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Observations of the three-peak equatorial ionization anomaly

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ABSTRACT

Low-latitude ionosphere is characterized by the well-known equatorial plasma fountain that produces several special features, including the equatorial ionization anomaly (EIA). At equatorial latitudes, the zonal electric field crosses the horizontal magnetic fields, creating the ExB drift that uplifts the ionospheric plasma and creates the ionization trough at the magnetic equator and plasma density enhancements at ±12–15° of magnetic latitudes during geomagnetically quiet conditions. This ionospheric uplift due to the ExB drift is often referred to as "fountain" effect. During geomagnetic storms, prompt penetration electric fields and storm-enhanced thermospheric winds can reinforce the fountain effect to super-fountain effect, as the plasma lifts higher in altitudes and the overall electron density enhancements within the EIA crests can reach very high values.

Besides this classic dayside 2-peak EIA profile, it has recently been shown that strong geomagnetic storms can produce 3- or even 4-peak structures in the daytime ionosphere (e.g., [2]). In addition to that, Maruyama et al., 2016 [3] has recently shown that 3-peak density structure can occur even under geomagnetically quiet conditions.

In this work, we discuss the occurrence of the dayside three-peak electron density structure in the F2 and topside regions of the ionosphere (example in Figure 1). For this purpose, we use 5-year data set of the electron density from the in-situ measurements by the Planar Langmuir Probe (PLP) onboard CHAMP satellite. Our analysis shows that the 3-peak structure can occur sufficiently often around the solstice period under geomagnetically quiet conditions. The third ionization peak occurs in the afternoon hours in the summer hemisphere (Figure 2, and [1]), caused by the strong thermospheric summer-to-winter winds.

From the numerous 3-peak events occurred during 2003-2009, we select several ones for a more detailed study. For the selected 3-peak events, we ran the Coupled Thermosphere Ionosphere Plasmasphere Electrodynamics (CTIPe) model. We found that the CTIPe model does not always reproduce the third ionization peak.

Key words: topside ionosphere, electron density, equatorial ionization anomaly (EIA), thermospheric winds

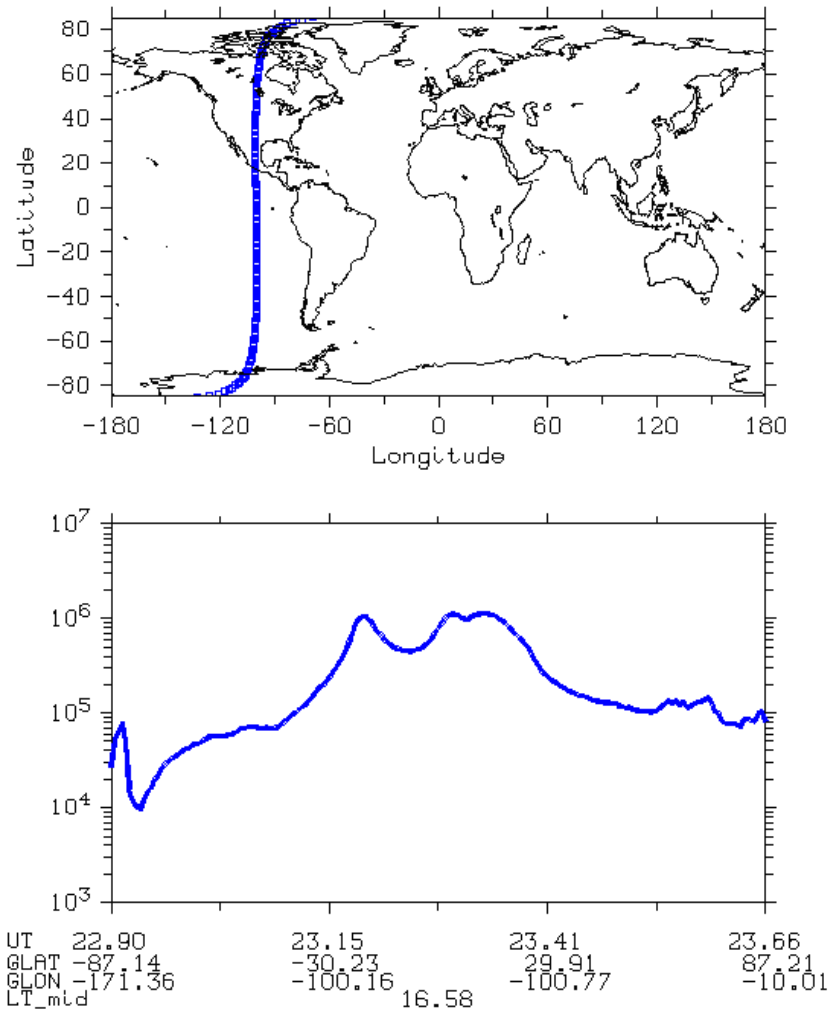

Figure 1. Example of 3-peak electron density structure measured on 9 May 2008 by CHAMP satellite (lower panel). Panel on the top shows the satellite trajectory.

