Observation of Shoreline Reflection of Infragravity Waves in the Port of Salalah, Oman

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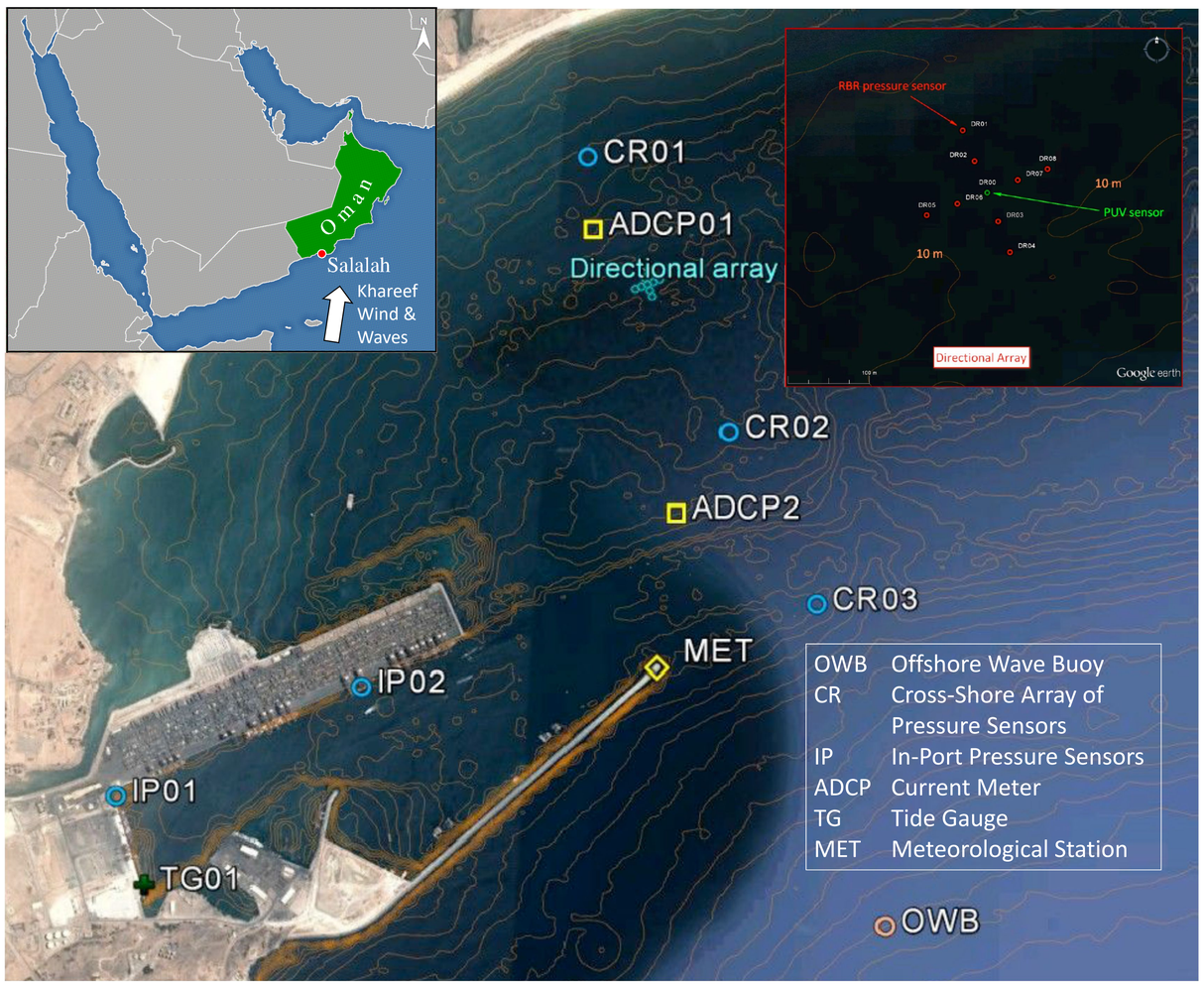

