



# Statistical Flow Study at Lunar Orbit with ARTEMIS (work in progress)

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Angelopoulos, Heli Hietala

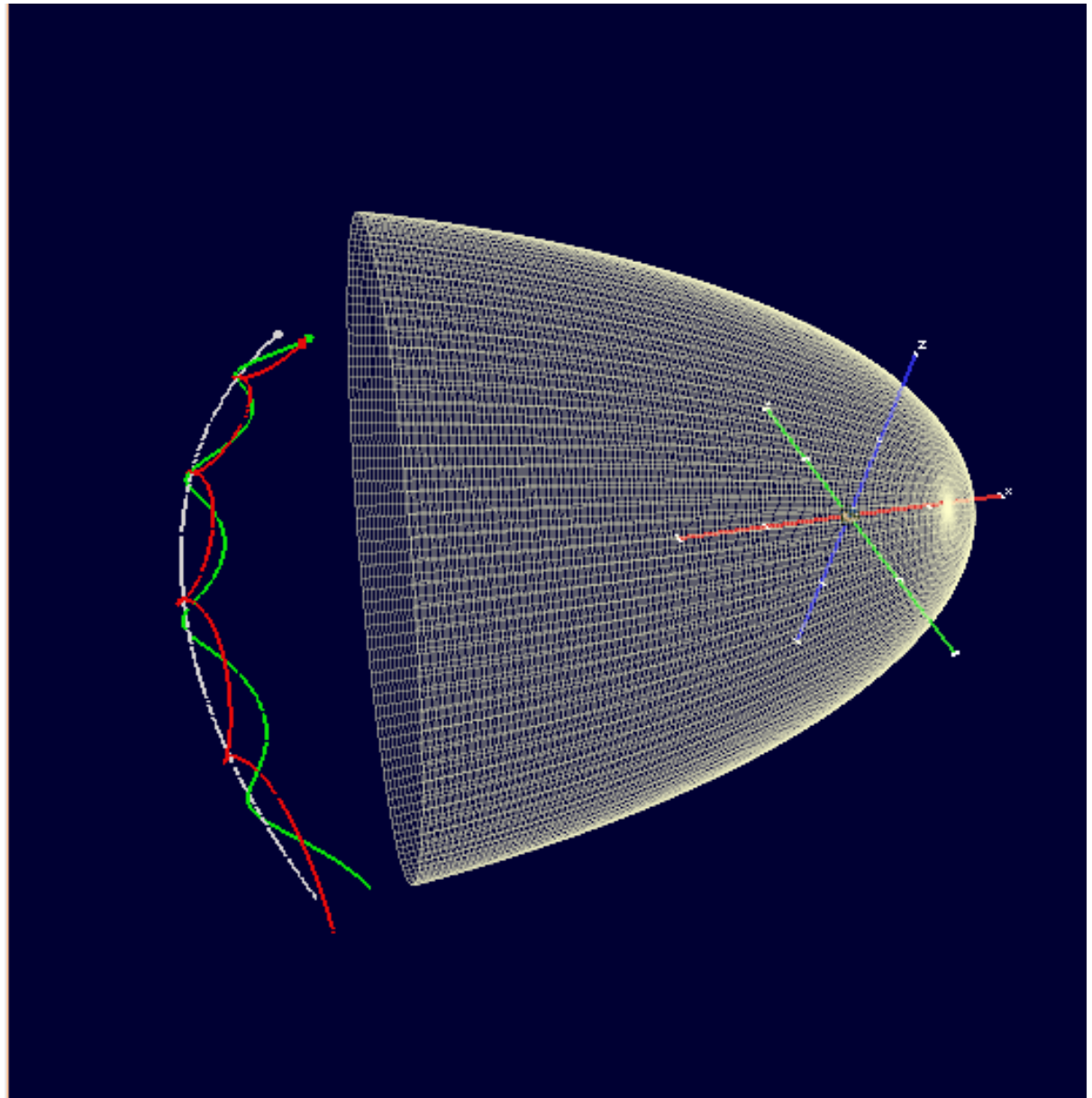


# ARTEMIS magnetotail passes



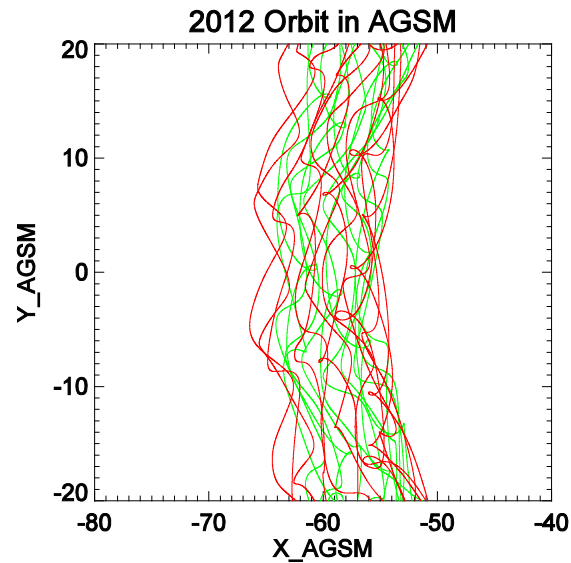
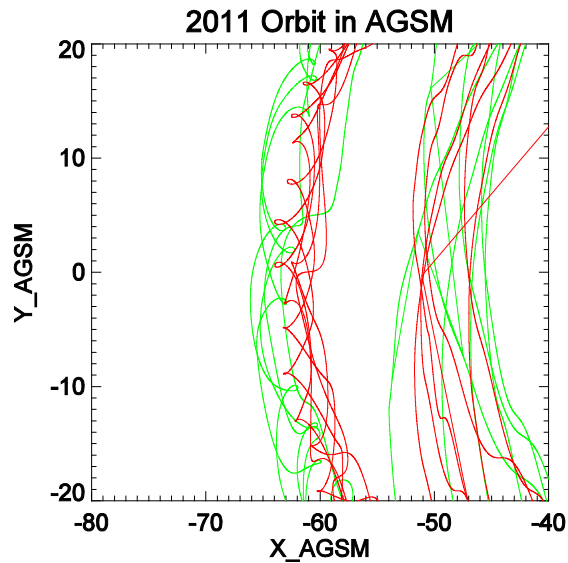
ARTEMIS probes monthly tail crossing for  $\sim 4$  days at lunar orbit

- So-far rarely visited region of tail is now regularly explored 4d/m
- first dual-s/c observations  $\sim 60$  RE downtail