References:

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[3] Maruyama, N., et al. (2016) A new source of the mid-latitude ionospheric peak density structure revealed by a new Ionosphere-Plasmasphere model. *Geophys. Res. Lett.,* V. 43, doi:10.1002/2015GL067321.

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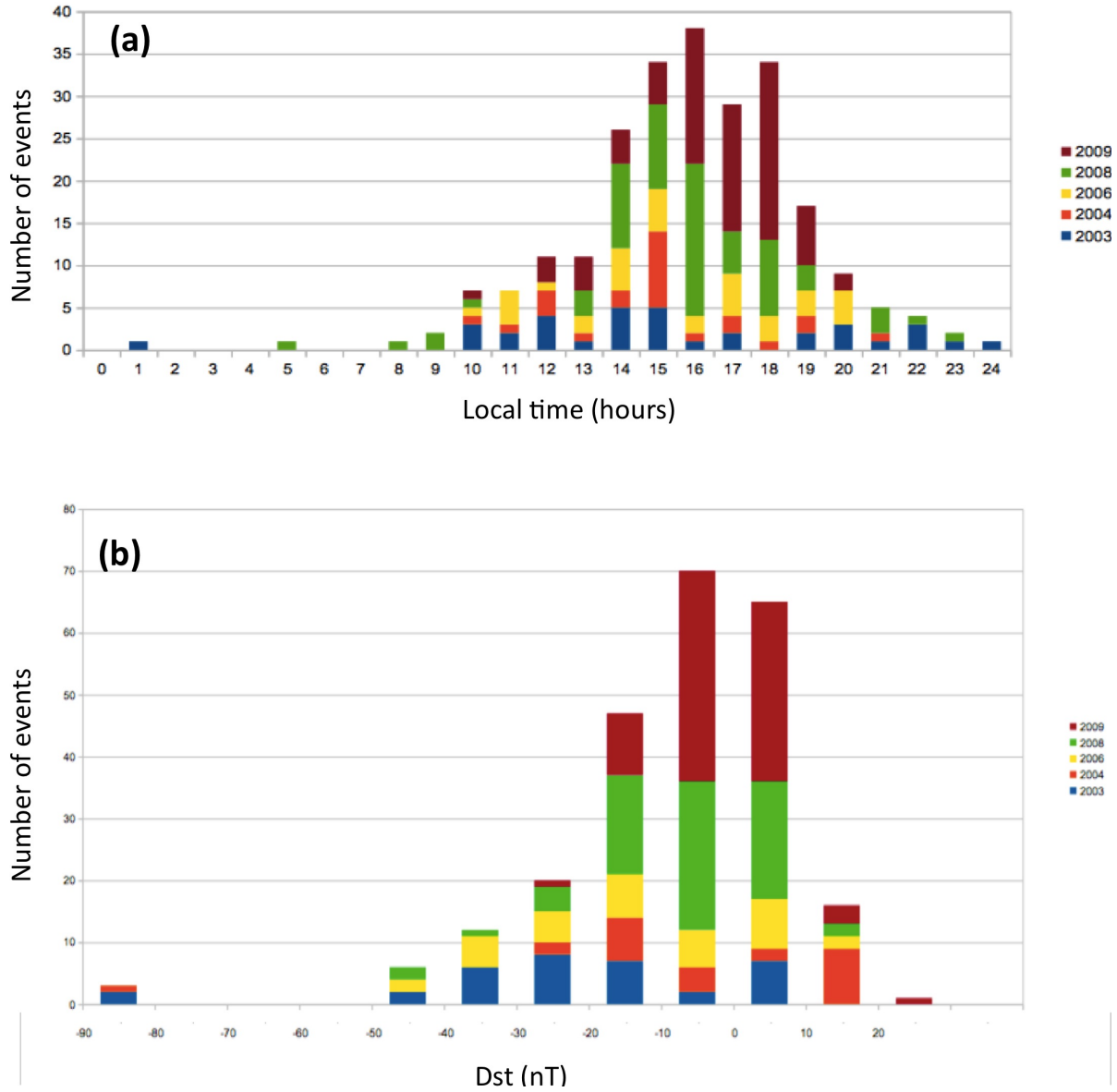

Figure 2. Occurrence of the 3-peak electron density structure as derived from the in-situ electron density measurements by CHAMP: dependence of local time (a) and in index of geomagnetic activity Dst (b).