

**Australian National Facility for Ocean Gliders  
2009-2013 IMOS EIF Facility Project Plan**

IMOS Facility:	Australian National Facility for Ocean Gliders (ANFOG)
Operating Institution:	The University of Western Australia
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Collaborating Institutions:	CSIRO Marine and Atmospheric Research Sydney Institute of Marine Science/UNSW SARDI/Flinders University Australian Institute of Marine Science Institute of Antarctic and Southern Ocean Studies

**Overview:**

This project will extend and enhance the Australian Facility for Ocean Gliders (ANFOG). All of the nodes which are currently using ocean gliders (Bluewater, SAIMOS, NSWIMOS and WAIMOS) will continue the current level of infrastructure to 2013. Enhancements include glider deployments at the SOTS site and Coral Sea (Q-IMOS) allocated from 09/10 EIF funds and Slocum glider tracks in Tasmania and the North-west Australia (subject to co-investment by WA Government) during 2010-13.

The data streams from ocean gliders are available through eMII from deployments to date: off Tasmania, New South Wales, South Australia and Western Australia. These data streams are being used to monitor boundary current systems (Leeuwin, East Australian and Flinders Currents) and their eddy systems.

**Nature of Investment:**

The proposed investment comprises three components with budgets presented separately

- A. *Extend*:** Extend from 2011 to 2013 the existing ANFOG deployments in Bluewater, SAIMOS, NSWIMOS and WAIMOS (south-west)
- B. *Enhance (EIF funding)*:** Seagliders deployments to SOTS and GBROOS from the initial 09/10 allocations of EIF funds and Slocum deployments in Tasmania and Northern Australia (subject to co-investment)

## Implementation Strategy:

### Summary

- ***Extend*:** Maintain the existing glider deployments in Bluewater, NSWIMOS, SAIMOS, and WAIMOS to 2011 (NCRIS funding) and extend to 2013 with EIF funds.
- ***Enhance (Seagliders)*:** Seagliders were allocated from the 09/10 EIF funding to purchase 6 Seagliders, 4 to be allocated to SOTS and 2 to be deployed offshore GBR in the Coral Sea. The Seagliders have ordered and are delivery date is March 2009. It is expected that the first gliders at these two regions will be deployed in March/April 2009. These deployments will continue to 2013.
- ***Enhance(Slocum)*:** New glider tracks were requested by WAIMOS and TASIMOS. WAIMOS requested 2 additional glider lines in the north-west of Australia (Pilbara and Kimberley) to run at quarterly intervals (subject to WA Government co-investment). TASIMOS requested 2 gliders to maintain continuous glider transects along the south Tasmania. The total request is for 3 additional Slocum gliders.

### Objectives

The main objective of ANFOG is to provide a fleet of continental shelf and deep water gliders to obtain sustained data streams requested by the IMOS node science and implementation plans. This requires the maintenance of the ocean gliders, deployment and recovery, glider navigation and data Quality Analysis and Quality Control (QA/QC).

Ocean gliders are autonomous vehicles designed to operate in water depths up to 1000 m. By changing its buoyancy, the glider is able to descend and ascend. For IMOS, two different types of gliders are in operation. The Slocum glider is designed to operate to a maximum depth of 200m and a maximum endurance of 30 days, whilst the Seaglider is able to operate to a maximum depth of 1000m and a maximum endurance time of up to 6 months. Both gliders have the same suite of sensors to measure conductivity (for salinity), temperature, dissolved oxygen, fluorescence, turbidity and CDOM (dissolved organic matter) with depth.

The data streams from ocean gliders are available from different locations across Australia: off Tasmania, New South Wales, South Australia and Western Australia. A summary of ANFOG glider deployments to June 2009 are presented as Tables 1 and 2. These data streams are used to monitor boundary current systems (Leeuwin, East Australian and Flinders Currents) and their eddy systems.

The ANFOG plan addresses the IMOS strategic priorities as follows:

#### *Providing a national backbone for observing boundary currents*

The main aim of the glider deployments are to sample boundary currents and are reflected in the science and implementation plans of each of the nodes. The deployments of the Bluewater and

climate node off the east coast of Tasmania and those of NSW-IMOS off Sydney are both sampling the East Australian Current and its eddies. The deployments for SAIMOS samples the Flinders current whilst the WAIMOS deployments sample the Leeuwin Current. The gliders have sensors which in addition to temperature and salinity, record dissolved oxygen, fluorescence, turbidity and CDOM which provide information on biological parameters through the water column.

