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3D Global PIC simulation of Cusp Dynamics and Alfvenic transition layers at cusp outer boundary during IMF rotations from north to south

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The first 3D global full electro-magnetic particle-in-cell (PIC) simulations in the global view of solar-wind-magnetosphere interaction are performed, and compared with the statistical surveys of the plasma flows measured by the CLUSTER satellites in the high-altitude cusp region of the Northern Hemisphere. he magnetospheric polar cusp regions are considered to be key regions to transfer mass, and energy from the solar-wind to the plasma sheet. Using the global PIC simulation, we try to understand these key regions and the dynamical interactions that occur there. Statistical experimental observations of the cusp boundaries from CLUSTER mission made by Lavraud et al. (2005) have clearly evidenced the presence of a transition layer inside the magnetosheath near the outer boundary of the cusp. This layer characterized by $\mathrm{Log}(\mathrm{M}_A) \sim 1$ allows a transition from super-Alfvenic to sub-Alfvenic bulk flow from the exterior to the interior side of the outer cusp and has been mainly observed experimentally under northward interplanetary magnetic field (IMF). The role of this layer is important in order to understand the flow variations (and later the entry and precipitation of particles) when penetrating the outer boundary of the cusp. In order to analyze this layer, a large 3D PIC simulation of the global solar wind-terrestrial magnetosphere interaction have been performed, and the attention has been focused on the cusp region and its nearby surrounding during IMF rotation from north to south. Present results retrieve quite well the presence of this layer within the meridian plane for exactly northward IMF, but its location differs in the sense that it is located slightly below the X reconnection region associated to the nearby magnetopause (above the outer boundary of the cusp). In order to clarify this question, an extensive study has been performed as follows: (i) a 3D mapping of this transition layer in order to analyze more precisely the thickness, the location and the spatial extension of this layer on the magnetosphere flanks for a fixed Northward IMF configuration; (ii) a parametric study in order to analyze the impact of the IMF rotation from north to south on the persistence and the main features of this transition layer; (iii) following these analysis, a 3D mapping and analysis of particle distributions from this transition layer to the so-called stagnant cusp exterior in order to reveal the mechanism of this layer. We show how these transition layers render the flow from super to sub Alfvenic and allow the particles enter into the magnetic cusp region.