Spatial Distributions of Total Electron Content Variations Associated with Earthquakes

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The coseismic ionospheric disturbances are generated by the acoustic wave and atmospheric gravity wave excited by earthquakes. In the previous studies, it is found that the perturbations of total electron content (TEC) are correlated with the magnitude of the earthquake. On the other hand, the relationship between the magnitude and the spatial distributions of these perturbations are not examined in detail. Using two-dimensional TEC maps derived from the GNSS Earth Observation Network (GEONET), in this study, we have analyzed the spatial distributions of TEC variations associated with earthquakes. First of all, the TEC distribution map is divided in grid whose size is 0.2 x 0.2 degrees. The spectral intensity of the TEC perturbations is calculated using Fast Fourier Transform. The average of the spectral intensity in each grid is determined from those in the ionospheric pierce points (altitude = 350 km) located with in each grids. After the center of the TEC variation distributions are determined from the average map, the latitudinal and longitudinal width of the TEC perturbations are estimated by fitting the perturbations with the Gaussian function. We analyzed 5 earthquakes (M > 6.8) whose epicenters are located at the sea around Japan since 2000. The wave recorders installed by the Japan Meteorological Agency observed the heights of tsunamis. Using these data, the heights of tsunamis in the epicenter are determined using Green's theorem, which explains the relationship between the height of tsunami and the depth of the sea. The results of the fitting shows that the latitudinal width of TEC variations is correlated with the height of tsunami, while longitudinal one is not. This is because, in the events that occurred along the coast, the height of tsunami is highly fluctuated due to the coast line. In such events, therefore, we determined the latitudinal width of TEC variations using ionospheric pierce points located on land-side. In the result, the correlation between the longitudinal distribution of TEC variations and the height of tsunami increased. Since the correlation between TEC variations and the height of tsunami is high, if events of the analysis target increase in the future, there is a possibility that the location, time and scale of the tsunami can be estimated.

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