A diagram illustrating magnetic field lines. A central white circle represents a source of magnetic flux. Solid orange lines represent field lines that curve around the source, forming a dipole-like pattern. Dashed red lines represent field lines that are more distant and less curved. The overall shape is roughly oval, elongated horizontally.

Reconnection and the Role of the Magnetosphere/Ionosphere

Brian Walsh

Boston University

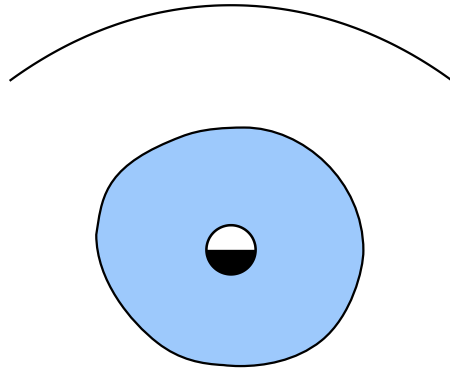
CEDAR/GEM2016

bwalsh@bu.edu

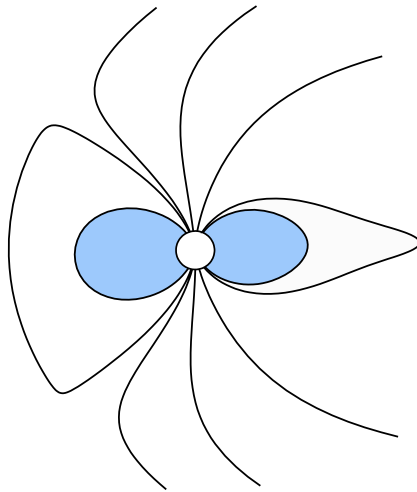
**BOSTON
UNIVERSITY**

Plasma supply to outer-magnetosphere

Calm

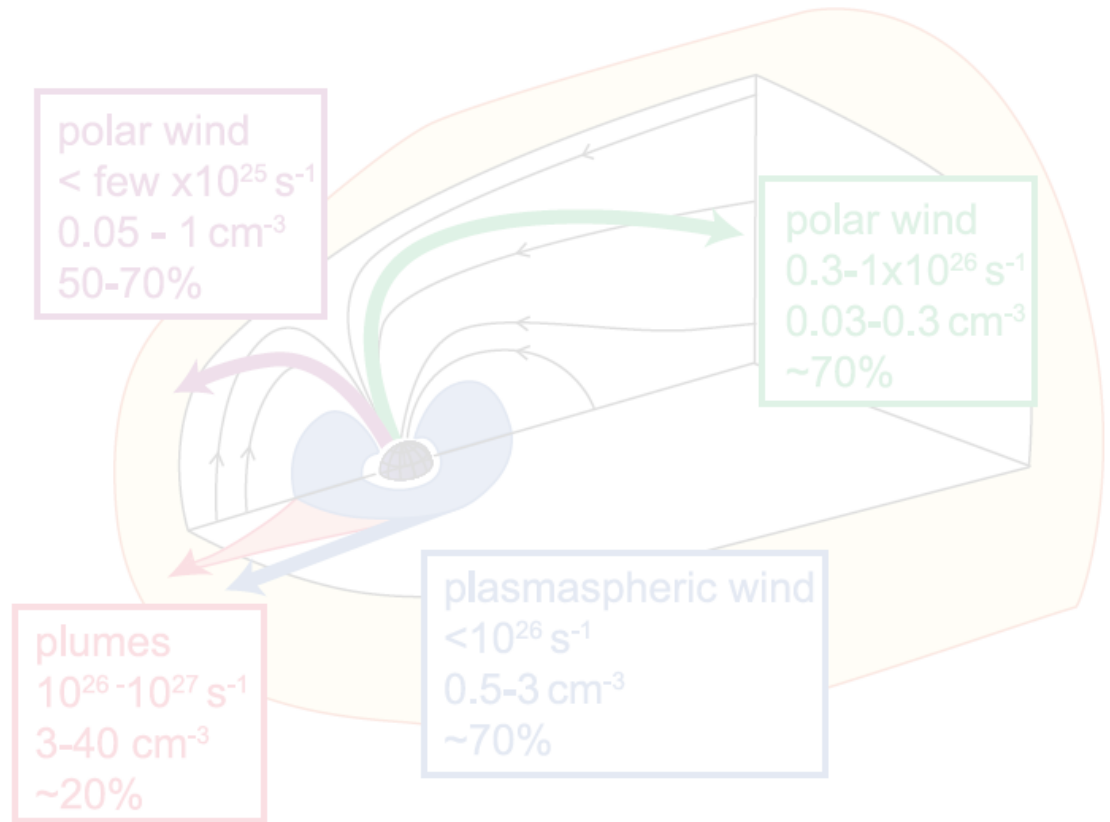


Equatorial plane



Meridional plane

“Disturbed”



polar wind
 $< \text{few } \times 10^{25} \text{ s}^{-1}$
 $0.05 - 1 \text{ cm}^{-3}$
50-70%

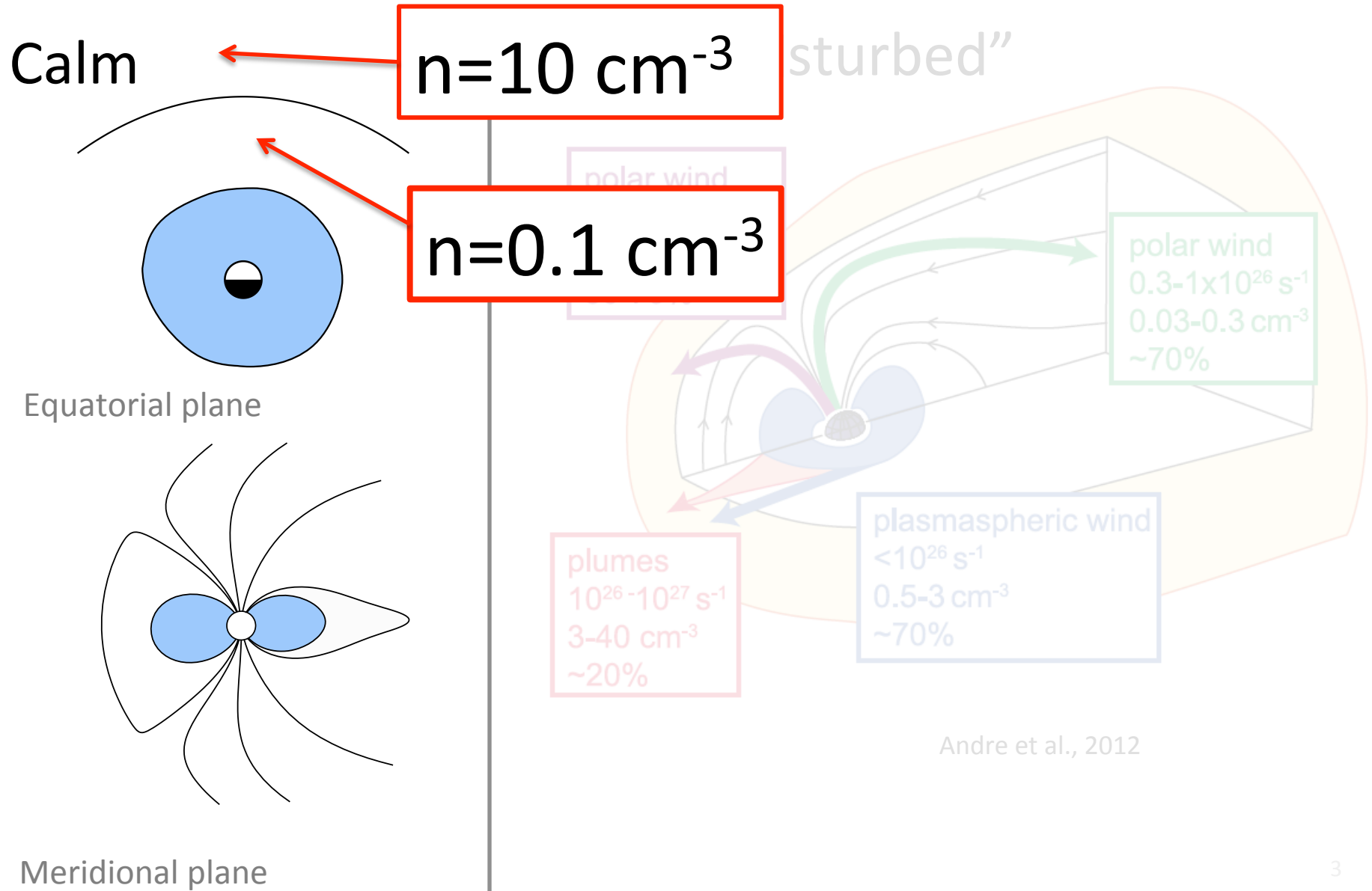
polar wind
 $0.3 - 1 \times 10^{26} \text{ s}^{-1}$
 $0.03 - 0.3 \text{ cm}^{-3}$
~70%

