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MULTI DIAGNOSTICS OF DYNAMIC LARGE SCALES IONOSPHERIC STRUCTURES

HANNA ROTHKAEHL* **AND ANDRZEJ KRANKOWSKI†**

*Space Research Center Polish Academy of Sciences (SRC PAS)
00-716 Bartcka 18 A, Wasaw, Poland

†University of Warmia and Mazury in Olsztyn, Geodynamics Research Laboratory
(GRL/UWM)
, 1 Oczapowski St., 10-957, Olsztyn, Poland

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Abstract. The mid-latitude electron density trough observed in the topside ionosphere has been shown to be the near-Earth signature of the plasmapause and can provide useful information about the magnetosphere-ionosphere dynamics and morphology. The details description of the structure and dynamic can be very important in order to build the proper physical models and for applications purposes and services. The aim of this presentation is to show manifestation of ionospheric trough structures and dynamic diagnosed by various measuring techniques as: in situ wave and plasma diagnostics, TEC measurements, occultation (RO) measurements, and ground based low frequency diagnostics. We would like also to give overview of different physical process related to different type of instability occurred in main ionospheric trough region.

1 INTRODUCTION

For present the evolution of ionospheric trough in time and space domain we need some multipoint measurements and different type of measurements techniques. To develop a quantitative model of evolution ionospheric trough features during geomagnetic disturbances the analyse of particle and waves in situ measurements and TEC data and RO was carried out.

For present the evolution of ionospheric trough in time and space domain we need some multipoint measurements and different type of measurements techniques. To develop a quantitative model of evolution ionospheric trough features during geomagnetic disturbances the analyse of particle and waves in situ measurements and TEC data and RO was carried out. The mid-latitude electron density trough observed in the topside ionosphere has been shown to be the near-Earth signature of the plasmapause and can provide useful information about the magnetosphere-ionosphere dynamics and morphology. The high resolutions plasma particle diagnostics and wave diagnostics located on board of currently operated satellite DEMETER can give us precisely description of trough signatures and instabilities at define point in space . On the other hand GPS permanent networks such as IGS and EPN provide regular monitoring of the ionosphere in a global scale. Recently, TEC maps have been produced with 5 min intervals and with spatial resolution of 150 200 km. On other hand the radio occultation techniques is considered. The radio occultation technique using GPS signals has been proven to be a promising technique to retrieve accurate profiles of the ionospheric electron density with high vertical resolution on a global scale. FormoSat-3/COSMIC (Constellation Observing System for Meteorology, Ionosphere and Climate) is a joint scientific mission between Taiwan and the U.S.A. The mission placed six small micro- satellites into six different orbits at 700 800 kilometer above the earth surface. Each microsatellite has a GPS Occultation Experiment payload to operate the ionospheric radio occultation (RO). With the ability of performing both rising and setting occultation, FormoSat-3/COSMIC has been producing about 2000 profiles of the ionospheric electron density per day.

In order to better understanding the physical process occurred in plasmapause region during strong geomagnetic disturbances we present the data gathered by help the ground-based ULF Hylaty station located in Bieszczady mountains. The aim of this paper is to present some general behaviour of trough dynamics as well as the fine structures of ionospheric trough and discuss the different type of instability generated inside the trough region from ULF frequency range thru VLF up to HF frequency range. As a consequence of different time scales of physical processes occurred in the near Earth environment during geomagnetic disturbances we discusses the different fine structures of main ionospheric trough both in particle as well as in waves presentation. .In order to better understand the physical conditions and evolution of ionosphere trough region and describe the coupling between ionosphere and inner magnetosphere the global map of TEC parameters was constructed and RO profiles were carried out.

2 RESULTS

On the basis of case studies of selected geomagnetic storms, the typical morphology of the middle-latitude trough and wave activity inside the trough is known. The studies were based on the data gathered by low orbiting spacecraft such as IK-19, MAGION-3 and DEMETER.

In order for the physical processes responsible for reconstructing the top-side ionosphere to be processed with different time scales in different regions (particularly in the foF2 layers and at the equator of plasmapause) the irregular and double-structural shape of the ionospheric trough was detected during strong and rapid changes in geomagnetic activity (Fig.1). The study found that during strong geomagnetic disturbances, increases in broadband wave emission beginning from the ULF frequency band, through the VLF frequency band up to HF frequency band can be observed. Moreover, theoretical considerations indicated that the generation of those waves were induced even by some local drivers such as, for example, a beam of energetic particles, or by remote indicators located at the equator of the plasmapause. The investigation showed the main ionospheric trough region is a turbulent plasma region, particularly during geomagnetic disturbances. The plasma heating process starts at the plasmapause equator and this is followed by a transfer of heat along the field line to the topside ionosphere region and excites the turbulent region of the ionospheric plasma.

