

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

Satellite SST Products Sub-Facility Plan

Overview:

Proposed Infrastructure Investment:	Satellite Sea Surface Temperature Products extension
IMOS Facility:	Satellite Remote Sensing Facility
Operating Institution:	Bureau of Meteorology
Facility Leader (for this Proposal):	Dr. Helen Beggs, CAWCR, Bureau of Meteorology. Ph: 03 9669 4394, Email: h.beggs.bom.gov.au
Other(s) key people involved:	Leon Majewski, Bureau of Meteorology
Collaborating Institutions:	<p>CSIRO Marine and Atmospheric Research (Dr Edward King, Dr Peter Turner):</p> <p>NOAA/STAR (Ms Eileen Maturi, Dr Andy Harris, Dr Jon Mittaz): Contributing MTSAT-1R SST processing system plus upgrades</p> <p>Group for High Resolution SST Science Team (Chair: Dr Craig Donlon): Scientific advice and testing/use of IMOS SST products.</p> <p>NASA JPL PO.DAAC (Jorgez Vazquez, Ed Armstrong): Serving real-time GHRSSST satellite SST data products</p> <p>NOAA National Ocean Data Center (Dr Ken Casey): Serving long-term archived GHRSSST satellite SST products.</p>

Nature of Investment:

Implementation Strategy:

- **Summary**

The aim of the Australian Satellite Sea Surface Temperature (SST) Products sub-facility is to provide real-time and reprocessed, high-resolution, locally received, satellite SST data products over the Australian region in the internationally accepted Group for High Resolution SST (GHRSSST – <http://www.ghrsst.org>) L2P (single swath) and L3 (gridded, composite) formats. The products will be produced at the Bureau of Meteorology (Bureau) in collaboration with CSIRO Marine and Atmospheric Research using best-practice, processing and calibration methods supported by GHRSSST. The infrared satellite sensors to be used are AVHRR on the NOAA polar-orbiting satellites and those on the geostationary satellites operated by the Japanese Meteorological Agency (JMA) (MTSAT-1R) and the Korean Meteorological Agency (KMA) (COMS). Raw, direct broadcast, 1 km resolution, data from AVHRR will be reprocessed to bulk SST back to at least 1992. Raw data from MTSAT-1R will be reprocessed to skin SST back to June 2006.

The 1 km resolution, Australian region, HRPT AVHRR GHRSSST-format SST products produced through this sub-facility are not publicly available from any other source and are vital in particular for coral reef research and bleaching prediction and the Bureau's planned ultra-high resolution (2 km) numerical weather prediction models over Australian cities. However, these new IMOS AVHRR SST L2P and L3C products are predominantly only available over the region north of 55°S, due to the Bureau's raw AVHRR data from Antarctic stations (Casey and Davis) only being available in delayed mode by ships (~ 6 months). Figure 1 shows the approximate coverage of the various Australian and Antarctic AVHRR receiving stations.

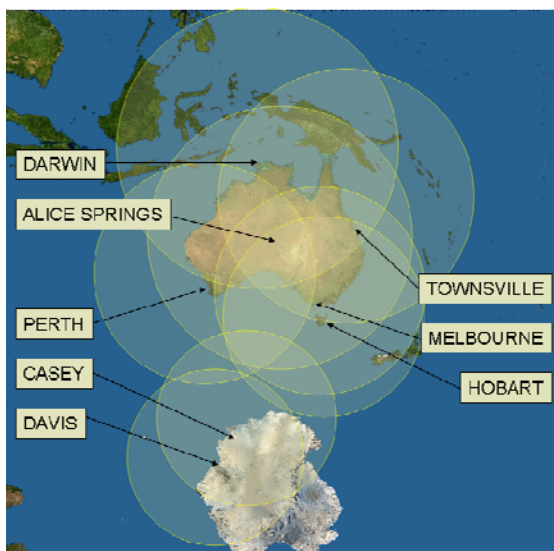


Figure 1. Data coverage from AVHRR reception ground stations in Australia and Antarctica.

One particularly exciting research application of an extended Southern Ocean coverage, 1 km resolution, AVHRR L3C product is for a study of the occurrence of “Antarctic Warm Spots” during Austral summer in low wind, clear sky conditions. These Antarctic Warm Spots are predicted by skin SST diurnal variation models (eg. see Figure 2) but not actually observed or reported through direct observations. Several “Arctic Warm Spots” have been recently

reported by Dr Steinar Eastwood of Met.No, observed in various global satellite SST GHRSSST products.