plumes
 $10^{26} - 10^{27} \text{ s}^{-1}$
 $3 - 40 \text{ cm}^{-3}$
~20%

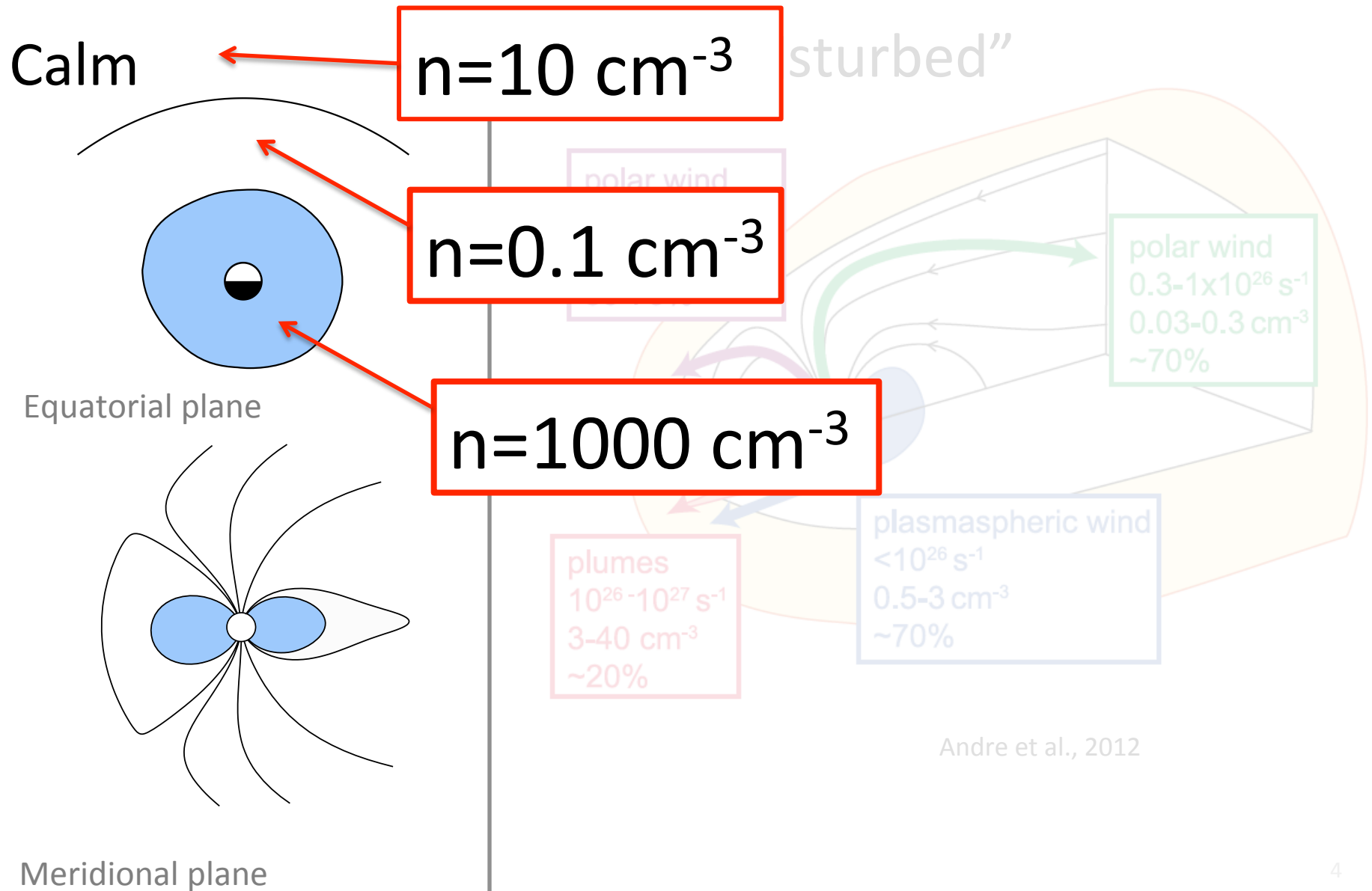
plasmaspheric wind
 $< 10^{26} \text{ s}^{-1}$
 $0.5 - 3 \text{ cm}^{-3}$
~70%

