

## **REPORT ON GODAE AND ARGO**

*(Submitted by the Chair of the International GODAE Steering Team)*

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### **Summary and purpose of document**

To inform CGMS Members of the status of GODDAE and ARGO activities.

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### **ACTION PROPOSED**

CGMS Members to note the report on status of the activities for GODDAE and ARGO and comment as appropriate.

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## 1. GENERAL

The Global Ocean Data Assimilation Experiment (GODAE) is a Pilot Project of GOOS and is approaching its intensive phase 2003-2005. It is supported by a GODAE Office in Melbourne and enjoys patronage from many of the leading satellite and ocean observation agencies, as well as from technical and operational groups.

*Argo*, the initiative to populate the world's ocean with 3000 profiling floats, each taking a 2000 m profile of temperature and salinity every 10 days, is also a GOOS Pilot Project. The *Argo* Science Team (AST, Chaired by D. Roemmich) provides excellent leadership on scientific, technical and implementation issues. The complementarity between *Argo* and satellite programmes was recognized explicitly in its design and remains a key motivating factor.

GODAE played a key role in the publication of "Observing the Oceans in the 21<sup>st</sup> Century", a volume based on the 1999 OceanObs Conference. The IGST met in Gulfport, Mississippi in December 2001 ([http://www.bom.gov.au/GODAE/6th%20IGST/summary\\_report.htm](http://www.bom.gov.au/GODAE/6th%20IGST/summary_report.htm)). This document includes items from that meeting as well as general issues for the future. The AST last met in Hobart 12-14 March 2002; the report of that meeting is on the *Argo* web site (<http://www.argo.ucsd.edu/iast4.pdf>). In general terms, *Argo* is making excellent progress and is exceeding expectations in key technical areas such as salinity measurement.

## 2. ARGO (<http://www.argo.ucsd.edu/>)

International commitments to the *Argo* project continue to increase. More than 10% of *Argo* has now been deployed, with about 340 floats presently active (see Table below). For the latest float positions, see <http://w3.jcommops.org/website/ArgoMap>. The number of active floats will increase rapidly over the coming year - over 1500 floats have now been funded, with additional proposals over the next three years averaging nearly 900 floats per year. Several challenges are looming, including the final steps to complete the data management system, technical aspects of float performance, regional float deployment planning mechanisms, and the need for rapid utilization of *Argo* data. Another objective of the meeting was to encourage float-providing nations to increase deployments in the Southern Hemisphere - and to that end a Southern Ocean Science Symposium was held in a joint session with the CLIVAR Southern Ocean Panel.

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

Technical issues relevant to the *Argo* array have been reviewed. A major development is the availability later this year of the Iridium system for improved communication bandwidth, two-way capability, and decreased surface time for *Argo* floats. The cost-effectiveness of *Argo* communications may be improved by several orders of magnitude. Continuing successes with stable salinity sensors means *Argo* is exceeding its benchmark target by a considerable margin. Longevity of the sensors is not fully tested, but initial deployments are very promising.

A formal mechanism has been established for iteration and web publication of regional plans for float deployment. For each ocean basin a deployment coordinator is identified as well as points of contact for all float-deploying groups. After communication with the float providers, the coordinator will publish plans extending approximately 12 months in advance, and these plans will be updated at least every 6 months. A number of other issues related to large-scale

implementation of Argo were discussed. A mini-symposium was held describing early scientific results from Argo data and it was agreed to emphasize Argo results in future meetings.

