201年3月11日地震にともなう中緯度トラフの発達、磁気赤道上空のプラズマ密度増加

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Modification of ionosphere before 2011 March 11 earthquake

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Ionosphere disturbance which was seen prior to an earthquake which occurred on 11 March 2011 off the coast of Tohoku was studied. Ionosphere data which were used are: atomic oxygen ion density acquired with US satellite DMSP, and maximum plasma density obtained by ionosondes. Global Ionosphere Model (GIM) is used as side evidence to support findings of DMSP data and ground based data...

Although during the earthquake preparation period, magnetic disturbance is strong, global survey of ground based maximum plasma density shows that special disturbance is limited to earthquake area. Satellite data (DMSP and GIM) analysis shows three important findings before the occurrence of the earthquake; (1) Over geomagnetic equator enhancement of atomic oxygen ion density is found, (2) midlatitude trough is formed before the earthquake and it moves toward lower latitude as EQ day approaches, and (3) no clear difference of O+ behavior between east and west of the epicenter is identified. Night time NmF2 at high latitude ionosonde stations such as Khavalovsk, and Beijin shows 2 days oscillation from 5 March and disappears on the 12th March. As the latitude of the station is lower, 2 days oscillation becomes unclear, and the duration of the appearance is shorter.

In order to explain both ground based and satellite data consistently, one idea of enhanced east/west ward dynamo electric field during daytime/ nighttime is discussed. We presume gravity wave of very small amplitude (the period of 20-30 minutes, and horizontal scale of >1000 km) as a source of dynamo E field modification. Internal gravity wave of extremely small amplitude cause d by ground motion interacts with planetary scales waves below 10 km, and is amplified.

The 2011 off the Pacific Coast of Tohoku Earthquake (2011 太平洋東北沖地震、38 ド 6.2N, 142 度 51.6E) 前後の上部電離圏の様子を DMSP（Defense Meteorological Satellite（Defense Meteorological Satellite Program）衛星により得られた酸素原子イオン密度のデータ、および全世界のイオノゾンデで観測された最大電子密度を調べた。DMSP 衛星 (F13 1995-2015; F14 1997-2015) は 2011 年の期間においては高度約 850 Km、軌道傾斜角 98.8 度　で夕方 17 時ごろ、明け方 5 時ごろを通過する太陽同期軌道である。高い高度のために大きな地震の電離圏の影響を研究するには不適当であると思われたが、DMSP のデータは予想に反して新しい事実を提供することになった [Oyama et al. 2016」。これらは

1. 中緯度トラフ [Rodger et al., 1992；Yigen, E., and M. Moldwin , 2005] のより明瞭な形成とこれに伴う中緯度トラフの赤道側の酸素原子イオン密度の増加
2. 磁気赤道上空に酸素原子イオン密度の増加がみられる。この増加は中緯度トラフ赤道側の酸素原子イオン密度の増加と対でおこる。

DMSP における上記の発見は GIM (Global Ionosphere Model) でも確認された。

Khabarovsk, Wakkanai, Kokubunji , Beijin , Jeju などのイオノグラムには、地震発生前に二日周期の最大電子密度変動が約 1 週間みられる。上記の２つの発見は 2011 年 3 月 11 日の地震に限られたものでなく、1 に関しては 2011 年 2 月 2 日の北緯 54.97, -東経 199.54E、D=35km, M5.9 の地震、および 2007 年 3 月 25 日の、北緯 37.3 度、東経 136.41 度、D=40km で発生した M6.9 の地震でも同じような振る舞いが見られる。2 に関しては 2008 - 2010 の期間に日本で起こった M > 7 の 10 個の地震のうち 8 個に同じく磁気赤道上空の電子密度の上昇がみられる [Ryu et al., 2016]

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