Project Argo

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In March 2000, several members of the PICES Physical Oceanography and Climate Committee (Drs. Howard J. Freeland (Canada), Stephen C. Riser (U.S.A.) and Kuh Kim (Korea)) attended the second meeting of the International Argo Science Team (IAST-2) at the Southampton Oceanography Centre, UK. At that meeting, Dr. Kuh Kim became a member of the International Argo Science Team (Drs. Freeland and Riser were appointed in this capacity earlier). In April, we and the PICES Chairman, Dr. Hyung-Tack Huh, attended the International Implementation Planning Meeting for Argo Floats in the Pacific Ocean and Adjacent Regions in Tokyo. Argo is moving steadily towards the deployment phase, and the purpose of this article is to report my views on the progress of Argo program.

The first important change is visible in the title of this article, the spelling of “Argo” with only a capital first letter. We decided to cease considering the project name as an acronym. It is a partner project with Jason so we should regard Argo as just a proper name. For those not familiar with these names, Jason-1 is the satellite that is due to be launched in September of this year as a successor to the very successful Topex-Poseidon satellite. Jason-2 should be launched in about 5 years as a successor to Jason-1. In Greek mythology Jason sailed in a ship called Argo with his crew (the Argonauts) in search of the Golden Fleece.

Argo is intended to deploy 3000 robotic floats in a global array. These are the profiling Alace floats that have been described previously in PICES Press. Dean Roemmich from the Scripps Institution of Oceanography deployed 3000 floats in a 3° x 3° array in a computer model, allowed them to drift for a while and then produced the schematic diagram opposite (Fig. 1). The floats will drift at a target pressure of about 2000 dbars. Periodically they will adjust their buoyancy, float to the surface, observe a profile of temperature and salinity on the way up and transmit that to a satellite. Thence, the data will be reported to the owner of the float who will process the data in real time and transmit profiles on the Global Telecommunication System (GTS), which is accessable to all members of the World Meteorological Organization, and post data on the WWW. The complete Argo archives will be available free of charge to any and all users in near-real time. Each float has sufficient energy for about 200 profiles. Thus any float could potentially supply data for 5 to 6 years.

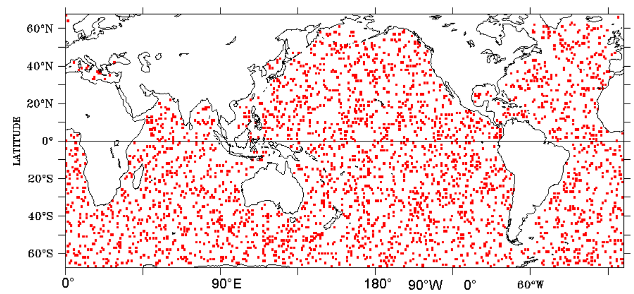

Fig. 1 Highly schematic map showing a possible distribution of 3000 floats.

The countries and entities planning to deploy floats in support of Argo presently are: Australia, Canada, the European Union, France, Germany, Japan, Korea and the United States. There may be small contributions from some other countries, possible contributors include New Zealand, India and Brazil.

Argo is expected to supply data on the internal dynamics of the ocean every 10 days. Jason will provide global sea-level data. These two projects will supply data to GODAE, the Global Ocean Data Assimilation Experiment, that is the object of the whole exercise, to demonstrate the feasibility of seasonal climate forecasts up to 1 year in advance.

So where is Argo now? Of the float-deploying nations, two, U.S.A. and Japan (the two largest contributors), have secure funding and are moving ahead rapidly. Canada has a commitment to supply 10 floats to Argo, but has a rough target number much greater. For all of the other nations including the European Union, funding remains somewhat uncertain. Summing all of the national targets, we still remain a little short of the 3000 floats required, but the discrepancy is small and might be accommodated by contributions from smaller participants. Deployment in large numbers is likely to begin in 2001.

The really exciting development involves demonstration of the ability to launch one type of profiling float (the APEX float manufactured by Webb Research) by air. This float is now certified for launch from C-130 aircraft. This makes the rather daunting task of deploying floats in remote corners of the Earth considerably easier. So far seven floats have been air launched. Of these six are reporting data, and the

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role of ocean conditions as a factor influencing decisions concerning the removal of hydroelectric dams on the Columbia River (Phil Levin, NMFS/Seattle).

