

Detection and modeling of the ionospheric gravity/tsunami waves and perspective for future tsunami remote sensing systems

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Propagating ionospheric gravity waves associated to tsunami have been observed for the Sumatra, December 26th, 2004 and the Peru, June 23, 2001 events. These waves, detected by the dual frequency altimeters onboard in the Jason-1 and Topex/Poseidon satellites for Sumatra and by GPS receivers in both cases, confirm that the ionosphere is affected by tsunamis and that the ionospheric signals can be used for tsunami monitoring. We present here the first comparison between synthetic ionospheric signals and the associated observations. We model first the tsunami using a finite difference scheme that resolves the hydrodynamical equations on a 2' bathymetric grid. A realistic seismic source is used, constrained by the Topex and Jason altimetry data. We then use a 3D pseudo-spectral modeling of gravity waves in a non-isothermal atmosphere for computing the generated gravity wave. The response of the ionospheric plasma to the consequent neutral motion is then computed. The model solves the hydromagnetic equations for three ions: O₂⁺, NO⁺ and O⁺ and electrons to obtain the perturbed density and polarization electric field respectively. We reproduce with a good agreement the Total Electron Content (TEC) perturbations observed by Topex/Poseidon and Jason-1 in the case of the Sumatra tsunami. We then discuss the effect of the magnetic latitude, local time, activity of the ionosphere and amplitude of the tsunami in the signal to noise ratio, as well as the detection delay, associated to the propagation of the internal gravity wave from the sea level to the ionosphere. We finally conclude with the perspective of this technique for possible tsunami warning and present different concepts for performing real time and continuous monitoring of the ionosphere, either from space or from the ground.