

**Call for Proposals under the IMOS (EIF) Five Year Strategy:  
Enhancement or extension of IMOS – July 2009 to June 2013**

**Facility Project Plan template**

**Proposals should be submitted by 30 October 2009 to:**

Tim Moltmann, IMOS Director, University of Tasmania

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**Background:**

This template has been provided to allow Facility and Sub-Facility Leaders, and other interested parties to prepare a Facility Project Plan following a call for proposals announced on 18 September 2009, with a closing date of 30 October 2009.

Prior to completing this template, please read the IMOS Five Year Strategy (the 'Strategy'), and Detailed Guidelines for Proposal Development (the 'Guidelines') – see the IMOS website at: <http://imos.org.au/eif.html>.

The Facility Project Plan must be in the following template and contain the information set out below:

**Overview:**

Proposed Infrastructure Investment:	Integrated Southern Ocean Ecosystem and Biogeochemical Observation Program
IMOS Facility:	SOOP
Operating Institution:	Australian Antarctic Division
Facility Leader (for this Proposal):	Dr Simon Wright, AAD, 03 62323338, <a href="mailto:Simon.Wright@aad.gov.au">Simon.Wright@aad.gov.au</a> Dr Graham Hosie, AAD, 03 623233364, <a href="mailto:Graham.Hosie@aad.gov.au">Graham.Hosie@aad.gov.au</a> Dr Tony Worby, AAD, 03 62262985, <a href="mailto:Tony.Worby@aad.gov.au">Tony.Worby@aad.gov.au</a>
Other(s) key people involved:	Dr Andrew Davidson, Australian Antarctic Division Dr Bronte Tilbrook, CSIRO Marine and Atmospheric Research Prof. Andrew McMinn, University of Tasmania Dr Rudy Kloser, CSIRO Marine and Atmospheric Research Dr Andrew Constable, Australian Antarctic Division Dr Richard Matear, CSIRO Marine and Atmospheric Research Dr. Andrew Bowie, ACE CRC Prof Graham Jones, Southern Cross University A/Prof Zoran Ristovsky, Queensland University of Technology
Collaborating Institutions:	(Name(s) of other Institutions who will provide resources or otherwise assist with the Proposal)

**Please attach:**

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution

- Resume of Facility Leader
- Letters received from Collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment

# Integrated Southern Ocean Ecosystem and Biogeochemical Observation Program

## Nature of Investment:

### Summary

**Extend** and **Enhance** existing IMOS AusCPR and the SCAR Southern Ocean CPR Survey into the Southern Ocean (see AusCPR sub-facility plan; Richardson and Hosie)

**Include** existing phytoplankton and environmental monitoring transects in the Southern Ocean

**Link** with international programs SOOS, ICED, Sentinel and with ongoing ecosystem and biogeochemical models through ACE CRC and CMAR

**New** observational programs for DMS, aerosols

## 1. Summary

The observing program outlined in this proposal is largely based on existing observational programs that can be enhanced or expanded to address the common goals of IMOS and the Southern Ocean Observing System (SOOS) to fill critical gaps in our current sampling capability. We propose an integrated system that will observe:

- physical oceanography
- chemical oceanography, particularly nutrients
- sea ice extent and properties
- ocean colour, chlorophyll and other pigments
- phytoplankton species composition, abundance and productivity
- zooplankton species composition, distribution and abundance
- fish and mesopelagics by acoustics
- carbon dioxide flux
- release of dimethyl sulphide.

It will provide sustained data series that clarify interactions over seasonal, annual and longer cycles along routes of *Aurora Australis* and *Astrolabe*, supplemented by data from Japanese vessels through the ANREACCH programs, as well as a restricted data set from fishing vessels travelling to the Heard Island – Kerguelen Plateau.

It will be specifically designed to link with models:

- ecosystem models in relation to CCAMLR
- biogeochemical models, particularly in relation to carbon flux and sulphate release

Understanding the response of marine biota to climate forcing is important both for climate and for management of marine resources. This approach recognises that changes at the ecosystem level can only be understood within the context of comprehensive physical and chemical measurements of the environment, with strong links to and from models that will both guide sampling strategy and enable us to identify and predict system responses to climate change and other anthropogenic forces.

