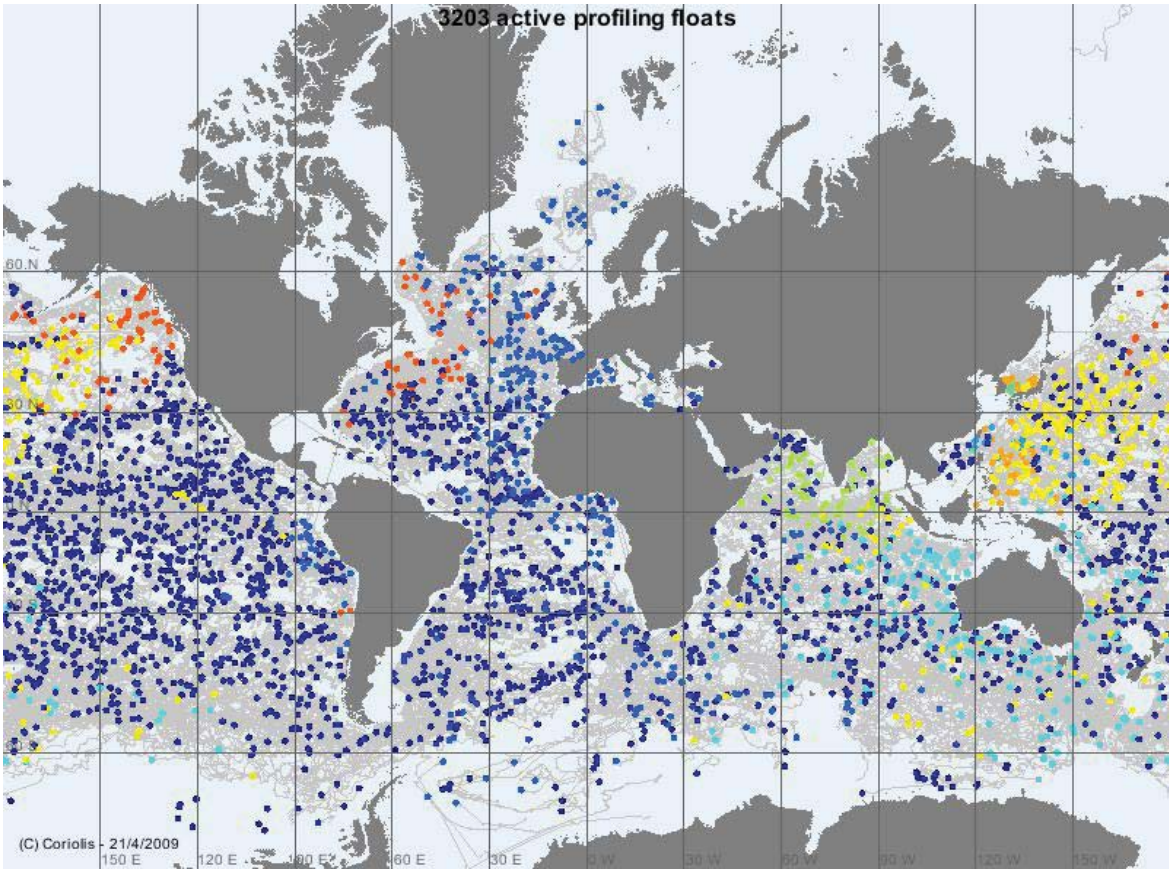
Sylvie Pouliquen [sylvie.pouliquen@ifremer.fr]

The Argo Data Management Team meeting was hosted by the University of Hawaii, Honolulu, USA 28-31 October 2008 and 36 persons from 10 countries and 28 institutes attended. The full report can be found on the ADMT web site (http://www.coriolis.eu.org/cdc/meetings/Argo-DM-report-9th.pdf).

The real time data stream is performing according to requirements and 90% of the data are made available within 24 hours. 240 new active floats were entered in the data management system as well as 600 historical floats. About 3000 floats are transmitting good data in real-time.

Delayed mode processing is moving and 100,000 profiles were processed in delayed mode this year which corresponds to the amount of new profiles acquired by Argo.

The main issue is that it is difficult to dedicate additional manpower to process the delayed mode backlog. It is important to continue the training of delayed mode operators through the DMQC workshops if we want to guaranty the quality of the Argo DM dataset.



