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## **Wave Analysis of Traveling Ionospheric Disturbance (TID) in GPS TEC Launched by the 2011 Tohoku Earthquake**

Abstract:

TIDs have been detected using various measurement techniques, including HF sounders, incoherent scatter radars, in-situ measurements, and optical techniques. However, there is still much we do not yet know or understand about TIDs. Observations of TIDs have tended to be sparse, and there is a need for additional observations to provide new scientific insight into the geophysical source phenomenology and wave propagation physics. The dense network of GPS receivers around the globe offers a relatively new data source to observe and monitor TIDs.

In this paper, we use Total Electron Content (TEC) measurements from various GPS receivers throughout the continental United States to observe TIDs associated with the 11 March 2011 Tohoku tsunami. The tsunami propagated across the Pacific to the US west coast over several hours, and corresponding TIDs were observed over Hawaii, and via the network of GPS receivers in the US. The network of GPS receivers in effect provides a 2D spatial map of TEC perturbations, which can be used to calculate TID parameters, including horizontal wavelength, speed, and period.

Much work is still needed in order to fully understand the ocean-atmosphere coupling mechanisms, which could lead to the development of effective tsunami detection/warning systems. The work presented in this paper demonstrates a new technique for the study of ionospheric perturbations that can affect navigation, communications and surveillance systems.

If time permits, we will also describe the TIDDBIT HF sounder system being deployed in Hawaii for the US Navy for the purpose of detecting and studying TIDs caused by tsunamis, and other TIDDBIT systems deployed to support geolocation purposes.