*Continuing to build institutional strengths into national capability*

Gliders are highly specialised equipment encompassing a variety of expertise including electronics, satellite communications, computer software and remote navigation. In addition, the deployment and recovery gliders also need specialist knowledge. ANFOG has developed all of this capability over the past couple years and are currently in a position to transfer these nationally. In the first instance, all the nodes currently have the capacity to recover the gliders after a deployment and this is now a regular occurrence. ANFOG is beginning to transfer the knowledge to deploy gliders to each of the nodes. For Seagliders the deployment process is straightforward and the first unassisted deployment was performed by NSW who deployed a Seaglider on Southern Surveyor in October 2009. This will be extended to the other nodes in the next few months. The Slocum gliders are a bit more complicated with the requirement to check the ballast etc prior to deployment. It is expected that all of the nodes will have the capability to deploy and recover gliders without direct assistance from ANFOG staff by mid 2010.

*Exploring the potential for whole-of-system approaches*

The glider data provides information on the water column which is of use to both physical and biological oceanographers. The physical data provide the system forcing whilst the biological data provide the primary production which is one of the drivers of the ecosystem.

*Driving down the cost per observation*

Gliders have been developed as a cost-effective alternative to traditional ship based sampling and thus by using the gliders we have already driving the cost per observation down. However, within ANFOG we also need to make efficiencies to bring the cost of observations lower. We have attempted to do this by examining the procedures that are currently operational. One of the main changes we have done is to acquire the ability to refurbish Seagliders in-house (previously the Seagliders had to be returned to manufacturer) this will make an improvement in the cost as well as efficiency. This also enables the purchase of batteries locally thus keeping the costs lower.

**List of major activities – including major party(s) involved, duration, start, finish**

<b>Extension</b>	<b>Node</b>	<b>Major Parties</b>	<b>Duration*</b>	<b>Start</b>	<b>Finish</b>
<b>NCRIS + Extension</b>					
Slocum glider	SAIMOS	SARDI/Flinders	4 deployments/year	2009	2013
Slocum glider	NSW-IMOS	SIMS/UNSW	4 deployments/year	2009	2013
Slocum glider	WAIMOS	UWA/CMAR	8 deployments/year	2009	2013
Seaglider	Bluewater	CMAR	4 deployments/year	2009	2013
Seaglider	SAIMOS	SARDI/Flinders	3 deployments/year	2009	2013
Seaglider	NSW-IMOS	SIMS/UNSW	3 deployments/year	2009	2013
Seaglider	WAIMOS	UWA/CMAR	6 deployments/year	2009	2013

Enhancement					
Seaglider	Bluewater/ SOTS	CMAR/SOTS	8 deployments/year	2010	2013
Seaglider	Q-IMOS	AIMS	3 deployments/year	2010	2013
Slocum glider	TASIMOS	CSIRO	8 deployments/year	2010	2013
Slocum glider**	WAIMOS	UWA/CMAR	8 deployments/year	2010	2013

\*Indicates the number of deployments per year

\*\* Subject to co-investment

AIMS            Australian Institute of Marine Science  
 CMAR          CSIRO Marine and Atmospheric Research  
 Flinders       Flinders University)  
 SARDI         South Australian Research and Development Institute  
 SIMS          Sydney Institute of Marine Science  
 UNSW         University of New South Wales  
 UWA           University of Western Australia  
 SOTS          Southern Ocean Timeseries

Bluewater      Bluewater and Climate Node  
 NSWIMOS     New South Wales IMOS Node  
 Q-IMOS       Queensland IMOS Node  
 SAIMOS       South Australian IMOS Node  
 TASIMOS      Tasmanian IMOS Node  
 WAIMOS       Western Australian IMOS Node



**Figure1 – ANFOG deployments: the glider indicate the locations where current deployments have been undertaken. The red lines (North-west shelf and Tasmania) are enhancement using Slocum gliders whilst the yellow lines are enhancements using Seagliders for SOTS mooring and Coral Sea.**

### **List of major equipment to be purchased / developed**

The current glider fleet consists of the following:

Seagliders:	5 units
Slocum:	3 units (+1 to be purchased from self-insurance)

Enhancements:

Seagliders:	6 units (already under order, to be delivered in March 2010)
Slocum:	4 units (2 are subject to co-investment by WA government)

### **Access, pricing regimes:**

#### **How will data access be provided?**

Data from the gliders are received near-real time by ANFOG via satellite (Iridium) communications. Only a sub-set of the data is received via satellite and this data (not quality controlled) is available as transect plots via ANFOG website to be used mainly as monitoring of the glider and to make science decisions with regard to piloting. Upon glider recovery, the data are QA/QC'd and are provided to eMII. To date (February 2010) data from all completed glider deployments to December 2009 are available through eMII – this will continue through the extension and enhanced phases of EIF funding.