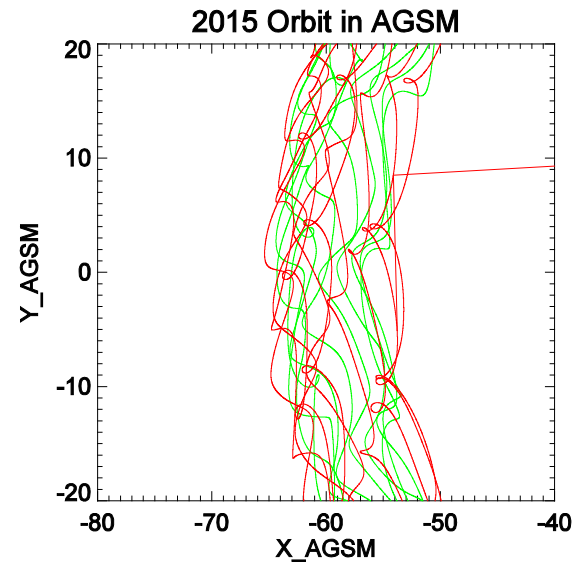
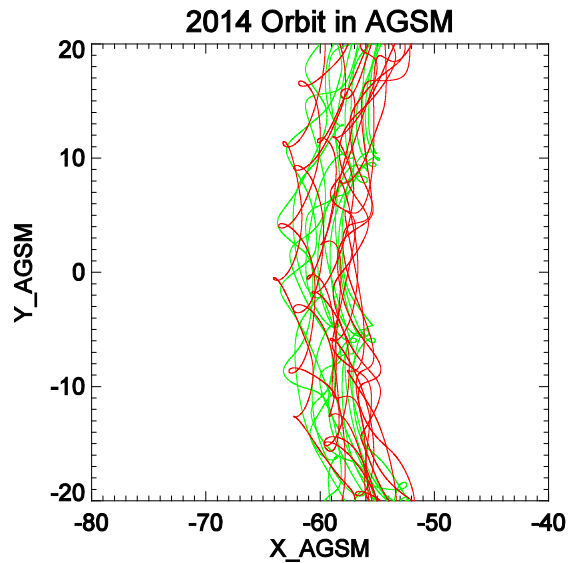
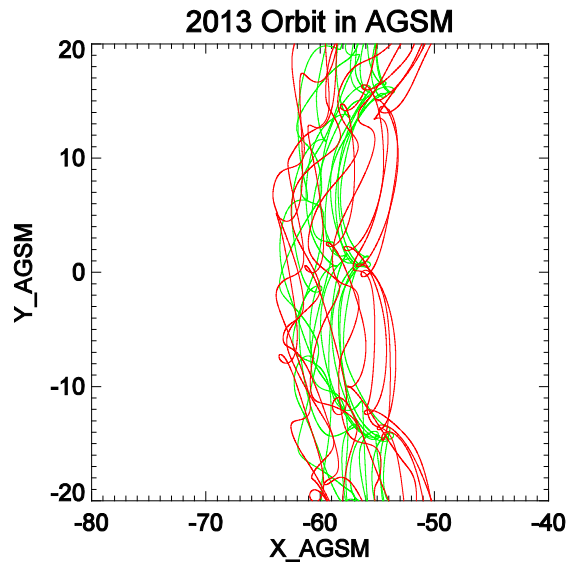