## Major characteristics and benefits of the proposal

1. Combines standardised observations from ships of opportunity running repeat transects south of Australia to the Antarctic continent with similar observations from ships traversing Australia's area of interest in the Southern Ocean;

2. Links observations on oceanography and atmosphere to both ends of the trophic spectrum, from primary producers to top predators ;
3. Includes sea-ice as the major region-specific, climate-sensitive component of the physical environment. Sea-ice is known to have a direct, but as yet unquantified, link to Southern Ocean primary production;
4. Integrates with other major national and international initiatives, in particular the Southern Ocean Observing System (SOOS), generating opportunities for co-investment and leveraging resources;
5. Builds on established IMOS facilities: data from this program will provide a context for spatial/temporal data on predator foraging areas collected by AATAMS. They will also complement the Southern Ocean Time Series (SOTS) mooring data, extending the geographic applicability of data collected from single sites, while SOTS data will allow temporal interpolation between relatively infrequent SOOP cruises.
6. Links with the Antarctic Sea ice Processes and Climate (ASPeCt) program. This was established in 1997 under the auspices of SCAR to coordinate international efforts to improve the understanding of Antarctic sea ice processes. A key program within ASPeCt has been the development of an underway observing system from ships operating in the Antarctic sea ice zone, to record the thickness, concentration and snow cover characteristics of the ice. This resulted in the first circumpolar climatology of Antarctic sea ice thickness (Worby et al., 2008) derived from almost 100 voyages of data between 1980 and 2005. The ASPeCt program is ongoing, and the underway data collected in the sea ice zone would strongly complement the observations in this proposal.

## 2. Objectives

### **Background**

The Southern Ocean, the region south of the Subtropical Convergence at ~45°S, is of immense global significance. It connects three of the world's major ocean basins as well as the upper and lower limbs of the overturning circulation. It is one of the most important regions for carbon dioxide drawdown and has shown some evidence of change over the past several decades, as outlined below. The Southern Ocean is also regionally significant through climatic interactions with the Australian continent. Major krill, squid and finfish fisheries already exist in the region with the potential for expansion.

The Southern Ocean ecosystem is structured in response to the Antarctic circumpolar current, oceanographic fronts, the overturning circulation that brings nutrients to surface waters, and the seasonal cycles in irradiance and sea ice - all of which are predicted to change in response to climate change. Consequently, the ecosystem is sensitive to changes in oceanic and atmospheric conditions through nutrient input, circulation, wind-driven mixing, irradiance, sea-ice extent etc., but the ecosystem also influences regional climate through carbon dioxide drawdown and production of the climatologically active gas dimethyl sulphide (DMS). Changes in physical sea ice environment (in particular net ice production) have the potential to significantly affect Southern Ocean ecosystems and Southern Ocean circulation.

### **Threats and changes**

Threats to the Southern Ocean come from global warming, circulation changes, acidification, sea ice retreat, changes to the mixing regime, increased UV exposure, invasive species and increased harvesting pressures. The Southern Ocean has also been identified as a possible region for large-

scale ocean iron fertilisation to stimulate the biological pump and reduce anthropogenic carbon dioxide in the atmosphere.

A number of significant changes have already been observed, including:

- Freshening of the upper layers of the SO due to increased precipitation and melt
- Warming and freshening of Antarctic bottom water
- Regional changes in the extent and duration of sea ice
- Thinning of foraminifera shells due to ocean acidification
- Changes in zooplankton composition with smaller species more dominant
- Southward extension of the range of keystone species, e.g., *Emiliana huxleyi*.

Predicted changes, that could have significant flow-on effects to the climate system and the rest of the ecosystem, include:

- Reduction in primary production;
- Reduction in sea ice extent and thickness;
- Reduction in the sea ice bloom;
- Species changes and changes in the size spectrum of food, such as an increase in pico- and nanophytoplankton; mesozooplankton dominating over macrozooplankton

Comparable changes have already been observed in the North Atlantic and Pacific with catastrophic consequences for fisheries and predators. Arctic sea ice has also declined very significantly in both thickness and extent over the past 3 decades; the loss of sea ice at high latitudes has the potential to amplify the impacts of climate change through the ice-albedo feedback.

