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CROSS-SHORE TRANSFORMATION OF BOUND AND FREE INFRAGRAVITY WAVES OFF THE DUTCH COAST

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INTRODUCTION

Infragravity (IG) waves are key drivers for coastal erosion and thus need to be properly included in process-based modelling of coastal hazards. Uncertainties remain regarding the offshore boundary conditions for these long waves. Typically, only bound IG waves are included at the boundary, which means that the possible contribution of free IG waves, such as those radiated from distant coastlines, is neglected. Recent studies however suggest that incoming free IG waves could be significant, particularly in semi-enclosed basins such as the North Sea where they could contribute to coastal hazards (e.g., Reniers et al., 2021, Rijnsdorp et al. 2021). The objective of this work is to improve the understanding of the incoming IG wave field along the Dutch coast. We will quantify how bound and free IG waves develop in intermediate water depths and assess in which conditions (onshore directed) free IG waves become significant.

METHODS

This work relies on a novel dataset collected past Fall/Winter along the Holland coast as part of the Realdune/REFLEX experiment. Here we focus on the offshore part of the campaign which consists of three instrumented frames deployed in mean water depths of 14.5m, 8.9m and 6.5m (fig. 2A). These frames were equipped with ADCPs measuring continuously pressure, surface elevation (via acoustic surface tracking) and velocities at a frequency of 4 Hz for a period of 5 months (Nov 2021 to April 2022). The bound and free portions of the IG wave energy were estimated using bispectral analysis and their relative importance was analyzed for different storm events.

FIRST RESULTS

About eight energetic events were identified during the campaign, with sea-swell significant wave heights at the offshore frame over 3m and reaching up to 5m (fig. 1A). Over this period, the total IG wave height reached up to 0.4m at the deepest frame (fig. 1B). Figure 2 (C-E) shows how the total, bound and free IG energy varies along the transect for one of the storms. At the peak of the storm the total IG wave height at Frame 3 is twice as large as at Frame 1. During this event the free IG wave energy remains larger or equal to the bound energy at all locations ($(H_{IGbound}/H_{IGtot})^2 \leq 0.5$). At the conference, we will show how the properties of the free and bound IG wave field change between the frames for the different storm events. Specific attention will be given to the incident versus reflected properties of the IG waves.

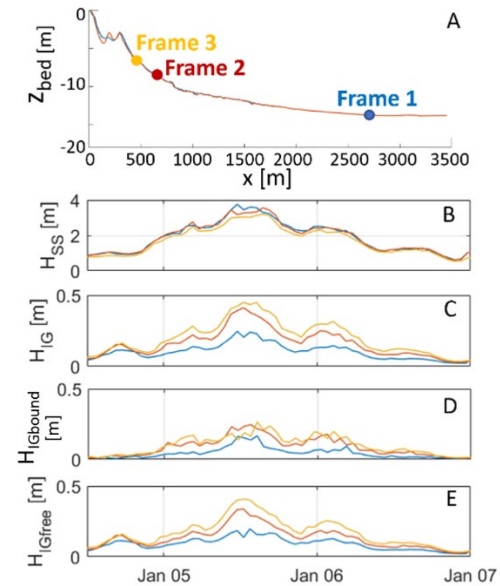

Fig. 2 – A: Bed profile and frame locations; B-E: Significant wave heights measured at the 3 frames during the Jan. 5th storm for the sea-swell (B) and the total (C), bound (D) and free (E) IG waves.

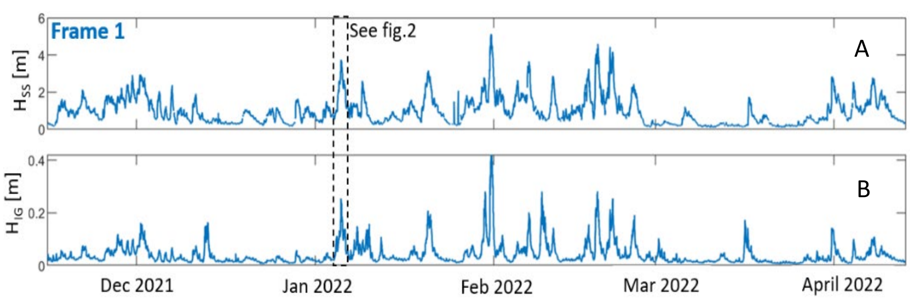

Fig. 1: Sea-swell (SS, f>0.05Hz) and infragravity (IG, 0.005<f<0.05 Hz) significant wave heights at the most offshore frame ($\bar{d} = 14.5m$) during the 5-month campaign.

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