# ARTEMIS orbits 2011–2015

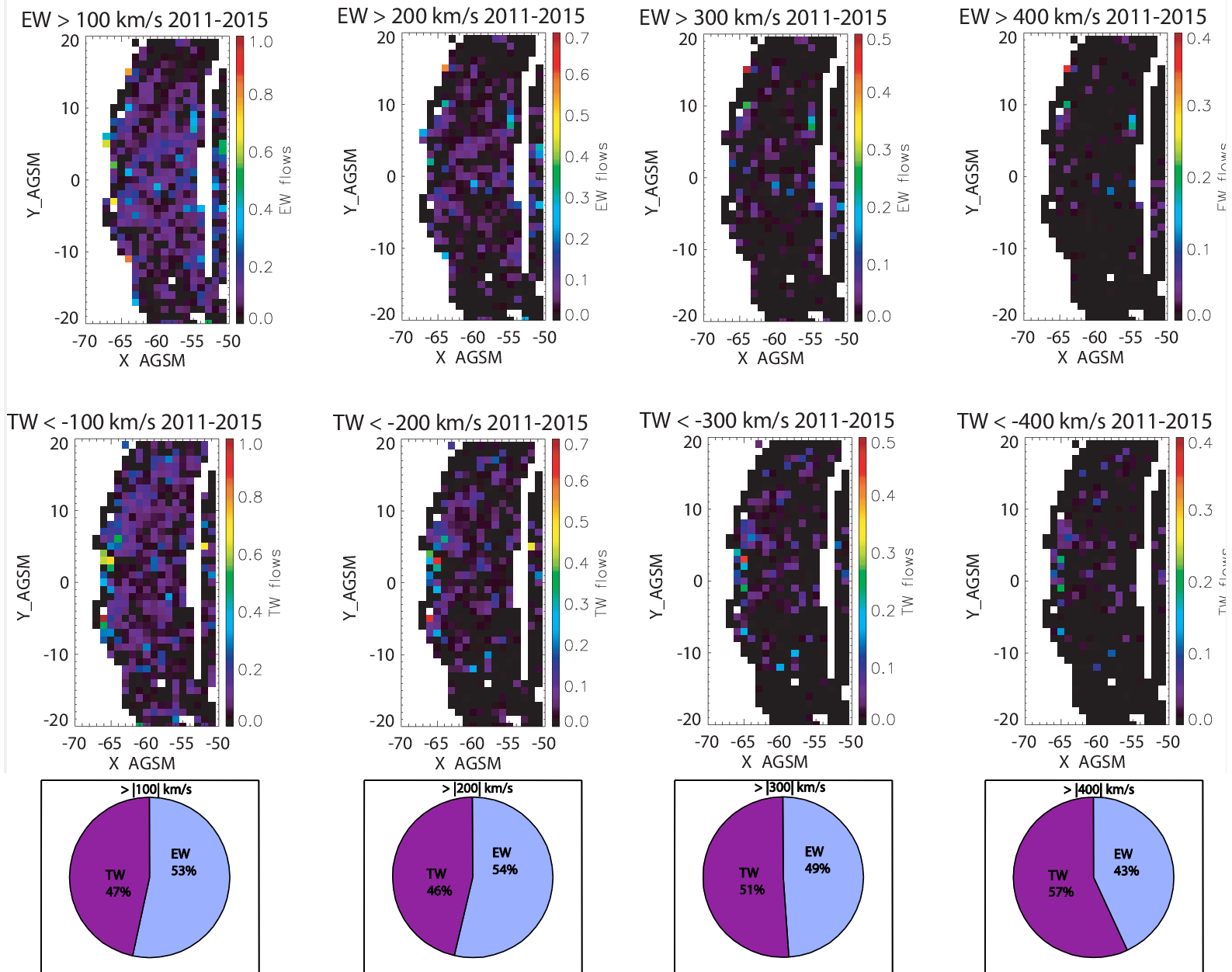


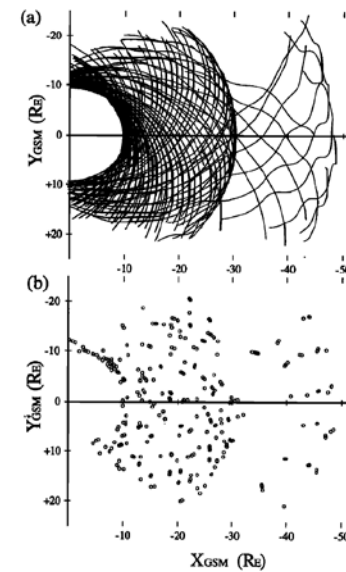
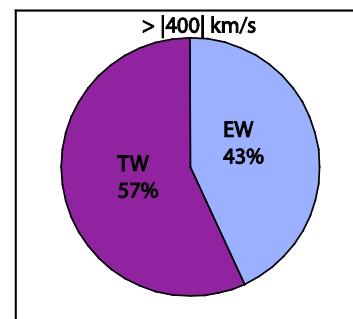
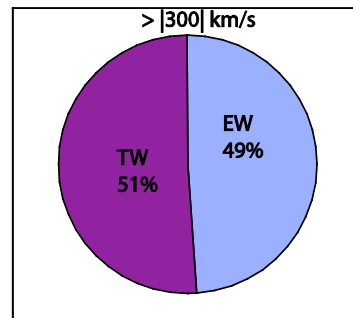
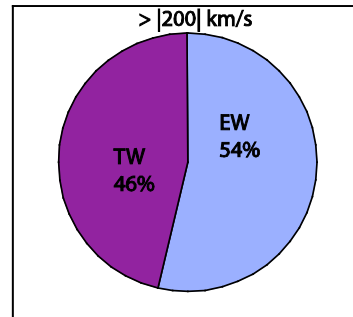
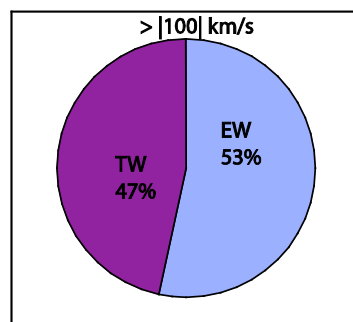
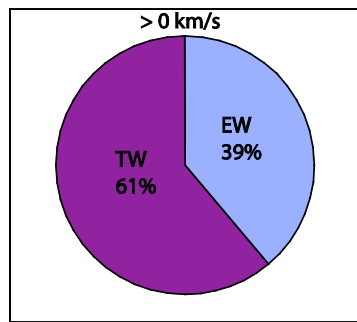
THB (P1)  
THC (P2)



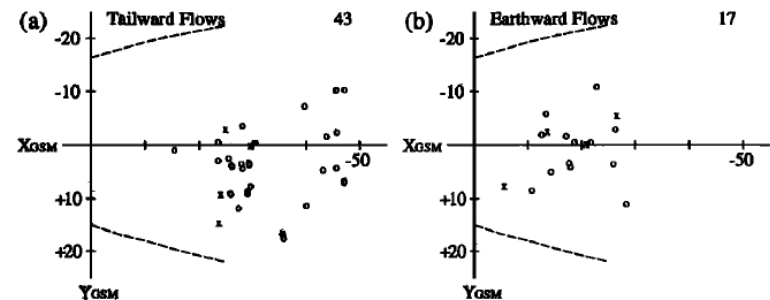
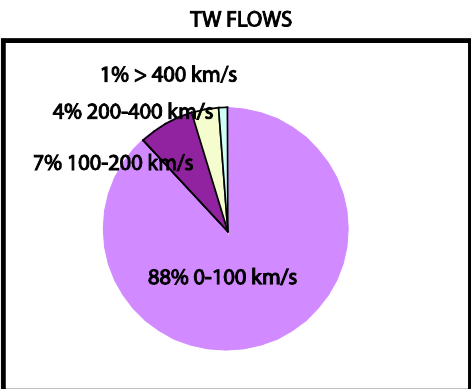
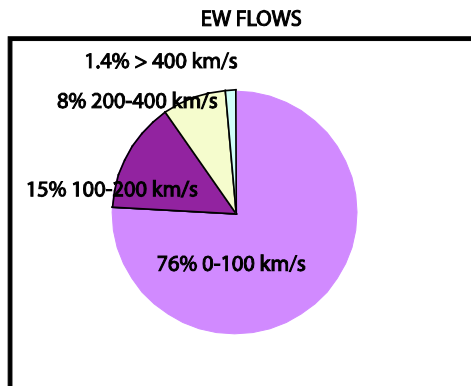


# Occurrence rate

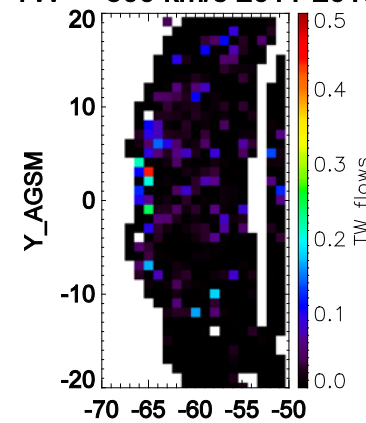
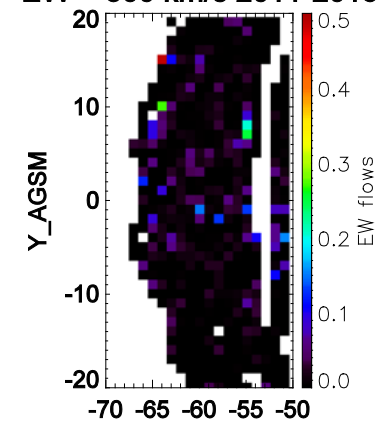




Nagai et al., 1998



**EW > 300 km/s 2011-2015**    **TW < -300 km/s 2011-2015**



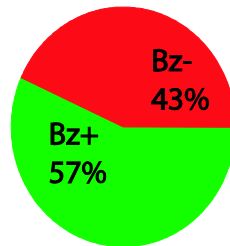
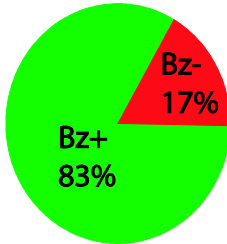


# Flows and Bz

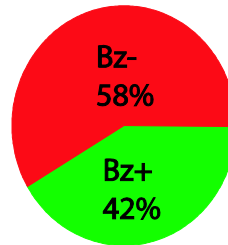
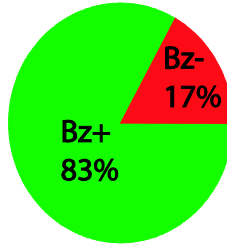
EW

TW

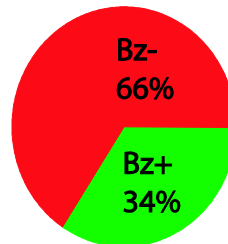
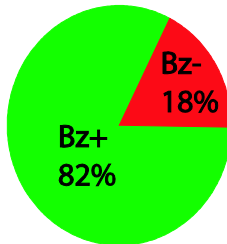
> |100| km/s



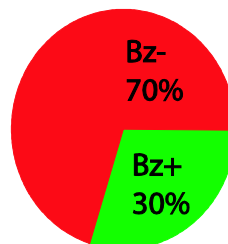
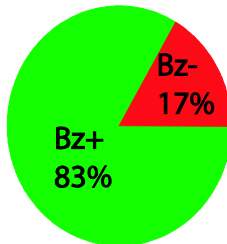
> |200| km/s