### **Key questions**

The following key questions will be addressed:

1. How do the productivity, species composition and size spectrum of Southern Ocean plankton communities relate to oceanography, seasonality and climate change?
2. Can we identify characteristic plankton communities that occupy specific water masses at particular times as a basis for parameterisation of productivity, food availability and carbon flux in ecosystem and biogeochemical models?
3. Can we resolve and quantify climate-induced changes in plankton communities and attribute causes that can be used for predictive modelling against the background of high seasonal and interannual variability?
4. Is the extent and/or thickness of Antarctic sea ice changing, and what would be the impact of changes on krill reproduction and Southern Ocean ecosystem dynamics?
5. What are the oceanographic and biological controls on CO<sub>2</sub> flux, DMS and aerosol emissions in the Southern Ocean, and how are these responding to climate change?
6. How can models and existing information be used to prepare and refine approaches, hypotheses, and especially sampling regimes to optimise effort?

### **Links**

*Bluewater and Climate Node*

This proposal focuses on aspects of the physical environment that directly impact the ecosystem, as well as the climatological feedback from the ecosystem. It addresses area #4 of the Bluewater observing system design : "*Discovering and understanding the links between ocean and climate variability and marine chemical cycling and ecosystems from multidecadal through to monthly timescales*".

The proposal links to the current and proposed IMOS BWCN observational programs:

*Astrolabe* XBT transect (Steve Rintoul and Ann Thresher)

pCO<sub>2</sub> (Bronte Tilbrook), extending and enhancing existing work to include ecosystem links

AusCPR (Anthony Richardson and Graham Hosie)

BioAcoustic SOOP (Rudy Kloser)

Ongoing phytoplankton monitoring program on *Astrolabe* since 2002 to present involving Brian Griffiths, Simon Wright, Andrew McMinn (currently outside IMOS)

Ongoing oceanographic/environmental monitoring from *Aurora Australis* (1990 – present).

### *Integration*

It extends these programs to establish an integrated observation system that measures physical and chemical oceanography, including micronutrients, sea ice properties, chlorophyll and other pigments, phytoplankton community structure and productivity, zooplankton community structure and surface distribution (CPR), coupled with the vertical distribution of zooplankton and fish (Echo sounders), population counts and feeding behaviour of selected predators (via ATAMMS), as well as the drawdown of CO<sub>2</sub> and evolution of dimethyl sulphide. It will link to targeted research cruises, laboratory and minicosm experiments that determine key parameters of plankton populations, informing ecosystem models in support of CCAMLR and biogeochemical models relating to ocean carbon flux through ACE CRC.

### *International links*

International linkages with other nations operating in the Southern Ocean will further enhance the product. Through the AAD we have developed strong collaborative research links with the Japanese Antarctic program which is already operating CPR routes in our region as part of the SCAR Southern Ocean CPR Survey. Their vessels *Shirase* and *Umitaka Maru* have similar underway marine environmental systems recording temperature, salinity, fluorescence, and they have been conducting routine pCO<sub>2</sub> and DMSP observations that would compliment our observations. We are continuing our discussions with Japan to further develop collaborative studies in response to the joint communiqué by Prime Ministers Rudd and Fukuda (June 2008) for the need for enhanced collaboration to understand climate change impacts on the region. Linking with SOOS will provide access to additional circum-Antarctic observations to further enhance IMOS observations and place them in a global context.

## **Links to IMOS five year strategy**

### *1. Ongoing development of a coherent, well-positioned Bluewater and Climate Node*

This program will provide a truly integrated marine observing system involving several major institutions with an ongoing investment in the Southern Ocean. The comprehensive set of observations may well represent the best chance of linking climate change to ecosystem effects, and the subsequent modelling will be critical in management decisions, particularly in Southern Ocean fisheries. Although not a national facility *per se*, experience gained from coordinated integrated measurements in this program will be applicable and hopefully extended to studies in other areas.

