Magnetospheric (90 – 4000 km) Field Aligned Electron and Ion (H+, He+, O+) Densities as a Function of Geomagnetic Storm Activity

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Field aligned electron (Ne) and ion densities and their variations as a function of geomagnetic storm activity are important parameters in the physics of the thermosphere, ionosphere, and magnetosphere. Whistler mode (WM) radio sounding [Sonwalkar et al., JGR, 2011] from the IMAGE satellite during 24 Aug – 18 Sep 2005, covering 3 major, 3 moderate, and one minor storm, has permitted measurements of electron and ion densities (90-4000 km) as a function of geomagnetic storm activity. During this period, WM echoes were observed on dayside (MLT~14, $1.7<L<3.5$) and nightside (MLT~3, $1.8<L<4.5$). Here we present results from the analysis of WM echoes observed on dayside between $1.8<L<2.2$. The analysis of echoes at other L-shell and nighttime is ongoing. From the analysis of WM echoes observed during quiet times nominal density models were built for Ne and relative ion concentrations (αH+, αHe+, αO+).

Relative to nominal quiet time conditions, we found the following general results for major and moderate storms: (1) Plasmapause moved from Lpp~4.5 during the quiet time to Lpp~2.4 during the disturbed time. (2) Before the storm onset, O+/H+ transition height, Ne above transition height, αH+, αHe+, αO+ remained comparable to their nominal quiet values, whereas Ne below transition height including at F2 peak increased. (3) During the recovery phase: (a) O+/H+ transition height increased, (b) Ne above transition height increased (1st day) and then decreased (2nd day), (c) αH+ remained same as the nominal value (1st day) and then decreased (2nd day), (d) αHe+ decreased (1st day) and then recovered to its nominal value (2nd day), (e) αO+ increased on the 1st and 2nd day and then returned to nominal value, (f) Ne at F2 decreased during the recovery phase. (4) In the case of minor storm, Ne and αO+ followed a similar trend, αH+ decreased (1st and 2nd day), and αHe+ remained unaffected. (5) The recovery times of electron density, relative ion concentrations, and O+/H+ transition height were found to be different. (6) In one case of major storm, during the main phase (~8 hours), Ne at all altitudes decreased compared to that at onset, but αH+, αHe+, αO+ remained comparable to their values before the onset. WM sounding measurements are augmented with those from DMSP, CHAMP, and ionosonde data. WM sounding results were in general agreement with DMSP and CHAMP data. Ionosonde overestimated Ne at F2 peak relative to WM sounding results.

The results presented here will be used to test current theories and physics based models (e.g. SAMI2) of thermosphere-ionosphere-magnetosphere coupling, to build empirical models of field aligned electron and ion densities, and to relate variations in plasma density and composition to those in thermospheric neutral wind and dynamo electric fields during geomagnetically active periods.