LIÈGE université

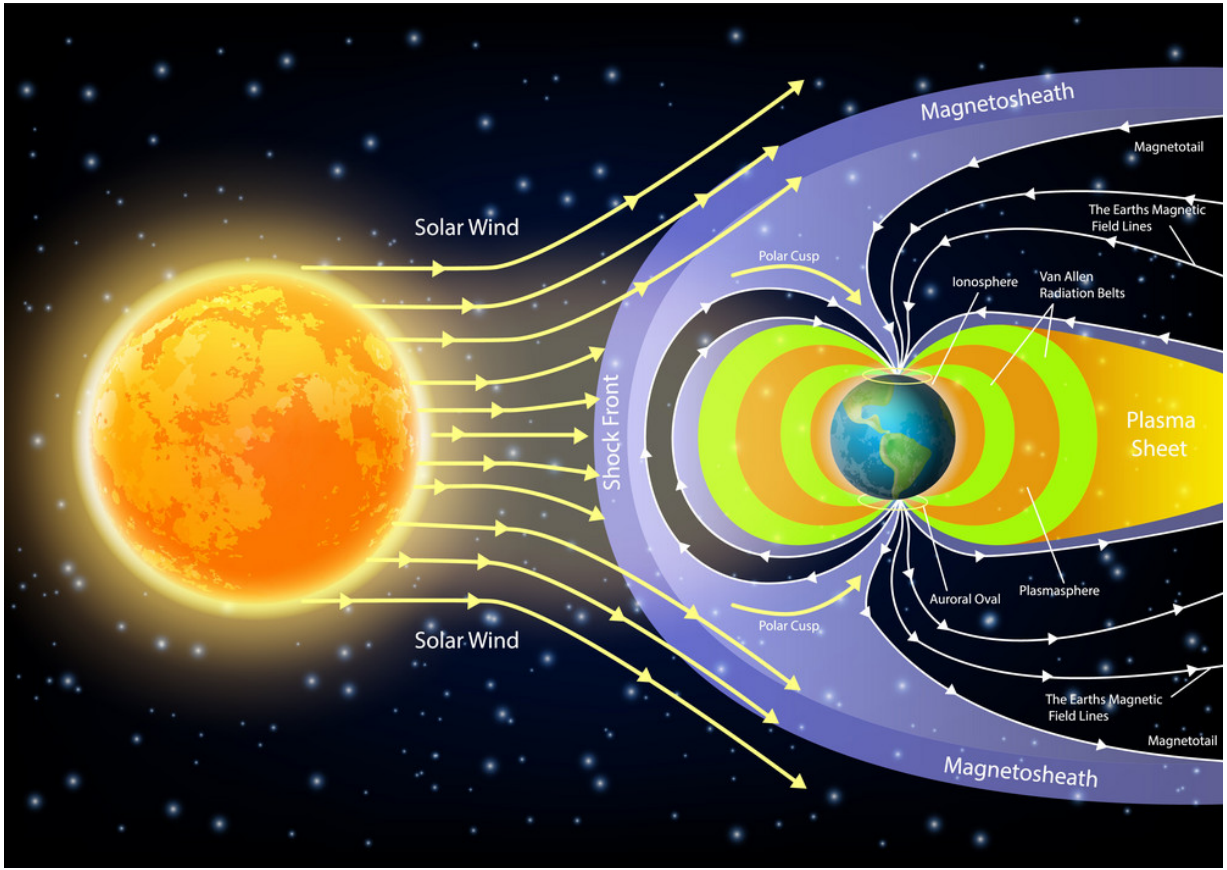
THE PLASMASPHERE DURING MAJOR MAGNETOSPHERIC STORMS

MOMA Meeting 2020

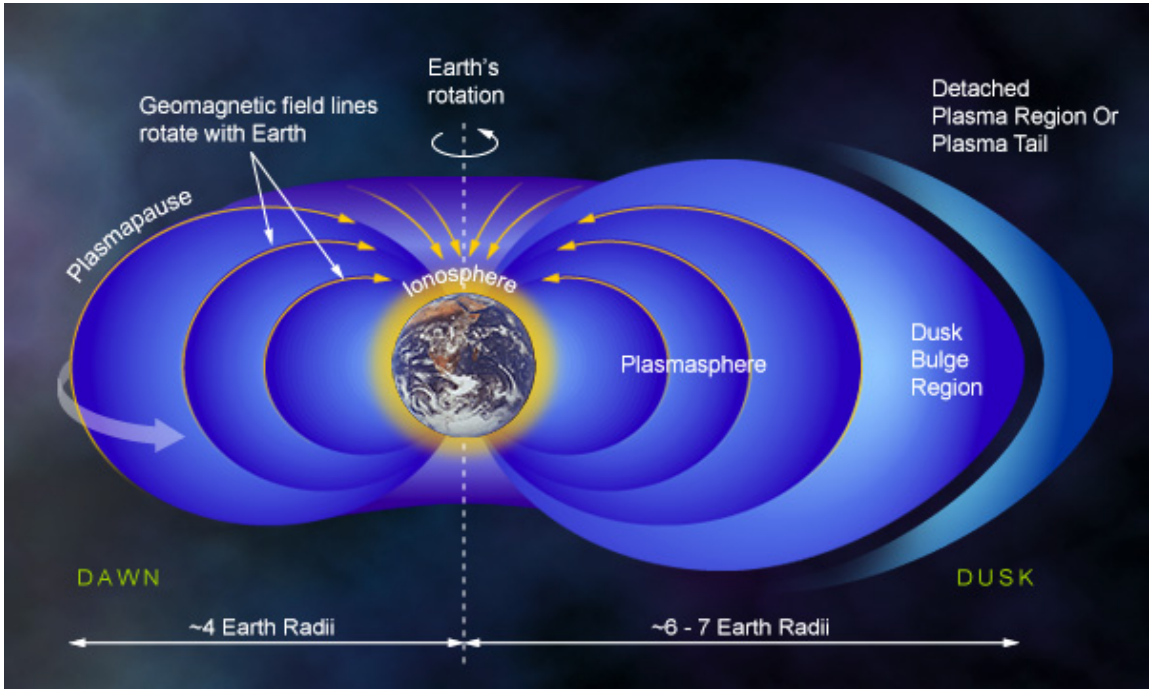
Jessy Matar
(PhD Student)

Advisor: Benoit Hubert

Introduction



Introduction



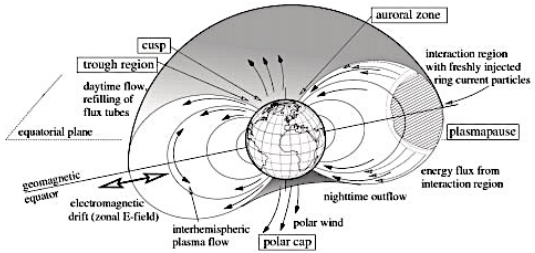
- Plasmasphere: forms a donut-shaped region surrounding the Earth
- Outer boundary: **plasmapause** observationally defined by an order of magnitude drop in plasma density
- Composition: H+, He+, O+, N+
- Environment characterized by closed field lines

