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## Argo achieves 3000 float goal!

#### Editorial

Since the last Newsletter in December 2006, Argo achieved the 3000th active float milestone on 1 November 2007. In the newsletter you will find an article on the status of the Argo array and some of the history behind reaching this great milestone. Additionally, there are a couple pages with photographs of Argo 3000 floats being deployed during the month of October. To see a full accounting of the photos submitted for the Argo 3000 web page, go to http://www.argo.ucsd.edu/FrArgo 3000.html. Take a moment to enjoy the feeling of accomplishment from achieving such a big and important goal for the Argo program. As you will see from the article and the photos, it was truly an international effort. Congratulations!

Despite reaching 3000 floats, earlier in the year, Argo discovered a pressure sensor problem. This systematic error affected around 200 instruments, many of which either have been corrected or are being corrected in real time by automated procedures. More details are provided in an article in this newsletter as well as on the website at http://wwwargo.ucsd.edu/Acpres offset2.html.

Another difficulty this year was a shortage in funding for the Argo Technical Coordinator position. Several countries involved in Argo plegded new or additional money to solve this problem. Thank you to the new contributing countries China, Germany and India!

The IOC hosted a successful Argo Steering Team meeting (AST-8) in Paris in March. In addition to discussing how to solve the challenges facing Argo, the AST members heard from various operational centers around the world. This gave the AST a chance to learn from Argo

data users what is working well with the Argo data system and what needs to be improved. To read these reports, look in the supporting documents file for the AST-8 meeting report on the www.argo.ucsd.edu website.

As part of the efforts to continue improving the Argo reference data set for delayed mode quality control, Steve Diggs from the CCHDO spoke to the AST members about ways to receive more recent cruise data. See his article in this Newsletter for an update on this topic and how to submit CTD cruise data in a secure manner.

There was an Argo/GODAE session at the IAPSO meeting in July of this year which John Gould convened. John contributes an article to this Newsletter discussing the various topics of the talks and the award to Russ Davis of the Prince Albert 1st Medal for his work on developing autonomous instruments for ocean observations.

The list of Argo-related papers published in the current year is highlighted in this newsletter. The number of papers continues to grow as the total reaches more than 300.

While it is important to celebrate the 3000th float deployment, it is also the start of a new phase for Argo - the sustained maintenance phase. The goal of this 10-year phase will be to demonstrate Argo's value. During this time, the data from Argo will continue to provide a picture of the world's oceans that can be used to monitor more closely changes in the ocean, to help predict ocean events like El Niño and to aid in climate prediction.

#### **Congratulations Argo 3000**

During the month of October 2007, over 100 floats were deployed by various Argo scientists around the world to reach 3000 active Argo floats. Since we cannot pinpoint exactly which float put the count of active floats over 3000, float deployers were invited to submit photos of "Argo 3000" float candidates. Many photos were submitted, with some being shown on the next couple of pages. All of the photos can be seen on the website (http://www-argo.ucsd.edu/FrArgo 3000.html).

Thank you for all the photos submitted and the work done along the way to make such a wonderful achievement possible.



Photo on top left: A Canadian Argo\_3000 float being launched by JAMSTEC personnel in the Bering Sea (photo by Hiroshi Matsunaga)

Photo above: The crew of R/V Chofu Maru deploy a JMA Argo 3000 float in the sea south of Japan (photo from Kazuhiko Hayashi)

Photo to the right: Crew members of R/V *Poseidon* storing an Argo 3000 NEMO float released near the Azores Island (photo by Holger Giese)

3000 ice float before deployment from the Au-



Photo to the right: A PMEL Argo\_3000 float being deployed from the Sea Education Association's SSV Robert C. Seamans (photo by Kara Lavender)



Photo above: Demonstration of an Argo\_3000 float in Wellington Harbor, NZ (photo by Alan Blacklock)

Photo to the left: Stephan Leizour of the GOODHOPE project checking the heart of an Argo\_3000 PROVOR float prior to deployment (photo from Sabrina Speich)

Photo below: California Polytechnic State University students and professors showing their Argo spirit and tattoos (photo by John Polling)



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#### **Argo Array Status**

Mathieu Belbéoch (Argo Technical Coordinator) [belbeoch@jcommops.org]

As Argo reaches 3000 active floats, it is a good time to reflect on how Argo reached this point. The following plots and accompanying text illustrate the voyage and touch on some of the things to come at the Argo Information Centre.

