Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SCG069-P01 Room:Convention Hall Time:May 25 14:00-16:30

Simultaneous observation of VHF radio wave transmission anomaly propagated beyond line of site prior to earthquakes in m

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The VHF radio wave transmission anomalies propagated beyond line of site prior to earthquakes (hereafter termed EQ-echo) have been observed more than 20 times from 2004 at the Erimo observatory (ERM) in Hokkaido, Northern Japan. A statistical relationship between magnitude of preceding earthquake (M) and total duration time of the EQ-echo (Te) has been proposed in this area (Moriya et al.2009). To confirm a region where the EQ-echo observed for each earthquake, we installed another 3 observatories with approximately 5 km spacing in the surroundings of ERM ; Fuyushima (FYS), Rusaki (RSK) and Tohyoh (TYO).

In consequence, the EQ-echoes have been observed at least one observatories prior to 7 earthquakes (totally 9 earthquakes M>3.9 occurred) between 2009 and Oct. 2010. The logarithm relationship between M and Te for these 7 earthquakes showed similar relationship proposed by Moriya et al. (2009).

In addition, EQ-echoes were simultaneously observed at three observatories, ERM,RSK and FYS, before earthquake in Hidaka Mountains at 10 Mar. 2009 (M=4.1). Although the wave forms of the EQ-echoes were similar in each record, the initial time and duration time of each EQ-echo were different in some minutes each other. To detect arrival direction of the EQ-echo, six-ways antennas were installed at every 60 degree in FYS since 2009. By using this multi-way antennas, we estimated the arrival direction of EQ-echo before the earthquake that occurred at 14 Oct. 2010 (M=5.5). Although this method seemed capture changes of arrival direction of EQ-echoes in duration time (from 120 to 170 degrees from the north), this estimated directions were different from the direction of epicenter (about 0 degree) and the Hiroo broadcasting station (about 80 degree). These time lags of EQ-echoes and change of arrival direction may suggest the expanding or moving of scattering object which affects appearance of an EQ-echo.

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SCG069-P02 Room:Convention Hall Time:May 25 14:00-16:30

Dual frequency interferometer system to detect for earthquake-related anomalous VHF radio propagation

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Recently, earthquake-related electromagnetic phenomena have been reported in various frequency bands. In the VHF band, it is known that anomalous propagation (invisible propagation) precedes larger earthquakes. It is considered to be caused by reflection and scattering of VHF radio waves due to atmospheric disturbances generated in the preparation process of larger earthquakes. Temporal correlation between earthquake and anomalous propagation has gradually been reported. However, a spatial correlation hasn't understood yet. Therefore, in this study, we develop a VHF band interferometer system and we conduct experimental test to evaluate characteristic of the system to identify disturbed area related to earthquake. The system is composed of two Yagi antennas, crystal filters, amplifiers, Phase Delay Controllers, FM digital tuners, a signal generator, and a Phase Difference analyzer.

Now, we perform observation for invisible propagation at Chiba Univ. with the developed system. The target transmitter is FM Sendai [77.1MHz]. The system is locked in direction for FM Sendai [N13^{o}E] with elevation of 20^o. Then, we observe 84.1 MHz which is not used for broadcast as a reference, because a comparison with behavior of dual frequencies helps to identify the source of invisible propagation, that is a natural source or a broadcasting source).

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SCG069-P03 Room:Convention Hall Time:May 25 14:00-16:30

VHF interferometry system for anomalous propagation of FM radio broadcasting wave and its preliminary result

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Earthquake-related electromagnetic phenomena have been reported in various frequency ranges in a few decades. There are a lot of observation methods of the earthquake-related phenomena. Active sounding using VLF and VHF radio transmitter is one of the popular methods. Anomalous propagation is registered prior to the large earthquakes. The over-horizontal propagation is considered to be generated by disturbances of the atmosphere above the epicenter or along the propagation path. A recent study shows that the appearance of anomalies was significantly enhanced within 5 days before earthquakes with M more than 4.8. However, there is no information on the scattered place.

In this study, a simple interferometer system for VHF radio wave to identify the source position between space-time of earthquake-related atmospheric disturbances has been developed and installed at Chiba University (Nishi-Chiba campus). The target FM radio station is located in Sendai and the broadcasting frequency is 77.1 MHz with horizontally polarization (5 kW). The distance between the receiver and the transmitter is approximately 300 km that is over-horizontal range.

In this presentation, evaluation of this system and a characteristic of the VHF radio wave propagation will be report.

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VHF anomalous transmission associated with lightning activity

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VHF electromagnetic (EM) waves cannot usually propagate long distance because they penetrate through the ionosphere. They can reach far away receivers beyond the line-of-sight only when reflection and scattering due to ionospheric or atmospheric disturbances happen. According to Fujiwara et al. (Geophys. Res. Lett., 2004), appearance of anomalies in the atmosphere before earthquakes (EQs) has been verified through observation of anomalous transmission of VHF EM waves beyond line-of-sight. The cross-correlation between the EQ occurrences and the anomalies shows that the appearance of anomalies was significantly enhanced within 5 days before EQs. Preliminary one-month observation has been done in Hualien, Taiwan, for observation of VHF anomalous transmission possibly associated with EQs. Taiwan is one of best place for the statistical study of EQ-related phenomena due to active seismicity. Suitable place for FM transmission observation is restricted due to FM radio station jam. In eastern Taiwan, less artificial noise may be expected because of only small city existence. Different allocation of FM radio in Taiwan and Japan contributes to less radio wave interference. In our observation, anomalous VHF propagation beyond line-of-sight during heavy thunderstorm activities was measured. Besides non-transient (the order of minutes to hours) anomalous VHF propagation caused by Es-layer reflection and radio duct, anomalous propagation lasting for a few hours during a heavy thunderstorm was found. A calculation of ray tracing did not support this refraction due to thunderstorm-scale duct. Our further investigation implies that this reflection may be caused by scattering of VHF radio wave inside the thundercloud.

