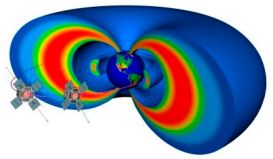
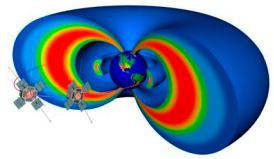


Internal Spacecraft Charging from the Environmental Radiation Monitors on the Van Allen Probes Spacecraft: Charging driven by solar wind conditions

Andrew Gerrard[1], Louis Lanzerotti[1],
Thomas Sotirelis[2], John Goldsten[2], Barry Mauk[2]

1. *New Jersey Institute of Technology*
2. *Applied Physics Laboratory-John Hopkins University*

Special Thanks to Kyungguk Min [Auburn],
the RBSPICE team,
and the larger VA Probes Team!



Environmental Radiation Monitors on VA Probes

The ERM packages are described in detail in Goldsten et al. [2012].

Power and data for the ERM instruments are on the same interface as the Radiation Belt-Storm Probes Ion Composition Experiment (RBSPICE) instrument Mitchell et al. [2013].

We focus on the two spacecraft charge monitors that are part of each ERM package, CM1 and CM2, each under different thicknesses of aluminum, 1-mm and 3.8-mm, detect penetrating electrons of >0.7-MeV and >2.0-MeV and protons of >15 MeV and >30 MeV, respectively.

The ERM charge monitors have a sensitivity of ~0.1-fA/cm^2 and up to ~3000-fA/cm^2

Charge monitor data are collected from both plates every 5-seconds.

Periapsis data (zero signal) used to estimate and remove system bias.

Bias-corrected raw data is then converted to current using pre-launch calibration.

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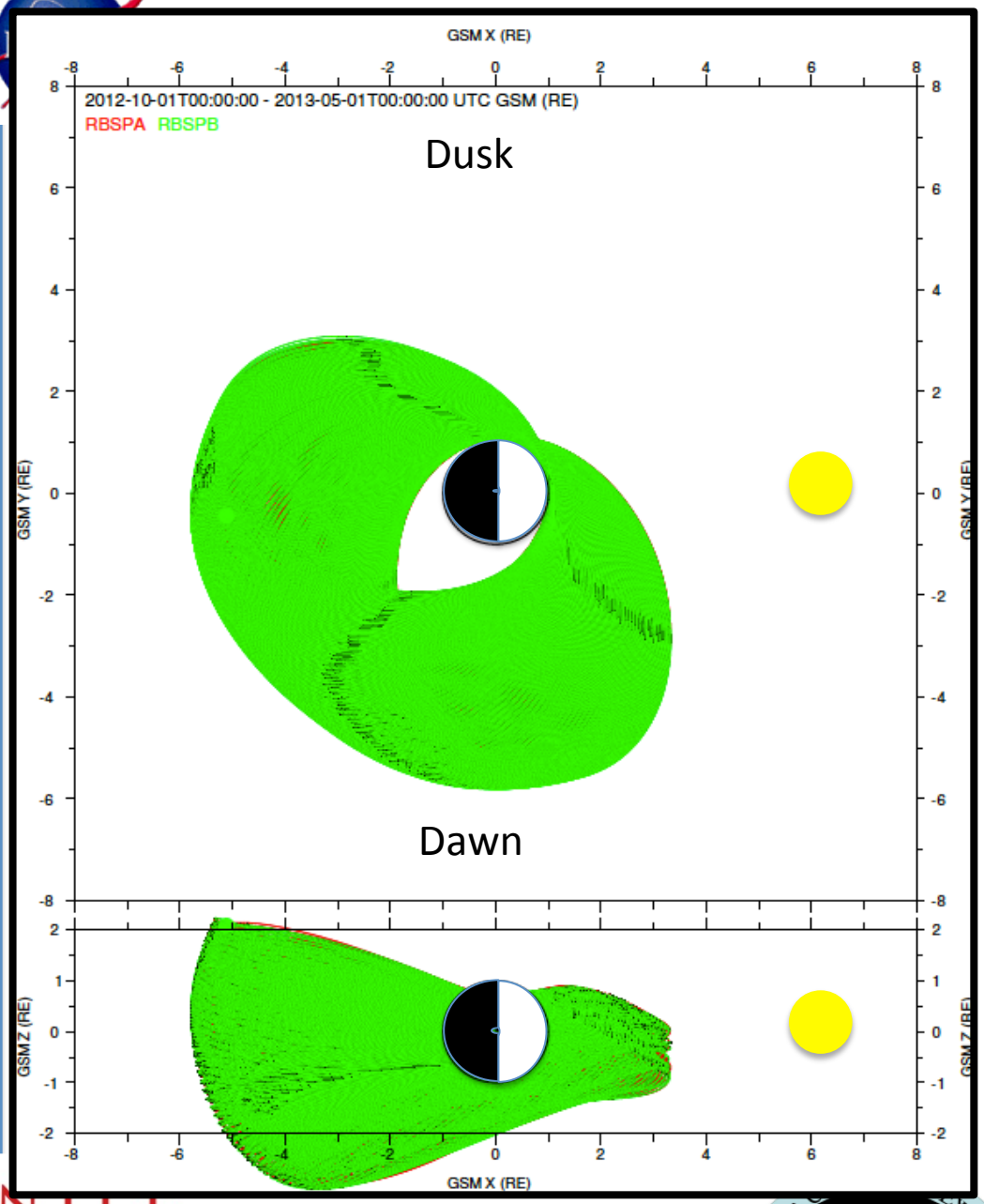