Much of the final discussion was led by David Welch and was directed at better coordination of sampling, in terms of where and when sampling is done, and the importance of using standard methods. The workshop identified increases in upwelling strength, nutrients, phytoplankton, zooplankton and salmonid numbers in 1999, but we should not lose sight of the fact that this may have been only a brief response to a strong La Niña. On the other hand, 1999 could mark the onset of another regime shift (or at least a minor climate shift). Whichever case turns out to be correct, the most interesting lesson that we have learned from field work in 1999 is that the ocean conditions can change quickly and coho salmon can respond almost as quickly. The third annual workshop will be organized in early 2001, in Nanaimo, B.C., Canada. Those interested in attending and/or keeping abreast of climate and oceanographic issues affecting juvenile salmonid distribution, abundance, growth and survival, should contact Bill Peterson (bpeterso@sable.nwfsc-hc.noaa.gov). For more details on the results of the Seattle workshop, feel free to contact Bill and he will put you in contact with the appropriate person(s).

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nature of the failure in the seventh case is well understood and will not recur. Though this will greatly simplify the process of deployment, there do remain parts of the world that cannot be reached easily with C-130 aircraft. In those cases deployment from surface vessels will remain the only (and likely expensive) option. Assistance from other countries to assist with the deployment of floats during their routine research missions may be needed.

At both meetings we discussed the handling of data in detail. All countries participating in Argo have agreed to the free exchange and transmission of data in near-real-time (usually interpreted as <12 hours) and absolutely no protection of data by scientists. Thus, all scientists with an interest in ocean circulation will have free and easy access to the global Argo database. Anyone using the data should make an effort to understand the processing of data that will take place. There will be a fast check on the data. This process will be automated to check the data to see if they are rational. For example, we may choose to compare data with a climatology and flag data that are >3 standard deviations away from the climatology. Other standard checks will take place, such as a speed check on the position data, to ensure that there is a reasonable chance that the data are of good quality. These data will be made available on the WWW. Later, there will be a visual examination of each profile acquired in a delayed-mode quality check. This may involve recalibration of the data based on new information on sensor drifts, for example. These data will be made available separately and identified as a delayed-mode product. Generally, float data will be processed at data centres in the countries that own the specific floats. However, arrangements will be made to exchange data on a daily basis between centres. Thus, the Canadian processing centre at MEDS in Ottawa will process data derived from Canadian-deployed floats and post those data. They will exchange data with other agencies, so that, for example, the US, Japanese and Korean data centres will own the Canadian data within a day of it being received by Canada, and vice versa. Thus, Korean users of float data will be able to acquire the global data sets from a source within Korea, Japanese users can use a Japanese source, etc.

Communication remains a major outstanding issue. At the present time all floats are communicating through *Système Argos*, because it is there, and it works, and it is reliable. However, the data transmission rate is extremely low. Experiments are being undertaken on the potential use of *Orbcomm*, a system designed to allow the tracking of commercial freight, such as containers, around the world. There are problems to resolve, and the data transmission rate on *Orbcomm* is not as great as we would like, but the results so far are quite positive.

Floats deployed in the open ocean will drift into the EEZs of countries that are not members of the Argo organisation. The Law of the Sea requires that coastal states be notified if a float is about to enter the EEZ of another country. This process will be handled for Argo by UNESCO. They will monitor launches and positions of all floats and issue notifications as required.

I would like to finish with some personal comments. The profiling float concept was developed exclusively by teams of physical oceanographers. During this process I suspect that some important opportunities might have been missed. I would rather have seen the development of a more generic platform that adjusts its buoyancy and has ports for fairly generic sensors. Perhaps we could create a float that observes profiles of chlorophyll or zooplankton or dissolved oxygen. Perhaps we could install computation capability to compute Thorpe scales. There are many possibilities, and I would encourage scientists to think about innovative sensor systems that might be installed on a profiling float.

There are now many web sites where information about the profiling floats, Projects Argo, Jason and GODAE can be found. I would suggest the following as a good starting point, which will quickly lead to the University of Washington, the Argo web site and many other places:
http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/alace/hjf_argo.htm