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Evolution of ionosphere-thermosphere (IT) parameters in the cusp region related to ion upflow events

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In this study we investigate the relationships of various IT parameters with the intensity of vertical ion flow. Our study area is the ionospheric cusp region in the northern hemisphere. The approach uses superposed epoch analysis (SEA) method, centered alternately on peaks of the three different variables: neutral density enhancement, vertical plasma flow, and electron temperature. Further parameters included are large-scale field-aligned currents (LSFACs) and thermospheric zonal wind velocity profiles over magnetic latitude (MLat), which are centered at the event time and location. The dependence on the interplanetary magnetic field (IMF) By component orientation and the local (Lloyd) season is of particular interest. Our investigations are based on CHAMP and DMSP (F13 and F15) satellite observations and the OMNI online database collected during the years 2002-2007. The three Lloyd seasons of 130 days each are defined as follows: local winter (1 January $\pm$ 65 days), combined equinoxes (1 April and 1 October $\pm$ 32 days), and local summer (1 July $\pm$ 65 days). A period of 130 days corresponds to the time needed by CHAMP to sample all local times.

The SEA MLat profiles with respect to neutral density enhancement and vertical plasma flow peaks show no significant but only slight (decreasing towards local summer) seasonal variations for both IMF By orientations. The latitude profiles of median LSFACs show a clear dependence on the IMF By orientation. As expected, the maximum and minimum values of LSFAC amplitudes are increasing towards local summer for both IMF By signs. With respect to zero epoch latitude, FAC peaks appear equatorward (negative MLat) related to Region 1 (R1) and poleward (positive MLat) to Region 0 (R0) FACs. However, there is an imbalance between the amplitudes of LSFACs, depending on the current latitude. R1 currents are systematically stronger than R0 FACs.

A somewhat different distribution of density enhancements and large-scale FACs emerges when the SEA is centered on electron temperature peaks. As expected, the background electron temperature increases towards summer and shows no dependence on the IMF By orientation. In contrast to the previous sorting the mass density enhancement shows a dependence on the IMF By sign and increases towards local summer in case of IMF By<0. As before LSFAC peak values are increasing towards local summer, but there is no clear latitudinal profile of upward and downward FACs. We think that intense precipitation of soft electrons (<100 eV) cause the electron temperature enhancement in the cusp region. But there is no direct dependence on the FAC intensity. But for neutral density enhancement and vertical plasma flow the combination of Joule heating and soft electron precipitation, causing electron temperature and conductivity enhancements, are required.