IMOS Integrated Marine Observing System

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

SOOP SST Sensors Sub-Facility Plan

Overview:

Proposed Infrastructure Investment:	Ship of Opportunity Sea Surface Temperature Sensors extension and enhancement
IMOS Facility:	SOOP Facility
Operating Institution:	Bureau of Meteorology
Facility Leader (for this Proposal):	Helen Beggs, CAWCR, Bureau of Meteorology. Ph: 03 9669 4394, Email: h.beggs.bom.gov.au
Other(s) key people involved:	Dr Craig Steinberg, AIMS Mark Underwood, CSIRO Marine and Atmospheric Research Fred Stein, Marine National Facility Prof. Ian Robinson, National Oceanographic Centre, Southhampton Dr Craig Donlon, European Space Agency and GHRSST
Collaborating Institutions:	AIMS CSIRO Marine and Atmospheric Research Marine National Facility National Oceanographic Centre, Southhampton European Space Agency Group for High Resolution Sea Surface Temperature (GHRSST)

Nature of Investment:

Implementation Strategy:

- **Summary**

Sea surface temperature (SST) is a Global Climate Observing System (GCOS) Essential Climate Variable. The IPCC use bulk SST data from volunteer observing ships in the assessment of global mean surface temperature changes. However, SST observations from ships typically have a warm bias compared with buoys of around 0.13°C (Reynolds et al., 2009) and a random error of 1.3°C (Zhang et al., 2009).

Infrared radiometers on satellites measure a skin SST at ~ 10 micron depth so *in situ* measurements of skin SST are the most effective means to calibrate these satellite sensors. The most accurate source of skin SST observations is from regularly calibrated and maintained ship-borne radiometers. Due to the scarcity of these data, however, bulk SST observations from drifting buoys, moorings, ships and Argo floats at depths ranging from 0.5 m to 10 m are usually used to calibrate satellite SST and are relatively effective for polar-orbiting satellites, especially at night, using the established, linear regression techniques. However, the development by the Group for High Resolution SST (GHRSST – http://www.ghrsst.org) of new, improved, calibration methods based on radiative transfer/physical models requires in situ radiometry (ship or platform based). In addition, to properly calibrate/validate hourly skin SST observations from geostationary satellites it is necessary to use observations of in situ skin SST collocated in space and time, and for this ship-borne or platform radiometer observations are essential. In addition, it is necessary to have accurate, in situ observations of the skin SST in order to study diurnal variation of the temperature of the surface ocean, validate diurnal variation models and more accurately estimate air-sea heat and gas fluxes.

The aim of this proposal is to sustain the existing program of the SOOP Sea Surface Temperature (SST) Sensors sub-facility from July 2011 to June 2013 in order to provide near real-time, accurate (~ 0.3°C), QC'd, SST data streams to the Global Telecommunications System (GTS) and IMOS Ocean Portal from all AVOF vessels equipped with automatic weather stations (AWS), two research vessels (RSV Aurora Australis and RV Southern Surveyor) and 3-4 tourist ferries (instrumented by AIMS/CMAR). As an enhancement to this existing sub-facility we aim to obtain sustained, accurate (<0.1ºC), real-time, in situ measurements of skin sea surface temperature (SSTskin) over waters to the north of Australia, from repeat (nightly) transects in Bass Strait and from the Marine National Facility using autonomous SST radiometers installed on two research vessels (RV Solander and RV Southern Surveyor) and one AVOF vessel (MV Spirit of Tasmania II) with one radiometer used as a rotating spare.

- **Objectives**

Extension

Near real-time, accurate (~ 0.3°C), quality assured, sustained, bulk SST observations from at least 13 vessels in the Australian region will be available from the GTS and IMOS Ocean Portal (in a common format incorporating quality control flags and metadata) which will improve:

- calibration/validation of satellite SST produced at BoM and overseas likely resulting in more accurate satellite SST over the Australian region feeding into Numerical Weather Prediction, seasonal and interannual prediction models, ocean models, climate studies and research applications
- accuracy/validation of operational SST analyses (both in Australia and overseas)
- accuracy of ship SST over Australian region input into climate SST data sets (eg. HadSST, ICOADS)

- validation of operational and research ocean models

- This proposal supports requirements of the BLUElink and IMOS Strategic Plan by:
    - extending coverage to tropics and including Southern Ocean
    - supporting model validation, enhancement and development
    - supporting improved understanding of climate system
    - contributing to national backbone observing boundary currents
    - contributions to a number of regional nodes and Blue Water and Climate Node
    - contributing key indicator information to whole-of-system approaches (ecosystems).

