

Detection of Seismic Associated ULF/ELF/VLF/HF Emissions over Andaman & Nicobar Islands Region (India)

By DEMETER Satellite

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ABSTRACT

As evidences have shown that electromagnetic phenomena associated with large earthquakes are considered to be most promising tools for earthquake studies. Measurements of electromagnetic phenomena can be classified into three types; the Passive ground based observation, the Ground based observation with the use of transmitter signals and the Satellite observations. The micro-satellite DEMETER (Detection of Electromagnetic Emissions Transmitted from Earthquake Region) has been launched recently for detecting/investigating the ionospheric disturbances caused due to seismic activity and to study globally the earth electromagnetic environment. The satellite is the first microsatellite developed by CENTRE NATIONAL D'ETUDES SPATIALES (Cnes), French National Space Agency. The disturbances from the surface of the earth are measured using several types of experiments like, IMSC (Measuring the magnetic components of waves), ICE (Measurement of quasi-continuous electric fields and the electric components of waves), IAP (Measurement of plasma parameters), ISL (Measurement of the characteristics of thermal plasma), IDP (Measurement of energetic particle spectra). The present paper deals with the detection of electric & magnetic field components of seismic activity associated ULF/ELF/VLF/HF waves mainly using ICE & IMSC experiments for the period with effect from 26th of December, 2004 to 31st of December, 2004 during which Andaman & Nicobar Islands region (Latitude- 11°.67N Longitude- 92°.76 E) suffered Tsunami (Tidal waves) as an effect of series of disastrous earthquakes (up to 50) having $M > 5$, Depth up to 40 km. Significant observations in ULF/ELF/VLF/HF ranges have been recorded/detected. It has been found that the ULF/ELF/VLF/HF ranges are promising tools to study earthquake.

INTRODUCTION

Satellite observations have the major advantage of covering almost all the areas of seismic activities throughout the world very quickly. But such observations are only useful if we can demonstrate their seismo tectonic origins, and define all their characteristics and their variability according to the conditions of the rupture and its environment. The measurements made by the DEMETER experiment have been intended to study emissions of electromagnetic waves observed during earthquakes and volcanic eruptions, disturbances in the ionosphere, the upper atmosphere, and the corresponding precipitations of particles, systematically. The paper presents seismic associated ULF/ELF/VLF/HF emissions observed as bursts in the ionosphere above the earthquake epicenter prior to main shock using DEMETER micro-satellite for the period during which series of disastrous Tsunamis were experienced by Andaman and Nicobar Island i.e. from 26th of December to 31st of December, 2004.

Observation made

- Detection of ULF(0-15Hz)/VLF(10Hz-18KHz)/HF(70-3.125MHz) electrical signals associated with seismic activity in the ionosphere using ICE sensor onboard DEMETER satellite a system of 4 electrical sensors.
- Detection of ELF(10Hz – 1KHz) magnetic signals associated with seismic activity in the ionosphere using IMSC sensor onboard DEMETER satellite a system of 3 magnetic sensors.

SEISMICITY OF ANDAMAN & NICOBAR REGION

The region where the series of disastrous earthquakes occurred from 26th December, 2004 to 31st December, 2004 marks the seismic boundary formed by the movement of the Indo-Australian plate as it collides with the Burma sub plate, which is part of the Eurasian plate. The Burma plate encompasses the northwest portion of the island of Sumatra as well as the Andaman and the Nicobar Islands, which separate the Andaman Sea from the Indian Ocean.

