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The response of the lower ionosphere driven by the chain of the meteotsunamis in the Mediterranean Sea during 23 - 28 June 2014

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The tsunamis are long waves originated in the seas and oceans from different reasons. The basic contribution to tsunami formation is created by the earthquakes, however there are another sources of the tsunamis. Among them some part of the tsunamis are formed due to the meteorological reasons. Such tsunamis formed under the influence of atmospheric processes are named the meteotsunamis. Jumps of the atmospheric pressure, typhoons, hurricanes, storms, cold fronts, etc. can be the meteotsunamis reasons. The meteotsunamis are observed at many locations around the world: in oceans, seas and even lakes. Tsunamis and meteotsunamis have the same periods, same spatial scales and they also generate internal gravity waves (IGWs) propagating upward into the ionosphere where they dissipate and produce perturbations in the plasma density. These perturbations can be detected by electromagnetic waves such as sub-ionospheric very low and low-frequencies (VLF/LF) signals.
A chain of meteotsunamis was observed in the Mediterranean and the Black Sea during 23 - 28 June 2014. These events were caused by a unique synoptic system that traveled above the Mediterranean Sea from Spain to Turkey and into the Black Sea. The system produced sharp atmospheric pressure changes (more than 2 hPa in 5 min), which caused tsunami waves in the open waters of 2-3 cm. The waves traveled in the open sea in different directions and intensified topographically close to the coast.
The measurements from the VLF/LF ground based network of receiver stations in the South Europe “The International Network For Frontier Research on Earthquake Precursors” (INFREP) were used to study the response of the lower ionosphere to the meteotsunamis in the Mediterranean Sea. Revealed VLF/LF anomalies coincided in time with meteotsunami events. The nighttime anomalies in low-frequency signal were observed on 23-24 June in the region between Spain and Sicily. The next VLF/LF anomalies were registered on 25-26 June near Italy and in the Adriatic Sea. The VLF/LF anomalies were also observed on 27 and 28 June with twice intensity in the region between Sicily and Crete and with much smaller intensity in the region Crete - Cyprus. The spectral analysis of the anomalous VLF/LF signals revealed periods between 15 and 30 min, coherent with the tsunami. These periods are also in good agreement with the periods of IGWs.