Statistical analysis of field-aligned distribution of plasma density in the plasmasphere

Takahiro Ikeda[1]; Yukitoshi Nishimura[2]; Takayuki Ono[3]; Masahide Iizima[4]; Atsushi Kumamoto[5]

[1] Dept. Geophys, Tohoku Univ.; [2] Department of Geophysics, Tohoku University; [3] Department of Astronomy and Geophysics, Tohoku Univ.; [4] Geophysical Inst., Tohoku Univ.; [5] Tohoku Univ.

http://stpp1.geophys.tohoku.ac.jp

The statistical analysis of field-aligned plasma distribution in the plasmasphere has been performed by using huge amount of the Akebono plasma wave data from 1989 to 1998. For statistical analysis, we made an average of plasma density structure with spatial resolutions of 500 km along field line within the L-shell range of L=1-3.

During geomagnetically quiet periods, the plasma density distribution in the noon sector (MLT is from 9 to 16) agrees with the diffusive equilibrium [Angerami and Thomas, 1964] model above 4,000 km along field line; however it shows obvious difference below 4,000 km for every L-shells. This difference increases with increasing the L value. The plasma density distribution in this area agrees with the exospheric equilibrium model [Eviatar, 1964]. On the other hand, the midnight (MLT is from 22 to 4) plasma density distribution agrees with the diffusive equilibrium model, and both densities are nearly identical above 4,000 km. This deference between noon and midnight may be due to the production effect of the ionosphere in the noon sector.

The equatorial electron density distribution in the noon sector (MLT is from 9 to 16) gradually decreases with L value, described by the formula of N=30,200∗Lˆ(-2.99) (/cc). The ratio of the standard deviation to the average electron density is 20-40%. This formula is nearly Lˆ(-3), and radial density distribution in higher MLAT region also shows nearly Lˆ(-3) low.

The storm time plasma density tends to show larger value in the equator region along the field line, if there is no signature of the donkey-ear phenomena. A trend of the minimum plasma density agrees with the exospheric equilibrium model. However, equatorial plasma density (magnetic latitude is from -20 to 20 degrees at L=2.6) does not goes down to the profile of the exospheric equilibrium model in large geomagnetic storms, so probably plasmaspheric refilling starts from near the equator.

During recovery phase, plasma density gradually increases and returns to a level of the quiet time distribution within about three days. The refilling ratio is measured 10-20/cc/h. An electron density value near the equator in L=2.4 did not reach to an diffusive equilibrium level even if geomagnetically quiet periods last ten days, this feature disagree from previous result of refilling simulation[Webb and Essex, 2001].

Based on the present study, it will become possible to obtain more accurate empirical model of classical model of the plasmasphere structure. From the base of this reference level, it will become possible to understand the larger disturbed state of the plasmasphere which may reveal the donkey-ear phenomena reported by Oya[1993].