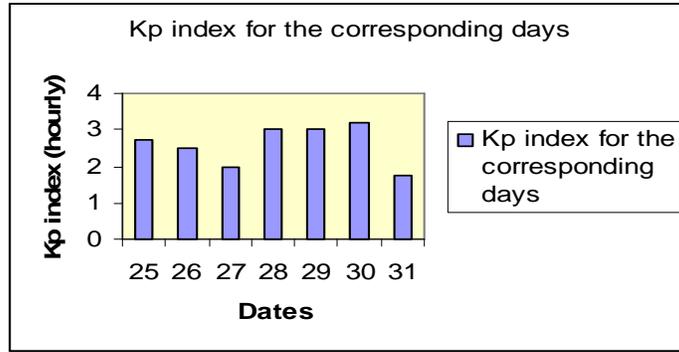


Fig. 1. Kp index for the corresponding period

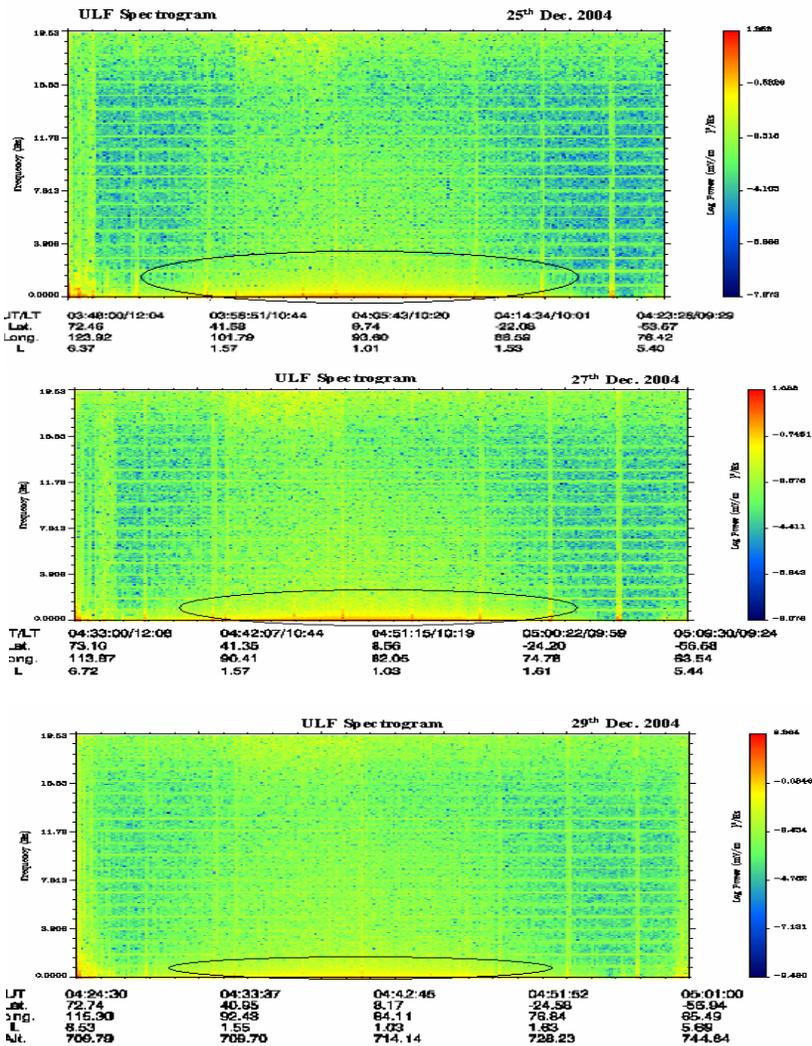


Fig. 2 a Recorded ULF emissions as a burst in the ionosphere just above the epicenters

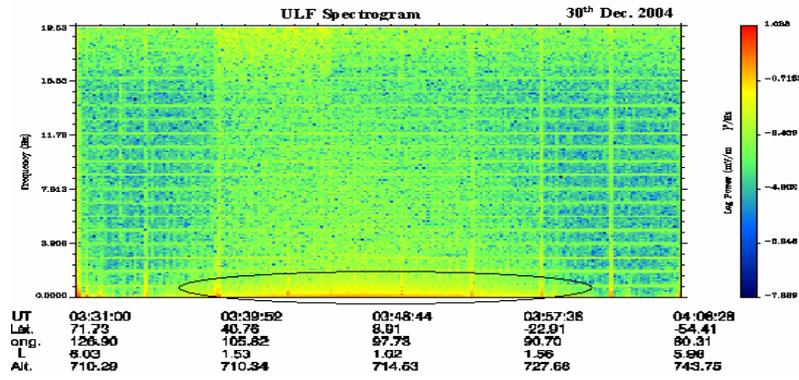


Fig. 2 b Recorded ULF emissions as a burst in the ionosphere just above the epicenters

