VERIFICATION OF OPERATIONAL OCEANMAPS SEA SURFACE TEMPERATURE

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1. INTRODUCTION

The BLUElink> Ocean Model, Analysis and Prediction System (OceanMAPS) has been operational at the Australian Bureau of Meteorology since August 2007 (Australian Bureau of Meteorology, 2007).

The BLUElink project is a collaborative partnership between the Australian Bureau of Meteorology, Commonwealth Scientific and Research Organization (CSIRO) and the Royal Australian Navy to develop an ocean forecast system designed for the Australian region.

A critical area of interest for numerical weather prediction is to obtain accurate analyses and forecasts of sea surface temperature (SST). Traditional methods rely exclusively on analyses of observational data using background fields of climatology or the previous days analyses. The development of OceanMAPS now provides potential sources for improvement over traditional approaches including a multi-variate analysis and forecast field. The performance of the present system for analysis and forecast SST is presented with comparisons of current operational SST analyses and observations.

2. MODEL

The BLUElink> Ocean Model, Analysis and Prediction System (OceanMAPS) version 1.0b is a global ocean model based on MOM4 version p0d (Brassington et al 2007). The system has a horizontal resolution of 0.1x0.1 degree in the Asian-Australian region and coarser elsewhere.

The OceanMAPS is designed to perform *two analysis cycles* prior to each *forecast cycle*. The first is an analysis cycle to provide a “best analysis” delayed by 8-9 days to maximise the coverage of altimetry and have a symmetric distribution of observations about the analysis time. A near real-time analysis is performed 5 days prior to the forecast start which ensures that altimetry at the analysis time is included. BLUElink> Ocean Data Assimilation System (BODAS) (Oke et al 2005) is used to perform a multi-variate, ensemble optimal interpolation initial analysis at the first and second cycle.

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The operational OceanMAPS runs twice a week on Monday and Thursday producing a seven day ocean forecast (Table 1). It produces three dimensional fields of ocean temperature, salinity and current, and two dimensional sea level heights.

Table 1. OceanMAPS analysis, nrt analysis and forecast cycle. Base date is day 0.

Cycle name	Begin date	End date
Analysis	-8 days (on Mon) -9 days (on Thu)	to NRT analysis
Near Real time (NRT) analysis	- 5 days	to base date
Forecast	base date	0 to +6 days

3. DATA

OceanMAPS SST is verified with three sources of observational SST products:

- The Australian Bureau of Meteorology's Regional Australian Multi-Sensor SST Analysis (RAMSSA) (Beggs, 2007).
- Satellite observed descending orbit (nighttime) SST from Advanced Microwave Scanning Radiometer for Earth Observation System (AMSRE) (http://wwwghcc.msfc.nasa.gov/AMSR/).
- The average daily buoy SST obtained from converting drifting and moored buoy SST observations from the Global Telecommunications System (GTS) to a "foundation" (pre-dawn) SST following the method described in Beggs (2007).

4. RESULTS

The verification period is from 1 September to 30 November 2008. The verification domain is the ocean around Australia from 5°S to 55°S and from 100°E to 170°E for RAMSSA and AMSRE. The verification domain for buoy SST is from 15°N to 70°S and from 90°E to 180°E.

The Root Mean Squared Error (RMSE) of OceanMAPS forecast SST is shown in Figure 1. It has been shown that the RMSE is increased with forecast days comparing both AMSRE and RAMSSA on the observation grids. The RMSE is higher when compared

with AMSRE SST than RAMSSA. RMSE are from 0.66 to 0.77°C validated by RAMSSA and 0.82 to 0.93°C by AMSRE.

The mean bias of OceanMAPS forecast SST is very small comparing both RAMSSA and AMSRE (Table 2). It ranges from 0.00 to 0.09°C for AMSRE and from -0.3 to 0.05°C for RAMSSA. It is interesting to note that in contrast to RMSE, the mean bias of OceanMAPS forecast SST generally decreases with forecast day.

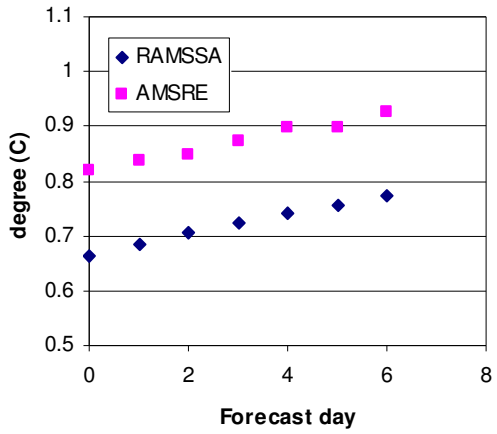

Figure 1. RMSE of OceanMAPS forecast SST compared with RAMSSA and AMSRE.

