



The Plasmasphere During Major Geomagnetic Storms: Analysis Of Trapped Particles In The Outer Radiation Belt

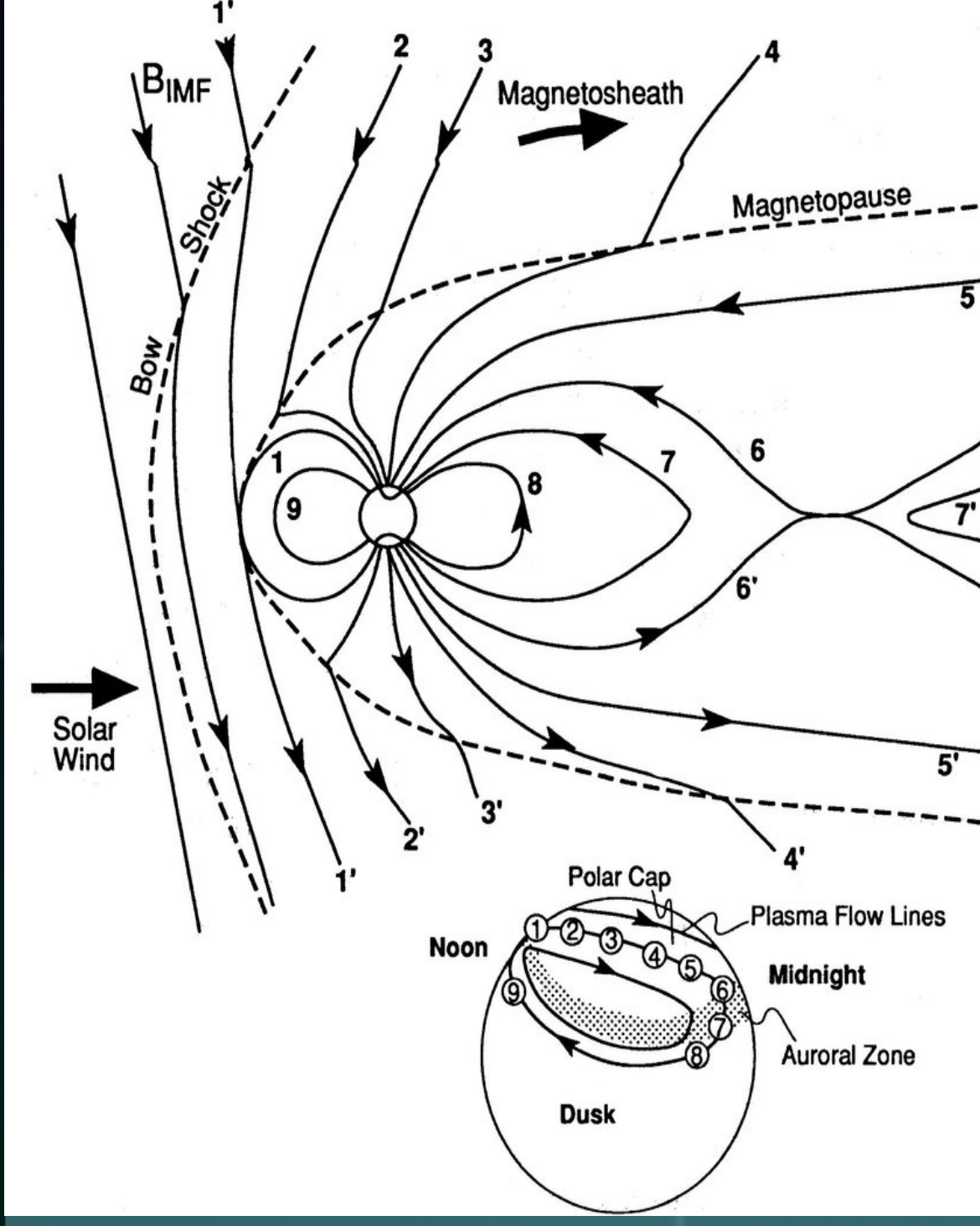
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OBJECTIVE

Find a possible relationship between the evolution of the trapped population and the process of magnetic reconnection during storms by combining measurements of the plasmasphere and the aurora to better understand and quantify the variability of the Earth's outer radiation belt during strong storms.