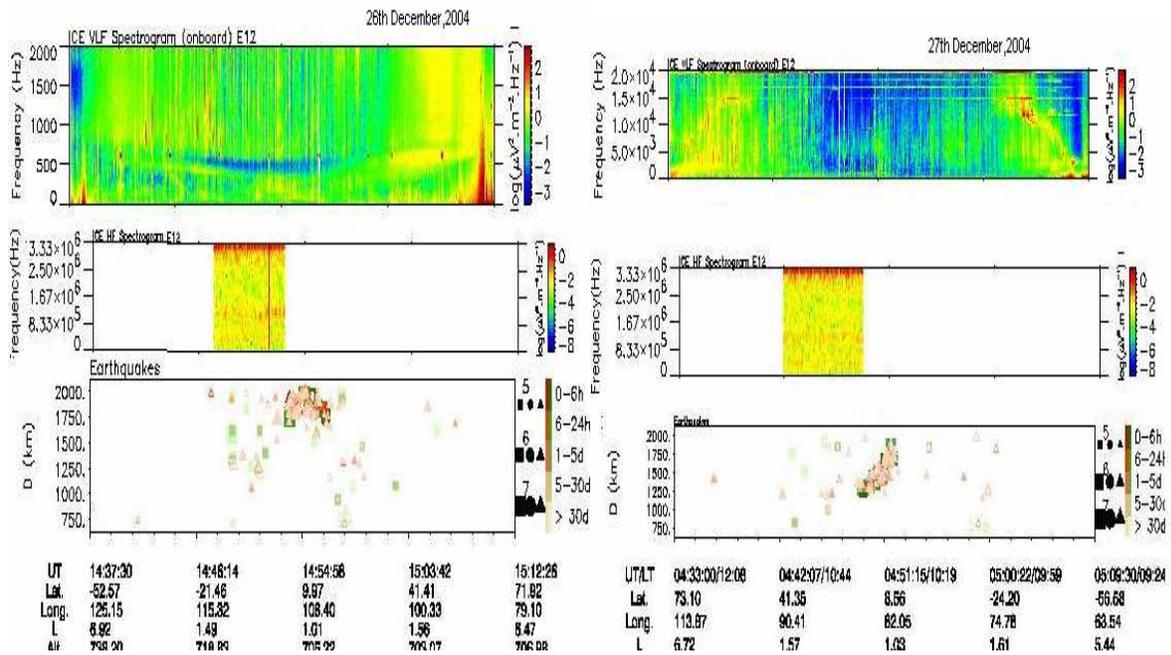


Fig. 3 Recorded VLF , HF emissions in the ionosphere(courtesy <http://demeter.cnrs-orleans.fr/>)

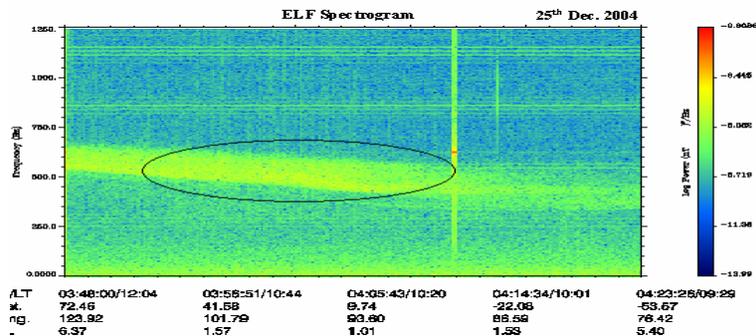


Fig. 4 a Recorded ELF magnetic emissions as a burst in the ionosphere above the epicenters

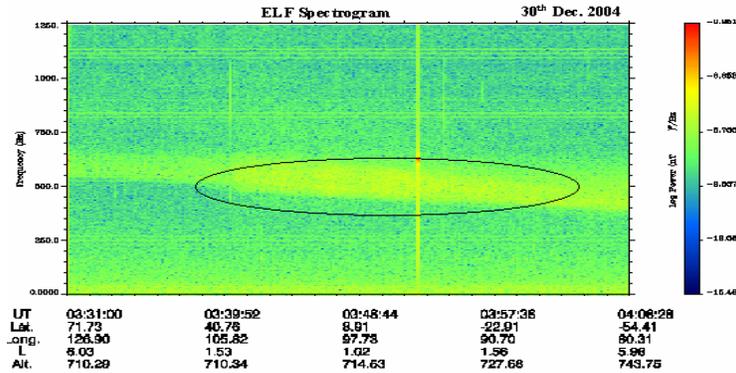


Fig. 4 b Recorded ELF magnetic emissions as a burst in the ionosphere above the epicenters

CONCLUSION

On the basis of the recorded emissions, the following conclusions have been laid down-

1. Electric field of seismic associated precursory ULF (up to 2 Hz) electromagnetic emissions have been detected for the corresponding event.
2. ELF magnetic field in the frequency range of 5Hz to 7Hz were detected as a burst in the ionosphere for the corresponding period.
3. VLF electric field in range of 2 kHz or more were recorded before the main shock.
4. HF electric field of more than 3MHz were recorded before the main shock.
5. The hypothesis that low frequency seismic signals penetrate upper atmosphere more easily than high frequency signals has been verified as ULF (up to 2Hz) were detected more often (for most of the days) than high frequency signals (ELF/ VLF/ HF)

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