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Determining the spatial and temporal variability of Enceladus' mass-loading rate from ion-cyclotron wave observations and hybrid simulations

Ronald Powell (1), Hanying Wei (1), Misa Cowee (1), Christopher Russell (1), Jared Leisner (2), and Michele Dougherty (3)

(1) UCLA, IGPP, United States (rpowell@igpp.ucla.edu), (2) University of Iowa, (3) Imperial College, London

The southern plume of Enceladus releases a significant amount of neutrals, ions and dust into the inner magnetosphere of Saturn, thus it plays a critical role in the dynamics of plasma transport. The moon is also considered to be the ultimate source for the dusty E-ring and the extended neutral cloud from 3.5 to 6.5 Saturn radii. The mass loading rate from the plume can not only be directly measured from plasma instruments, but can also be obtained from the magnetic signatures produced by the plume and the properties of ion-cyclotron waves (ICW) generated by pickup ions from the plume. The ICWs grow from the free energy of the highly anisotropic distribution of the pickup ions, and their powers are proportional to the density and energy of the pickup ions. At Enceladus, ICWs are detected by Cassini not only near the moon but throughout the extended neutral cloud in all local times. However, the wave power is largely enhanced near the moon's longitude rather than far away from it. This indicates that on top of the relatively azimuthally symmetric mass-loading source of the neutral cloud, there is a much denser cloud of neutrals centered on the moon and rotating with it. The latter source is the instantaneous mass loading from Enceladus' plume, which leads to asymmetry and dynamics in the magnetosphere. From hybrid simulations, we study the ICW generation and understand the relationship between wave power and pickup ion densities. From observations, we obtain the spatial profiles of the ICW power near and far from the moon. Through comparison with waves at longitudes far away from the moon, we investigate how significant is the plume's mass-loading with respect to the neutral cloud mass-loading. We also compare the waves along several groups of identical trajectories and find that the temporal variability of the plume is within a factor of two.