MODELLED AND OBSERVED IMPACT OF THE APRIL 2021 SOUTHERN OCEAN STORM

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Wind-wave extreme events are a major driver of coastal erosion (Lowe et al., 2010). As such, accurate estimates of metocean extremes are crucial to implement efficient and resilient coastal defense strategies. Global wave reanalysis datasets are commonly used to estimate wind and wave statistical properties for coastal engineering purposes. However, despite the impressive accuracy of such datasets in representing average significant wave height conditions (global biases against observations of less than 5 cm), models usually underestimate metocean extremes (Cavaleri et al. 2009; Cavaleri et al., 2020).

To obtain an understanding of model performance under extreme conditions, we focus on a single storm event generated in the Southern Ocean on April 7th, 2021. The distinct shape and trajectory of this storm generated waves that reached 9.5 meters along the Victorian coastline (April 10th, 2021), causing a one in 100-year storm event at Port Fairy, VIC, AU (https://www.abc.net.au/news/2021-04-12). The event is of interest as it was recorded by a recently installed Triaxys buoy at Cape Bridgewater, VIC, AU, and by satellite observations over the storm generation region. A preliminary comparison of ERA5 significant wave height estimates with the buoy measurements at Cape Bridgewater shows that ERA5 is biased significantly low, posing questions about the quality of modelled extreme value estimates for engineering design purposes.

To further study the model wave energy generation and propagation mechanisms, we back track the April 2021 storm to its Southern Ocean generation region. To do this, we first define the hourly storm center locations by applying a cyclone tracking algorithm (Murray and Simmonds 1991) to ERA5 mean sea level pressure data and extract the ERA5 hourly 10-meter neutral wind speed and significant wave height maxima near the cyclone center (Fig. 1). We then run a global WAVEWATCHIII (WW3) v6.07 model using different calibrations of the latest ST6 physics parametrization (Zieger et al. 2015; Liu et al. 2019) and extract the directional spectra at 6-hourly transects along the ERA5 wave height maxima locations (Fig. 1). The WW3 results show an improvement in the wave height estimates at Cape Bridgewater compared to ERA5. However, all models still show a significant negative bias. In the storm generation region ERA5 corrects the wave height biases by assimilating remote sensing observations, but the energy pumped into the model is lost along the cyclone trajectory and little "memory" of the assimilated energy is retained at the site of impact on the coastline.

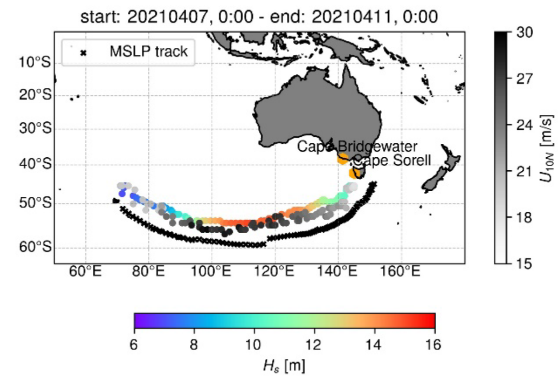

Figure 1 - Hourly April 2021 storm center locations (black crosses), together with the hourly significant wave height and neutral wind speed maxima locations. The yellow hexagons show the Cape Bridgewater and Cape Sorell Triaxys buoys.

This project aims to describe the performance of state-of-the-art global wave models in representing Southern Hemisphere extra-tropical cyclone waves and propose novel solutions to model wave height extremes. Ultimately, this work will contribute to more accurate extreme wave height estimates for safer and more efficient coastal infrastructure design.

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