Optimising the Australian Wave Observation Network

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Introduction

The publicly-available Australian national wave data network consists of 35 wave buoys distributed around the Australian coastline. The wave buoys observe significant wave height, wave period and wave direction. (Note that not all buoys observe wave direction – see Figure 1, below.) The density of the wave buoys is variable – at a glance, density is higher on the east coast compared to the rest of the coastline. This variability has resulted in some areas of the coastline being well accounted for in models and climate studies and other areas not being covered at all.

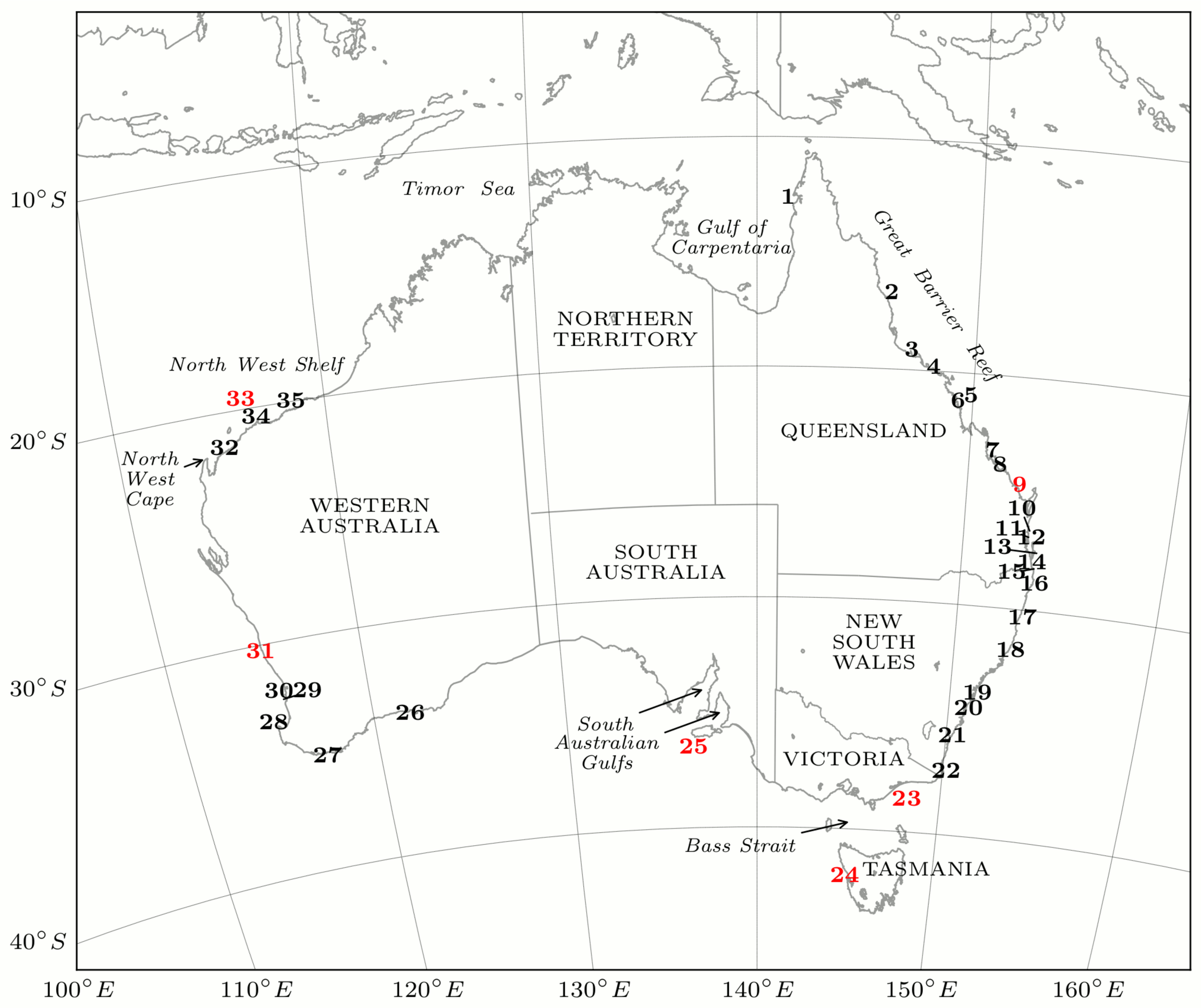

Figure 1: Location of wave buoys around the Australian coastline. Buoys not providing wave direction are in red.

Objective

This work aims to identify significant gaps in the existing wave buoy network in order to provide guidance for potential future deployments. In addition, the technique used allows us to easily identify which are the key buoys in the existing network.

