NEW AND ENHANCED SATELLITE SEA SURFACE TEMPERATURE PRODUCTS OVER THE AUSTRALIAN REGION

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1. INTRODUCTION

The Australian Bureau of Meteorology (the Bureau) is producing moderate-resolution SST products (~1.1 km resolution at nadir) in near real time from locally received NOAA Polar Orbiter data.

An experimental SST product with coarser resolution (~4 km resolution at nadir) is being calculated using data from the Japanese Advanced Meteorological Imager (JAMI) on board the MTSAT-1R geostationary satellite positioned over the equator at 140°E. The geostationary platform allows JAMI to provide an SST product covering the region 60°N-60°S and 70°E-160°W on an hourly basis, whereas observations from the constellation of polar orbiters provide only a partial/infrequent view of this region.

The AVHRR SST products are currently included (along with additional data streams received outside of the Bureau) in global and regional SST analyses that are used operationally in ocean forecasting and numerical weather prediction, including the prediction of tropical cyclones and severe weather events. The JAMI SST product will be incorporated into these analyses systems once development has been completed.

The uncertainty in these measurements has a direct impact on the accuracy of the analyses and hence operational performance. The Group for High Resolution Sea Surface Temperature (GHRSST) has developed a suite of data formats that incorporate pixel-by-pixel estimates of uncertainty. The Bureau is currently implementing data processing systems to generate these uncertainties.

These global and regional analyses have now been made available to the wider research community as part of the Bureau's commitment to the Group for High Resolution Sea Surface Temperature (GHRSST) and the Integrated Marine Observing System (IMOS).

2. DATA STREAMS

The Bureau, in conjunction with a number of consortia, operates a network of direct reception sites within Australia and Antarctica.

L-Band reception sites capable of receiving data from the AVHRR carrying NOAA-Polar Orbiter series are located at Melbourne, Darwin, Perth, Casey Station (Antarctica), Davis Station (Antarctica), Alice Springs (operated by GA) and Townsville (operated by AIMS).

X-Band reception sites are installed in Melbourne, Perth (WASTAC) and Townsville (AIMS). In 2009 the Bureau will install reception stations in Darwin and at Casey Station. These additional X-band stations will complement the existing reception sites to provide coverage equivalent to that provided by the L-Band network.

These upgrades will ensure that the Bureau will be able to provide SST products from current and future space based sensors that broadcast at X-band frequencies, such as the MODIS carrying NASA EOS platforms (Aqua and Terra) and the upcoming NPP and NPOESS series of environmental satellites.

The JAMI on board MTSAT-1R provides hourly observations of the Australian region centered on the equator at 140°E. JAMI has five channels, including the 3, 11 and 12um channels that are commonly used in the measurement of SST.

Data from MTSAT-1R is received at a number of Bureau operated reception stations (Melbourne, Brisbane, Sydney, Perth and Darwin). These reception sites will be capable of receiving JAMI data from MTSAT-2 when it replaces MTSAT-1R, ensuring continued generation of SST from geostationary platforms.

3. SST PROCESSING SOFTWARE

The Bureau has been producing estimates of SST from directly received AVHRR since the early 1990's. The processing software is built around the Man computer Interactive Data Access System (McIDAS). Cloud detection/clearing is carried out using a threshold method, based on a limited set of Clouds from AVHRR (CLAVR) assumptions (Stowe *et al*, 1999).

In 2007 NOAA and the Bureau implemented a version of the NOAA GOES SST processing system capable of processing JAMI data from MTSAT-1R (Maturi *et al*, 2008). Cloud detection/clearing is carried out using the probabilistic approach of Merchant *et al* (2005).

The Bureau routinely compares satellite based estimates of SST with observations from collocated and contemporaneous drifting buoys retrieved from the WMO Global Telecommunication System to monitor the uncertainty in the SST data products. The Bureau have implemented a Matchup Database (MDB) following the Medspiration guidelines (Piolle & Prevest, 2006). For each in-situ measurement the following steps are performed:

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1) find the closest satellite pixel (valid or not) to the in-situ measurement.
2) find the neighboring pixels that are within a specified spatial and temporal distance to the satellite image pixel identified in step 1. For example, get all satellite image pixels that are ±12 km and ±3 hours from the *in situ* measurement.
3) select the closest valid pixel by time, then by distance. This is the matchup.
4) calculate the following statistics for the neighboring pixels identified in step 2 and store them in the MDB:
   a) percentage of valid pixels;
   b) mean sea surface temperature;
   c) standard deviation sea surface temperature;
   d) percentage of pixels having proximity confidence values equal to 0-6 (for infrared sensors).

Results from the MDB are used to calculate the single sensor error statistics (SSES), following the GHRSST-PP Data Processing Specification v1.7 (GDS). Currently a spatial search size of ±12 km and a time difference threshold of 3 hours is used within the MDB to generate matches to be used in SSES calculation for AVHRR. For JAMI, a spatial search size of ±25 km and a time difference threshold of 1 hour is used to account for the larger pixel size and higher frequency observations.

Matchups from the preceding three weeks are sorted into groups by proximity confidence value. For each proximity confidence group the difference between satellite and in situ SST is calculated. From these differences a bias and standard deviation is obtained and used to calculate pixel-by-pixel error statistics.

4. DATA ACCESS AND DISTRIBUTION

The SST data, error statistics and additional data fields are used to create GHRSST GDS 1.7 formatted NetCDF files. These files are then distributed to internal users and external researchers.

