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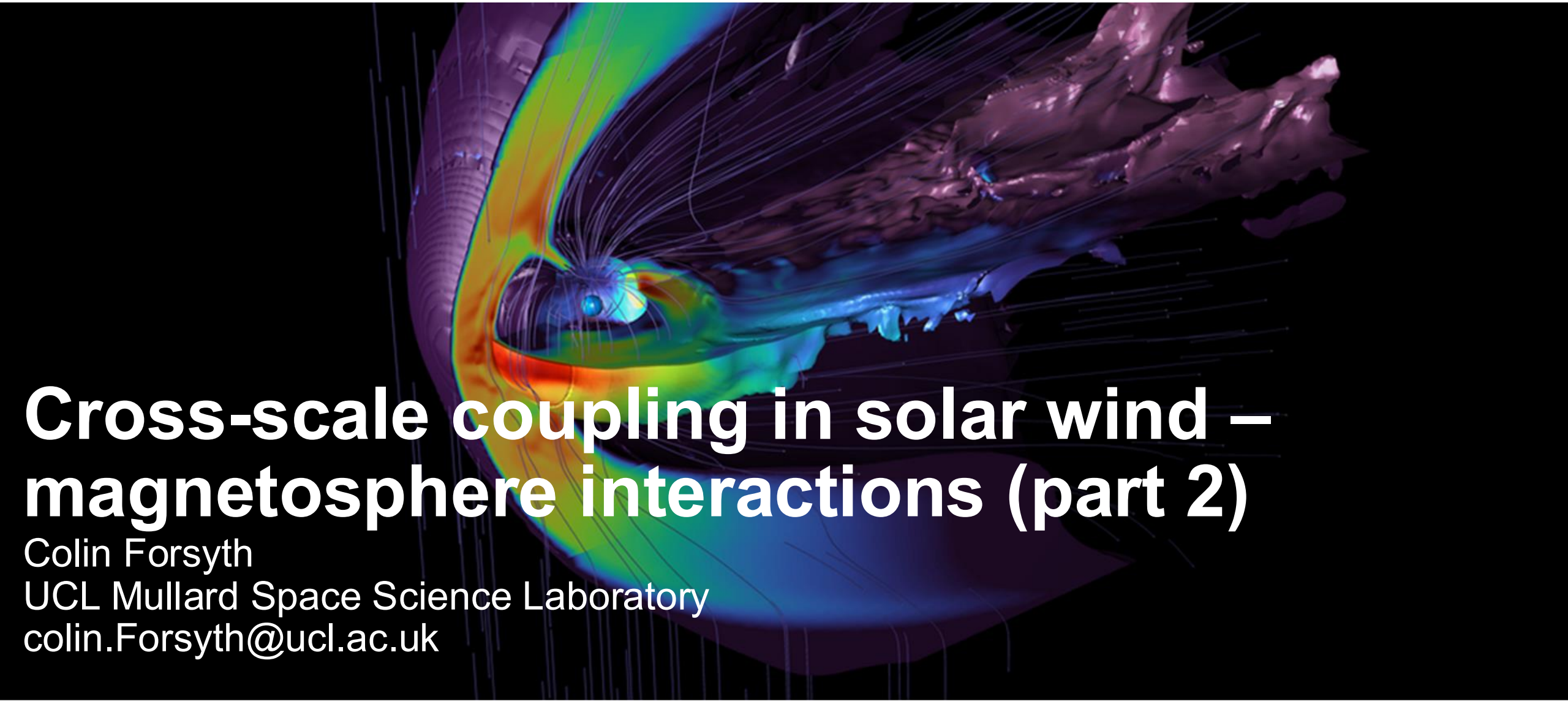

Cross-scale coupling in solar wind – magnetosphere interactions (part 2)

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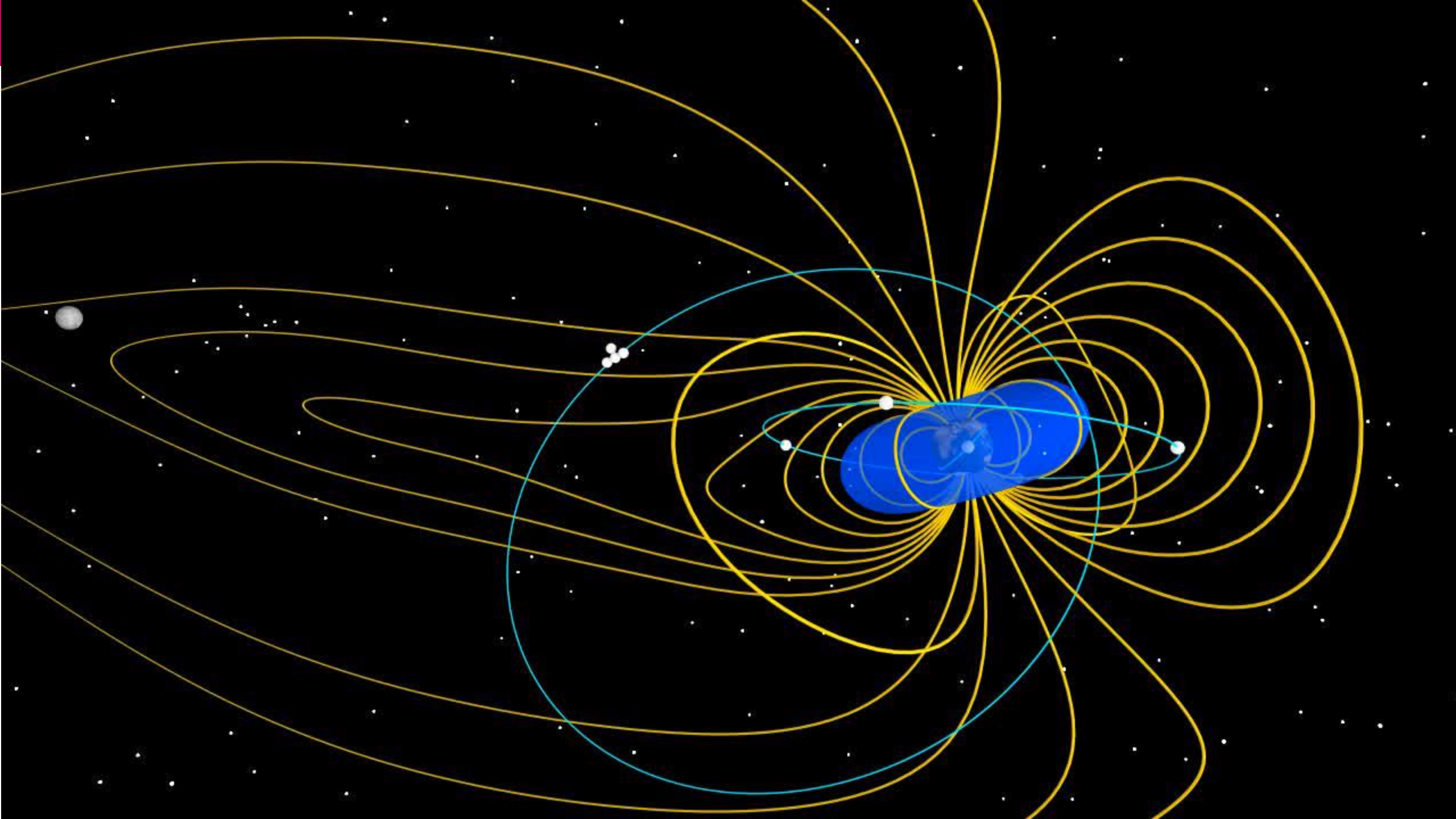
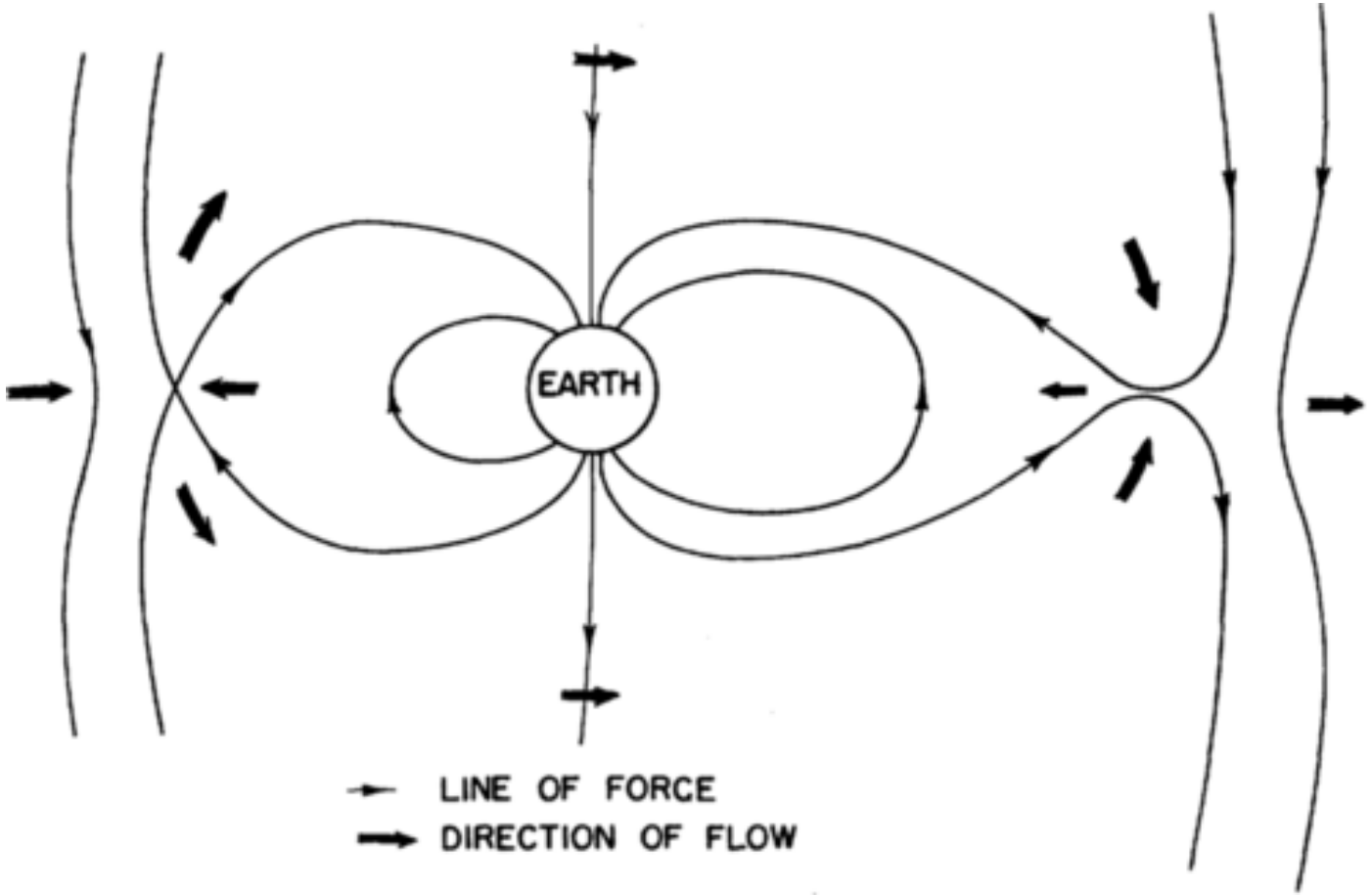
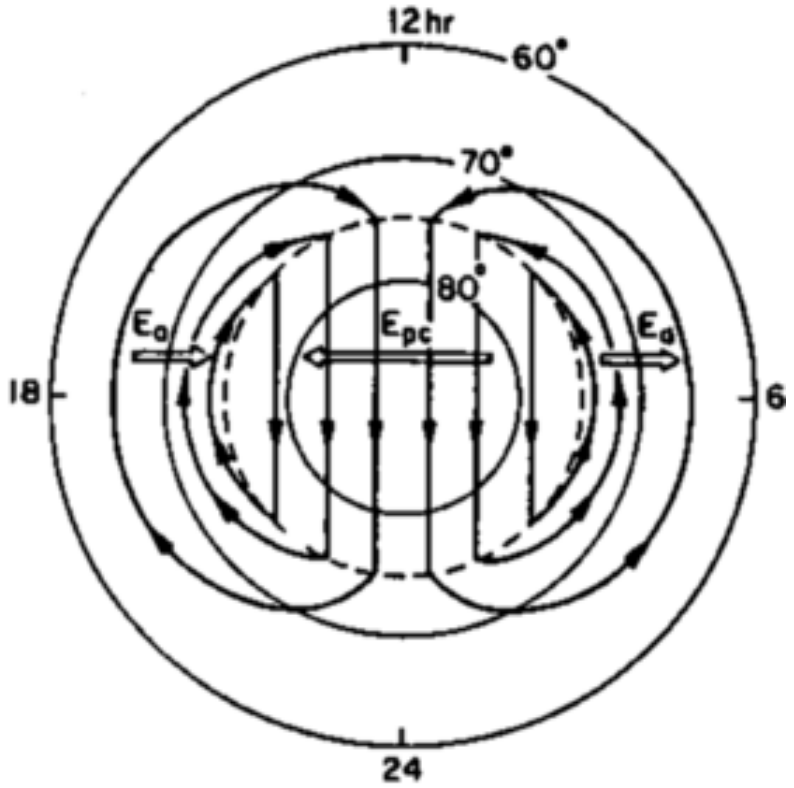
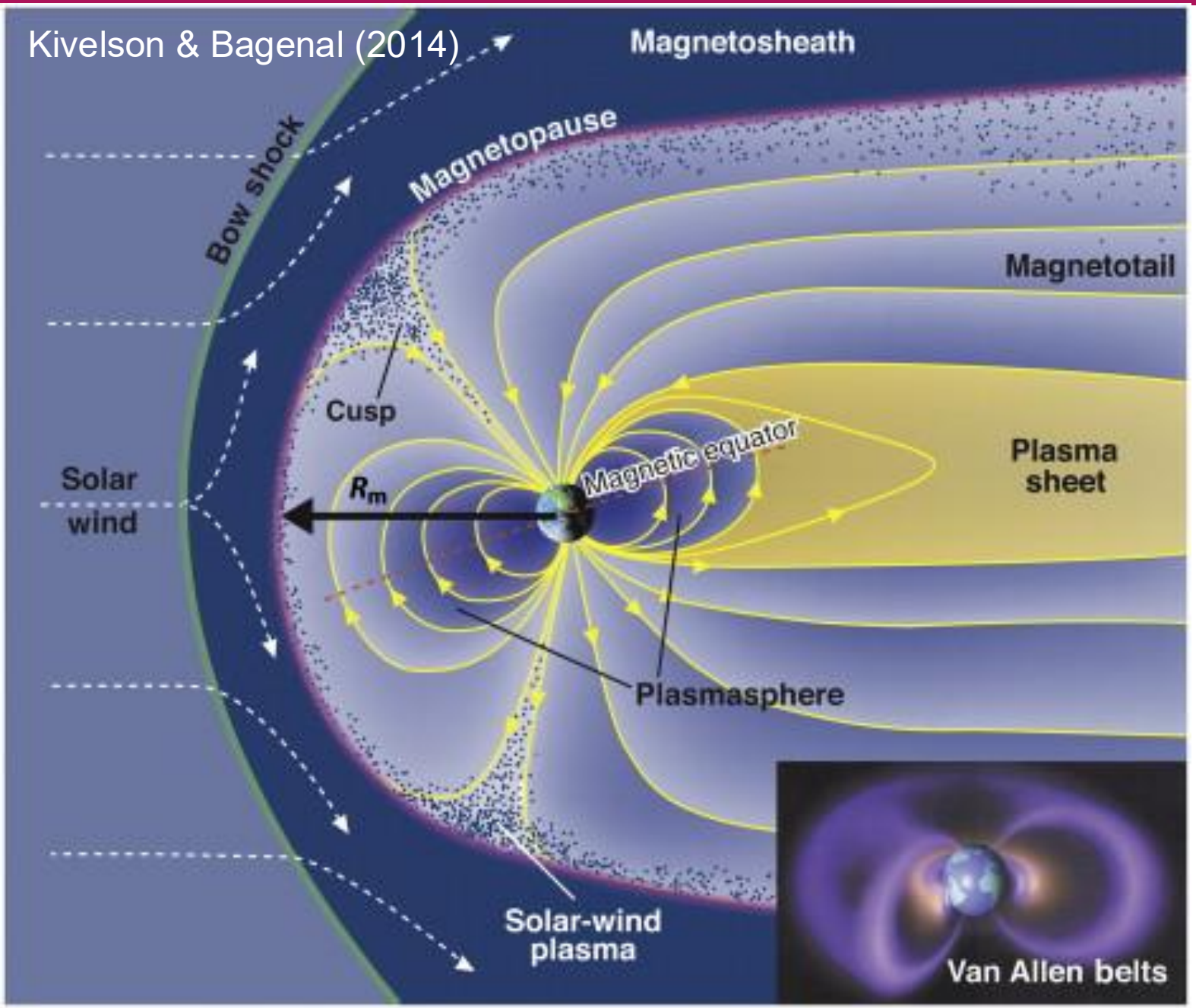


