Hybrid Model of Gas/Particle Plume of Enceladus

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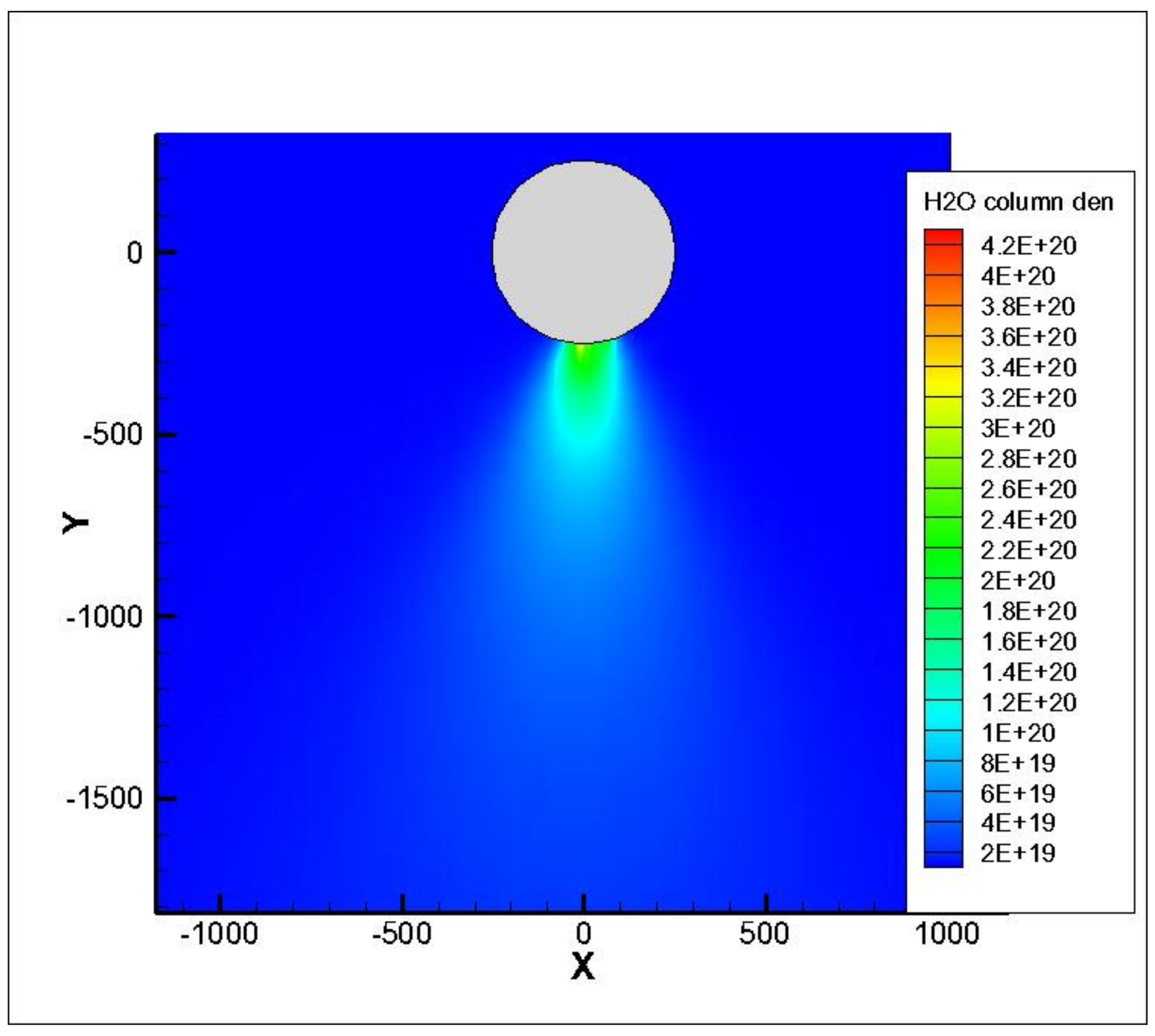


Figure 1: Limb view of Enceladus south polar plumes

Free Molecular Plumes

- Plume model is constructed from 8 point sources in the South Polar Region [1] (figures 1 & 2).
- Gas velocities are determined by DSMC simulation of converging diverging nozzle issuing into a vacuum.
- Flyby simulations are compared to Cassini INMS data [3].