Introduction

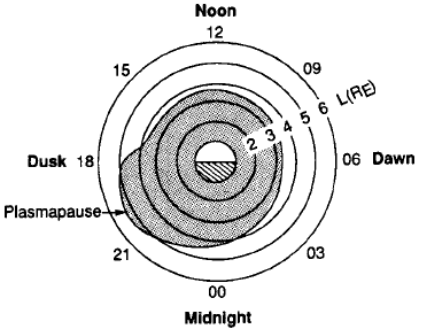
Motivation

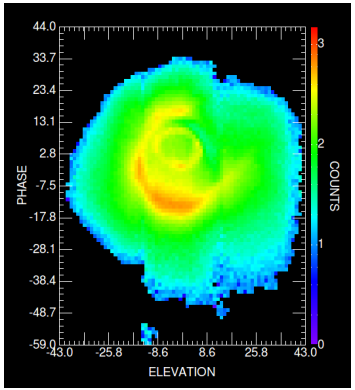
Geomagnetic Storm Impact On Earth's Plasmasphere And Comparison With The Aurora

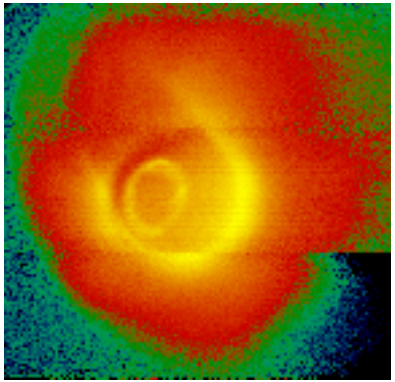
How is this variability related to magnetic reconnection and to the auroral response?



(Forester and Jawoski 2000)







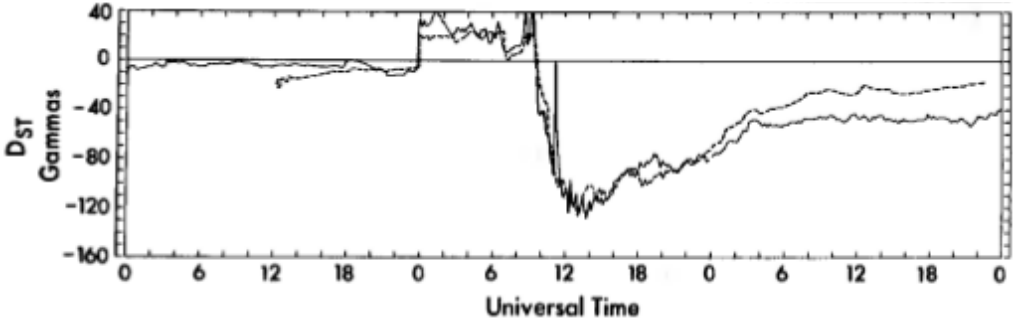
(IMAGE-EUV Earth's plasmasphere)

Introduction

STORMS

1. Initial Phase
2. Storm Main Phase
3. Recovery Phase

Duration: several days



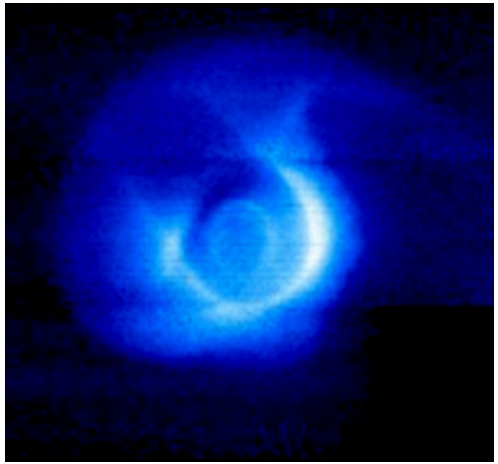
Investigate geomagnetic storms during which the radiation belts have more pronounced responses to global disturbances of the magnetospheric system and therefore produce larger disturbances in the magnetic field and Dst index, which is a proxy for the energy of the ring current particles

Instruments

- *IMAGE-EUV*
- *IMAGE-FUV*
- *SuperDARN*
- *GOES*

Instruments

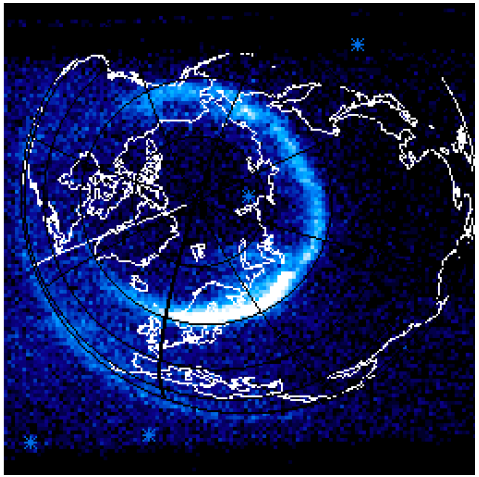
- ***IMAGE-EUV***
- *IMAGE-FUV*
- *SuperDARN*
- *GOES*



- Plasmasphere observations
- ~10 min cadence
- He^+ detected at 30.4 nm
- Density along LOS
- Boundary

Instruments

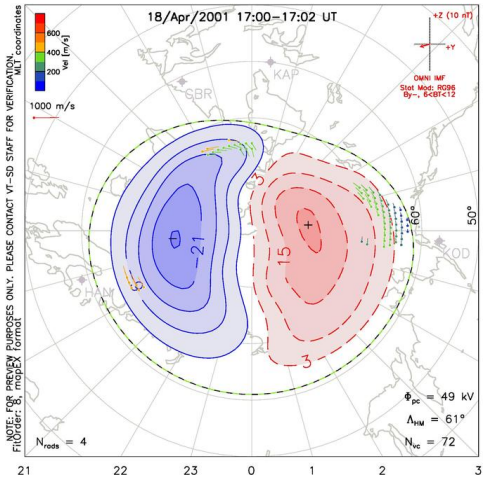
- *IMAGE-EUV*
- ***IMAGE-FUV***
- *SuperDARN*
- *GOES*



- SI12 observations of the proton aurora
- ~2 min cadence
- Doppler-shifted Lyman- α at 121.8 nm from the proton aurora

Instruments

- *IMAGE-EUV*
- *IMAGE-FUV*
- ***SuperDARN***
- *GOES*

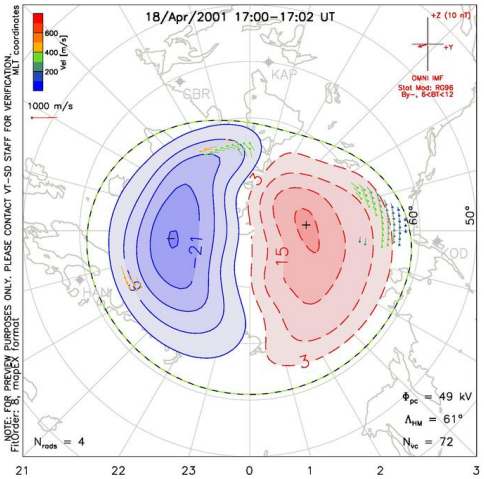


- Maps of the convection pattern
- Heppner-Maynard Boundary (delimits the latitudinal extent of the polar ionospheric convection)
- Ionospheric electric field

$$\vec{E}_i = - \vec{u}_i \times \vec{B}$$

Instruments

- *IMAGE-EUV*
- *IMAGE-FUV*
- ***SuperDARN***
- *GOES*



- Maps of the convection pattern
- Heppner-Maynard Boundary (delimits the latitudinal extent of the polar ionospheric convection)
- Ionospheric electric field

