Effects of Spatial Resolution on the Martian Pickup Ion Plume in Global Plasma Simulations

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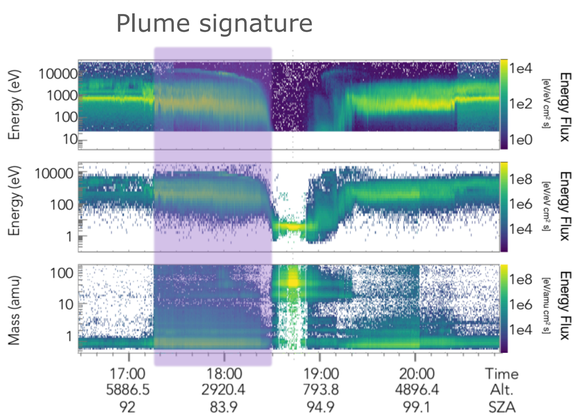
Introduction

- Solar wind interactions with the Martian ionosphere create a motional electric field where accelerated particles can escape
- MAVEN measurements and previous model challenges have shown a polar pickup ion plume in the Northern hemisphere to be a key component of ion loss at Mars
- Comparing BATSRUS multi-fluid MHD simulations of different resolution shows variation in plume location

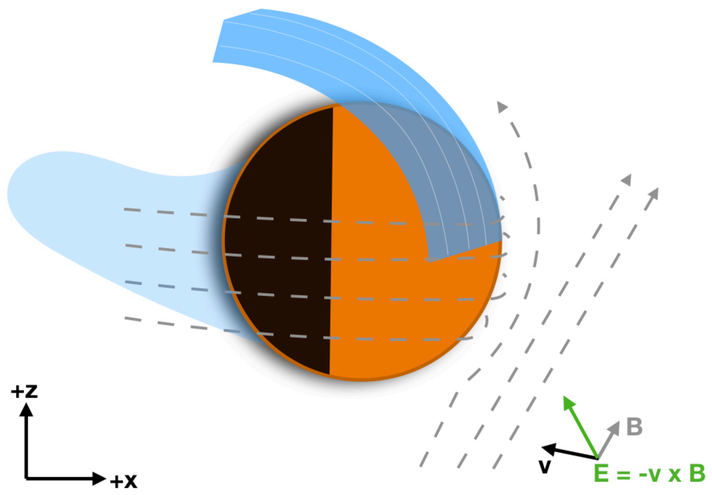
Upstream Conditions	
B	[-0.74, 5.46, -0.97] nT
v	[-350, 0, 0] km/s
n_p	4.9 cm^{-3}
n_a	0.14 cm^{-3}
T_p	59200 K
SSL	170°

- Model conditions were chosen to match MAVEN orbit #2349 (below) where plume signatures have been observed

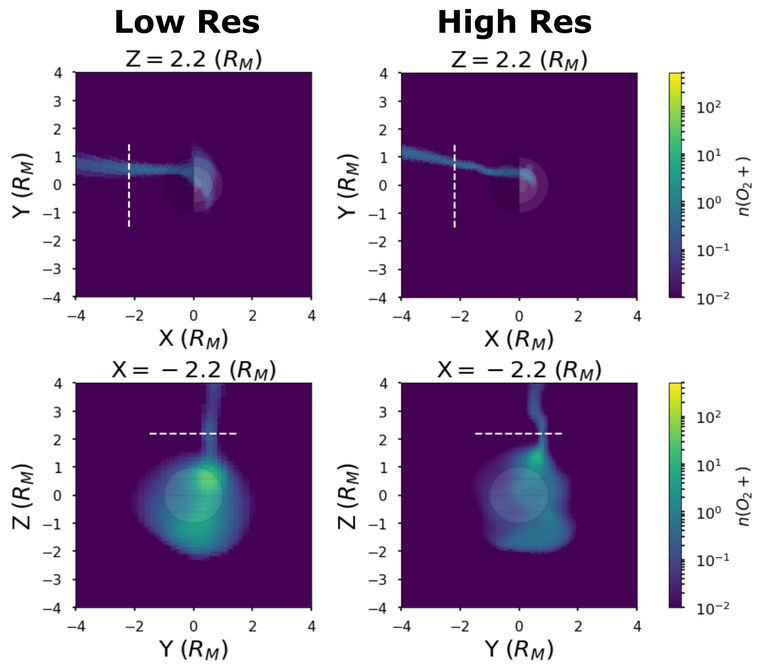


- Model resolution is changed by changing spatial refinement of boxes in a spherical grid

