Sea level change from altimetry and tide gauges in South Eastern Australia

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Abstract

Regional sea-level change in the south-east Australian coast is investigated using data from satellite altimetry missions (Topex/Poseidon, Jason-1 and Jason-2 from the RADS database) and tide gauges (from PSMSL) over the period from January 1993 to December 2010. Instead of separately estimating sea level rise on the coastline from tide-gauge data and offshore from satellite altimeter data, tide-gauge sea level records are merged with altimeter observations through a model to present a consistent view of the sea level variability in the region. The preliminary results are shown in this poster.

There are 32% of Australia's population (about 7.2 million) living in New South Wales (NSW), the south-east Australia. With large population centres, important agricultural and tourism industries clustered along the coastline, NSW is highly vulnerable to a rising sea level. It is, therefore, important to understand that there are specific localised or regional variations compared with the global average sea level rise (Fig.1).

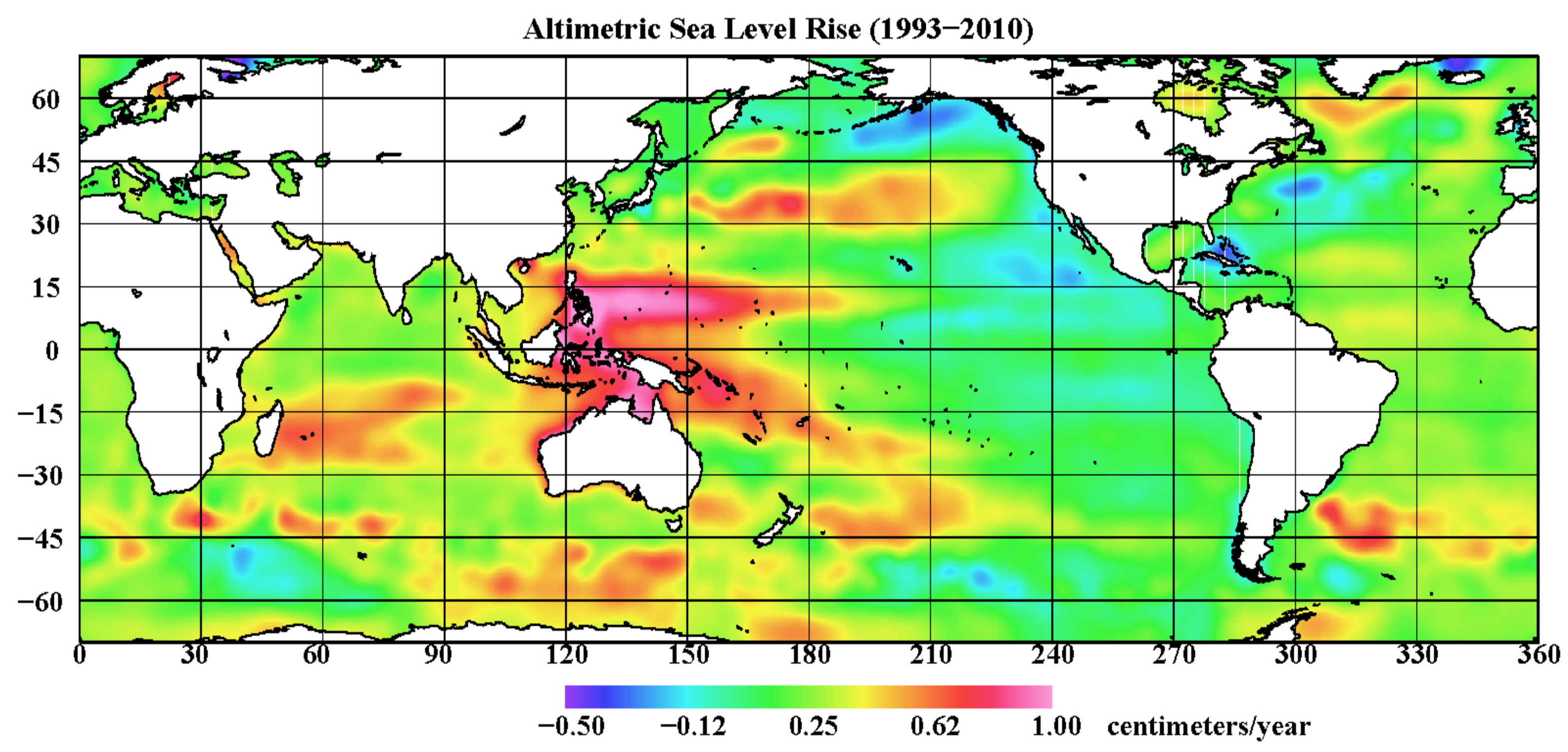

Fig.1. Trend of global sea level estimated from 18 years of satellite altimeter data (1993-2010), with a mean rise of 2.9 mm/year. It shows that around Australia the sea level has not risen uniformly, varying from 0-10 mm/year.