Large-scale magnetic coupling under southward IMF

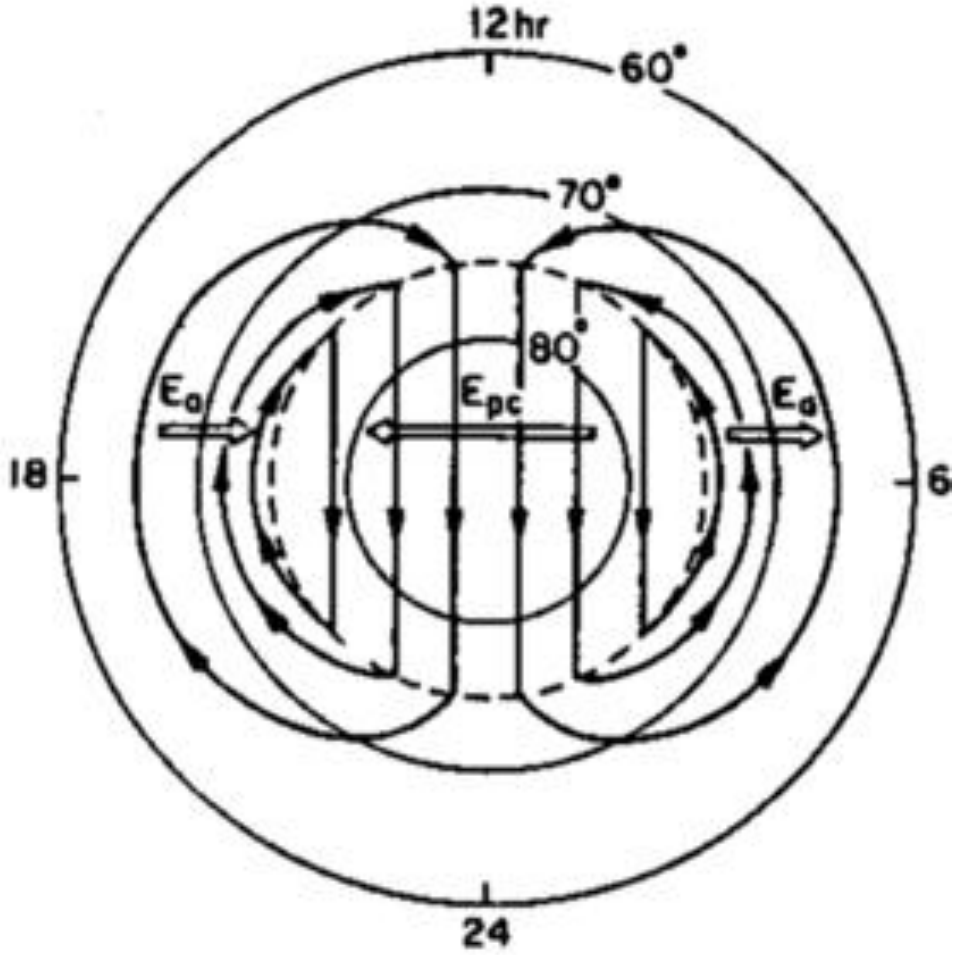




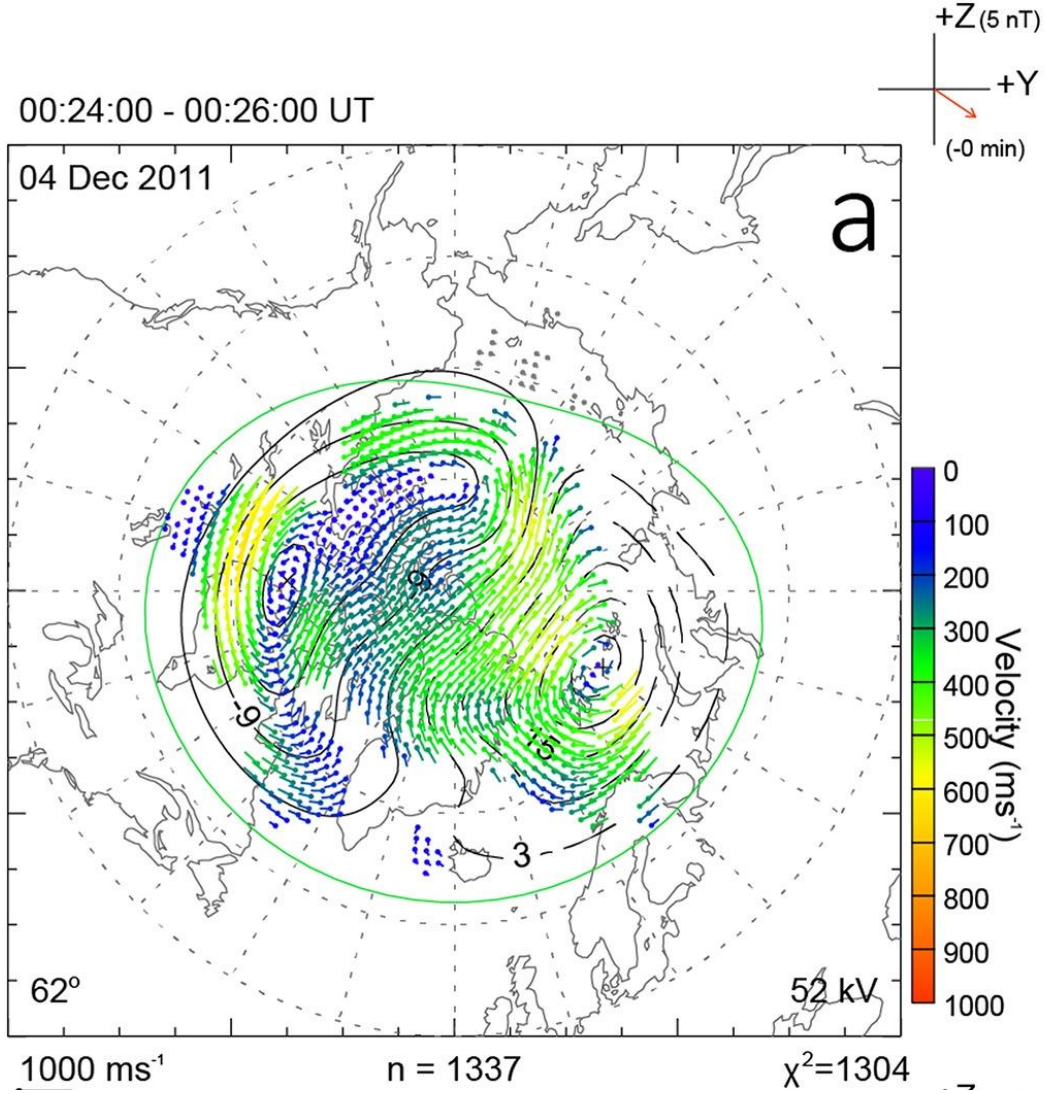
Dungey (1961)



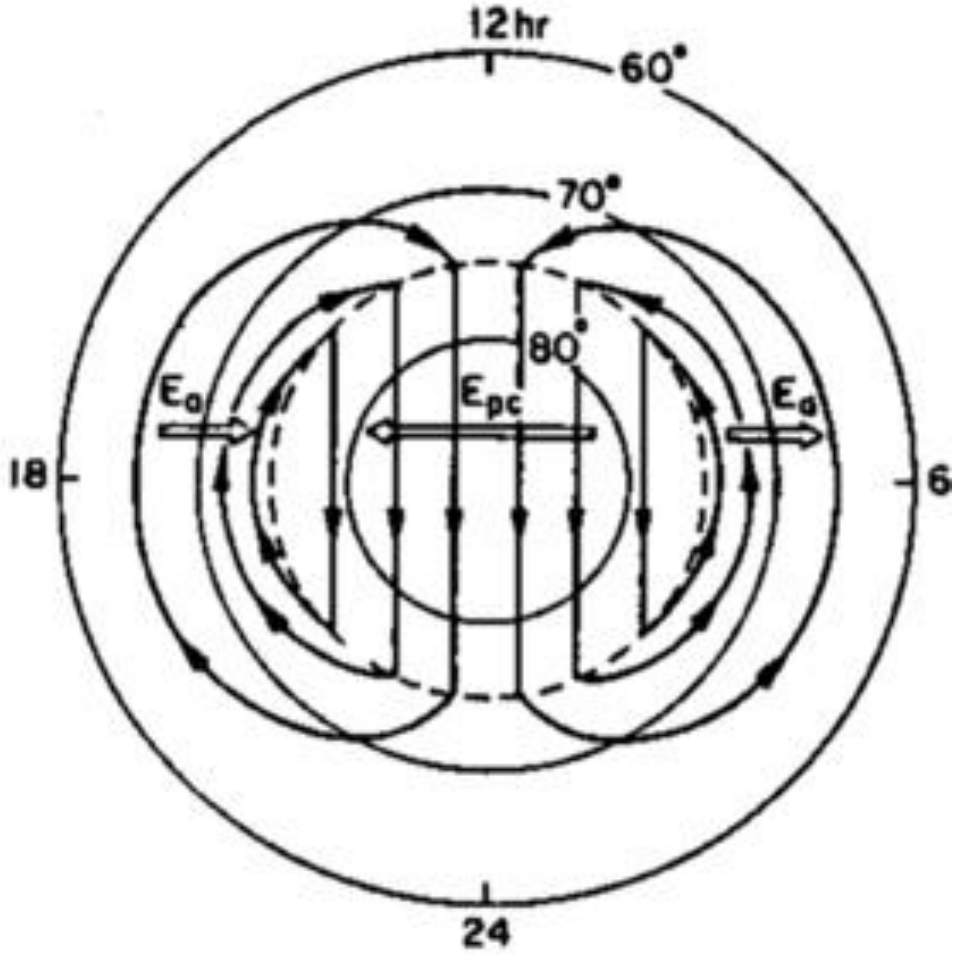
	Temperature	Density
Solar wind	12 eV	5 cm^{-3}
Sheath	200 eV	20 cm^{-3}
Lobe	10 eV	0.05 cm^{-3}
Plasma sheet (10-20 R_E)	1000 eV	1 cm^{-3}



Dungey (1961)



Fogg et al. (2020)



Dungey (1961)

Field line moves from 75° dayside to 75°
Footpoint moves 30°
1° ~ 100 km latitudinally

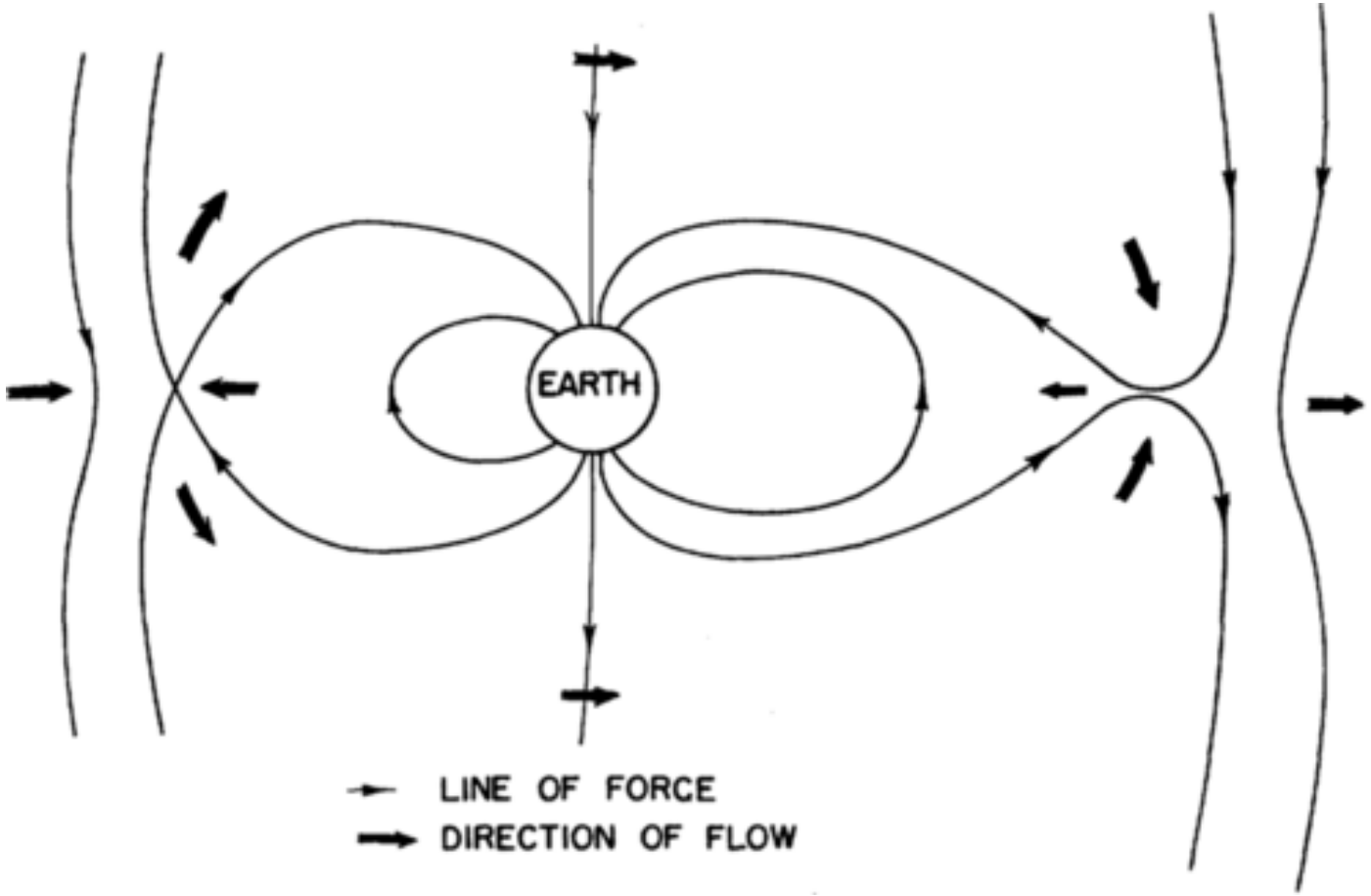
Footpoint moves at 500 m/s

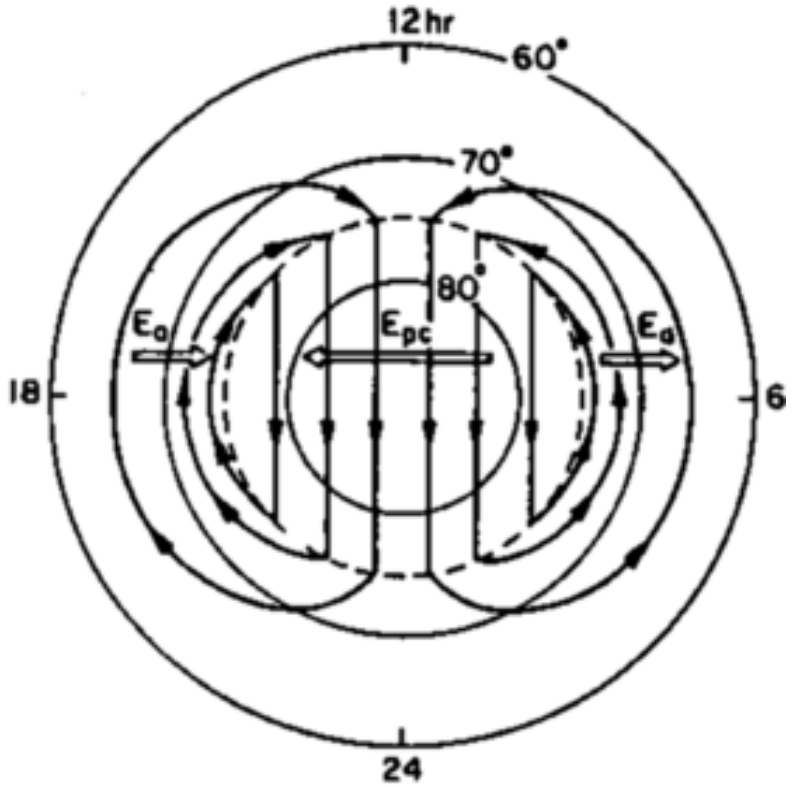
∴ Time for field to cross = 30*100/0.5 = 6000 s

