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One-two hour scale evolution of the inner magnetospheric plasma

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In the inner magnetosphere inside the geosynchronous orbit, energy-latitude patterns of trapped low-energy ring current ions (eastward drifting energy domain of less than 5 keV) are normally north-south symmetric because these ions are bouncing between southern and northern hemispheres with short bouncing periods (only about 10 minutes for 100 eV proton and 1 minutes for 10 keV protons at L=4). Therefore, for inner magnetospheric phenomena with longer time scale than few tens minutes, one can ignore the hemispheric difference when examining temporal changes of the ion distribution at a fixed latitude (or L value) and longitude. This fact gives an advantage to Cluster that has relatively quick perigee traversals and nearly north-south symmetric orbits, i.e., along nearly the same longitude (longitudinal difference between inbound and outbound is less than 1-2 hours) during 2001-2006. Therefore, any significant asymmetry in the ion energy-latitude pattern observed during the Cluster perigee traversals during 2001-2006 means a temporal effect such as ion energization, transport, or loss, with the time scale of order of an hour.

After removing traversals in which ion data are severely contaminated by the radiation belt particles (about one third of all traversals), e took statistics the inbound-outbound asymmetry of the ion population and its energy-latitude patterns at low energy (less than several keV) for the remaining 494 perigee traversals of Cluster spacecraft 4 during 2001-2006. As the baseline, we considered the following two ion populations that are commonly found in Cluster data: (1) Wedge-like energy-latitude structure at sub-keV range. (2) Similar to the wedge-like structure but dispersion is weak (nearly vertical in the spectrogram) and the energy range extends from the about 10 keV to sub-keV (Yamauchi et al., 2006).

For both types, the asymmetric cases are observed more frequently than the symmetric cases at all local time. The excess of the asymmetric case is reasonable for the second type that is most frequently observed at post-midnight because at this population is most likely related to the substorm injection. However, the excess of the asymmetric case for the wedge-like structure (first type) is unexpected because it is formed after long-time drift with slow drifting velocity. The peak local time for the asymmetric wedge-like structure is morning, whereas symmetric case is peaked at prenoon.