MODELLING THE GPS-TEC OBSERVATIONS AFTER LARGE EARTHQUAKES

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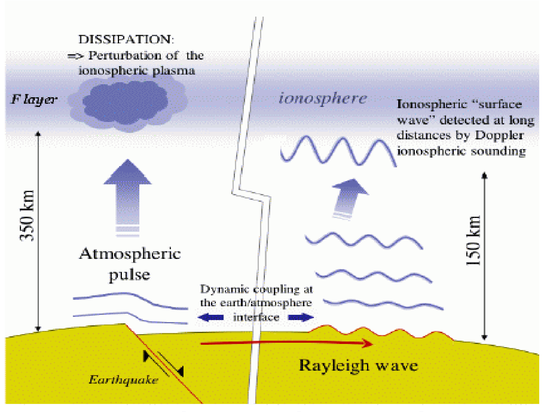


Fig. 1 : Coupling mechanisms between earth, its atmosphere and ionosphere involved after an earthquake (courtesy of J. Artru-Lambin)

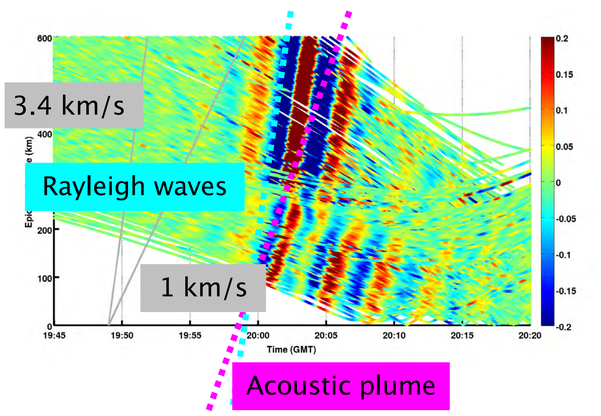


Fig. 2 : Epicentral distance time TEC series measured during the M=8.3 2003/9/25 Tokachi-Oki earthquake

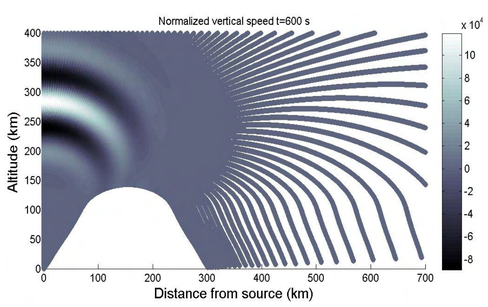


Fig. 3 : Acoustic plume launched in a stratified atmosphere : models the earthquake effect above the epicenter (after Heki & Ping, 2005)

Abstract

Ionospheric perturbations after large and shallow earthquakes are now commonly monitored by GPS with a current minimum magnitude of 6.5. In theory, the Total Electronic Content maps detected by a dense GPS network should present a similar pattern : at near field, the propagation of a slow wave (~1km/s) is related to the sound pulse generated at the epicentre, while at far field the fast (~3.5 km/s) wave train is excited by the Rayleigh surface waves. However, the satellites geometry is a key point for the observation of the two kinds, taking into account the 3D structure of the waves and the integration on the satellite-receiver ray-path. Then, we present the simulation results of the integrated electronic density perturbed by an acoustic plume for various ionospheric and geomagnetic conditions. The simulations are finally compared to the ionospheric perturbations monitored by the japanese GPS network GEONET just after recent major events : the Niigata-Chuetsu Oki earthquake of July 16, 2007 and the Iwate-Miyagi inland earthquake 2008 will be analysed here.

Geomagnetic field effect

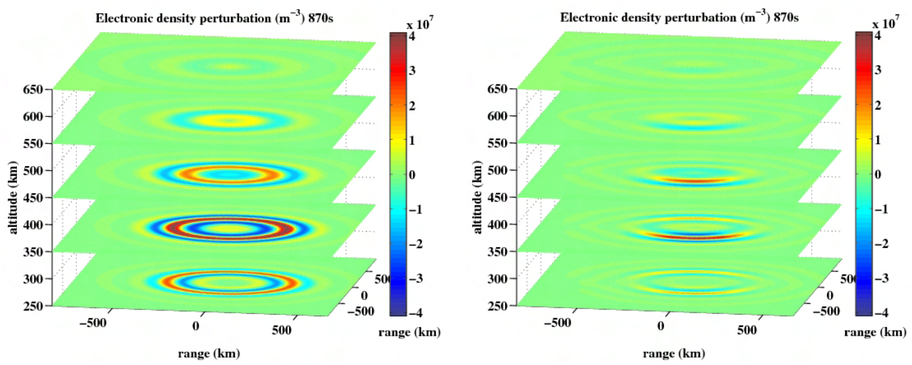
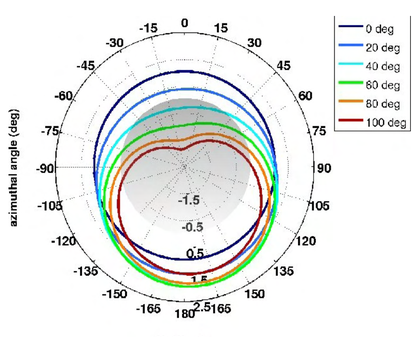


Fig. 4 : Simulated 3D electronic perturbation under the effect of an acoustic plume without and with magnetic field (modelled after Kherani et al.)

