Analysis of Swarm Electric Field Data in View of Tsunami Events and related Earthquakes

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Three Swarm satellites are equipped with Langmuir Probes (LP) measuring in-situ electron density of Earth electric field and POD GNSS receivers determining topside total electron content (TEC) in the upper ionosphere. It is proved that different events on the Earth and in its atmosphere have their own impact on Earth electric field, and the earthquakes are in this group. Many strong earthquakes induce tsunamis, which are also suspected as contributing to the gravity waves having an impact on the ionospheric TEC. These reasons encourage to the study on the sensitivity of Swarm LP and POD GNSS data to the abovementioned phenomena. Referring to the sensitivity of TEC data derived from GNSS stations to Earthquakes, sensitivity of GNSS and LP data at around 500 km high orbit is analyzed here. A similar orbital height can be found in case of many LEO missions equipped at least with GNSS POD receivers, which makes Swarm especially interesting data acquisition platforms.

The investigation of Swarm data in view of Tsunamis and earthquakes is difficult due to several factors. There are only three satellites, the two of which fly almost together, which gives in fact only two points of the survey. The orbital repetition period is long, which seriously limits the number of comparable observations in terms of the location and time of the day. Finally, the number of large earthquakes and tsunami events in time of Swarm science mission is low, and many Earthquakes do not coincide sufficiently with Swarm passes in time and space. All these factors, however, doesn't exclude an opportunity of analyzing of Swarm data passes above the earthquakes of magnitude nearby 8, linked with the tsunamis reaching several decimeters.

Swarm LP data is detrended and analyzed before the earthquakes and also during the earthquakes and resulting tsunami events. The GNSS POD topside TEC from Swarm is analyzed together as a background for LP data. In-situ electron density disturbances occurring during a pass close to the earthquake is compared to selected STEC measurements between LEO and GNSS satellites. Additionally absolute STEC values from selected nearby ground stations are analyzed in order to find existing correlations for detected disturbances in the electric and magnetic fields. All the observations are sparse in time and space, and therefore, leave some unanswered questions and uncertainties. However, several interesting perturbations over earthquake/tsunami events are observable in both Swarm LP data and GNSS TEC data.