Role of diffusion in a boundary region between hot-tenuous and cold-dense plasma sheets: THEMIS observations

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We investigated a boundary region between hot-tenuous and cold-dense plasma sheets (HT-CDPSs) in order to understand transport of cold dense plasma near the magnetopause deep into the magnetosphere. In this presentation, we will show a case study of THEMIS observations in which three of the THEMIS spacecraft in the dawn flank observed a HT-CDPS boundary. The HT-CDPS boundary was detected sequentially at THEMIS-E (farthest from the Earth), at THEMIS-A, and at THEMIS-D (nearest from the Earth), which suggests earthward transport of cold dense plasma. Ion density at each spacecraft indicates that the earthward transport of cold-dense plasma is not consistent with earthward convective motion of the flux tube filled with cold-dense plasma. We found from 2-D distribution functions that cold ions have a perpendicular anisotropy or are nearly isotropic and cold electrons have a parallel anisotropy at and just inside the HT-CDPS boundary, while cold ions have a parallel anisotropy and cold electrons are isotropic in the HTPS. Large electric field (~9 mV/m) and low frequency magnetic fluctuations ($<$0.02 Hz) were observed around the HT-CDPS boundary at least during the farthest boundary crossing. These observations suggest that there are electromagnetic waves or instabilities which can cause perpendicular (parallel) heating of ions (electrons) at HT-CDPS boundary and that diffusive process induced by such activities plays a significant role in transport of cold dense plasma in the magnetosphere.

Assuming that transport is controlled by eddy diffusion, we solved diffusion equation using ion density at THEMIS-E as time varying boundary condition. We found that the diffusion coefficient which can account for density profile at the other two spacecraft is an order of magnitude larger than the typical coefficients estimated from simulations of diffusive processes associated with kinetic Alfven waves or Kelvin-Helmholtz instability at the magnetopause. We will discuss how effective diffusion is attained.