Study of plasma pressure distribution in the inner magnetosphere using the low-altitude satellite data as one of important elements of the magnetospheric dynamics

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Plasma pressure distribution in the inner magnetosphere is one of the key parameters for understanding the main magnetospheric processes including geomagnetic storms and substorms. Therefore, during the last decades many efforts were concentrated on the study of pressure distribution in the inner magnetosphere. However, the pressure profiles obtained from in-situ particle measurements by the high-altitude satellites inside the plasma sheet and other regions of the magnetosphere do not allow the tracking the pressure variations related to the magnetospheric dynamics, because a time interval neaded to do this generally exceeds the characteristic times of the main magnetospheric processes. On contrary, fast movement of low-altitude satellites makes it possible to catch quasi-instantaneous radial or azimuthal profiles of plasma pressure along the satellite trayectory, using the precipitating particle flux data in the regions of isotropic plasma pressure. The low-altitude polar-orbiting Aureol-3 satellite was used for this study. IGRF, Tsyganenko 2001 and Tsyganenko 2004 storm time geomagnetic field models were used for the pressure mapping into the equatorial plane, and also to evaluate the corresponding volume of the magnetic flux tube, and the magnetic pressure. Study of azumuthal plasma pressure gradients showed that these gradients can be a source of the Iijima and Potemra's field-aligned current system. Study of radial plasma gradients showed that during quiet geomagnetic condition the profiles obtained coincide with the results obtained previously from the high-altitude measurements. On contrary, the plasma pressure profiles change significantly during the development of storms and substorms. In case of substorms, the modified interchange instability related to the existence of azimuthal plasma pressure gradients and field-aligned currents in equilibrium was proposed as a source of substorm expansion phase onset. Study of the strom-time pressure profiles showed that the plasma pressure profiles became sharper, and the interchange instability develops, when the plasma pressure profile becomes steeper than L^{-7}.