Possible detection of ionospheric disturbances during the Sumatra-Andaman islands earthquakes of December, 2004

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The results of the continuous monitoring of ionospheric disturbances using very low frequency (VLF) radio waves during the recent Sumatran earthquake are presented. Strong and anomalous shifts in the sunset-terminator are found during 22-31 Dec. 2004. Anomalous behaviours in daytime observation are also detected. On 26 Dec. 2004, there were altogether 23 major earthquakes and aftershocks (magnitudes 5.0-9.0 on Richter scale). There were 10 such earthquakes on 27 Dec., 2 on 28 Dec., 7 on 29 Dec. and 4 on the 30 Dec. 2004. Given that there was no major earthquake on 22 December, though anomaly began on that day, it is believed that VLF monitoring could be a useful tool for earthquake predictions as well.

Keywords: Earthquake, Ionospheres, Ionospheric disturbances, Radio waves, VLF

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1 Introduction

It is known for long that earthquakes could be a major cause of the ionospheric perturbations and the consequent disturbances in VLF signals[1-6]. Though the theory of the seismo-ionospheric interconnection is very poorly understood, it is believed that the seismic events cause the height of the reflecting layer to lower by as much as 2 km (Ref. 7). Thus, the sunrise and sunset terminators, at which the VLF signal shows minimum, will show anomalous shifts, as if the daytime has been extended. It is also known that the radon gas concentration rises anomalously above an earthquake epicentre which may also cause high degree of ionization, thereby affecting the strength of the VLF signals[8] at anomalous times. This also increases electrical conductivity of the layer between the earth surface and lower the ionosphere boundary by ~5 km.

The Centre for Space Physics (CSP) VLF receiving station in Kolkata (22°34′N, 88°24′E) has been monitoring VLF signals almost continuously and the data acquired during the last week of December 2004 showed many anomalous behaviours in the signal amplitude. The VLF receiver was monitoring the VTX station located at Vijayanarayanam (8°26′N, 77°44′E) at 17 kHz which is 1943 km away from the receiver. The receiving antenna was a gyrator whose description is available elsewhere[9,10]. The signal is automatically recorded through a sound card and is stored at a sampling rate of two per second. This procedure is valid as long as the signal has frequency below 22 kHz. Figure 1 shows the locations of the receiver and transmitter as well as the epicentre of the earthquake near Sumatra. Though the epicentre does not fall on the great circle path (GCP), given that the earthquake is one of the strongest, and that the Indian plate moved (by about 15 m) underneath the Burma plate along 1200 km rupture line, it is not preposterous to assume that the earthquake preparatory zone is spread out over a vast region. Also, on the same day, Andaman and Nicober islands also had several shocks and aftershocks of magnitude 6.0 or higher. Thus, it is believed that the ionosphere along GCP may be affected and that is what has been detected.

2 Results and discussion

Figure 2 shows the data of the present observation from 20 Dec. 2004 till 2 Jan. 2005, i.e. for a period of two weeks, from 0000 hrs to 2400 hrs LT (x-axis). The data are staggered in the vertical direction so that the comparison becomes easier. The vertical axis is in dB unit. This is the output of the soundcard system in the receiving computer. On 20 and 27 Dec. 2004 and on 1 Jan. 2005, the data are available for the whole

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