

Australian Government

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Utilising higher resolution satellite sensors to produce 2 km multi-sensor composites of sea surface temperature



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Introduction

As part of the Integrated Marine Observing System (IMOS), the Australian Bureau of Meteorology (BoM) has produced GHRSST L2P and 0.02° gridded L3U, L3C and L3S Sea Surface Temperature (SST) products over two domains (Australia and Southern Ocean) for the period 1992 to present. BOM has produced L3S SST products using 1 - 4 km resolution High Resolution Picture Transmission (HRPT) data from Advanced Very High-Resolution Radiometer (AVHRR) sensors on NOAA Polar Orbiting Environmental Satellites (NOAA-11 to NOAA-19). From 21st November 2018, BOM has additionally produced operational Multi-Sensor L3S products that are constructed by compositing SST from AVHRR sensors on NOAA-18 and 0.75 - 1.5 km resolution SST from Visible Infrared Imaging Radiometer Suite (VIIRS) sensors on Suomi National Polar-orbiting Partnership (Suomi-NPP). BoM now also produces experimental 0.02° x 0.02° Multi-sensor L3S SST products over single to multi-day scales by compositing SST from AVHRR sensors on MetOp-A, MetOp-B, NOAA-15, NOAA-18 and NOAA-19, along with SST from VIIRS sensors on Suomi-NPP and NOAA-20 polar-orbiting satellites. In addition to 1-day single sensor L3C composites of SST from these polar-orbiters, experimental subday scale single sensor L3C products are also produced from Himawari-8 SST.



Applications

Nowcasting coral bleaching:

ReefTemp NextGen uses night-only 1-day L3S Near Real Time maps of SST to provide information on coral bleaching risk for the Great Barrier Reef region. http://www.bom.gov.au/environment/activities/reeft emp/reeftemp.shtml

Fig. 6. BoM ReefTemp NextGen map of the 2 km SST anomaly for 2nd December 2018 off the Queensland coast, Australia, generated using IMOS night-only 1-day Multi-sensor L3S

IMOS 1-day: SST Anomaly 2 December 2018 GBR region



Fig.1 Sea Surface Temperature with quality level 4 and 5 for operational L3S 1day night file from (a) AVHRR only (NOAA-18) (b) Multi-sensor (NOAA-18+Suomi NPP) for 13th April 2019.

Quality Remapping and Data Composition

- The IMOS HRPT AVHRR L2P, ACSPO VIIRS L3U and EUMETSAT FRAC AVHRR L2P files are used to construct IMOS L3U files for NOAA-18, Suomi-NPP, NOAA-20 and MetOp-B satellite sensors.
- In order to merge data from different satellite sensors, the quality level of each dataset to be merged is redefined as the minimum of the original quality_level provided by the data provider and quality_level calculated using Sensor Specific Error Statistics (SSES). The latter is calculated using SSES bias (μ_{sses}) and SSES standard deviation (σ_{sses}) estimates.

$$q_{\rm sses} = \frac{1}{\sqrt{2}} \sqrt{\max\left(\left(\frac{\sigma_{\rm sses}}{\sigma_0}\right)^2 + \left(\frac{\mu_{\rm sses} - \mu_0}{\sigma_{\rm sses}}\right)^2 - 1, 0\right)}$$

$q_s = \lfloor 5 \exp^{\eta q_{\text{sses}}} \rfloor$

Different data sources can then be combined using q_s , provided that η/σ_0 = constant

Merged L3C SST over a given time period and location is defined as the weighted average of the best quality source L3U pixels on the IMOS 0.02 degree grid.



SSTs.

Nowcasting Marine Heat Waves:

IMOS OceanCurrent uses night-only 1/3/6-day L3S and night-only 1-month L3S http://oceancurrent.imos.org.au/

Fig. 7. IMOS OceanCurrent map of the 2 km SST anomaly and surface ocean current vectors for 25th April 2019, South East Australia, generated using IMOS night-only 6-day Multisensor L3S SSTs.



Studying coastal ocean features:

Given the improved spatial coverage of Multi-sensor L3S SSTs, they are useful to identify and study coastal upwelling events in the Australian region.

Fig.8 Upwelling Case Study: Bonney Coast 8th March 2018, Multi-sensor L3S-1day night SST ($QL \ge 3$).

Studying short-term ocean phenomena:

IMOS Himawari-8 L3C products can be used to study





• The data from NOAA-18, Suomi NPP, NOAA-20 and MetOp-B L3C data are composited using an equal weighted averaging method to construct the new experimental Multi-sensor L3S product.

Fig 2. Sea Surface Temperature from L3C 1-day Night file for (a) MetOp-B and (b) NOAA-20 on 13th April 2019.

Adding 1-4 km MetOp-B FRAC AVHRR SST data (Fig 2a) and NOAA-20 VIIRS SST data (Fig 2b) to existing data streams for operational Multisensor L3S (NOAA-18 and Suomi NPP, Fig 1b), shows significant improvement in spatial coverage (Fig 3).

diurnal warming and coastal upwelling, and for coastal model verification etc.

Fig 9. IMOS Himawari-8 hourly L3C SST (QL \geq 4) for 17th November 2018 at 08:00 UTC (~ 4 pm LT) over the Australian North-west Shelf.



We acknowledge the provision of raw AVHRR data

domain ($70^{\circ}E - 190^{\circ}E$, $70^{\circ}S - 20^{\circ}N$). It was found that:

the period from 1st Nov 2018 - 8th May 2019 over the Australian

- Experimental Multi-sensor night L3S had more $QL \ge 3$ matchups than operational AVHRR only L3S.
- Experimental Multi-sensor L3S shows lower bias and standard deviation values than AVHRR-only L3S SSTs for both day and night.

Fig 5. Validation statistics of the 1-day night operational AVHRR only



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L3S (left) and experimental Multi-sensor L3S (right) SSTs over a 30day moving window.



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NCRIS National Research Infrastructure for Australia

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