PLASMASPHERE EMPIRICAL MODELING WITH THE IMAGE MISSION

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Empirical models of plasmaspheric properties date from the pioneering work of Storey [Phil. Trans. Of the Royal Soc. (London) A, 246, 113, 1953[where he developed the analysis of ground whistler observations that lead to his estimate for the equatorial plasma density at L=3. The most recent in situ satellite study takes us to 1000 CRRES satellite passes and a statistical analysis of the plasmapause location at all local times and for varying geomagnetic conditions by [Moldwin et al. 2002, J. Geophys. Res., in press]. These and many other studies over the intervening 49 years have given us a strong familiarity with the distribution of cold plasmaspheric ions throughout the magnetosphere. The major components of inner plasmasphere, nightside bulge, sunward convection tail, and plasmapause are all well established. Storm-time erosion and the resulting ionospheric refilling has been encompassed, even if not completely understood. Small-scale density variations near the plasmapause and extending at least to geosynchronous orbit have been characterized in a variety of ways, even though we do not yet understand their origin.

The use of whistler observations from the ground and in situ satellite measurements to characterize plasmaspheric density distributions are an essentially heroic endeavor. This relatively successful pursuit is nearly always strongly aliased in time, space, or both by limited observing locations and changing magnetospheric conditions. Statistical derivations of the properties of density distribution depend on organizing measured properties into categories of similar plasmaspheric states. Statistical scatter in densities and boundary locations are invariably large, owing to a strong dependence on the historical detail of changing magnetospheric conditions and the crude indices available to describe those conditions. The highly variable nature of the plasmasphere may, in fact, limit the fidelity that can be achieved in any statistical characterization.

In contrast to that pessimistic suggestion, the IMAGE Mission now affords the opportunity to use global observations of thermal plasma density distributions in our empirical modeling efforts. What has previously required years of in situ measurement to “paint” a picture of plasma densities over a broad spatial extent can now be acquired in a single orbital pass from the Radio Plasma Imager (RPI) [Reinisch, et al., Space Science Reviews, 91, 319, 2000] or a single 10-minute image from the Extreme Ultraviolet Imager (EUV) [Sandel et al., Space Science Reviews, 91, 197, 2000]. Individual and extended IMAGE observations may enable empirical modeling of thermal plasmas to finally resolve spatial and temporal ambiguities that have hampered many decades of study. Plasmaspheric erosion and the development of small and large-scale density structures can be statistically characterized in the context of storm onset and recovery. The refilling of magnetic flux tubes as a function of L-shell and local time can be mapped. The statistical characterization of plasmaspheric properties can be compared and used to improve existing empirical models and theoretical predictions. Figure 1 shows six images obtained from the IMAGE/EUV instrument. The Sun is to the lower left in each image, as emphasized by the Earth’s shadow cast to the upper right. The darkened regions in the lower left of each panel are the result of automatic camera gain reduction in response to the proximity of the Sun to the camera field of view. Earth is in the center of each panel, with the aurora also clearly visible in the images. The bright region in each image is plasmaspheric He^+, which often shows considerable structure.

This paper will present early empirical modeling results from the inversion of IMAGE/EUV global intensity images to density distributions. Densities are obtained in this initial study through use of forward image modeling with a simple 3-parameter plasmaspheric and plasmapause mathematical model. Individual interior plasmaspheric density profiles and plasmapause locations are obtained every 10 degrees in magnetic local time for each EUV image analyzed. Derived profile parameters are statistically characterized in the context of storm magnitude and evolution. Identified patterns in the appearance of plasmaspheric structures, plasmapause erosion, and refilling will be presented. Comparisons to existing empirical plasmaspheric models and the implications for new modeling will also be discussed.

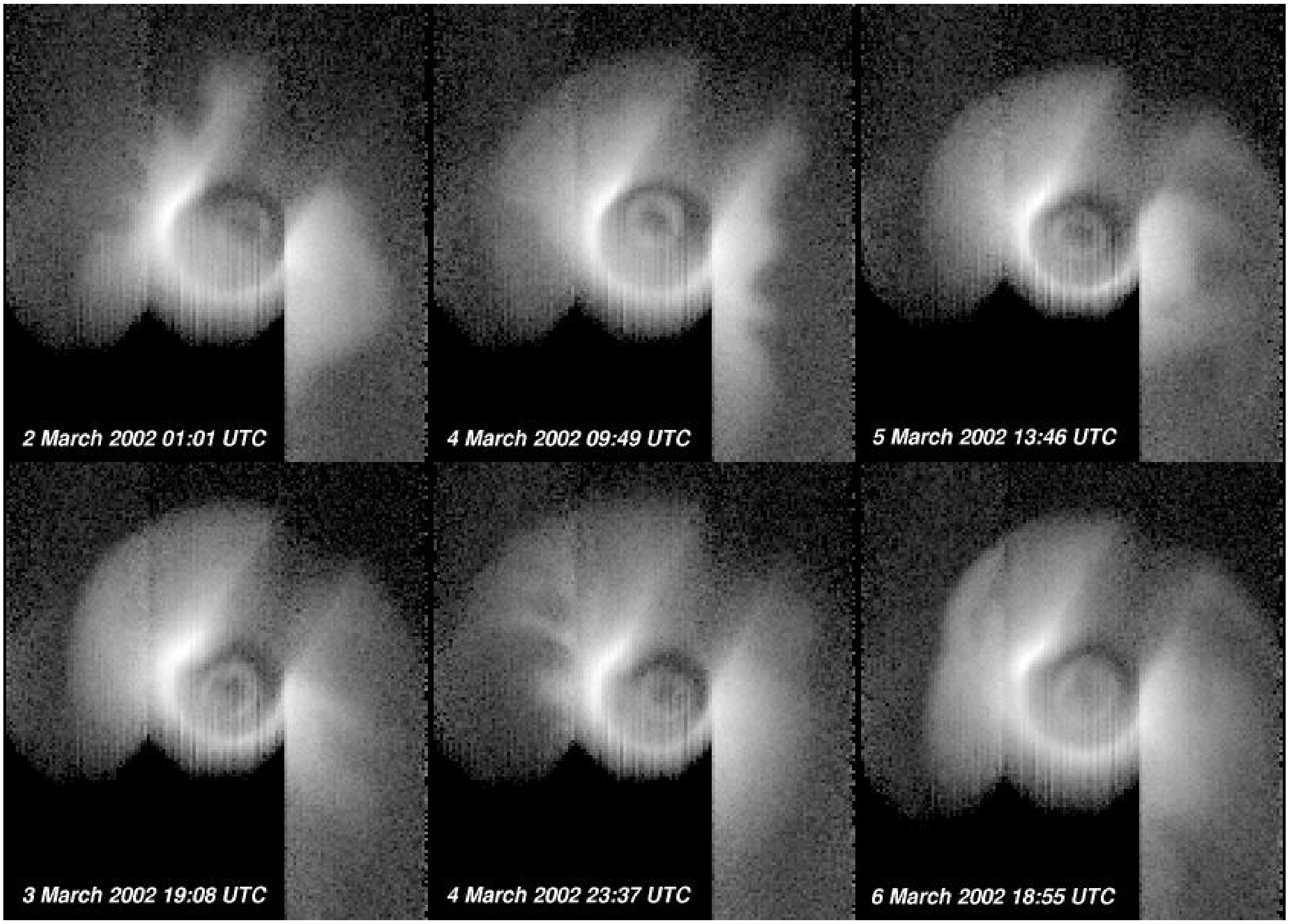

Figure 1: IMAGE/EUV image of highly structured plasmaspheric He^+