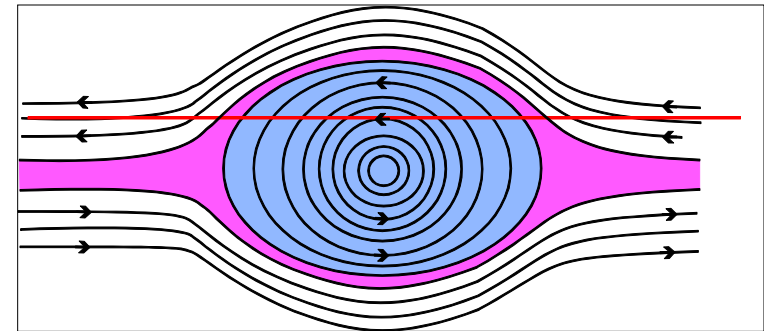
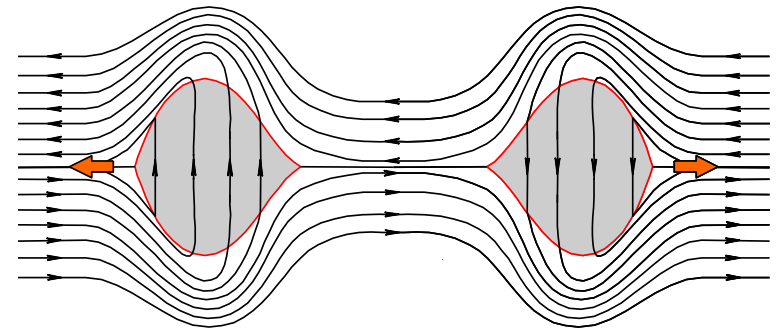
> |300| km/s



> |400| km/s



← Earth

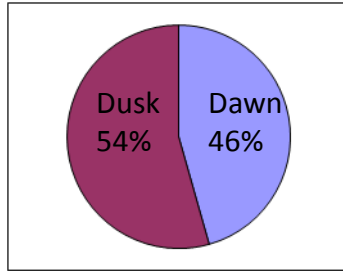
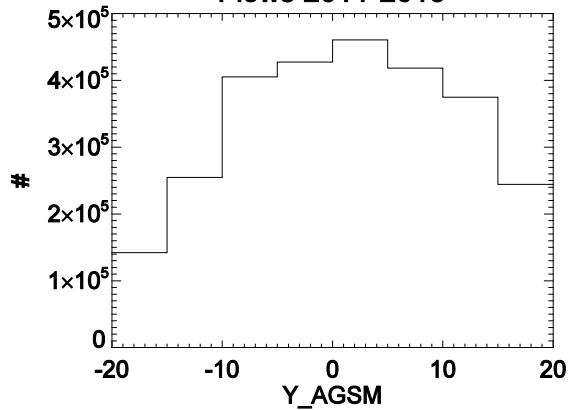




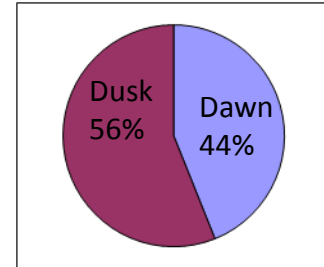
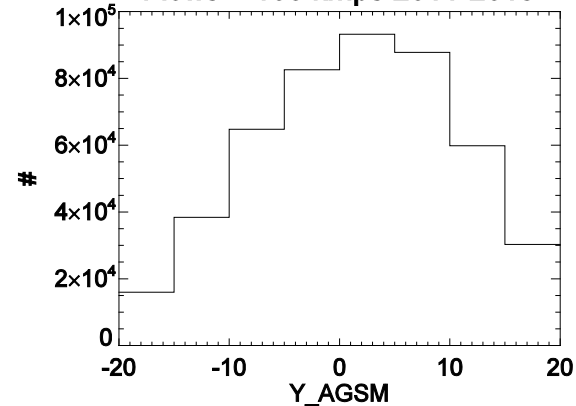
# Dawn-Dusk Asymmetry



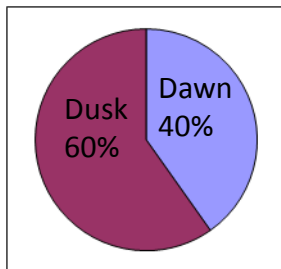
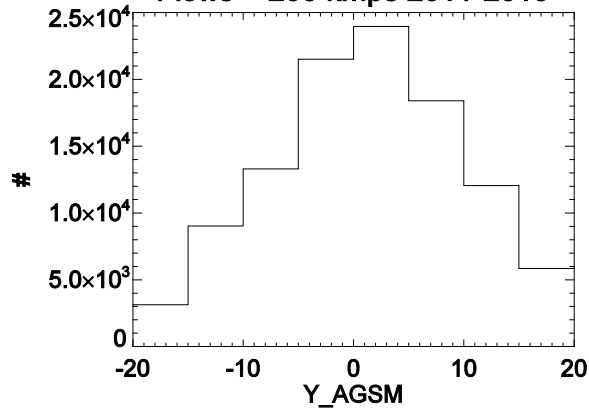
Flows 2011-2015



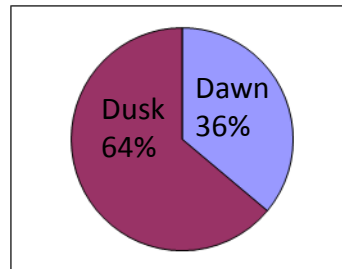
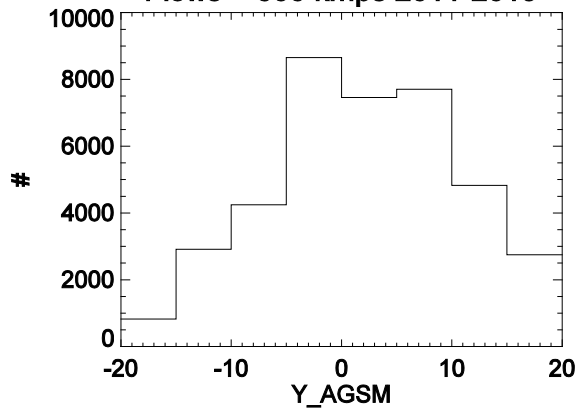
Flows > 100 km/s 2011-2015



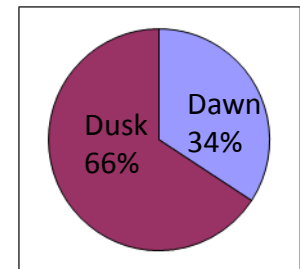
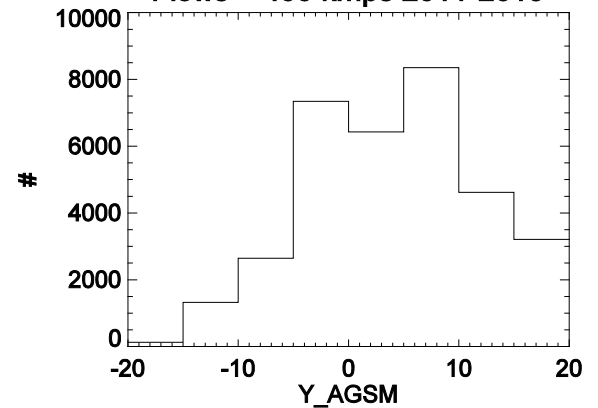
Flows > 200 km/s 2011-2015



