Ion Refilling Rates and Upward Ion Flux for L = 2.3 - 3.8 Flux Tubes

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Measurements of the eigenfrequency of geomagnetic field lines can provide information on the plasma mass density near the equatorial plane of the magnetosphere. Data from an extended meridional array of ground magnetometers therefore allows the radial density distribution, and its temporal variation, to be remotely monitored. Using cross-phase analysis of ground magnetometer array data, we determined the equatorial mass density during a moderate geomagnetic storm that commenced on 9 March 2004 following several days of magnetically quiet conditions. On 10 March, at the beginning of the storm recovery phase (Kp = 6+), the field line eigenfrequency over L = 2.34 - 3.83 was unusually high. This corresponds to very low mass densities, indicating that the plasmapause moved Earthward and these flux tubes were depleted. Over 10 - 13 March the eigenfrequency at these L values progressively decreased, indicating refilling of the flux tube to pre-storm levels, superimposed upon diurnal variations. By comparing density measurements we have determined the ion refilling rates and fluxes at the 1000 km level for the L = 2.34, 2.63, 3.26, and 3.83 flux tubes. The upward ion fluxes decreased with increasing L-value, being 3.9×10^{8} amu/cc/sec at L=2.34 and 1.49×10^{8} amu/cc/sec at L=3.83, respectively. These are in excellent agreement with daytime upward electron fluxes calculated by previous authors, and the L-value dependence can be explained by solar zenith angle control of ion production rates.