### *2. Impact and delivery through improving model output*

As mentioned above, the program will be specifically designed to link with ecosystem models in relation to CCAMLR (through AAD, Andrew Constable et al) and biogeochemical models (CMAR

and ACE CRC, Richard Matear et al), particularly in relation to carbon flux and sulphate release, that will help refine approaches, hypotheses, and especially sampling regimes to optimise effort. Data will be fed into E-N-P-Z-A models (environmental, nutrient, phytoplankton, zooplankton, acoustic). Other modelling and analysis methods such as Boosted Regression Tree (BRT) modelling and network analysis will be applied to look at spatial / temporal patterns and trophic interactions. BRT modelling has already been used successfully to combine physical-chemical-biological with CPR and satellite to define bioregions (Pinkerton et al. submitted). New network analysis methods provide new ways of visualisation and exploring interactions and relationships in large data sets such as the CPR data (Raymond and Hosie 2009), and can be used to link disparate data sets.

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

not applicable

### *4. Ongoing development of Regional Nodes*

It will directly contribute Bluewater and Climate node, as outlined above

### *5. Continuing to build institutional strengths into national capability*

This program combines strengths and resources of Australian Antarctic Division, CSIRO Marine and Atmospheric Research, ACE CRC and various universities into a coherent integrated program. Experience from this program will be directly applicable to other programs nationwide.

### *6. Exploring the potential for whole-of-system approaches*

This program is truly comprehensive, sampling all available parameters for oceanography, the ecosystem, and feedbacks to the environment that can be realistically observed from ships of opportunity, for import into ecosystem and biogeochemical models. It is coupled with ongoing research programs that extend the value of these observations for modelling, specifically designed to determine key modelling parameters of field populations that cannot be obtained through routine observations. These data will be collected through targeted research cruises that determine the properties of characteristic plankton communities, with associated process studies, minicosm and laboratory experiments.

### *7. Driving down the cost per observation*

A versatile automatic phytoplankton sampler is proposed for development as an AAD coinvestment that will dramatically reduce the staff time and costs for collecting samples. This machine would then be available for other IMOS and international programs

### *8. Creating and developing the information infrastructure*

The Australian Antarctic Division Data Centre (AADC) is already a partner of the IMOS facility and will be involved in data delivery.

### *9. Ensuring the data is used*

Data identified in section 5 will be made available to IMOS and SOOS through the AADC in a timely manner. Data will be specifically targeted to particular modelling groups (above) who will be involved in development of the sampling strategy and of course subsequent incorporation into model output targeted towards CCAMLR and IPCC in particular.

### *10. Partnering for sustained ocean observing*

Long-term observational programs are specific commitments as part of the AAD plankton strategy (currently awaiting endorsement) and as part of the obligations to the ACE CRC requirements for model development as mentioned above. Involvement in IMOS, SOOS, ICED and Sentinel are all linked as part of an ongoing observational strategy.

## **3. Activities**

### **Current monitoring in Australian sector of the Southern Ocean**

The region south of Tasmania (140-150 °E) has been regularly sampled for many years, by the Japanese (*Fuji*, *Shirase*, *Umitaka Maru* etc.) since 1965, Australia (*Nella Dan*, *Aurora Australis*) since 1980s, France (*l'Astrolabe*) since 1990s, as well as occasional cruises by other vessels (e.g. *Tangaroa*). In addition, physical oceanography, sea ice and meteorological data have been routinely collected across the Australian sector on Australian resupply and research cruises since the 1980s. In particular there is a large database of CPR data (in ice free areas) gathered since 1991 by the SO-CPR Survey, as well as ship-based sea ice data through ASPeCt. The French vessel, *l'Astrolabe* is heavily instrumented in a joint French-Australian program, and is an excellent platform for monitoring as it frequently crosses the Southern Ocean on the same transect, although it is normally limited to surface sampling. Its track lies close to the SR3 line as well as the Japanese return cruise track. In addition, there has been collection of underway acoustics data on the *Aurora Australis* in the past and the routine collection of such data in future is currently proposed through the IMOS BASOOP subfacility. These data form an excellent basis for an ongoing integrated monitoring program, especially since there are many data sets that go back some decades.