The Bureau aims to increase awareness and access to its data holdings. As such, these GHRSST formatted data files are being made available to the IMOS Australian Oceans Distributed Active Archive Centre (AO-DAAC). The AO-DAAC is designed to make various remotely sensed ocean products available to researchers through an OPeNDAP interface and associated metadata database.

Participants in the AO-DAAC project include both Universities and government agencies. The main institutions and agencies holding publicly available marine satellite data (other than the Bureau) that are involved in the AO-DAAC project are the Australian Institute for Marine Science (AIMS) in Townsville, Geoscience Australia (GA) and CSIRO in Canberra, Curtin University and the Western Australian Satellite Technology and Applications Consortium (WASTAC) in Perth, and the Tasmanian Partnership for Advanced Computing (TPAC) based at the University of Tasmania, and CSIRO, both in Hobart.

The AO-DAAC data acquisition network, displaying both reception stations and data nodes can be seen in Figure 1. A web-based interface to search the database (based on spatial and temporal criteria) has been developed and is currently undergoing extensive testing (Figure 2). Additionally, an aggregation tool was developed such that data returned by a web-query can be packed in a single HDF or netCDF file.

5. CONCLUSION

GHRSST-PP data sets generated within the Bureau from locally received HRPT AVHRR SST data are currently used in the ReefTemp (Maynard, 2008) project to map the risk of coral bleaching in the Great Barrier Reef Marine Park. By mid-2009 it is planned the AVHRR L2P products will be incorporated into the Regional Australian Multi-Sensor SST Analysis [RAMSSA; Beggs (2007)] that produces 1/12° resolution, daily SST analyses over the Australian region (20°N - 70°S, 60°E - 170°W).

Both RAMSSA and the Global Australian Multi-Sensor SST Analysis [GAMSSA; Beggs (2008)] which produces 1/4° resolution, daily SST, incorporate GHRSST-PP SST files from many organisations using a consistent data access framework. The Bureau aims to comply with GDS 1.7 (and the upcoming GDS 2.0) to enable the cross institutional use of SST products.

6. REFERENCES

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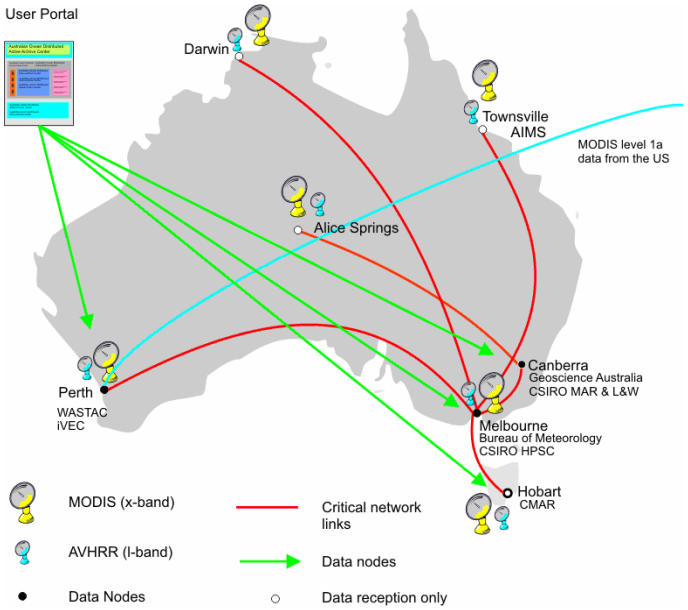

Figure 1. Reception system to be in place for AVHRR and MODIS at the end of 2008.

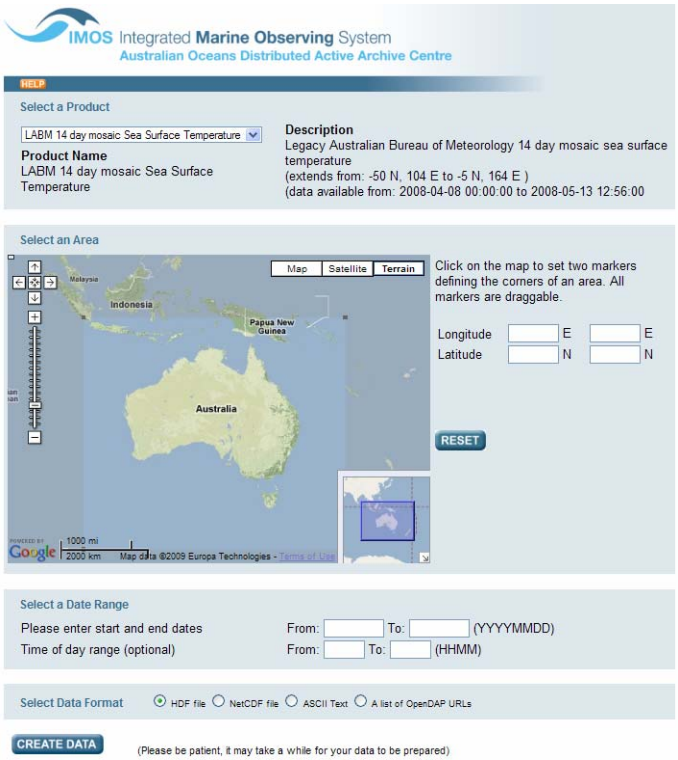

Figure 2. The AO-DAAC web interface. Spatial and temporal search criteria can be used to obtain desired data. The results can be retrieved as OPeNDAP URLS, ASCII text or as an aggregated HDF or NetCDF file.