The graph to the right shows the yearly deployments of Argo floats, by ocean, since 2000.

The table below shows the numbers of floats deployed per year in each ocean



	2000	2001	2002	2003	2004	2005	2006	2007	Total
Arctic Ocean	0	7	1	0	5	5	1	7	26
Atlantic Ocean	65	97	148	189	242	306	301	151	1499
Indian Ocean	13	24	106	124	158	113	149	136	823
Mediterranean Sea	6	4	9	13	18	17	12	7	86
Pacific Ocean	32	163	188	345	446	562	470	413	2619
Total	116	295	452	671	869	1003	933	714	5053



As can be seen from the plot to the left, more than 5000 floats were deployed to reach the 3000 operational floats target.

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One of the greatest achievements of Argo is to have developed international cooperation amongst 25 nations. An additional dozen of new countries will deploy some floats in the coming years thanks to the Argo donor programmes.

A simple view of the Argo network density helps in identifying gaps on a  $6^{\circ} \times 6^{\circ}$  grid (normalized on the  $3^{\circ} \times 3^{\circ}$ Argo standard). With most of Argo funding countries in the northern hemisphere it is still a challenge to fill the Southern Ocean.

A simple view of the Argo network mean age (mean for 6° x 6° grid) to anticipate future gaps in array coverage.

Even though Argo reached its initial target, and the float reliability has dramatically improved in the recent years, many floats will still need to be replaced each year to maintain full coverage.

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For the 3070 active floats (as of 1 Dec. 2007), 98% of the floats send their data in real-time on the GTS and to Argo GDACs. The remaining 2% are monitored on a daily basis to encourage data managers to set up data distribution as soon as possible and to not "waste" profiles used by operational centers.

7% of the floats are grey listed due to a problem with the sensors. Some of these can be corrected in real-time or delayed-mode.

380,472 profiles are available at the GDACs, including 168,589 (44%) high quality profiles provided by the delayed mode quality control process.







Use Google Earth to track the floats in real time and access key web pages for individual floats.

http://w3.jcommops.org/FTPRoot/Argo/ Status/status.kmz

http://w3.jcommops.org/FTPRoot/Argo/ Status/inactive.kmz

#### **Argo Support Center:**

The Argo user community is growing and increasingly diverse. The Argo user support activities are being strengthened and organized properly. In order to process the queries in a structured and timely manner, a centralized procedure has been set up. The AIC and the Argo Project Office (Argo TC + M. Scanderbeg) provide an operational user desk via http://support.argo.net and support@argo.net. All requests and their answers are archived in the AIC database.

In addition, all data users are invited to use this central node to provide feedback on the data quality or any problem they note in the data system. Information will be routed as appropriate to data providers.

A mailing list will be set up very soon to facilitate communication between Argo and its user community. An Argo web forum will be set up as well to allow informal discussion on Argo.

#### Report on the Eighth Argo Steering Team Meeting

Dean Roemmich (AST Co-chair) [droemmich@ucsd.edu]

The 8th meeting of the international Argo Steering Team was held in Paris on March 7-9 2007, hosted by the Intergovernmental Oceanographic Commission (IOC) of UNESCO. IAST-8 focused on the maturing nature of the Argo project, identifying a number of issues and opportunities that arise as Argo transitions from its implementation phase of the past few years to its sustained maintenance phase. A discussion of this transition was led by J. Gould, and most of the meeting agenda was devoted to issues related to the transition. Highlights of these include: **National funding** 

Most Argo national programs continue to be supported by research funding, which poses difficulties for sustaining the observations over decadal timescales. Therefore, mechanisms for long-term support are required.