Andre et al., 2012

Plasma supply to outer-magnetosphere

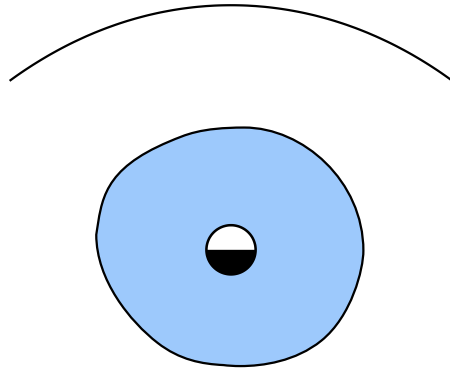


Plasma supply to outer-magnetosphere

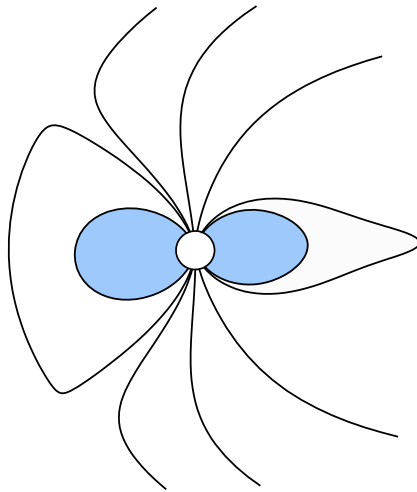


Plasma supply to outer-magnetosphere

Calm

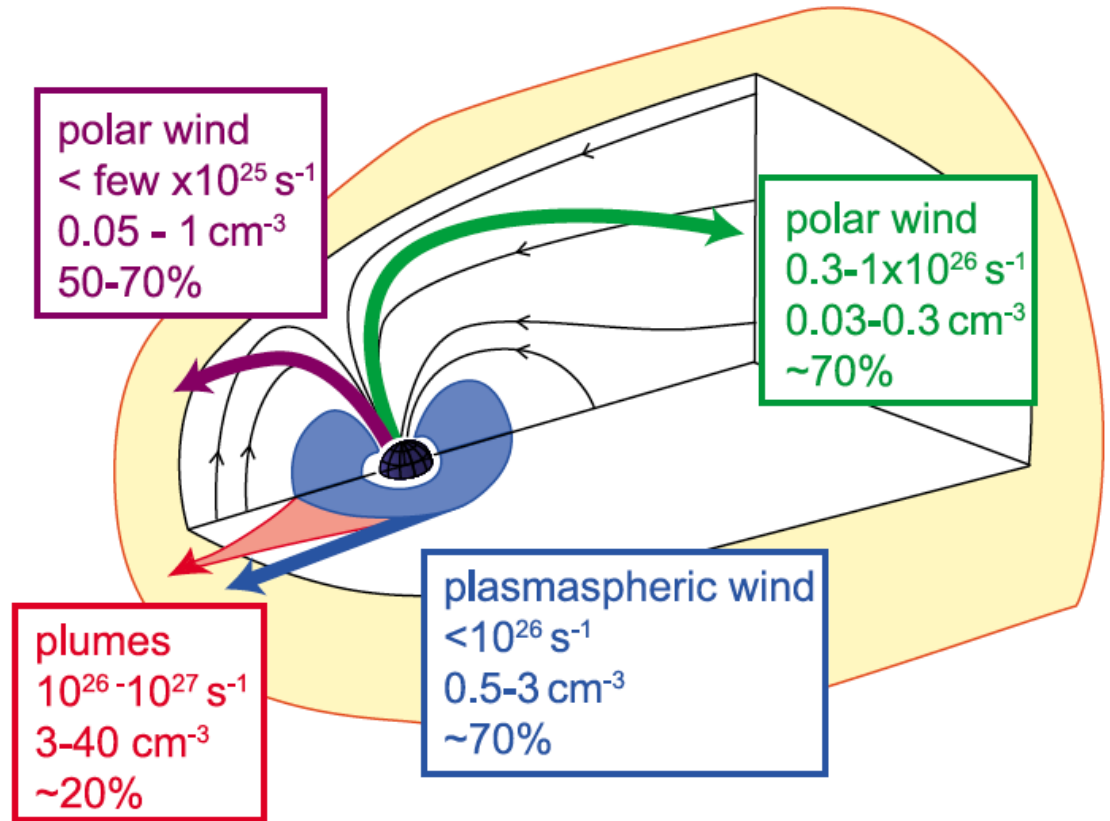


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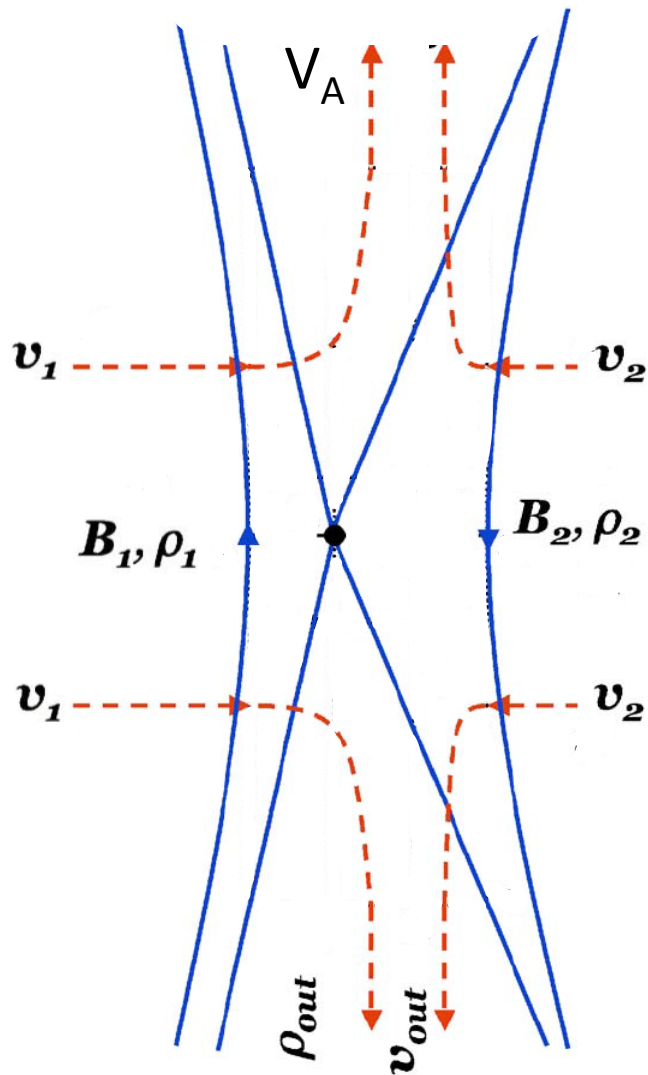
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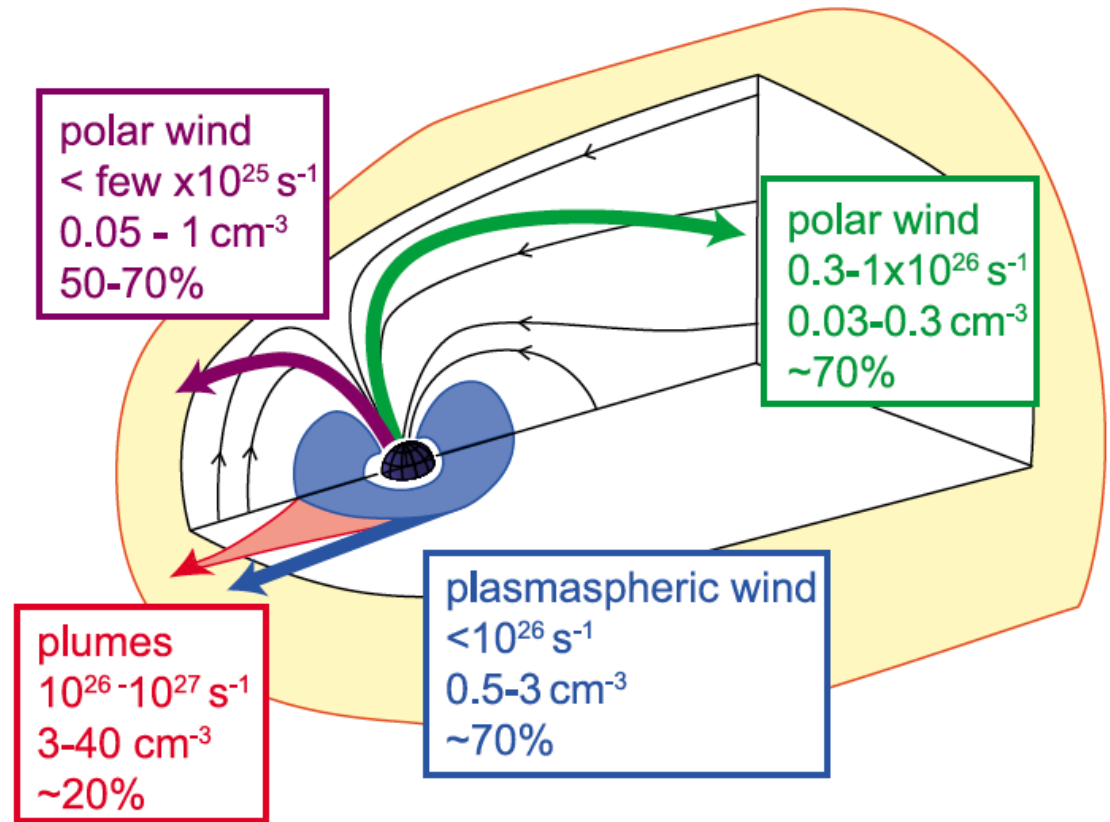
Plasma supply to outer-magnetosphere

Asymmetric Reconnection



Adapted from Cassak and Shay 2007

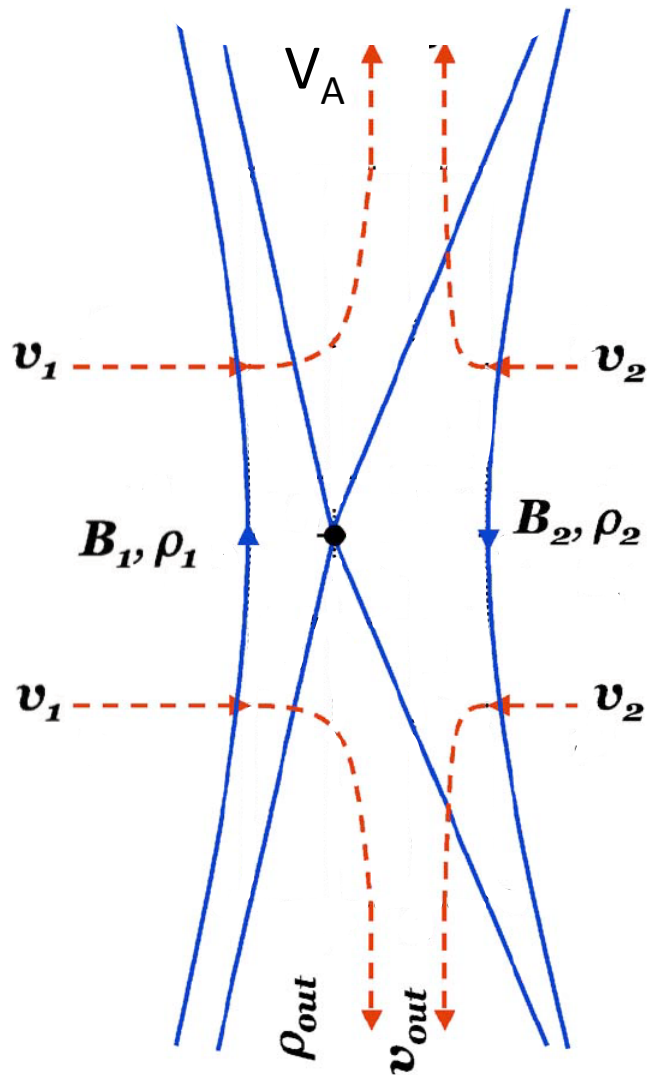
“Disturbed”