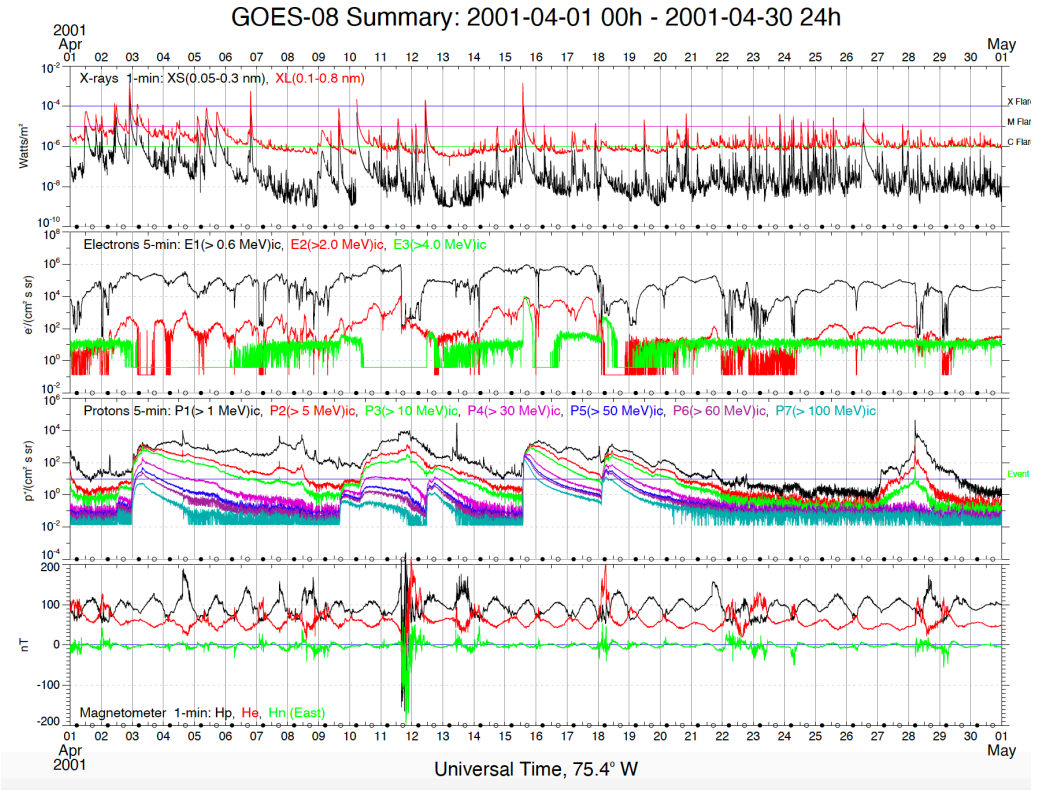
$$\vec{E}_i = - \vec{u}_i \times \vec{B}$$

SuperDARN + IMAGE FUV

➡ Estimate the motion of the O/C field line boundary, the motional electric field, and the reconnection rate magnetopause/magnetotail

Instruments

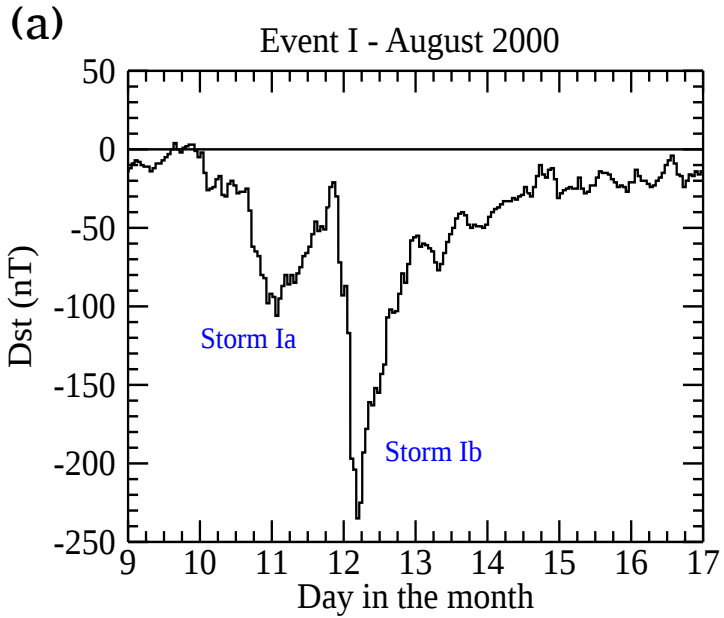
- *IMAGE-EUV*
- *IMAGE-FUV*
- *SuperDARN*
- ***GOES***

