Impact of Plasma Mass Density on the Magnetosphere Configuration

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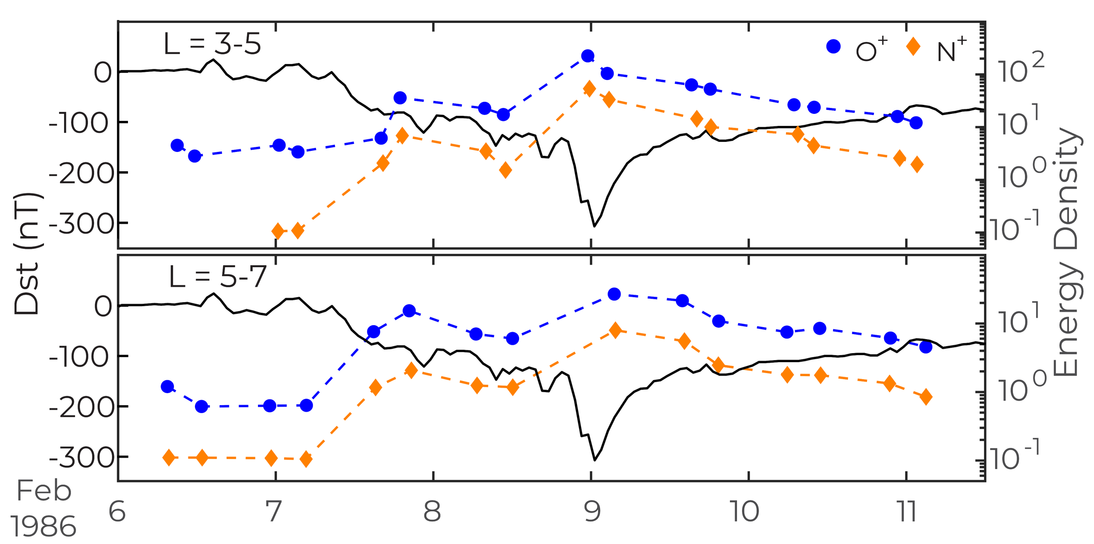
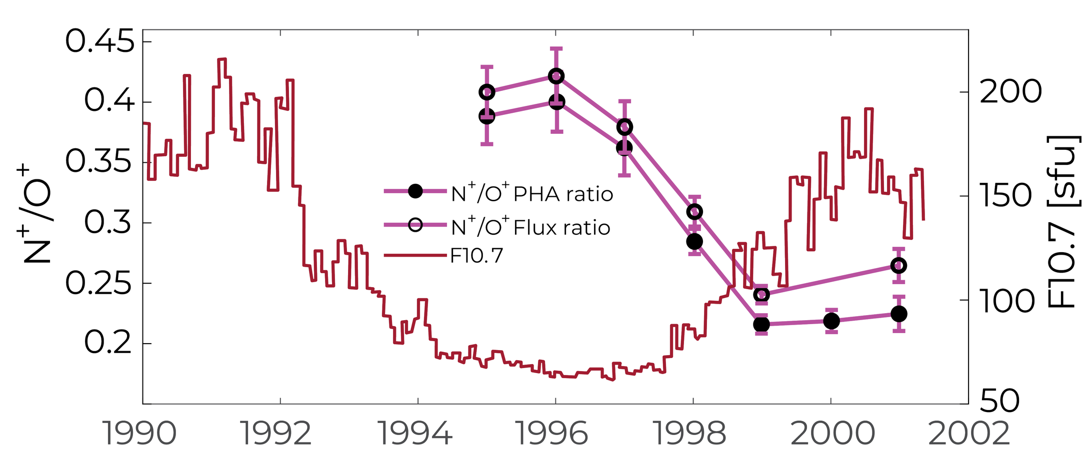
MOTIVATION

- Heavy ions regulate many magnetosphere processes. [Lin *et al.*, 2020]
- N^+ ions have been observed in the ionosphere & magnetosphere since the 1960s, but instrumentation limitations have hindered further understanding of their dynamics. [Chappell *et al.*, 1982; Lin *et al.*, 2022]
- $n(N^+)$ can be comparable to $n(O^+)$ in the inner magnetosphere. [Craven, 1993]

> What is the impact of inner magnetospheric plasma mass density on the global magnetosphere configuration?