Enhancement

Near real-time, accurate (< 0.1°C), sustained, skin SST observations from two research vessels and one Australian Volunteer Observing Fleet vessel will be available from the IMOS Ocean Portal to significantly enhance:

- calibration/validation of polar-orbiting and particularly geostationary satellite SST over the Australian region, especially over tropical waters
- research into diurnal variation of the surface ocean
- validation of skin SST diurnal variation models (feeding into improvements in coupled air-sea models for tropical cyclone, seasonal and interannual prediction)
- estimates of air-sea heat and gas fluxes over the oceans surrounding Australia, particularly tropical waters

- This proposal supports requirements of the BLUElink and IMOS Strategic Plan by:
    - providing high-resolution data in the tropics
    - supporting model validation, enhancement and development
    - supporting improved understanding of climate system
    - contributing to national backbone observing boundary currents
    - contributions to a number of regional nodes and Blue Water and Climate Node
    - making data available for users
    - contributing key indicator information to whole-of-system approaches (ecosystems).

- **Activities**

Extension

- BoM: Existing hull-contact temperature sensors recalibrated. Start: Jul 2011. Finish: Jun 2012.
- BoM/CMAR/AIMS: Near real-time, QC'd, bulk SST available to GTS and Ocean Portal from at least 13 vessels (3 tourist ferries, 2 research vessels and at least 8 AVOF). Start: Jul 2011. Finish: Jun 2012.
- BoM: Purchase 4 extra hull-contact sensors for any additional AVOF-AWS vessels and for spares. Start: Jan 2012. Finish: Jun 2012.
- BoM: All new AVOF-AWS vessels (expect 2) installed with hull-contact sensors. Start: Jul 2011. Finish: Dec 2012.
- BoM: Near real-time, QC'd, SST from new ships available to GTS and Ocean Portal. Start: Jan 2013. Finish: Jun 2013.

Enhancement

- BoM: .Prepare tenders for equipment. Start: Apr 2010. Finish: Jun 2010.
- BoM: Recruit PO2 for radiometer work. Start Jun 2010. Finish: Dec 2010.
- BoM: Aug 2010: Close of tenders/Award of tender.
- External Agency: Build autonomous radiometers. Start: Sep 2010. Finish: March 2011.
- BoM: Purchase 3 radiometers and water bath black body and undergo ~2 weeks training in operation, maintenance and calibration. Start: Apr 2011. Finish: Jun 2011.

- BoM: Install and test one radiometer on Spirit of Tasmania II. Start: Jul 2011. Finish: Aug 2011.
- BoM/MNF: Install and test radiometer on RV Southern Surveyor. Start: Sep 2011. Finish: Dec 2011.
- BoM/AIMS: Install and test radiometer on RV Solander. Start: Jan 2012. Finish: Jun 2012.
- BoM: Implement system to process, QC and format radiometer data. Start: Sep 2011. Finish: Jun 2012.
- BoM: Routinely maintain and calibrate radiometers from the three vessels. Start: Jul 2011. Finish: Jun 2013.
- BoM: Near real-time, QC'd, skin SST from 3 vessels available to Ocean Portal and GHRSST. Start: Jun 2012. Finish: Jun 2013.

- **Equipment to be purchased/developed**

Extension

4 x SBE 48 Hull-Contact Temperature Sensors: Available from SeaBird for ~USD$4000 each.

Enhancement

4 x autonomous radiometers for skin SST (ISARs constructed by NOCS cost 45k GBP each).
1 x water bath black body including calibration rig (NOCS quote 7.5k GBP).

Access, pricing regimes:

- How will data access be provided?

All the QC'd SOOP bulk SST data is available within 24 hours to the Global Telecommunications System, and therefore available to Meteorological and Oceanographic agencies around the world for input into SST analysis systems, ocean forecasting models and satellite SST validation systems. It is also available in eMII-compliant netCDF format in near real-time to eMII and therefore via the IMOS Ocean Portal.

