Correlation between deep-sea fish sighting and earthquakes around Japan

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One often believes that deep-sea fish washing-up on shore is one of unusual animal behavior before earthquakes (EQs) in Japan. Suehiro (1968) reported that oarfish (ryugu-no-tsukai) was caught in the shallows of Niijima a few days before 1957 Izu-Niijima-Kinkai EQ (M6.3). They substantially assumed that deep-sea fish floated on the shallows was regarded as an EQ precursor, because they are seldom events. On the other hand, some people have claimed that they are not the EQ precursor. In this presentation, we will discuss correlation between deep-sea fish washing-up on shore and earthquake occurrences around Japan or geomagnetic disturbances.

Keywords: deep-sea fish, earthquake, geomagnetic disturbance

Souce mechanism for seismo-EMs- Coupled interaction of rock rupture with deep Earth gases

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None

Keywords: seismio-electromagnetics, rock rupture, exo-electron

2D and 3D structures of Ionospheric anomalies preceding the large earthquake

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Many papers on ionospheric anomalies possibly associated with large earthquakes have been reported. As for the Ionospheric approach, it is important to reduce the effect of geomagnetic storms. 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 in magnitude and 4 types in the onset time (local time). A bootstrap method is used to calculate the average variation of the TEC for each type of storm. Then, we could find the accurate period affected by each type of storm. Next we performed statistical analysis of the TEC anomalies possibly associated with large earthquakes in Japan area during 1998-2013. There are statistical significance of positive TEC anomalies 1-5 days before and 16-20 days after M>=6.0 earthquakes. The significance of 16-20 days after earthquakes may be due to aftershock effects of the Tohoku earthquake. Then, we used the Molchan’ s error diagram to evaluate the efficiency of TEC anomalies for short-term earthquake forecasts. The result indicates that the predictions based on TEC anomalies are better than random guess, which suggests that the TEC anomalies contain certain precursory information of earthquakes.As for the tomographic approach, we investigate the spatial and temporal distribution of ionospheric electron density prior to the 2011 Tohoku earthquake (Mw9.0) and additional large earthquakes in Japan. We found the common TEC increase on 1-5 days prior to the earthquakes was remarkable and the electron density was decreased around the east-region of reconstructed area above the epicenter around 250 km altitude and increased the wide area around 3-400 km, respectively. We also analyzed several cases for ionospheric storms using the tomography. The detailed results will be presented in my talk.

Keywords: TEC, Ionospheric Tomography, Ionospheric anomalies preceding the large earthquake

Spatiotemporal Variations of the b-value and Total Electron Content Prior to Large Earthquakes in Japan

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In recent years, there are many reports on electromagnetic phenomenon preceding large earthquakes. Anomaly of the total electron content (TEC) is one of the most promising anomalies for the short-term earthquake forecast. On the other hand, it is reported that the b-value around the epicenter region decreases prior to the large earthquake. The b-value can compute using the Gutenberg Richter law. The lead time is around few or tens of years. We can’ t discriminate anomalous changes on earthquakes and solar activities easily at the moment. In this paper, we try to develop a method for the earthquake short-term forecast using the b-value and the TEC analysis. We investigate the effectiveness of the integrated analyses on the b-value for the middle-term forecast and TEC analysis for the short-term forecast.
We select the 2003, 2008 Tokachi-oki EQ (M8.0) and the 2011 Tohoku-oki EQ. As results, we found the variation of b-value has a tendency to decrease for M7class EQs in the analyzed regions and the neighbor's area. For the 2003Tokachi-oki EQ, we investigated temporal variation for the b-value with interval of 1day. We found decrease of b-value occurred 16 days and 2-3days before the main shock. On the other hand, for anomaly of the TEC in the Hokkaido-region,we found significant increase of TEC 2 days before the EQ (M>6.0, D<40 km) using the statistical analysis during 1998-2015. That is, the positive anomaly is dominant, In the case of the 2003 Tokachi-oki EQ, TEC anomaly occurred 2 days before main shock. However, immediately after this TEC anomaly, solar activity becomes active, and after that, positive anomaly may be masked from solar activity. From these results, in the 2003 Tokachi-oki EQ, we found that anomaly of b-value occurred 16 days before main shock after that, TEC anomaly occurred. The results for the 2011Tohoku-oki EQ show the similar tendency in b-value and TEC variations.
From above results, we can conclude that simultaneous use of the b-value and the TEC analysis is suggestive of the effectiveness in short-term earthquake forecast for the M7 or higher earthquakes Details will be given in the presentation.

Keywords: Earthquake, Electromagnetics, b-value

Ionospheric perturbations due to earthquakes observed simultaneously by subionospheric VLF/LF wave and GPS TEC measurements

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The Gravity Waves (GWs) produced by an earthquake propagate upward from the epicenter to the ionosphere. The GWs interact with the ionospheric plasma and generate the density perturbations which can be detected by different radio remote sensing techniques. In this paper, we study the vertical coupling between the lithosphere-atmosphere-ionosphere (LAI) coupling through signature of IGW waves generated from major seismic activities observed in different altitudes (D and F layers) by subionospheric VLF/LF waves and GPS TEC measurements. We will demonstrate the Travelling ionospheric disturbances (TIDs) induced by major earthquakes observed in the both ionospheric altitudes and deduce their propagation characteristics.

Keywords: VLF subionospheric waves, GPS TEC, very low frequency, earthquake, gravity wave, travelling ionospheric disturbance

Correlation between earthquake occurrence and the anomalous propagation of VHF radio waves indicated by the gain and the p-value of prediction maps produced by a simple objective algorithm in the Shimabara area, Kyushu, Japan

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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 (e.g. 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). Anomalous (i.e., beyond the line of sight) VHF-band radio-wave propagation is one such claimed short-term precursor; physical preparatory processes of earthquakes may produce/attract electromagnetic scatterers in the area over the source of the impending earthquake (Kushida and Kushida, 2002, Moriya et al.,2010). Hokkaido University has been monitoring this anomalous propagation in several regions in Japan. On April 14th 2016, an Mw 6.5 earthquake occurred in Kumamoto, which was followed by a nearby greater Mw 7.3 event on April 16th. Just before these events, anomalous propagation of the VHF radio wave from an FM station in Miyazaki was observed at Shimabara receiving station. Epicenters of these Kumamoto events were between the broadcast and receiving stations. To evaluate the statistical significance of the tendency that such anomalies precede impending earthquakes in this region, we made a spatio-temporal map of earthquake alarm (though for only one spatial grid, which is the region between the Miyazaki broadcast and the Shimabara receiving stations) based on the data for 2015 to 2016; after anomaly appears, we turn ON the alarm for a certain period of time L, and thus divide the whole observation period into “Alarm ON”, “Alarm OFF”, and “Undecided (due to missing data)” periods. The alarm map was compared with the occurrence of local earthquakes with M > 4.5 after declustering. The result, the associated p-value was not low enough to suggest the statistical significance.

Keywords: Earthquake prediction map, objective algorithm