Orbits and Data

- The data shown herein were obtained during the first 7-months (October 1, 2012-April 30, 2013) of the Van Allen Probes mission.
- During this time, the apogee of the Probes precessed from ~06 MLT to 00-MLT (i.e., from the dawn-side to the midnight sector).

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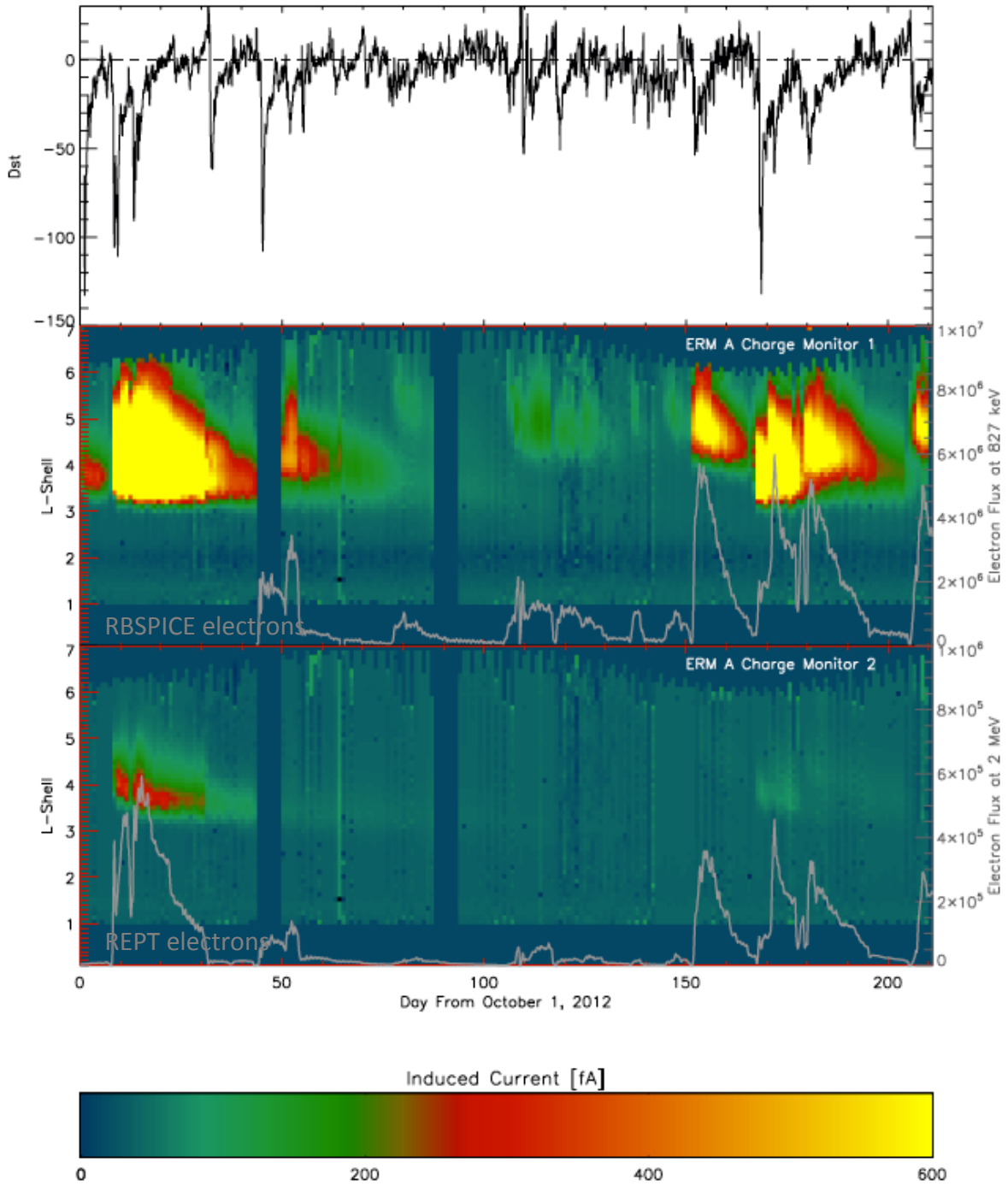
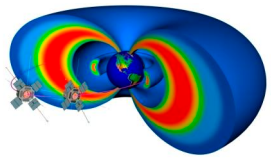
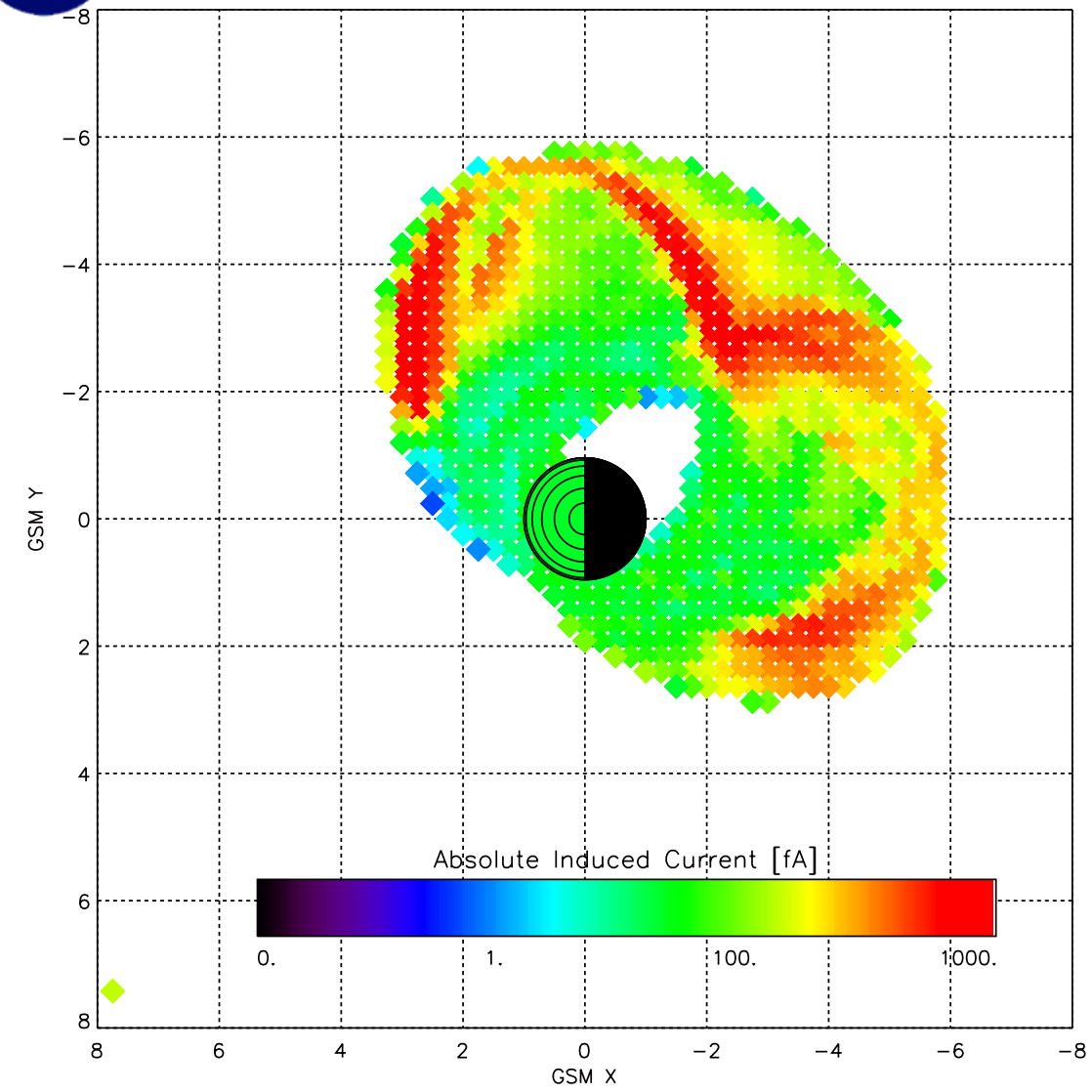