Other end of the field is connected to the solar wind and travelling at 450 km/s

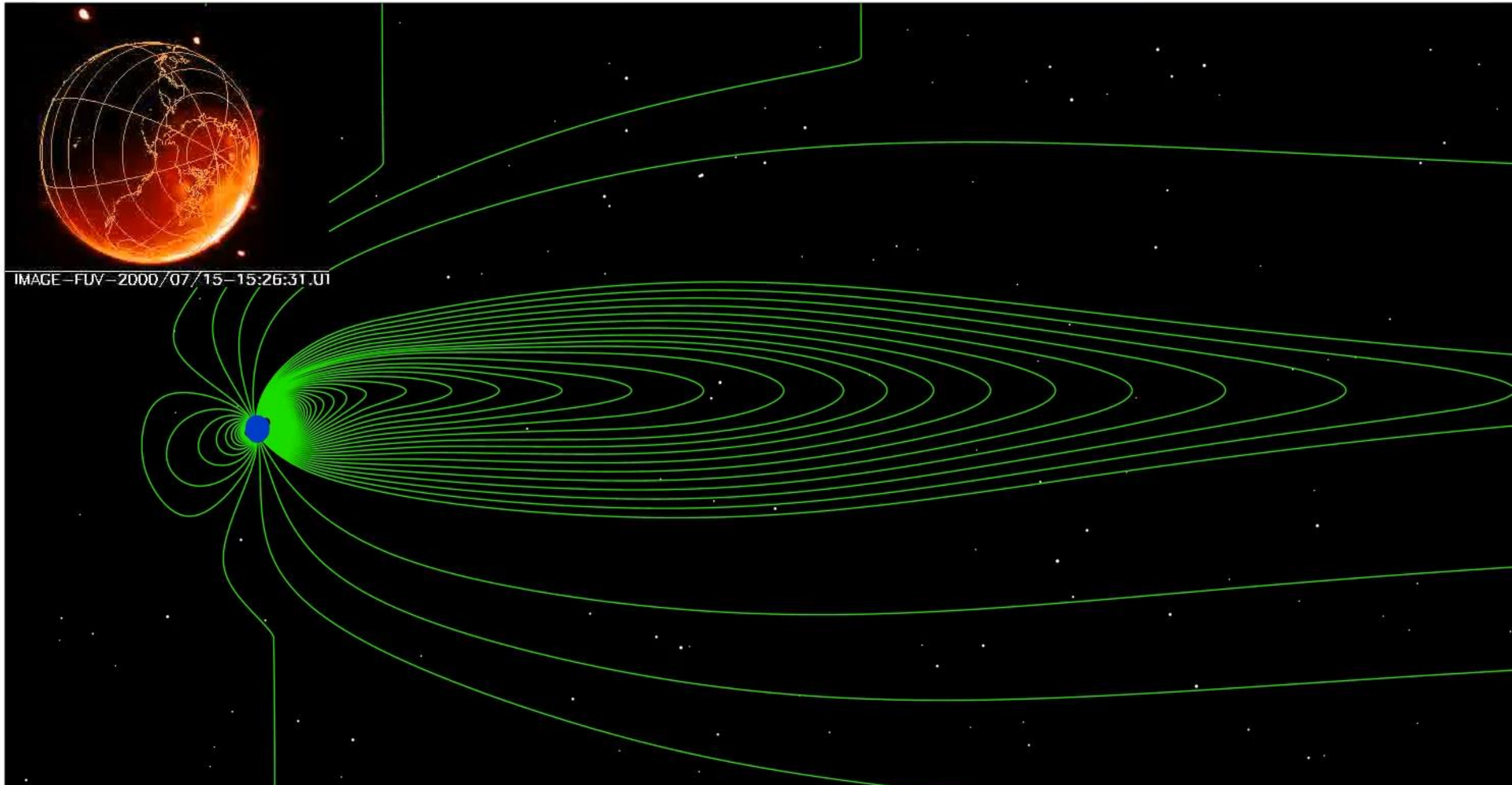
Distance solar wind end travels = 450*6000 = 2.7 Mm
Distance travelled in R_E = 2.7e6 / 6371 = 424 R_E

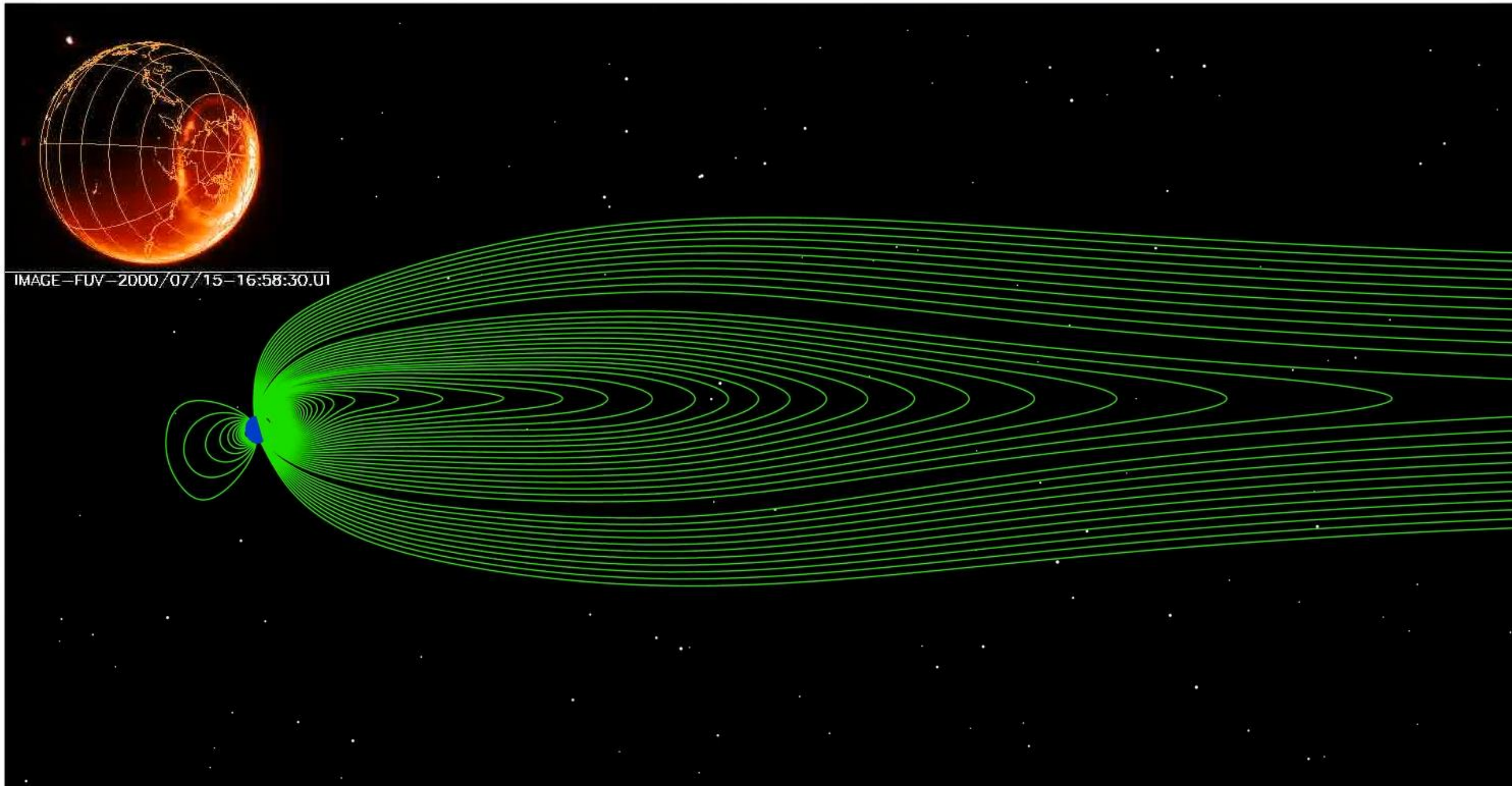
Can rates of reconnection match?



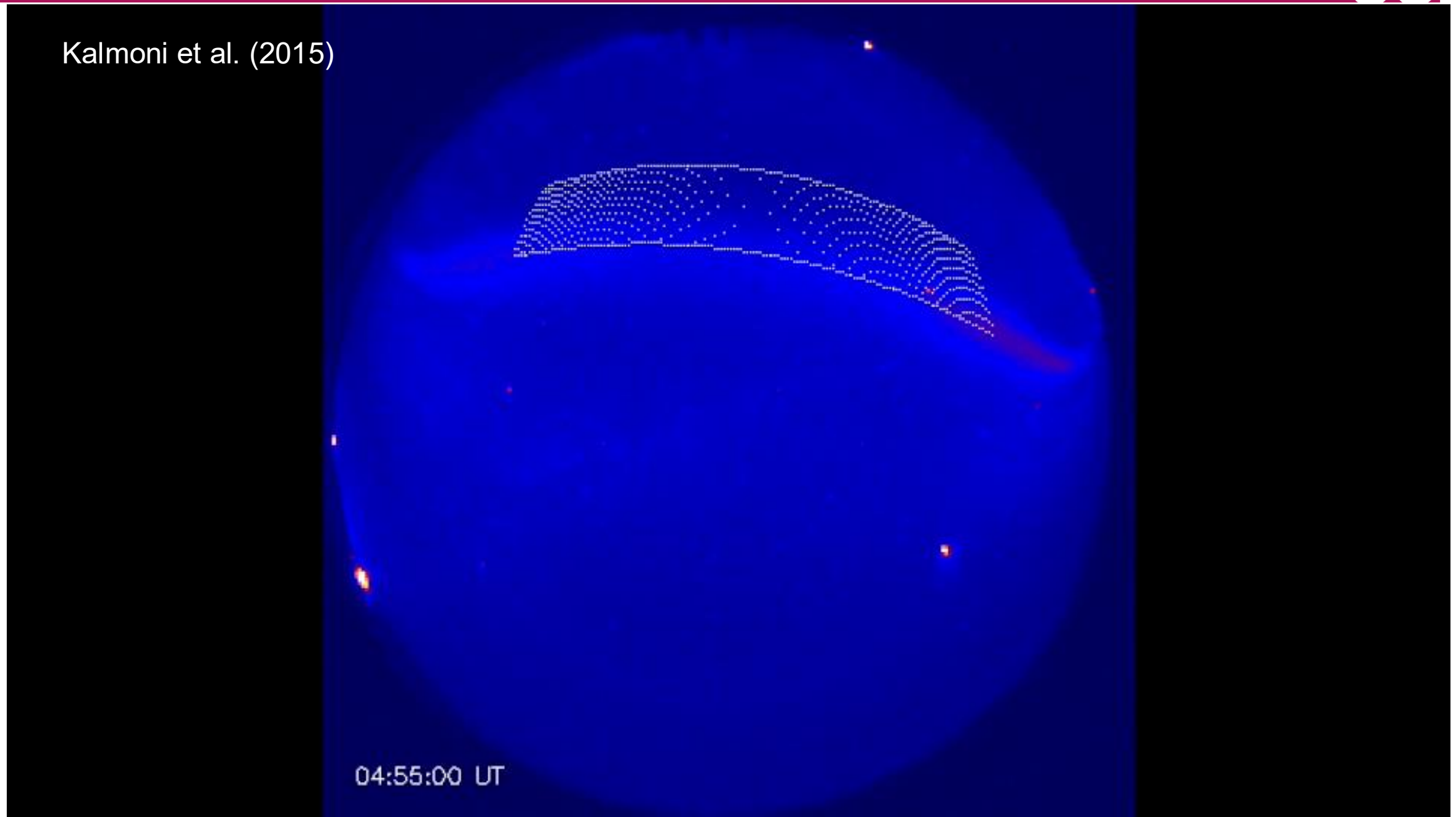


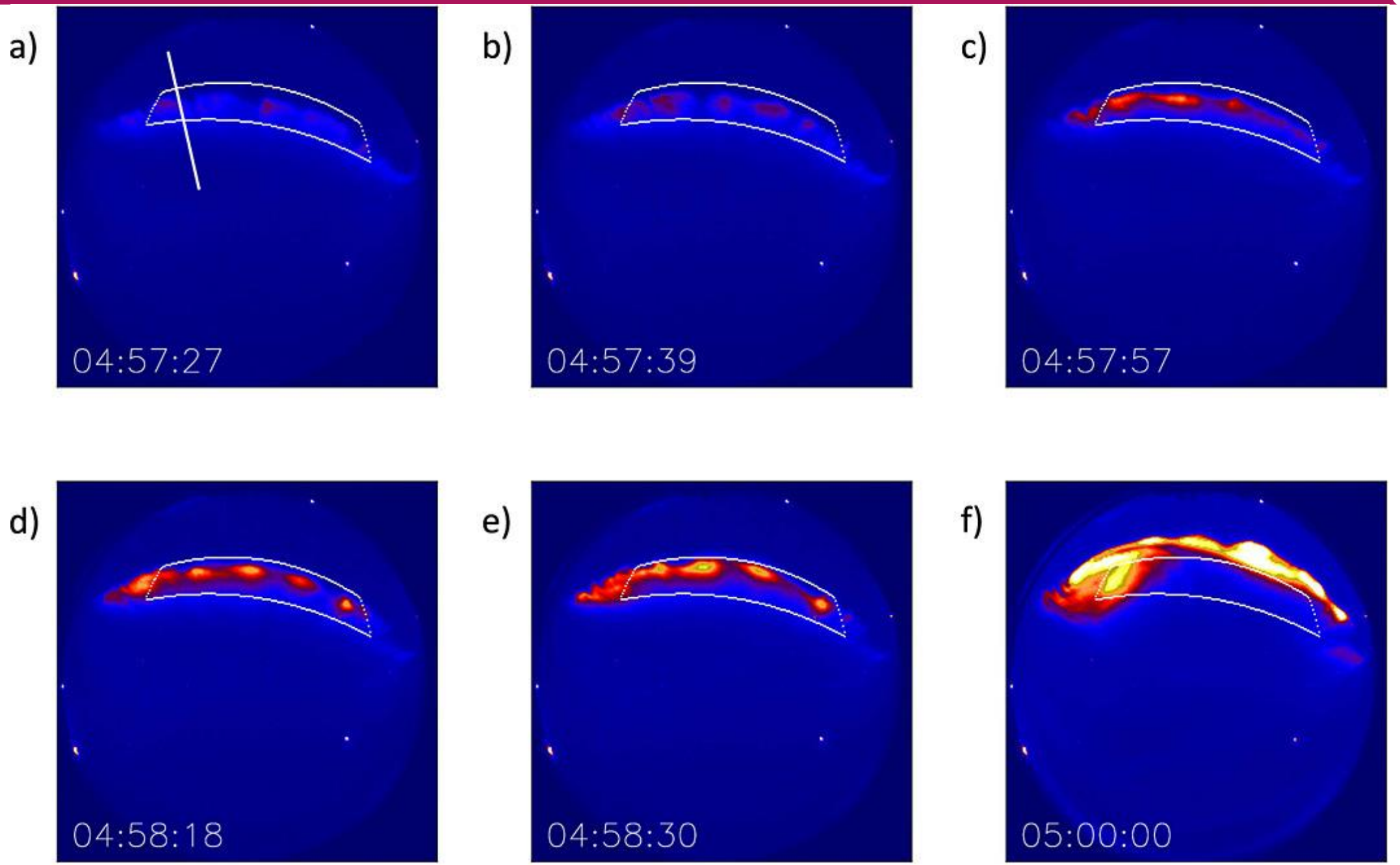
Dungey (1961)


IMAGE–FUV–2000/07/15–15:26:31.01


IMAGE–FUV–2000/07/15–16:58:30.01

Kalmoni et al. (2015)