Flows > 300 km/s 2011-2015

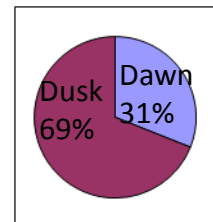
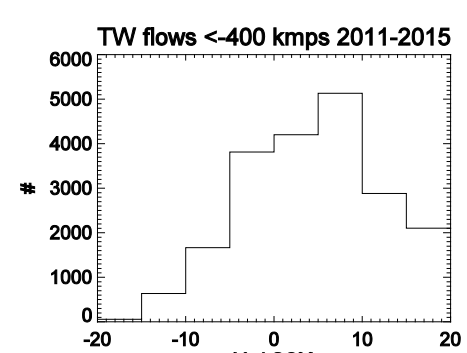
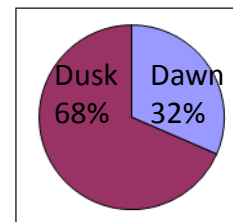
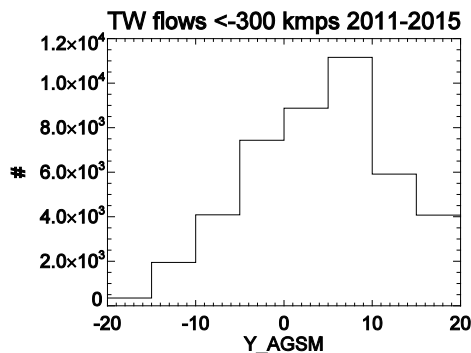
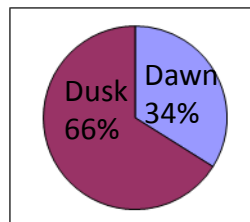
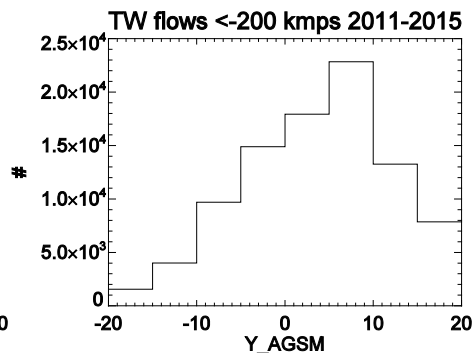
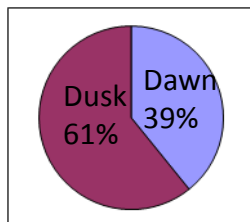
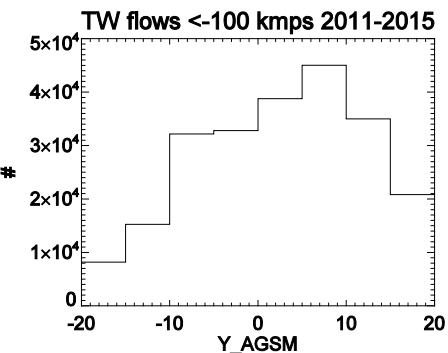
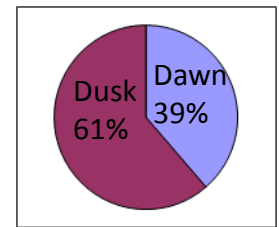
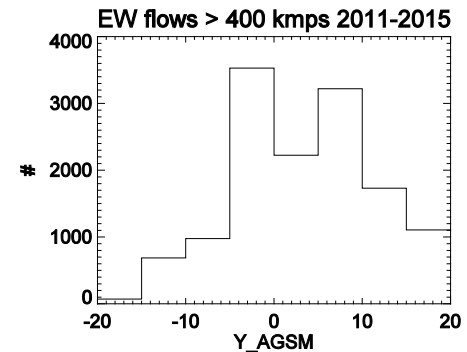
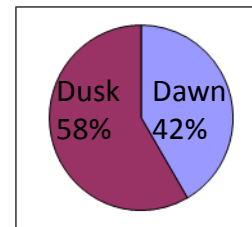
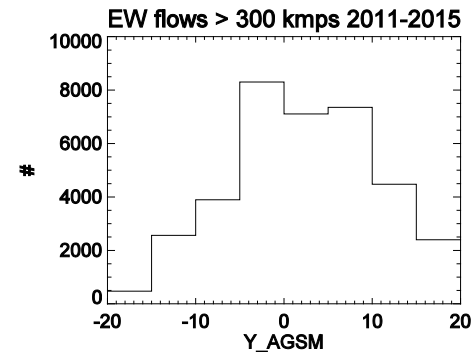
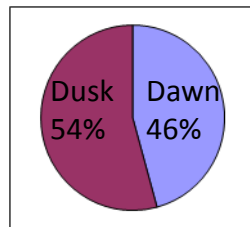
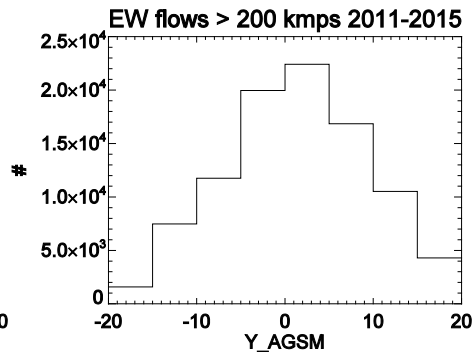
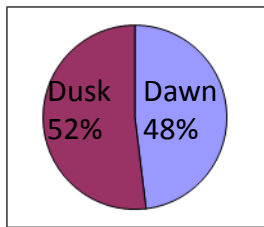
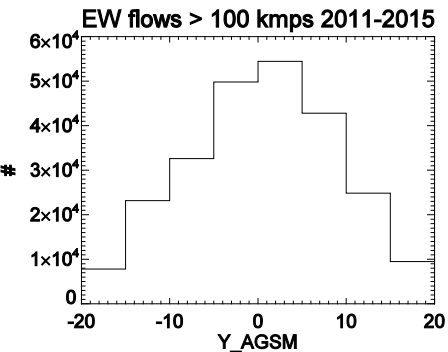


Flows > 400 km/s 2011-2015





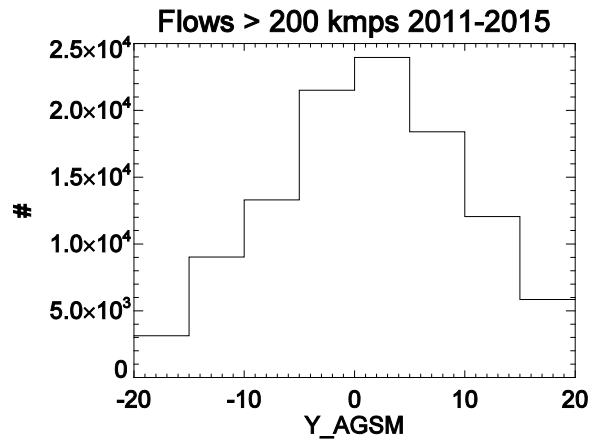
# Dawn-Dusk Asymmetry EW vs. TW



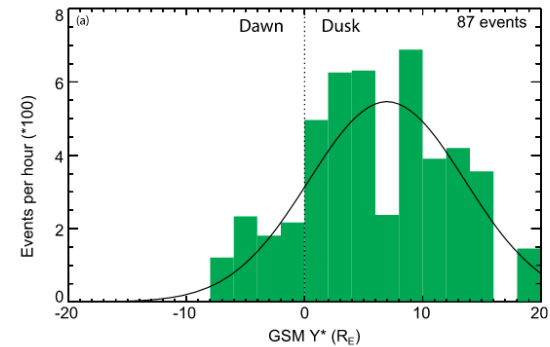




# Dawn-Dusk Asymmetry

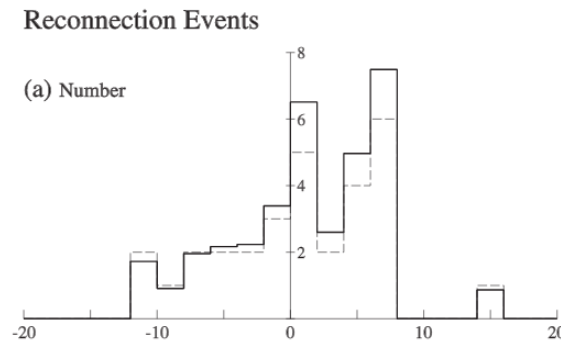


TCRs (THEMIS):