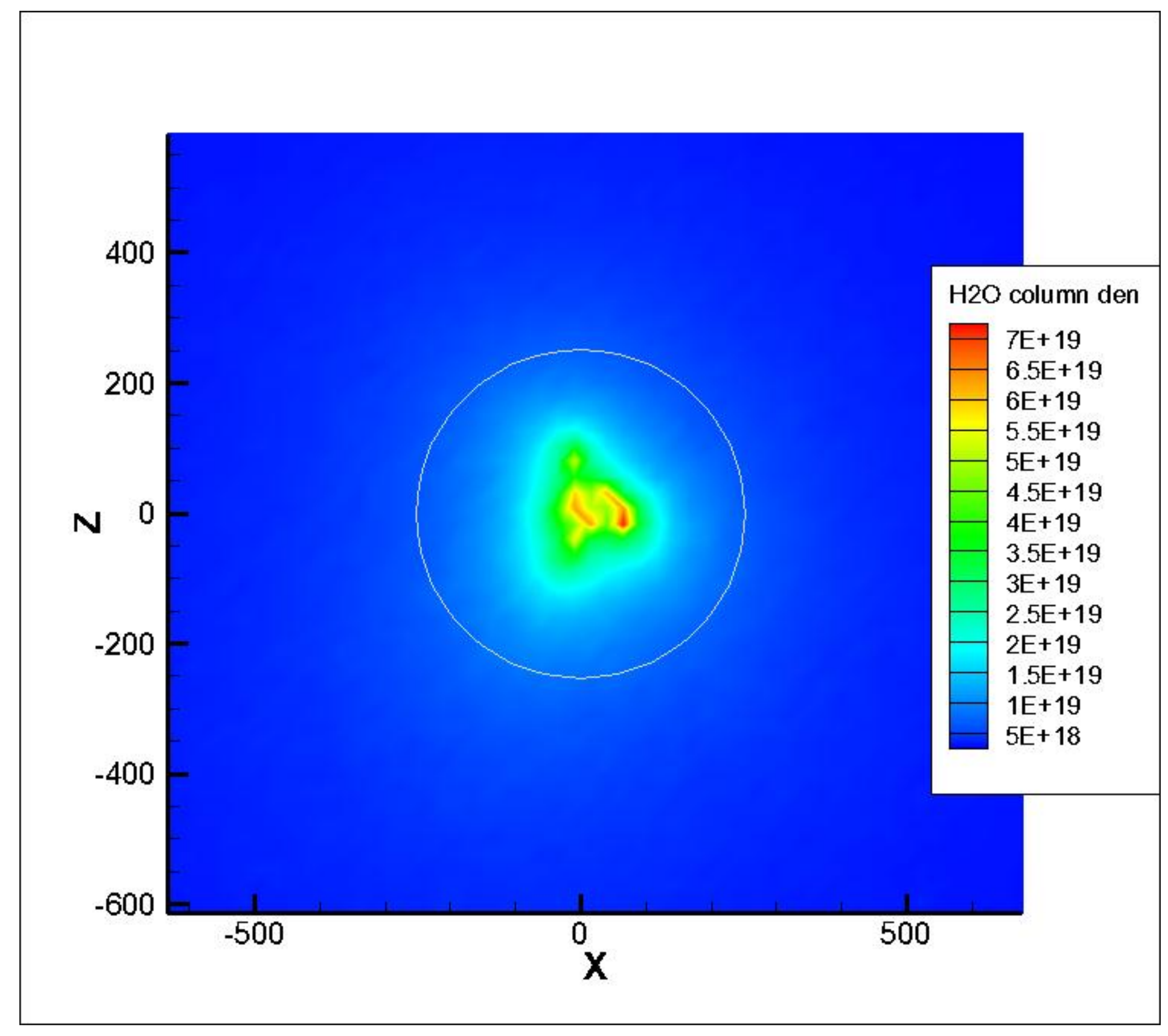