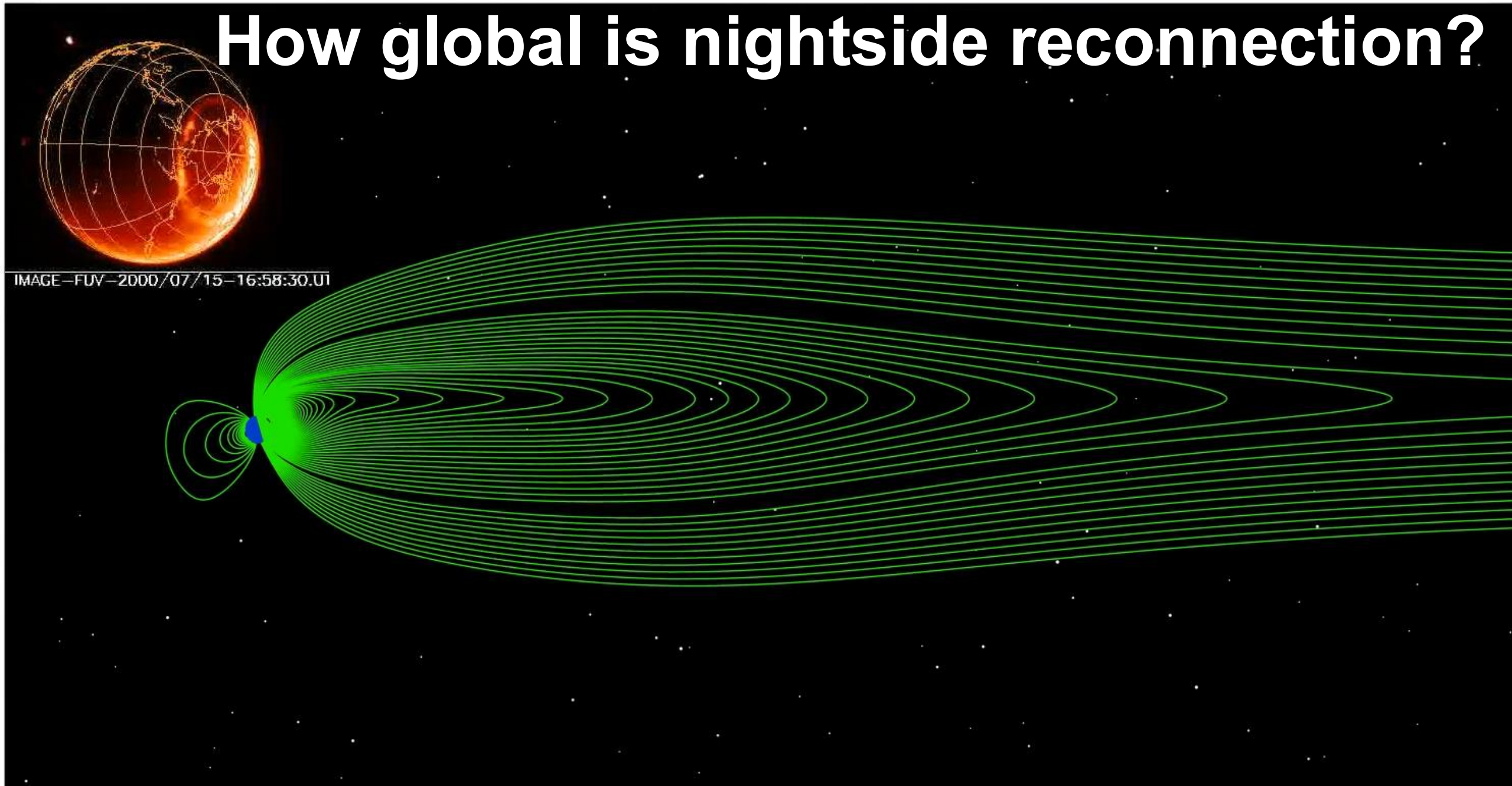



a)
04:57:27
b)
04:57:39
c)
04:57:57
d)
04:58:18
e)
04:58:30
f)
05:00:00

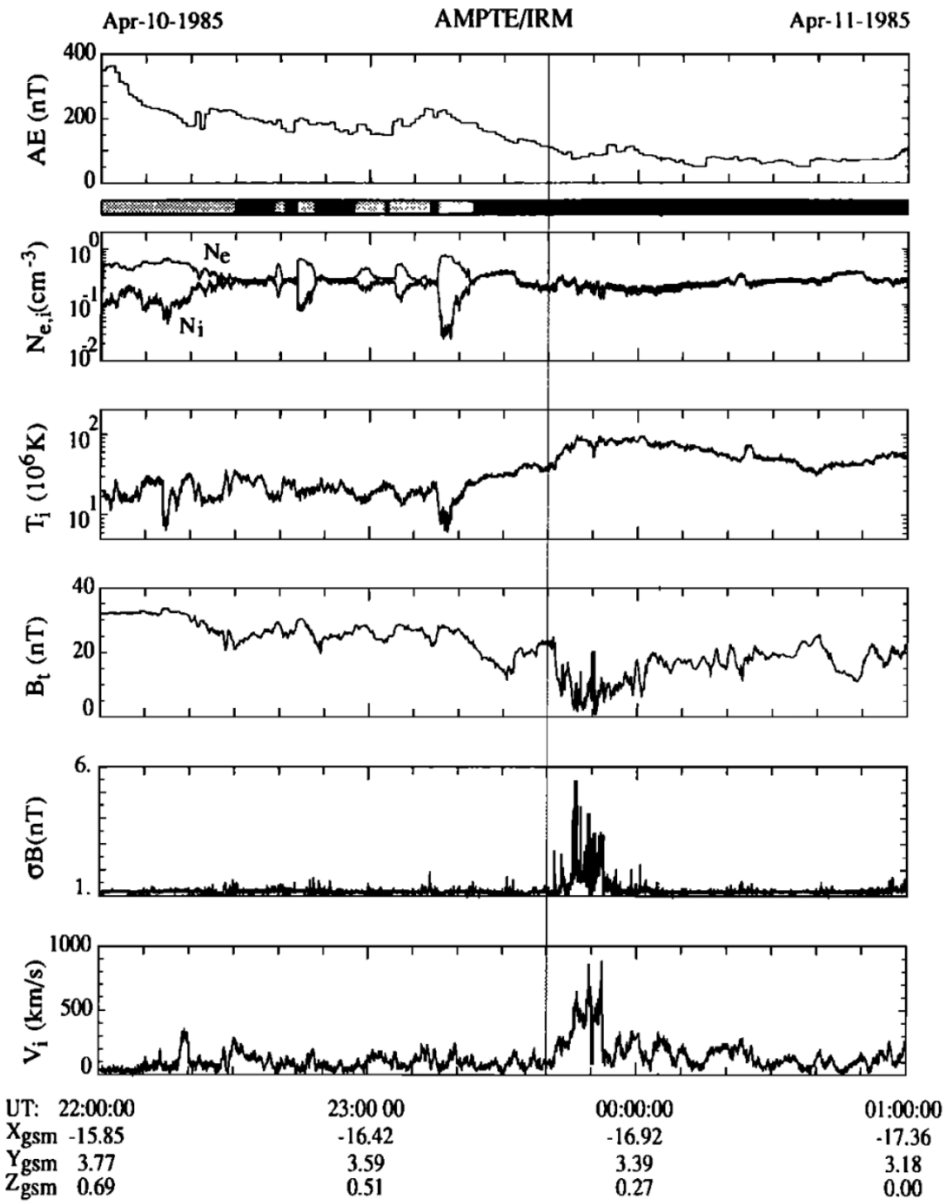
Kalmoni et al. (2018)

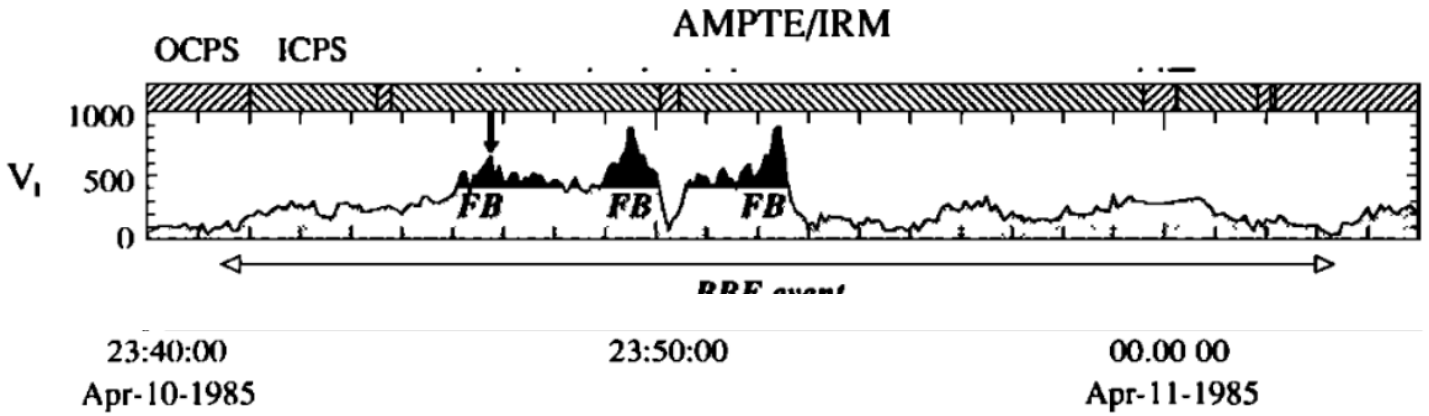
Separation~10-100 km
n = 15 cm^{-3}
B = 24 nT
T = 3 keV
Ion inertial length = 58 km
Ion gyroradius = 250 km

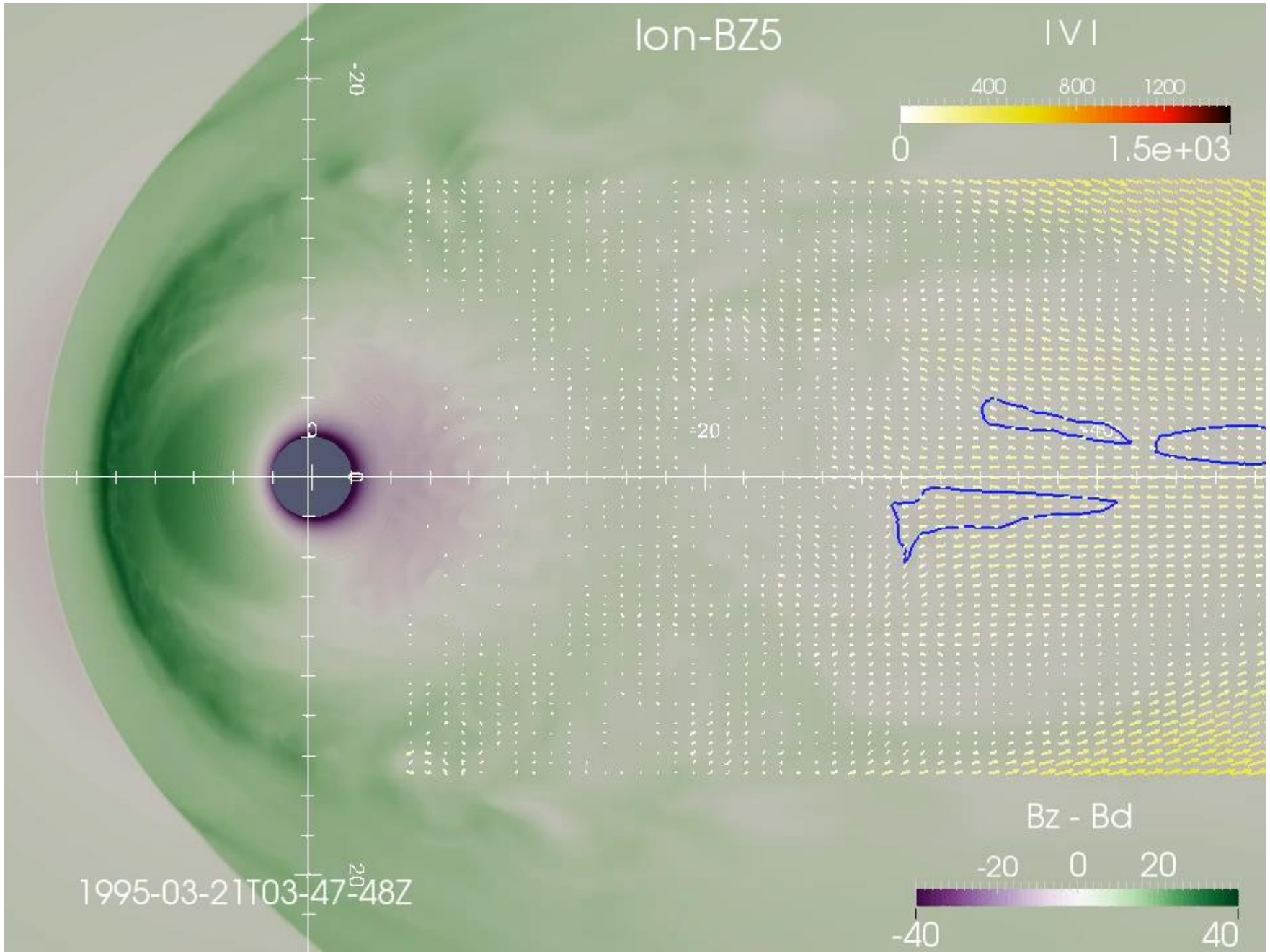
How global is nightside reconnection?



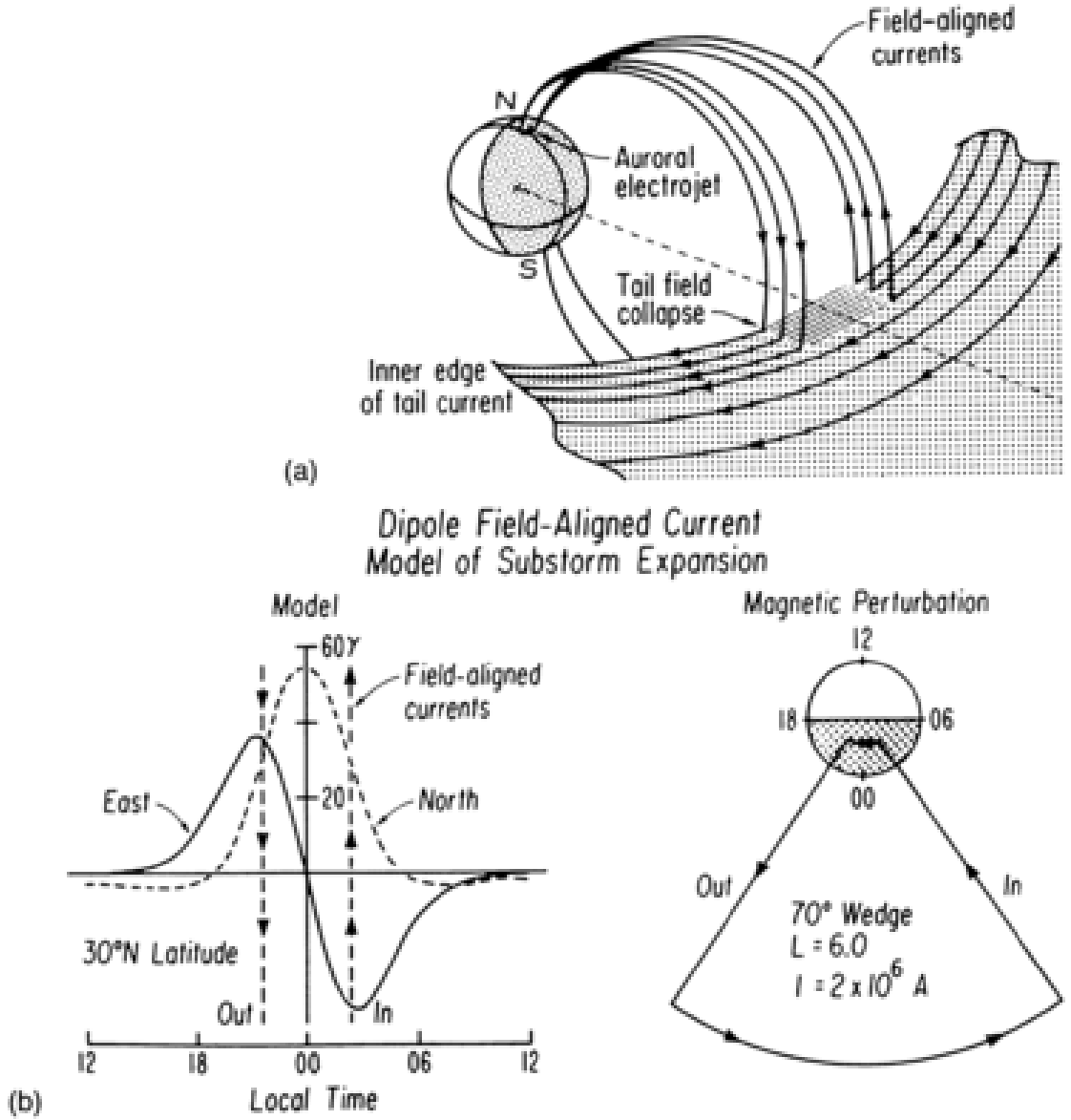
Angelopoulos et al. (1992)



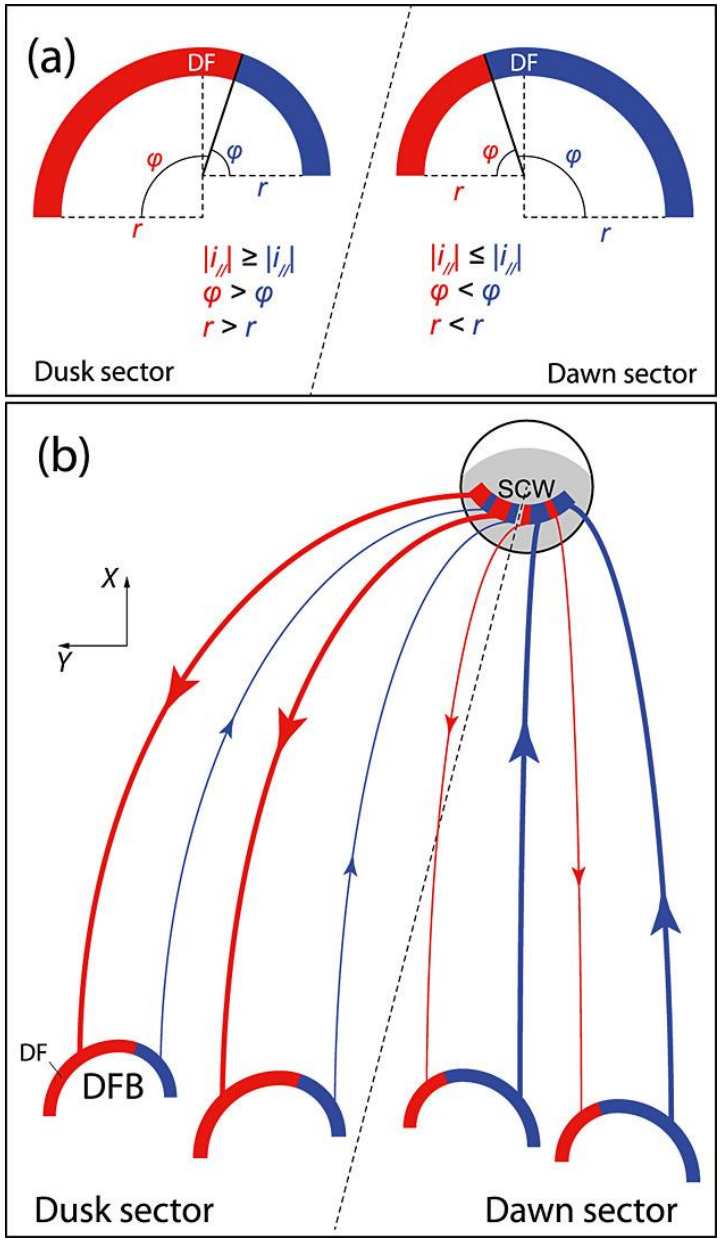




Wiltberger et al. (2015)

