IONOSPHERIC WAVES ASSOCIATED WITH EARTHQUAKES AND NUCLEAR EXPLOSION USING TOTAL ELECTRON CONTENT (TEC)

(T3.3-P5)

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ABSTRACT

The atmospheric infrasonic and gravity waves can be excited by seismic activities such as earthquakes and tsunamis. The ionospheric wave monitoring system of GPS data associated with earthquake has been developed from GPS observation stations network. Using Sliding Fast Fourier Transform (SFFT) on differential Total Electron Content (TEC) data estimated from the carrier phase data of the GPS signal, the irregularity of ionospheric fluctuations within a few seconds to tens of minutes period with varying average amplitudes in order less than 0,01 TECU can be detected in the ionosphere. At a certain moment, the ionospheric fluctuations become more regular with amplitude reaching greater than 0,01 TECU. GPS data inspection methodology during the occurrence of large earthquakes showed that ionospheric wave can be detected several minutes to several hours after the earthquake and tsunami. The Nuclear explosions were examined using this method. The results indicate a little TEC anomaly after the explosion.

METHODS

Earthquake effects on ionosphere can occur through the Lithosphere-Atmosphere-Ionosphere (LAI) coupling. Large earthquakes and tsunamis can induce the atmospheric infrasonic and gravity waves that propagate through the ionosphere, so the ionosphere fluctuates in order of the atmospheric infrasonic and gravity waves periods.

Advances in science and technology made the GPS technology as a learning facility in Total Electron Content (TEC) anomaly detection related with earthquake effects. Recent studies have shown that earthquake and tsunami affected the ionosphere through the atmospheric infrasonic and gravity waves and have been found in large earthquake cases.

A brief description of system to determine ionospheric irregular fluctuations as effect of seismic activities such as earthquakes and tsunamis is shown in Figure 1. To examine effect of nuclear explosion in ionosphere, we also apply this method.

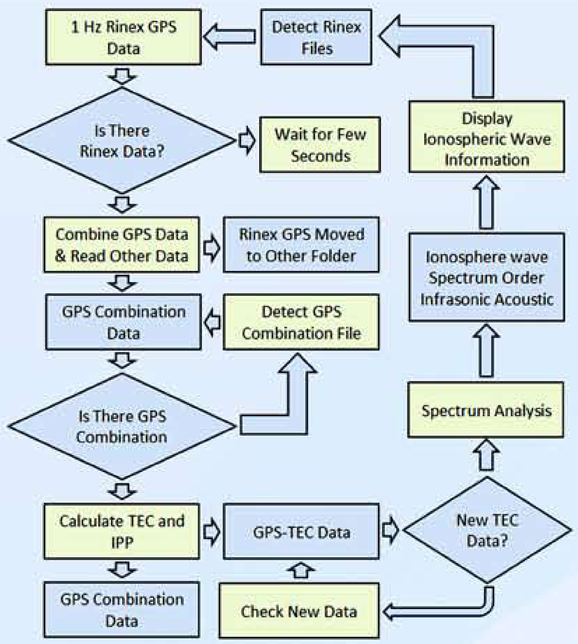

Figure 1 Flow chart of ionospheric wave monitoring system from GPS data.

CONCLUSIONS

1. The ionospheric waves associated with earthquake and tsunami activities can be showed by ionospheric wave monitoring systems. The ionosphere periodic oscillation is equal to the order of infrasonic wave oscillation to atmospheric gravity waves.
2. Testing Sliding Fast Fourier Transform (SFFT) on differential Total Electron Content (TEC) to Aceh earthquake and tsunami December 26, 2004 showed that the methodology was able to detect the ionospheric waves caused by this earthquake and tsunami.
3. Application SFFT method in North Korea nuclear test, January 6, 2016 at 01:30:01 UTC indicate ionospheric anomaly after the explosion.

