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Origin of the "Odessa tsunami" of 27 June 2014: Data assessment and numerical modelling

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During 23 to 27 June 2014, several locations in the Mediterranean and the Black Sea were hit by destructive tsunami-like waves. Analysis of synoptic conditions, air pressure and sea level records indicated that all these events were meteorological tsunamis, i.e. tsunami-like waves generated by short-lasting (a few tens of minutes) but intense air pressure disturbances. The north-western Black Sea was one of the regions impacted: at approximately noon on 27 June a 1-2 m high wave struck the beaches of Odessa, the third largest Ukrainian city, and the neighbouring port-town Illichevsk. Several people were injured and taken to hospital.
Throughout the day, a distinct meteotsunamigenic synoptic pattern, accompanied by pronounced air pressure oscillations, was observed over the Black Sea, 150 to 300 km south of Odessa, stretching from Romania in the west to Crimea in the east. Right at the time of the event, a 1-2 hPa air pressure jump was recorded at Odessa. We have utilized a barotropic ocean numerical model to test two hypothesis: (1) a tsunami-like wave was generated by an air pressure disturbance propagating directly over Odessa; (2) a tsunami-like wave was generated by an air pressure disturbance propagating off-shore, approximately 200 km to the south of Odessa. Surprisingly, 1.5 times higher maximum modelled sea level heights in Odessa were obtained in the second set of experiments. The resulting increase was 10 cm per 1 hPa of air pressure change for an offshore disturbance and 7 cm per 1 hPa for a direct forcing experiment. The numerical model decisively confirms the meteorological origin of the tsunami-like waves on the coast of Odessa and implies that intensified long-ocean waves in this region were generated via the Proudman resonance mechanism while propagating over the northwestern Black Sea shelf. Upon hitting the shelf-break, modelled ocean waves detached from the air pressure disturbance and reflected northwards. Following the reflection, the waves propagated along a submarine canyon hitting precisely Odessa and Illichevsk. These results are further supported by analysis of satellite imagery, clearly depicting a convective cloud propagating eastward over the shelf break, coincident with timing of the event.