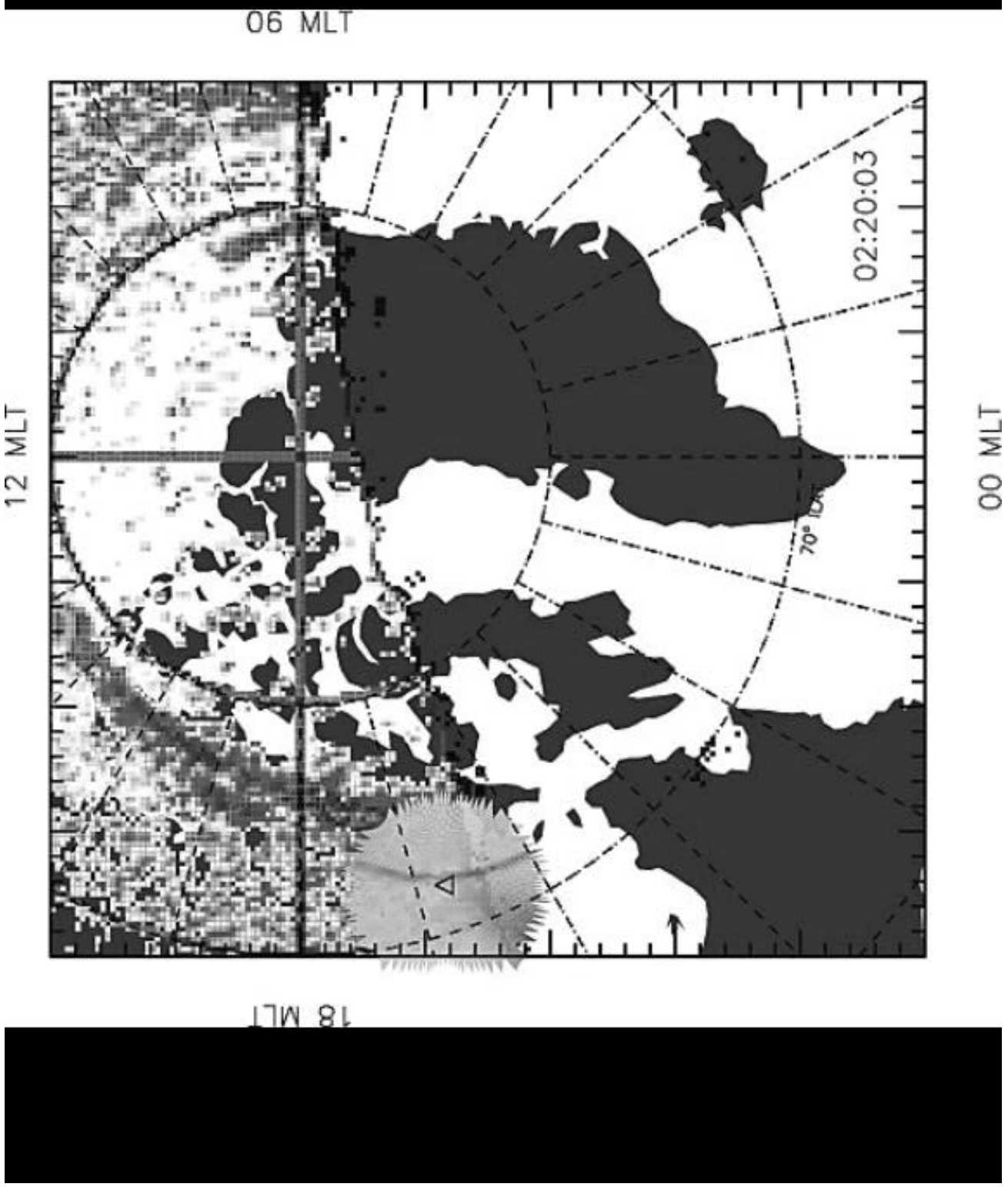


McPherron et al. (1973)

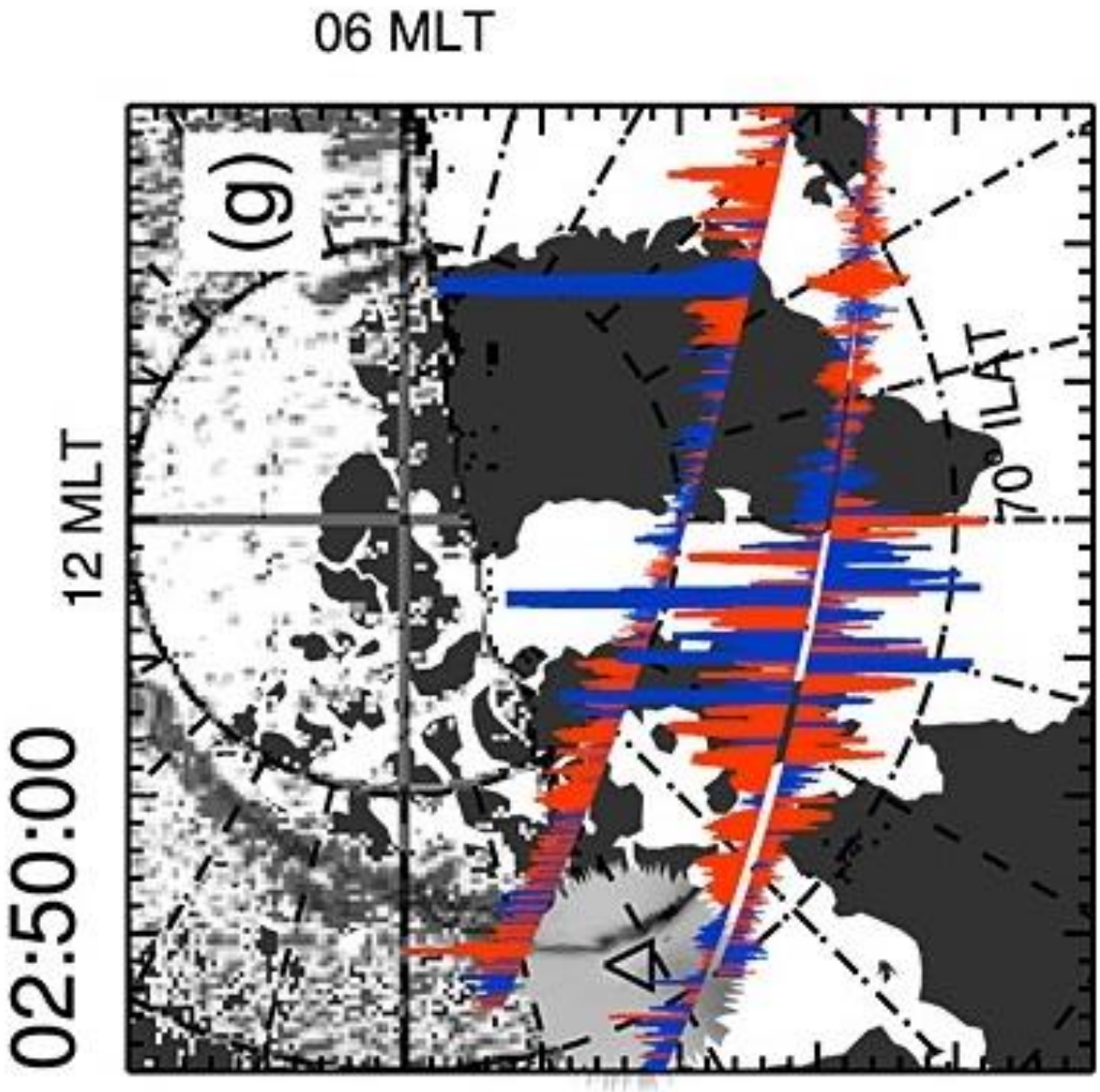


Liu et al. (2015)

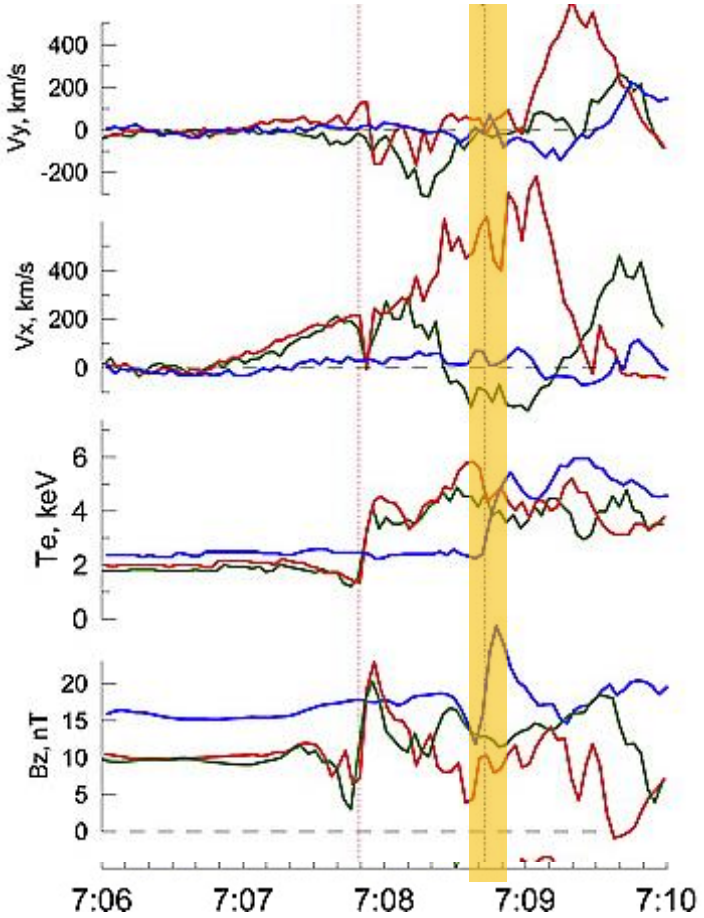
Forsyth et al. (2014)

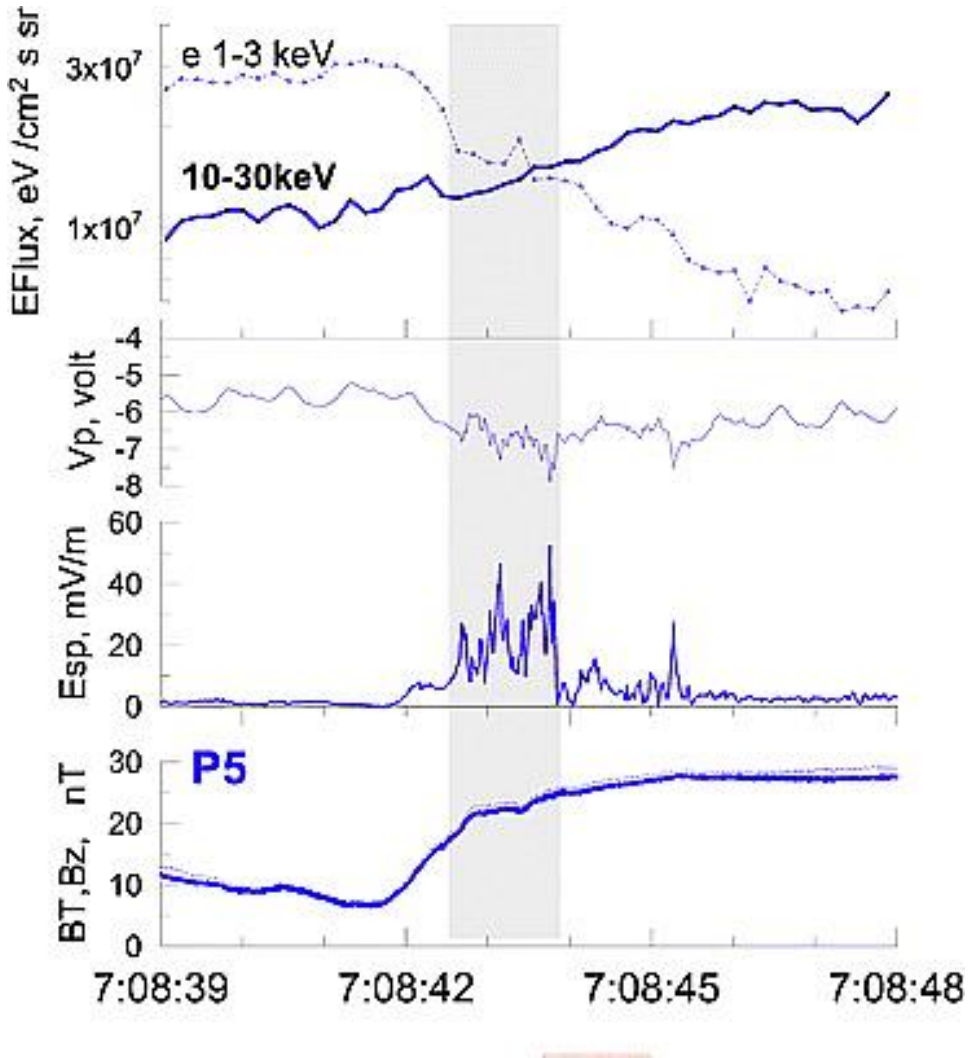


Forsyth et al. (2014)

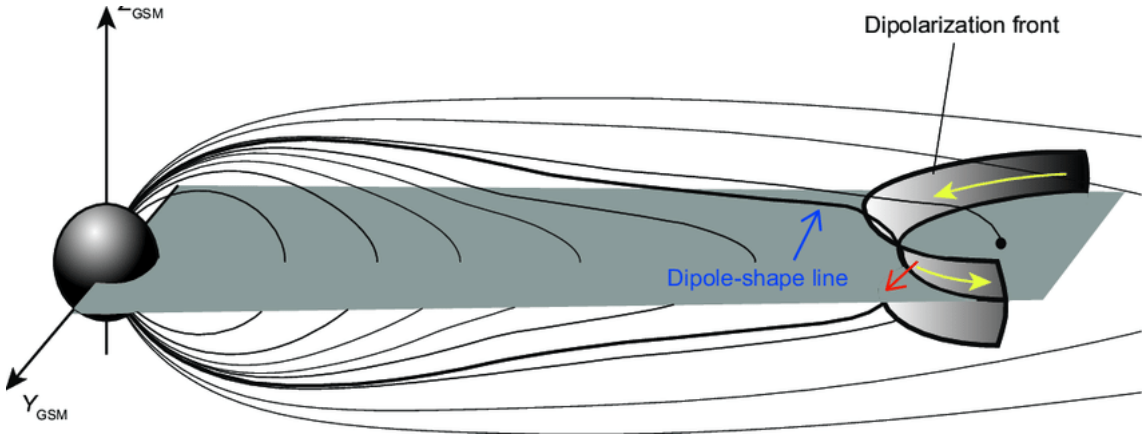


Coupling a fluid and kinetic scalees

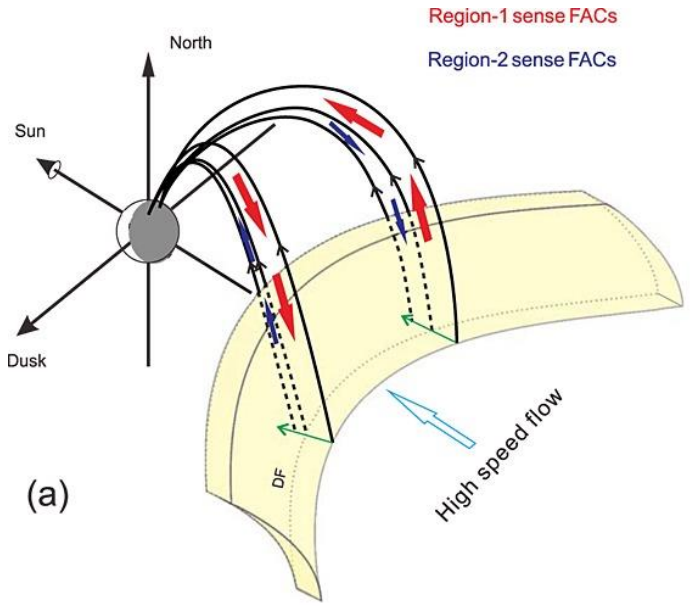


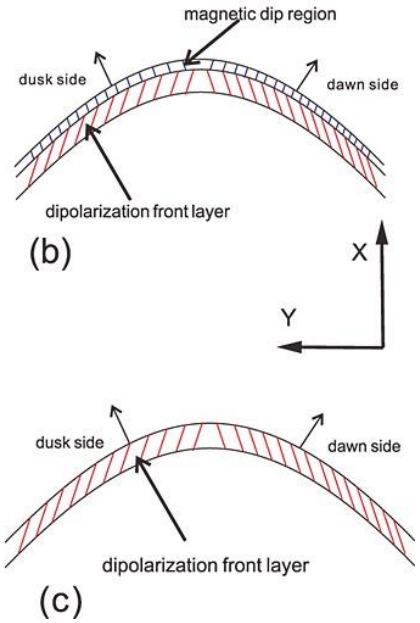


Sergeev et al. (2009)

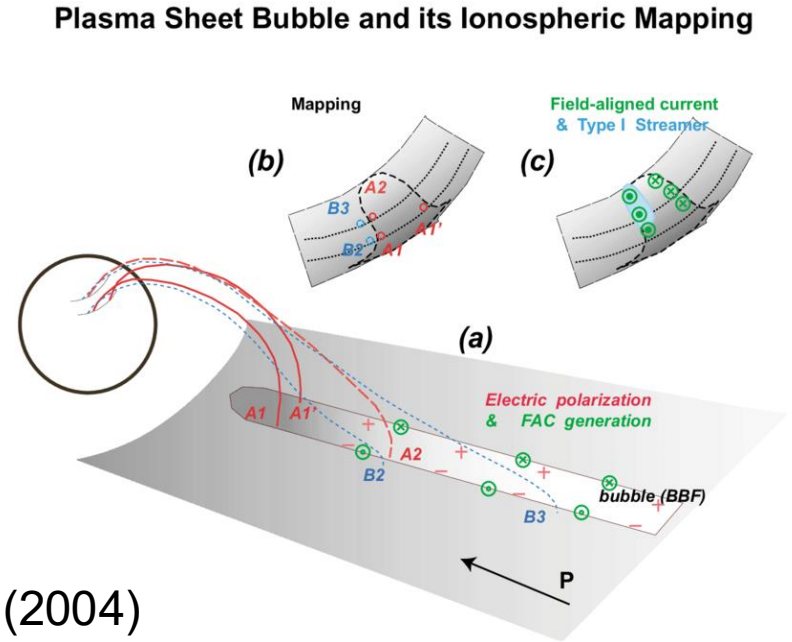


Fu et al (2012)



