Data analysis of infragravity waves observed along the Belgian coast

YURI PEPI[1], LEANDRO PONSONI[1], WIETER BOONE[1]

[1] *VLIZ - Flanders Marine Institute (VLIZ), Oostende, Flemish Region, Belgium*

Infragravity waves are a type of surface wave characterized by periods between 30 and 300 seconds, amplitudes that range from a few millimeters to tens of centimeters, and wavelengths of kilometers (Munk, 1950). These waves are generated by various mechanisms such as height variation of incoming waves, varying wave heights causing the breaking point of the waves to vary with height, and nonlinear interaction between shorter waves (Bertin et al, 2018). They have been observed to cause extreme water levels and resulting damage in various locations around the world (Yamanaka et al., 2019). Infragravity waves also play a significant role in coastal dynamics (Svendsen, 2005) and can cause various nearshore processes such as beach and dune erosion (Roelvink et al., 2009), seiches in harbors (Melito et al., 2006), and wave-driven coastal inundation (Stockdon et al., 2006). To understand the behavior and impacts of infragravity waves, field observations and measurements are essential. However, measuring these waves can be challenging due to their low amplitude and long period. Traditional wave measurement techniques such as wave buoys and radar are not well-suited for measuring infragravity waves, as they are designed to measure shorter period gravity waves. Instead, specialized instruments and techniques are needed to accurately measure infragravity waves. Acoustic Doppler Current Profilers (ADCPs) are widely used to measure these waves. ADCPs use sound waves to measure the velocity of the water and can be used to measure both infragravity and gravity waves depending on their sampling frequency. Another method is the use of high-accuracy pressure sensors. These sensors can be deployed on moorings or on the seafloor to measure the water level and can be used to detect even the small amplitude of infragravity waves. Nevertheless, their relevance and occurrence along the Belgian coast remain poorly understood (Verleye et al., 2022). A study is being conducted by researchers from VLIZ, UGent, and KULeuven in collaboration, in the framework of the FWO project ”Influence of infragravity sea waves during storms on the hydro- and morphodynamic processes along hybrid soft-hard coastal defense structures with a shallow foreshore”. The referred study focuses on the Belgian coast, where a mooring was deployed off the coast, in front of the Nieuwpoort harbor entrance. Both ADCP (Nortek AWAC 1 MHz) and pressure sensor (RBR Quartz3q) were set to measure continuously at 4 Hz, allowing them to capture both infra- and gravity waves. An extensive data analysis and evaluation of the sensor performance were conducted to assess the sensitivity, measurement range, and ability to detect infragravity waves of low amplitude. This data analysis procedure was essential in determining the suitability of the sensors for the intended purpose of the project. The frequency, wavelength, and amplitude of the infragravity waves were quantified and the correlation with other oceanic processes, such as tides and wind-generated waves, was analyzed. The data analysis tools and results of this initial study provide a foundation for future research on infragravity waves along the Belgian coast, including the potential implementation of a long-term, near-real-time

monitoring system utilizing multiple measurement locations.

References

Bertin, X., de Bakker, A., van Dongeren, A., Coco, G., Andro, G., Ardhuin, F., et al.. Infragravity waves: From driving mechanisms to impacts. Earth-Science Reviews, 177, 774–799. (2018).

Melito, I., Cuomo, G., Bellotti, G., Franco, L.. Field Measurements of Harbour Resonance at Marina di Carrara. Paper Presented at the 30th International Conference on Coastal Engineering held in San Diego, U.S.A. (2006)

Munk, W. H. Origin and generation of waves. Coastal Engineering Proceedings, 1. (1950).

Roelvink, D., A. Reniers, A. van Dongeren, J. van Thiel de Vries, R. McCall, and J. Lescinski. Modeling storm impacts on beaches, dunes and barrier islands. Coastal Eng. 56 (11–12): 1133–1152. (2009)

Stockdon, H. F., R. A. Holman, P. A. Howd, and A. H. Sallenger.. Empirical parameterization of setup, swash, and runup. Coastal Eng. 53 (7): 573–588. (2006)

Svendsen, Ib A. Introduction to Nearshore Hydrodynamics. WORLD SCIENTIFIC. (2005)

Verleye, T.J.; Dauwe, S.; Pepi, Y.; Hernandez, F.; Everaert, G.; Troch, P.; Monbaliu, J.; Pirlet, H.. Het voorkomen van tsunami's, rogue waves en infragravitaire golven in de zuidelijke Noordzee - Een wetenschappelijke synthese. VLIZ Beleidsinformerende Nota's, 2022_003. Vlaams Instituut voor de Zee (VLIZ): Oostende. 30 pp. (2022).