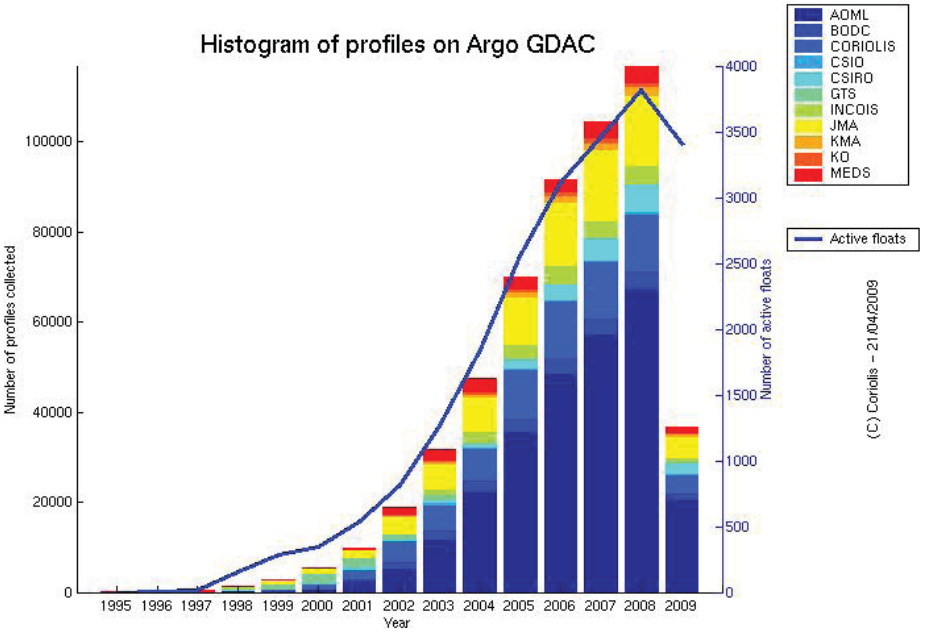
Active Floats in April 2009

The new developments are presently ongoing to improve the Argo data quality between real-time and delayed mode processing. This is the work that is carried on within ARCs or the Coriolis GDAC using comparison with climatology, with altimetry or with neighboring observations. These lists of anomalies are gradually being included in the AIC reports.

Progress has been made on trajectories, led by M. Ollitrault in cleaning up the data, first at Coriolis, then with AOML and with JMA datasets. The results were shown at ASW3 by M Ollitrault and consistency checks will be built from this experience at the GDACs.

The decision has been taken to standardize the technical files to allow enhanced monitoring of the Argo fleet and to allow surface pressure correction and trajectory work more easily. The format was adopted, the file checker has to be updated by the US-GDAC and then DACs will reformat their files and submit them in one batch for each DAC according to a schedule that needs to be consolidated.

Users have to be aware that real time processing is automatic and bad data may be passing through. It is important to set up tools to detect bad data in the Argo dataset earlier than Delayed Mode Quality Control and the Argo team is working on this issue. As Argo is a huge dataset, manpower is an issue in data management and therefore we have to set up priorities to improve the quality of this wonderful dataset. See the editorial on Argo data quality and global-change research in the newsletter.



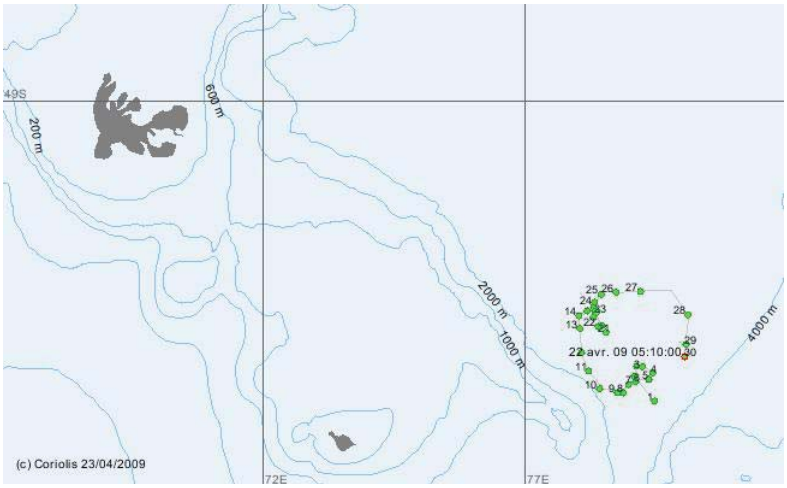
More than 100 000 new profiles each year on the global ocean

