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

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ARTEMIS probes monthly tail crossing for ~ 4 days at lunar orbit

- So-far rarely visited region of tail is now regularly explored 4d/m
- First dual-s/c observations ~ 60 RE downtail
Occurrence rate
Nagai et al., 1998

EW FLOWS

1.4% > 400 km/s
8% 200-400 km/s
15% 100-200 km/s
76% 0-100 km/s

TW FLOWS

1% > 400 km/s
4% 200-400 km/s
7% 100-200 km/s
88% 0-100 km/s

EW > 300 km/s 2011-2015
TW < -300 km/s 2011-2015
Flows and Bz

EW

TW

> \[100\] km/s

Bz+ 83%

Bz- 17%

> \[200\] km/s

Bz+ 83%

Bz- 17%

> \[300\] km/s

Bz+ 82%

Bz- 18%

> \[400\] km/s

Bz+ 83%

Bz- 17%
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

Dusk 54%  Dawn 46%

Dusk 56%  Dawn 44%

Dusk 60%  Dawn 40%

Dusk 64%  Dawn 36%

Dusk 66%  Dawn 34%
Dawn-Dusk Asymmetry

**Occurrence of reconnection (Geotail):**

Reconnection Events

- (a) Number

**Ion diffusion region (Cluster):**

Cluster ion diffusion regions: observed locations (Anti-parallel reconnection)

**TCRs (THEMIS):**

Imber et al., 2011

Nagai et al., 2010

Eastwood et al., 2010
convective flows ($v_{\perp}$)

convective flows ($v_{\perp}$)
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
  \( v_x < -200 \text{ km/s} : 46\% \)
  \( v_x < -300 \text{ km/s} : 51\% \)
  \( v_x < -400 \text{ km/s} : 57\% \)
- EW flows associated with positive Bz (~ 80%)
- TW flows with negative Bz (~ 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
  \(|v_x| > 200 \text{ km/s} : 54:46 \text{ (EW)} 66:34 \text{ (TW)} \)
  \(|v_x| > 300 \text{ km/s} : 58:42 \text{ (EW)} 68:32 \text{ (TW)} \)
  \(|v_x| > 400 \text{ km/s} : 61:39 \text{ (EW)} 69:31 \text{ (TW)} \)
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