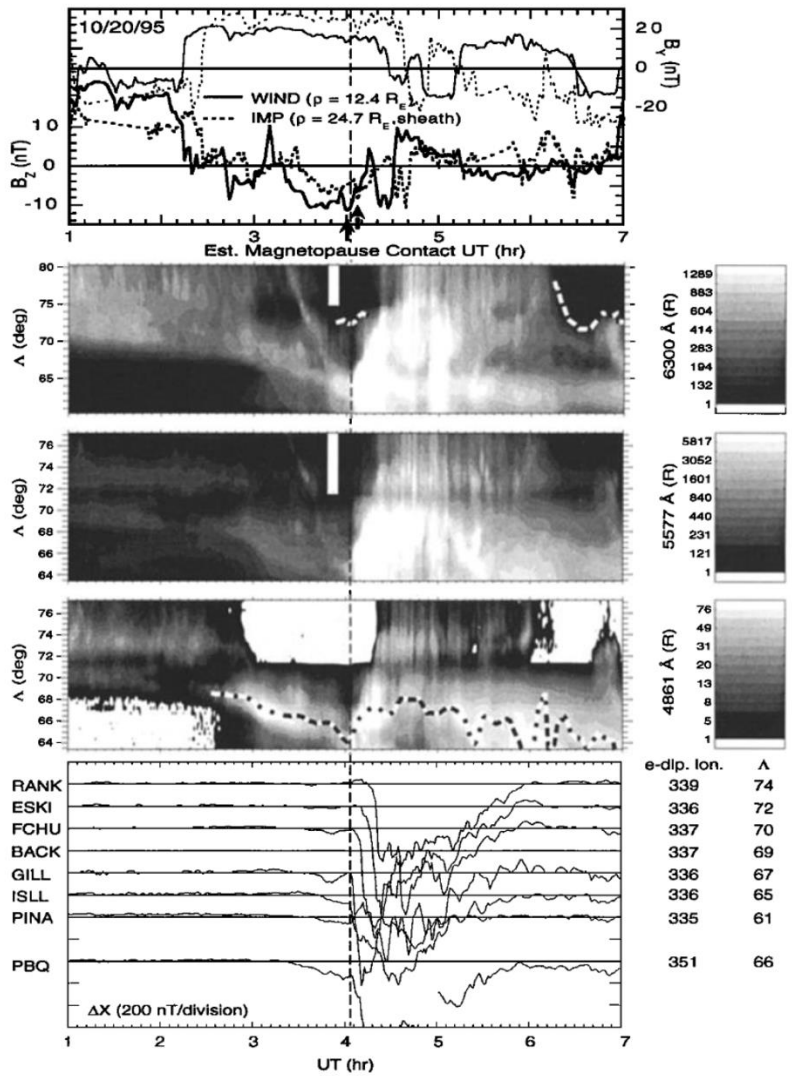


Sun et al (2013)

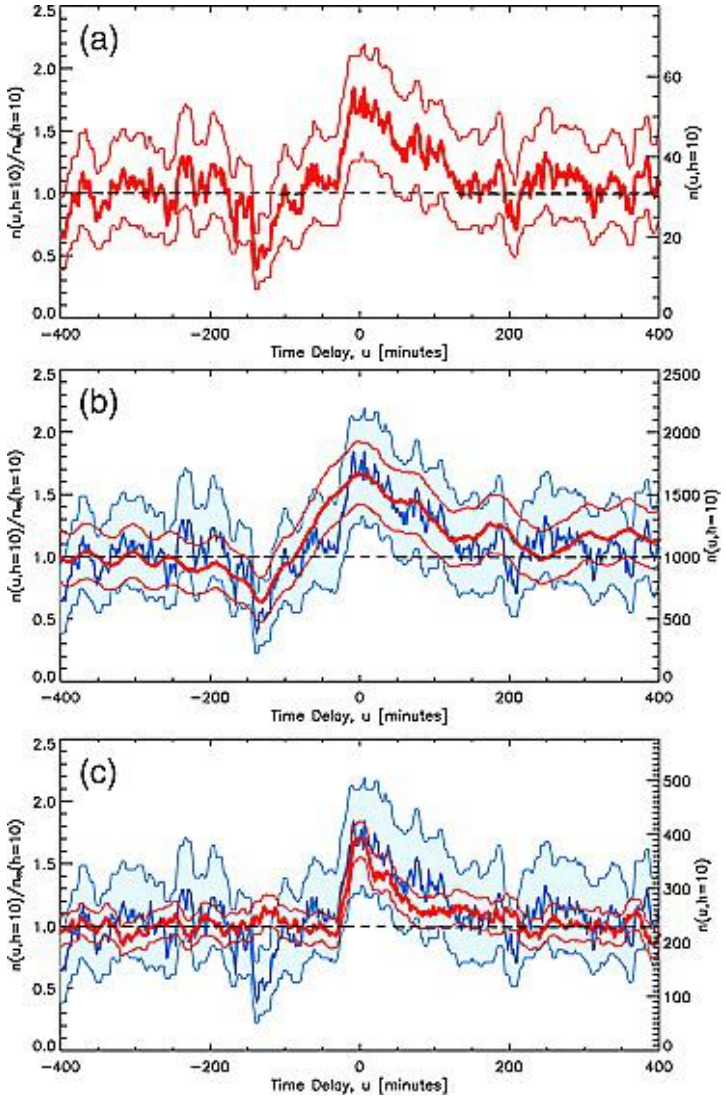


Sergeev et al. (2004)

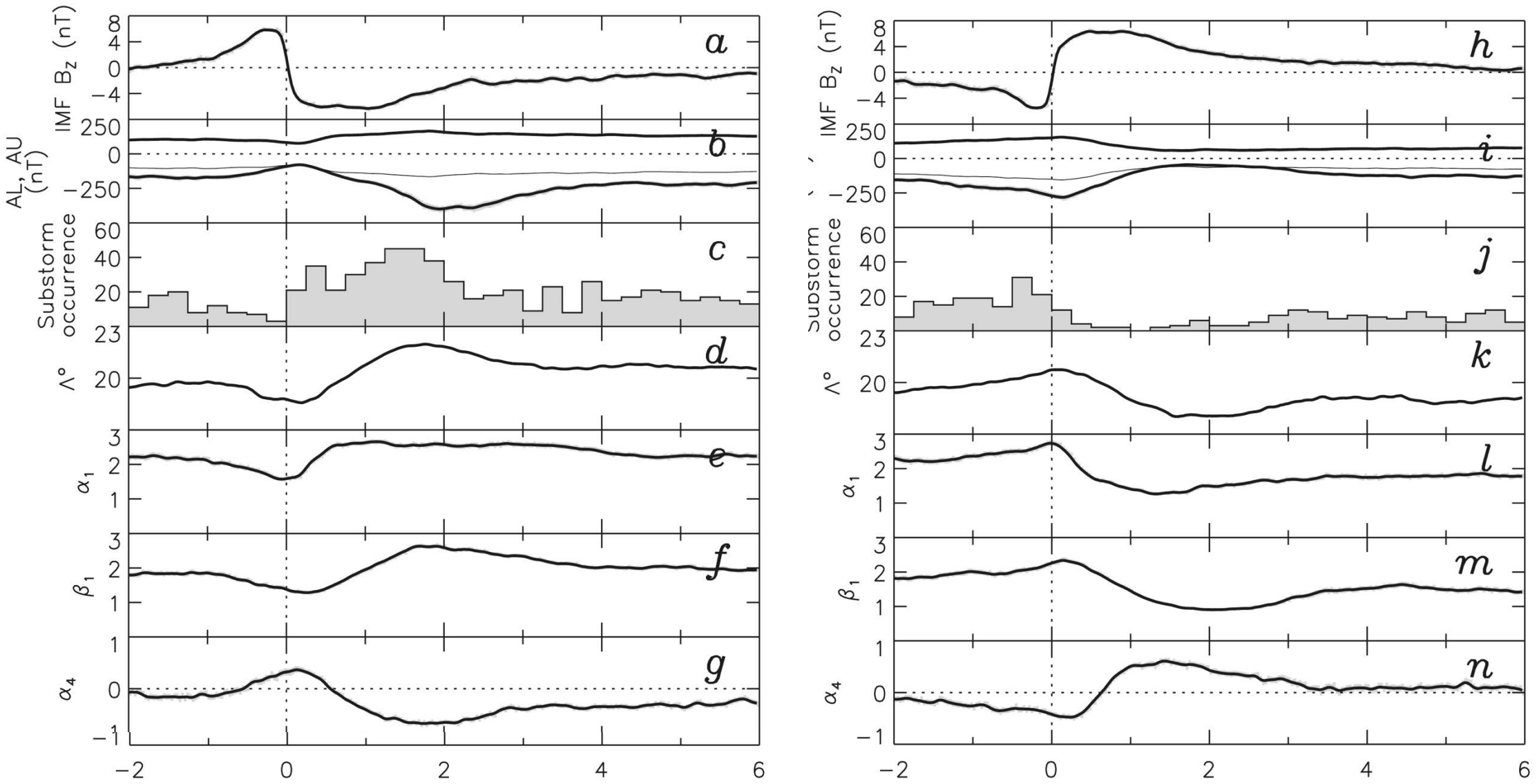
When is coupling not coupling?



Lyons et al. (1999)



Morley & Freeman (2007)



Milan et al. (2018)

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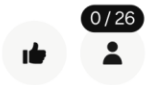
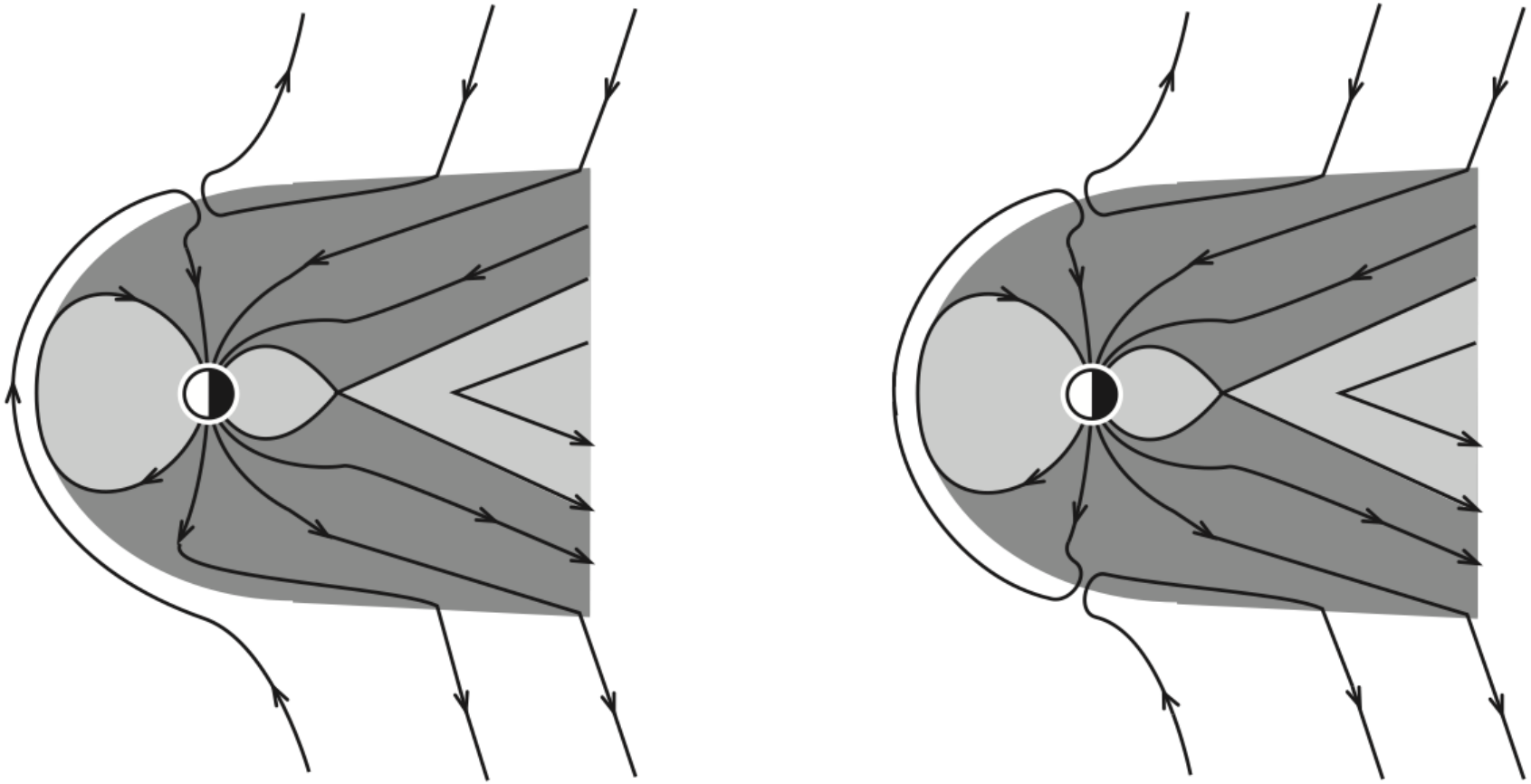
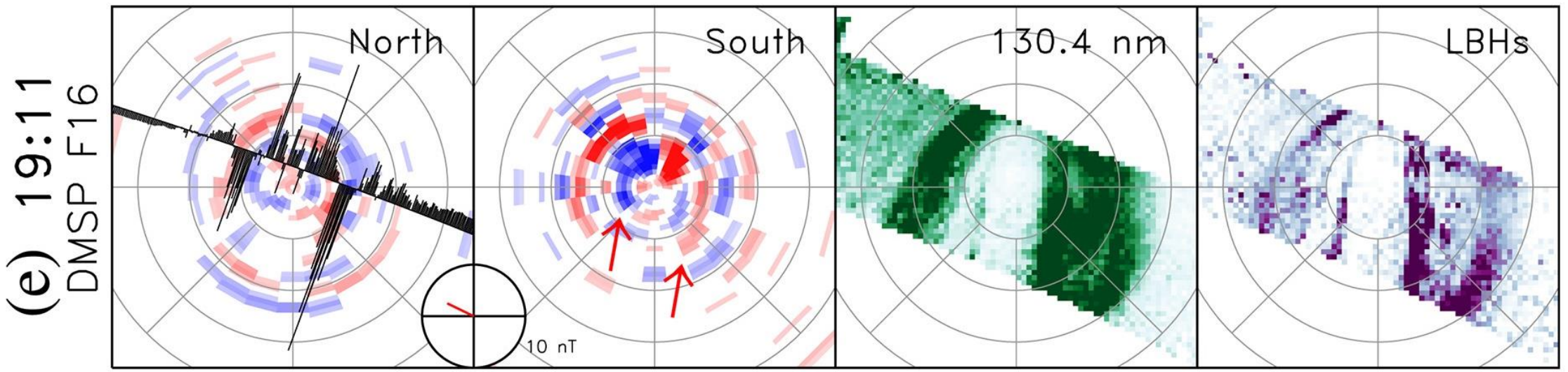


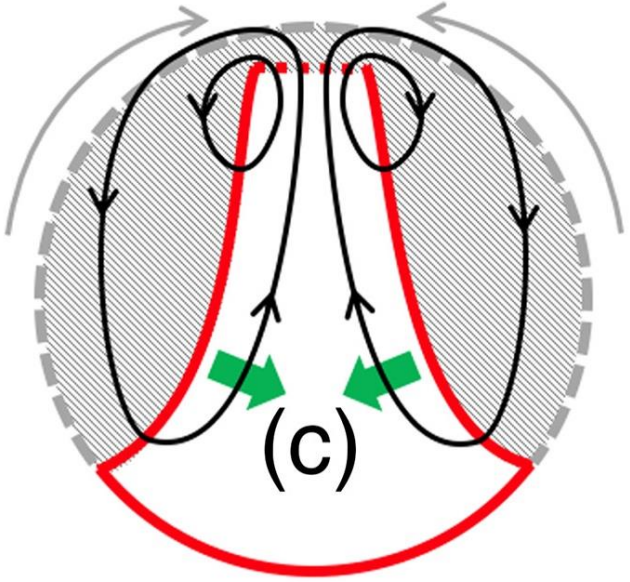
Large-scale magnetic coupling under northward IMF

