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Water group ions in Saturn's magnetosphere: High precision measurements of mean mass

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The primary source of ions in Saturn's magnetosphere is water from the plumes of Enceladus. Rater than being ionized in the immediate vicinity of Enceladus, these molecules form a large neutral cloud in orbit around Saturn. The spatial extent of this cloud is not well-constrained, and the overall ion production rate us somewhat uncertain. To balance this source of plasma, ions are lost to the system through a combination of radial transport and dissociative recombination. As with the source processes, the details of these loss processes are not very well-constrained. One source of information would be the abundance of the individual water group species (O^+, OH^+, H_2O^+ and H_3O^+) as a function of radial distance. Such compositional information could be compared to models of physical chemistry and transport.

Unfortunately, the ion mass spectra available from the Cassini CAPS instrument are do not resolve the water group peak. As a result, fits the data for water group composition have large, correlated uncertainties. In contrast, we have found that the same data may be used to determine the mean mass of the water group ions to very high precision (approximately 0.025 AMU per 256 second integration.) We present results of this analysis showing the mean mass as a function of radius for multiple orbits and local times. The mean mass typically decreases from 17.75 AMU at 5 R_S to 17.25 AMU at 10 R_S, with a distinct change in the slope of the profiles commonly seen around 7 to 8 R_S. The implications of these results for ion sources and transport will be discussed.