#### **How will data and products be managed?**

ANFOG has developed a data management manual which has been distributed to users and is available through the IMOS website:

[http://imos.org.au/fileadmin/user\\_upload/shared/ANFOG/ANFOG\\_data\\_management2\\_3.pdf](http://imos.org.au/fileadmin/user_upload/shared/ANFOG/ANFOG_data_management2_3.pdf)

#### **What are the dependencies on external / other facilities (national and international)?**

Although ANFOG is developed capability for the maintenance and communications with the gliders, it is still dependent on the manufactures to provide assistance in the maintenance of the gliders.

#### **Collaborative structures for allocation of priorities**

The allocations for glider deployments are determined by IMOS office through the allocation of funds to ANFOG. In turn, ANFOG liaises with the node operators to seek their priority times (eg alignment with ship schedule etc), availability of boats, weather conditions etc cooperation of SARDI, CSIRO, SIMS, SOTS and AIMS for the deployment of recovery of gliders.

## Governance

### Performance indicators

The Key performance indicators for ANFOG are:

- Management and servicing of the existing glider fleet.
- Ensuring the delivery of Seagliders allocated under EIF funding 09/10 by March 2010.
- Continued successful deployment and recovery of gliders allocated under NCRIS funds.
- Successful deployment and recovery of Seagliders at SOTS mooring and Coral Sea by June 2010.
- Development of national capability for the deployment and recovery of ocean gliders.
- Facilitation and advice on the uptake of glider data
- QA/QC of glider data and transfer to eMII.

### Describe key risks and risk management strategies

	Description of Risk	Rating of Likelihood	Rating of Consequence	Assessment of Net Risk	Proposed Treatment of Risk
1.	Loss/damage of glider during deployment and recovery	unlikely	major	medium	Procedures for the deployment and recovery of all gliders have been developed.
2.	Loss/damage of glider during extreme weather (e.g. storms)	likely	major	high	Procedures for piloting gliders either to deeper water (or recovery) when adverse weather is forecast have been developed.
3.	Loss/damage of glider due to satellite communication failure	unlikely	major	medium	Redundancy in communications has already been built into Slocum gliders. Here, the Argos communications systems are used to locate the glider if the Iridium system fails.
4.	Loss/damage of glider due to system failure	unlikely	major	medium	Gliders are equipped with ballast which is released when a system failure occurs.
5.	Unauthorized recovery of glider (say by fishermen, recreational boats etc)	likely	major	high	Labels will be attached to glider informing finders to leave the glider on the ocean and to call the operations centre at UWA.
6.	Loss/damage of glider due to adverse weather conditions	likely	major	high	Awareness of the severe weather conditions and undertaking manoeuvres which pilot the glider away from danger – however this cannot be undertaken at all times due to the unpredictable nature of the weather.

**Note: The following was provided for 2009/10 Annual Business Plan:**

The main risk to the facility is the malfunctioning of a glider and subsequent recovery or loss of the glider. No gliders were deployed prior to 30 June 2008 and hence this risk did not arise.

However, a trial deployment of a Slocum glider off Western Australia, resulted in a glider malfunction. The glider encountered a pitch motor malfunction and aborted its mission. The glider was communicating its position but was entrained into 2 strong Leeuwin Current eddies and was transported ~300 km northwards. Two attempts to recover

the glider were mounted, the first using a boat from Fremantle and the other from Geraldton. The latter effort was successful. The total cost of glider recovery was ~\$11,000 (2 boats, 2 days @ \$5500).