Method

- The method is based on assessing the characteristics of the spatial coherence of the wave field.
- In areas where the wave field varies on large spatial scales, less dense observations are needed, and in areas where the wave field varies on small spatial scales, a denser observational network would be needed.
- The technique uses monthly means calculated from the CAWCR wave hindcast January 1979 - April 2016 (Durrant et al 2014).
- For each modelled data point, correlations between modelled variables (**significant wave height**, **mean period** and **mean direction**) at that location and at each buoy site were calculated.
- The maximum of the 35 correlation values for each modelled data point are plotted in Figure 2a (significant wave height) and 3a (wave direction). Figure 2b and Figure 3b identify which buoy is most highly correlated with each modelled data point for significant wave height and wave direction, respectively.
- Areas of lowest maximum correlation values are the least well represented by the existing network, and thus the most important gaps.
- The most significant buoy in the existing network was determined by removing each buoy individually and calculating the average maximum correlation across the remaining network. The buoy whose removal caused the greatest decrease in average maximum correlation can be regarded as the most significant buoy in the network.

Results

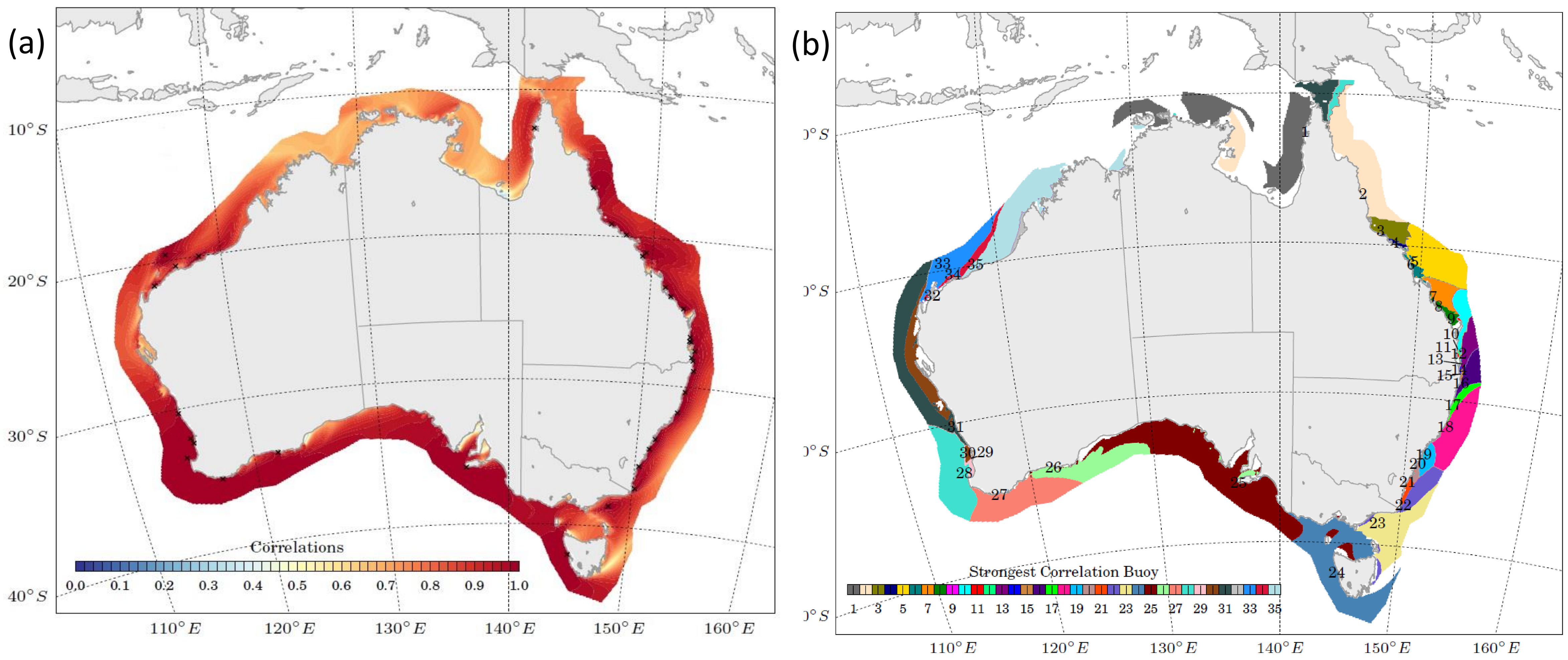

Figure 2: Results for significant wave height. (a) Maximum correlation values. (b) Regions correlating most strongly with each buoy (for correlation values > 0.7)