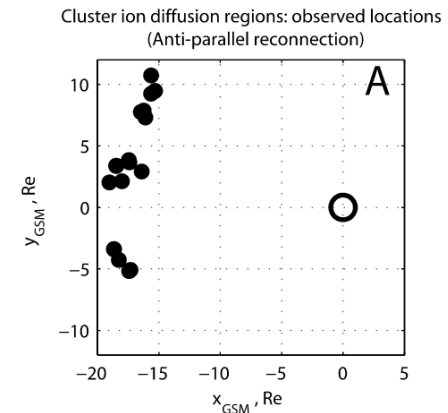
Imber et al., 2011

Occurrence of reconnection (Geotail):



Nagai et al., 2010

Ion diffusion region (Cluster):

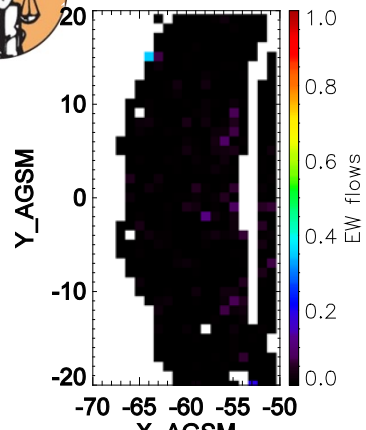


Eastwood et al., 2010

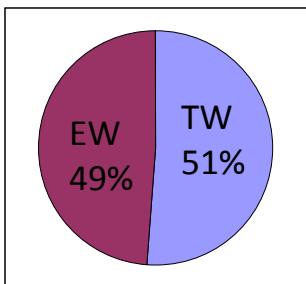
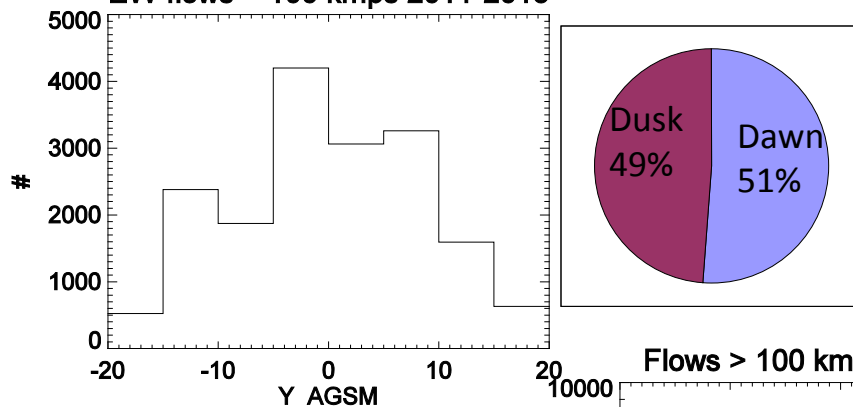


# convective flows ( $v_{\text{perp}}$ )

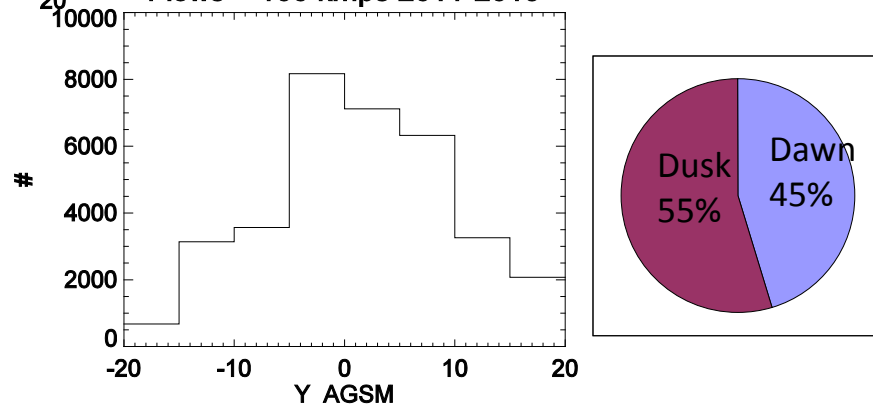
EW > 100 km/s 2011-2015



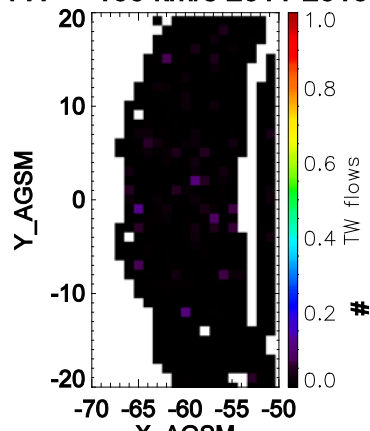
EW flows > 100 km/s 2011-2015



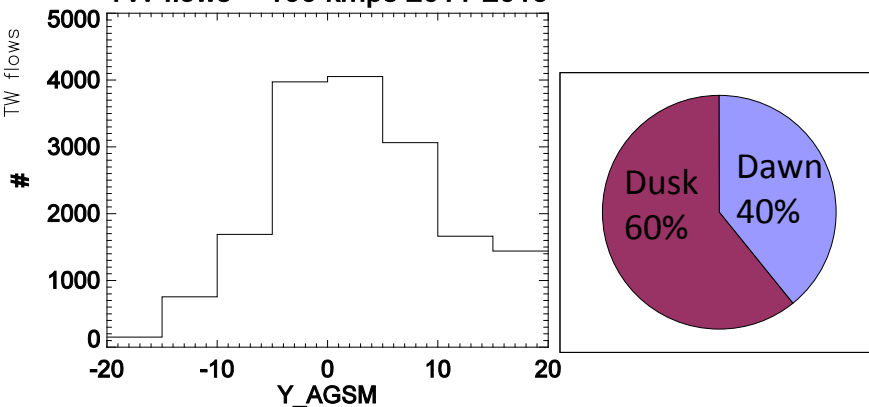
Flows > 100 km/s 2011-2015



TW < -100 km/s 2011-2015



TW flows < -100 km/s 2011-2015





# WORK TO DO

- include P2
- flow characteristics: duration, frequency,...
- FS => include higher energies = faster flows
- plasma parameters: density, temperature, pressure: differences EW/TW?
- relation to substorms (AE)
- flux rope association with EW/TW flows
- associated ionospheric signatures
- global flux/energy budget



# SUMMARY

- ARTEMIS flow statistics ~ - 60 RE
- 5 year data 2011-2015
- Flows  $> 200$  km/s : EW:TW = 54:46
- gradual increase of TW portion of flows with increasing speed
  - $v_x < -200$  km/s : 46%
  - $v_x < -300$  km/s : 51%
  - $v_x < -400$  km/s : 57%
- EW flows associated with positive  $B_z$  ( $\sim 80\%$ )
- TW flows with negative  $B_z$  ( $\sim 58\%$  ( $< -200$  km/s) -  $70\%$  ( $< -400$  km/s) )
- Dawn-dusk asymmetry in flows
- Dawn-dusk asymmetry stronger for TW flows
- gradual increase of dawn-dusk asymmetry with increasing speed