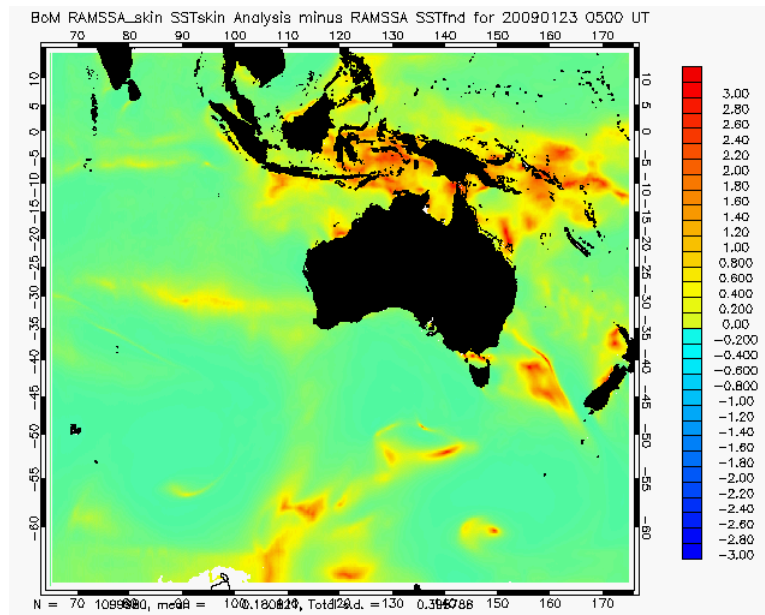


Figure 2. The Bureau of Meteorology's experimental, regional, skin SST analysis ("RAMSSA_skin") minus its operational, regional, foundation SST analysis ("RAMSSA") for 23 January 2009 at 0500 UTC over the RAMSSA_skin domain, 65°E to 185°E, 15°N to 65°S (Beggs et al., 2009a).

South of 45°S, there are zonally averaged differences of up to 0.4°C between SST measured from operational NOAA satellites and other satellite sensors such as AATSR on Envisat and AMSR-E on Aqua (Reynolds et al., 2009). The relatively large differences between the major sources of satellite SST results in wide divergence of different daily SST analyses over the Southern Ocean (Beggs et al., 2009b; Rutherford, 2009), resulting in differing inputs to weather, seasonal, interannual and climate models over this region. Improvements to the calibration of satellite SST data streams over the Southern Ocean are obviously needed.

The proposal is to continue support for system improvements, data processing, data management and validation of the existing IMOS GHRSSST-L2P and GHRSSST-L3 SST products from infrared sensors on NOAA polar-orbiting and JMA and KMA geostationary satellites from July 2011 to June 2013. All new IMOS in situ SST data will be assessed for their suitability for calibration and validation of the IMOS satellite SST products. In particular, skin SST from the proposed ship-borne radiometers will be utilised.

As an extension to the existing IMOS AVHRR GHRSSST products, the Bureau will produce more accurate and useable, 1 km resolution, AVHRR SST products over the Southern Ocean by upgrading the AVHRR processing systems at Casey and Davis stations and improving the calibration of this data by using the new IMOS in situ SST data from ships, Argo, buoys (drifting and moored) and possibly gliders and seals. Casey and Davis archived raw AVHRR data (back to 1997 and 2007 respectively) would also be reprocessed to GHRSSST format SST files for IMOS.

