Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS27-01 Room:201A Time:May 26 15:15-15:30

Correlation between strandings of marine mammals at the Kashima-Nada beach and earthquakes

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A mass stranding of Melon-headed whales (Peponocephala electra) occurred at the Kashima-Nada beach, Japan, seven days before the 2011 M9.0 Off the Pacific coast of the Tohoku Earthquake (Tohoku EQ). Kashima-Nada beach is located 300 km southwest of the epicenter. Some people said that the mass stranding might be a precursor of the Tohoku EQ. In this study, we performed statistical analyses to determine the level of correlation between strandings at the Kashima-Nada beach and EQs. We concluded that the mass stranding was not correlated with the Tohoku EQ.

Keywords: Stranding, Earthquake, Kashima-Nada, Geomagnetic disturbance

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Excitation mechanism and detection of electromagnetic pulses prior to earthquakes

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We have been observing electromagnetic (EM) pulses generated by earthquake, and recently clarified behaviors of EM waves excited by seismic waves, in which EM pulses can be easily excited due to piezo-electric effect in the earth crust by vibrations of seismic S-waves [1]. On the other hand, we could not detect EM pulse at the rupture time of earthquake. Furthermore, even in laboratory experiment, we could not confirm intense EM noise excitation in frequency ranges of MHz-kHz. Therefore we have concluded that EM pulse cannot be generated in the situations of cracking of earth crusts.

In order to clarify behaviors of EM pulses which would be excited prior to earthquakes. We speculated a generation mechanism of EM pulse in the earth that a kind of resonance in the earth crust by the vibrations of the seismic P-wave propagation in it is important. So we conducted a laboratory experiment in order to inspect EM radiation from crusts. The experimental setup consists of ranging two granite pillars of 10 cm x 10 cm in cross section and 50 cm in length. A small glass ball is pinched between the cross sections of interface of the ranging granite pillars. By increasing external pressure given to the cross sections at the both ends of the ranging pillars, the small glass would be fractured. Then a negative stress impact is given to the interface of the ranging two pillars, and seismic P-waves propagate in the granites. EM pulse excited in the granite pillar due to piezo electric effect can be radiated out. So the stress impacts and following seismic P-wave propagations in a crust with some scale are key point for generating an EM pulse. We will show the experimental result.

Under the speculation based on the experimental result, we have been looking for the observation result. We finally found an EM pulse detected at about 7 hours prior to a rather large earthquake (M3.9), whose waveforms are similar to those obtained in the laboratory experiment.

[1] Minoru Tsutsui, Behaviors of Electromagnetic Waves Directly Excited by Earthquakes, IEEE Geoscience and Remote Sensing Letters, Vol. 11, No. 11, pp. 1961-1965, 2014.

Keywords: observation of electromagnetic pulses, earthquake precursor, excitation mechanism

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Anomalous phenomena of Schumann resonances in possible association with earthquakes

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The anomalous behaviour in Schumann resonances was observed at a Japanese station, Nakatsugawa (geographic coordinates: 35.45 degree N, 137.3 degree E), which appeared as an enhancement in the fourth harmonic about one week before the 1999 Chi-chi earthquake (EQ) in Taiwan (Hayakawa et al., 2005). Schumann resonance is a global resonance phenomenon triggered by global lightning activity in the tropic (Nickolaenko and Hayakawa, 2014). A mechanism to explain this anomaly has been proposed with a model in terms of the wave interference between the direct ELF signal from one of the world-lightning centers and that scattered by the seismo-ionospheric perturbation above Taiwan (Hayakawa et al., 2005; Nickolaenko et al., 2006). This case study was extended statistically by using the ELF data observed at Nakatsugawa during 6 years (1999 to 2004) with special reference to EQs in Taiwan (Ohta et al. (2006)). With the criterion of magnitude greater than 5.0, there were observed 33 EQs in and around Taiwan, and the Schumann resonance anomaly is observed for 9 EQs (so that the anomaly percentage is 9/29 (because no observation at Nakatsugawa due to some malfunction of the equipment for 4 EQs)). 29 EQs included 7 EQs in the land, while other 22 EQs took place in the sea. As the result of analysis, anomalous Schumann resonances are observed for all inland EQs. 2 sea EQs from the 22, had the anomalous Schumann resonances, but these two EQs had the following characteristics: one was the largest magnitude and the other the shallowest. This paper discloses the causative link between EQs in Taiwan and anomalous behaviour in Schumann resonance in Japan, and also suggests the land/sea asymmetry in generating the seismo-ionospheric perturbation closely associated with the mechanism of lithosphere-atmosphere-ionosphere coupling.

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Keywords: Schumann resonance, earthquakes, Nakatsugawa observatory

Japan Geoscience Union Meeting 2015
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MIS27-04 Room:201A Time:May 26 16:30-16:45

A statistical study for relationship between anomalous transmission of VHF band waves and earthquakes at Hidaka area

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Electromagnetic precursors associated with the impending earthquake, such as variations of geoelectric current, total electron contents in the ionosphere, and anomalous transmission of radio waves in the VLF or VHF band, have been observed (ex. Hayakawa, 1996). Recently, some researchers have discussed how these precursory phenomena relate statistically to the impending earthquake (Le et al., 2010; Orihara et al., 2012, Hattori et al., 2013, Han et al. 2014).