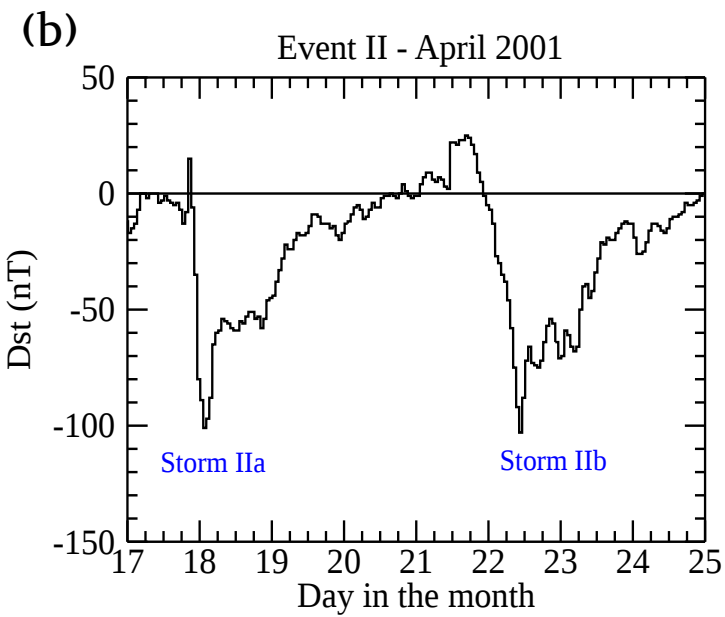


Observations

Dst Index

Year	Month	Day
2000	8	9
2001	4	17

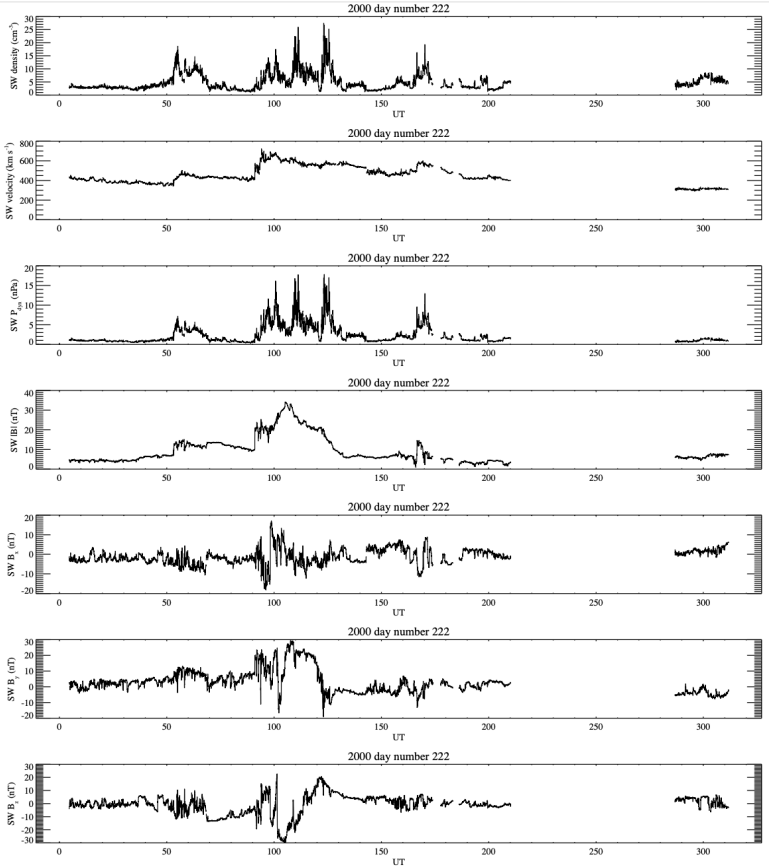


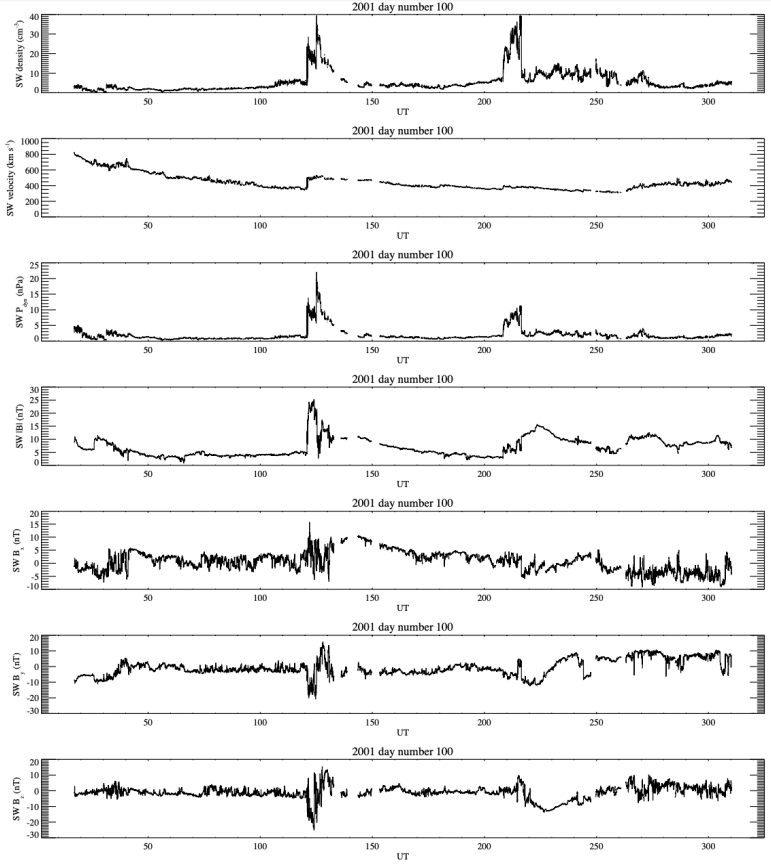


Good auroral and plasmaspheric observations from both the EUV and FUV

Observations

OMNI Solar Wind Measurements

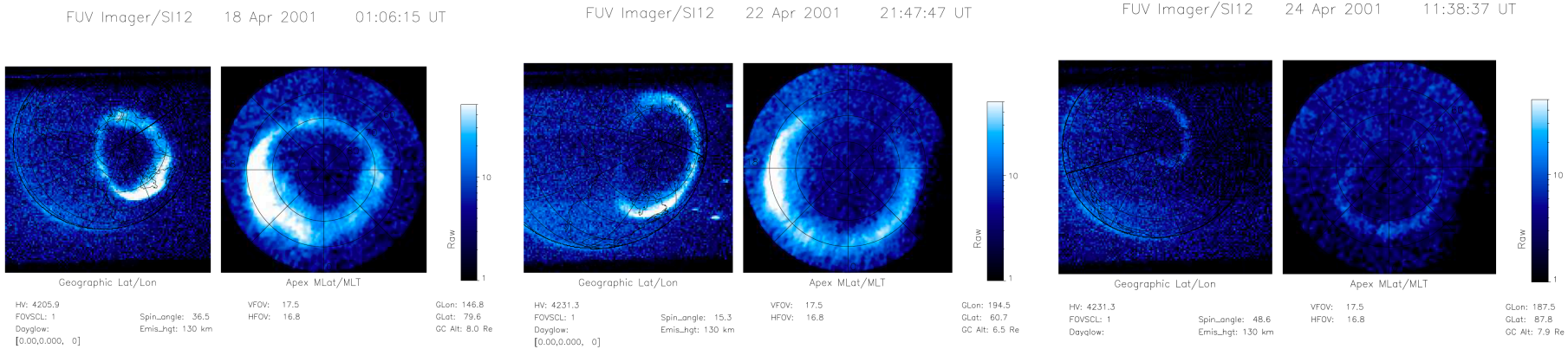


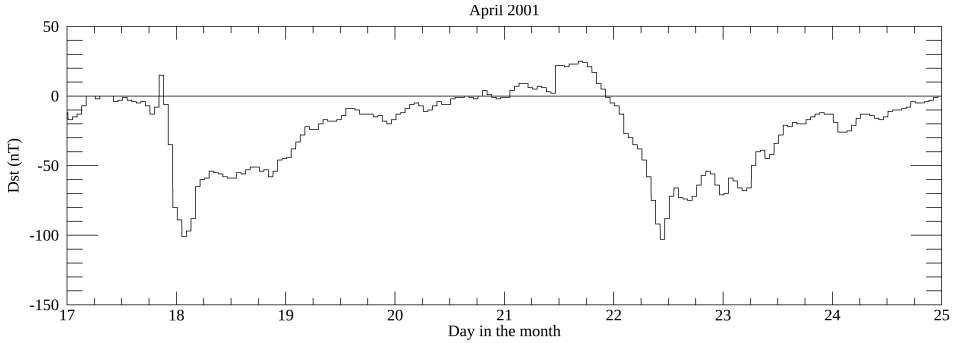


Observations

IMAGE-FUV

Expansion-Contraction of the polar cap

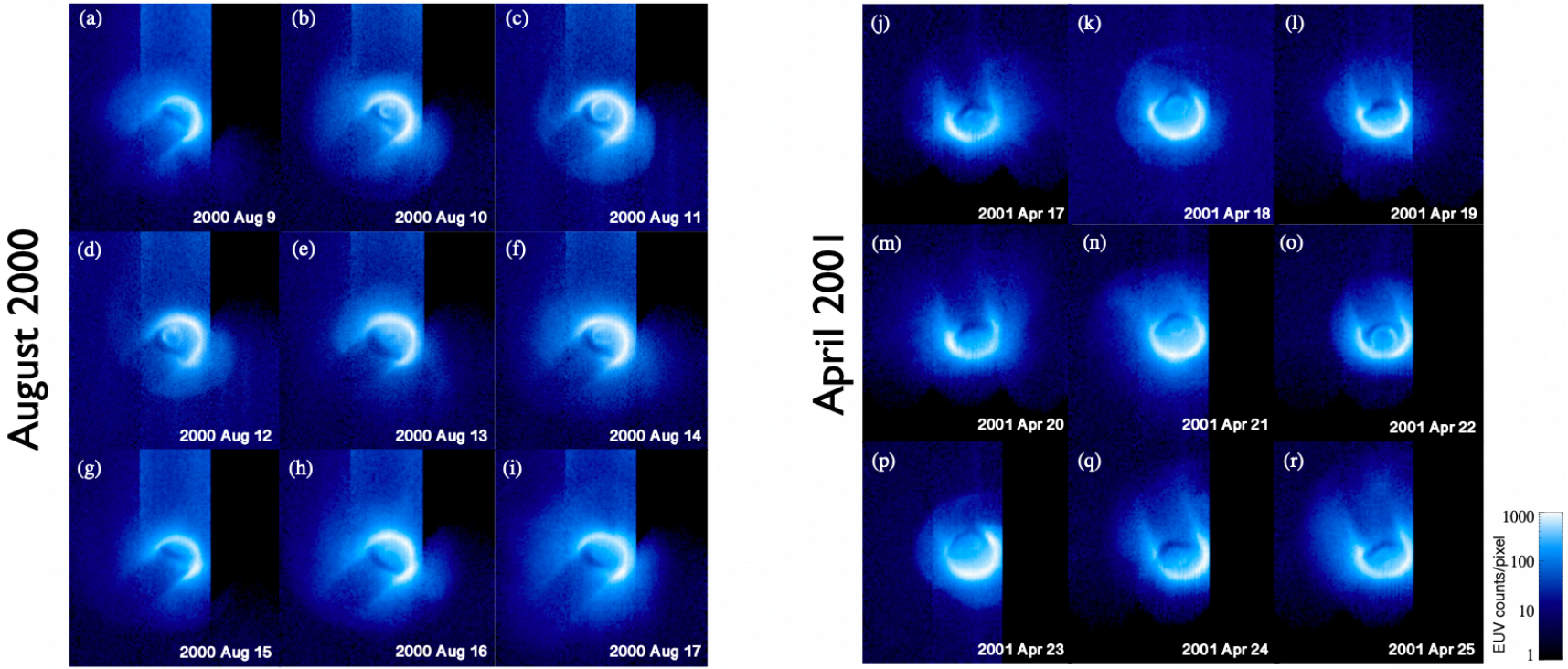




Observations

IMAGE-EUV

Expansion-Contraction of the plasmasphere

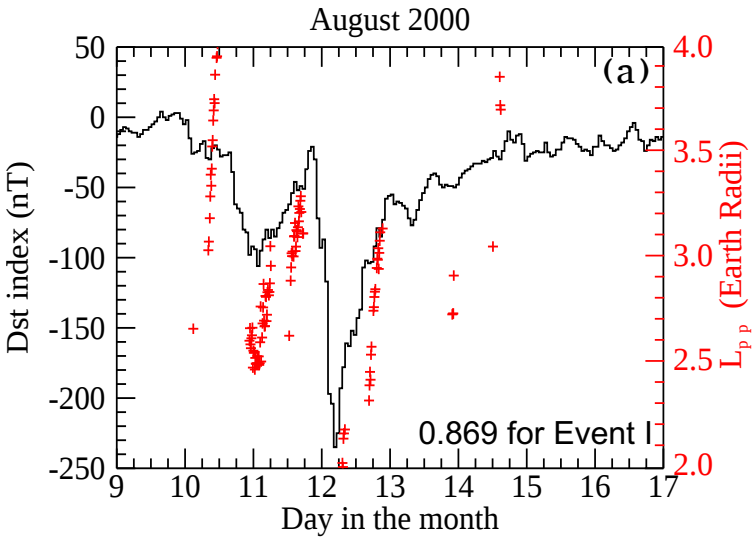