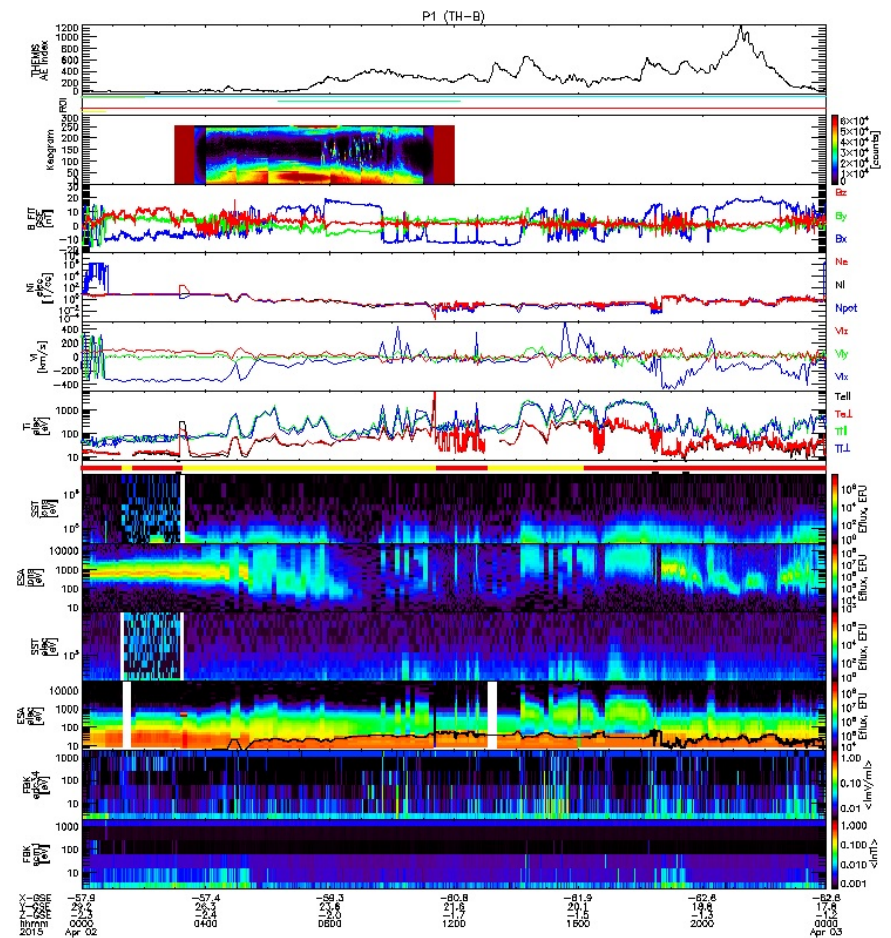
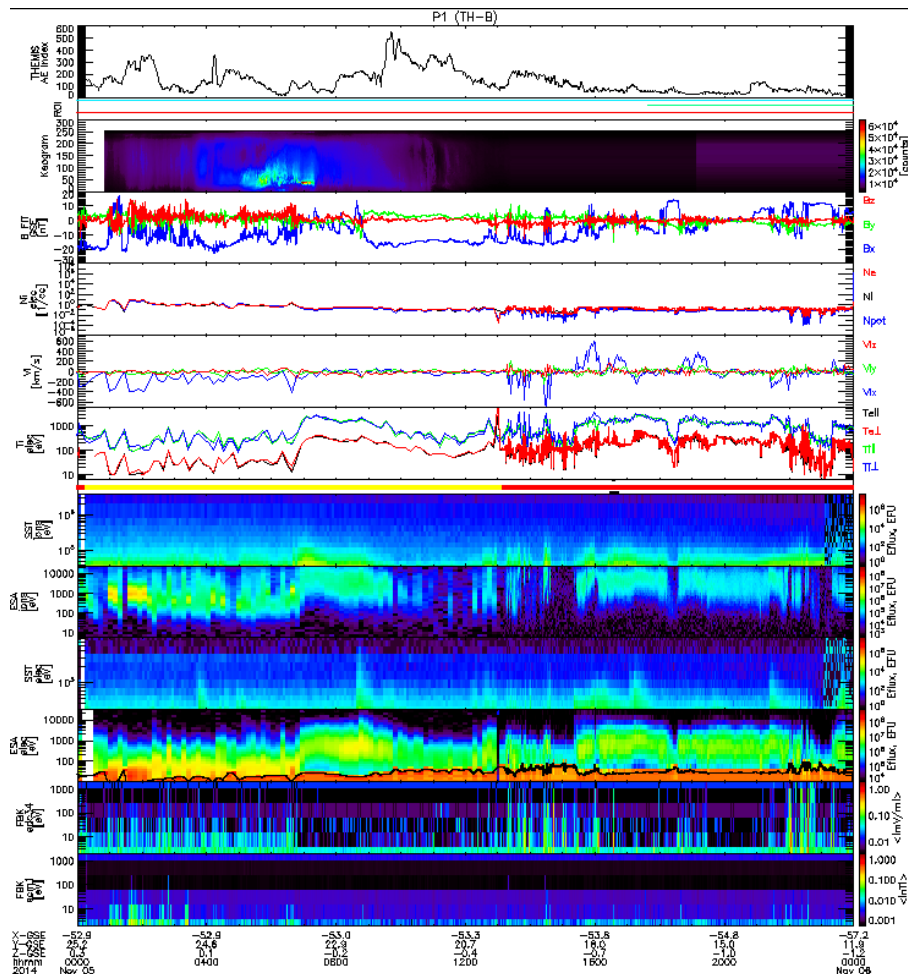
$ v_x  > 200$ km/s : 54:46 (EW)	66:34 (TW)
$ v_x  > 300$ km/s : 58:42 (EW)	68:32 (TW)
$ v_x  > 400$ km/s : 61:39 (EW)	69:31 (TW)