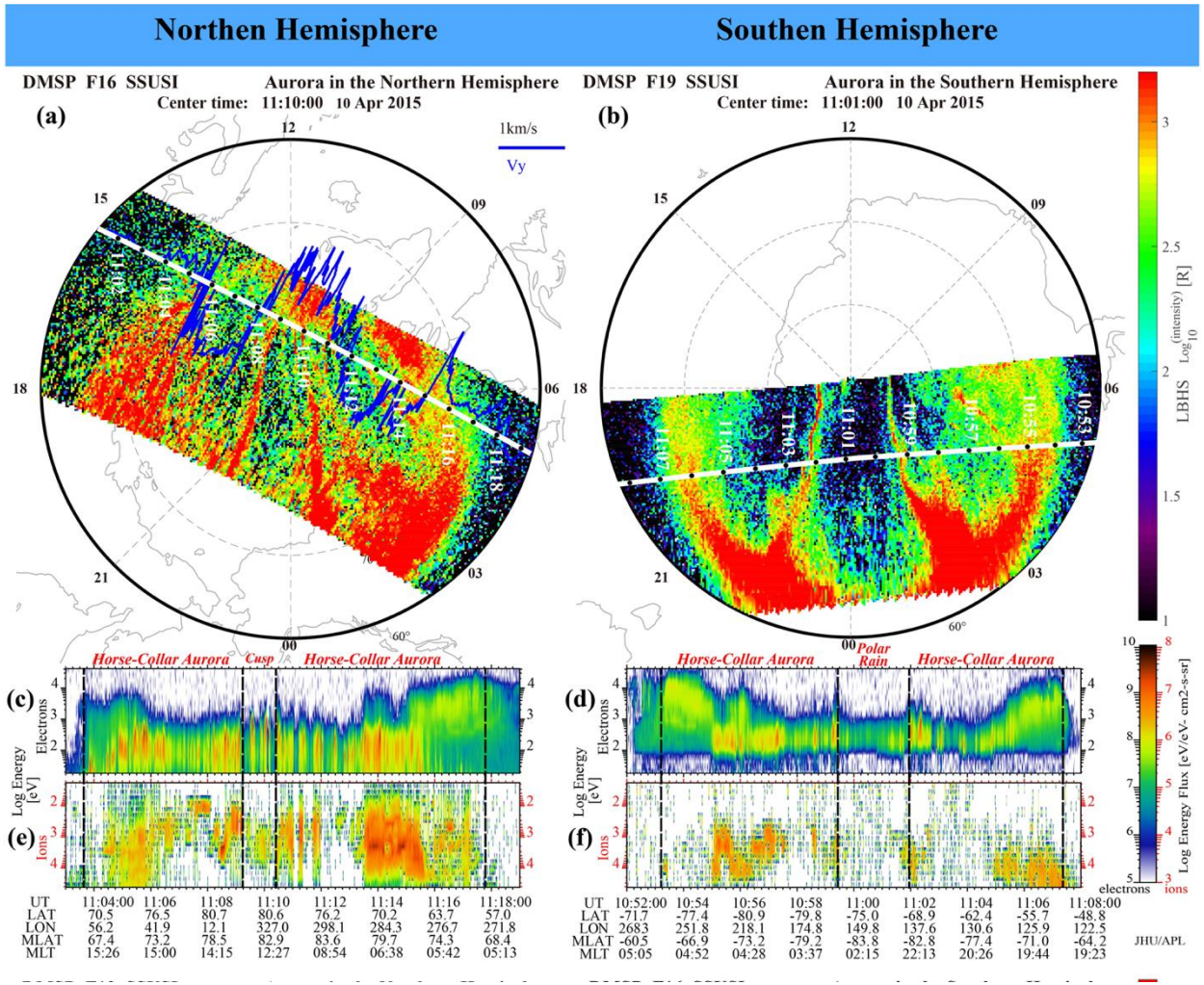


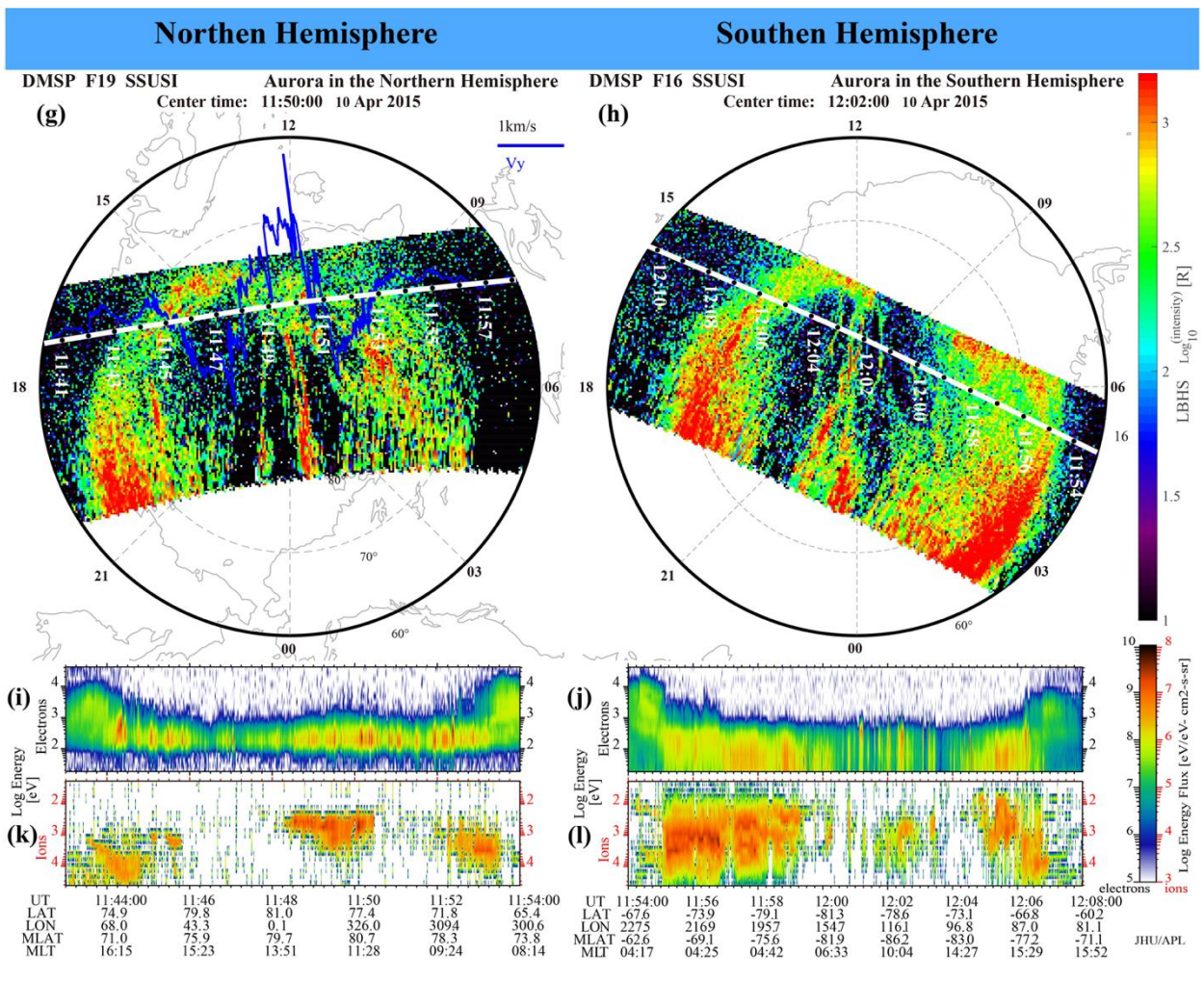
Imber et al. (2007)



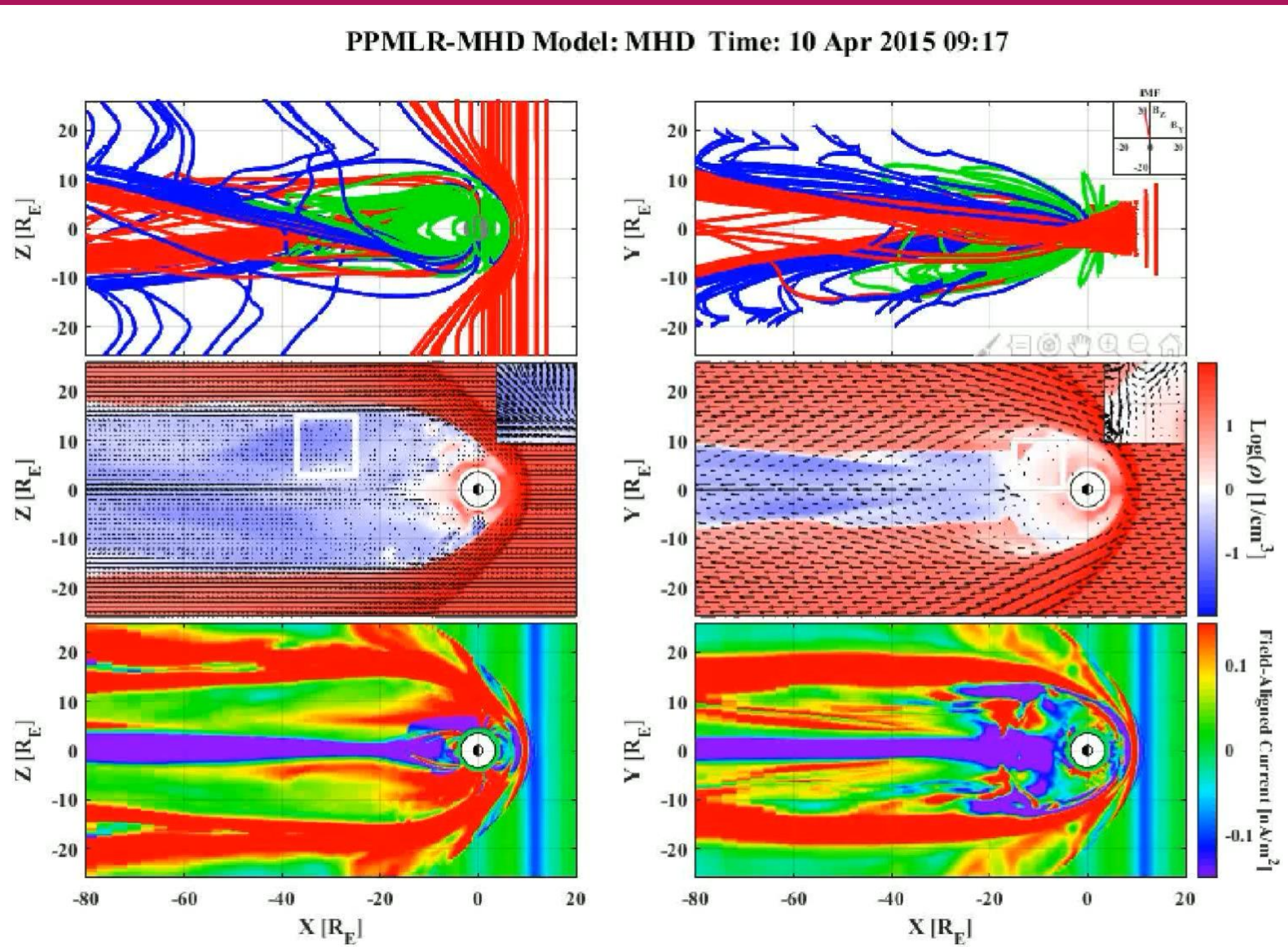
Milan et al. (2020)



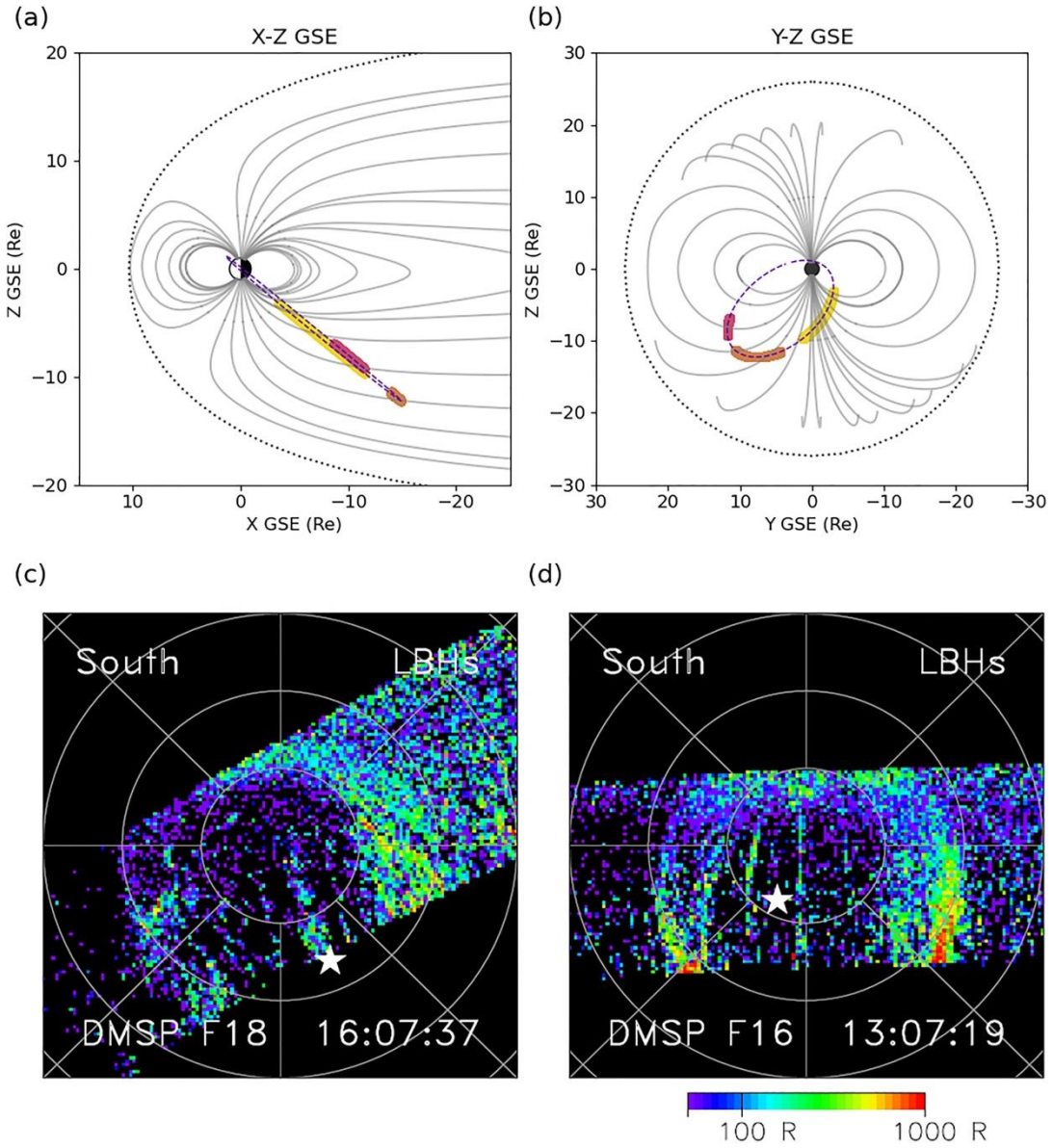


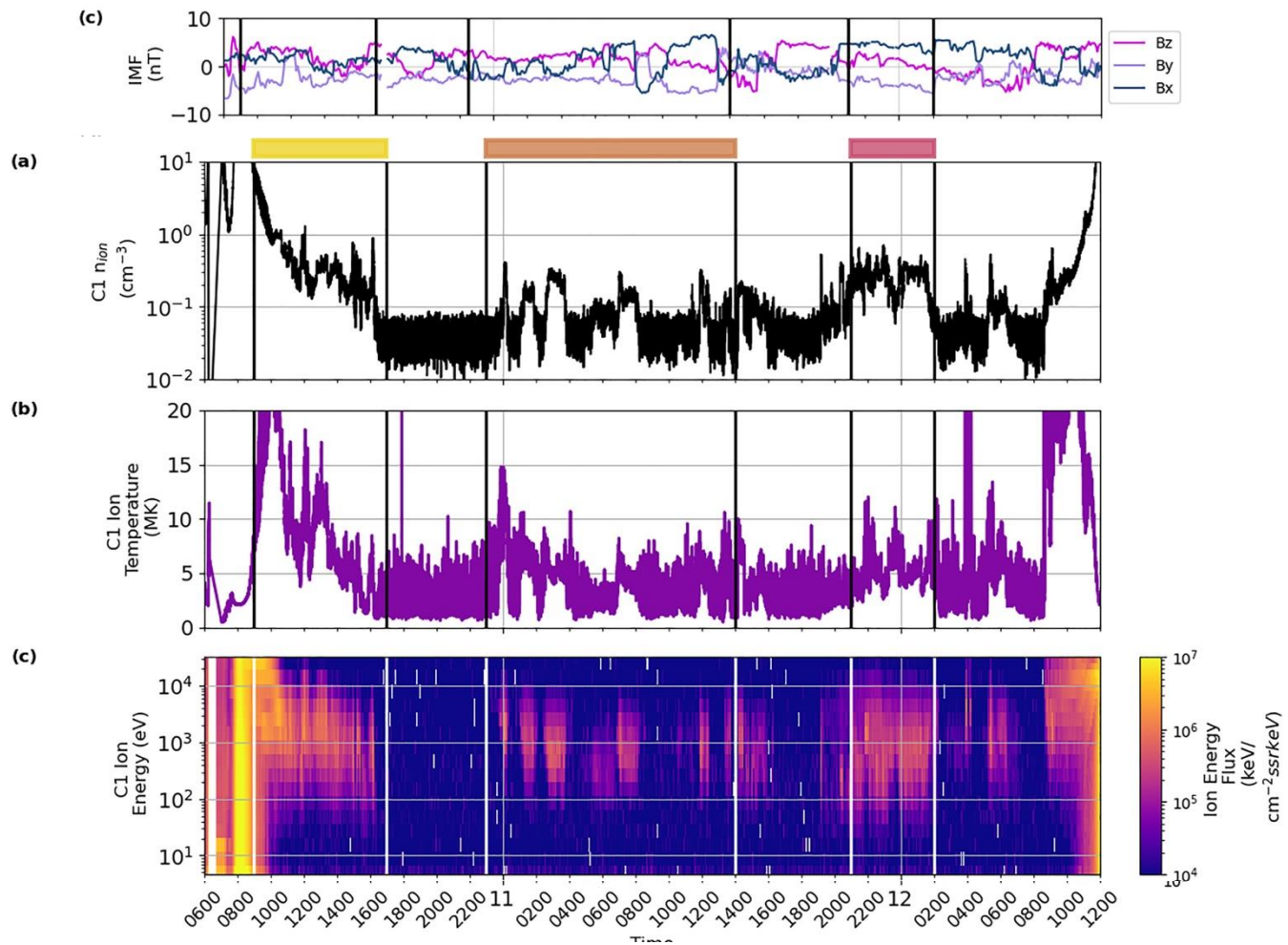


Wang et al. (2023)



