Field measurements and modelling of nearshore currents at a high-energy geologically-constrained beach

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INTRODUCTION

While the dynamics of rip currents is well documented on open coasts, only a handful of field works have focused on rip currents flowing along embayed, geologically-constrained, environments where headland rips prevail. Moreover, these few studies were limited to rip current flow under low-moderate incident wave conditions. They showed that headland rips can potentially extend much further seaward than other types of rip currents (Scott et al., 2016). Accordingly, headland rips are hypothesized to play a major role in exchanging sediments between the surf zone and the continental shelf, particularly through headland bypassing (McCaroll et al., 2018). This questions the depth of closure concept in embayments (Valiente et al. 2019). The present study introduces a comprehensive 3-week field experiment carried out at the mesotidal high-energy beach of Anglet (SW France) during October 2018. The experiment aimed at describing wave-induced circulation dynamics in a complex geologically-constrained environment, characterized by the presence of a rocky headland and a prominent submerged reef. During the experiment, the field site was exposed to a wide range of offshore wave conditions, including high-energy storm events, which induced a large variability of flow patterns.

METHODS

In order to capture the spatio-temporal variability of rip flow circulations in presence of strong geological inheritance, a large array of high-frequency measurements were collected at Petite Chambre d'Amour (PCA) beach, at Anglet. Along with a complete bathy-topo survey of the field site, four ADCPs and six GPS-tracked drifters were deployed to measure Eulerian and Lagrangian flows. Additionally, headland-based and Unmanned-Aerial-Vehicle-mounted cameras were used to monitor the full extent of rip current patterns. During the experiment, PCA beach was exposed to a wide range of incident wave conditions characterized by long-period (up to 16 s peak wave period) high- to low-energy wave events (up to 4 m significant wave height) with different angles of incidence. In order to depict the typical rip flow patterns that were observed during the experiment, specific wave events spanning different incident wave conditions are selected and thoroughly analyzed.

RESULTS AND PERSPECTIVES

A slight change in offshore wave conditions (particularly wave height and obliquity) or tide elevation was found to potentially dramatically change circulation patterns along the embayment. Such patterns varied from e.g. enclosed rip-cell circulation primarily enforced by the submerged reef to large-scale headland rip flushing the entire surfzone through transient surfzone eddies. Figure 1 shows velocities and water depth measured during storm conditions (Hs = 4 m and oblique incidence) by the most offshore current meter mounted in 12-m depth 800-m offshore. Measurements show nearly depth-uniform mostly offshore-directed flows of approximately 0.3 m/s, which is the signature of an intense headland rip driven by the deflection of the longshore current against the headland. Figure 1 also shows that rip flow is strongly unstable with, at low tide, 5-min time- and depth-averaged offshore flow peaking at 0.6 m/s with characteristic periods of more than 1 h. To our knowledge, this is the first measurement of what is sometimes referred to as megarip. An XBeach model is set-up to hindcast rip flow patterns during the field experiment. It will be further used to understand the natural variability of surf zone circulation along this embayment and to address the implications for sediment exchanges between the surf zone and the inner shelf.

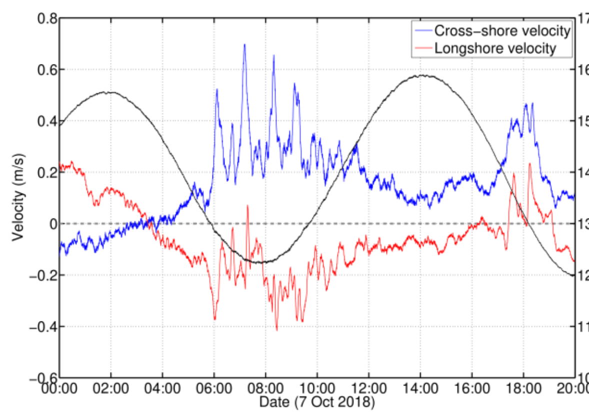

Figure 1 - Offshore 5min- and depth-averaged velocities and water depth measured during storm conditions.

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