Fig. 5 :
Attenuation function in polar representation of the perturbation under the local geomagnetic field for different inclination angle of launched acoustic rays.



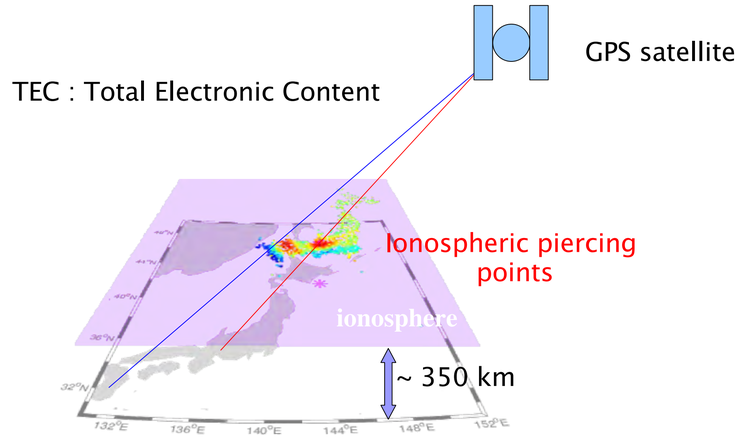


Fig. 7 : Ionospheric mapping

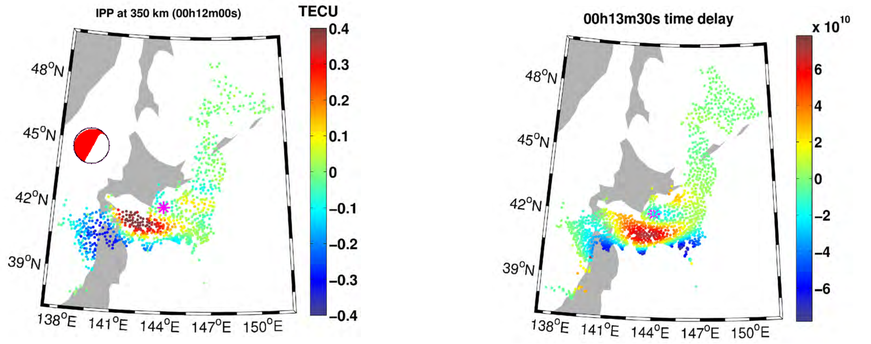


Fig. 6 Left : time-filtered Slant TEC map measured 12 minutes after the Tokachi-Oki earthquake
Right : synthetic TEC map modelled by integration of the 3D perturbed electronic density along the GEONET stations-satellite ray paths at fig. 4

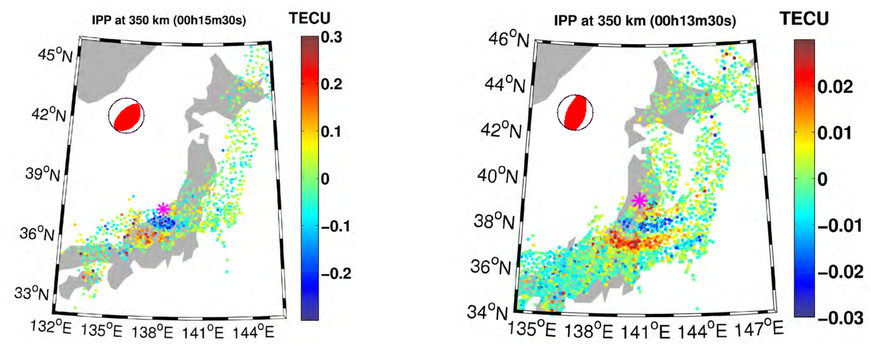


Fig. 7 Left : time-filtered STEC map measured after the M6.6 Niigata-Chuetsu Oki earthquake (07/16/2007)
Right : time-filtered STEC map measured after the M6.9 Iwate-Miyagi inland earthquake (06/13/2008)

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References :

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K. Heki and J. Ping, 2005. Directivity and apparent velocity of the coseismic ionospheric disturbances observed with a dense GPS array, Earth and Planetary Science Letters, vol. 236, pp. 845-855.

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