General Characteristics

- Charge enhancements associated with ring-current activity, in turn caused by the magnetospheric response to interplanetary structures (later)
- "Background charging" of ~60-fA
- Reduction of charging in the slot region

APL



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- Charge enhancements associated with ring-current activity, in turn caused by the magnetospheric response to interplanetary structures (later)
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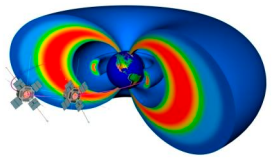
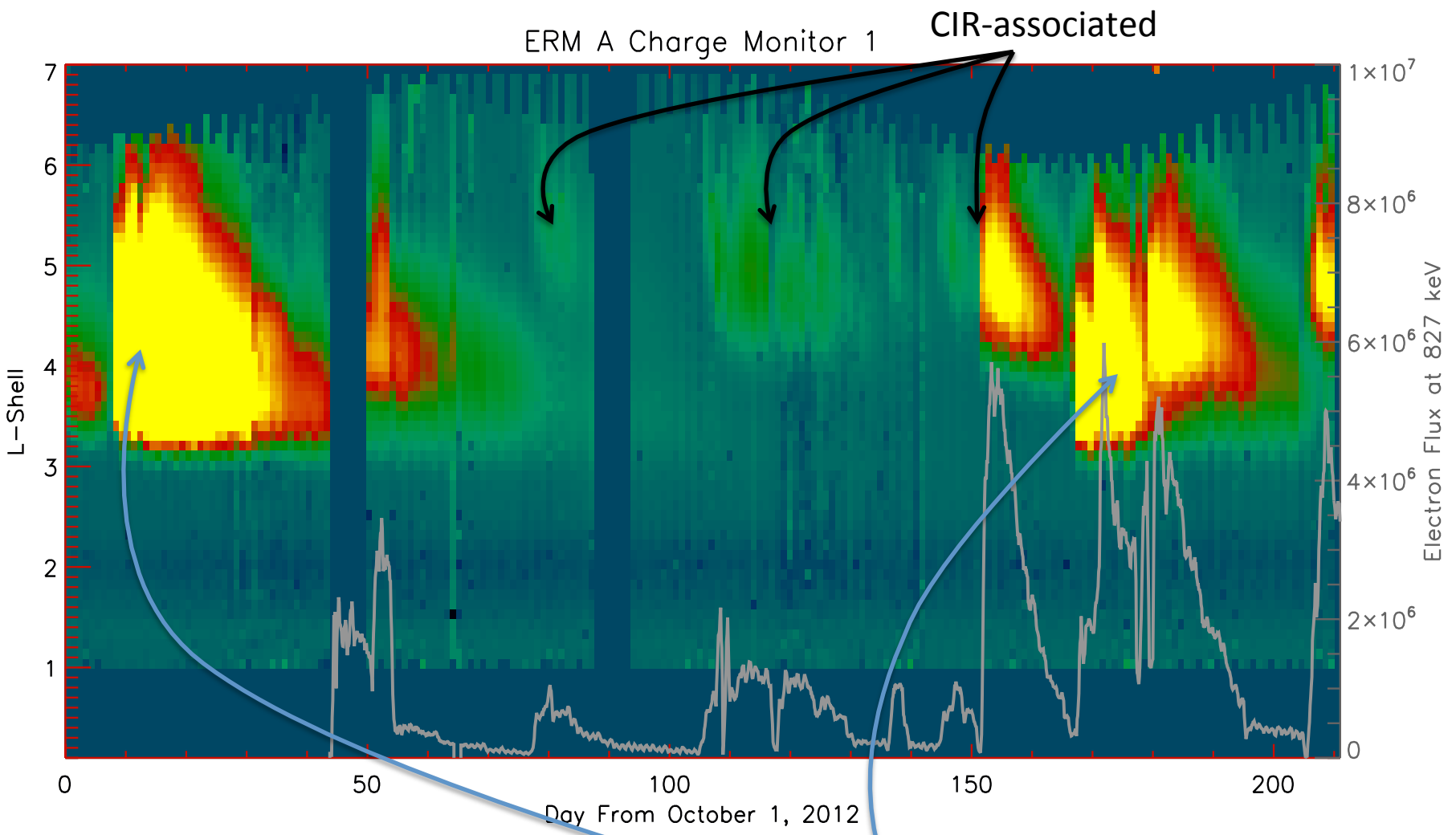
[Note coord. flip on this slide.]

