Multi-spacecraft observations of cold-dense plasma sheet under northward IMF

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The near-Earth plasma sheet becomes cold and dense under northward interplanetary magnetic field (IMF) condition, which suggests entry of solar wind plasma into the magnetosphere across the magnetopause. The cold and dense trend of the plasma sheet is more apparent in the magnetotail flank regions that are interface between cold solar wind plasma and hot magnetospheric plasma. Several physical mechanisms have been proposed to explain the solar wind plasma entry across the magnetopause and resultant formation of the cold-dense plasma sheet in the tail flank regions. However, cold-dense plasma is occasionally found in the midnight magnetotail as well, and plasma transport from the magnetopause deeper into the magnetosphere has not been understood yet. Here we report that cold-dense plasma is simultaneously detected in a wide region of the near-Earth plasma sheet, including the inner magnetosphere, under the prolonged northward IMF and relatively high dynamic pressure conditions, by using data from Geotail, MMS, ERG, and Cluster. In one event, the ion distribution functions on the duskside both in the outer magnetosphere and in the inner magnetosphere show two distinct populations in low- and high-energy ranges, which implies that the low-energy (cold) population of solar wind origin may enter the magnetosphere by a common process. On the other hand, energies of the cold component and the magnetic field strengths suggest that the cold component in the inner magnetosphere may not have its origin in the magnetotail. We also note that no southward turning of the IMF took place for the period of our interest and thus no injection from the magnetotail into the inner magnetosphere was expected. The entry location(s) of the cold-dense plasma found deep inside the magnetosphere and its transport mechanism remain to be studied.

Keywords: Magnetospheric plasma transport, Cold dense plasma, Northward IMF, Multi-spacecraft observation (MMS, Geotail, Arase, etc.)

