Earth Systems and Climate Change Hub

National Environmental Science Programme

climate change **science brief**

Wind-wave climate change along Australia's coast

Climate change is driving changes to surface ocean winds and to the characteristics of the resulting wind-waves. Changes to the height, length or direction of wind-waves are expected to impact Australia's coastline, potentially contributing to future coastal flooding and erosion.

The Earth Systems and Climate Change Hub has assessed how wind-waves may change around Australia, and globally, under future warmer climate scenarios using a new community-driven wind-wave model ensemble.

The resulting comprehensive information and dataset will assist coastal managers to understand which areas around our coastline will be most prone to changes in wind-wave conditions.

Wind-wave driven coastal flooding and erosion pose risks to coastal populations and ecosystems

Coastal flooding and extreme shoreline erosion are expected to occur more often in coming decades due to climate-driven sea-level rise. These effects will be exacerbated by the combined effects of wind-waves, storm surges and tides, which are also subject to climate-driven changes. In some parts of Australia, climate-driven changes to wind-waves and their influence on shoreline stability may even surpass the effect of sea level rise, highlighting the need to better understand how wind-waves will change under a warmer climate.

However, uncertainty remains in projections of how the characteristics of wind-waves will change, with different analyses presenting contrasting changes in the magnitude and/or signal of wind-wave changes across the global ocean. These limitations have made it difficult to produce local-scale assessments of future coastal risk and vulnerability.

Earth Systems and Climate Change (ESCC) Hub researchers have participated and provided leadership in this field of research through the Coordinated Ocean Wave Climate Projections (COWCliP) project. COWCliP is an international collaborative research project, supported by the World Meteorological Organization, which focuses on enhancing global knowledge of how coastal wind-wave conditions are changing under a warming climate.

Understanding risk through new wind-wave projections

The COWCliP community compiled a new model ensemble of 21st Century wind-wave climate projections, with over 150 simulations of future wave scenarios.

TOP: Image: Nick Pitsas/CC BY 3.0

RIGHT: **Changes to wind-waves are expected to contribute to future coastal flooding and erosion along Australia's coastline.**
Image: iStock.com/Daria Nipot

These new wind-wave projections equip coastal managers with the knowledge they need to understand how wind-wave climate fields (such as significant wave height, wave period or length, and/or wave direction) will change along the world's coastlines.

Historical wind-wave variability and change for Australia

Climate variability associated with the major drivers of Australia's climate (i.e. El Nino, the Southern Annular Mode, the Pacific-South American Modes, Blocking and Madden-Julian Oscillation) all have important influences on wind-waves.

Research under the ESCC Hub has helped to clarify the climatological response of wind-waves around Australia's coasts to these climate drivers. Better understanding of the relationship between climate variability and wind-waves provides the potential to achieve seasonal, and potentially longer, predictability of wind-waves. This may be of future benefit to coastal managers.

Projected change in Australia's 21st Century wind-wave climate

ESCC Hub research provides evidence that changes to wind-wave climate are likely to occur along many coastal regions of Australia. Some coastlines in South Australia, Tasmania and New South Wales will exhibit changes in more than one way. For example, projections for Australia's southern coastline show robust increases in annual mean wave periods, along with anticlockwise shifts in the south-westerly wave directions to become slightly more southerly. Associated changes in frequency and/or intensity of storm wave events can exacerbate coastal stress, either by contributing to episodic erosion events or altering coastal sediment budgets that can drive potential chronic erosion issues.

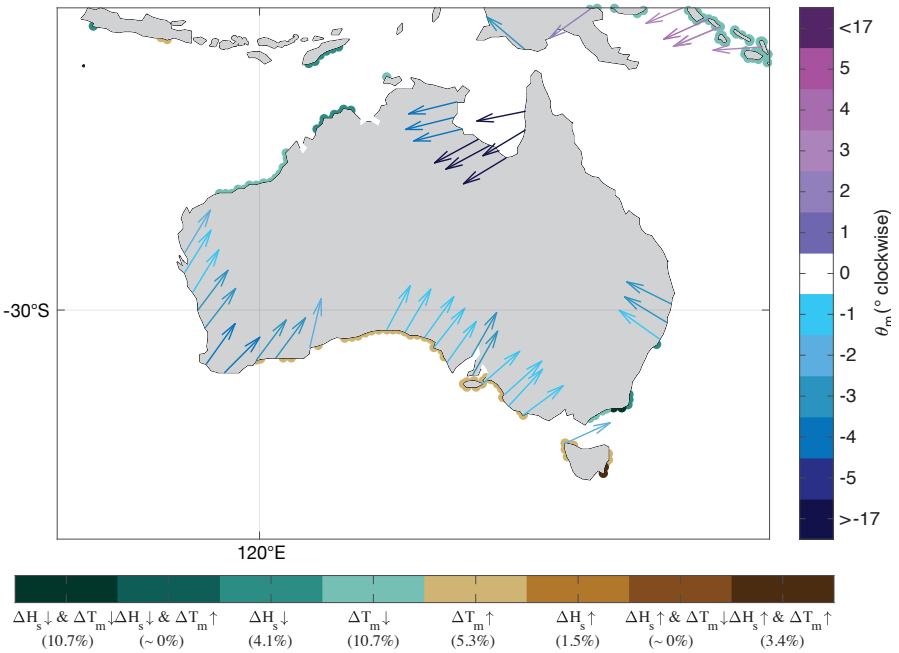

FIGURE 1 **Robust projected 21st Century changes in Australia's offshore wave conditions.** Coastal segments exhibiting robust changes in mean significant wave heights (Hs) and mean wave periods (Tm) are coloured according to the lower colour axis. Percentage values given represent the fraction of coastline for each condition. Projected changes in mean wave direction are represented by the arrows, with the magnitude of change (in degrees, positive clockwise) given by the colour according to the right-hand-side colour axis, and the direction of the arrow representing the historical mean. Projected changes presented correspond to the relative difference between historical (1979-2004) and the end of the 21st century period (2081-2100) under a high emission RCP8.5 scenario.

> *These new wind-wave projections equip coastal managers with the knowledge they need to understand how wind-wave climate will change along the world's coastlines.*

Informing coastal practitioners

The ESCC Hub has helped to quantify how wind-waves will change under a warmer climate at both a national and state level. The Hub (via COWCliP) has also contributed to the development of a community database of wind-wave climate projections so that coastal managers and engineers around the world can access and incorporate state of the art wind-wave information and data into their decisions and activities.

Coastal practitioners can also use this information to consider risks (such as widespread flooding and severe erosion) at wind-wave exposed beaches to improve coastal planning and management decisions.

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