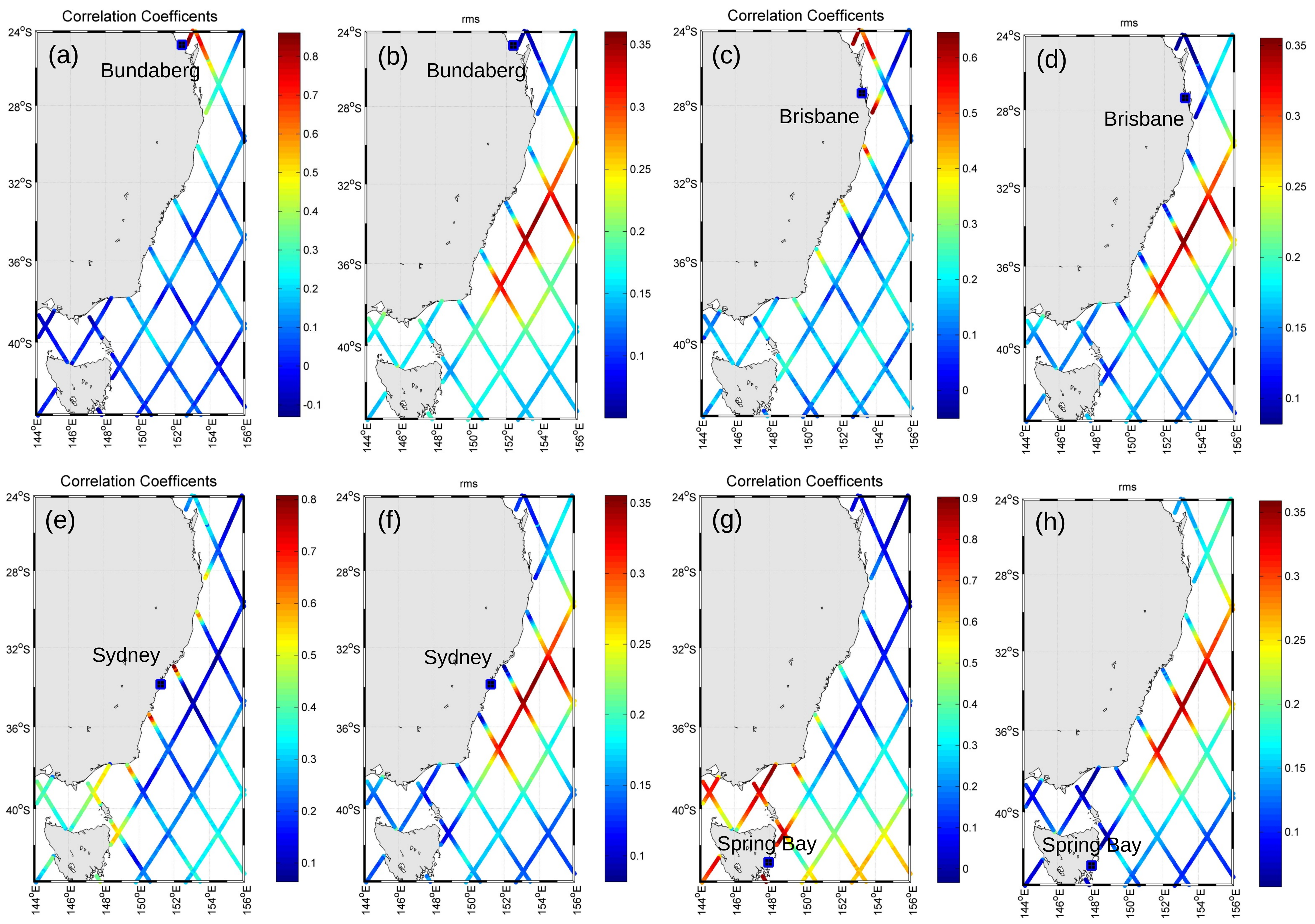

Fig.2. Distributions of the correlation coefficients and root mean square (RMS) errors between tide gauge and altimeter sea level measurements at Bundaberg, Brisbane, Sydney and Spring Bay. Both Altimeter and tide gauge sea level observations have been detided prior to the calculation. Correlation coefficient's and RMS errors are calculated at every point along altimeter tracks.

