OBSERVATIONS OF ELECTROMAGNETIC PHENOMENA IN VHF BANDS POSSIBLY ASSOCIATED WITH EARTHQUAKES

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ABSTRACT

In order to observe electromagnetic phenomena associated with earthquakes, we constructed observatories in Chiba prefecture, Japan, and started observations in VHF bands. We obtained following results. 1. An FM broadcasting wave at 77.1 MHz was observed whose station locates 300 km north. Receiving level showed fluctuations that seem to have correlation to earthquakes. 2. We found broadband weak noises spread in 50 MHz band. These noises appeared one day before a corresponding earthquake and lasted a few days. 3. We were sometimes able to observe waves of Malaysia TV at 48.25 MHz, which is refracted with F-layer. It was significantly attenuated about one hour before earthquakes occurred in Okinawa area where is on the way from Malaysia to the observatory.

INTRODUCTION

Electromagnetic phenomena possibly associated with earthquakes have been reported in wide range of frequencies for the last several years [1,2]. These phenomena were sometimes observed before the main shocks of the corresponding earthquakes from minutes to weeks. The phenomena, therefore, would be useful to know the occurrence of earthquakes prior to them. Because the energy of radio waves themselves in the frequency range is so small, they could be produced with faint phenomena preceding the main shocks such as micro cracks, friction, and movement of rocks and/or water under the ground. Mechanisms of the phenomena, however, not solved yet mainly because observational results are not sufficient yet. In this paper we present results of our observations in the last few years.

OBSERVATION SYSTEM

In order to observe electromagnetic phenomena associated with earthquakes, we have constructed three observation sites in Chiba prefecture: Nishi Chiba, Tateyama, and Katsuyama (Fig. 1), and started regular observations in VHF (Very High Frequency: 30-300 MHz) bands. We observe 50 MHz natural noise with 5-element Yagi antennas for NSEW directions in horizontal polarization to the horizontal direction at each site. Broadband observations from 50 to 76 MHz are also done with a log periodic dipole-array antenna at Tateyama [3,4]. Observations of FM radio broadcasting wave are done with Yagi antennas [5]. We use spectrum analyzers to investigate spectral characteristics of observed signals.

RESULTS OF OUR OBSERVATIONS

We obtained following results after the last three years observations.

Anomalous Propagation of FM Radio Broadcasting Wave

We observed radio wave from Sendai FM broadcasting at 77.1 MHz whose station locates about 400 km north from Tateyama. Receiving level of FM radio wave was normally flat and silent but there are sometimes fluctuations. We classified daily data according to the strength of such fluctuations as shown in Fig. 2. We have found the correlation to earthquakes is getting larger according to the level fluctuations are stronger as shown in Fig. 3 [5].
Fig. 1: Locations of our observatories in south Kanto area of Japan.

Fig. 2: The classification of the baseline patterns based on fluctuation of the level. The data of Type (a), Stable, have the standard deviations of less than 0.075. Type (b), Slow Fluctuation, has those between 0.075 and 0.1. Type (c), Rapid Fluctuation, shows rapid fluctuations has those between 0.1 and 0.2. Type (d), Waving and Fluctuation, has the standard deviation of more than 0.1.

Fig. 3: Correlation between earthquakes and the type of the data. 61% of data in the observed period show Type (a), but only 14% of them correlate to earthquakes of M ≥ 4.5 occurred within two days after. In contrast, 6% of data classified to Type (d) and 32% of them correlate to earthquakes. We may conclude that the occurrence rate of earthquakes is getting higher according to the fluctuation of the baselines goes stronger.
Hints of Broadband Noise Emission in 50MHz Range

We have observed electromagnetic waves at 50 +/- 2.5 MHz with a spectrum analyzer with the antenna directed to west at Tateyama. We have found broadband weak noises spread in the whole frequency band with no significant frequency structures. These broadband noises started at least one day before a corresponding earthquake and last a few days. All these earthquakes locate in the west direction from the observatory as shown in Fig.4. In the receiving data in 8 months, 6 enhancements of such natural noises related to the earthquakes were observed [3].

Decrease of Oversea TV Waves Possibly Affected by Earthquakes

We were sometimes able to observe electromagnetic interference of artificial signals at 48.25MHz and 49.75MHz. These two line spectra were identified as the wave broadcasted by Malaysia and/or Thai TV, and China TV station, respectively. These signals would be reflected and/or refracted with F-layer in the ionosphere. The signal from Malaysia (Thai) was decreased one hour before earthquakes, which occur in Okinawa area where locates on the way propagating from Malaysia (Thai) to the observatory. We propose a hypothesis that the attenuation is caused by some disturbance in E-layer above epicenters in Okinawa (Fig.5) [4].

Fig.4: Locations of the earthquakes during the period from Feb.10 to Sep.17, 2000. The enhancements of VHF electromagnetic broadband noise were observed in association with the earthquakes located in the west direction as shown with filled circles.
Fig. 5. A schematic picture of the hypothesis explaining the observed decrease of the TV wave from Malaysia associated with the earthquakes occurring in Okinawa area.

REFERENCES