Shoreline Response to the Southern Annular Mode at WEC site: Satellite Analysis

James Thompson1, Nick Cartwright1, Amir Etemad-Shahidi1, Guilherme Vieira da Silva1, Julian O’Grady2

1 Coastal and Marine Research Centre, Griffith University, Gold Coast, AUSTRALIA.

email: james.thompson3@griffithuni.edu.au

2 CSIRO, Melbourne, AUSTRALIA.

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Understanding shoreline dynamics is a key step towards the successful management of coastal environments. This study investigates natural shoreline variability at Grassy Beach with a particular focus on the relationship between the local wave climate and the Southern Annular Mode (SAM). The present analysis is part of a larger study into the influence of a nearshore wave energy converter (WEC) on the shoreline dynamics. Grassy is a sandy embayment on King Island in Bass Strait, Australia, with a wave climate dominated by southwesterly Southern Ocean swells. Shoreline position pre-WEC deployment from 1987 to 2021 was determined from Sentinel and Landsat satellite imagery (n = 420 images) using the CoastSat Python toolkit. Empirical orthogonal function (EOF) analysis found seasonal beach rotation to be a dominant mode of variability (20% of total variability), with opposing shoreline movement at either end of the embayed beach and a pivot point near the middle. The corresponding temporal EOF alternated in sign between winter and summer. These results show shoreline retreat (erosion) happening in winter at the exposed eastern end and during summer at the western end. The Bass Strait wave climate is influenced by SAM, with more powerful waves likely in Austral autumn and winter when the SAM index is positive. A positive phase of SAM during winter was found to increase shoreline retreat at the eastern end and leads to a stronger beach rotation signal describing 24% of the total variability. These results provide new insights into the influence of SAM on shoreline dynamics and highlight the importance of considering relevant climate drivers in coastal assessments. For nearshore structures such as WECs, it is critical to first assess the natural variability of the site and relevant driving factors through multi-decade spatio-temporal analysis before analysing the coastal impact of such structures.