The new radiometer SST data and ancillary fields will be supplied in the eMII-compliant netCDF format to eMII. There is currently no suitable format for skin SST radiometer data for the GTS.

- How will data and products be managed?

Extension

An IMOS funded 0.1 FTE PO2 is currently employed by BoM in CAWCR. That person is responsible for maintaining systems for data quality control, processing, reformatting and upload to eMII and adding metadata and new vessels to BoM and eMII systems.

Enhancement

An IMOS funded PO2 will be employed by BoM in the Data Quality and Instrumentation group. That person will be responsible for designing and maintaining systems for data quality control, processing, reformatting, metadata and upload to eMII.

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

Extension

AIMS: Agreed to supply near real-time telemetry of data from 2-3 ferries.
Mike Mahoney: 0.2 FTE per year to do technical support.
Craig Steinberg: 0.05 FTE per year for project management.

Enhancement

AIMS: Agreed in principle to supply 0.04 FTE of a technician's time per year to retrieve and re-install the radiometer on the RV Solander.

MNF: Waiting on response to request for co-contribution of the supply 0.04 FTE of a technician's time per year to retrieve and re-install the radiometer on the RV Southern Surveyor.

- Collaborative structures for allocation of priorities

Governance

- Performance indicators

There are various ways to validate the accuracy and consistency of the IMOS SOOP SST data streams (both from radiometers and bulk SST sensors). The Bureau currently routinely validates each SOOP SST data stream as it comes on line against AATSR SST from EnviSAT to check the accuracy. In addition, an independent validation is performed by OSI-SAF through Met.No by comparing 1 km resolution bulk SST observations from AVHRR sensor on ESA's METOP-A polar-orbiting satellite with every individual drifter, mooring and ship SST observation from the World Meteorological Organisation's (WMO) Global Telecommunications System (GTS). The statistics for comparisons of the IMOS SOOP SST data streams with METOP-A SST can be accessed in near real-time from http://saf.met.no/validation/list_sst_mdb_global.php. Current indications are the bulk SST observations from the seven vessels now sending near real-time data to the GTS and eMII are of equivalent accuracy as drifting buoys (~ 0.3°C).

- Describe key risks and risk management strategies

o Loss of use of an AVOF vessel for hull-contact sensors. Likelihood: Medium. Strategy: Budgeted for changeover of two hull-contact sensors on replacement vessels. Overall impact: Low.
o Loss of radiometer due to catastrophic damage that cannot be fixed. Likelihood: Low. Strategy: Either replace with "spare" radiometer or request IMOS PO for extra funds to replace radiometer. Overall impact: Medium – likely to impact IMOS milestones.
o Departure of experienced Bureau staff. Likelihood: Medium. Strategy: Replace staff but will take several months. Overall impact: Medium - likely to delay IMOS milestones.

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

In response to the comment: "Need to develop criteria for how new vessels and data streams are selected for inclusion in the SOOP fleet", subfacility 2c SOOP SST Sensors original proposal was to obtain near real-time SST data from all the AVOF vessels (currently 8), both AIMS GBR tourist ferries and the Rottnest Island Ferry. Through subfacility 2d, SST data from RV Southern Surveyor and RSV Aurora Australis has been added to this original list. So far, 2c has not deviated from the original IMOS proposal.
In response to the review panel recommendation 13: "SOOP in conjunction with nodes need to develop a clear plan for uptake of data, especially the new datastreams, integration of the components within the SOOP facility, and into coastal Nodes", Dr Beggs advertised the

availability of the high-quality IMOS SOOP SST data stream at the GHRSST Users Symposium and 10th GHRSST Science Team Meeting in California in May/June 2009. The international satellite SST research and operational community are all ready using the IMOS SOOP SST data (accessed via the GTS) for validation of satellite SST products, SST analyses, climate data analyses (eg. ICOADS and HadSST) and research.

- **Budget:**

See excel spreadsheet: IMOS_EIF_Facility_Budget_Worksheet_for_2009-13_2c_SOOP_SST_30Oct2009.xls

- Description of proposed new infrastructure for Nodes – please complete the Table on the next page, referring to Attachment 1 to the Guidelines for further information

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>				