INTRODUCTION



The interaction between the Earth's magnetic field lines and the solar wind results in a cycle of magnetic field lines opening and closing known as the Dungey substorm cycle, mostly governed by the process of magnetic reconnection. The geomagnetic field lines can therefore have either a closed or an open topology.

Closed field lines can trap electrically charged particles that bounce between mirror points located in the North and South hemispheres while drifting in longitude around the Earth, forming the plasmasphere, the radiation belts and the ring current.

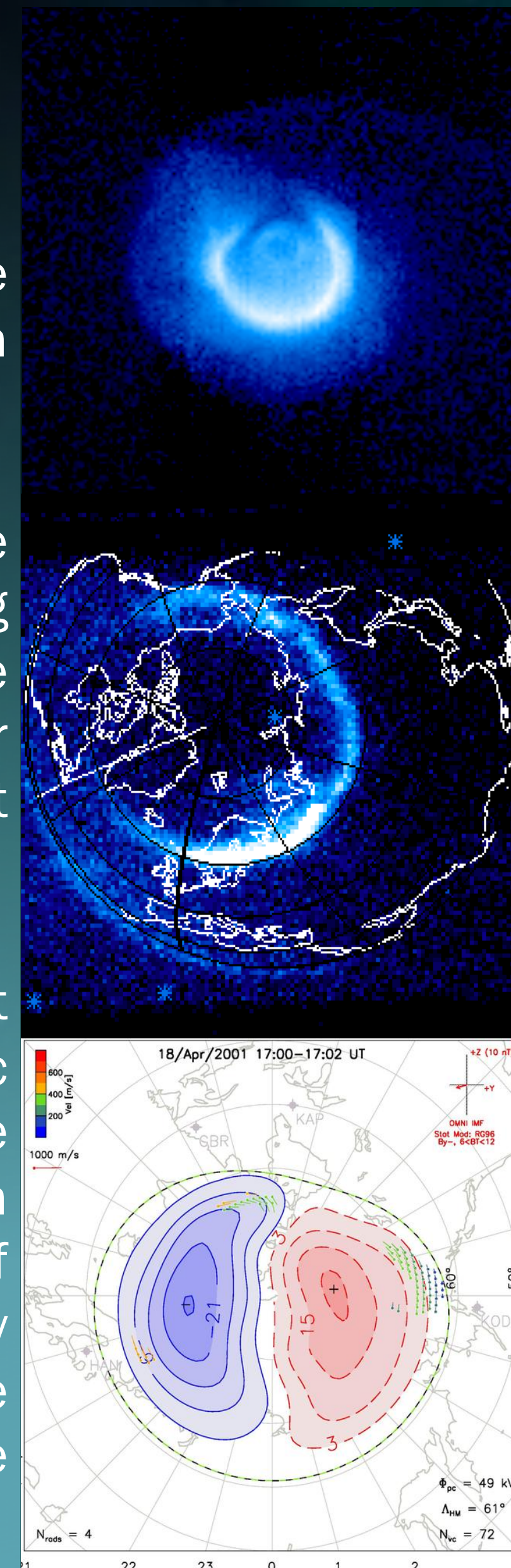
The outer boundary of the plasmasphere is the plasmapause. Its location is mostly driven by the interplay of the corotation electric field of ionospheric origin, and the convection electric field that results from the interaction between the IMF and the geomagnetic field.

At times of prolonged intense coupling between these fields, the response of the magnetosphere becomes global and a geomagnetic storm develops. The ring current created by the motion of the trapped energetic particles intensifies and then decays as the storm abates. The ring current and the trapped particles are expected to vary during storms.

