Tsunami-induced ionospheric signatures database from GNSS-TEC observations

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Abstract

As tsunamis propagate across open oceans, they remain largely unseen due to the lack of adequate sensors. To help better mitigate the tsunami risk, we use a GNSS-based detection method that takes advantage of the efficient coupling of tsunami waves with the atmosphere. Atmospheric waves forced by tsunamis propagate upward, reaching the ionosphere. At ionospheric heights, they put charged particles into motion, creating propagative phenomena known as Traveling Ionospheric Disturbances (TIDs). Thanks to GNSS, such disturbances can be monitored and observed using the Total Electron Content (TEC) derived from dual-frequency measurements. However, due to the highly dynamic behavior of the ionosphere, identifying the tsunami-induced signatures in the noisy TEC measurements is complex. Moreover, as the number of GNSS satellites and receivers increases, the amount of TEC data to handle during the process of detecting tsunami-induced signatures becomes humanly unmanageable. Therefore, we built a procedure to identify tsunami-induced ionospheric TEC signatures and apply the method to build a database of such signatures that appear after the passage of past tsunamis across the Pacific Ocean. Such database could later feed machine learning algorithms and improve the robustness of the tsunami detection procedures.