Parameter	Ship or program				
	<i>l'Astrolabe</i>	<i>Aurora</i>	<i>Shirase</i>	<i>Umitaka Maru</i>	Other*
Oceanography					
<b>CTD</b>	O	O	R	R	
<b>XBT</b>	R	O	R		
<b>Thermosalinograph</b>	R	R	R	R	
Alkalinity	R				
<b>pCO<sub>2</sub></b>	R	O			
<b>nutrients</b>	R	O	R	R	
iron		†			
Oxygen isotopes	R				
Phytoplankton					
<b>Chl a</b>	R	R	R	R	
<b>Fluorescence</b>	R	R	R	R	
<b>HPLC pigments</b>	R	R			
<b>FRRF, PAM Fluorescence</b>	R	†			
Phyto-, protozoan species	R	O			†
DNA	R	O			
Zooplankton					
<b>CPR</b>		R	R	R	R
<b>Automated CPR</b>	†	†			
Norpac net		†	R	R	
<b>Acoustic monitoring</b>		R		R	
DNA		†	†	†	
Atmosphere					
<b>Irradiance</b>	R	R	R	R	
<b>CO<sub>2</sub></b>	R	O		O	
<b>DMS</b>		O		O	
<b>Aerosols</b>		†		O	
<b>Sea Ice thickness, concentration, snow cover</b>	R	R			

Table 1. Parameters currently being measured. Key: R, regular; O, occasional; †, planned. Parameters marked in bold are regarded as in-scope for IMOS. Other parameters require considerable analysis time and are regarded as research products that will "value-add" downstream.

## **Cruises**

These cruises will continue into the foreseeable future as critical components of the AAD, ACE CRC and ANREACCH research plans and as contributions to SOOS. It is planned that they will be supplemented by sampling from fishing boats travelling to Heard Island. They will be supplemented with satellite observations (e.g. sea surface temperature, dynamic height, sea ice extent, ocean colour) to give a synoptic view of ocean dynamics.

Routes:

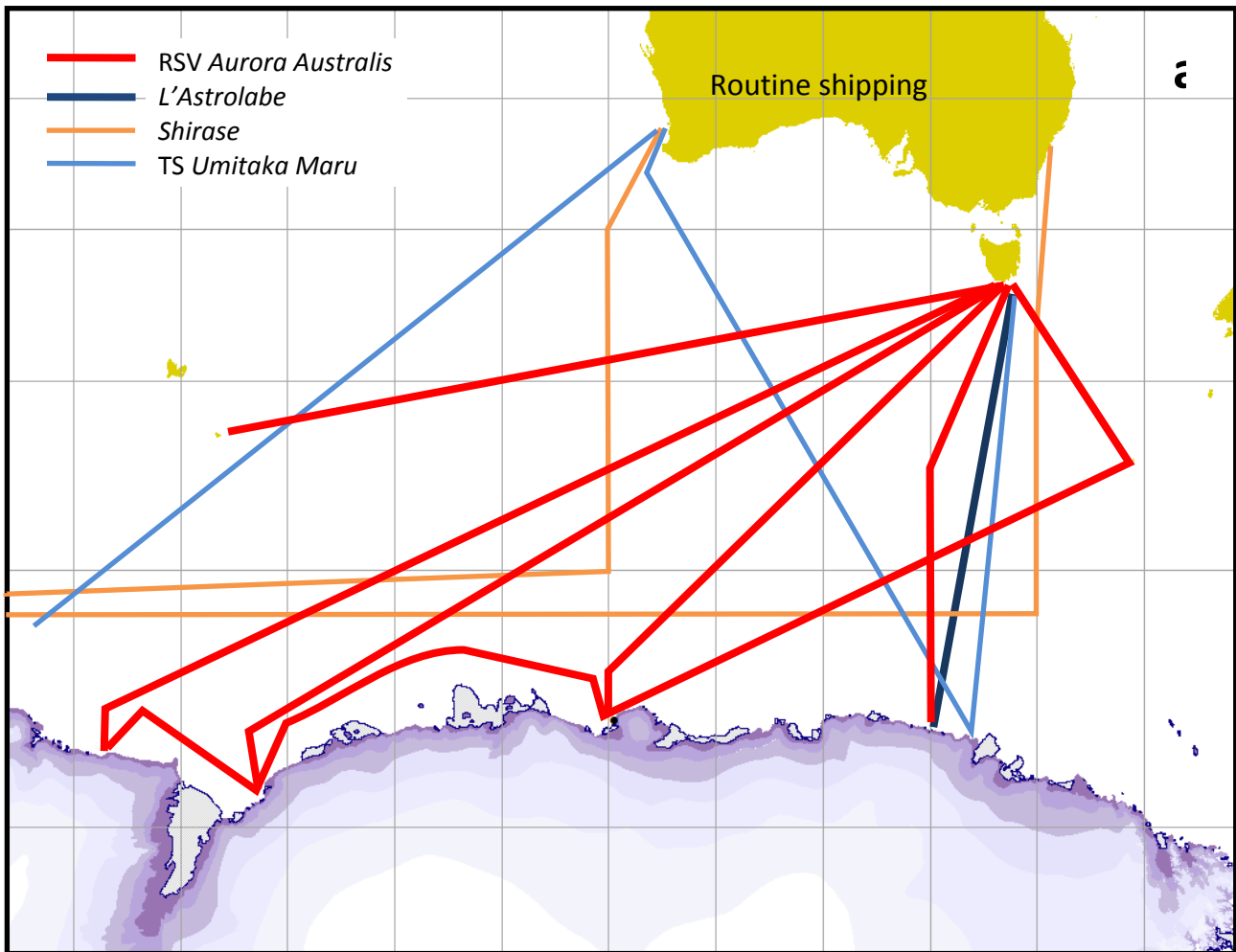
*l'Astrolabe*: Hobart – Dumont d'Urville