Table 2. Mean bias (°C) of OceanMAPS forecast SST compared with AMSRE and RAMSSA..

Forecast day	AMSRE	RAMSSA
0	0.09	0.05
1	0.07	0.03
2	0.04	0.02
3	0.04	0.01
4	0.05	-0.01
5	0.02	-0.02
6	0.00	-0.03

The distribution of SST difference (dT) between OceanMAPS SST and RAMSSA from total number of comparison data is shown in Table 3. It indicates that 70% of OceanMAPS analysis day 0 SST is within ±0.5°C, and about 96% within ±1.2°C when compared with RAMSSA. For OceanMAPS forecast day 6 SST, 57% are within ±0.5°C and about 80% within ±1.2°C. Forecast SST has a larger error than analysis. There is 11% absolute SST difference larger than 1.2 °C for forecast day 6 SST, while there is about 4% for analysis day 0 (Table 3). This study shows a warm bias for OceanMAPS analysis SST, but cool bias for forecast day 6 SST in comparison with RAMSSA.

The SST difference between OceanMAPS analysis SST and RAMSSA is shown in Figure 2. It suggests that the large differences are more likely to appear in tropical area and high latitudes.

Table 3. Frequency of SST difference (dT) between OceanMAPS SST and RAMSSA.

SST difference (°C)	Analysis day 0 (%)	Forecast day 6 (%)
dT<-2.5	0.07	0.60
-2.5<dT≤-1.2	1.75	5.35
-1.2<dT≤-0.5	10.78	18.04
-0.5<dT≤ 0	31.88	29.81
0<dT≤0.5	37.92	27.14
0.5<dT≤1.2	15.17	14.54
1.2<dT≤2.5	2.28	4.10
dT>2.5	0.15	0.41

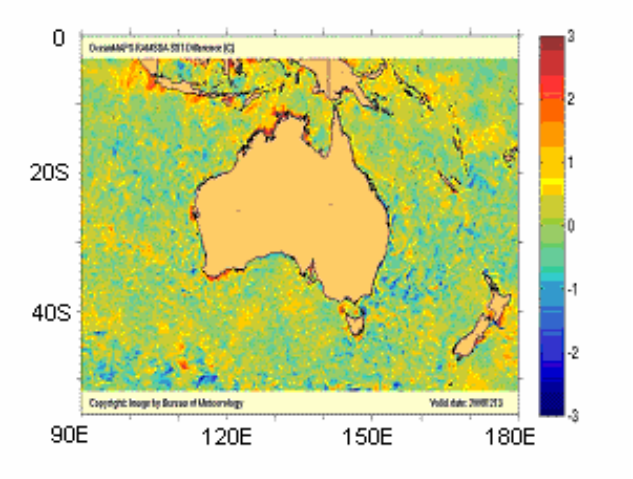

Figure 2. SST difference between OceanMAPS analysis and RAMSSA on 13 December 2008.

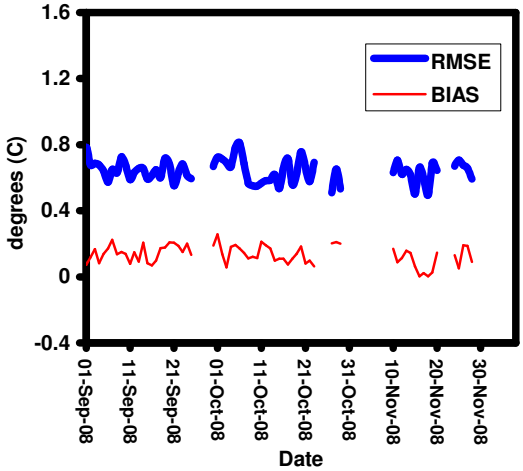

Figure 3. Average daily mean bias and RMSE of OceanMAPS analysis cycle SST minus buoy foundation SST over the region 15°N to 70°S and from 90°E to 180°E.

Compared with buoy foundation SST, the RMSE of OceanMAPS analysis cycle SST ranges from 0.51 to 0.82°C and the bias is from 0 to 0.25°C (Figure 3). These results are in agreement with the verification of RAMSSA and AMSRE (Table 4). The RMSE against buoy is higher than RAMSSA and lower than AMSRE.

Table 4. RMSE and mean bias of OceanMAPS analysis cycle SST.

	RMSE	Mean bias
buoy	0.64	0.13
RAMSSA	0.57	0.10
AMSRE	0.70	0.12

5. ACKNOWLEDGEMENTS

We gratefully acknowledge the numerous and valuable contributions to the development of the system from the BLUElink> science and technical team, Bureau of Meteorology, CSIRO and the Royal Australian Navy, NASA, CNES, ESA, AVISO, NOAA, US Navy, the Argo Science team, Geoscience Australia, OSTST, GODAE, GHRSST. The authors would like to thank Terry Skinner for his comments on this manuscript.

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