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Characterizing wave height in La Réunion Island from microseismic signature of cyclones and austral swells

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The Réunion Island in the South-West Indian Ocean is often affected by austral or cyclonic swells that may have strong impacts on coastal infrastructures. The ReNovRisk project that started in 2017, developed by Météo-France and the University of La Réunion aims at improving cyclone forecasts in the South-West Indian Ocean, by better modelling atmosphere and ocean interactions and by increasing direct observations to better calibrate and validate the swell activity. In the present study, we first analyze the microseismic noise recorded by permanent and temporary seismic stations operating in La Réunion. Together with microseismic noise, we analyze data issued from oceanographic instruments deployed in coastal areas: pressures gauges, OSSI sensors (pressure and temperature) and Acoustic Doppler Current Profiler (ADCP) sensors from which wave height and water currents are derived. These sensors were operated during the period March-May 2017, September-October 2018 and will be deployed twice a year, in and outside of the lagoon, at a depth between 10 and 80 m, with an operational recording of 3 months.

Our results for the austral swells occurring in March-May 2017 and September-October 2018 show that the swells measured on both sides of the reef have the same patterns, except that the amplitudes outside the lagoon are ten times higher than those inside. This demonstrates the major role of the coral reef in attenuating the swell and therefore the importance of preserving it to reduce coastal wave submersion hazards. The amplitude of the primary microseisms (0.05 Hz-0.1 Hz) display a good correlation ($\sim$0.95) with the swell height, confirming its generation by swell-coast interaction. Secondary Microseisms (SM) that develop within the storm at several thousands of km in the Austral Ocean reach the island 1-4 days before the swell hit the coast of La Reunion island, suggesting that SM monitoring may provide a robust way for predicting large swell events.

During the cyclones, the PSD show that the microseismic noise levels in both the PM and SM frequency bands intensified. In the PM band, our results show that the amplitude of the microseismic noise depends on both the distance and the intensity of the cyclone. We observe a clear correlation between the swell height as provided by the WWIII model in the neighbourhood of La Réunion Island and the microseismic noise amplitude, indicating a coastal origin for the PM and confirming that the seismic noise amplitude may be used as a proxy of the swell height. SM is clearly visible for cyclone distance of $\sim$1000 km. Following the arrival of the SM and depending on the cyclone-station distance, the swell hits the coast of the Island and generates the PM signal. This demonstrates that SM can be used to monitor the cyclone activity, but may also provide precursory information on swell arrival time and amplitude.