METHODOLOGY

Instruments

- **IMAGE-EUV**
Observes the distribution of the trapped helium ions (He+) in the plasmasphere at 30.4 nm.
- **IMAGE-FUV**
Takes images of the proton/electron aurora using SI12, SI13 and WIC. We use the SI12 data to identify the polar cap boundary (not contaminated by dayglow).
- **SuperDARN**
Measures the line-of-sight velocity of the ionospheric plasma and produces large scale maps of the convection pattern including the location of the Heppner-Maynard Boundary (HMB) which represents the latitudinal extent of the ionospheric convection pattern.

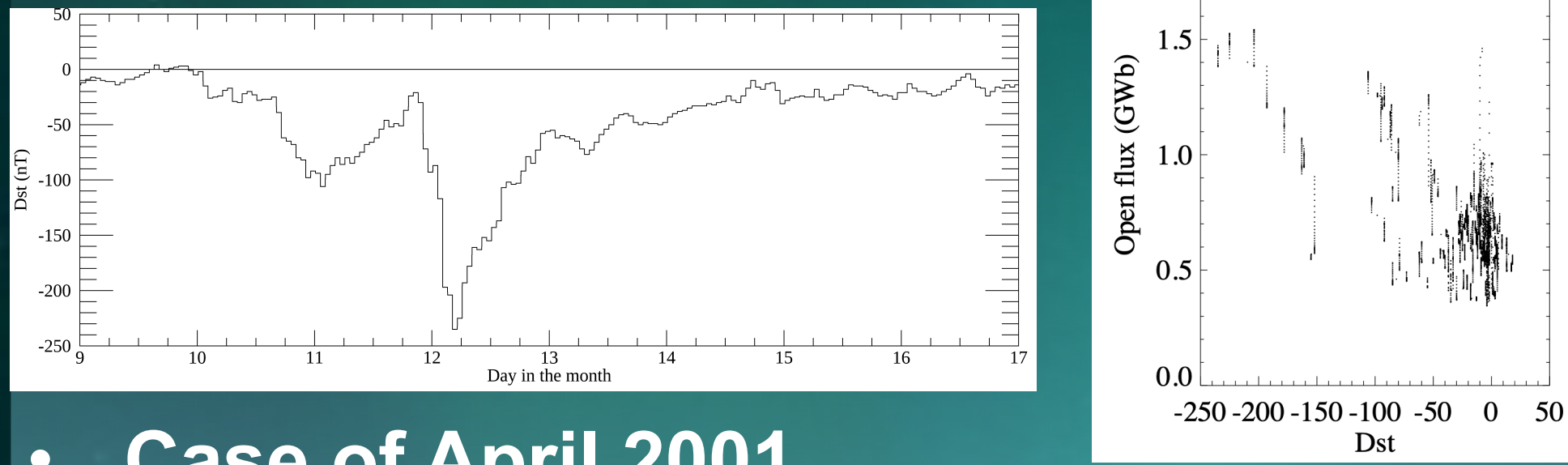


The storms selected have good auroral and plasmaspheric observations from both IMAGE FUV and EUV.