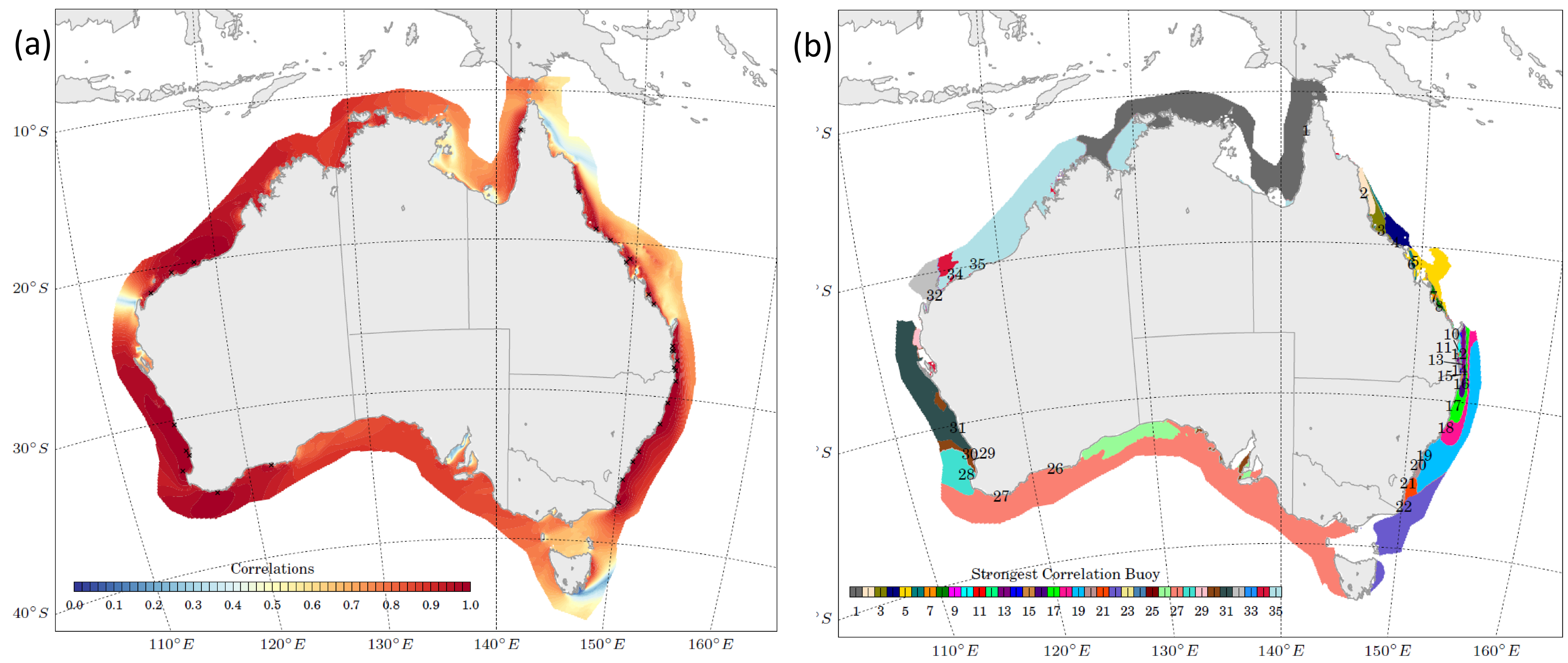

Figure 3: Analogous to Figure 2, results for wave direction. Only buoys providing wave direction (see Figure 1) are used in these results

Buoy Removed (see Figure 1)	Average maximum correlation across all three variables	Percentage decrease in average maximum correlation
1	0.672	5.427%
2	0.704	1.017%
25	0.704	0.933%
23	0.706	0.743%
35	0.706	0.631%
24	0.707	0.475%
33	0.709	0.307%
27	0.709	0.286%
5	0.709	0.247%
No buoys removed	0.711	0%

Table 1: Identifying the most significant buoys in the network (assuming all buoys measure wave direction)

Discussion

- Figure 2a and Figure 3a suggest that there are a number of regions whose wave climate is not well represented by the existing buoy network and should therefore be considered high priority for new buoy deployments. These are:
  - the Gulf of Carpentaria
  - the Timor Sea
  - the South Australian Gulfs region
  - Eastern Tasmania.
- These results do not take into account the distribution of the population or locations of maritime activity, such as fisheries.
- Costs of deployment and ongoing maintenance may also be important.
- Table 2 identifies Buoy 1 as the most significant buoy in the existing observation network over all three variables (see last dot point in 'Method').
- The conclusions here are valid only in relation to the wave climate at spatial scales larger than that of the underlying modelled wave hindcast, which has a spatial resolution of approximately 7 km.
- Further planned work includes:
  - Performing the analysis for extreme values (95th percentiles) in addition to monthly means
  - Examining different methods of assessing the most important buoys in the network.

References

Durrant T, Greenslade D, Hemer M, Trenham C (2014) A Global Wave Hindcast focused on the Central and South Pacific. CAWCR Technical Report No 70