### *International Commitments for Argo Floats*

*18 Mar 02*

<u>Number of Floats by Country</u>	<u>Argo</u>	<u>Float</u>	<u>Argo</u>	<u>Float</u>	<u>Argo</u>	<u>Float</u>	<u>Argo</u>	<u>Float</u>	<u>Proposed</u>	<u>Prop Float</u>
	<u>Funded</u>	<u>Equiv's</u>	<u>Funded</u>	<u>Equiv's</u>	<u>Funded</u>	<u>Equiv's</u>	<u>Funded</u>	<u>Equiv's</u>	<u>over next</u>	<u>Equiv's</u>
	<u>FY99</u>	<u>FY99</u>	<u>FY00</u>	<u>FY00</u>	<u>FY01</u>	<u>FY01</u>	<u>FY02</u>	<u>FY02</u>	<u>3 years</u>	<u>over 3 yrs</u>
Australia	10				13		7		93	
Canada	10		42		20		25		75	
China					10		8		105	
Denmark						5			30	
European Comm.			10		70					
France		8	3		50		95		160	
Germany				18		22		42	115	
India							31		119	
Japan			24	4	76	8	90		300	
New Zealand			2		2		2		6	
Republic of Korea					19		15		90	
Russia		1		2		2	2	1	6	
Spain									30	
United Kingdom			13		50	5	45	12	150	40
<u>U.S.A.</u>	<u>55</u>		<u>132</u>	<u>51</u>	<u>174</u>	<u>43</u>	<u>275</u>	<u>7</u>	<u>1238</u>	<u>75</u>
<b>TOTALS</b>	<b>75</b>	<b>9</b>	<b>226</b>	<b>75</b>	<b>484</b>	<b>85</b>	<b>595</b>	<b>62</b>	<b>2517</b>	<b>115</b>
<b>TOTALS BY YEAR</b>	<b><u>FY99 = 84</u></b>		<b><u>FY00 = 301</u></b>		<b><u>FY01 = 569</u></b>		<b><u>FY02 = 657</u></b>		<b><u>Ave/Yr = 877</u></b>	

Argo, in collaboration with SOPAC, GODAE/OOPC and the JCOMM Service Group, convened a Workshop on "Potential Applications of Ocean Observations for the Pacific Islands" in Fiji, October 4-7 2002. The main objective was to explore potential for exploiting ocean data and products. Copies of presentations, preliminary conclusions and an outline of a work plan can be found at <http://conf.sopac.org/wiki/PAOOP/>. By all measures, the meeting was a significant success and there is considerable potential for greater uptake of both satellite and *in situ* (e.g., Argo) data.

### 3. GODAE (GLOBAL OCEAN DATA ASSIMILATION EXPERIMENT) (<http://www.bom.gov.au/GODAE/>)

GODAE has lead responsibility for developing and demonstrating new ocean products and services. Prototype products are available from several groups (see URLs below). A draft Implementation Plan is now available through the GODAE web site and it emphasizes the central importance of satellite data for the intensive phase and for the future. Key URLs are:

- Strategic Plan: ([http://www.bom.gov.au/GODAE/Strategic\\_Plan.pdf](http://www.bom.gov.au/GODAE/Strategic_Plan.pdf))
- High-Resolution SST Pilot Project: <http://www.ghrsst-pp.org/>
- GODAE Symposium: <http://www.bom.gov.au/GODAE/Symposium/GODAEGB.html>
- Prototype products and URLs: [http://www.bom.gov.au/GODAE/godae\\_product\\_urls.htm](http://www.bom.gov.au/GODAE/godae_product_urls.htm)

Some specific aspects are mentioned below.

#### 3.1 The GODAE Symposium

The En Route to GODAE Symposium drew an attendance of around 230 people and was held over 2½ days at Biarritz, on the south-west coast of France. The Jason SWT met at the same location in the 3 days prior. A selection of material is available through the GODAE Home Page or directly at <http://www.bom.gov.au/GODAE/Symposium/> (go to Presentations and, in particular, to the Round Table discussion). In time, all presentations will be made available.

The posters were excellent and generated a great deal of discussion. The larger-than-anticipated attendance and participation did leave far too little time for participants to view and discuss the posters, an aspect that will have to be borne in mind for any subsequent meeting. Six posters were chosen for their excellence and the young scientists awarded prizes. The judges were uniformly of the opinion that the standard of the posters was extremely high.

The plenary session papers were excellent and were delivered with conviction. A sentiment expressed several times was that GODAE was exciting and fresh and, perhaps more importantly, exuding relevance. The discussions were vigorous and, even after 4 years of thinking and talking GODAE, stimulating and refreshing. It is dangerous to particularise but the papers by Minster, Bell, De Mey, Le Provost, Pinardi and Chassignet truly captured the great innovation and excitement that is GODAE. We arrived with confidence that GODAE was on course and left with a long list of challenges and issues that suggested we are only just beginning the hard (and likely most interesting) part. And that is as it should be.

