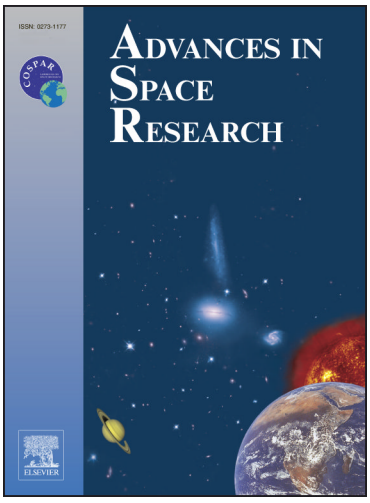

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Atmospheric-ionospheric disturbances following the April 2015 Calbuco volcano from GPS observations

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Abstract

The atmospheric-ionospheric anomalies triggered by eruptions of the Calbuco volcano on 22th and 23th, April 2015 are investigated from 50 continuous GPS stations observations. Prominent total electron content (TEC) disturbances with the amplitude of 0.1~0.4 TECU are found about one hour after the eruptions. The disturbance lasts more than one hour for the first eruption and about half hour for the second eruption. The disturbance features are extracted from PRN03 and PRN23 for the first eruption and PRN13 and PRN28 for the second eruption. The propagation velocities from the travel time diagrams are around 800 m/s and 900 m/s for the two eruptions, respectively. The spectrogram of filtered TEC time series is centered at 3.7 mHz, which is in the frequency range of infrasonic waves. The distribution and characteristics of the TEC anomalies are closely associated with the position relationship between SIP tracks and volcano. The results of SO_2 and temperature anomalies around the eruptions obtained from Aura/Ozone Monitoring Instrument (OMI) and COSMIC vertical profiles are consistent with results from GPS TEC.

Keywords: Atmospheric disturbances; GPS; COSMIC; TEC; Volcano

1. Introduction

Large volcanic eruptions can trigger acoustic resonance between the Earth surface and the atmosphere. Some of the resonance waves leak upward into the ionosphere and trigger ionospheric disturbances (Caudron et al., 2015; Nakashima et al., 2016; Shah and Jin, 2015; Wang et al., 2016). The atmospheric-ionospheric anomalies can be detected by the atmospheric temperatures and ionospheric total electron content (TEC). Atmospheric delay is one of the main errors in global positioning system (GPS), which now can be estimated and has widely used in climatology and space weather (Jin et al., 2004, 2006, 2007a, 2007b, 2008a, 2008b, 2009, 2011a, 2013, 2014a, 2016, 2017a; Jin and Park, 2007; Jin and Luo, 2009; Jin and Komjathy, 2010; Jin and Najibi, 2014; Li et al., 2017) as well as earthquakes (Heki, K. et al., 2006; Afraimovich et al., 2010; Jin et al., 2010, 2011b, 2013 and 2017b). A detailed method using GPS TEC to study the 2008 Wenchuan earthquake and the 2011 Japan earthquake was introduced by Jin et al (2015). Furthermore, distinct TEC disturbances with an amplitude of 0.03~0.16 TECU were detected by GPS after 12 minutes of the eruption of the Asama volcano in Japan on 1th September, 2004 and the velocity of the ionospheric anomalies was around 1.1 km/s (Heki et al., 2006). The propagation speed of the anomalies was similar to the velocity of acoustic waves in the ionosphere.

The ionospheric anomalies triggered by strong earthquake or large volcano eruption were found in the form of a typical N-shape wave at first. While the mechanism and processes of earthquake or volcano