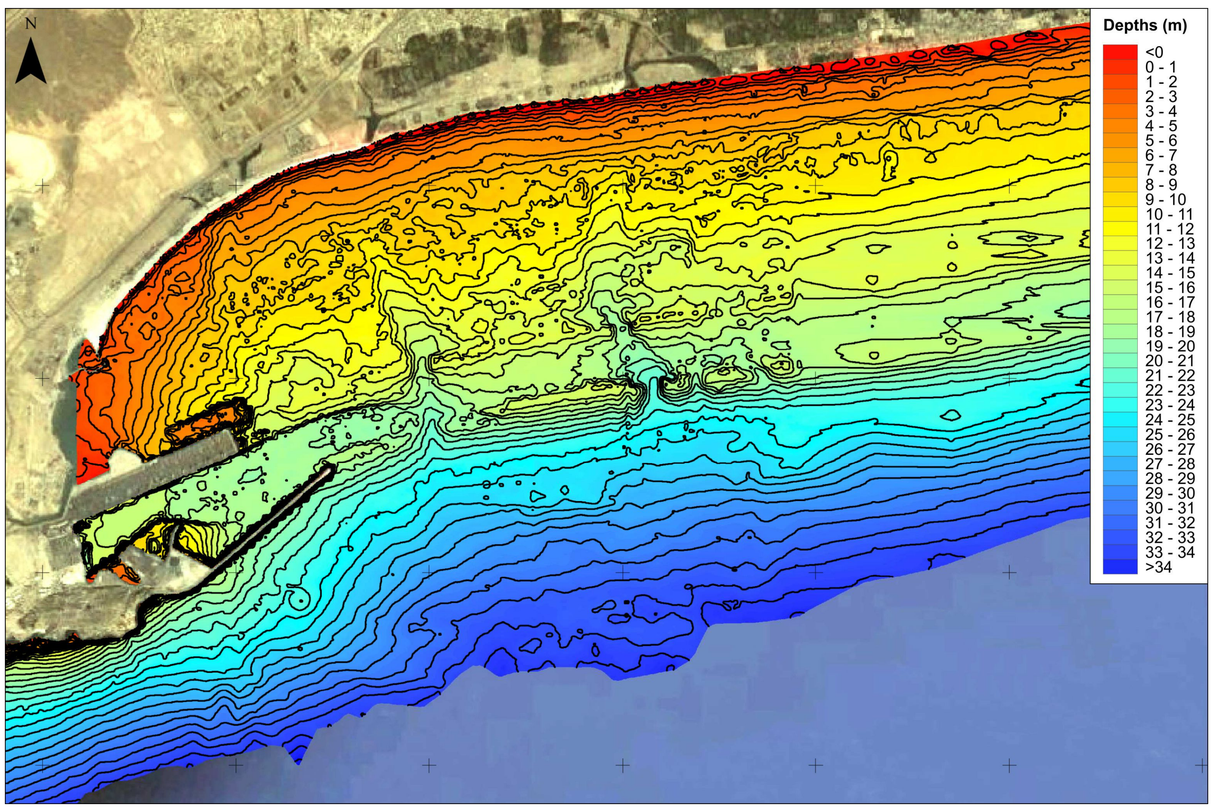

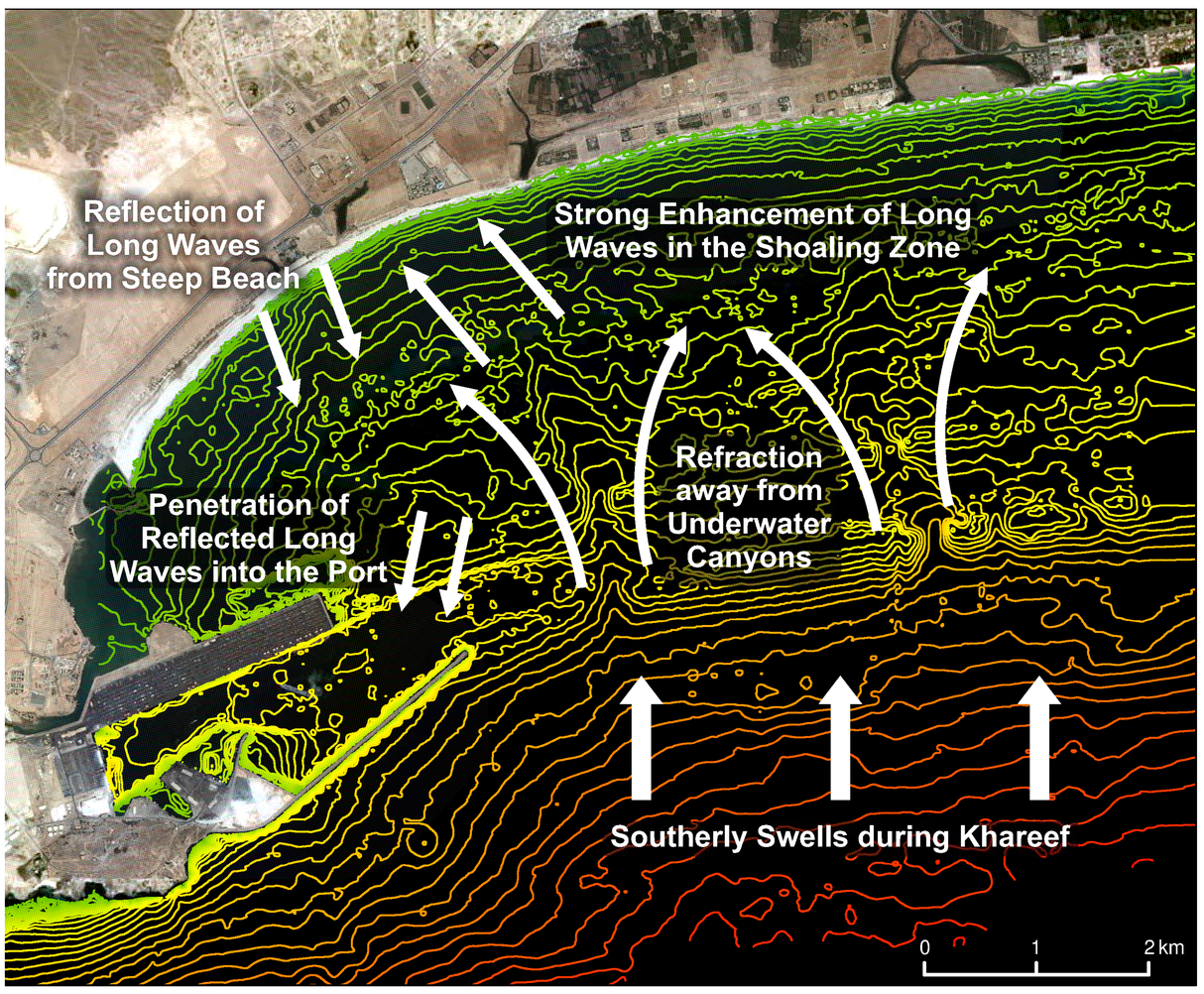

The loading and unloading of container ships in the Port of Salalah, Oman, is occasionally disrupted due to excessive surge motions of moored ships. The loading of a container onto a moving target is challenging and the container can get jammed in the cell guides on the ship. The surge motions of the vessels are due to infragravity waves induced by incoming swells during the Khareef Southwest monsoon (June through September). The long waves do not break at the beach, but reflect here and enter the port from the lee side of the existing breakwater.

An extensive measurement campaign was conducted consisting of collection of swell, infragravity wave, current, water level and meteorological data. In total, 19 instruments were deployed during a period of five months. The primary objective was to confirm the source of long-period oscillations previously observed in the port basins.

A key part of the set-up was a directional array outside the port consisting of eight pressure sensors and one PUV sensor, where infragravity wave directions could be derived and compared using different instruments in the array. The radius of the array was 40 m to the inner sensors and 80 m to the outer sensors.

Directional spectra obtained from the PUV instrument agreed well with spectra obtained using different combinations of pressure sensors. Therefore, the choice of the radius of the array was not critical for the results. The Bayesian Direct Method (BDM) provided the most consistent results for wave directions and reflection coefficients, both for swell and infragravity frequencies.

A large amount of infragravity wave reflection from the shore was observed during the Khareef season. Reflection was especially significant at high tide. The large reflection can be explained by the steep beach slopes that is formed each year due to erosion during the Khareef season. The steepest slope is formed close to the waterline at high tide. The same tidal modulation of infragravity waves was observed inside the port. A strong correlation was found between the shoreline reflected infragravity wave height outside the port and the total infragravity wave height inside the port.