Ionospheric seismology: From the remote sensing of tsunamis in Earth atmosphere to Venus perspectives

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Ionospheric seismology, which was at most seen as an exotic way to record doubtful signals in the early 2000 has gain maturity, especially after the worldwide observations made during the Tohoku 2011 earthquake and tsunami.

We compare and illustrate the different observation techniques available today, with a focus on ground, air-based and space-based GPS measurement and airglow and illustrate the later with data recorded during the Tohoku 2011 and Haida Gwai earthquake and tsunamis. We then discuss the physics enabling the conversion of seismic waves into electron perturbation (for GPS data) and light emission (for airglow). This allow us to model these signals and to discuss the sensitivity of the coupling between seismic or tsunami waves and acoustic or gravity waves to the atmosphere structure, the subsurface and crust structure, the ocean thickness and local time, ionospheric state and magnetic latitude.

We then show that these signals can already be inverted and used to predict with very high accuracy the amplitudes of tsunami at the sea level and a characterization of the seismic source of large earthquake, enabling important perspective for the future improvement of the global and regional tsunami warning systems.

We conclude by showing that the atmospheric-seismic coupling is not only important for Earth seismology but also for exploration of the interior of Venus, as this planet is likely the best in term of solid/atmosphere seismic coupling strength.