*Aurora Australis*: Various, including Hobart – Casey, Davis, Mawson, Macquarie Island, Heard Island, SR3, I9

Japanese Antarctic vessels: Fremantle – Syowa – Sydney; Cape Town-Syowa-Fremantle-Dumont d'Urville-Hobart

Fishing Vessels: Albany, Fremantle – Heard Island region

See map, following page



#### 4. Major equipment to be purchased/developed

The following equipment is requested through IMOS to fill gaps in the current capability. Sensors would be field tested first on *Aurora Australis* before being duplicated on *L'Astrolabe*. We will be encouraging *Umitaka Maru* to develop complementary systems where possible. Note that *L'Astrolabe* sampling is limited by space and staff considerations and rationalisation/redesign needs to occur before much else can be undertaken (requested separately via Tilbrook proposal).

- Spectroradiometer system: upward and downward looking spectroradiometers to measure ocean colour, comparing upwelling and incoming radiation with phytoplankton biomass and species data (collected simultaneously) for satellite ground-truthing. 2 x \$66K
- Phytoplankton autosampler: simple robotic system to filter samples for pigments and diffuse reflectance, water samples for microscopy, nutrients, DMS/DMSP. Will allow sampling at regular sites (e.g. certain latitudes) and in response to environmental parameters, while reducing staff workload. This is proposed initially as an AAD coinvestment, with a second unit to be purchased in year 3 of the program (See below) ~ \$50K
- Fast Repetition Rate Fluorometer: To measure phytoplankton physiological state and productivity, to be deployed on *Aurora Australis*, complementing the existing unit on *Astrolabe*. \$55K

- Transmissometer: Measures total amount of particulate matter in the water: phytoplankton, protozoa, bacteria and detritus, calibrated by regular samples of particulate organic carbon. 2 x \$9.5 K
- Aerosol sampler. Capable of collecting particles as cloud condensation nuclei as well as aerosol iron input \$35K
- Aerosol sampler: linkage for DMS work: \$20K
- Cytometer: Counts cells and measures size distribution – determines food availability for various grazers and also the sedimentation velocity of particulate organic carbon \$60K
- Air Ionisation Spectrometer measures newly formed ions resulting from oxidation of DMS. \$70K
- Sea / ice camera. ASPeCT Ice observations are generally taken by a trained observer every hour from the ship's bridge, but we propose installation of a digital camera housed on the side of the ship. This would take a photograph every five minutes (hourly away from the ice zone), stamped with coincident time, position and direction of view, and will provide higher spatial resolution data to determine the exact location of the ice edge, or ice bands, estimates of ice concentration and thickness, icebergs, sea state. 2 x \$10K
- ICP/MS analysis for iron in aerosols \$45K
- GC analyses for DMS \$20K
- Improve clean seawater intake on *Aurora Australis* \$15K
- Underway CTD for *Aurora Australis*. This will provide vertical profiles of temperature and conductivity along the ship's track, which it can profile to approximately 400 m at 12 knots. This will be useful for validation of the Argo network, and will allow mixed layer depths and frontal positions to be reliably mapped without the need for an ongoing XBT program. There will need to be wider discussions on this instrument and check that it can be deployed while the CPR is in the water. \$100 K

