The role of Bora winds in generating short-period O(30 min) seiches in the Adriatic sea

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An array of oceanographic instruments deployed on an approx. 1.2-km long transect on the Senigallia Adriatic shelf fronting Misa River mouth captured persistent (approx. 2 days), low-frequency oscillations of sea level and cross-shore velocity, following the strong Bora event of Jan, 24-25th, 2014 (the field experiment is described in Brocchini et al., 2017). The Bora storm generated remarkably energetic waves, with 10-s peak period and 3-m significant height. Following the storm, pressure and velocity records show 20 to 120 min oscillations, with amplitudes in the order of 10-20 cm/s, and 2-10 cm. Pressure oscillations were in phase across the entire 1.2-km transect. Pressure and cross-shore velocity spectra show well-defined, distinct peaks at frequencies close to multiples of 0.01 1/min, which suggests a seiche process. The velocity spectrum decays fast at frequencies < 0.03 1/min, while the pressure spectrum exhibits additional peaks at 0.01 and 0.02 1/min, a behavior consistent with the neighbourhood of the shoreline antinode of a cross-shore standing wave.

Although the oscillations follow, and are obviously related to, a strong Bora event, the forcing mechanism and their large scale structure and dynamics are not well understood (details of Bora events themselves have only recently been clarified; Grisogono and Belusic, 2008). Due to its basin shape and topography, the Adriatic may exhibit both longitudinal and transversal seiches. Longitudinal seiches are typically associated with intense winds out of SE, large frontal systems, or with cyclonic activity, with a dominant 22-hour fundamental mode that persists for days. The much shorter period of the observed oscillations observed suggests seiche modes that are dominantly transversal.

Here, we use theoretical and numerical models to investigate the spatio-temporal structure and the generation mechanism of these oscillations. The generation mechanism could be a combination of stress fluctuations in the Bora wind, and convection cells associated with unstable atmospheric stratification in the wake of the Bora event. As narrow jets, Bora winds exhibit significant instability and velocity fluctuations (10-min oscillations between 15 and 25 m/s; Grisogono and Belusic 2008). Convection cells forming in an unstable atmospheric stratification in the wake of a cold-front passage over the North sea were shown to be the forcing of ocean surface
oscillations on a similar scale observed at Port of Rotterdamwere, the Netherlands (DeJong and Battjes, 2004).

The study highlights aspects of the relation between Bora events and transversal seiches that are not well documented and poorly understood, but relevant in relation with other air-sea interaction processes that have a significant shoreline impact, such as wave activity, meteotsunamis, and flooding induced by storm surges.