MULTI-SCALE INFRA-GRAVITY WAVE DYNAMICS – THE FRENCH BASQUE COAST

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INTRODUCTION

Coastal risk management has the primary goal to protect population and infrastructure from wave-driven hazards, but also to address the changes ecosystems undergo due to human activities. The world-wide push towards sustainable shorelines and the need to built communities resilient to coastal hazards has increased the demand of accurate and comprehensive numerical solutions to gain a better understanding of the critical wave processes.

Phase-resolving numerical models have become increasingly popular for computations of the wave regime near the coast. These models not only allow for the transformation and interaction of swell waves with each other and with the bathymetry, but also include the generation and propagation of infra-gravity (IG) waves, which are known to have a major contribution to coastal flooding, damage of infrastructure, and sediment transport.

METHODOLOGY

In this study, we analyze the critical wave processes, which govern the French Côte Basque (Basque Coast), a 30 km long stretch of coastline in SW France, characterized by pocket beaches, sandy and rocky shorelines as well as irregular offshore bathymetry. The Côte Basque can be considered a representative continental shelf coast.

We have used a Boussinesq-type model, which was validated with laboratory and field data, and calculated a suite of characteristic swell scenarios at different tide stages for the environment. Spatial variations in the properties of IG-waves are presented using power spectral density, swash, IG-energy flux and dissipation, and cross-correlations. These methods are suitable to show a representative two-dimensional distribution of energy across swell and multi-scale IG-period bands. The analyses also show hot spots with predominantly bound and free IG-wave energy.

RESULTS

The stretch of coastline is exposed to energetic open-ocean swells – particular during the winter period. The bathymetry is a major factor in the distribution of IG wave energy that are highly influenced by the irregular bathymetry located approximately 3-4 km offshore of the study area. A historic dredging deposit offshore of the Adour River causes refraction and wave focusing, which results in consistently higher IG-wave heights south of the river entrance. An extensive rock formation to the south of the deposition site causes additional wave focusing patterns which lead to higher IG-energy between the beaches of Anglet and Biarritz. The water level is demonstrated to substantially affect the IG-wave behavior, more than the wave direction. Swash oscillations in the IG-frequency band are greater than or equal to sea-swell swash oscillations at nearly all locations along the studied shoreline.

CONCLUSIONS

The study shows that IG-wave processes along continental coastlines can be highly dependent on the local bathymetry and can build inter-connected features. This implies that numerical modeling over large areas is necessary to assess the dynamic processes. Modeling along one-dimensional cross-sections or retrieval of field data at individual sites is often not sufficient to obtain a complete picture of the processes that govern a site of interest.

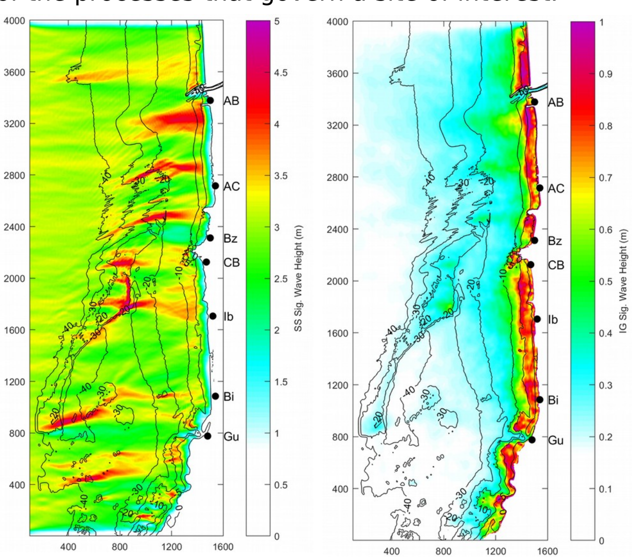

Figure 1 – Example of significant sea-swell (left) and infragravity (right) wave heights from computed results relative to the local bathymetry.

REFERENCES

Nestler (2020): Nearshore infragravity waves along the French Basque coast computed by a phase-resolving model, MS thesis, Univ. Pau & Pays de l'Adour.