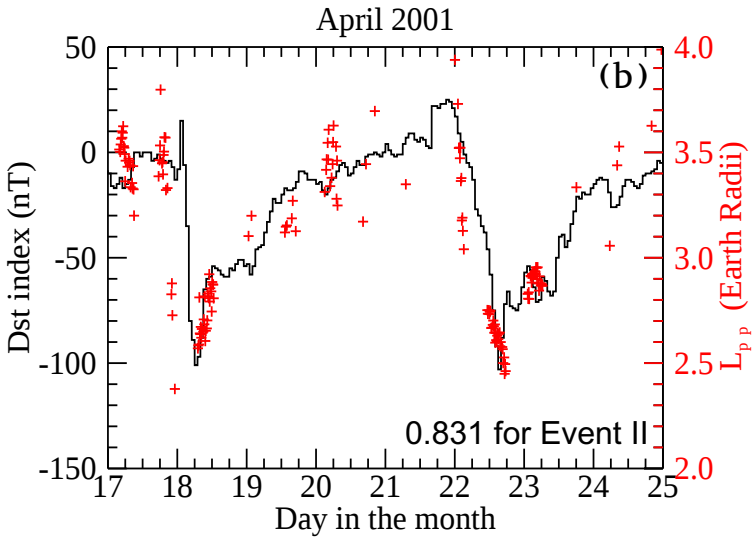
Analysis

We will look into **correlations** between parameters like open flux and reconnection rate as well as SW properties with the plasmasphere response which can help identify which parameters are most relevant and relate during the storm time

Analysis

IMAGE-EUV



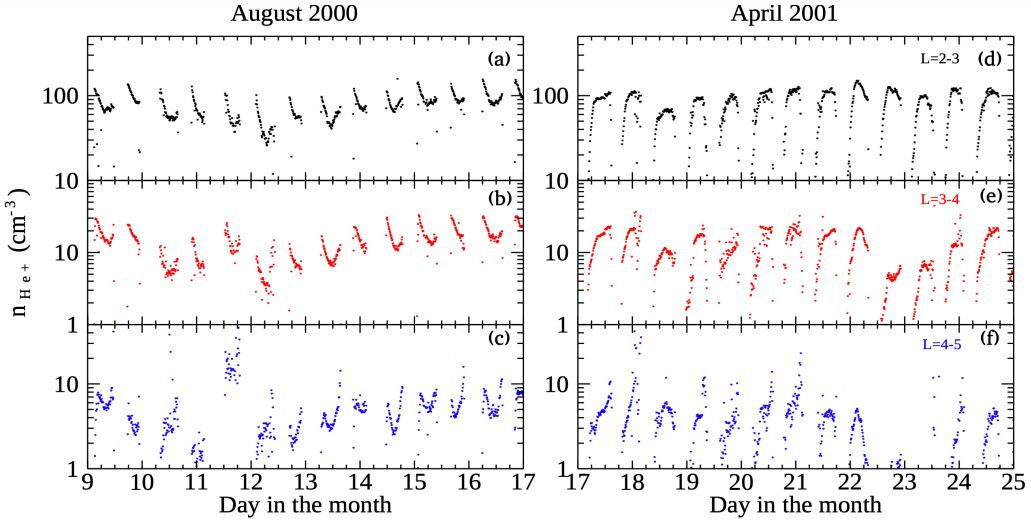


Extracting the position of the plasmapause from the EUV observations

High Pearson correlation found

Analysis

IMAGE-EUV

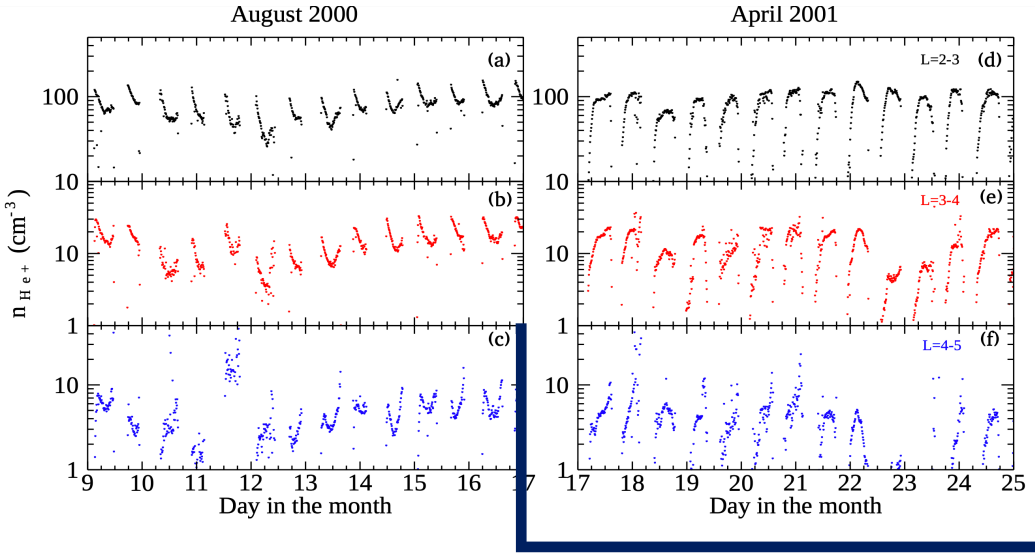


Plasma density deduced from the EUV data (EUVSim)

