THE WAVE CLIMATE OF SOUTH-EAST AUSTRALIA AND FUTURE WAVE PROJECTION BY THE END OF 21ST CENTURY

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In this study, high-resolution unstructured ocean wave datasets based on a third-generation wave model (WAVEWATCH III, WW3) were developed for south-east Australia (Figure 1). Through this study, we aim to understand the wave climate based on hindcast model datasets and develop future wave projections by the end of the 21st century.

In the first part of the study (Liu et al., 2022a), a hindcast model, driven by ERA5 winds (Hersbach et al., 2020) and nested within a global wave hindcast model (Liu et al., 2021), was used to investigate the wave climate of south-east Australia over the period 1981-2020. The model results are extensively validated against a network of coastal buoys and demonstrate that the model can capture the overall wave characteristics in this region. Analyses of model outputs across the 40-year period show that significant wave height (H_s) has increased by approximately 5% and a slight counterclockwise rotation of peak wave direction has occurred with likely implications for coastal processes. Seasonal variations show higher H_s in winter compared to summer, which is driven by dominant Southern Ocean swell. The peak wave direction in the eastern region shifts from south-westerly in winter to south-easterly in summer. In autumn and winter, there is a statistically significant correlation between wave conditions and the Southern Annular Mode. During these seasons, a southward movement of Southern Ocean low pressure systems is associated with increased H_s, an increase in the peak wave period and a counterclockwise rotation of the peak wave direction.

In the second part of the study (Liu et al., 2022b), the WW3 model with the same setting, but driven by ACCESS-CM2 global climate winds (Meucci et al., 2022), was used to study the projected future wave climate of south-east Australia under two different greenhouse gas emission scenarios (SSP1-2.6 and SSP5-8.5). The wave model shows good agreement with coastal long-term buoy observations and the independent WW3 hindcast dataset over the historical period 1985-2014. The projected mean H_s for SSP5-8.5 by the end of the 21st century (2071-2100) shows a robust increase for the majority of the domain, but a decrease in nearshore regions, mainly due to projected decreases in local wind speed. The increase in H_s for SSP1-2.6 is relatively small. Seasonal variations show that H_s (SSP5-8.5) is primarily influenced by Southern Ocean swell in spring and winter and local winds prevail in summer and autumn. Extreme value analysis shows a stronger increase in extreme wave climate for SSP5-8.5 than for SSP1-2.6. Extreme values of H_s for SSP1-2.6 show a projected decrease in western regions of the domain and an increase in the east. Extreme values of H_s for SSP5-8.5 show a decrease in the nearshore areas of Victoria. This study shows that projected wave climate changes in south-east Australia may have potential implications for Tasmanian and Victorian coastline stability.

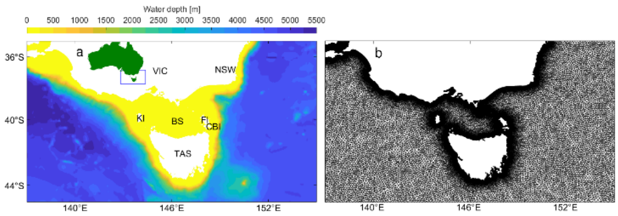

Figure 1 - (a) Water depth and (b) the unstructured grid of the model domain. The insert is Australia. The blue line is the open boundary conditions provided by the global wave model. VIC=Victoria, NSW=New South Wales, TAS=Tasmania, KI=King Island, FI=Flinders Island, CBI=Cape Barren Island, BS=Bass Strait.

REFERENCES

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz-Sabater, J., et al. (2020), The ERA5 global reanalysis. Quarterly Journal of the Royal Meteorological Society, 146(730), 1999-2049.

Liu, J., Meucci, A., Liu, Q., Babanin, A. V., Ierodiaconou, D., & Young, I. R. (2022a), The wave climate of Bass Strait and south-east Australia. Ocean Modelling, 172, 101980.

Liu, J., Meucci, A., & Young, I. R. (2022b), Projected wave climate of Bass Strait and south-east Australia by the end of the twenty-first century. Climate Dynamics.

Liu, Q., Babanin, A. V., Rogers, W. E., Zieger, S., Young, I. R., Bidlot, J.-R., et al. (2021), Global wave hindcasts using the observation-based source terms: Description and validation. Journal of Advances in Modeling Earth Systems, 13(8).

Meucci, A., Young, I. R., Hemer, M., Trenham, C., & Watterson, I. G. (2022), 140 years of global ocean wind-wave climate derived from CMIP6 ACCESS-CM2 and EC-Earth3 GCMs: Global trends, regional changes, and future projections. Journal of Climate, Under review.