Meridional distribution of proton plasma and pressure-driven currents in the nightside inner magnetosphere: Arase observation

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Plasma pressure, anisotropy, and beta value in the inner magnetosphere have been well examined in terms of L value and magnetic-local time distributions, but their the meridional distribution has not yet been revealed by observations. The present study examines the averaged meridional distributions of proton plasma parameters and pressure-driven currents in the nightside (20-04 h MLT) ring current region during disturbed time (SYM-H from -50 to -20 nT) using the long-term data set of the Arase satellite. Since the Arase satellite has a large inclination orbit (31^o inclination), it covers the magnetic latitude (MLAT) range of 0-40^o and the radial distance greater than 6 Re. The plasma pressure was calculated based on proton fluxes for the energy range of 10-180 keV observed by the Medium-energy particle experiments - ion mass analyzer (MEP-i) instrument onboard Arase. We find that the perpendicular and parallel plasma pressures significantly decrease with the absolute value of the magnetic latitude (|MLAT|) at L less than 5 (L is defined by the Tsyganenko 96 model). The plasma pressure on the same L shell at 30-40^o |MLAT|is about 20-50% of that at 0-10^o. On the other hand, at L greater than 5.5, the plasma pressure does not monotonically decrease with |MLAT|. The pressure anisotropy which is defined by the perpendicular pressure divided by the parallel pressure decreases with radial distance, and shows no clear dependence on |MLAT|. The perpendicular plasma beta drastically decreases with |MLAT|. We compare the observed plasma pressure distribution with the theory of field-aligned particle distribution proposed by Parker [1957]. The relative plasma pressure distribution predicted from the magnetic strength and anisotropy is almost consistent with the observed plasma pressure for L = 4-5. We then calculated the azimuthal current distribution based on the proton plasma pressure distribution in the $(X_{SM}{}^2+X_{SM}{}^2)^{1/2}$ - Z_{SM} plane. The resultant pressure-gradient current spreads over ˜0-20^o in |MLAT|, while the curvature current is limited within ˜0-10^o. These results indicate that the latitudinal variations of plasma parameters and pressure-driven currents are not negligible, and the magnetic latitude of satellites should be considered in addition to L value and magnetic local time of satellites.