Andre et al., 2012

Plasma supply to outer-magnetosphere

Asymmetric Reconnection



Adapted from Cassak and Shay 2007

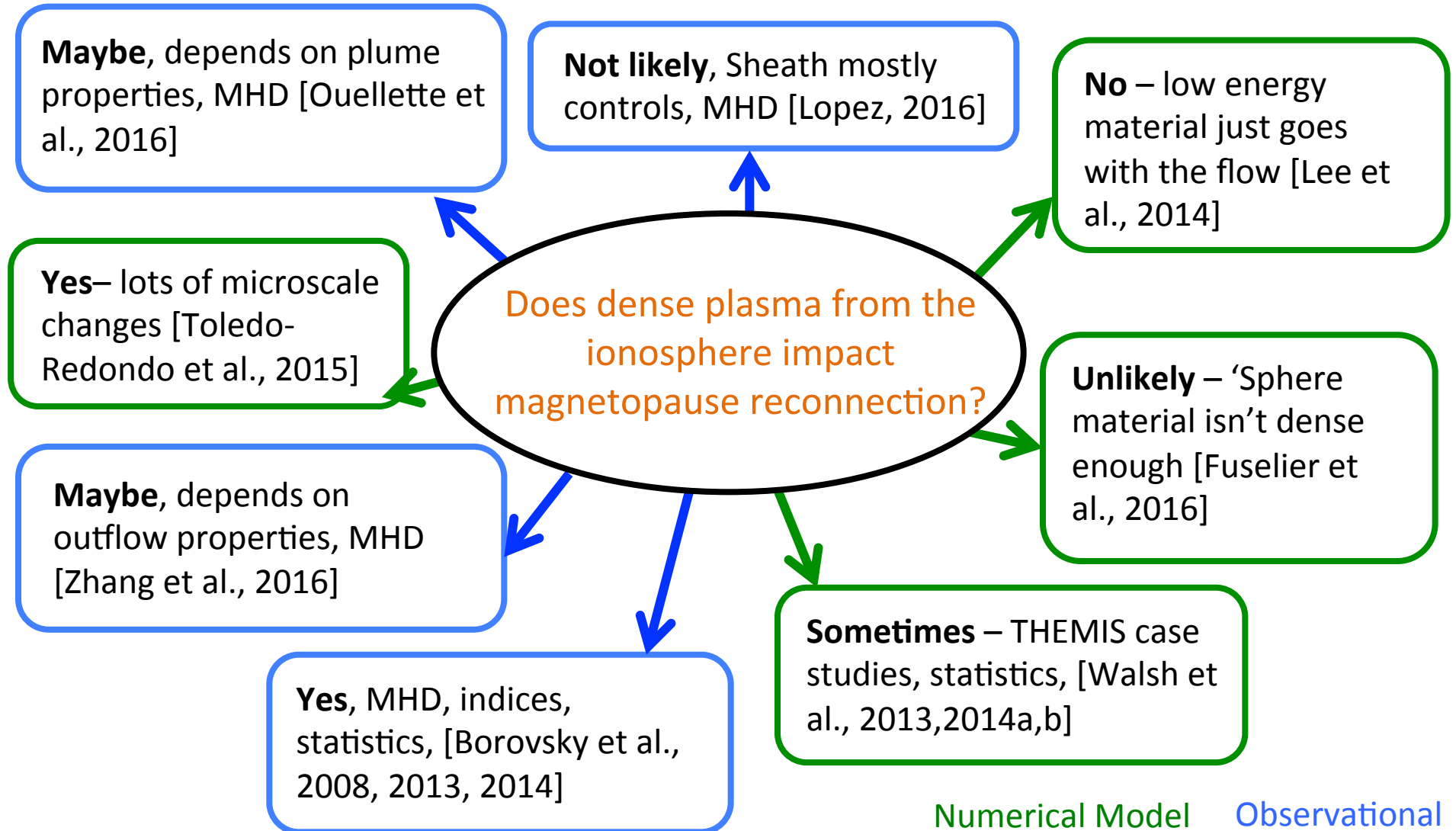
Plug in numbers* –

1. Reconnection rate scales with Alfvén speed ($V_A \sim B n^{-1/2}$)
2. $n=0.1$ 100cm^{-3} due to inclusion of plume
3. Assuming all other variables stay constant, reconnection will **decrease by $\approx 33x$**

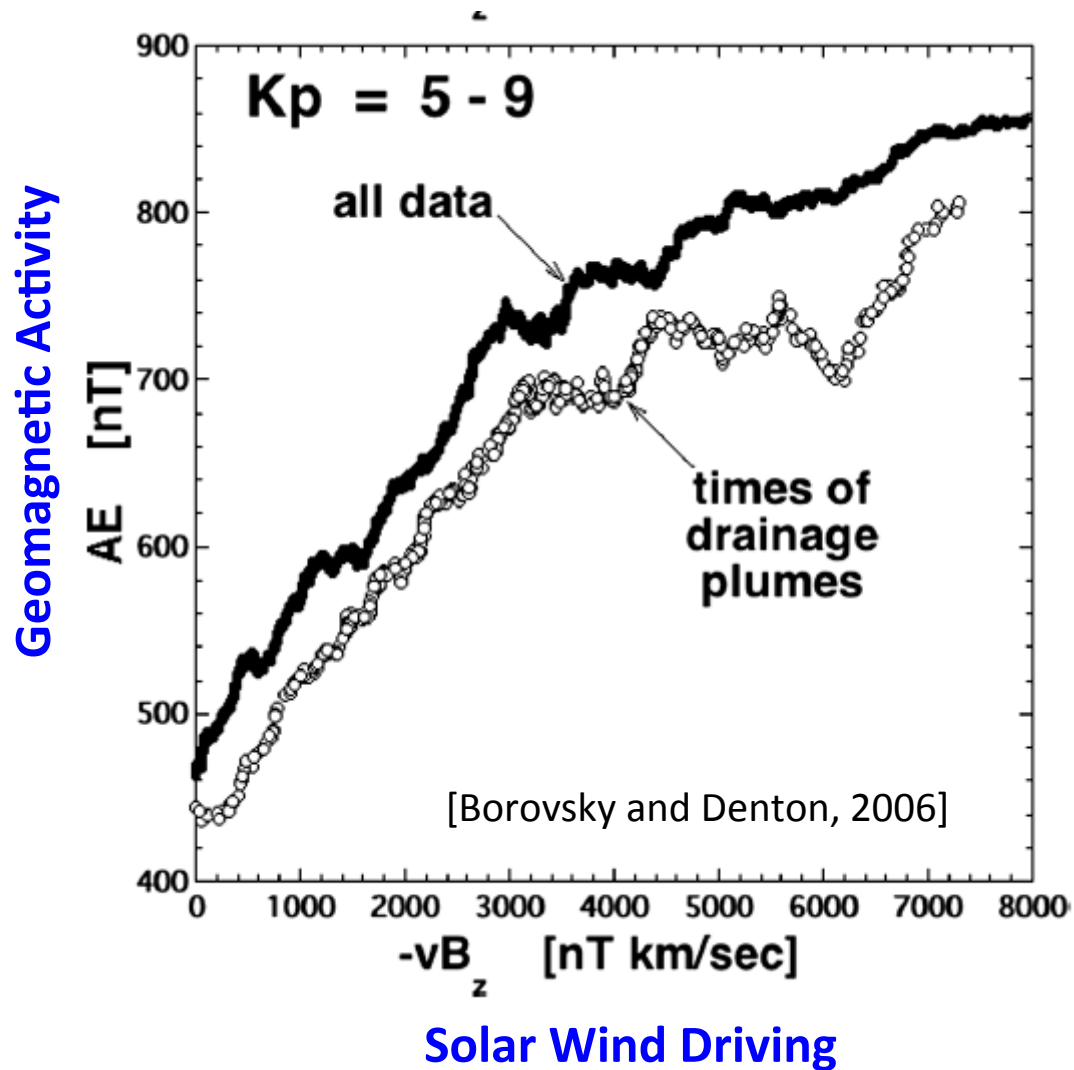
[Su et al., 2000; Borovsky et al. 2006; McFadden et al. 2008; Andre et al., 2012; Walsh et al., 2013; Walsh et al., 2014ab; Lee et al., 2014; Wang et al. 2014]