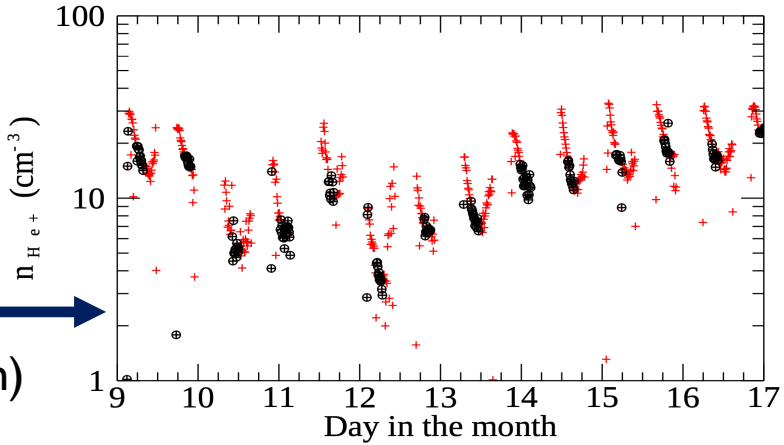
(Using the method in Goldstein et al. 2003)

Analysis

IMAGE-EUV



Matar et al. (in preparation)



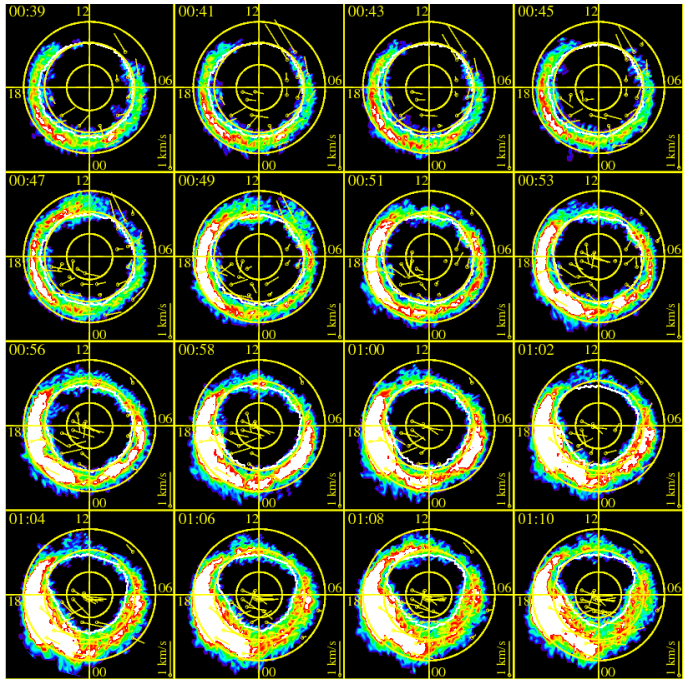
Plasma density deduced from the EUV data (EUVSim)

(Using the method in Goldstein et al. 2003)

Analysis

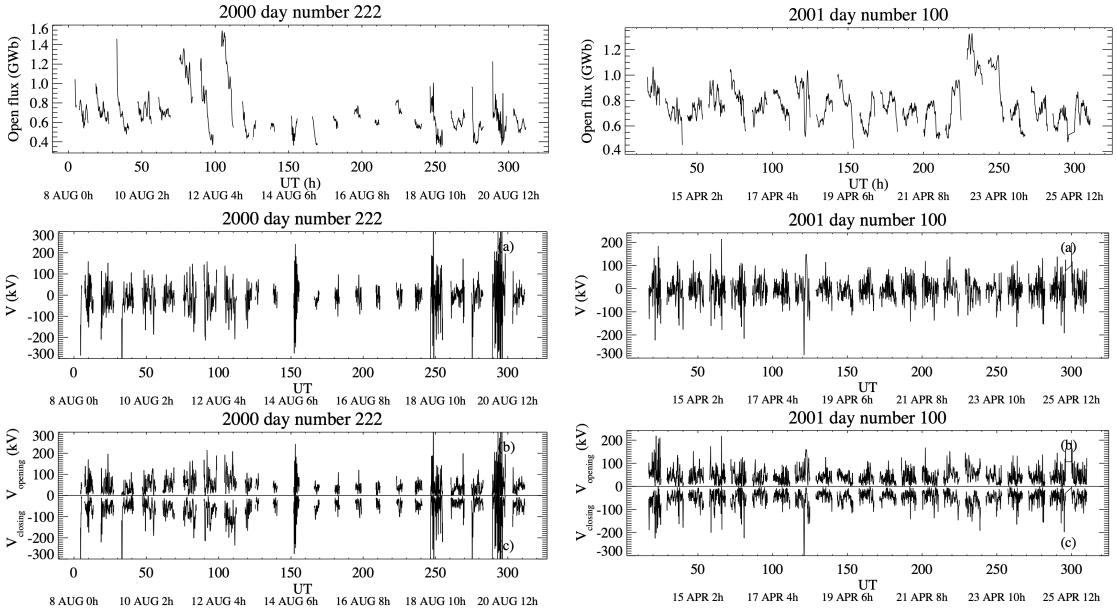
IMAGE-FUV

Reliable boundary determination!



(Method from Hubert et al.2006)

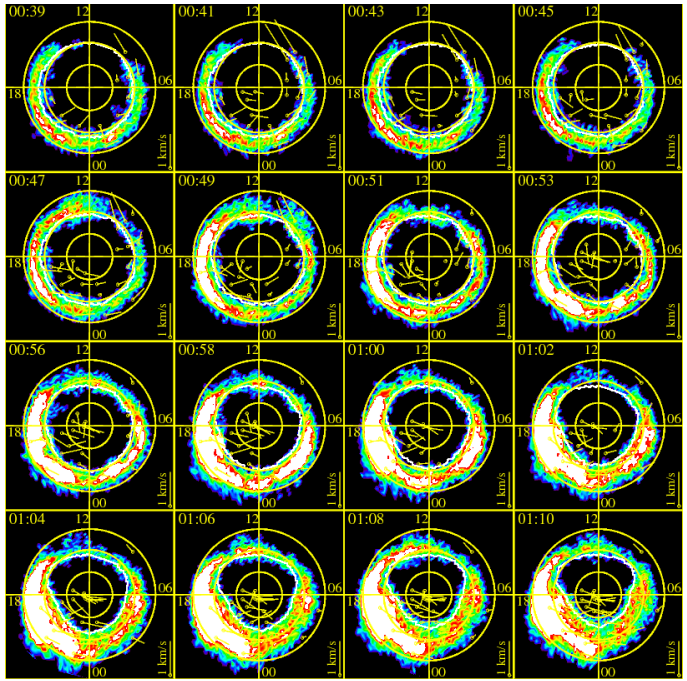
Estimate the magnetic open flux and the opening/closing reconnection voltages using SI12 and SuperDARN