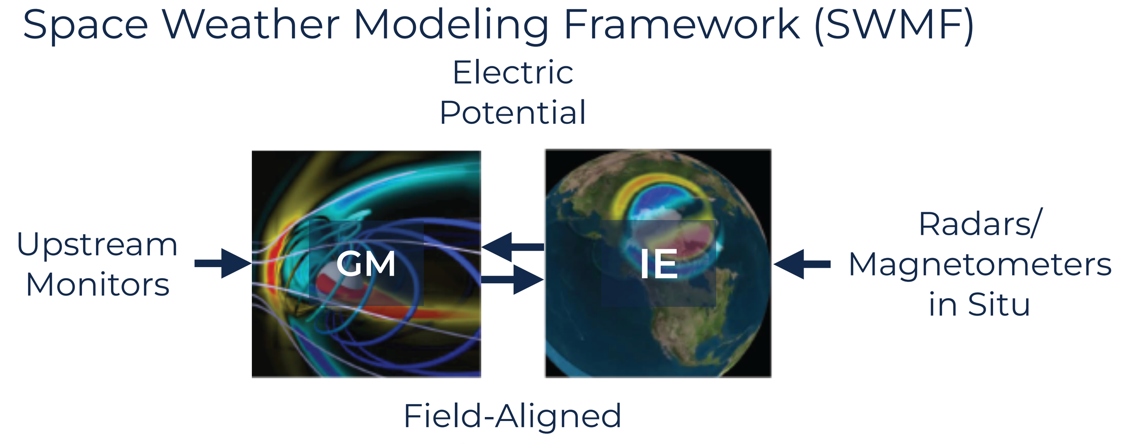
AMPTE [digitized from Hamilton et al., 1988]



Geotail [digitized from Christon et al., 2002]