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SCG069-P05 Room:Convention Hall Time:May 25 14:00-16:30

The summary of the research of seismo-electromagnetic phenomena observed by the observation network of Chubu University

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Earth Watch Safety Net Research Center of Chubu University has established electromagnetic observation network in order to study seismo-electromagnetics. We have observed ULF/ELF electromagnetic waves in order to catch the emissions from the focal region of earthquakes. And we have observed VLF electromagnetic waves at Kasugai in order to measure the change of the propagation characteristic in the ionosphere and atmosphere disturbed by the energy from the epicentral region.

In this study, we talk about the result of the observation by this network. Anomalous ULF emissions and excitations of Schumann resonances were observed at Nakatsugawa station in the case of the 2004 Mid-Niigata Prefecture and 2007 Noto Hantou earthquake. And we found some ULF emissions propagated from the direction of the epicentral area of 2007 Noto Hantou earthquake. However, in the case of the 2008 Iwate-Miyagi Nairiku earthquake and 2009 Suruga-Bay earthquake, we could not found anomalous ULF/ELF signals, and could not find ULF electromagnetic waves possibly propagated from the epicentral areas. But we found some changes of the propagation characteristic of VLF electromagnetic waves before these earthquakes.

The observed ULF/ELF/VLF anomalies possibly associated with earthquakes were not so convincing enough to forecast the earthquakes at this stage. These anomalies observed by ULF/ELF/VLF ranges would be only a little hint of the mechanism and scenario of the generation of the seismo-electromagnetic phenomena. And so we need more event studies, further observation and interdisciplinary research.

This multi-point observation network is now supported by Academic Frontier Project for Private Universities: matching fund subsidy from MEXT, 2006-2010.

Keywords: seismo-electromagnetics, ULF/ELF/VLF observation, Schumann resonance

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Study of the Lithosphere-Atmosphere-Ionosphere Coupling (Chemical cannel)

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Recently, Ionospheric anomalies possibly associated with large earthquakes have been reported by many researchers. These reports suggest the existence of ”Lithosphere- Atmosphere-Ionosphere Coupling (LAI coupling)”. For the LAI coupling, 3 cannels have been proposed; they are ”acoustic”, ”chemical”, and ”electromagnetic” channel. In this study, the chemical cannel is considered to be dominant and in order to understand basic characteristics of it, we observe ion content concentration, atmospheric electric fields, and meteorological parameters in the southern part of Boso Peninsula. We have installed COM-3700, produced by Com System Inc., to observe ion content concentration at Akishima (Tokyo), Kiyosumi (the southern part of Boso Peninsula) and Uchiura (the southern part of Boso Peninsula). Atmospheric electric field and weather conditions (temperature, humidity, air-pressure and window conditions) have also been observed simultaneously at Kiyosumi station. We are now collecting fundamental data to understand variations. In our presentation, we will show you observed data and their possible relationship.

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Possible ionospheric anomalies associated with large earthquakes in japan: Case study with GEONET

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Recently, there are many reports on earthquake-related electromagnetic phenomena. Anomalous TEC (Total Electron Content) changes preceding large earthquakes are one of the most among of them. In this study, TEC anomaly variations in time and space have been investigated for the 2007 Noto-Hanto earthquake (M6.9) and the 2007 Chuetsu-Oki earthquake (M6.8). In this study, TECs from ground based receivers GPS have been computed with using the GEONET, which provide a higher resolution than those from GIM (Global Ionosphere Maps). In order to remove a daily variation of TEC, 15 days backward running average TECmean(t) and its standard deviation sigma(t) at a specific time are taken for the normalization. The normalized TEC$*$(t) is defined as follows: TEC$*$(t) = (TEC(t)-TECmean(t))/sigma(t).

For the 2007 Noto-Hanto earthquake, TEC$*$ decreases excess -3sigma criterion 5 and 13 days before the earthquake near the epicenter. The duration of the above negative anomalies lasts more than a few hours. In space, the region of the negative anomalies is concentrated in a small area. On the other hand, positive anomalies beyond +3sigma are detected 12 ,17 and 18 days before the earthquake. In space, the region of the positive anomalies with +3sigma 12days before the earthquake is found to be extent all over Japan.

For the 2007 Chuetsu-Oki earthquake, there are positive anomalies beyond +3sigma. They are detected 5, 12 and 17 days before the Chuetsu-oki earthquake near the epicenter. The duration of positive anomalies is more than a few hours. In space, the region of the positive anomalies with +3sigma 5 days before the earthquake is found to be extent all over Japan. But there are no negative anomalies beyond -3sigma a few days before the earthquake.

These results are correlated with the GIM based TEC anomalies for both earthquakes.