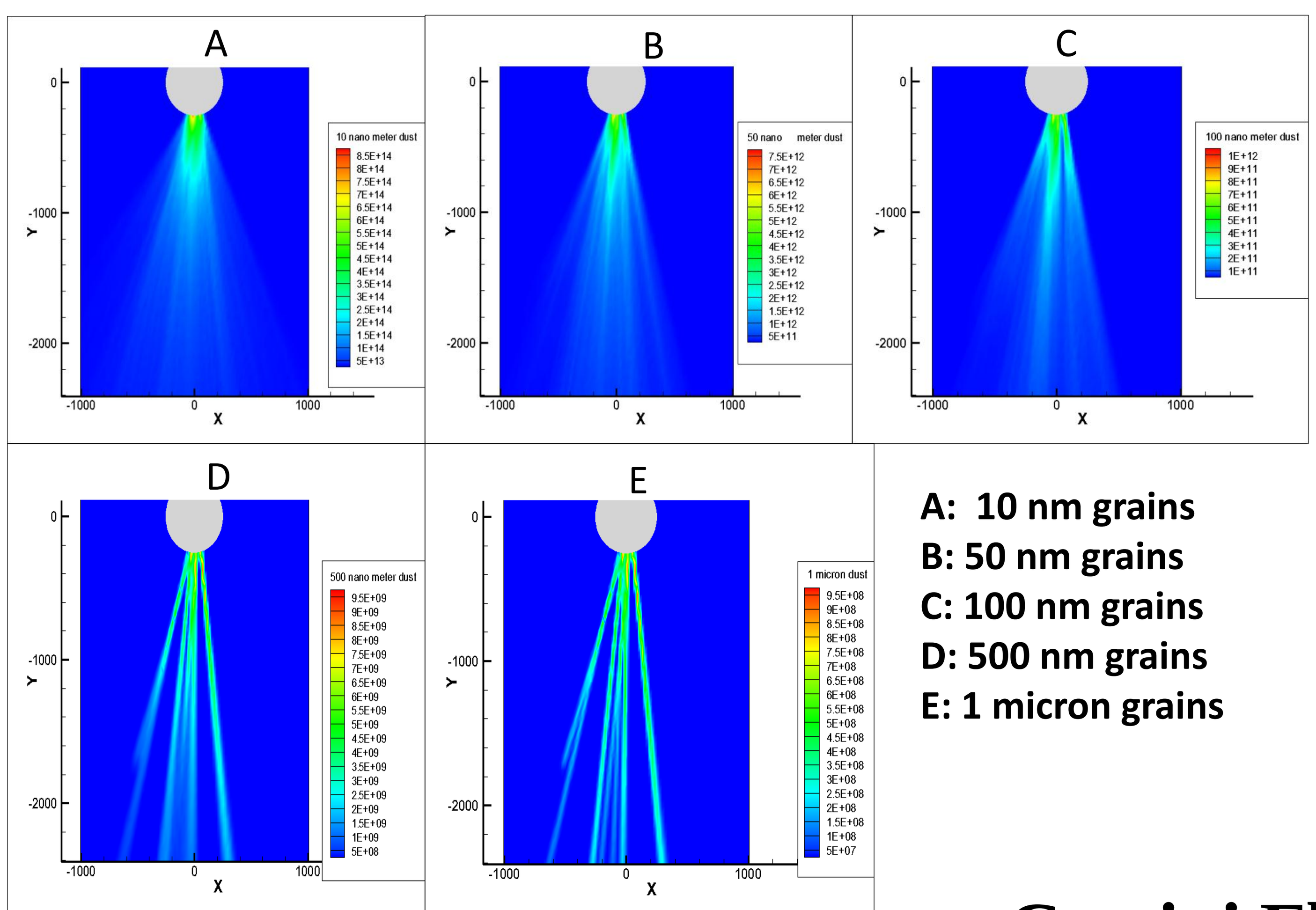