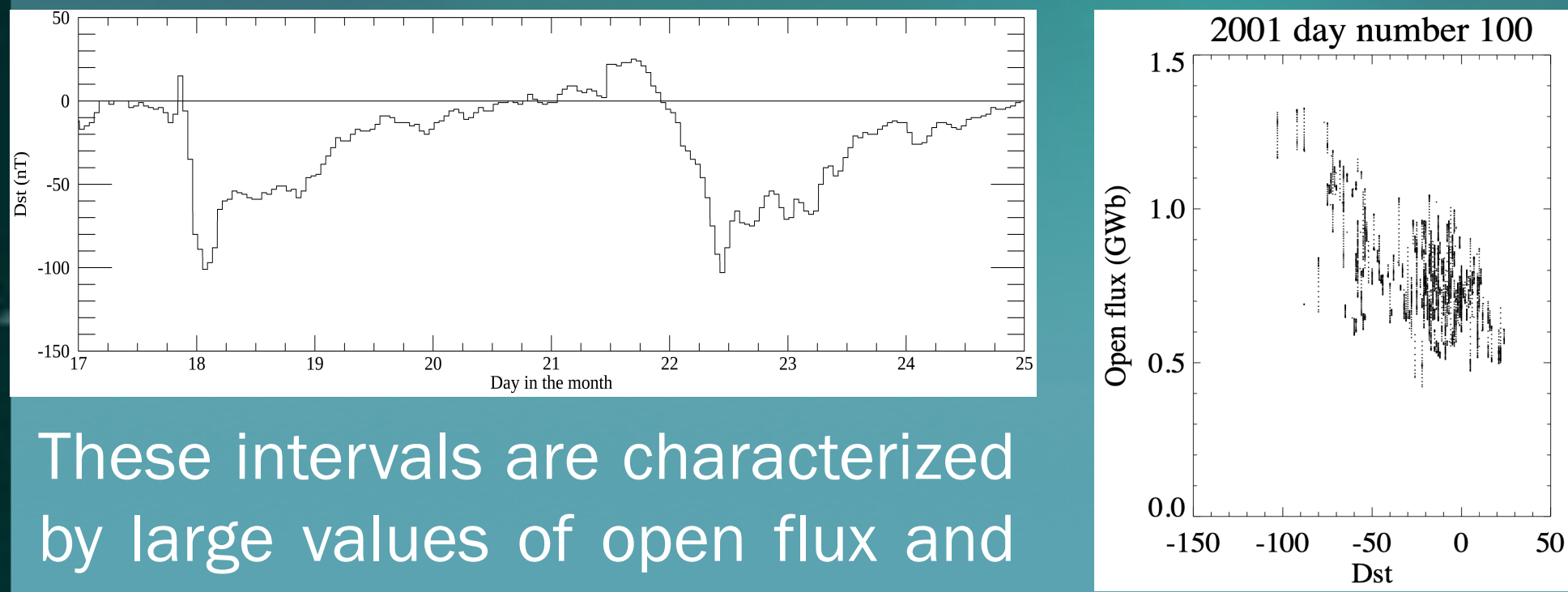
- Estimating the magnetic open flux and the opening/closing reconnection voltages using IMAGE-SI and SuperDARN.
- Mapping electric potential (using T96) between the magnetosphere and the HMB in the ionosphere. We use the HMB latitude as a proxy for the plasmapause location (L_{pp}) as it should be located at the equator edge of the convection pattern.
- Estimating the voltage and electric field in the vicinity of the plasmapause using SuperDARN.
- Extracting the location of the plasmapause from the EUV observations.
- Deducing the tangential electric field component of the moving plasmapause using IMAGE EUV observations of the plasmasphere.
- Comparing the plasma response during storms to the auroral precipitation at high ionospheric latitude.