Analysis

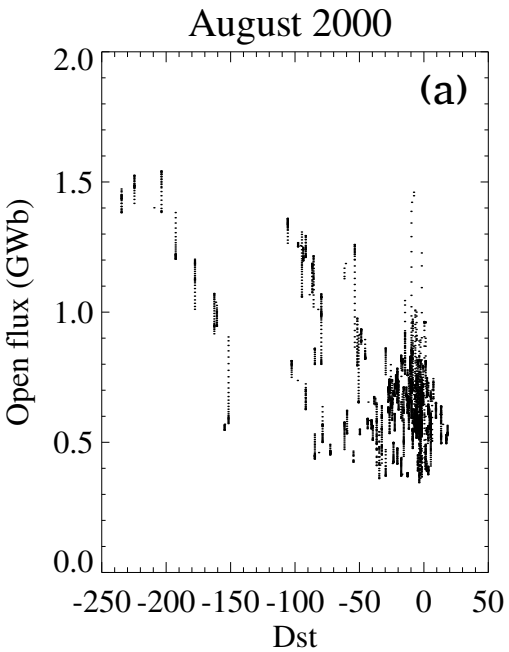
IMAGE-FUV

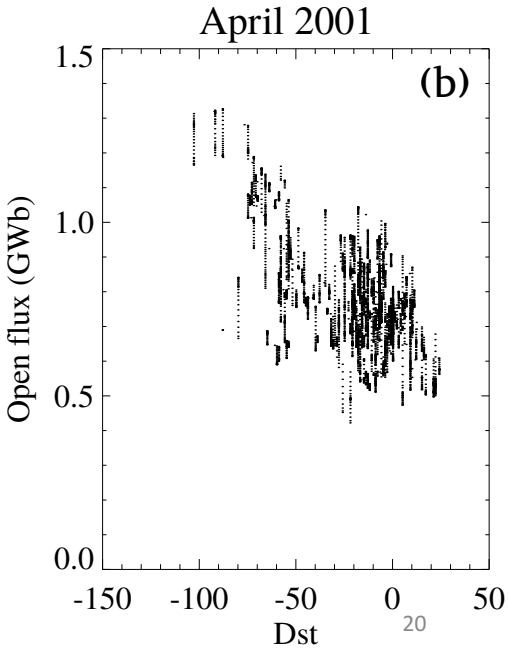
Reliable boundary determination!



(Method from Hubert et al.2006)

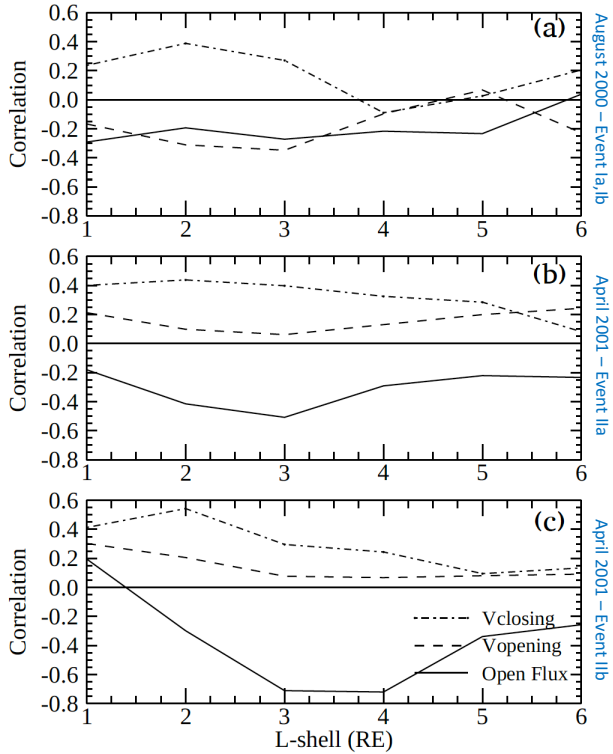
- Open flux decreases when the Dst increases
- Correlation found to be -0.665 and -0.613





Analysis

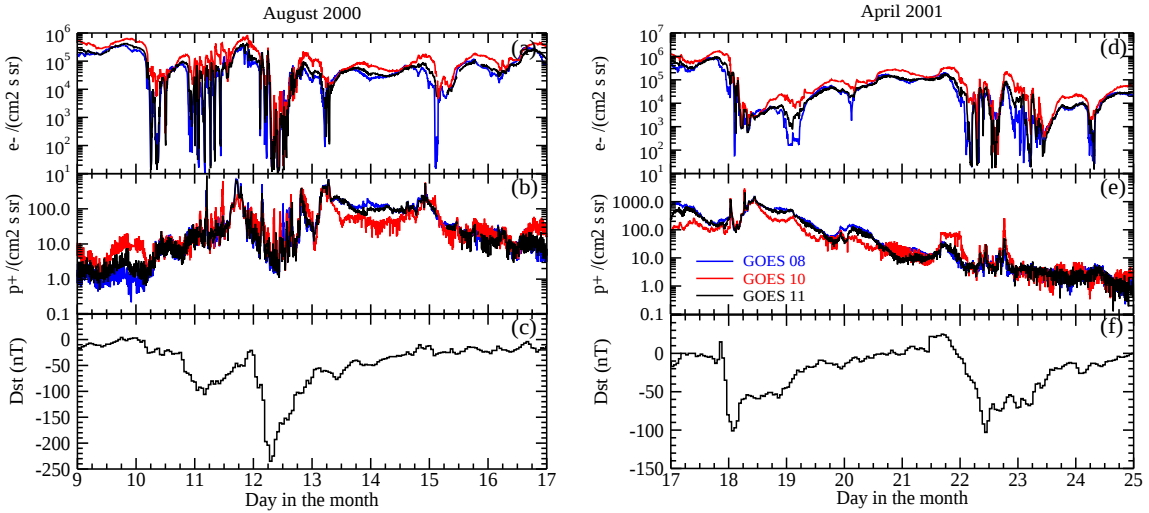
IMAGE-FUV/EUV



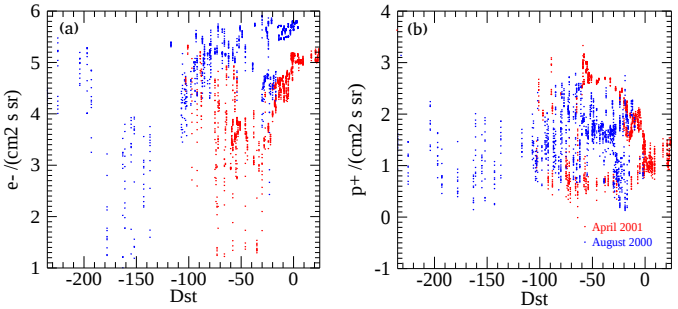
Good correlation between He^+ density and open flux