### *Phytoplankton autosampler*

One of the key limitations to phytoplankton sampling, particularly on the *Astrolabe*, is staff time required for filtration. Currently, five parameters are measured that require individual filtrations: chlorophyll and HPLC pigments, spectral absorbance, DNA, coccolithophorid counts, and plankton netting (currently these are not all sampled simultaneously except at seven predetermined reference sites, to avoid operator overload). This represents a considerable workload for staff and effectively precludes inclusion of any other measurements.

To solve this problem, an automatic filtration apparatus is proposed that would collect phytoplankton samples on *Astrolabe*, *Aurora Australis* and other SOOPs. This would enable regular filtration of a variety of samples (including, but not restricted to phytoplankton) and considerably reduce the workload on the shipboard staff. Unfortunately such a machine does not currently exist, but there is a great need for such equipment in ecosystem monitoring around the world, including for cal/val of satellite ocean colour data.

Since this is such a key item for our program, AAD Chief Scientist John Gunn has indicated that he would support (with all due caveats) an application to build and field-test a prototype instrument within the AAD. Our science support manager estimated \$100K for the prototype and \$50K for subsequent ones, which would then be available for other IMOS routes. We have thus proposed the initial development costs and field testing as an AAD coinvestment to the program. The prototype would be tested on *Aurora Australis*, then deployed on *Astrolabe*. We have thus requested \$50K

from IMOS as an investment during year three for a second unit that would end up on *Aurora Australis*.

Development of this unit would be in accordance with strategy #7 of the IMOS five-year strategy, "Driving down the cost per observation", as it would greatly decrease the staff costs of sampling. This strategy states that "new methods and approaches will be investigated". From responses to requests to colleagues about information on an instrument, it is clear that such an instrument would be widely applicable in other IMOS programs as well as internationally. With the AAD taking the development initiative and prototyping risk, it is hoped that \$50K can be set aside in year three for a second instrument.

#### Cost estimate

IMOS Facility	2010/11	2011/12	2012/13	Total
SOOP	321.5	185.5	80	507

#### Coinvestment

Note these figures include identified salary contributions from AAD, UTAs and SCU staff but NOT CSIRO staff members who are already contributing to IMOS programs and who would thus divert some of their time towards Southern Ocean samples, nor Japanese collaborators.

They also include a \$100 K co-investment to develop the plankton autosampler and \$25.4K per year as contributed analytical costs

IMOS Facility	2010/11	2011/12	2012/13	Total
SOOP	533.4	417.4	417.4	1368.2

## 5. Data access, pricing regimes

### Data access

Sustained observations of a range of parameters are necessary to address these questions. Those in **bold** would be primary IMOS data outputs, with others available downstream after analysis.

#### *Oceanography*

- **temperature, salinity**
- alkalinity, macronutrients, micronutrients (e.g., iron), **pCO<sub>2</sub>**, oxygen

#### *Marine Cryosphere*

- **sea ice extent**
- sea ice thickness
- ice drift and dynamics
- abundance and distribution of ice algae

#### *Atmosphere*

- **air temperature, pressure, wind**
- **DMS<sup>†</sup>, aerosols<sup>†</sup> (sulphate/iron),**
- **PAR, hyperspectral incoming radiation<sup>†</sup>**

#### *Biology*

- **ocean colour (ship-based hyperspectral)**
- **diffuse reflectance data**
- **calibrated underway fluorescence, chlorophyll a**
- **pigment analysis, phytoplankton species and counts,**
- **calibration and validation of ocean colour satellite data.**
- **continuous plankton recorder (CPR) for zooplankton and phytoplankton**
- primary production (FRRF, oxygen isotopes)
- **hydroacoustics<sup>†</sup> – 38, 120, 200 kHz**

All data will be time stamped and geo-coded, with many collected simultaneously allowing for direct integration and comparison. Data can also be compared with geo-coded satellite imagery (SeaWiFS and MODIS).