#### **Operational applications**

It is recognized that operational applications will have a major role in justifying a sustained Argo project. In the interest of understanding the present status and data requirements of operational applications, and to encourage more communication between Argo and the operational centers, a mini-symposium was held including presentations/discussion with representatives from most of the operational users of Argo data. Each center had different results to present, however the overall messages were that the Argo data stream is working well, but could still use some improvements and that the evaluation of the Argo data assimilation is in the beginning stages. As the Argo data become a larger part of the assimilated data and the time period of the Argo data grows, several centers are evaluating Argo data's influence on their models. Additionally, the centers requested a more frequently updated greylist as well as a reanalysis data set each year with the most up-to-date version of each profile. A detailed report from each center is available in the supporting documents file for the AST-8 meeting report.

#### **Argo Products**

As Argo reaches more complete global coverage for several years running, products based on only Argo data can be produced and distributed to the scientific community. A. Fischer presented some work that the Ocean Observations Panel for Climate (OOPC) has done on creating ocean indices and displaying them on a website. AST members are encouraged to think of ocean indices products which could be created based on Argo data and added not only to the OOPC website, but also to the Argo website. These products can help demonstrate Argo's value and the need for the data.

#### **Argo Information Centre**

In addition to providing a mechanism for satisfying IOC Resolution XX-6 on float deployment notification, the AIC's Argo Technical Coordinator has developed many useful tools and applications for float tracking and provides technical support for a range of activities such as recovery of beached instruments. For a mature Argo, the sustained activities of the Technical Coordinator and relationship to other JCOMMOPS functions must be defined, as well as identifying sustained support for the AIC. The ATC's next major goal will be to develop a user desk system to address any sort of problems users may have with Argo data. The goal would be to get questions quickly routed to a person who is knowledgeable about the issue to resolve the problem in a timely manner. Questions and answers will also be archived so users can search the archives. **Data quality issues** 

# Recent problems with incorrect pressure binning in Argo/WHOI FSI floats has highlighted the need for Argo to become more proactive in rapidly identifying and correcting data quality problems. Specific steps were discussed and agreed. See the article about the pressure problem on page X of the Newsletter.

#### Reference data

The primary data quality issue for profiling floats is detection and adjustment of salinity drift caused by bio-fouling. For delayed-mode quality control, Argo requires a global database of reference quality CTD data with emphasis on recent data. It was requested that each national program identify and send to Steve Diggs at CCHDO data (CTD profiles) from a recent CTD cruise to track the file through CCHDO's system. These more recent CTD profiles could then be added to the reference database for delayed mode quality control. A separate but parallel issue is to learn the extent to which Argo data from newer floats can be used as a reference for adjustment of data from older instruments. Work is being done to compare Argo data sets with high quality CTD data in regions where there is sufficient data. Also, a prototype database of Argo reference profiles is being established for testing in delayed mode quality control.

#### Extending float lifetimes

For the long-term maintenance of the Argo project, and recognizing the difficulty in deployment of floats in remote ocean regions, it is desirable to extend the lifetime of profiling floats beyond the present capability of ~4 years. Extended lifetimes of 6+ years can be attained with technical improvements. S. Riser presented some improvements to float technology made by Webb Research including an Apex float hull made from composite that extends the depth range of Apex floats in the tropics. S. Pouliquen reported that the new Provor float has an improved energy budget ( > 150 cycles at 2000m) and a new hydraulic pump. The latest deployments of these floats show a high level of reliability. N. Shikama reported that JAMSTEC successfully carried out the first field test on its high viscosity silicon oil gear pump float.