NO correlation found between the reconnection voltages and the He^+ density

Analysis

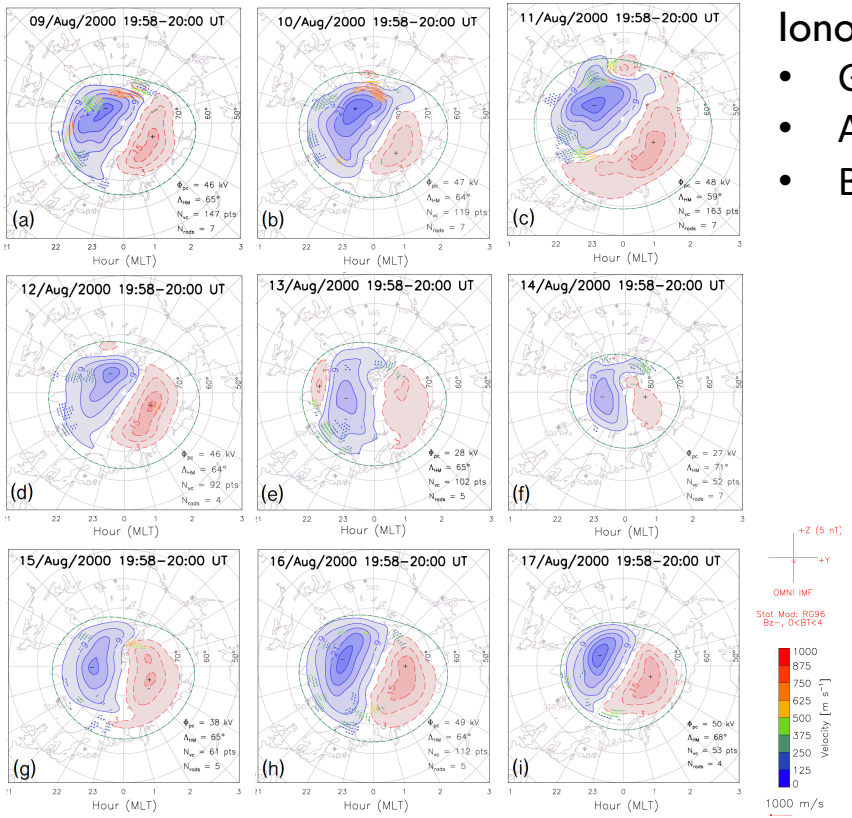


Matar et al. (in preparation)



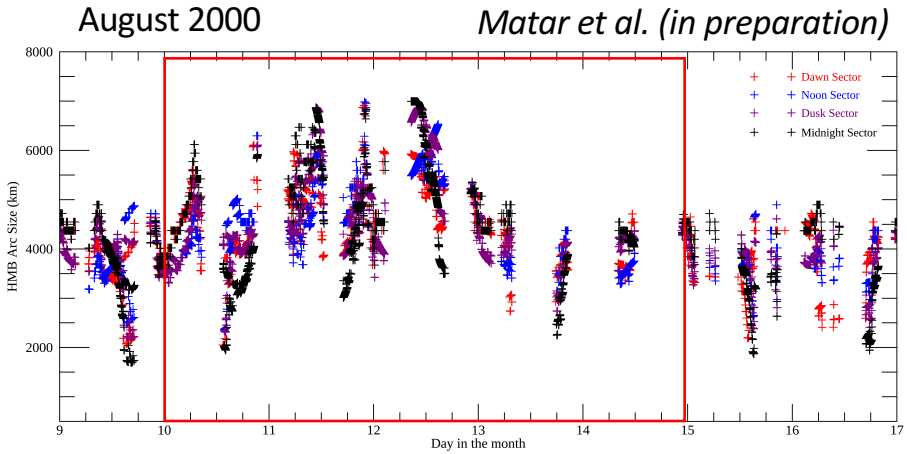
For both storms a good correlation is deduced

Analysis



Ionospheric convection pattern measured by SuperDARN

- Green lines represent HMB
- Arrows represent measured ionospheric convection velocity
- Blue-red shades show ionospheric potential



Correlation with Lpp: -0.869

Discussion

Comparing results of the aurora and the plasmasphere using IMAGE

- Quality of results limited by the availability of the IMAGE observations along the satellite track
- Time differences between the different measurements

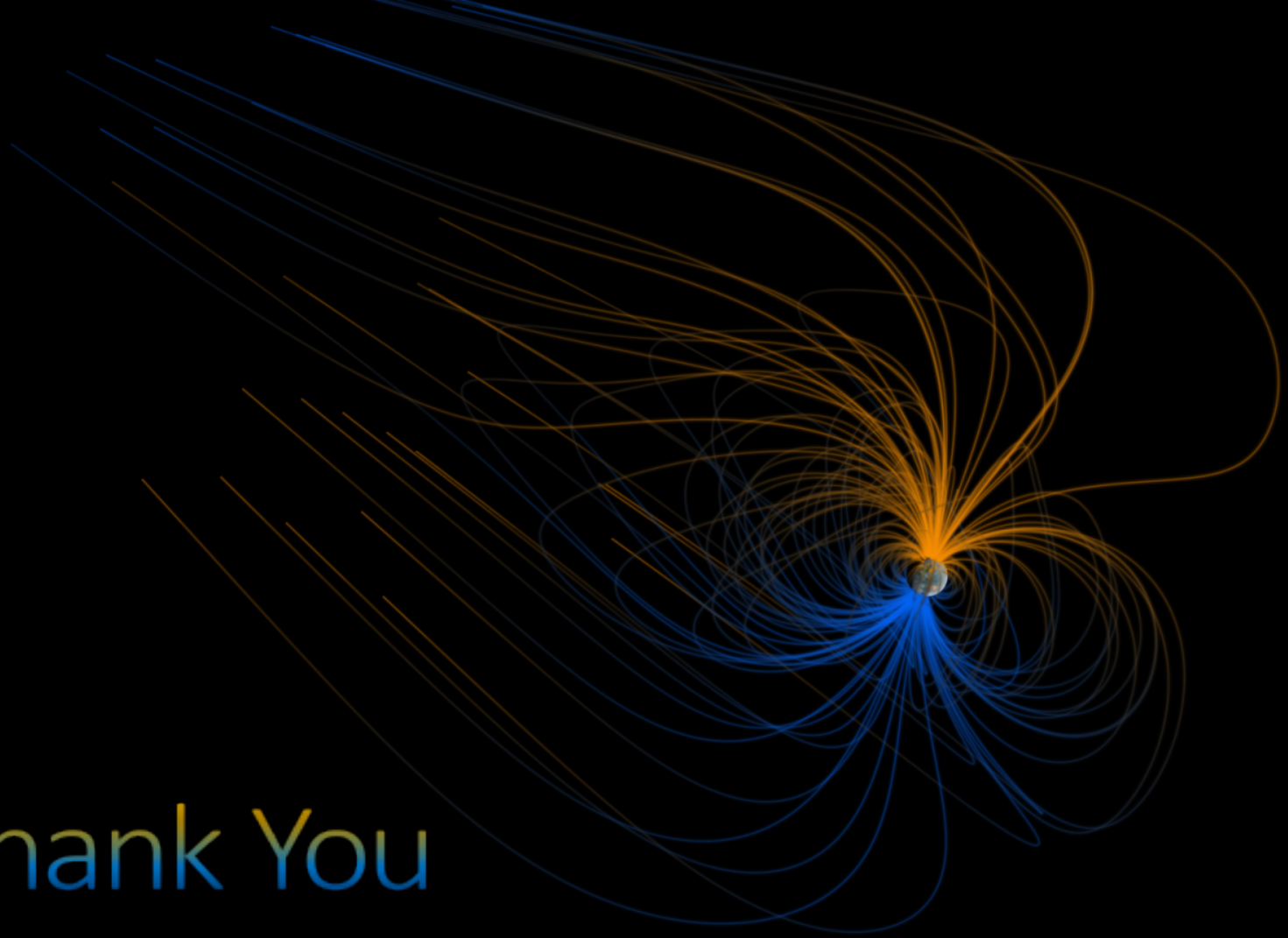
Conclusions

1 Derive correlations between different magnetospheric parameters during major geomagnetic storms

- Strong correlation found between the Dst index and the average plasmapause location (L_{pp})
- The plasmasphere responds promptly to changes in the solar wind, etc…

2 Correlation enhanced particularly during ACTIVE storm phase

3 No relation between the reconnection rates and the trapped particles during major storms, we speculate none would be found either during weaker storms



Thank You