Simulation of water group neutral density in Saturn's inner magnetosphere: importance of hot electrons

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Saturn's inner magnetosphere has been considered to be dominated by water group neutrals (H_2O, OH, and O) that have originated from icy satellites, which are Enceladus (L˜3.94), Tethys (L˜4.89), Dione (L˜6.26), and Rhea (L˜8.74). These neutral particles are considered to dominate the dynamics of Saturn's inner magnetosphere since the neutral density in Saturn's inner magnetosphere is about ten times greater than the plasma density. Therefore, it is important to reveal the neutral distribution in Saturn's inner magnetosphere to understand the plsma dynamics. Cassini observations have revealed that icy moon Enceladus (L˜3.94) is highly active with plumes of water from its south polar region (Porco et al., 2006).

We have derived distribution characteristics of water group neutral cloud in Saturn's inner magnetosphere using a Monte-Carlo procedure to account for H_2O density observed by Cassini, and OH density observed by the Hubble Space Telescope (HST). The key points of our simulations are that we treated the following simultaneously:

1.including the plume ejection, satellite sputtering, and E ring sputtering in the source,

2.using Cassini plasma parameters to calculate some chemical reactions, and

3.simultaneously solving H_2O, OH, and O as Ip [1997] had done.

We also used plasma parameters such as ion densities and electron temperature, which depend on some chemical reactions, based on Cassini observations. Results show that the distributions form azimuthally asymmetric feature. The asymmetric distributions are caused by short lifetimes of hot electron impact rates which depend on background hot electron density and temperature. These neutrals also peak near Enceladus due to copious H_2O source rate of the plumes. A parameter survey reveals that the H_2O and OH observations can be fit if the source rate of the plumes is $4*10^{28}$ H_2O/sec, although this rate is higher than source rate of the plumes observed by Cassini. A cause of this discrepancy might be due to neglect of a hotter neutral cloud originated from newly pick- up ions in this simulation. Another possible cause could be the difference of hot electron parameters between the Cassini observations and Voyager observations. The contribution of the hotter cloud and the hot electrons will also be discussed.