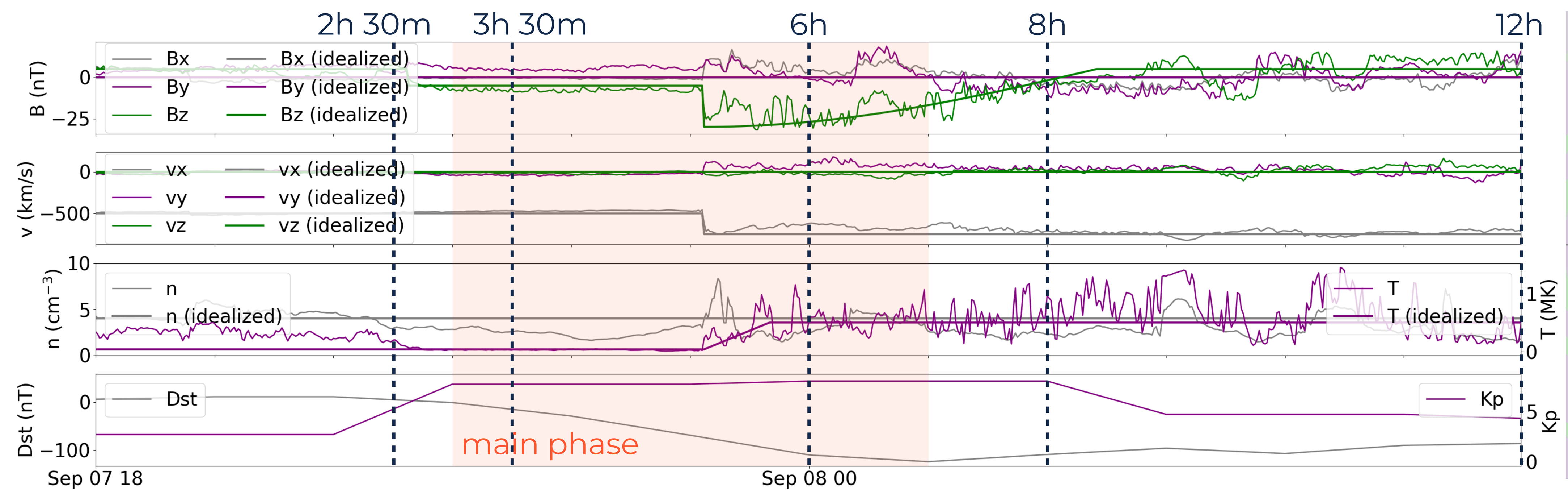
METHODOLOGY

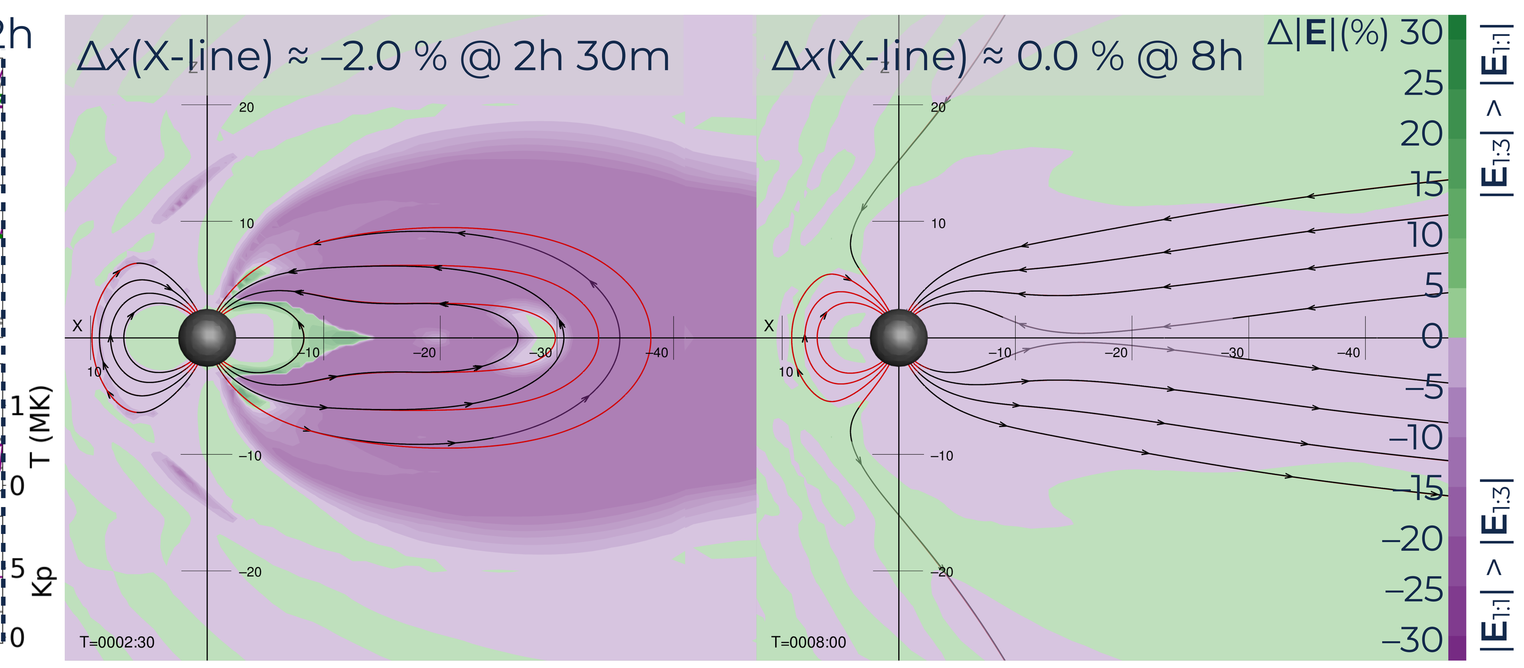
- Multifluid Magnetohydrodynamics (MHD): H^+, N^+, O^+
- Space Weather Modeling Framework (SWMF)



