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Models of Saturn's Bow Shock, Magnetopause and Current Sheet Based on the Results of Global MHD Simulations

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We present models of Saturn's bow shock, magnetopause and current sheet which have been developed using the results of our global, 3D MHD simulations of the magnetosphere. Our global MHD model self consistently treats the entire magnetosphere and includes magnetospheric plasma sources from a major disk-like source from Enceladus and the rings and a secondary toroidal plasma source from Titan. The model produces solutions which are not constrained to be symmetric therefore the results are quite useful in trying to extend previous models that have been generated using Cassini data. Because we can carefully control the inputs to our MHD model, we do not have to worry about separating variations due to local time, varying upstream conditions, spacecraft motion or changes in the mass loading rate that often make interpreting the data complicated. To generate our surface models, we begin by performing a series of steady states runs of the global model. To date we have more than 15 runs using different upstream dynamic pressures, axial tilts (corresponding to different Saturn seasons), upstream magnetic field orientation and internal mass loading rates. From each of these simulations we extract the surface every hour during a minimum of 100 hours. Because many of the runs show non-steady behavior we fit our analytic model surfaces to each of these simulation surfaces over several periods of the inherent dynamics. For the bow shock we fit a 4-parameter model to the surface where the fast magnetosonic Mach number falls to 90% its upstream value in the MHD simulations. In the case of the magnetopause, we determine the location of the surface using flow streamlines starting in the solar wind and then fit a 9-parameter analytical model that includes terms that represent the location of the cusps. Finally, for the current sheet location we will present a model that is based on that of Arridge (JGR, 2008) but that includes local time asymmetries. In each case, the models are a function of solar wind dynamic pressure as well as the Saturn season (axial tilt).