The observation of anomalous VHF-band radio-wave propagation beyond the line of sight prior to earthquakes is one of candidate method to predict an earthquake. It is considered that the anomalous propagation events were the result of scattering of VHF-band radio waves in preparatory process of immediately prior to earthquakes occurring around the observation area (Kushida and Kushida, 2002, Moriya et al.,2010). And, quantitative correlation between logarithm of the total duration of scattered wave transmission and the magnitude, or maximum seismic intensity has been proposed (Moriya et al., 2010).

Nevertheless, statistical relationship between anomalous radio wave intensities defined by clear threshold, and occurrence time of impending earthquakes have not been investigated yet. We carried out statistical investigation by using received radio-wave intensity data from a FM station beyond the line of sight between 1st January, 2012 and 31st December, 2013, observed at Erimo observatory, Hokkaido. The sporadic E layer appears frequently in summer, and it affects to the anomalous transmission of FM wave data. We removed the anomalous radio-wave intensity data affected by the sporadic E by the simultaneous appearance of anomalous intensity at the other observatory far away.

During this period, we calculated the success rate (the ratio of number of intensity anomalies that an earthquake observed within certain days to total number of intensity anomalies) and the alarm rate (the ratio of number of earthquakes that observed intensity anomaly within certain days to total number of earthquakes) in case of earthquakes (M>3.0) that occurred at the epicentral distance with in the radius of 100km and 150km from the Erimo observatory.

As a result, the earthquakes M>4.5 that occurred within 100km from Erimo observatory showed higher the success rate than that of an random occurrence case. The maximum gain of the success rate between the present case and the random occurrence case was obtained within 10 days after anomalous reception.

The results also indicated that the success rate by the anomalous radio-wave propagation was related with the earthquake (M>4) that occurs within 10 days with probability of approximately 30%.

We classified earthquakes occurrence into northern and southern area based on the latitude of the Erimo observatory, and considered success rate gains and alarm rate gains respectively. The results indicate that the gain is tend to be higher the earthquakes occurring in northern area than the southern area.

Keywords: precursory phenomena, statistical study, success rate, alarm rate

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On the GPS-TEC and geomagnetic declination precursors

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Details will be elsewhere (Enomoto & Heki submitted in GJI)

Keywords: 2011Tohoku-Oki earthquake, ionosphere total electron content, geomagnetic declination, precursorb

Japan Geoscience Union Meeting 2015
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MIS27-06 Room:201A Time:May 26 17:00-17:15

Statistical characteristics of the Ionsopheric TEC disturbances over Japan area

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To reduce the effect of strong geomagnetic activities such as geomagnetic storms, the TEC data of 2 days after Dst index exceed -60 nT were excluded in previous statistical studies of earthquake related TEC anomalies. Actually, the influences of a magnetic storm on TEC variations depend on the intensity and onset time of the storm. In this study, to clarify such dependences, we applied classification analysis method to the storm data (Dst) and discussed the response of TEC variation to each type of storm.

We picked out all the 294 geomagnetic storms during 1998-2013, and classified them into 3 types according to its magnitude and 4 types according to the onset time (local time). We checked the TEC data from 2 days before till 5 days after the onset of each geomagnetic storm. A bootstrap method (10000 times extraction) is used to calculate the average variation of the TEC for each type of storm. The average variation can be regarded as an average response of TEC to the related type of storm. If the average value of TEC exceeds the mean$\pm 2\sigma$ threshold, we consider it being affected by the storm. By this mean, we could find the accurate period affected by each type of storm.

Keywords: statistical analysis, geomagnetic storm, Ionsopheric TEC disturbances, bootstrap method, earthquake

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MIS27-07 Room:201A Time:May 26 17:15-17:30

The role of earthquake source parameters in the subionospheric VLF/LF anomalies before main shock

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Although subionospheric VLF/LF anomalies have been observed for some of the major earthquakes, their generation mechanisms are still unclear. In this paper, we focus on the detailed earthquake source parameters such as centroid moment tensor (CMT) solution in addition to traditional earthquake magnitude and depth information to study the occurrence relationship between earthquake types and corresponding ionospheric anomalies. As a result, we found that the ionospheric anomalies are observed prominently in association with thrust type earthquakes.

Keywords: ionospheric perturbation, VLF/LF transmitter, earthquake, CMT solution

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MIS27-08 Room:201A Time:May 26 17:30-17:45

Statistical study of pre-seismic subionospheric disturbance observed by the DEMETER and ground-based measurements

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The atmospheric and the ionospheric disturbance have been reported as an electromagnetic phenomenon related to the earthquakes in the 1980s. These phenomena have been expected to be useful for the short-term earthquake prediction. Motivated by this background, we statistically investigate pre-seismic subionospheric disturbances by using the VLF electric field data of the DEMETER.

Keywords: Earthquake, Subionospheric disturbance, DEMETER

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MIS27-09 Room:201A Time:May 26 17:45-18:00

Development of Early Warning System for Crustal Activity: Detection of Preparation Process using Multiple-Observation

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New observations from ground and space have provided multiple evidences of pre-earthquake signals and the latest studies show their statistical significance, repeatability, and universality. To understand the preparation process of large earthquakes and slow-slip events in subduction zone, especially to clarify the nucleation stage of the earthquake cycle, we plan to establish observation network in Boso, Japan, where large subduction earthquakes are expected soon. Since the subsurface fluid flow may play an important role in the preparation process of subduction activities, we intend to employ electromagnetic approaches. Geophysical monitoring such as ULF geomagnetic and geoelectrical observations, radon measurements, ocean bottom pressure measurements, and inland GPS movements, will be incorporated to help to understand the preparation process and evaluate the applicability of various pre-earthquake signals towards short term earthquake forecasting.