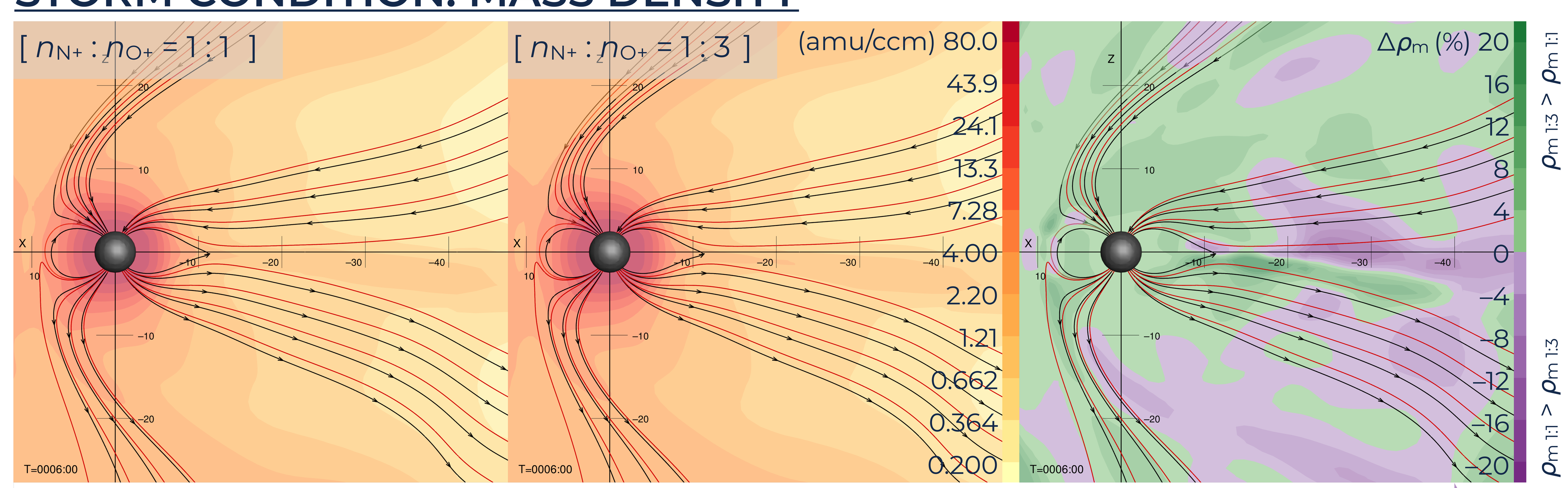
- 12-hour solar wind driver: DISCOVR measurements of the Sep 2017 storm (Sep 7 18:00 – Sep 8 6:00)
- Inner Boundary Ion Density Setup ($\Sigma_i \rho_i$ = 28 cm^{-3}):
  - **[$n_{N^+} : n_{O^+}$ = 1 : 1]** 80% H^+, 10% N^+, 10% O^+
  - *vs.* **[$n_{N^+} : n_{O^+}$ = 1 : 3]** 80% H^+, 5% N^+, 15% O^+ @ 2.5 R_E
- Domain: 292 R_E × 256 R_E × 256 R_E (~2.6M cells)

