

GPS 4次元トモグラフィーによる地震発生に伴う電離層内波動現象の解明

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Analysis of wave propagation in the ionosphere associated with earthquakes by the GPS 4D tomography

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GPS-TEC observation by GEONET during the 2003 Tokachi-Oki earthquake shows a clear propagating ionospheric disturbance. Heki and Ping (2005) interpreted the phenomena as a propagating sound wave in the thermosphere which was originally radiated into the atmosphere from the earthquake source region. 1Hz GPS-TEC data from GEONET provide a dense line of sight coverage of space and time above and around the Japanese islands during and the after the earthquake. Seismology has developed a method to retrieve 3D images of seismic velocity structure inside the Earth from noise-rich travelttime delay measurements of seismic body waves from earthquakes to the seismic stations. We have extended the seismic tomography method to obtain stable the spatially and temporally continuous variations of the electron content images.

The image results show dispersive propagating waves, i.e., the phase speed of the waves is different from the wave energy propagation speed. The first phase, which appears first 100 km above the epicentral area, propagates horizontally with a phase speed about 1km/s and the secondary phase propagates slower. A close examination of the propagation of the first phase shows dispersion of the phase (Figure 1). The positive peak of the first phase travels 10% faster than the negative peak so that the peak shape broadens as it proceeds. The amplitude of the positive peak diminishes as it propagates over 1400 km distance from the source region. In contrast to the positive peak, the negative peak first appears as small amplitude and grows after traveling over 1000 km from the source region.

Study of the evolution of the 4D GPS-TEC disturbance will provide rich information about the mechanisms of generation and propagation of ionospheric disturbance through the solid-earth-atmosphere-ionosphere coupling. An ultimate goal is to retrieve the earthquake fault parameters by modeling the GPS-TEC observations.

