Astrophys Space Sci (2013) 345:231–237
DOI 10.1007/s10509-013-1389-2

ORIGINAL ARTICLE

Anomalous variation in GPS TEC prior to the 11 April 2012 Sumatra earthquake

Fuying Zhu · Yiyan Zhou · Yun Wu

Received: 22 January 2013 / Accepted: 9 February 2013 / Published online: 21 February 2013

Abstract On 11 April 2012, a strong earthquake of magnitude Ms8.6 occurred near the west coast of Northern Sumatra, Indonesia. In this paper, we investigated the morphological characteristics of anomalous variations in Global Positioning System Total Electron Content (GPS TEC) prior to the earthquake by the method of the statistical analysis. It was found the TEC anomaly was firstly decreased, then, it became more enhanced, finally, it decreased, the peak of anomaly enhancement arose from 13:00–17:00 LT on April 5 lasted for ∼4 hours and the anomalous ionospheric regions extended to ∼40° in longitude and ∼20° in latitude, its location did not coincide with the vertical projection of the epicenter, but lies at the north and south of the geomagnetic equator, meanwhile, corresponding ionospheric anomalies are also observed in the magneto conjugate region. Potential causes of these results are discussed,eliminating the ionospheric anomalies that may be caused by solar activities and magnetic storms, it can be concluded that the observed obvious anomalous variation in GPS TEC on April 5 were possibly related to the earthquake.

Keywords Anomalous variation · GPS TEC · Precursors of earthquakes

F. Zhu (✉) · Y. Zhou · Y. Wu
Key Laboratory of Earthquake Geodesy, Institute of Seismology, China Earthquake Administration, Wuhan 430071, China
e-mail: fyzhu027@yahoo.com.cn

F. Zhu · Y. Zhou · Y. Wu
Wuhan Base of Institute of Crustal Dynamics, China Earthquake Administration, Wuhan 430071, China

1 Introduction

Since the ionospheric anomalies was first discussed for the great Alaska earthquake as early as in 1964 (Bolt 1964; Davies and Baker 1965; Leonard and Barnes 1965), it has been fairly verified that the ionosphere anomalous variation will occur in a few days or hours before the strong earthquakes (Calais 1995; Chmyrev et al. 1997; Liperovsky et al. 2000; Silina et al. 2001; Liu et al. 2001, 2002, 2004, 2008, 2009, 2010, 2011; Gaivoronskaya and Pulinets 2002; Plotkin 2003; Afraimovich et al. 2004; Pulinets and Boyarchuk 2004; Pulinets et al. 2005; Krankowski et al. 2006; Zakharenkova et al. 2007, 2008; Zhao et al. 2008; Lin et al. 2009; Zhou et al. 2009; Hsiao et al. 2010; Lin 2010, 2011; Xiong et al. 2011; Yao et al. 2012), the seismic- ionospheric precursor offers a unique advantage in determining the three elements of earthquake (Pulinets and Boyarchuk 2004). Especially, the peak electron density in the F2-layer is one of the important parameters to study the ionospheric anomaly before the earthquakes (Gaivoronskaya and Zelenova 1991; Depuev and Zelenova 1996; Pulinets 1998; Liu et al. 2000; Silina et al. 2001; Pulinets and Legen'ka 2003; Rios et al. 2004; Pulinets and Boyarchuk 2004; Hobara and Parrot 2005; Liperovskaya et al. 2006; Singh and Singh 2007; Xiong et al. 2008), and the measured ionospheric perturbations following the earthquakes were able to infer source parameters in remarkable agreement with seismic measurements (Afraimovich et al. 2001). For this reason, the ionosondes should be an efficient means to detect the seismo-ionospheric effects. However, compared with the wide distribution of earthquake zones worldwide, there are not more than 300 ionosondes available, especially in the oceans, these is less ionosondes available. On the other hand, only a fraction of them can be continuously operational. Therefore, the temporal and spatial coverage of