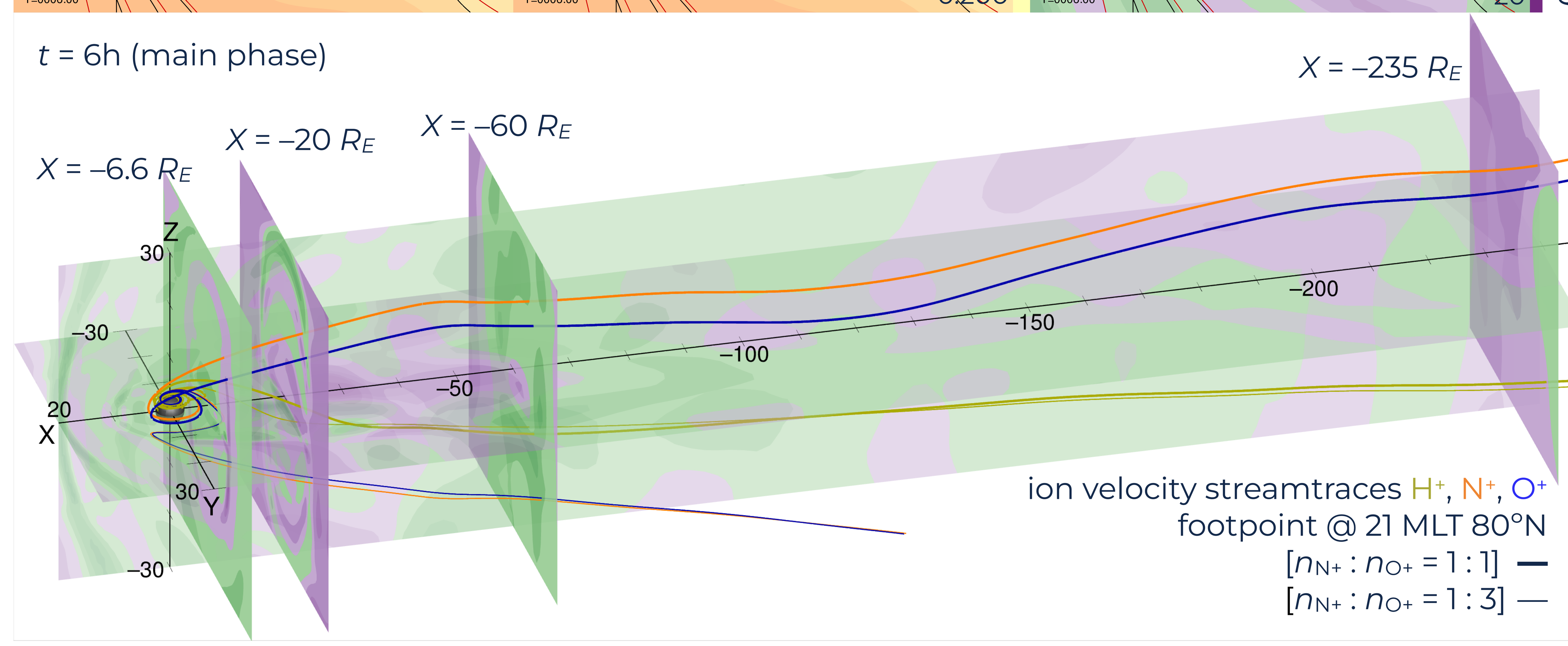
IDEALIZED CONDITION: E & B FIELDS

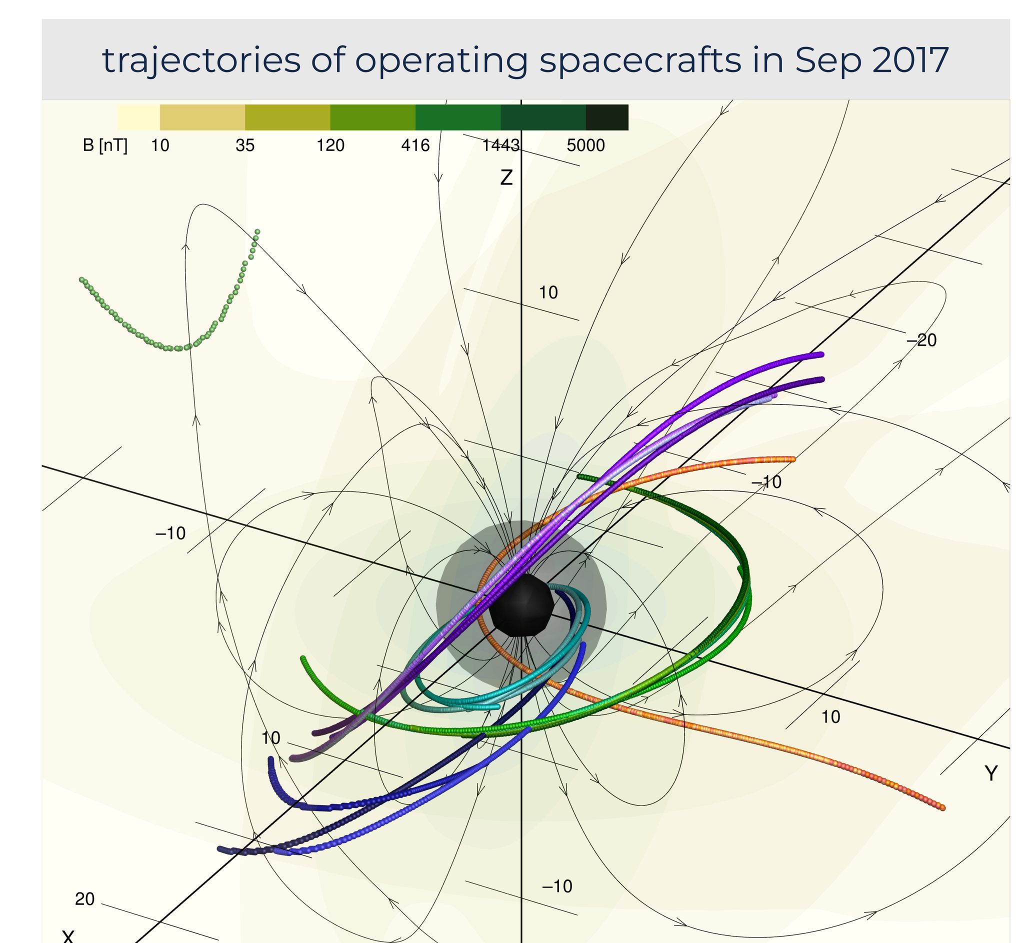


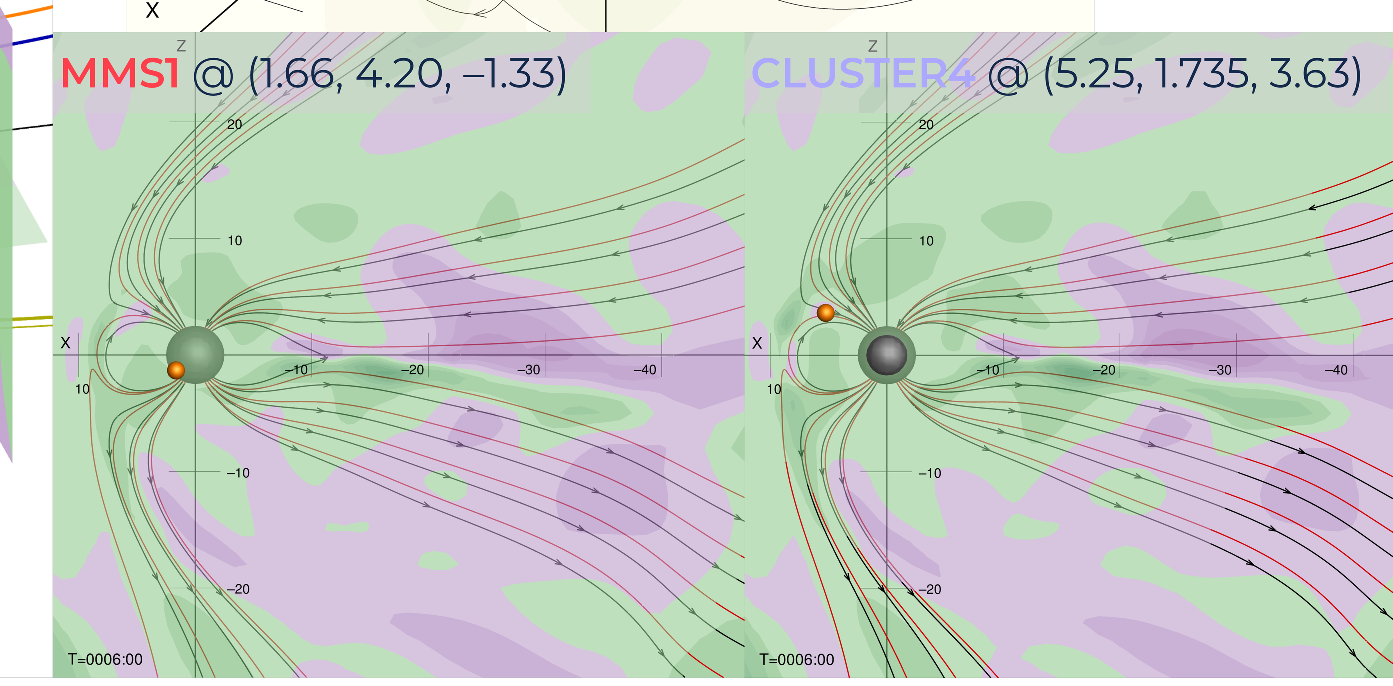


STORM CONDITION: MASS DENSITY









CONCLUSION

- Even under idealized conditions, ion composition alters the electric and magnetic fields in the magnetosphere.
- Under the driving forces of observed solar wind data, the total mass density for case [$n_{N^+} : n_{O^+}$ = 1 : 1] is lower outside the magnetosphere and in the far tail, while the total mass density for case [$n_{N^+} : n_{O^+}$ = 1 : 3] is higher in the lobe regions in the magnetosphere.
- Heavy ion streamtraces differ greatly between the two cases.
- The magnetic field difference between the two cases is more prominent in observed conditions.

ACKNOWLEDGMENTS

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