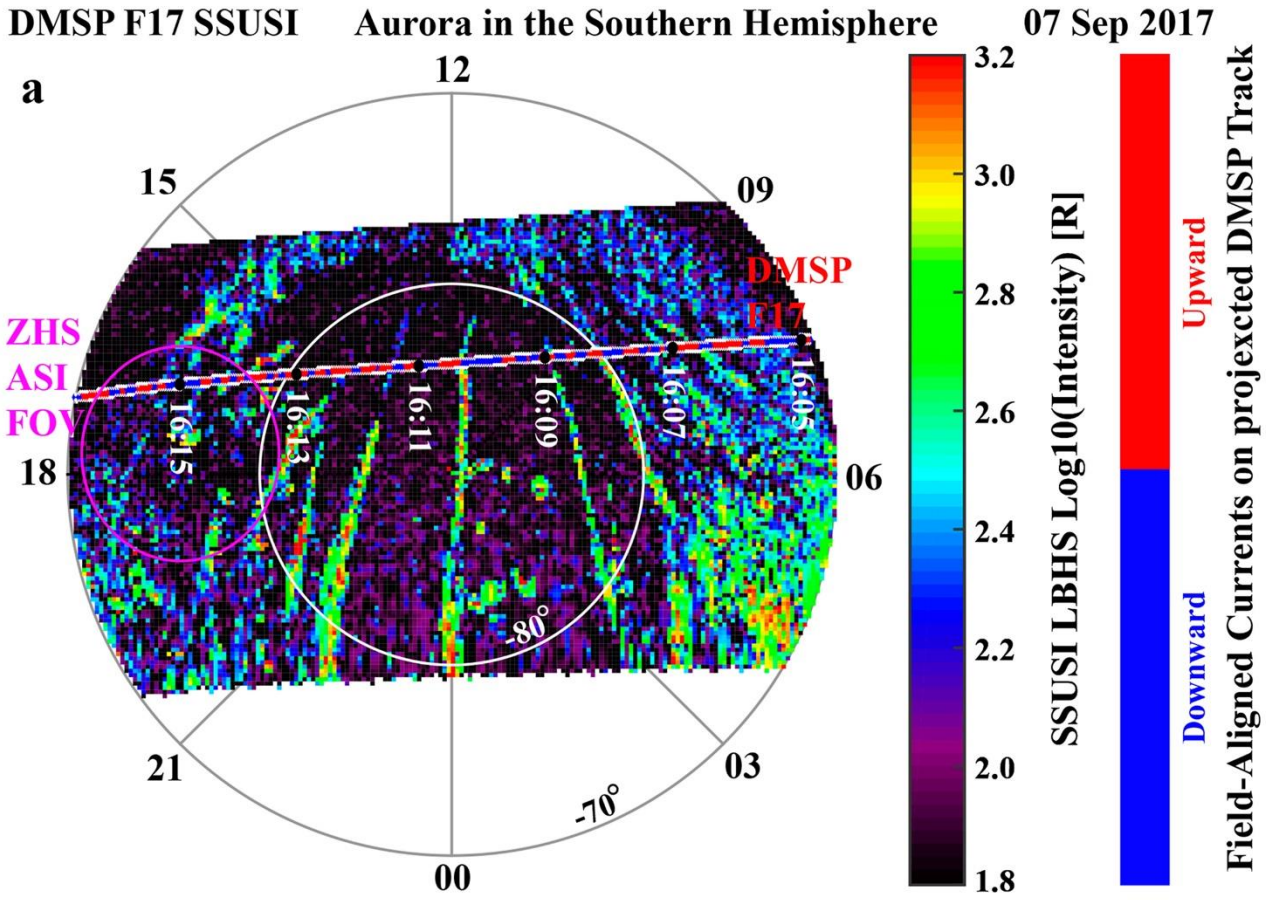
Wang et al. (2023)

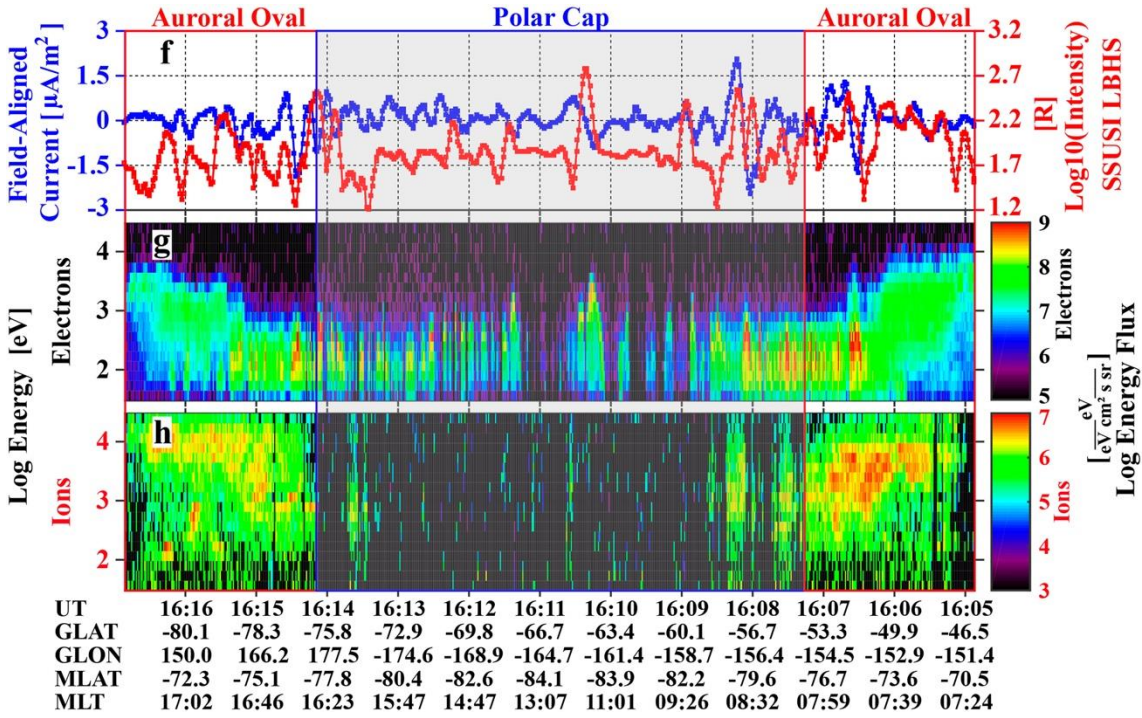




Mooney et al. (2025)

Scale size of northward IMF aurora





DMSP orbital speed = 2 km s^{-1}
Brightness enhancements for ~10 – 20 s
∴ Arc width ~ 20 - 40 km

Zhang et al. (2020)

SMILE for the magnetosphere

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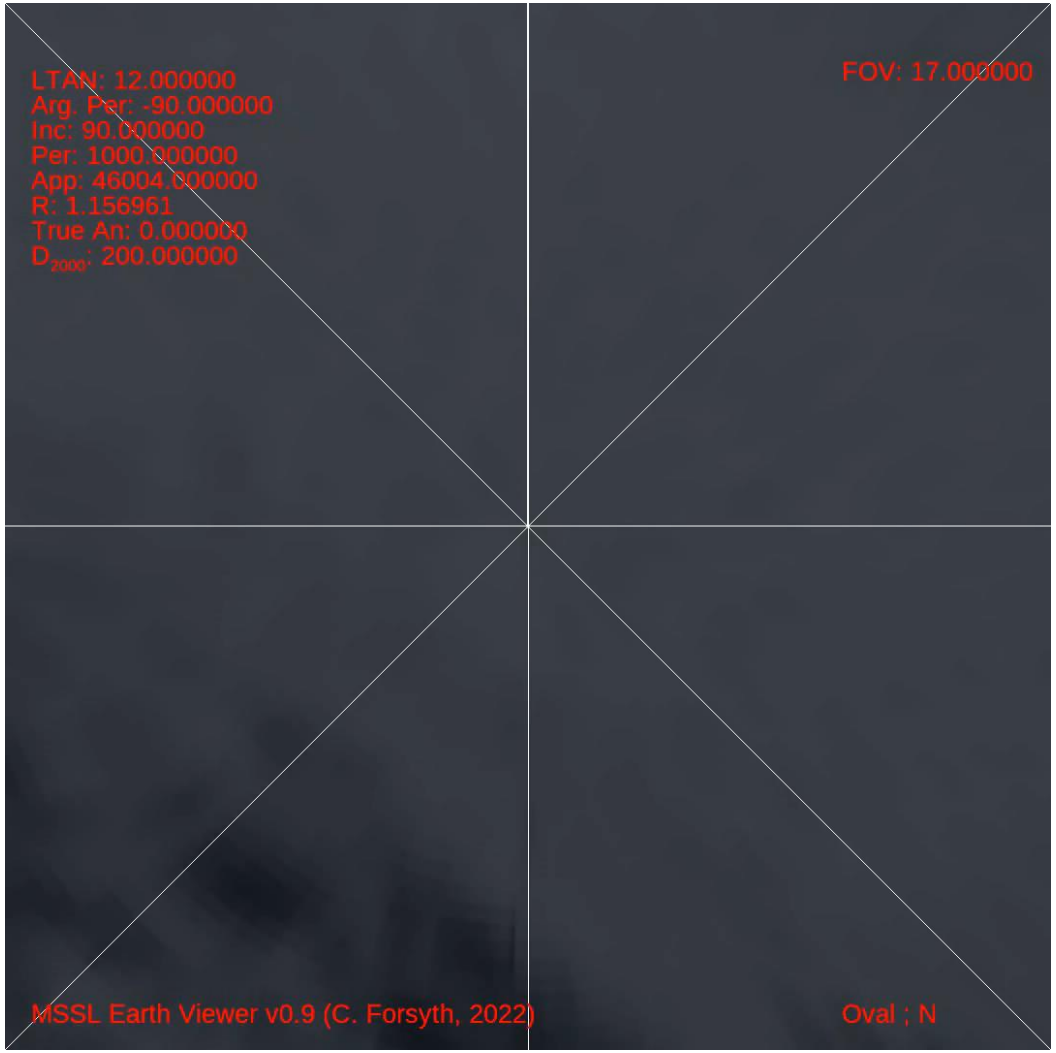
An unprecented global auroral view

NASA IMAGE



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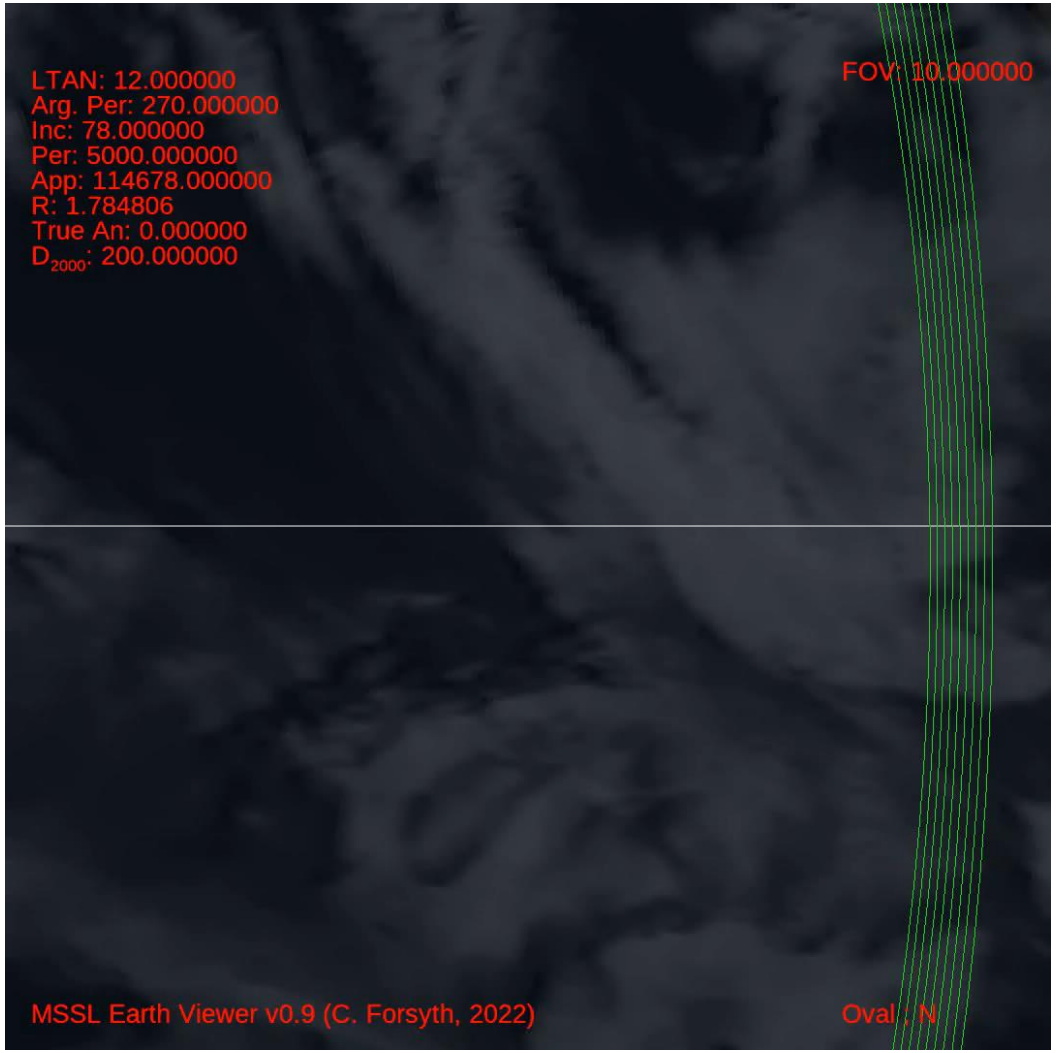
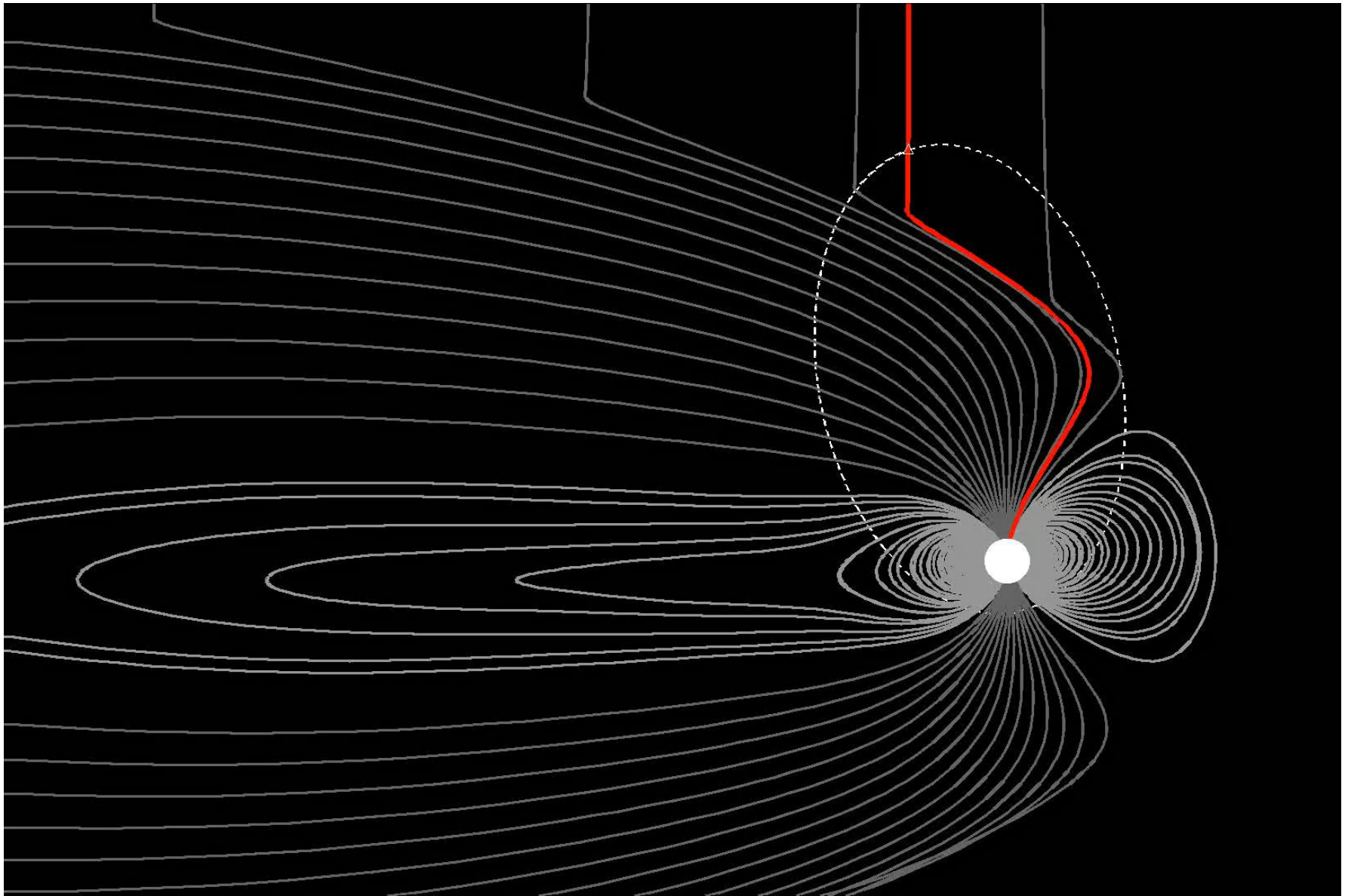


Long in the lobes, quick in the sheet



Large scale driving leads to cross-scale coupling

- Unbalanced dayside and nightside reconnection leads to builds up of open flux
- Kinetic-scale instabilities arise and lead to global disruption of the magnetotail and plasma energisation
- Nightside reconnection can lead to fluid-scale flows with kinetic-scale proceses at the boundaries
- Northward IMF can lead to removal of flux from the tail and the creation of narrow but long shear flows and field-aligned currents in the magnetosphere

To be continued… by you!