The final Round Table discussion explored several of the issues that had arisen through the meeting. The topics reflect the challenges that GODAE must address over the coming years:

- (1) Are the links and interaction with application areas working, particularly for coastal, biological and marine ecosystem approaches?
- (2) How does GODAE engage end users and ensure appropriate feedback?
- (3) Are we exchanging data, products, knowledge, ... adequately?
- (4) How do we engage science now and when GODAE systems are established as operational mechanisms?
- (5) The largest challenges in Data and Information Management remain with community attitude. What can GODAE do to help?
- (6) We must begin planning for 2008 now for transition of (a) the observing system, (b) the model and assimilation systems, and (c) the data systems and servers.

The Conference was supported by several of our patrons and other sponsors, including CNES, NASA, ONR, EUMETSAT, ESA, NOAA, IRD, Météo France, IOC and WMO. It is believed that those sponsors who had the opportunity to attend the Symposium would have felt well satisfied with their investment, as did GODAE. The contribution of CTA to local arrangements was first-class, as always. The support of CNES and CTA in the organization of this meeting was first rate.

### **3.2 Quality control for operational systems**

US GODAE identified the need for systematic evaluation of the quality control procedures and the impact of various model and assimilation assumptions on the performance of these schemes. At the IPRC Workshop, Cummings (FNMOC) noted that the results of QC from the FNMOC system are routinely posted to the Monterey server (statistics on OmF, OmA and data rejection flags, among other things). The IGST concluded that such intercomparisons would be extremely valuable and should be an integral part of the Implementation Plan.

The IGST agreed to initiate a model and data assimilation Quality Control monitoring and evaluation project. Cummings has agreed to lead the project. Initially, the intercomparisons should be restricted to a few regions where ocean dynamics and physics are well understood; where the climatology is well known; and where data redundancy provides hope of unambiguous interpretation. Because of the great importance attached to Argo, it was felt that a good initial step would be to provide regular statistics on the impact and fate of Argo data. An initial Workshop is to be held in association with the GODAE Symposium on 11 June 2002 (see Symposium web site for details).

### 3.3 Ocean current data and products

The IGST is in broad agreement that ocean current data are important but there continues to be some debate about the need for a special data centre. Some groups do produce blended surface ocean current products based on altimetry, surface drifters, and a wind-based estimate of Ekman drift.

The IGST has developed a Prospectus for such a project agreed that there was a good case for at least testing the interest in such a Facility. An outline of a Prospectus is included at Annex 3 of the IGST VI Report.

### 3.4 GHRSSST: The GODAE High-Resolution SST Pilot Project (<http://www.ghrsst-pp.org/>)

The initial GHRSSST Implementation Plan has been completed and circulated for review to around 40 scientists and key programme managers. The draft can be accessed through the GHRSSST web site. The GHRSSST-PP Science Team has made excellent progress in developing its strategy and has significant commitments to the plan.

### 3.5 National initiatives

There has been good progress with several national efforts (see the products URL above). Some specific cases are given below.

Considerable progress has been made in the UK (see, for example, <http://www.met-office.gov.uk/sec5/OA/FOAM/FOAM.html>). A 1/3° global model will be operated through 2003-2005. A data assimilation reanalysis from 1980 through to the present ("ENACT") was being planned. A high-resolution (1/9th degree) model was developed for the Arabian Sea.

The data and products are releasable except in "crisis" circumstances. The existence of GODAE was critical for this decision. GODAE also provided opportunities for shared development (e.g., with MERCATOR) and for improving systems through community tests and intercomparisons. GODAE is seen to be adding real value to the ocean modelling and assimilation enterprises of the Met Office.

In France, the MERCATOR project is releasing real-time prototype products. There are several phases to the MERCATOR approach (see <http://www.mercator.com.fr/>):

Phase 1 (now)	1/3° North Atlantic model
Phase 2 (2002)	1/15° North Atlantic model
Phase 3 (2003-2005)	1/15° North Atlantic model + 1/4° Global model
"Operational" Phase 2006+	The above

The schedule and milestones of GODAE have been crucial for planning within MERCATOR and for promoting collaboration and exchange consistent with the principles of the GODAE Common. GODAE provides a focus for end-users and added-value applications. A new agency was being planned to implement MERCATOR, supported by contributions from all the agency partners. A Director would be appointed shortly. Talks were also underway on the operational phase (2006 and beyond). GODAE played an important role in national plans and emphasized the fundamental importance of international cooperation and collaboration under the GODAE banner.