*Only considering fluid impact

Yes, No, Sometimes



Yes → ionosphere plasma plays a role in controlling coupling



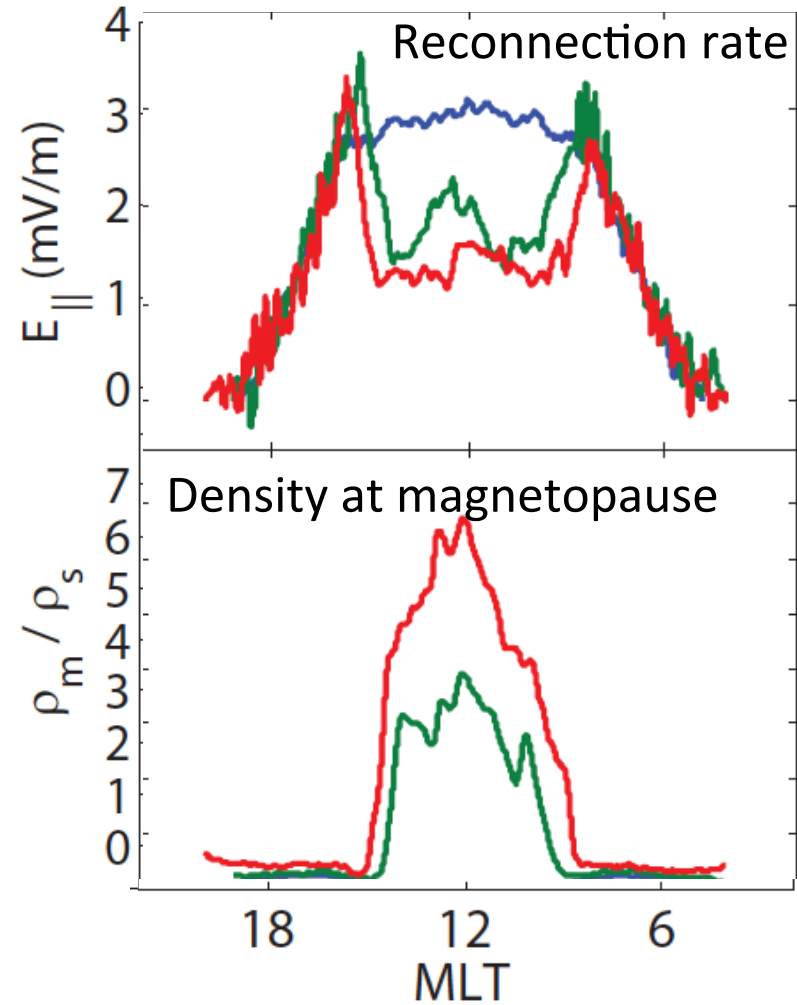
No → ionosphere plasma doesn't
impact magnetopause reconnection

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- The magnetosphere just isn't dense enough
[Fuselier et al., 2016]

No → ionosphere plasma doesn't impact magnetopause reconnection

- The magnetosphere just isn't dense enough [Fuselier et al., 2016]
- “Things adjust” upstream [Lopez et al., 2010, Lopez 2016]. Locally may change, but total remains the same



[Ouellette et al., 2016]

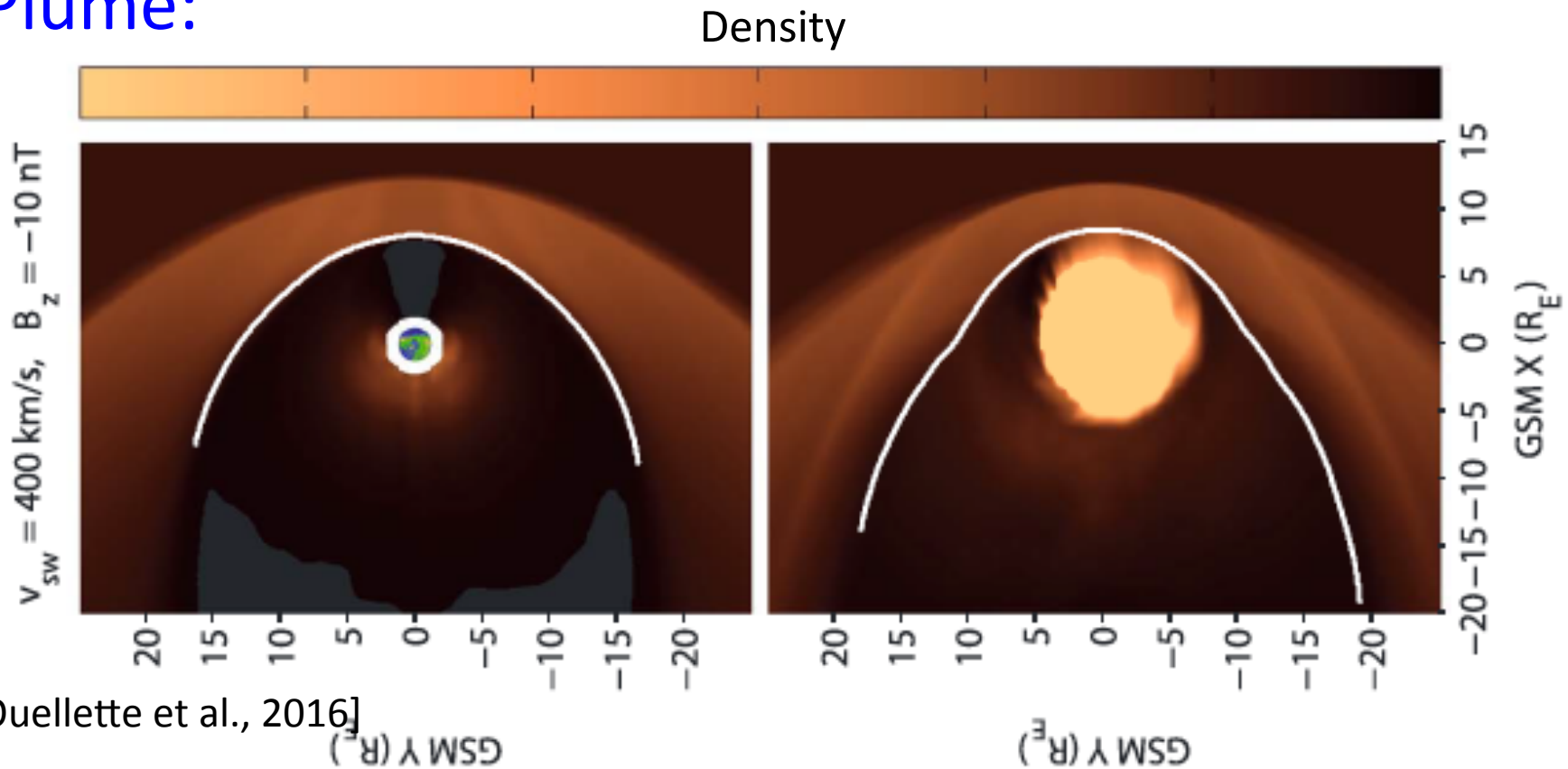
Sometimes

- Ion species
- Ion outflow
- Plume density
- Plume properties

Sometimes

- Ion species
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- Plume properties

Plume:



[Ouellette et al., 2016]

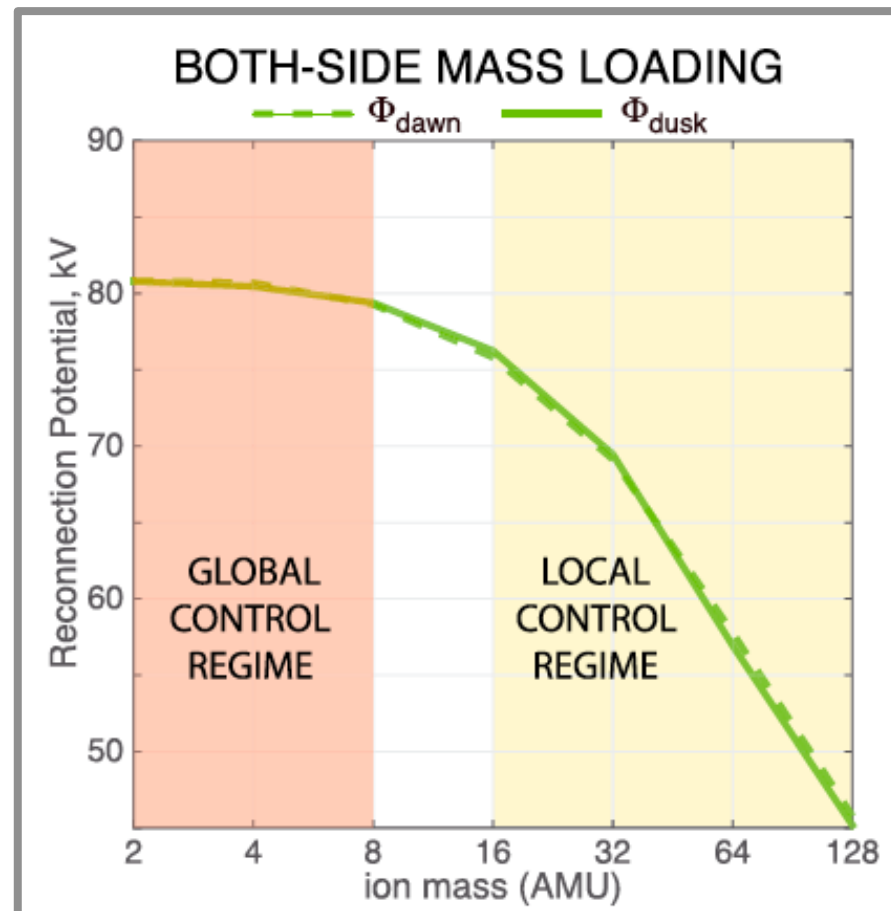
Sometimes

- Ion species
- Ion outflow
- Plume density
- Plume properties

Outflow:

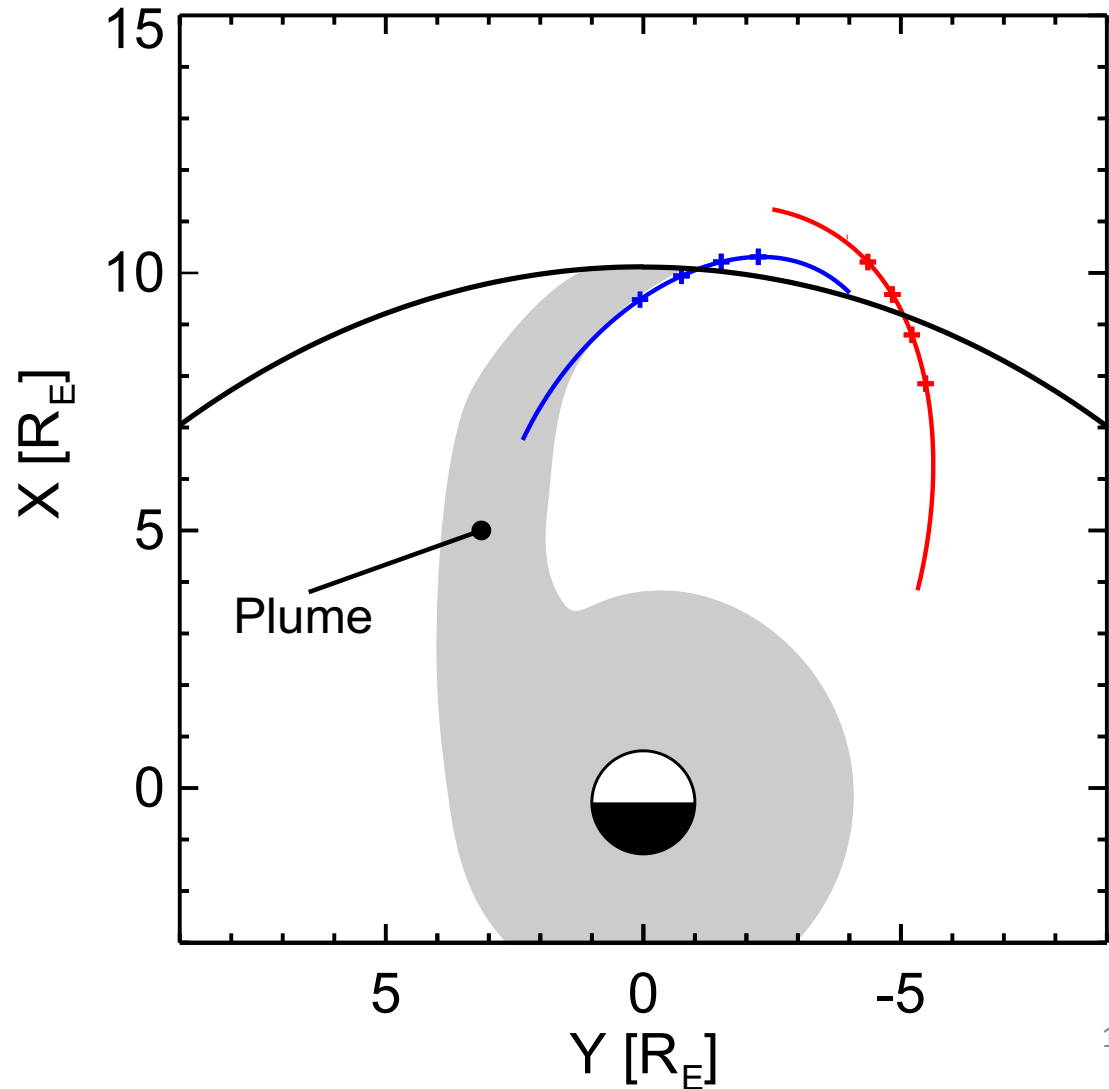
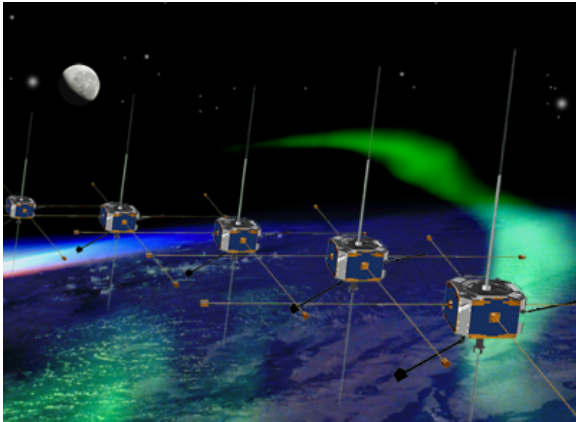
Result from MHD
with ion outflow

Zhang et al., [2016]



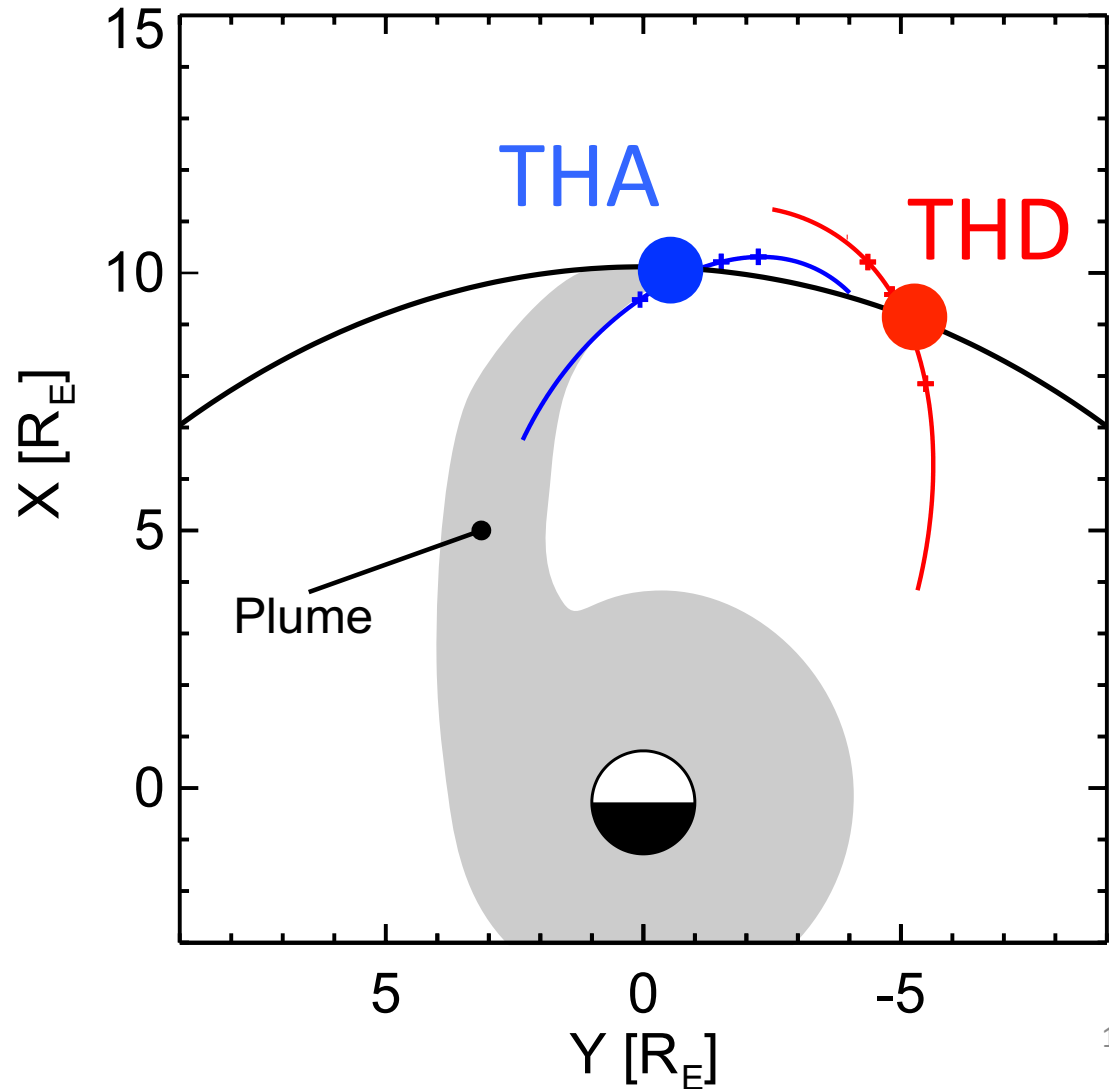
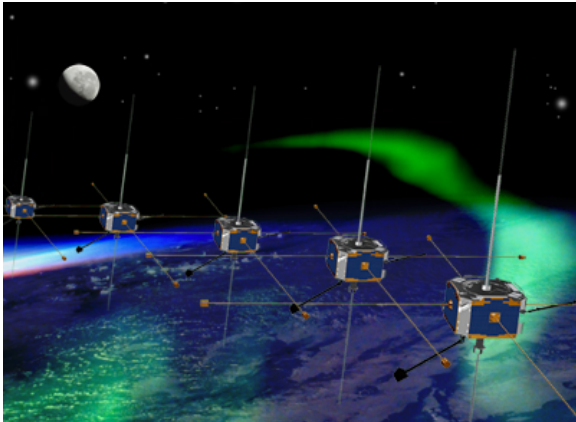
Yes → Clear local impact: Spacecraft measurements