#### New sensors on Argo floats

Argo floats provide potential platforms for accommodating additional sensors that may increase the scientific value of the Argo array. Any additions must be carefully considered and cannot impact the core capabilities of Argo, including float lifetime. A proposal for a two yearlong oxygen pilot program was presented. The proposal included a cost analysis for adding oxygen sensors to floats, possible sites for the pilot array, analyses of the currently available oxygen sensors as well as results from some of the floats that carry oxygen sensors. The AST endorsed the continued development of oxygen sensor technology and the continued planning of the oxygen pilot project. To read the Oxygen White Paper containing the details of the proposal, go to http://www-argo.ucsd.edu/ o2\_white\_paper\_web.pdf .

Outreach

Several outreach activities occurred this year and a few of them were reported on at the meeting, including work being done in Argentina. Floats were donated to Argentina and technicians were taught how to activate, deploy and use floats. Additionally, a project similar to the "Adopt a Buoy" program was launched at local high schools to help students learn about local waters.

The full report of the AST-8 meeting and the supporting documents file is available on the AST website at http://www.argo.ucsd.edu/ FrMeeting reports.html.

Thank you IOC for hosting the meeting.



#### Pressure offset errors found in WHOI Argo floats

#### Dean Roemmich [droemmich@ucsd.edu] and Howard Freeland [FreelandHj@pac.dfo-mpo.gc.ca]

In the spring of this year, it was discovered that Argo profiles from SOLO floats with FSI CTD from the WHOI Argo Program had incorrect pressure values. Profile data may have been offset upward by one or more pressure levels, resulting in a significant cold bias for these instruments. The problematic floats were mostly in the Atlantic Ocean (198 out of the 211 active FSI SOLO instruments as of March 2007). After further study of these floats, it was found that a subset can be corrected exactly using automated procedures, while another subset requires expert examination to produce an approximate correction.

Profiles that can be corrected using automated procedures have been corrected and files have been replaced on the GDACS by 20 October 2007. Procedures for real-time correction of these profiles have been in place since 10 October 2007. These floats have been removed

from the greylist as of 10 October 2007, meaning the profiles are available on the GTS.

Profiles that need expert examination are being inspected and corrected files are being placed on the GDACs as they are completely corrected. Errors are noted in the files corresponding to the uncertainty in the pressure correction. Since these profiles cannot be corrected automatically, the corresponding instruments continue to be greylisted (i.e. profiles are not on the GTS).

While studying this pressure offset error, a related problem was discovered in a group of WHOI SOLO SBE profiles. Reported pressures from these instruments corresponded to the bottom pressure of bins rather than to the mid-bin pressure. This 1/2 bin pressure offset error is generally less than for the FSI profiles mentioned above. For the affected WHOI SOLO SBE instruments, all profiles have now

been corrected and are available on the GDACs. The real-time data stream for these instruments has been corrected as of 14 September 2007. These instruments are not greylisted.

For a complete list of the WMO ID numbers for the affected instruments in each of the groups discussed above, see http://wwwargo.ucsd.edu/Acpres offset2.html.

The Argo project will continue to improve procedures for detection and correction of data quality problems, and Argo endeavors to provide data of highest quality possible. Users should note that near real-time data are subject only to automated quality checking, and the best quality data for climate research applications are available only in delayed-mode ("D" files). Users can assist by reporting any data quality problems to support@argo.net and to the AST co-chairs if the problems persist.



Timetable of Argo-relevant meetings						
2008						
March 17-20, 2008	Exeter, United Kingdom	AST-9	http://www.argo.ucsd.edu/AcAST-9.html			
November 10-15, 2008	France	GODAE Final Symposium	Argo Session and a meeting of the Ocean Surface Topography Science Team			

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serving system.