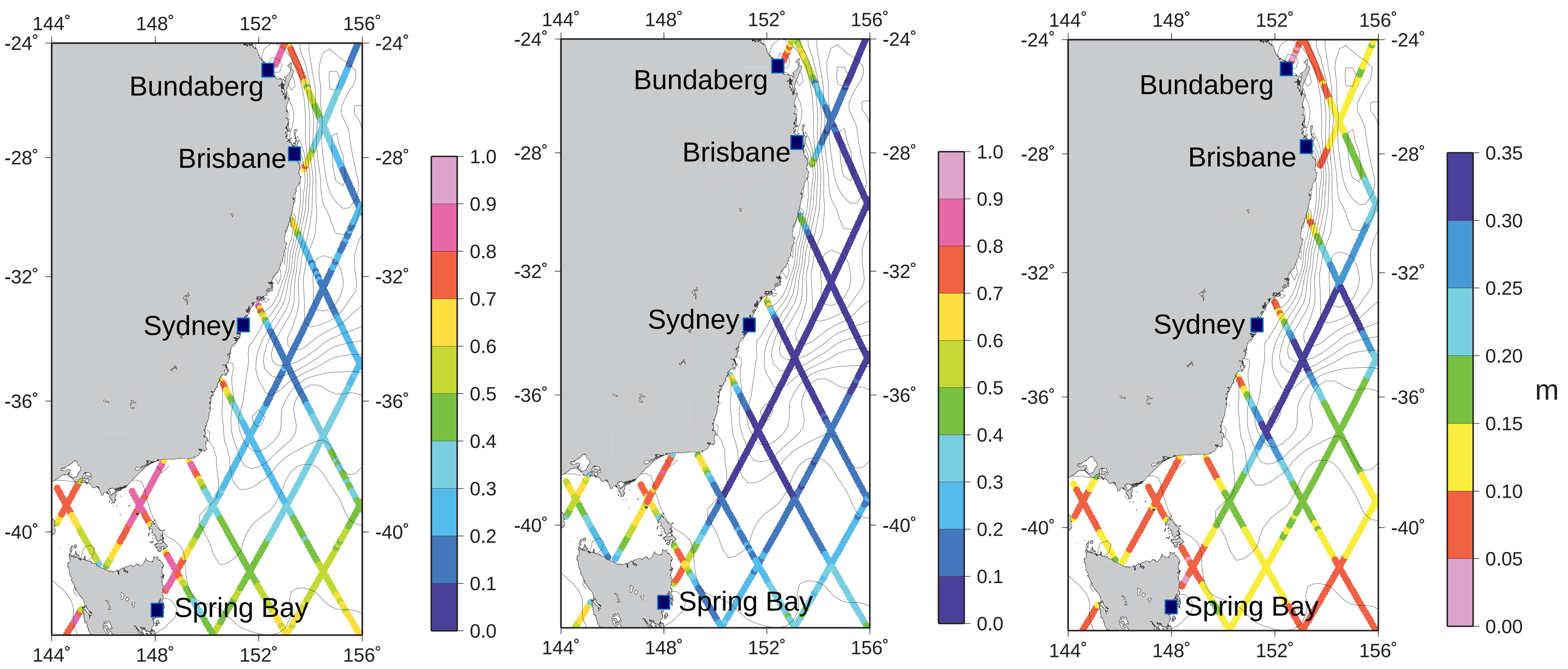

Fig.3. Performance of the multivarate regression model (a) correlation coefficients, (b) Hindcast skill and (c) RMS errors (m), where the altimeter-derived sea level anomalies have been regressed upon the sea level observations from the four tide gauges (in red squares). Background contours are CNES CLS09 mean dynamic topography (m).

Data

Data used are sea level measurements (1993-2010) from multi-satellite altimeter missions and four tide gauges along the south-east Australian coastline. The gauges are located at Brisbane, Sydney, Spring Bay and Bundaberg.

Results – Pointwise Correlation

To determine the relationship between two types of data sets, the correlation at each tide gauge with altimeter along-track observations is calculated (Fig.2). The correlation coefficients >0.7 are observed around gauges Spring Bay, Bundaberg and Brisbane northwards (Fig.2g, 2a and 2c), while at Sydney tide gauge (Fig.2e) high correlations only appear about 60 km to the coastline along altimeter tracks. Beyond 60 km in the open ocean in the Tasman Sea, both data sets are less (<0.4) or little correlated. More importantly, computed RMS errors related to all tide gauges (Fig.2b, 2d, 2f and 2h) reach their maximum in the area, where altimeter tracks cross the East Australian Current (EAC).

Results – Multivarate Regression

A multivariate regression model is used to aggregate both altimeter and tide-gauge sea level observations and to estimate sea level variability in the region (Fig.3). The model performs well in the south coastal area (the Bass Strait), where the EAC's effect is relatively small, with the hindcast skill and RMS ranges of ~0.4-0.8 and ~5 cm, respectively. However, the smallest hindcast skill and largest RMS error are found along the centre flow of the EAC, indicating again the same features as observed in the pointwise correlation analysis. With the ocean mean dynamic height shown in Fig.3 as background, it is very clear that an altimeter mainly measures sea level variations related to the EAC system offshore of NSW coasts, while tide gauges monitor the coastal sea level near the NSW coastline.

Conclusions

The rate of sea level rise has been estimated using satellite altimetry from 1993 to 2010, which shows a considerable spatial variability around Australia (~0-10 mm/year). In the south-east Australian coastal ocean, sea level change observed by altimetry is dominated by the EAC system. Near the NSW coast within about 60 km, observations from altimeter and tide gauge are highly correlated. Further study is necessary to investigate how sea level change affects the EAC system in NSW coastal waters.

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