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SCG69-P06 会場:コンベンションホール 時間:5月24日 17:15-18:30

Coseismic ionospheric disturbances and preseismic TEC anomalies of 2005 Nias and 2007 Bengkulu earthquakes from GPS-TEC

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Ionospheric Total Electron Content (TEC) is easily derived from the phase differences of the two L band carrier waves of the Global Positioning System (GPS) satellites. Past GPS-TEC studies revealed various kinds of ionospheric disturbances originating from phenomena in the solid earth, e.g. volcanic eruption [Heki,2006], launches of ballistic missiles [Ozeki and Heki, 2010], mineblasts [Calais et al., 1998]. The 2005 Niasearthquake (Mw 8.7)[Briggs et al., 2006]and the 2007 Bengkulu earthquake (Mw 8.6)[Gusman et al., 2010] occurred as mega-thrust earthquakes in the Sunda arc, Sumatra, as aftershocks of the 2004 great Sumatra-Andaman earthquake(Mw 9.2) [Banerjee et al., 2005].

In this study, we investigate the coseismic ionospheric disturbances (CID) and pre-seismic TEC anomalies of these two earthquakes, the largest earthquakes whose ionospheric disturbances have never been studied in spite of available GPS data.Continuous GPS data in Sumatra and nearby islands are taken by the SUGAR (Sumatra GPS Array) network,which is designed by members of the Tectonics Observatory at Caltech and the Indonesian Institute of Sciences (LIPI).The sampling rate of the network is 2 minutes, sparser than 30 second sampling usually employed in other GPS networks.

CIDs have relatively short time scales, and we model temporal changes in TEC with polynomials of time and subtract them to isolate short-term changes in TEC. To investigate spatial characteristics of CID,e.g. propagation speed of such disturbances, we calculated sub-ionospheric points (SPP), ground projections of theionospheric piercing point of line-of-sights assuming a thin layer of ionosphere at altitudes ˜300 km. CIDs are detected clearly in signals of three satellites 25, 27 and 28 in the Bengkulu earthquake. Satellite 25 and 27 was located in the western sky during this time interval and moving from north to south. Because of relatively high elevation, their SIPs are close to the GPS sites. Disturbance signals moved north-westward from the epicentre gradually changing their shapes. The signals showed that the disturbance started with a positive pulse (i.e. TEC increase), being consistent with the earthquake mechanism [Astafyeva and Heki, 2009]. Apparent velocity of CID was calculated from their arrival times at different point. They were estimated as 0.74, 0.77, and 0.82 km/s with satellites 25, 27 and 28, respectively, and the propagation started from the centre of uplift about 15 minutes after earthquake.These velocities are consistent with one another within their uncertainties, and suggest that they were acoustic waves excited near the epicentre and propagating in the ionospheric F layer (i.e. not by the Rayleigh surface wave).

CID of the largest aftershock (Mw7.9) of the 2007 Bengkulu earthquake was also studied. By analysing the phase dataofthe satellite 21, we found thatacoustic-wave-origin CID with amplitude of 0.04-0.35 TECU propagatedas fast as about 0.60 km/s.

Next we investigated if there are preseismic TEC anomalies similar to the 2011 Tohoku-oki earthquake [Heki, 2011] before the 2007 Bengkulu earthquake. The disturbances are sought by three satellites (25,27 and 28) following the procedure of Ozeki and Heki [2010] (modelling vertical TEC by cubic polynomials of time).We found that clear pre-seismic TEC enhancement occurred about 60 minutes before the earthquake just like other M9 class earthquakes reported by Heki [2011].

The Nias earthquake occurred to the west of the Sumatra Island at 16:09:36 UTC, 28 March, 2005. We found that the TEC time series over a few hours period before and after the earthquake have been disrupted by severe plasma density luctuation known as plasma bubbles. This event is commonly seen in low latitude regions after sunsets [Li et al, 2009; Chu, 2005].

Figure a. (Left) SIP trajectories of the satellites and its error time series after the Bengkulu earthquake (right). B. (left) TEC disturbances by satellite 25 and its SIP trajectories (right)

キーワード: GPS, TEC, Ionosphere, Coseismic, Preseismic
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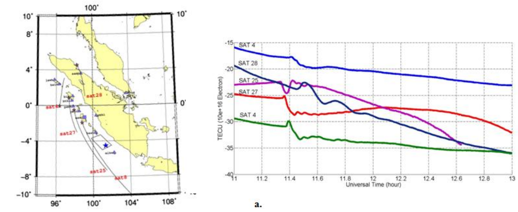

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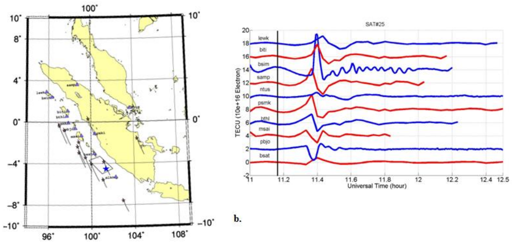

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