In the period July 2008 to June 2009 a total of 23 glider deployments were made. These include 19 Slocum deployments and 4 Seagliders. Gliders were deployed at all of the nodes: New South Wales, Tasmania, South Australia and Western Australia. Some problems were encountered, particularly early July/August but after the experience gained there were no such problems in the later deployments. However, loss of a Slocum glider occurred at the end of June 2009 during a major storm event which transported the glider closer to shore across limestone reefs which most likely damaged the glider and caused it to sink thus disabling its communication system.

***For existing Facilities, respond to any issues raised in the 2008 IMOS Review***

20. *Arrange a meeting early 2009 of the main organisations in Australia with glider experience with a view to developing a plan for operational capability and engineering support in the regions.*

This meeting was held during the annual AMSA conference (July, 2009) in Adelaide and was represented by the current users in the nodes (Bluewater, NSW-IMOS, SAIMOS, WAIMOS); current operators of ocean gliders in Australia, other than ANFOG (CMAR, DSTO) and other interested parties (WETLABS, AUV). With regard to the developing operational capability in the regions, a report will be prepared for the Director of IMOS by December 2009 to chart the best way to distribute operational capacity. It should be noted that all nodes (e.g. NSW deployed a Seaglider off the Southern Surveyor in October 2009) are now able to recover gliders without ANFOG assistance and some of the nodes are also able to deploy Seagliders without ANFOG assistance.

21. *In the light of operating experience to date and overseas experience, review and recast the ANFOG timetable in the 2009/10 business plan (due February 2009), and remaining budget to be set in line with that plan*

This was achieved and a deployment plan was agreed. To date the milestones set in the plan has been achieved.

**Budget**

***Detailed budget in 'Final IMOS EIF Project Plan' submitted to DIISR 26 February 2010***

***EIF Funds***

ANFOG was awarded \$1.5 million for 2009/10 for deployment of Seagliders at (a) the SOTS site (\$ 1 million); and, (2) in the Coral Sea, offshore of the Great Barrier Reef (\$ 0.5 million). Majority of these funds were for the purchase of 6 Seagliders for which orders have been placed with iROBOT the current manufacture. The Seagliders will be delivered in March 2010 and the milestones requires that gliders be deployed prior to June 2010.

***Extension of existing Facility***

All of the Nodes have indicated that that current glider deployments, initiated through NCRIS funding be continued using EIF funding through to June 2013.

***Expansion of existing Facility***

The expansion of the facility is primary through deployment of gliders in regions not covered by current deployments. These include:

- (1) Seagliders (4) at SOTS site (as part of 09/10 allocation)
- (2) Seagliders (2) in Coral Sea (as part of 09/10 allocation)
- (3) Slocum gliders (2) in the north-west of Australia (2010-2013) – subject to co-investment
- (4) Slocum glider (2) off Tasmania (2010-2013).

There has also been demand by the facilities for inclusion of downwelling light in the new gliders. The cost of the new sensor is relatively small (~\$10,000) and have been included in the budget.

### **Co-investments – source and nature**

The main co-investments from the facilities are through the provision of vessels for the deployment and recovery of the gliders as well as providing local technical support.

The co-investment by the facility host (UWA) includes the all of the infrastructure requirements of the facility as well as the provision of the glider laboratory used for the re-furbishment, testing, calibrations and preparation of the gliders.

### **Staffing details**

The present staffing is as follows and will be continued through to 2013.

*Facility Leader:* Prof C Pattiaratchi (funded through UWA, 0.1 FTE)

*Operations Manager:* Ben Hollings (funded through IMOS funds, 1.0 FTE)

*Data Manager:* Dr Mun Woo (funded through IMOS funds, 1.0 FTE)

*Bio-optics data:* Dr Christine Hanson (funded through IMOS funds, 0.8 FTE)

*Electronics Technician:* Dennis Stanley (funded through IMOS funds, 1.0 FTE)

*Administration:* Ruth Gongora-Mesas (funded through IMOS funds, 0.6 FTE)