Simulation Resolutions		
Resolution	Radial	Angular
Low	10 km	3°
High	5 km	1.5°

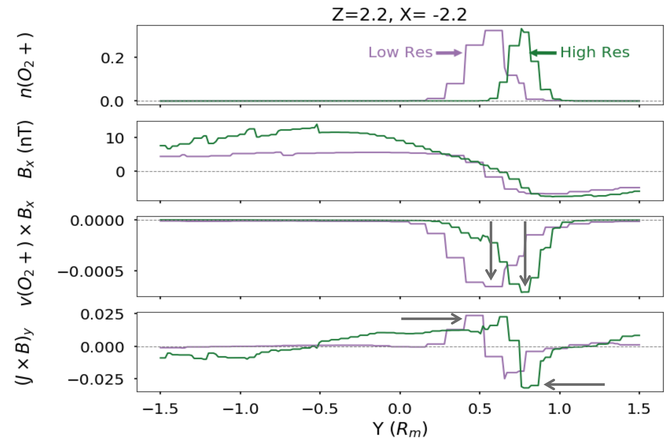


Resolution choice affects spatial variability



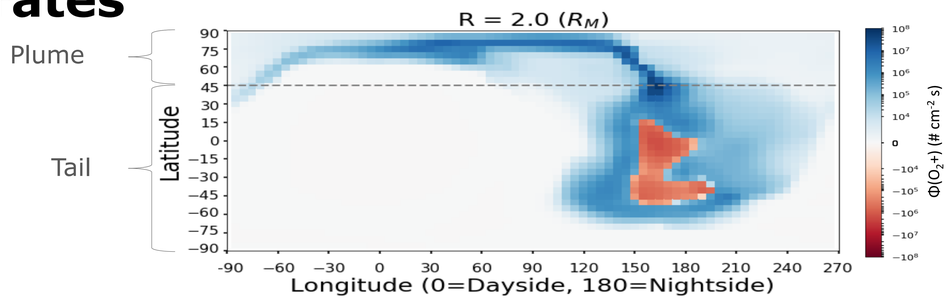
- Simulations of different resolution produce a plume in different locations, sometimes separated by up to ~0.2R_M

Electromagnetic fields affect plume location



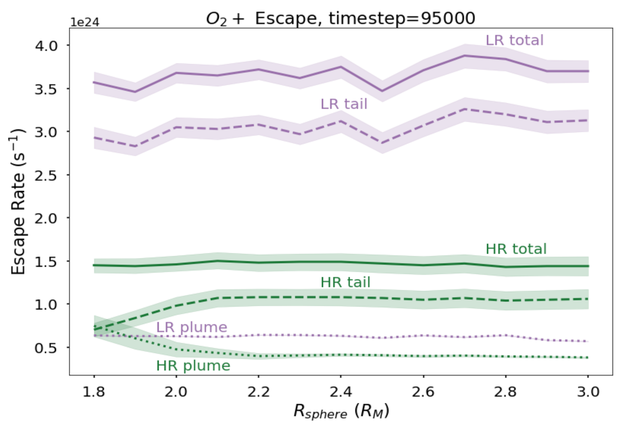
- VxB forces accelerate ions "down" plume
- JxB forces collimate plume

Resolution choice affects escape rates



High res simulation O_2+ flux map showing sampled regions used for escape calculations

- Low resolution simulation produces higher O_2+ escape in plume, tail, and total
- Resolution choice changes O_2+ escape in plume, tail, and total by ~1.5, 3 and 2.5 times, respectively



O_2+ escape rates calculated from 1.8-3.0 R_M. Shaded regions represent 1σ uncertainty calculated across all timesteps