MIS30-P04 Room:Convention Hall Time:May 21 18:15-19:30

Focal Mechanism Dependence of Coseismic Ionospheric Disturbance Waveforms Revisited:Strik Slip,Normal,and Reverse Fault

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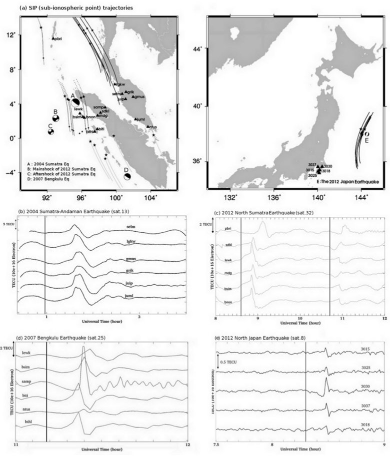
Ionospheric Total Electron Content (TEC) is easily derived from the phase differences of the two L band carrier waves of the Global Positioning System (GPS) satellites. Past GPS-TEC studies revealed various kinds of ionospheric disturbances including those by large earthquakes. Here we study coseismic ionospheric disturbances (CID) of earthquakes with three different kinds of focal mechanisms, i.e. reverse, strike-slip, and normal faulting. The first category earthquakes include the 2004 Sumatra-Andaman (Mw 9.2) and the 2007 Bengkulu (Mw 8.5) earthquakes. Their CIDs have already been reported in past studies [Heki et al., 2006; Cahyadi and Heki, 2013], but here we present some new data from GPS points in Malaysia. The second category includes the 2012 April northern Sumatra earthquake (Mw 8.6), one of the largest strike-slip earthquakes ever observed. Normal fault earthquakes large enough to disturb the ionosphere are rare. Astafyeva and Heki [2009], by analyzing the 2007 January outer rise earthquake off the central Kuril Islands, suggested that coseismic crustal subsidence in normal-fault earthquakes excite atmospheric waves led by a rarefaction pulse, and hence will cause CID starting with the negative polarity. However, theoretical considerations predict that such waves may not be stable enough to reach the F layer. In December 2012, we experienced a normal fault earthquake in the outer rise region of the Japan Trench (Mw 7.3), which would offer the second opportunity to study the CID waveform of normal-fault earthquakes.

We use GPS data from SUGAR (Sumatra GPS Array), the Malaysian GPS network, and GEONET (GPS earth observation network) in Japan. CIDs are detected clearly in signals of two satellites 13, and 20 in the 2004 Sumatra Andaman earthquake (Fig.1b). Satellite 32 and 20 in the 2012 April Sumatra earthquake detected clear CID in the western sky (Fig.1c). These CID started with only positive changes, possibly originating from the uplift region of the sea floor. Clear CIDs were also detected by satellite 8 in the 2012 NE Japan earthquake. An interesting result from the 2012 normal fault earthquake in Japan is that its CID signals initiated with positive pulses (Fig.1e). After all, we could not find any correlation of the CID signal waveforms with the focal mechanisms of earthquakes

In addition to the initial change polarities, we study various aspects of the CIDs including propagation speeds, atmospheric resonances, directivity, etc. To investigate spatial characteristics of CID, e.g. propagation speed of such disturbances, we calculated sub-ionospheric points (SPP), ground projections of the ionospheric piercing point of line-of-sights assuming a thin layer of ionosphere at altitudes ˜300 km. We also briefly mention pre-seismic TEC anomalies of the 2012 north Sumatra earthquake because its moment magnitude suggests the existence of small preseismic TEC anomalies as found before M9 class earthquakes [Heki, 2011; Cayadi and Heki, 2013].

(Figure caption) Figure 1. (a). SIP (sub-ionospheric point) trajectories by four satellites before/after the three earthquakes in Sumatra (left), i.e. the 2004 Sumatra-Andaman (black), the 2007 Bengkulu earthquake (light grey), the 2012 North Sumatra earthquake (dashed line), and the 2012 outer rise earthquake in NE Japan (right). On the trajectories small black stars are SIP at the time when earthquakes occurred, and beach balls indicate mechanisms of earthquake. (b), (c), (d) and (e) show time series of slant TEC changes in these earthquakes. The black vertical lines in the time series (b, c,d,e) indicate the earthquake occurrence times (for the 2012 event, the largest aftershock ˜2 hours after the mainshock also generated CID).

Keywords: reverse fault, normal fault, strike-slip, GPS-TEC, earthquake


(a) SIP (sub-ionospheric point) trajectories
12°
8°
4°
0°
−4°
92°
96°
100°
104°
pbri
lgkw
selm
grik
juip
gmus
samp
sdkl
mdg
lewk
bsim
bnon
bthl
biti
juml
ntus
A
B
C
D
A : 2004 Sumatra Eq
B: Mainshock of 2012 Sumatra Eq
C: Aftershock of 2012 Sumatra Eq
D: 2007 Bengkulu Eq
44°
40°
36°
132°
136°
140°
144°
3037
3030
3015
3018
3025
E
E :The 2012 Japan Earthquake
(b) 2004 Sumatra-Andaman Earthquake (sat.13)
5 TECU
selm
lgkw
gmus
grik
juip
juml
TECU (10e+16 Electron)
1
2
Universal Time (hour)
(c) 2012 North Sumatra Earthquake (sat.32)
2 TECU
pbri
sdkl
lewk
mdg
bsim
bnon
TECU (10e+16 Electron)
8
9
10
11
12
Universal Time (hour)
(d) 2007 Bengkulu Earthquake (sat.25)
2 TECU
lewk
bsim
samp
biti
ntus
bthl
TECU (10e+16 Electron)
11
12
Universal Time (hour)
(e) 2012 North Japan Earthquake (sat.8)
0.5 TECU
3015
3025
3030
3037
3018
7.5
8
9
Universal Time (hour)