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RESULT AND DISCUSSION

Testing on Aceh earthquake day of December 26, 2004 showed that ionospheric waves could be detected several minutes to several hours after the earthquake and tsunami depending on the distance of ionospheric observation point from the earthquake epicenter (Figure 2). North Korea nuclear test, January 6, 2016 at 01:30:01 UTC also were examined using this method. The results indicate ionospheric anomaly after the explosion (Figure 3).

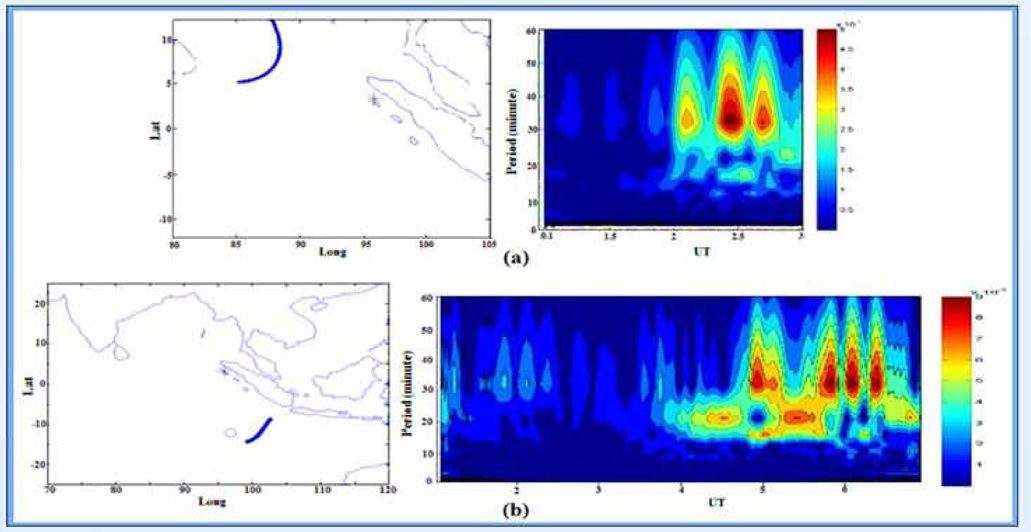

Figure 2 Infrasonic ionospheric wave appeared after the Aceh earthquake, December 26, 2004 that occurred at 00:58:53 UT, (a) Ionospheric wave with a period of 34 minutes at 1:51 UT and (b) Ionospheric wave with a period of 22 minutes at 4:00 UT.

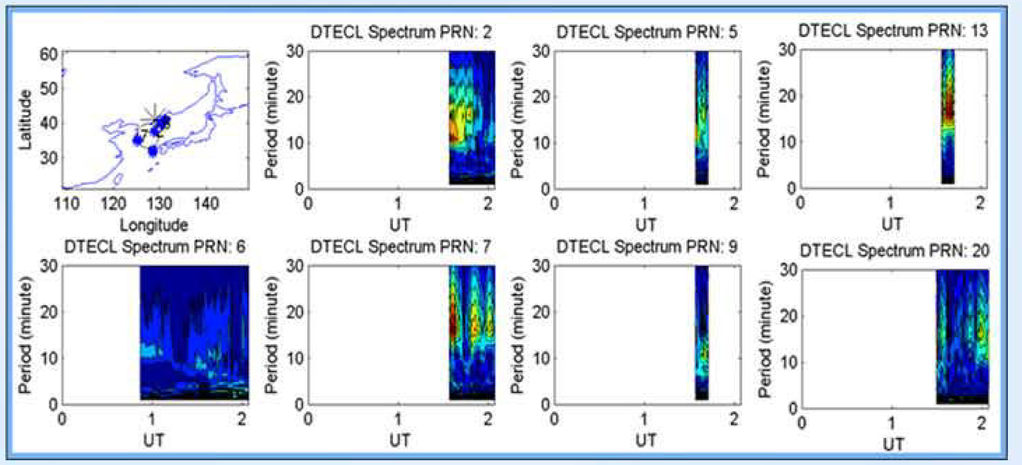

Figure 3 Ionospheric wave after January 6, 2016 North Korea nuclear test at 01:30:01 UT (DAEJ Station).