Figure 2: South polar view of south polar plumes.

Figure 3



A: 10 nm grains
B: 50 nm grains
C: 100 nm grains
D: 500 nm grains
E: 1 micron grains

Grain Trajectories

- Trajectories for 5 sizes of ice grains are modeled (figures 3 A through E).
- Grain velocity distributions are determined using DSMC.
- At vent surface, the grain velocities are equal to the gas velocity, but gradually differ in expanding plume.
- As grain size increases, grain plumes become more collimated.

Cassini Flybys

- Water vapor escapes from sources at Mach 5.
- Sources are assumed to be axisymmetric vents with radii of 3 m.
- Total mass flux is 100 kg/s at a temperature of 52 K at the vent exit.
- Maximum densities and signal durations agree well with Cassini INMS data [3].
- A parametric approach to constraining individual source strength should yield more accurate results.

Figure 4

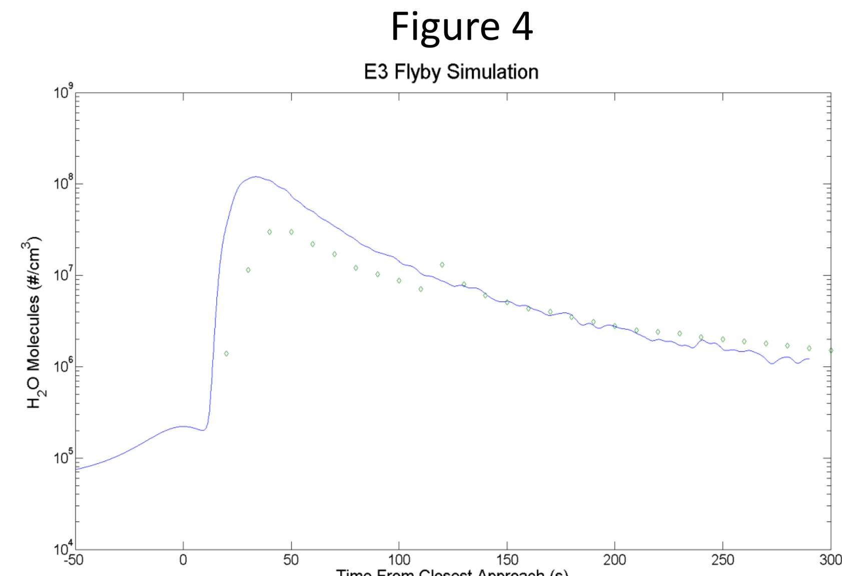


Figure 5

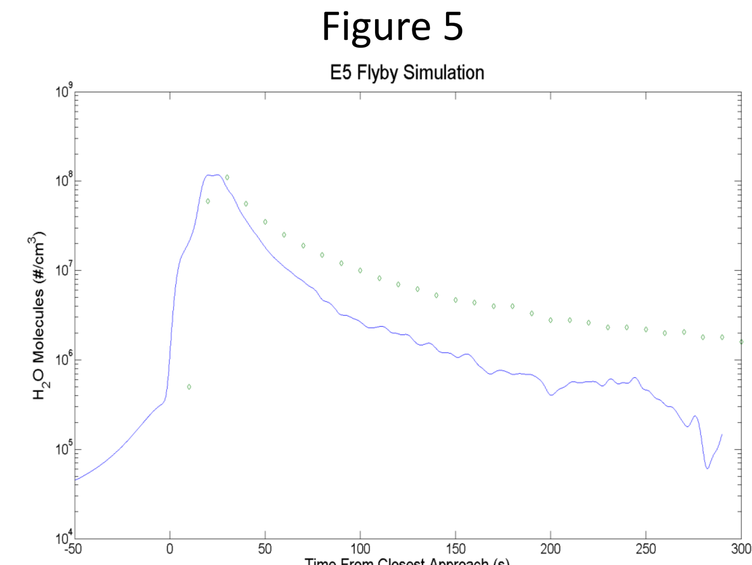


Figure 6

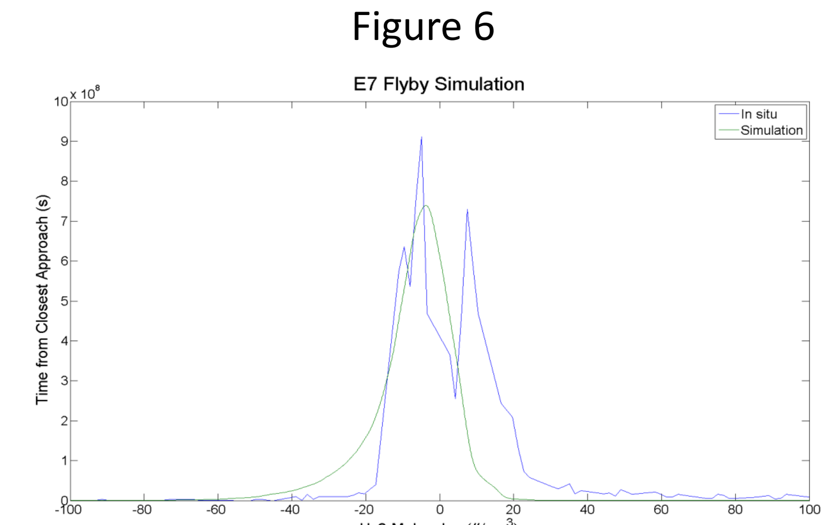


Figure 7

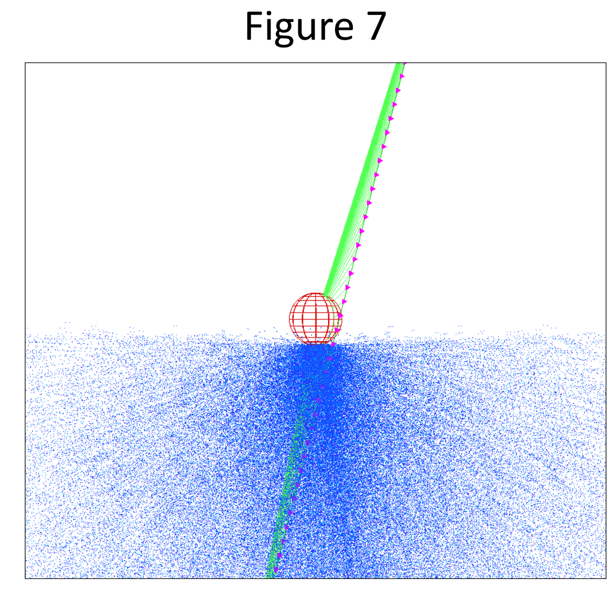


Figure 4: Simulation of the INMS response during Cassini E3 flyby.
Figure 5: Simulation of the INMS response during Cassini E5 flyby.
Figure 6: Simulation of the INMS response during Cassini E7 flyby.
Figure 7: Wire frame model of Cassini E3 Flyby.