The existence of fossil broadband emission inside the plasmasphere close to the plasmapause after strong geomagnetic disturbances was also detected and analysed. This fact confirmed the previous observation of a turbulent plasma region located inside the plasmasphere close to the plasmapause but registered at a few Earth radii. The broadband electromagnetic and electrostatic fossil emissions observed in the VLF and HF frequency range after strong disturbances will now allow the construction of more realistic models of the energy transfer in the ionosphere-magnetosphere coupling processes(Fig.2). Furthermore, the data collected by the DEMETER satellite show that during an increasing level of geomagnetic activity an enhancement of Alfven and EMIC waves inside the ionospheric trough region can be observed.

During changes in geomagnetic activity, determination of the trough position is not possible using only one type of diagnostic. The multi instrumentation diagnostics approach allows to determining the trough minimum position, poleward edge and equatorward edge of the main ionospheric trough and to descible filamentary stucures inside ionospheric trough. The global maps constructed using the TEC data gathered by the GPS network and radio occulatation echniques RO was used for validation in situ measurements and for describing the general property and tendencies in the near-Earth plasma environment.

3 CONCLUSIONS

In order to assess the accuracy of the three dimension and time dependent main ionospheric trough modeling multi instruments and multi point diagnostics should be used. The presented TEC, RO techniques and in situ waves and plasma diagnostics can be good tools set for monitoring and giagnostics large dynamic scales of ionosphere.

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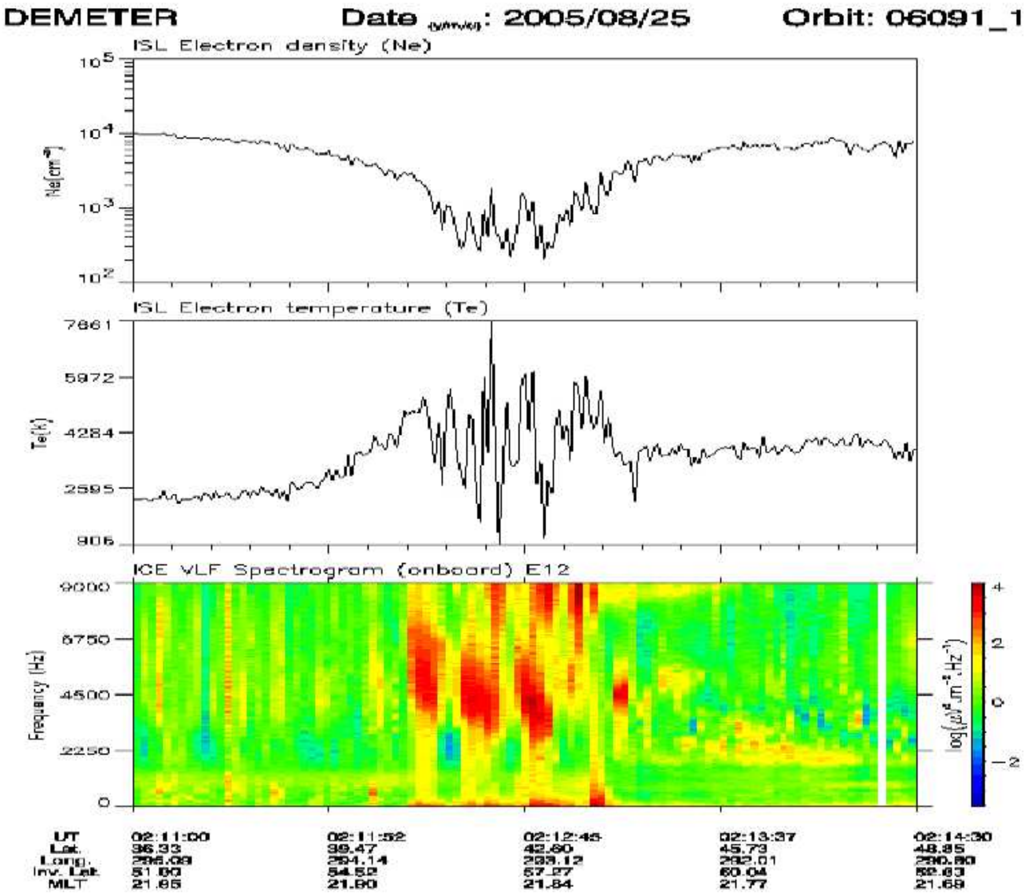