**Table 1 – Summary of Slocum glider deployments Nov 08 to Feb 10**

<b>Glider</b>	<b>Node</b>	<b>Location</b>	<b>Date Deployed</b>	<b>Date Recovered</b>	<b>Duration (days)</b>	<b>Distance (km)</b>	<b>Casts</b>
<b>UNIT109</b>	NSWIMOS	Port Stephens, NSW	25-Nov-08	11-Dec-09	16	1003	1484
<b>UNIT104</b>	SAIMOS	Marion Bay, SA	15-Jan-09	05-Feb-09	21	518	3594
<b>UNIT106</b>	WAIMOS	Fremantle, WA	20-Jan-09	10-Feb-09	21	487	2937
<b>UNIT106</b>	WAIMOS	Fremantle, WA	20-Feb-09	13-Mar-09	21	445	3225
<b>UNIT104</b>	WAIMOS	Fremantle, WA	13-Mar-09	27-Mar-09	14	348	2232
<b>UNIT109</b>	NSWIMOS	Harrington, NSW	17-Mar-09	09-Apr-09	23	706	1721
<b>UNIT104</b>	WAIMOS	Fremantle, WA	02-Apr-09	27-Apr-09	25	517	3939
<b>UNIT109</b>	WAIMOS	Fremantle, WA	15-May-09	03-Jun-09	19	380	4300
<b>UNIT104</b>	SAIMOS	Marion Bay, SA	28-May-09	24-Jun-09	27	600	3712
<b>UNIT130</b>	WAIMOS	Fremantle, WA	03-Jun-09	25-Jun-09	22	459	3914
<b>UNIT106</b>	WAIMOS	Fremantle, WA	29-Jul-09	11-Aug-09	13	195	2083

<b>UNIT106</b>	WAIMOS	Fremantle, WA	21-Aug-09	31-Aug-09	10	202	2015
<b>UNIT106</b>	NSWIMOS	Harrington, NSW	02-Oct-09	29-Oct-09	27	705	1765
<b>UNIT130</b>	NSWIMOS	Port Stephens, NSW	28-Oct-09	19-Nov-09	22	696	1612
<b>UNIT104</b>	SAIMOS	Marion Bay, SA	04-Nov-09	26-Nov-09	22	511	3050
<b>UNIT106</b>	WAIMOS	Two Rocks, WA	08-Dec-09	24-Dec-09	16	221	1980
<b>UNIT106</b>	WAIMOS	Two Rocks, WA	22-Jan-10	15-Feb-10	23	395	4448
<b>UNIT104</b>	SAIMOS	Marion Bay, SA	10-Feb-10	-	8	227**	1229**
<b>UNIT130</b>	WAIMOS	Two Rocks, WA	18-Feb-10	-	4	41**	629**
				<b>TOTAL</b>	<b>346</b>	<b>8465</b>	<b>48720</b>

\*\* current deployment 21 Feb 2010

**Table 1 – Summary of Seaglider deployments Nov 08 to Feb 10**

<b>Glider</b>	<b>Node</b>	<b>Location</b>	<b>Date Deployed</b>	<b>Date Recovered</b>	<b>Duration (days)</b>	<b>Distance (km)</b>	<b>Casts</b>
<b>sg154</b>	BLUEWATER	Maria Island, TAS	13/02/2009	14/04/2009	60	1200	860
<b>sg151</b>	BLUEWATER	Bicheno, Tas	22/04/2009	24/06/2009	63	875	1060
<b>sg152</b>	WAIMOS	Kalbarri, WA	20/05/2009	8/06/2009	19	480	1210
<b>sg155</b>	SAIMOS	Portland, VIC	26/05/2009	7/08/2009	73	1860	830
<b>sg154</b>	NSWIMOS	Southern Surveyor, NSW	19/10/2009	12/01/2010	85	2382	834
<b>sg153</b>	WAIMOS	Kalbarri, WA	11/11/2009	16/01/2010	66	1185	914
<b>sg152</b>	BLUEWATER	Bicheno, Tas	26/11/2009	27/01/2010	62	1787	840
				<b>TOTAL</b>	<b>428</b>	<b>9769</b>	<b>6548</b>

**TABLE: Observations required by the Nodes in relation to this Facility**

Facility	Observations required by the Node			
	NCRIS Funded (already allocated to Jun11) (see Appendix 1 of the Guidelines)	EIF first \$8M funded (already allocated to Jun10) (see Appendix 1 of the Guidelines)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
Bluewater & Climate	1 Seaglider		1 Seaglider	
WAIMOS	2 Seagliders 2 Slocum		2 Seagliders 2 Slocum	2 Slocums
GBROOS Q-IMOS		2 Seagliders		
NSW-IMOS	1 Seaglider 1 Slocum		1 Seaglider 1 Slocum	
SAIMOS	1 Seaglider 1 Slocum		1 Seaglider 1 Slocum	
SOTS		4 Seagliders		
Tasmania				2 Slocums