Geomagnetic Storm Cases

Case of August 2000

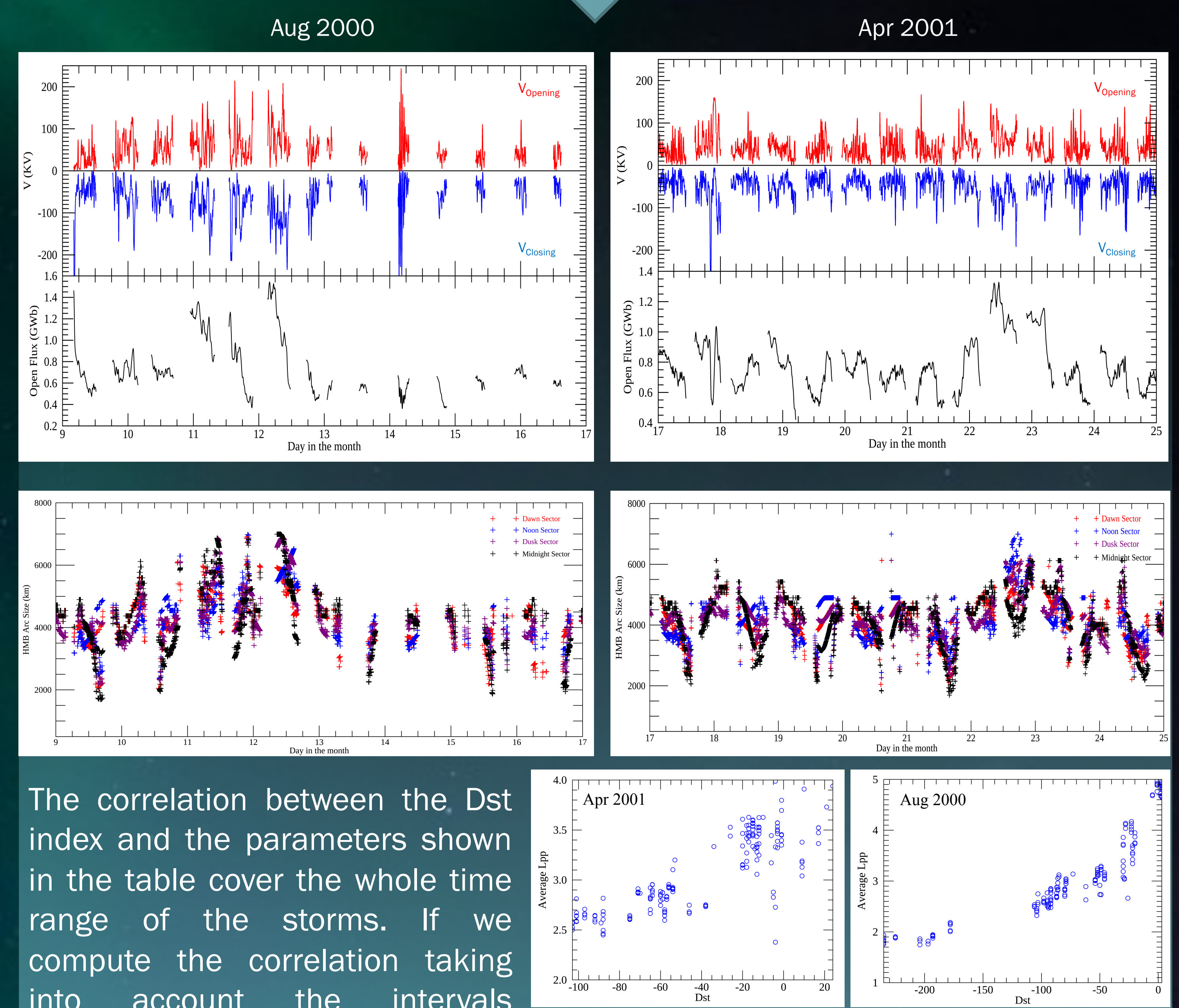


Case of April 2001



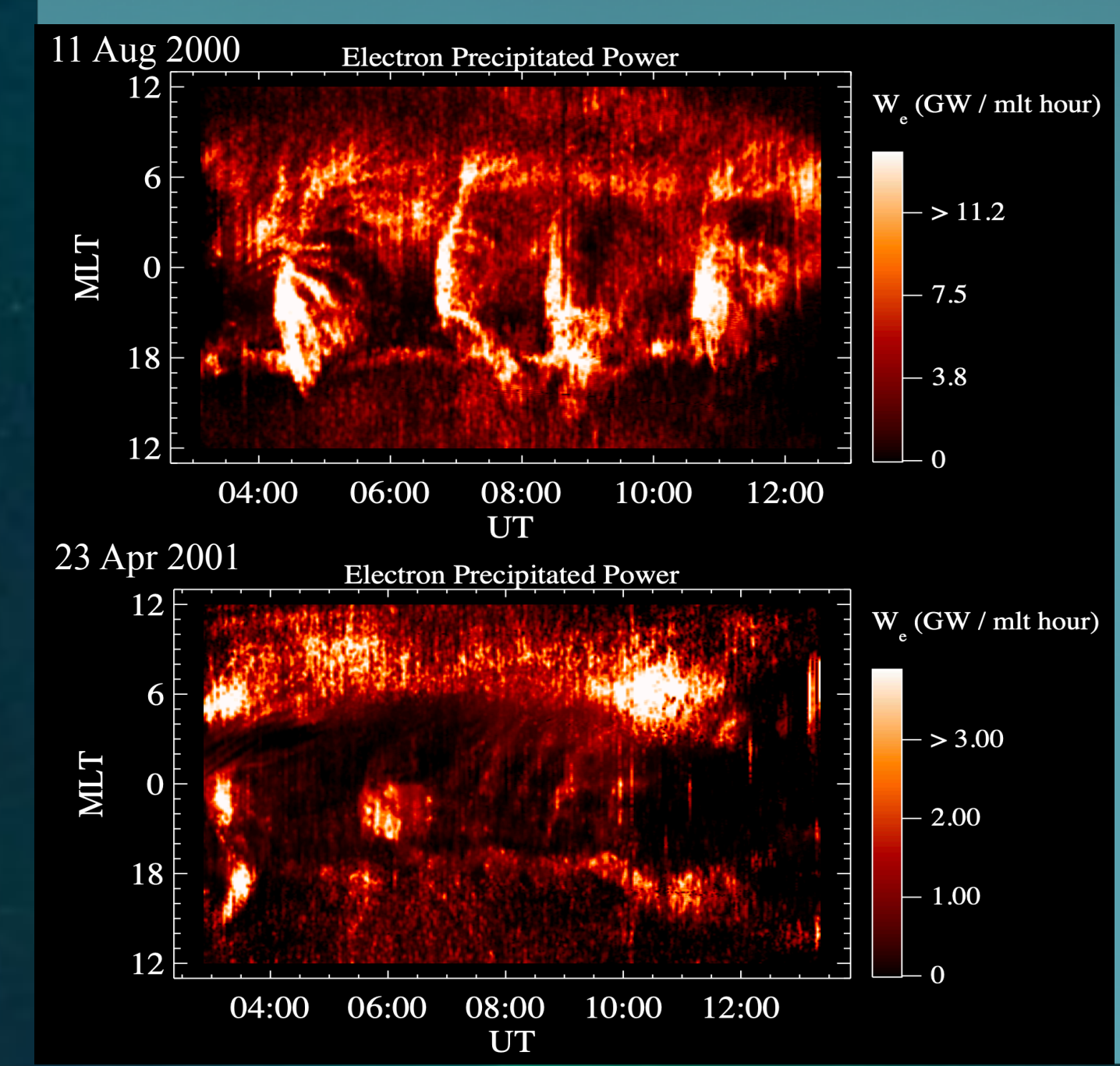
These intervals are characterized by large values of open flux and reconnection rates.

RESULTS



The correlation between the Dst index and the parameters shown in the table cover the whole time range of the storms. If we compute the correlation taking into account the intervals between the main and recovery phase, the correlation increases.

	V_{sw}	$ B _{sw}$	B_z, sw	B_y, sw	Φ	V_{op}	V_{cl}	P_{dyn}	L_{pp}
Aug 2000	-0.651	-0.809	0.438	-0.562	-0.665	-0.197	0.192	-0.411	0.869
Apr 2001	-0.210	-0.400	0.298	-0.011	-0.613	-0.118	0.197	-0.230	0.831



The electron precipitated power is the main contributor to the aurora emission. In a previous study (Matar et al. 2019), we find that the precipitated electron power of the aurora and the electron energy deposition rate from reconnection are of the same order of magnitude during substorm cases. We expect the same for storm cases. This could explain the origin mainly of the precipitated electrons observed at the ionosphere. Also we suspect that it could relate to the plasmasphere response during storms.

- Strong correlation found between the Dst index and the average plasmapause location (L_{pp}) and another correlation found between the HMB latitude and the open flux. Also we found a good correlation values during storm times between the Dst index and the open flux, the solar wind velocity and other parameters.
- We expect to find a relation (direct or indirect) relating the plasmasphere density and location, Dst index, open flux and reconnection.
- Precipitating electrons are dominant in the ionosphere during storm time.

CONCLUSIONS

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