New Arvor floats deployed and sending data

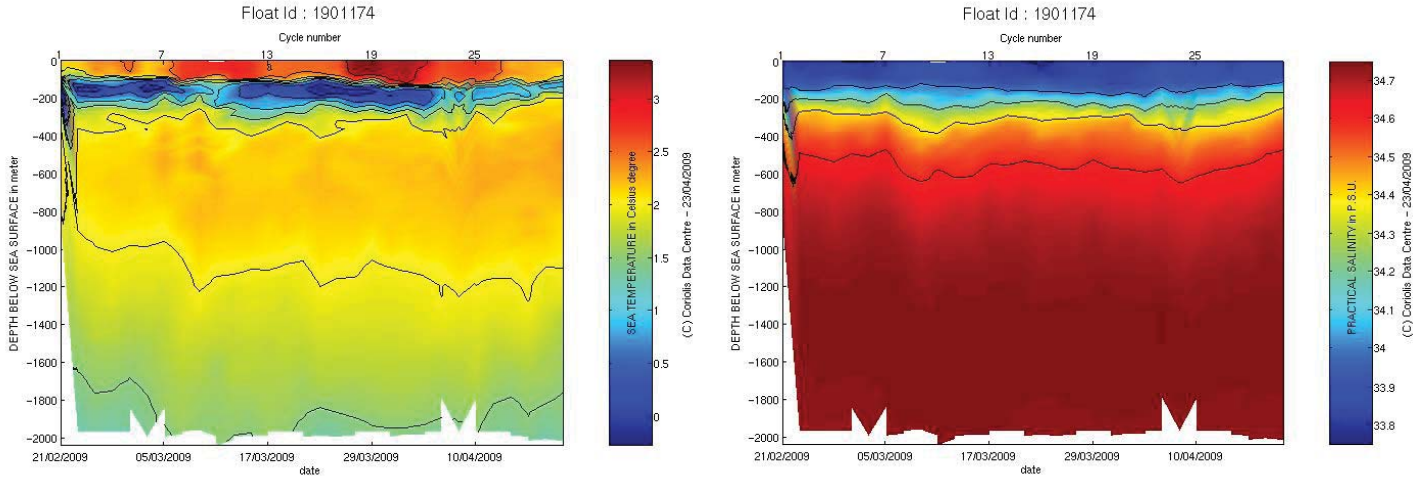
Sylvie Pouliquen [sylvie.pouliquen@ifremer.fr]

Arvor is a new, fully Argo compatible, profiling float designed to acquire salinity and temperature profiles using the "SEA-BIRD" CTD metrology. The design has been performed by Ifremer, the French institute for sea research, using their important knowledge in float activities and well qualified subassemblies. NKE is the company which is manufacturing Provor and has achieved the industrial design of Arvor. Two of the first ten Arvor floats have been deployed last February (2009) south east of Kerguelen Islands. They are cycling every two days in order to assess their performance. Presently they are working according to specifications. See the trajectory plot to the right and the temperature and salinity time series below.

Photo of Arvor in the water



Arvor float trajectory as of 23 April 2009.



Temperature time series and salinity time series for Arvor float. The float is sampling every 2 days to a depth of almost 2000 meters.

Timetable of Argo-relevant meetings			
2009 - 2010			
September 21-25, 2009	Venice, Italy	OceanObs'09	http://www.oceanobs09.net/
September 28 - October 2, 2009	Toulouse, France	ADMT-10, DMQC-4, ARC-3	Argo Data Management Team -10 meeting Delayed Mode Quality Control - 4 meeting Argo Regional Center - 3 meeting
October 23 - November 1, 2009	Jeju Island, Korea	PICES 18	http://www.pices.int/meetings/annual/PICES-2009/2009-background.aspx
March 23-25, 2010	La Jolla, CA, USA	AST-11	Argo Steering Team -11 meeting http:///www.argo.ucsd.edu/FrAST-11.html