# DATA



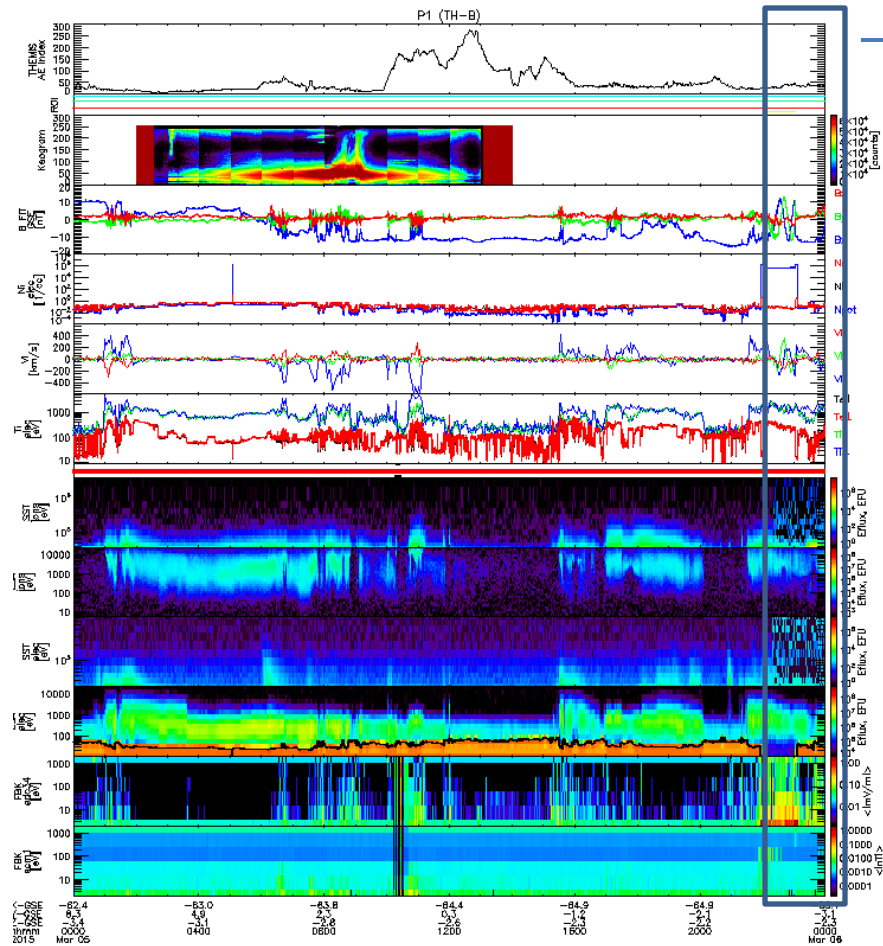
- 2011-2015 THB (P1) [and THC (P2)] magnetotail intervals
- magnetotail crossings selected by eye (exclusion of LLBL)



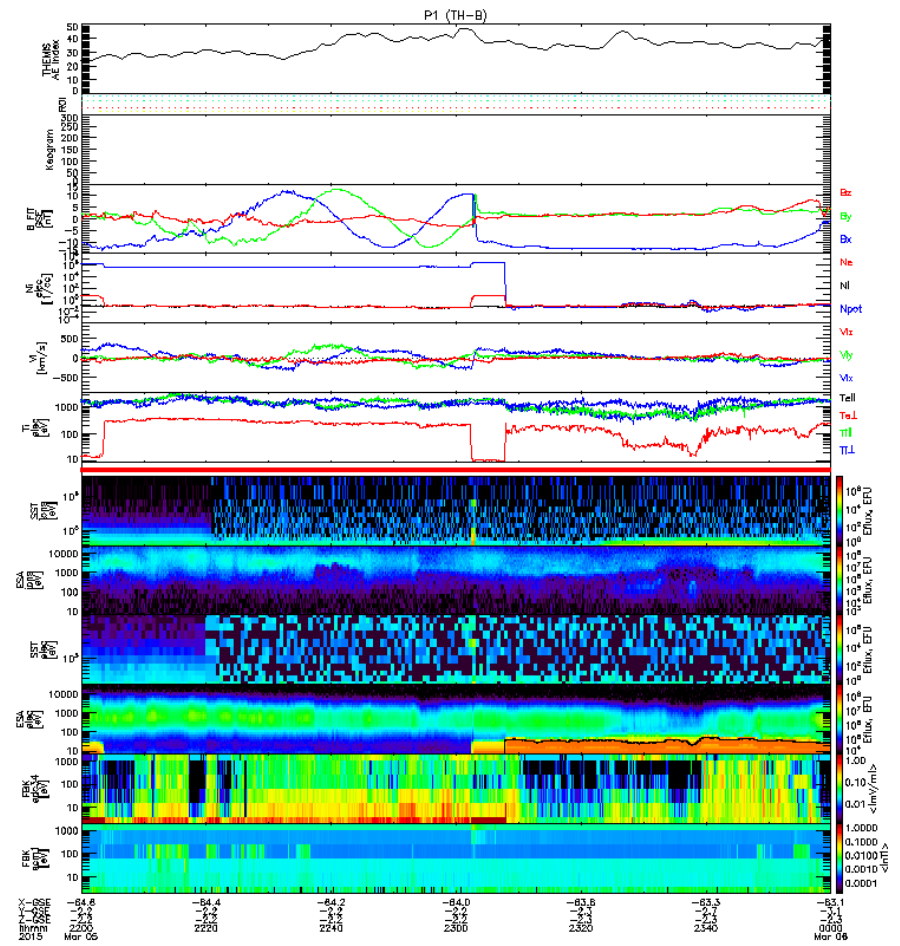


# DATA

- exclusion of lunar shadow



00:00-24:00



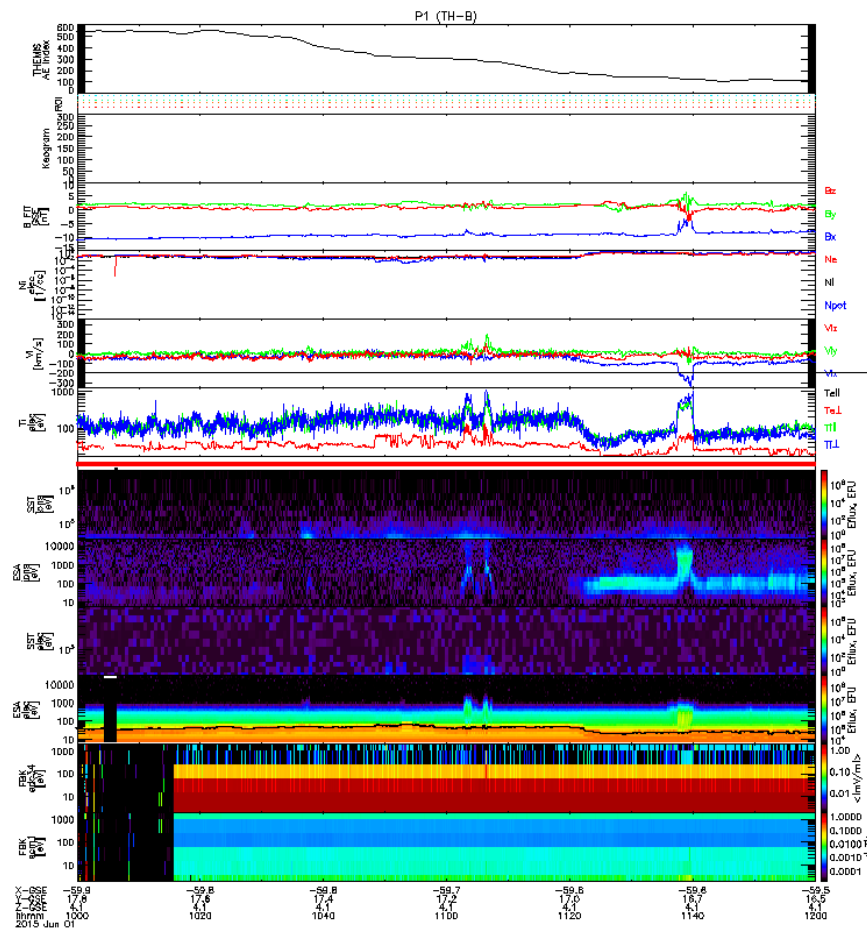
22:00-24:00





# DATA

- not excluded (yet): mantle flow



10:00-12:00