Figure 8

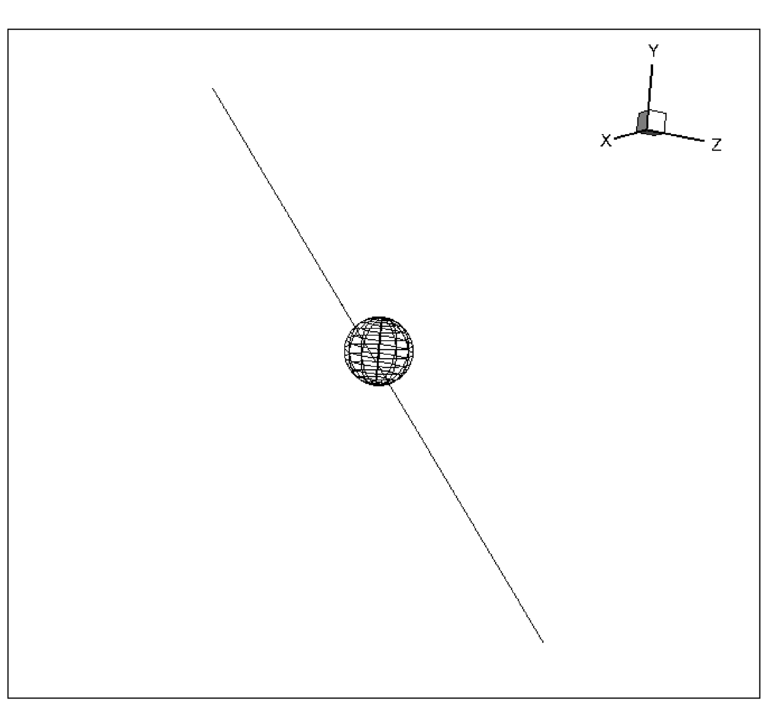


Figure 10

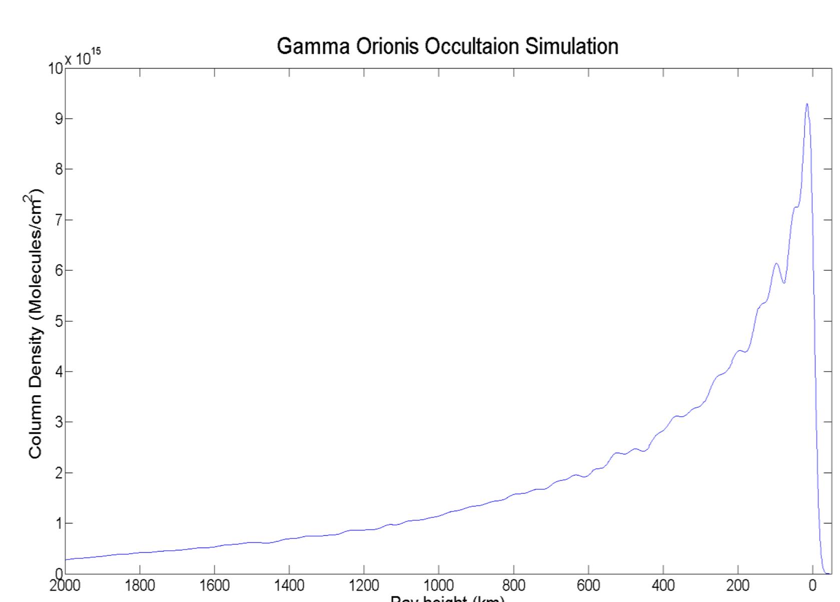


Figure 9

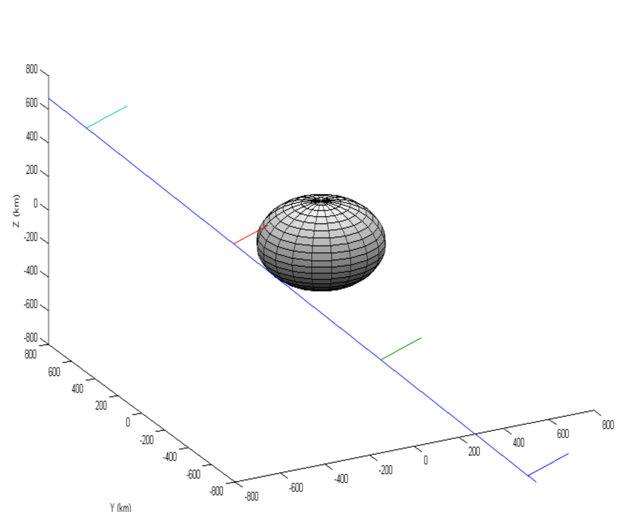


Figure 11

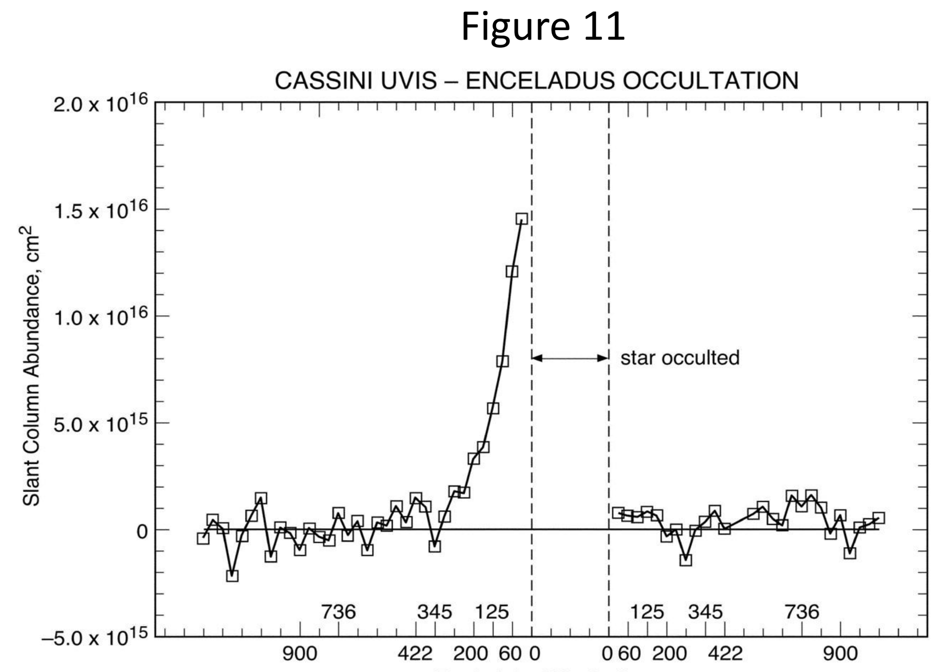


Figure 8: Wire frame of gamma Orionis occultation; the line of sight is into the page.
Figure 9: Wire frame of gamma Orionis occultation; the line segments are look vectors.
Figure 10: Line of sight integration model of Gamma Orionis occultation depicting column density versus ray height.
Figure 11: *In situ* Cassini UVIS data depicting column density to ray height [2].

Occultation of Gamma Orionis

- A line-of-sight integration method was used to find column densities along a look vector using Cassini trajectory data from NAIF.
- Occultation simulation results are compared to Cassini UVIS data [2] (figures 9 & 10).
- The magnitude and shape of the occultation agree well with *in situ* data, but constraining individual source strengths should improve the simulation.
- Further occultation simulations will help constrain source strength.

References: [1] Porco C.C. et al. (2006) *Science*, 311, 1393-1401. [2] Hansen C.J. et al. (2006) *Science*, 311, 1422-1425. [3] B. D. Teolis J. H. et al. (2010) Journal of Geophysical Research, 115, A09222