Figure 1: The manifestation of filamentary structure inside main ionospheric trough detected on the board of DEMETER satellite. Upper panel shows the electron density changes inside trough region, middle panel shows the electron temperature, bottom panel reflects the waves activity in VLF frequency range.

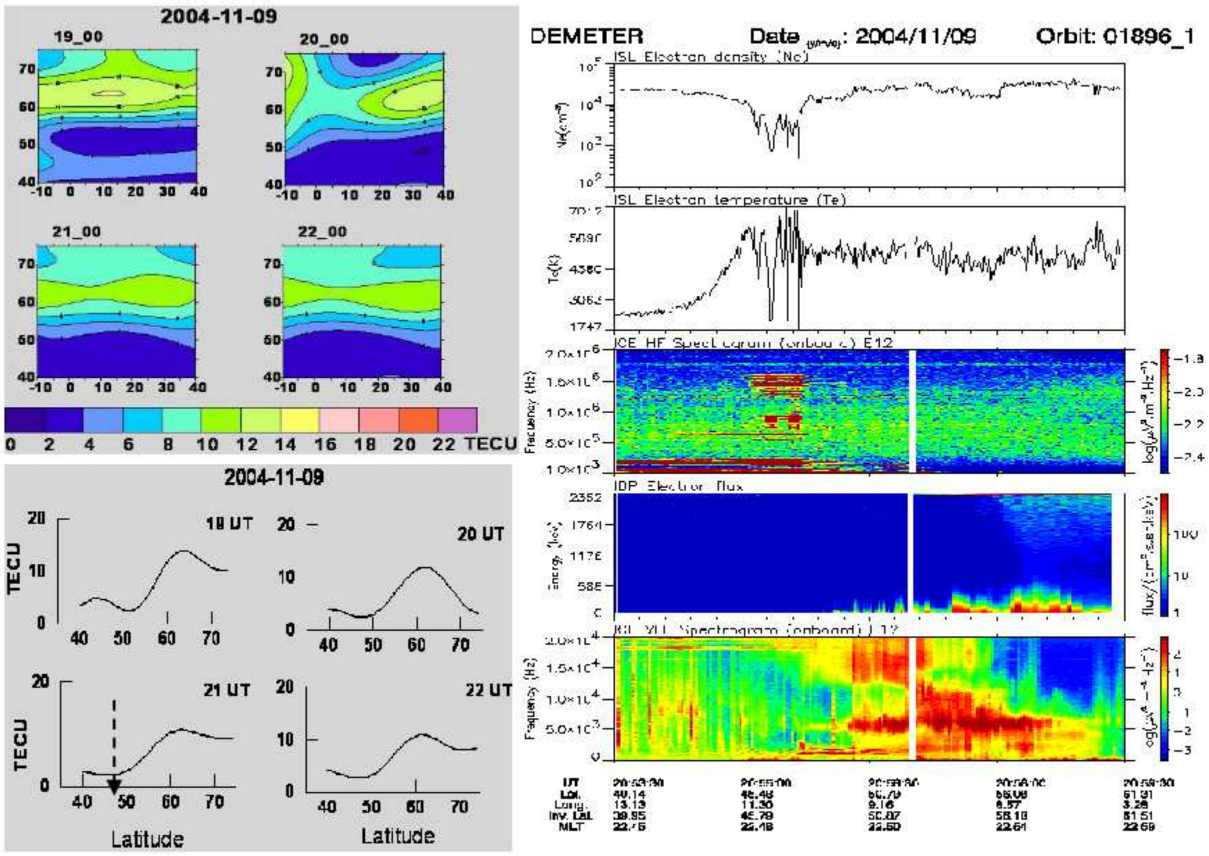

Figure 2: The sequence of wave and plasma measurements registered on board of DEMETER satellite on 09.11.2004 during recovery phase of geomagnetic storm right panel, differential TEC maps over Europe for 09.11.2004 left panel.the arrow marks the position of trough determined form in situ measurements.