THEMIS measurements

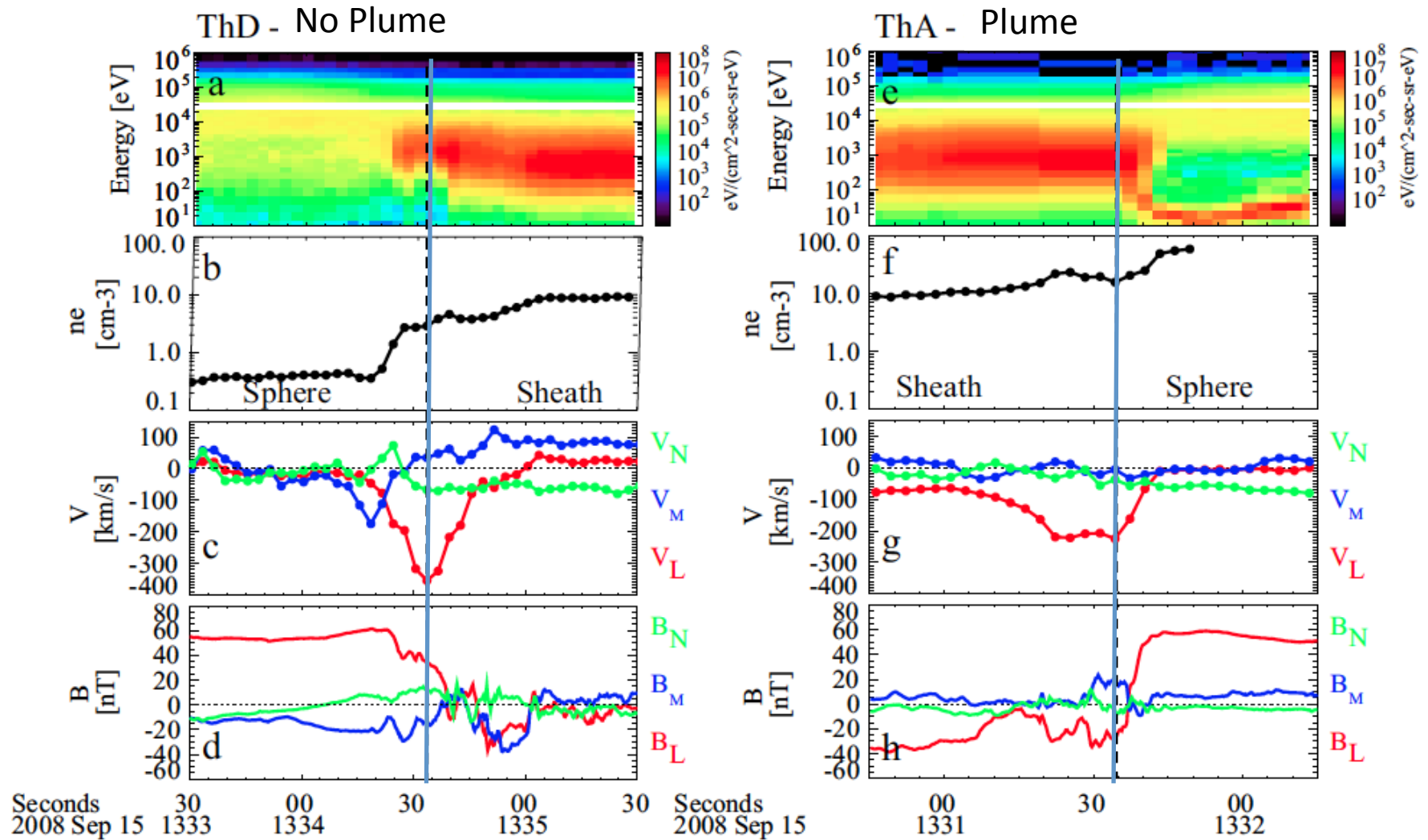


Yes → Clear local impact: Spacecraft measurements

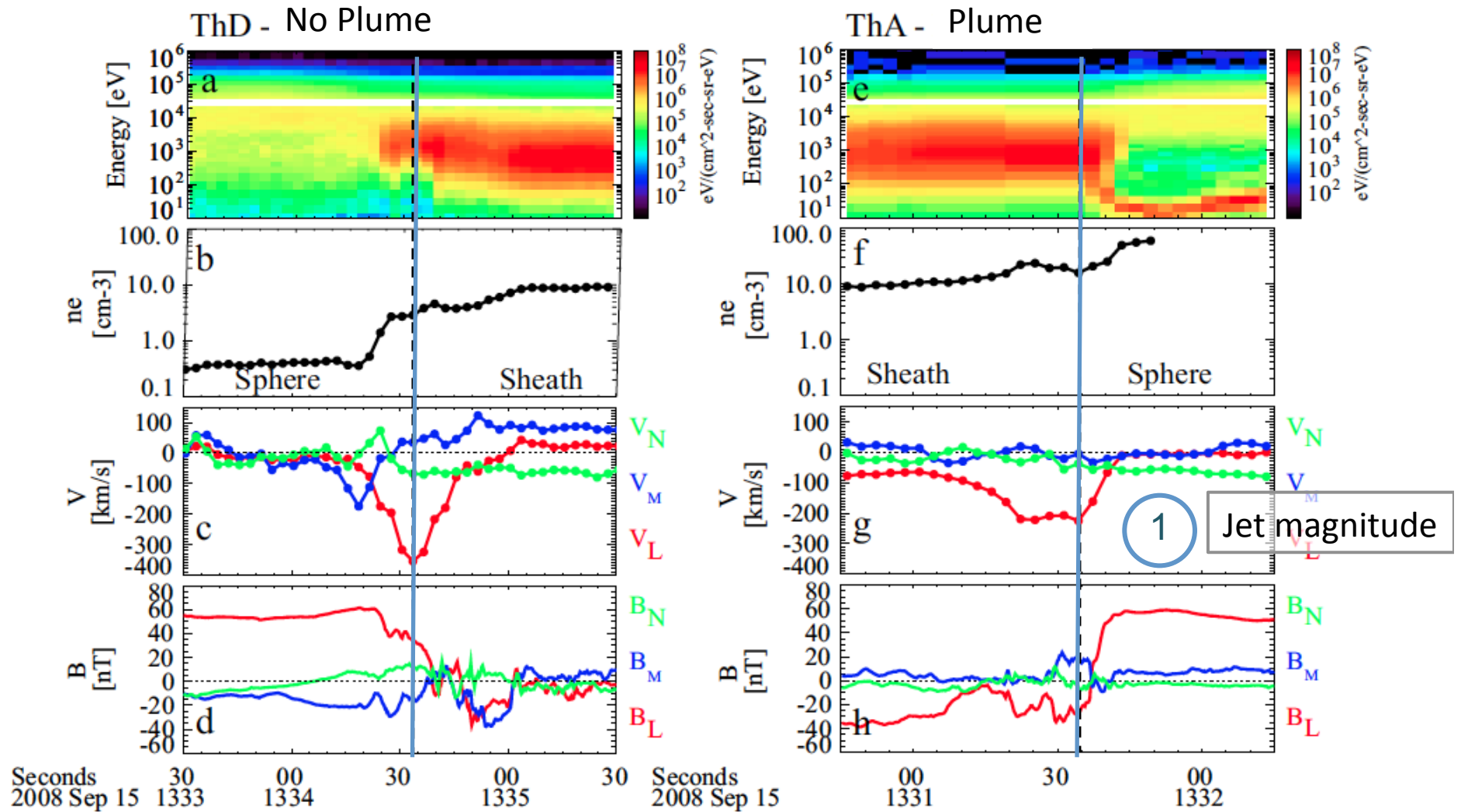
THEMIS
measurements



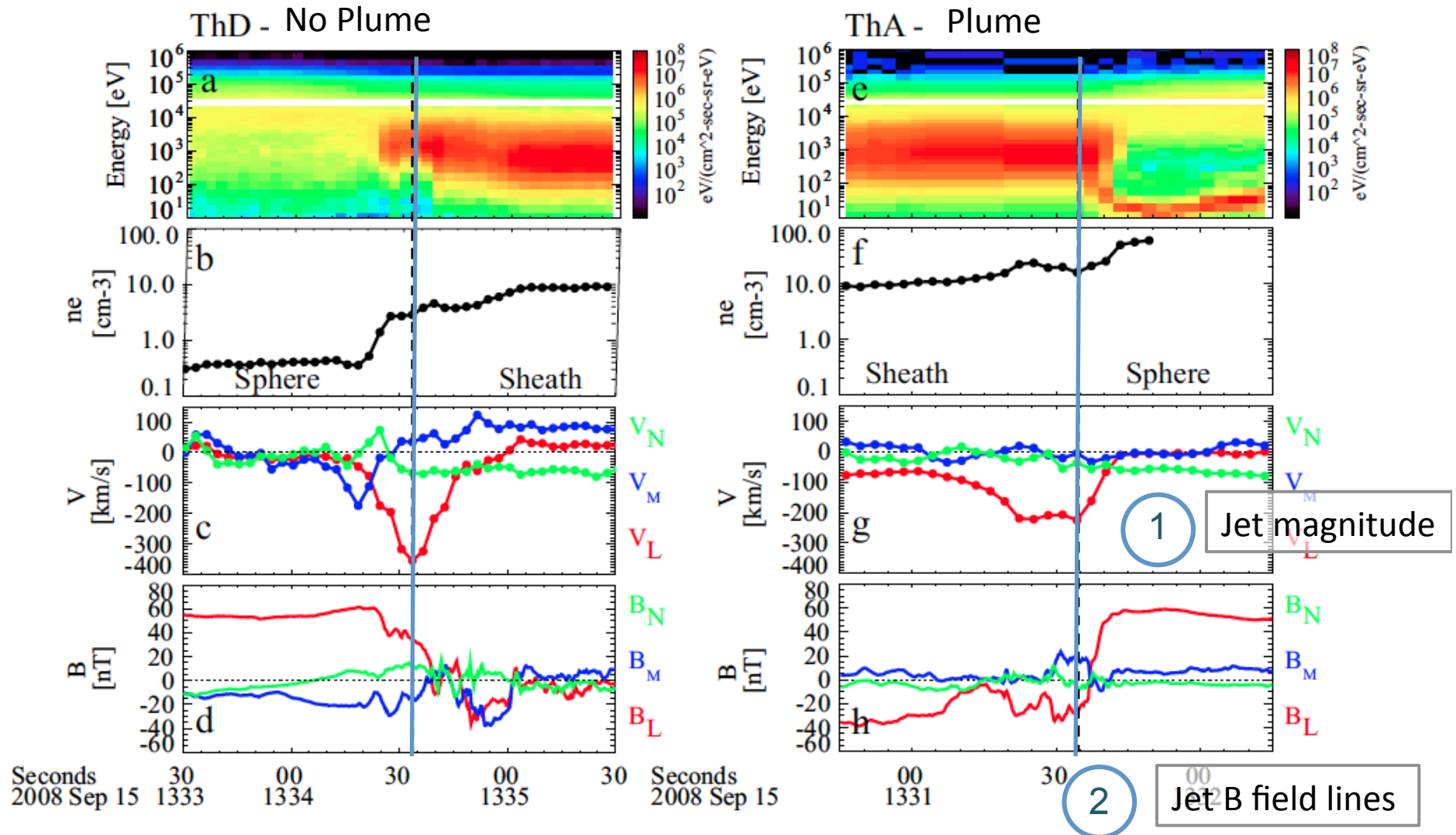
Magnetopause Crossings



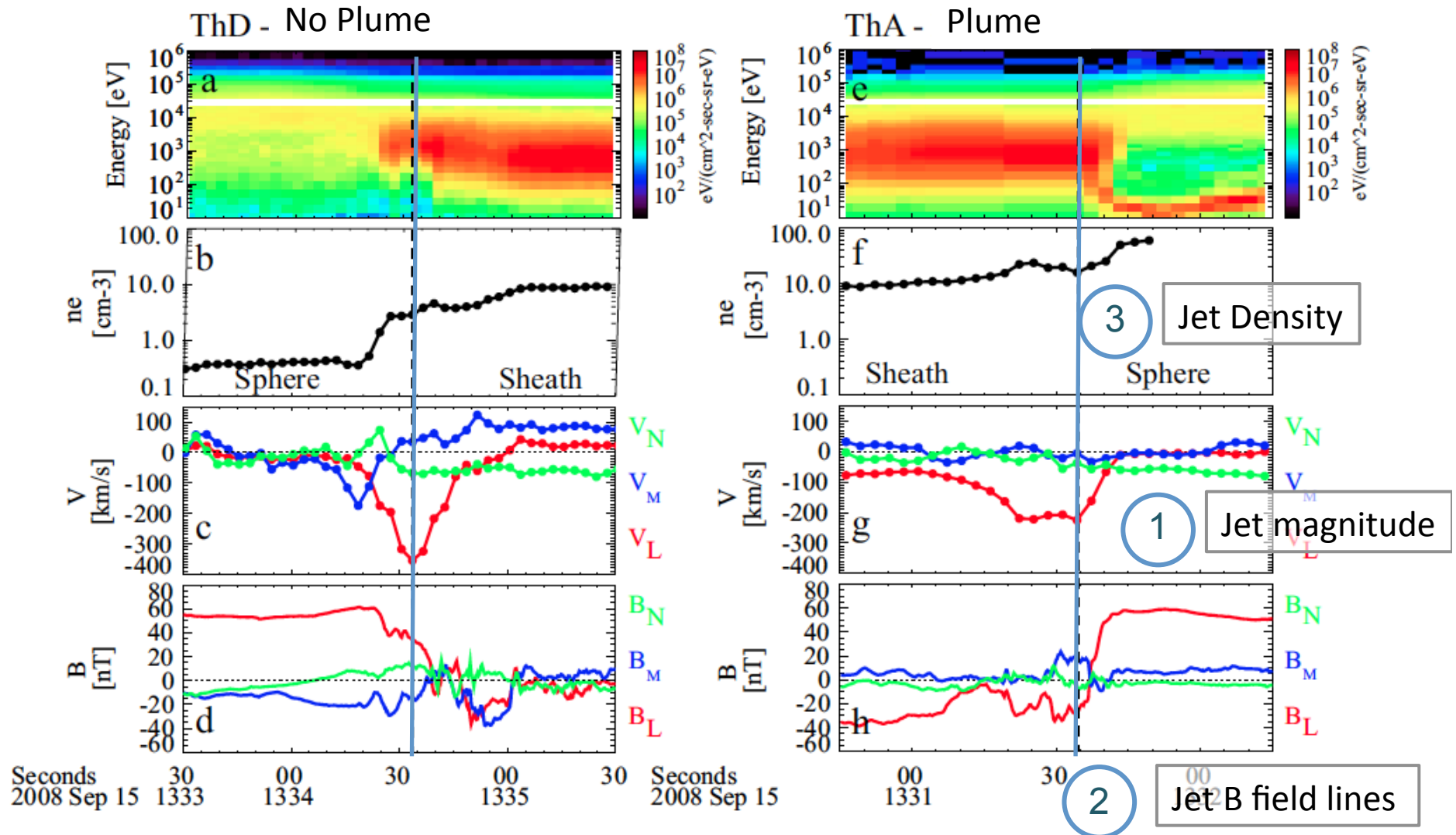
Magnetopause Crossings



Magnetopause Crossings



Magnetopause Crossings



Summary + Needs

- Material from the ionosphere can likely decrease the efficiency of solar wind-magnetosphere coupling with the right conditions
- A better understanding of the cold plasma in the magnetosphere
 - Better models/measurement for ion outflow
 - Better knowledge of plume properties at magnetopause (side, duration)