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On the generation of a meteotsunami, the case study of supercell storm, over Adriatic Sea

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In the afternoon of July 22, 2023, a very intense thunderstorm developed over the central Po Valley. It quickly cross the Adriatic sea traveling from the center of the Po Valley to the Croatian coast, moving in the direction northwest-southeast. The thunderstorm speed ranged between 50 and 80km/h, with a downdraft exceeding 100 km/h, wind gust up to 120 km/h, which led to the formation of intense hailstorms with hail larger than 8 cm. The pressure difference between the front and central regions of storm, reaced 6 hPa, with peaks up to 10 hPa. As the supercell moved towards the coast, the combined effects of the downdraft and the pressure variation, along with the storm's speed, likely triggered a meteotsunami. Both amateur evidences and instrumental observations showed the propagation of a wave along the Adriatic coast, from North to South, with an amplitude of about 40 cm and a period of approximately 20 minutes. This phenomenon was observed from Ravenna (where the stormcell moves from land to sea) to Ancona, San Benedetto del Tronto, and Ortona with a propagation speed comparable with the storm speed thus, in good agreement with a possible Proudman resonance. Physical analysis and numerical simulations of the atmosphere and ocean were performed using numerical models: WRF (Weather Research and Forecasting System), ICON (Icosahedral Numerical Model), and ROMS (Regional Oceanographic Modeling System), coupled with SWAN (Simulating Waves in Nearshore) at 1 km horizontal resolution. The atmospheric results accurately reproduced the storm's structure and evolution. The coupled ROMS and SWAN model was performed to assess the individual impacts of the downdraft, the vertical component of the downdraft, the pressure surge, and the overall storm surge. This work presents the outcomes and key factors contributing to the generation and amplification of this phenomenon.