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A SATELLITE-GROUND STUDY OF THE DYNAMICS OF THE BULGE REGION OF THE EARTH'S MAGNETOSPHERE

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The dense plasma envelope of the Earth, called the plasmasphere, extends outward to a distance of about three to seven earth radii at the equator. At the outer limits of the plasmasphere, the plasma density usually drops sharply by a factor of from 5 to 40. This drop occurs at the so-called plasmapause; the low density region extending beyond it to the outer limits of the Earth's magnetized envelope, or magnetosphere, is called the plasmatrough.

A complex, dynamic, and poorly understood (and described) part of the the plasmasphere is the bulge region, usually located near dusk, where the plasmasphere radius is known to reach a maximum and where its shape is known to be highly variable. The bulge is a center of interest because it undergoes fast and complex changes during so-called substorms or magnetic storms, when large amounts of energy communicated to the magnetosphere by interaction with the Solar Wind are released, redistributed, and dissipated. In our research, we have been using data from multiple ground stations and satellites to see how the plasmasphere in the dusk sector is modified during these disturbances. There is clearly some type of erosion process, during which the plasmasphere is diminished in size, and it is believed that the "excess" plasma is peeled off and carried (convected) away toward the outer bondary of the magnetosphere (the magnetopause). However, very little is known about the physics of this erosion process, and about how the plasmasphere recovers during the quiet periods that follow such disturbances.

Our case studies from three multiday periods in 1982 have produced a number of new findings, including the first evidence from ground based Very Low Frequency (VLF) whistler stations of a narrow high density tail or streamer, extending sunward from the dusk side of the plasmasphere, and clear evidence from the Retarding Ion Mass Spectrometer (RIMS) experiment on DE 1 of sunward and outward bulk flow of dense plasma near dusk. The study has revealed new evidence of the accumulation of large regions of dense plasma in the afternoon sector at locations well beyond the main plasmasphere, and has raised a number of questions concerning the relation between narrow streamers, which apparently can be formed near the edge of the main plasmasphere, and the often large outlying regions, which can extend for several earth radii along a satellite orbit.

The study has also shown that the plasmapause region after dusk is one in which irregular density structure tends to develop, and in which such structure may persist for days during a quieting/calm period. Of substantial potential importance to plasmasphere physics is our additional evidence that much of the bulge structure and activity takes place beyond an inner plasmasphere, the shape of which is strongly influenced by nightside substorm-associated plasmapause forming mechanisms. In this outer region, which is the more identifiable portion of the bulge, there appears to be a tendency for dense plasma "islands" to accumulate and to circulate in the afternoon-dusk sector in a kind of eddy flow that does not encircle the Earth in the manner of plasma flow at smaller radii.

Our work, being conducted jointly with B.Giles and C.Chappell of MSFC, R. Anderson of the U. of Iowa, P. Decreau of the U. of Orleans, and Y. Corcuff of the U. of Poitiers, is continuing into the final stages of figure preparation and interpretation, and we expect to complete our major study sometime this fall, with partial support from a grant to Stanford from MSFC.

NOTE: In addition to this main work, I have also been collaborating with D. Gallagher and P. Craven of SSL on development of an empirical model of equatorial electron density in the Earth's magnetosphere. I have also been collaborating with Bill Boeck and the lightning group at SSL on a joint study of lightning videotaped from the Shuttle in January, 1990.