Photo courtesy of H. Freeland

#### **ARGO NEWS IN BRIEF**

#### Argo and GODAE in Perugia

John Gould [wjg@noc.soton.ac.uk]

The historical Umbrian town of Perugia, Italy was the venue for an exciting insight into the scientific progress made by Argo and of the ways in which the data are being assimilated into models and used in a wide range of operational and pre-operational applications. (This will probably be the only occasion on which Argo science will be discussed with a 2000 year-old mosaic outside the lecture room. http://www.unipg. it/guide/site7.html)

The two-day session "Argo and GO-DAE - regional and global partners", with 61 abstracts, was the best supported of the sessions sponsored by IAPSO (The International Association for the Physical Sciences of the Ocean) in the 24th meeting of the International Union of Geodesy and Geophysics. Surprisingly, despite the importance of the US contribution to Argo, only three of the submitted poster/oral abstracts were from the USA. This was compensated by large numbers of papers from Japan, China, France and UK.

Dean Roemmich gave an overview talk entitled "Argo observes global variability in the oceans" and Keith Haynes (University of Reading, UK) provided an excellent overview of GODAE replacing the planned talk by GODAE Co-chair Pierre-Yves Le Traon who was unable to attend due to a family bereavement.

All the presentations were of a very high standard and I am reluctant to single out any particular ones. However I was particularly struck by the increased focus on Argo velocities with papers by Brian King (UK), Marie-Helene Rio (France), Ji Fengying (China), and JJ Park (Korea). There were many examples of the

Dean Roemmich standing outside Caffe ARGO in Perugia, Italy Photo by: John Gould

operational use of Argo data in producing ocean products and forecasts (France, Japan, UK, EU). A paper by Shigeki Hosada used Argo salinity data in an initial attempt to monitor the strength of the ocean-atmosphere hydrological cycle. Stephanie Guinehut showed how comparisons between steric height calculations from Argo and satellite altimetry were able to reveal the anomalous nature of the WHOI/FSI floats; perhaps pointing to an effective means of monitoring the health of the array.

Using Argo to calculate global heat content was not just confined to the Argo/GODAE session but was also discussed in a symposium of sea level rise. Indeed Argo received wide exposure in Perugia. Argo

posters were displayed on The World Climate Research Programme stand and at the launch of the Electronic Geophysical Year (eGY) (http:// www.egy.org/) with its focus on open access to earth observation data – an area in which Argo excels.

Finally, Russ Davis received the Prince Albert 1st Medal from IAPSO for his pioneering work in developing autonomous ocean observations of which the PALACE float was the predecessor of the present Argo floats. His lecture provided a comprehensive overview of the development of ocean observations.

Those who were in Perugia found the science and the venue stimulating and exciting. The next IAPSO meeting at which Argo science will again feature will be in Montreal, Canada in July, 2009.

The abstract titles may be viewed at http://www.iugg2007perugia.it/abstracttype.asp

- select the IAPSO symposia
- select sessions
- select Details
- · select Abstracts list

#### 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.

#### **Opportunities to showcase your Argo research**

#### Float of the Month on AIC website

Beginning last August, each month a float of the month is featured on the AIC website with text and graphics explaining the data from the float. November's float, a pre-Argo float deployed by AOML in January 2000, is featured along with its data for the past seven years. October's float was an ice float deployed by the University of Washington. This feature is a great way to learn about different 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, email argo@ucsd.edu with text and plots you would like included web page.

#### 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 June, so please submit your article idea to argo@ucsd.edu by April 2008. We will let you know soon after if your article idea has been accepted for the upcoming newsletter.

#### Argo's CTD Reference Dataset: An Update

Steve Diggs: SIO/CCHDO (sdiggs@ucsd.edu)

There are now more than active 3000 floats in the Argo A great number of these floats are approaching their useful system lifespan, but even newest floats have sensors that start to drift from the moment they are deployed.