US GODAE hosted a Workshop on *Global Ocean Data Assimilation: Prospects and Strategies* (see [http://nsipp.gsfc.nasa.gov/usgodae/aworkshop/usgodae\\_assim\\_wkshop.html](http://nsipp.gsfc.nasa.gov/usgodae/aworkshop/usgodae_assim_wkshop.html) and the Abstracts therein). Several points were made:

- Data set development is a key activity of US GODAE
  - Scientifically prepared standards (see intercomparison discussion)
  - Description and knowledge of QC procedures
  - Value-added data sets
  - Feedback to the data providers
  - Observing system sensitivity experiments/studies
- Data and product serving and, in particular, the Monterey Server
- Assimilation
  - Error models and analysis of assimilation histories
  - Provider feedback
  - Dealing with biases.

The HYCOM project (see <http://hycom.rsmas.miami.edu/>) has made considerable progress.

- 1/12° North Atlantic and North Pacific models, and a 0.72° global model (with Cooper and Haines assimilation of altimetry) during 2003-2005.
- Target is 1/12° global model by 2006
- Information distributed via LAS (200 Gb on-line and 1.6 Tb offline)
- Currently shifting from the R&D phase to assimilation
- Developing user aspects of project

The GODAE framework was critical for the development of US work. The impacts included:

- Encouragement to release data to foster synergy, collaboration and value-adding
- Access to, and participation in, intercomparison projects (lead to improvements in systems)
- Substantial impact on the Navy commitment to operational ocean prediction
- Paradigm shift in openness
- Enhanced evaluation and quality assurance for navy systems and products

GODAE would continue to add value over and above the national activities (e.g., in the organization of data streams; on the operational-research partnership, etc.).

### **3.6 Implementation Plan**

Much of the last IGST meeting was devoted to discussion of the Implementation Plan. Specific actions were agreed in several areas.

#### **3.6.1 Intercomparison Projects**

##### *NORTH ATLANTIC IC PROJECT*

A prioritized approach was agreed by the IGST. The aim would be to involve around 4-6 models from the participants (MERCATOR, FOAM, HYCOM, 2 Navy models). Some groups would take the responsibility for *gathering* information from other participants and preparing intercomparison displays. In other cases the LAS architecture would be used to develop common displays and the information would remain distributed. A paper describing the elements and metrics for the project would be developed for Biarritz. The aim would be to have real-time comparisons set up for 2003-2005.

### NORTH PACIFIC IC PROJECT

A set of Metrics was developed at the IPRC meeting (see Annex 7 of the IGST VI Report). The initial focus would be the NW Pacific. Like the Atlantic project, a paper would be prepared (expanded from Annex 7) and this would provide the basis for a Symposium paper. Kamachi (MRI) and Mitsudera (IPRC) will provide the lead.

### EQUATORIAL IC

Rienecker (GSFC) has volunteered to lead this project, most likely in collaboration with WGSIP. A half-page outline would be prepared with a schedule for action (discussions are underway with the Chair of WGSIP).

### **3.6.2 Data and Product Servers**

The effectiveness of data and product service is a key issue for GODAE (see also OOPC report). The IGST agreed to hold a Workshop in association with the Symposium (June 12). Annex 8 of the IGST report provides details.

## **4. CONCLUSIONS**

*Argo* continues to develop with strength and is pursuing an ambitious implementation programme. There are some technical challenges but for the most part these challenges are not posing critical issues. Some innovative solutions are emerging for ice-covered regions that had previously been a problem area. The prospect of additional telecommunication options offers great potential for *Argo* – improved communication of data (the whole data set) and two-way communication for adjusting the schedule of floats. Global implementation remains the highest priority. The data management activities are providing innovative solutions that, in part, are providing models for renovation of other in situ data streams.

GODAE is progressing well on most fronts. Some aspects, such as the development of the Implementation Plan, are progressing rather more slowly than is ideal but this does not seem to be a critical weakness. The GODAE Symposium provided an opportunity to assess and advertise progress and to develop some needed links into the applied community. The *Argo* Pacific Workshop and the second Indian Ocean Workshop also provide excellent opportunities for developing greater impact in the developing regions. The links with Coastal GOOS provide many opportunities for both communities.