Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS26-09 Room:102B Time:May 21 11:30-11:45

Tsunami induced ionospheric disturbances detected by GPS-TEC observation after the 2011 Tohoku earthquake

TSUGAWA, Takuya[1*], NISHIOKA, Michi[1], SHINAGAWA, Hiroyuki[1], MARUYAMA, Takashi[1], OGAWA, Tadahiko[1], SAITO, Akinori[2], OTSUKA, Yuichi[3], MATSUMURA, Mitsuru[4], NAGATSUMA, Tsutomu[1], MURATA, Ken T.[1]

[1]NICT, [2]SPEL, Kyoto Univ., [3]STEL, Nagoya Univ., [4]University of Electro-Communications

All the details of the commencement and evolution of ionospheric disturbances after the 2011 off the Pacific coast of Tohoku Earthquake were revealed by the high-resolution GPS total electron content observation in Japan. The initial ionospheric disturbance appeared as sudden depletions by about 6 TEC unit (20%) following small impulsive TEC enhancements around 05:54UT, about seven minutes after the earthquake onset, near the epicenter. At 06:00UT, zonally extended enhancements of TEC appeared in the west of Japan, and traveled to the southwest direction. From 06:00UT to 06:15UT, large-scale circular waves
with two peaks propagated in the radial direction in the propagation velocity of 3,457 m/s and 783 m/s for the first and second peak, respectively. Following the large-scale waves, medium-scale concentric waves appeared to propagate at the velocity of 138-423 m/s after 06:15 UT. In the vicinity of the epicenter, shortperiod oscillations with period of about 4 minutes were observed after 06:00 UT for 3 hours or more. We focus on the the circular and concentric waves in this paper. The circular or concentric structures of the large- and medium-scale waves indicate that these ionospheric disturbances had a point source. The center of these structures was located around 37.5 deg N of latitude and 144.0 deg E of longitude, 170 km far from the epicenter to the southeast direction. We termed this center of the coseismic ionospheric variations as ”ionospheric epicenter”. According to the propagation velocities, the large-scale waves would be caused by the acoustic waves generated from the propagating Rayleigh wave for the first peak and from the sea surface near the epicenter for the second peak. The wavelength and the propagation velocity of the medium-scale concentric waves tended to decrease with time. This characteristic is consistent with the result of a numerical model of the coseismic atmospheric wave, indicating that these medium-scale waves were caused by the atmospheric gravity waves. The amplitude of the large- and medium-scale circular waves were not uniform depending on azimuth of their propagation direction, much larger in the north and west directions than other directions. This directivity could not be explained by the previously proposed theory.

Keywords: ionosphere, earthquake, tsunami, acoustic wave, atmospheric gravity wave, concentric wave