### **Analysis/Modelling**

Initial analysis of bioregional data and temporal sequences would be conducted through AAD Data Centre with input from CSIRO/ACE-CRC personnel. The Development of coupled productivity/ecosystem/carbon models are explicit components of the new ACE CRC. Sampling regimes have been specifically designed to facilitate such models by focussing on identifying bioregions and typical planktonic communities whose characteristics and seasonal succession can be parameterised (e.g. productivity, nutrient and iron requirements, size spectrum, export flux, gas exchange) for numerical models by observations from monitoring programs plus targeted research cruises, as described above.

### **Coordination and Management**

The coordination and management of Southern Ocean observations within IMOS will occur within the Bluewater and Climate (BW&C) Node. Overall sampling strategy will be developed iteratively in conjunction with relevant modellers. Coordination of sampling effort on various ships (particularly *l'Astrolabe*) will require group consultation with those in other programs to ensure that the sampling and equipment is manageable.

### **Program linkages**

- Australia Nippon Research on East Antarctic Climate Change (ANREACCH) - will enhance sampling in this region with existing technologies.
- SCAR Southern Ocean CPR Survey
- Southern Ocean Observing System (SOOS)
- Southern Ocean Sentinel
- Integrated Circumpolar Ecosystem Dynamics (ICED)
- Antarctic Fast Ice Network (AFIN)
- Antarctic Sea Ice Processes and Climate (ASPeCt)
- International Study of the Marine Biogeochemical Cycles of Trace Elements and Isotopes (GEOTRACES)

### **Stakeholders**

- CCAMLR
- DCC, DEWHA, Government agencies
- CEP-ATCM
- SOOS-GOOS
- IPCC

- IMAS

### **Key Staff**

This proposal sits within a larger research effort and contributes directly to programs within AAD, ACE CRC as well as the program linkages above. Those directly involved with samples or associated programs include:

#### *Australia*

##### **AAD:**

Zooplankton: G. Hosie, S. Kawaguchi

Phytoplankton/Microbial Ecology: S. Wright, A. Davidson, P. Thomson, K. Westwood, M. de Salas, I. Pearce

Sea ice: A. Worby, P. Heil

Modelling: A. Constable and team

##### **CSIRO:**

Productivity: B. Griffiths

Acoustics: R. Kloser

CO<sub>2</sub> / oxygen : B. Tilbrook

Oceanography: S. Rintoul, A. Thresher

Modelling: R. Matear

##### **ACE CRC:**

Sea ice: J. Lieser, K. Meiners

Ocean biogeochemistry: T. Trull, A. Bowie

Zooplankton: W. Howard

##### **University of Tasmania:**

Phytoplankton: A. McMinn, G. Hallegraeff,

##### **Southern Cross Uni / Queensland University of Technology:**

DMS/Aerosols: G. Jones / Z. Ristovski

#### *Japan*

Phytoplankton: M Fukuchi, T. Odate, N. Horimoto, T. Ishimaru,

Zooplankton: K. Takahashi, A. Tanimura, D. Lindsay, M. Moteki,

Remote sensing (ocean colour): T. Hirawake,

#### *France*

Alkalinity: A. Poisson,

Zooplankton/Productivity: P. Koubbi

### **References**

Pinkerton, M., Smith, A.N., Raymond, B. Hosie, G.W. Sharp, B., Leathwick, J.R, and Bradford-Grieve, J.M. (submitted) Surface distribution of *Oithona similis* in the Southern Ocean: predictions using Boosted Regression Trees. Deep-Sea Research I.

Raymond, B. & Hosie, G. (2009) Network-based exploration and visualisation of ecological data. Ecological Modelling 220: 673-683

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

Facility	Observations required by the Node			
	NCRIS Funded (already allocated to Jun11)	EIF first \$8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			
Bluewater & Climate				
WAIMOS				
GBROOS				
NSW-IMOS				
SAIMOS				
Other <enter name>				