

Report from the Ionosphere Precursor Study Group -

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**Abstract:** "Ionosphere Precursor Study Task Group," which was formed with the support of the Mitsubishi Foundation in 2014-2015. The group promotes the study of ionosphere precursors (IP) to EQs and aims to prepare for a future EQ dedicated satellite constellation, which is essential to obtain the global morphology of IPs and hence demonstrate whether the ionosphere can be used for short-term EQ predictions. Outcomes and specific research areas that emerged from the one-year project are described.

**Collaboration:**

We organized an "Ionosphere Precursor Study Task Group (IPSTG)" with the support of the Mitsubishi Foundation in October 2014 as a one-year project. The data to be studied includes both ground-based and satellite data.

Under IPSTG, as a first step, we have chosen EQs of M larger than 7 that occurred in Japan during 2007–2010, because data from four satellites is available during this period.

Year	m	d	hr.	min	sec	lat.	lon.	Dep(km).	M	remarks
2007	01	13	04	23	21.00	46.23	154.55	10	8.1	High latitude EQ
2007	03	25	00	41	57.91	37.132	136.411	40	6.9	USGS D=30.5
2007	07	16	01	13	22.55	37.334	138.365	41	6.8	
2008	05	07	16	45	18.77	36.136	141.364	159	7.0	

2008 06 13 23 43	45.36	39.017	140.528	21	7.2
2010 02 26 20 31	25.92	25.551	128.408	104	7.2

Table 1. List of the earthquakes aimed for the data analysis

(Provided by Japan Meteorological Agency)

The EQs are listed in Table 1. EQ which occurred on Jan 13 2007 in the table 1 is intensively studied together with the magnitude 9.0 Tohoku EQ on March 11 2011 ( $38^{\circ}.297$  N,  $142^{\circ}372$ E), especially in relation to mid latitude trough. To conduct statistical analysis on the existence of the ionosphere precursor, NmF2 and TEC were used by following the method proposed by Liu et al. [2014].

Satellite data are mainly used for event study. Satellites which acquired data are DMSP, CHAMP, DEMETER, and Fromosat2/COSMIC. DMSP which was at the 800km circular orbit provides  $O^+$ ,  $H^+$ , Ti and plasma drift velocity. CHAMP provides Ne at the height of  $\approx 400$  Km. DEMETER provide Ne at the height of  $\approx 700$ km. One of the outputs from the study is that we found the formation of mid latitude trough, and the equator ward movement for March 11 2011 EQ. The second output is that we found the enhancement of plasma density over geomagnetic equator for 5 EQs out of 7 which we studied.

### **Concluding remarks:**

To accelerate the study of ionosphere EQ precursors and confirm their applicability for predicting future EQs, micro satellite constellation mission is essential.

While we prepare for such a near future satellite mission, further analysis of the existing data acquired from available satellites such as DMSP, CHAMP, FORMOSAT-3/COSMIC, and FORMOSAT-1 (ROCSAT-1) should be continued. We stress here that international collaboration can accelerate the process to get global morphology of ionosphere disturbance, as well as understand its physical mechanism.

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### **Reference**

Liu, J.Y., C. H. Chen, and H. F. Tsai, A statistical study on ionospheric precursors of the total electron content associated with 146  $M > 6.0$  earthquakes in Japan during 1998- 2011, Earthquake Prediction Studies: Seismo Electromagnetics, edited by Hayakawa, PP.1-13, TERRAPUB, 2014.

Details of the talk is in “Final Report to Mitsubishi Foundation”(English Version) printed in Feb.2016.

The report is available upon request. Send request to “oyama@pssc.ncku.edu.tw

