WAVE TRANSFORMATION ON A ROCKY SHORE: FROM FIELD WORK ON RE ISLAND TO 3D MODELING

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INTRODUCTION

Improving knowledge of the processes driving coastal flooding is a key issue in the era of climate change, especially for decision support of public policies and operational forecasting. From regional to city scales, different processes interact, such as tide, storm surge, waves, wave setup, or infra-gravity waves, and further depend on the area topography, bathymetry, sedimentology and external forcings. While sandy beaches have been the subject of many studies, rocky beaches are still poorly understood compared to sandy beach context, despite the important part of rocky French and world coasts. In this paper, we investigate the swell transformation on the rocky beach of Ars-en-Ré with an extensive field campaign and a numerical modelling with a 3D non-hydrostatic circulation model Symphonie NH (Marsaleix et al., 2019).

FIELD CAMPAIGN

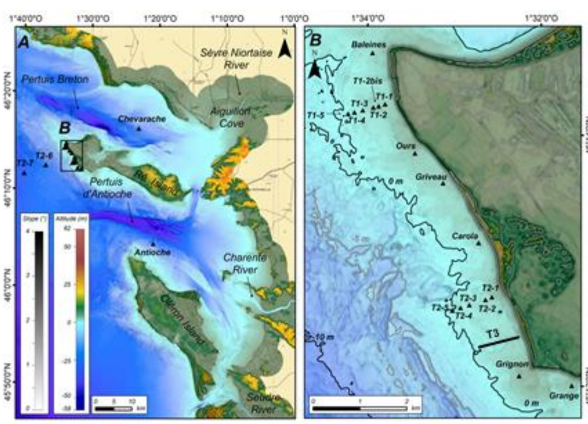

Figure 1 – Bathymetry of the field site and locations of the instruments (black triangles)

The study site is located along the north-west coast of the Ré Island, in Ars en Ré (Figure 1). It is subject to a semi-diurnal tidal regime with a maximum tidal range of around 5.7 m along the coast. About 40 instruments, including profiling and point current meters, tide gauges, offshore wave buoys and pressure sensors, are deployed on the T1 and T2 cross-shore transects between September 2020 and May 2021. From 11 to 15 January 2021, a third transect T3 further south was densely instrumented, with 20 pressure sensors, 2 profiling current meters and 3 single-point current meters (Figure 2).

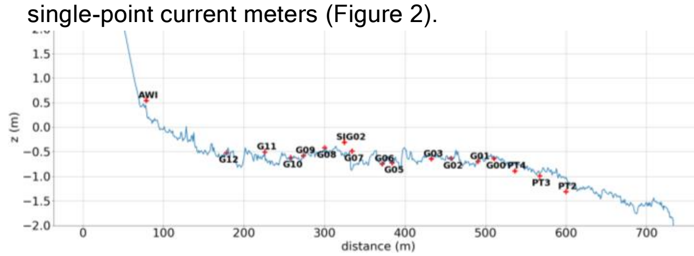

Figure 2 – Vertical profile of transect 3 and positions of the different instruments

All these measurements will be used to identify the contribution of the different processes involved in short-wave transformations as a function of tidal variation, mean sea level and seabed microgeometry, and its impacts on elevation of the water level.

3D NH MODEL

A 3D non-hydrostatic phase-resolved wave model (Marsaleix et al., 2019) is implemented over the area covered by the observations, with a spatial extent of about 10 km (alongshore direction) by 5km (cross shore direction), with a variable horizontal resolution, from 2.5m onshore to 5m offshore, and 10 vertical levels.

This high-resolution model is nested in a large-scale low-resolution hydrostatic model providing low-frequency hydrodynamic conditions (sea surface level induced by tide and atmospheric pressure, shelf-scale ocean circulation) for the initial state and for the lateral open boundary conditions. Waves are introduced using measured frequency and directional spectra at a buoy located on the open offshore boundary of the model, retaining only periods longer than 5s (permitted by the grid resolution). Several simulations of a few hours are performed on selected events (Figure 3).

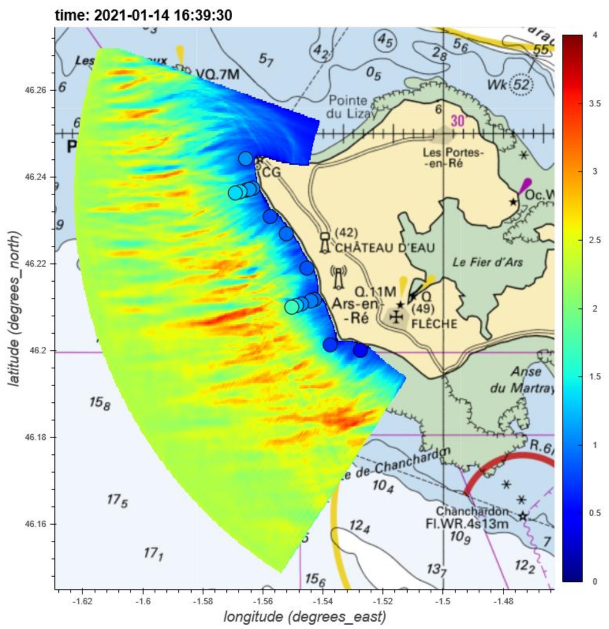

Figure 3 – Significant wave height in the model on January 14th during a rising tide. The colored points represent the observations.

RESULTS AND PERSPECTIVES

Field data and model are used in synergy to decipher the combined processes acting on wave transformation: the model assists the field data processing of the measurements (water level reconstruction methods, much finer and extended space and time description) while measurements allows the model to be precisely calibrated on all the physical processes and in particular on the bottom friction parameterization. The parameterizations resulting from Dealbera's work in the basin (see Dealbera's abstract) are also examined. The work carried out enables the parameterization of simplified barotropic and spectral models used for operational wave and storm surge forecasting.

REFERENCES

Marsaleix, Michaud and Estournel (2019): 3D phase-resolved wave modelling with a non-hydrostatic ocean circulation model, Ocean Modelling Volume 136, pp. 28-50.