А method for estimating float sensor drift requires a regular supply of ship-board CTD profiles of depths of at least 1000m The Argo Data or more. Management Team (ADMT) proposed a plan 12 months ago to routinely acquire these high-quality CTD sets. This plan requires cooperation from the Argo Regional Centers (ARCs), US-NODC, Coriolis/ IFREMER and the CLIVAR and Carbon Hydrographic Data Office (CCHDO) at Scripps. The CCHDO (originally the WOCE Hydrographic Program Office) at Scripps has evolved into

an international center for the

acquisition, quality control and

CHD Carbon Hydrographi Data Office HOME | DATA BY OCEAN | SEARCH DATA | SUBMIT DATA CONTACT MONDAY, DECEMBER 10, 2007 SEARCH 0 The CCHDO Secure File Repository Submit Data Retrieve a file To submit a file, select the appropriate file with a brief note Retrieve and view a file from the file list below. Jser No argo Jim Swift's 108S data in the South-West Indian Ocean from February 2007. These data are part of the US-Repeat Hydrographic Survey. File: Browse... i08s 33RR20070204 nc ctd.zip Notes: Delete files you have uploaded Submit data and notes

CLIVAR &

dissemination of global hydrographic data and metadata. The CCHDO represented Argo's interests at the IODE meeting in March, and a formal request was made to each member country's NODC to assist the ADMT and the ARCs in their efforts to identify and rapidly acquire CTD profiles to be included the Reference Dataset. The response to this request was mixed.

Parallel efforts by Coriolis, US-NODC and the CCHDO to work directly with cruise Chief Scientists have been more successful. Coriolis has updated the Reference Dataset with numerous profiles made available through a cooperative agreement between French and German scientists. In addition. a joint CCHDO/US-NODC meeting was held in September, and a detailed dataflow was agreed upon which will insure that US-NODC has the most recent version of the CCHDO database.

CTD data from the Pilot Research Moored Array in the Atlantic (PIRATA) cruises from July 2007 have been ingested into the most recent version of the Reference Dataset, with the balance of the PIRATA-2007 cruise data expected by the end of the year. The CCHDO has data management responsibilities related to numerous other programs, such as the US-Repeat Hydrography Program, CARBOOCEAN, SASSI, DIMES and

#### Dean Roemmich receives Sverdrup Gold Medal Award Howard Freeland [FreelandHj@pac.dfo-mpo.gc.ca]

It was announced today (8 November 2007) by the American Meteorological Society (www.ametsoc.org) that the Sverdrup Gold Medal is awarded this year to Prof. Dean H. Roemmich. The citation reads "For major contributions to the measurement and understanding of the ocean's role in climate, and for leading the development and implementation of the Argo profiling float array."

While we know that Argo is a group achievement it would never have been possible without the leadership shown by Dean from the very beginning of this project. Please join me in offering our heartiest congratulations to Dean for an award richly deserved.



Ocean as red lines with Argo float locations overlaid as yellow dots.

CTD profile acquisition plan and the prospects look better than ever to fully populate the Reference Dataset with thousands

of recent observations in every area of the global ocean.

There have been a lot of changes to the original

GEOTRACES so these data may be made available to Argo without delay. The most recent ADMT meeting in Hobart, Australia provided

an opportunity for Coriolis, CCHDO, and US-NODC personnel to organize a detailed plan to design a fully synchronized tri-agency reference dataset for Argo. The three organizations were directed to construct a

virtual data center for the submission and processing of new CTD data from the ARCs as well as profiles submitted to one of the three organizations.

The ARCs are expected to contribute CTD data through the CCHDO for the exclusive use of the Argo quality control community, however, some of these centers have raised legitimate concerns regarding the security and disposition of each country's non-public In response to these concerns, data. the CCHDO is hosting a flexible, private, password controlled submission

websites for all incoming data. The portal for this secure website is seen in the upper inset graphic.

Although the original temporal window for CTD profiles was rather narrow (18 months old or less), the group will focus dramatically on increasing the number of Southern Ocean observations from almost any vear due severe lack of CTD data in that area. The Google plot to the Earth left demonstrates CCHDO's data holdings in the Southern



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