- **Objectives**

- Significantly improve the accuracy and useability of 1 km resolution SST products from NOAA polar-orbiting satellites over the Australian region and Southern Ocean for improved weather, seasonal, coral disease and coral bleaching now-casting and prediction, and research requiring accurate ($< 0.3^{\circ}\text{C}$), 1 km resolution, gridded SST data.
- Reprocess at least 19 years of archived raw data received at Australian and Antarctic ground stations from these satellites feeding into global and regional SST reanalyses for climate studies
- Contribute real-time and reprocessed, 1 km resolution, AVHRR SST L2P and L3C products to GHRSSST, enabling them to be incorporated into global and regional, gap-free, analyses of SST from multiple satellites (eg. NASA's G1SST global 1 km, Medspiration's Great Barrier Reef 1 km, and the Bureau's RAMSSA regional 9 km SST analysis products).
- This proposal supports requirements of the BLUElink and IMOS Strategic Plan by:
 - extending coverage to Southern Ocean
 - supporting model validation, enhancement and development
 - supporting improved understanding of climate system
 - contributing to national backbone observing boundary currents
 - contributing to a number of regional nodes and Blue Water and Climate Node
 - making data available for users
 - maximising the benefit (and therefore costs) from existing observations
 - contributing key indicator information to whole-of-system approaches (ecosystems).
- **Activities**
 - BoM: Stitching code modified in order to stitch archived raw AVHRR data from Casey and Davis. Start: Jul 2011. Finish: Dec 2011.
 - BoM: Reprocess daily, multi-sensor, AVHRR SST mosaic back to ~1992 using new IMOS AVHRR SST processing systems and archived Antarctic data. Jan 2012 – Dec 2012.
 - BoM: New IMOS AVHRR SST processing code ported to Casey and Davis Stations in Antarctica in order to produce real-time, GHRSSST format, level 2 (swath) and level 3 (composite, gridded). Start: Jul 2011. Finish: Jun 2012.
 - BoM: Calibration of 1 km AVHRR SST over Southern Ocean modified to include new IMOS data (ships, drifting buoys, SOTS, Argo, mammals?). Start: Jan 2012. Finish: Dec 2012.
 - BoM: Cloud and ice masks improved in AVHRR SST over the Southern Ocean using world's best available methods. Start: Jan 2012. Finish: Dec 2012.
 - BoM: Update operational systems so that real-time and reprocessed 1 km resolution, AVHRR level 2 (swath) and level 3 (composite) SST products available to GHRSSST and IMOS Ocean Portal from Casey and Davis Stations as well as the Australian region. Start: Jan 2013. Finish: Jun 2013.
- **Equipment to be purchased/developed**
 - \$48k for upgrades to Casey and Davis data processing and data storage at the Bureau.

Access, pricing regimes:

- How will data access be provided?

In collaboration with CSIRO, the Bureau has recently commenced producing real-time and reprocessed 1 km resolution AVHRR SST level 2 (swath) and level 3 (composite) products in the internationally accepted GHRSSST formats from NOAA-17, NOAA-18 and NOAA-19. These files will be made available through the IMOS AO-DAAC, IMOS Ocean Portal and the GHRSSST Global Data Assembly Centre (hosted in the U.S. by JPL). The impact of the more accurate AVHRR SST data on the Bureau's regional SST analyses will be tested by CAWCR in 2009.

- How will data and products be managed?

Satellite SST products will be managed by the IMOS Scientific Programmer at the Bureau of Meteorology (currently Dr George Paltoglou).

- What are the dependencies on external / other facilities (national and international)?
- Collaborative structures for allocation of priorities

Governance

- Performance indicators

The new AVHRR level 2 SSTs are significantly more accurate than the Bureau's pre-existing AVHRR level 2 SST data from NOAA-17 and NOAA-18 satellites, with standard deviations of night-time match-ups with drifting and moored buoys approximately halved through improved processing techniques. They are also more accurate than the current global AVHRR SST L2P products from NOAA-17 and NOAA-18 available through GHRSSST. For example, over the period 1 June 2008 to 31 July 2009, the standard deviation of matchups between nighttime NOAA-18 SST and buoys over the Australian region was 0.53°C for the Bureau's pre-existing, 1 km resolution, AVHRR level 2 SST product and 0.47°C for the GHRSSST global, 9 km resolution, AVHRR L2P product generated by NAVOCEANO. For the same satellite, period and region, the standard deviation from the new IMOS 1 km AVHRR SST L2P product was 0.26°C, significantly lower than both the legacy and NAVOCEANO NOAA-18 SST products.

- Describe key risks and risk management strategies
 1. Loss of polar-orbiting satellite data stream. Likelihood: Low. Strategy: Replace with data from another NOAA operational polar-orbiter. Overall impact: Low.
 2. Loss of MTSAT-1R data stream. Strategy: Replace with either data stream from JMA's replacement geostationary satellite, MTSAT-2, or KMA's COMS geostationary satellite. Overall impact: Low.
 3. 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
- Budget

See excel spreadsheet: IMOS{EIF_Facility_Budget_Worksheet_for_2009-13_11a_Satellite_SST.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>				