Training boosts understanding of marine data and observations

Copy of an article from the PI-GOOS web site

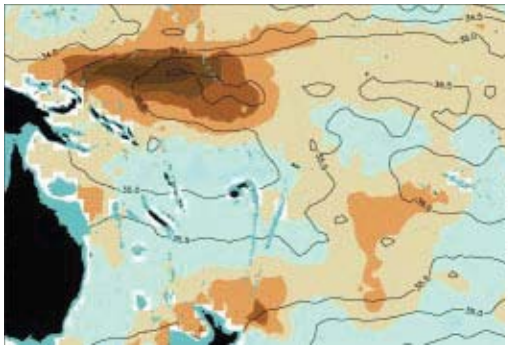
Workshop participants

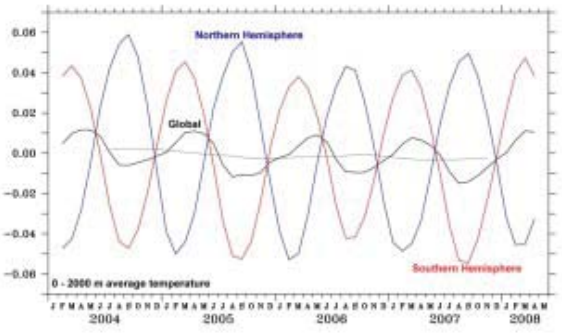
All photos courtesy of Virginia Rokoua (virginia@sopac.org) and Marcie Grabowski (mworkman@hawaii.edu)

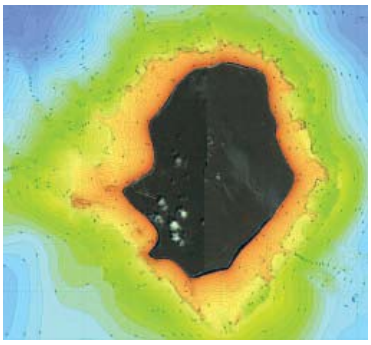
Over the last decade the number of coastal and open ocean programs collecting marine environmental data in the Pacific has grown substantially. Uptake and use of the data being generated by these programs is relatively low amongst Pacific Island countries. A training workshop was therefore held in Nadi, Fiji, from 22-25 Sept 2008 with the aim of improving understanding and awareness of the data and data products that are currently available, and provide hands-on training in their use.

More than 30 technical specialists in fisheries, environment, climate and weather, from across the Pacific Islands region participated in the 4-day training course, held jointly at the Tanoa International Hotel and Fiji Meteorological Service. Training was provided by marine data specialists from the US and Australia, along with a number of Pacific regional and international organizations.

Participants gained hands-on training in a wide array of marine data and products, ranging from sea level observations from the network of gauges located on the shorelines of many Pacific Island nations, to oceanographic measurements taken by the global network of profiling floats operated under the international Argo programme.







Observations are collected to help understand the marine environment and to make more informed management decisions. Participants learned how observations can be used to warn of coral bleaching events, monitor sea level rise, and assess the risks from proposed coastal developments such as the widening of shipping channels.

Training was also provided in a number of web- and PC-based systems designed to provide easy access to a variety of important marine data.

The workshop ended with a call for the development of an online catalogue of marine data and observations, and for more targeted training on specific issues faced by countries.

A dedicated workshop page containing resources and information can be found on the PI-GOOS web site. To go there directly, use this link: http://www.pi-goos.org/index.php/education/marine-data-workshop-2008.

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Please send argo@ucsd.edu citations for Argo articles submitted, in press or published to keep the bibliographies updated.

How to Acknowledge Argo Data

The Argo Steering Team encourages the use of a standard acknowledgement in publications that use Argo data: "*These data were collected and made freely available by the International Argo Project and the national programs that contribute to it. (www.argo.ucsd.edu, argo.jcommops.org). Argo is a pilot program of the Global Ocean Observing System*". People using Argo float data should, as a courtesy, contact the person responsible for the floats used and outline the type of research or analysis that they intend to carry out.

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Information about Argo can be found at www.argo.ucsd.edu and from the Argo Information Centre at argo.jcommops.org. The AIC site includes information about the present and past distribution of Argo floats. Argo data may be downloaded from the Global Data Centers www.usgodae.org/argo/argo.html and www.ifremer.fr/coriolis/cdc/argo.htm