3-D MULTI-FLUID MODEL OF THE PLASMA INTERACTION AT TITAN HIGHLIGHTING THE IMPORTANCE OF ION GYRORADUS EFFECTS. D. Snowden[1] and R. Winglee [1]University of Washington, Box 351310 , Seattle WA 98195-1310, dsnowden@u.washington.edu

Abstract: Using a 3D multi-fluid simulation we show that finite ion gyroradius effects are important in characterizing the plasma interaction at Titan. The plasma interaction is similar to that at Venus and Mars in that the incoming flow is deflected around Titan through an interaction with Titan's ionosphere. This interaction forms an induced magnetosphere that consists of a cavity region around Titan and a wake of outflowing plasma. However, the plasma interaction at Titan is significantly different from Venus and Mars because the incident ions have gyroradii on the order of Titan's diameter. The multi-fluid method is ideal for studying Titan's plasma interaction with Saturn's magnetosphere because it incorporates ion cyclotron and multi-ion species effects similar to hybrid codes but the fluid treatment enables grid refinement down to as small as 26 km.

The results from our three dimensional multi-fluid simulation demonstrates that ion gyroradius and heavy ion effects cannot be neglected when characterizing the plasma interaction near Titan. Ion gyroradius and heavy ion effects drastically change the mass loading and magnetic field draping around Titan. The asymmetric pick-up of ions from Titan's ionosphere leads to a very asymmetric mass loaded region. We find that the large ion gyroradius of picked-up ionospheric species results in an extension of the ionosphere and, therefore, the mass loading and magnetic pile-up on the anti-Saturn side of Titan. Also, the additional thermal pressure provided by heavy ion cyclotron motion in the near Titan causes the shielding currents to form at higher altitudes. The flow of energetic ions into Titan's ionosphere is also greatly affected by the inclusion of ion gyroradius effects. Ions on the anti-Saturn side of Titan's magnetosphere are accelerated away from Titan's into Saturn's magnetosphere however ions on the Saturn facing side of Titan's are accelerated towards Titan and back into the ionosphere. Therefore, the Saturn facing side of Titan's ionosphere experiences both less shielding from incident Kronian plasma and additional heating due to the acceleration of heavy ions in the ionosphere.

Finally, ion gyroradius effects also very important to the dynamics of ion outflow into the Kronian magnetosphere. We find that well confined heavy ion beams form on the anti-Saturn side of Titan's magnetosphere and extends more than three Titan radii from Titan's main ion tail before rejoining the ion tail about six Titan radii downstream. The location of this ion beam is dependent on the Kronian field orientation and we find that during the TA, TB, and T3 encounters the bulk of the ion beam was located below Titan's equatorial plane. We also find good agreement with Cassini magnetometer data from the TA, TB, and T3 encounters and the ion loss rate measured by Cassini during the TA encounter for a single set of incident conditions.

These results demonstrate that heavy ion and ion cyclotron effects change the size of the induced magnetosphere around Titan, the distribution of plasma within the induced magnetosphere, and the localized deposition of energy into Titan's upper atmosphere by pick up ions. The multi-fluid simulations also verify the formation of heavy ion beams that extend several Titan radii in to the Kronian magnetosphere.