Charging Associated with Interplanetary Structures





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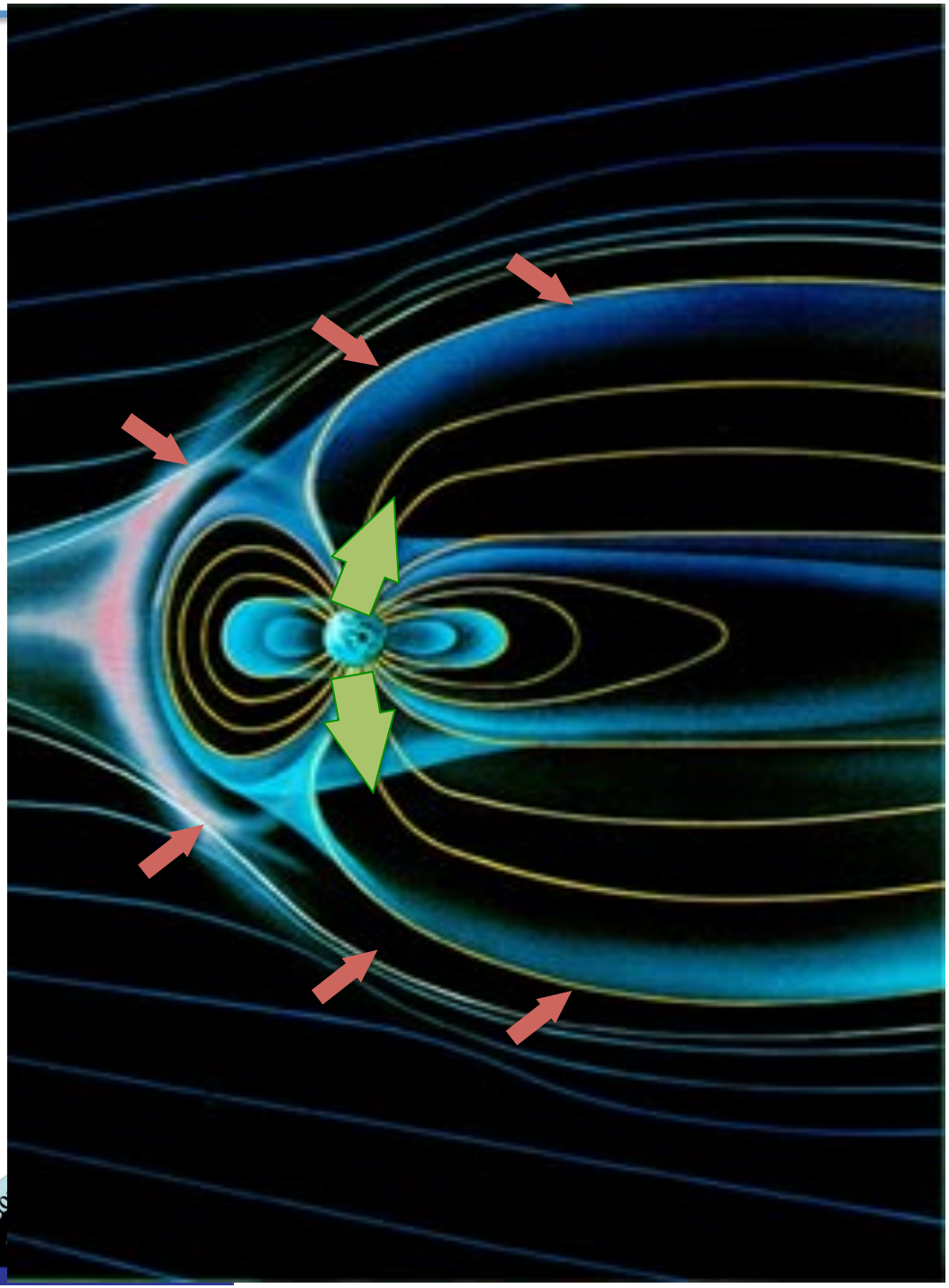
Cautionary Note

- Phase 1: Interplanetary structure enters Earth's space environment
- Phase 2:
- Phase 3:



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Cautionary Note

- Phase 1: Interplanetary structure enters Earth's space environment
- Phase 2: ???
- Phase 3:

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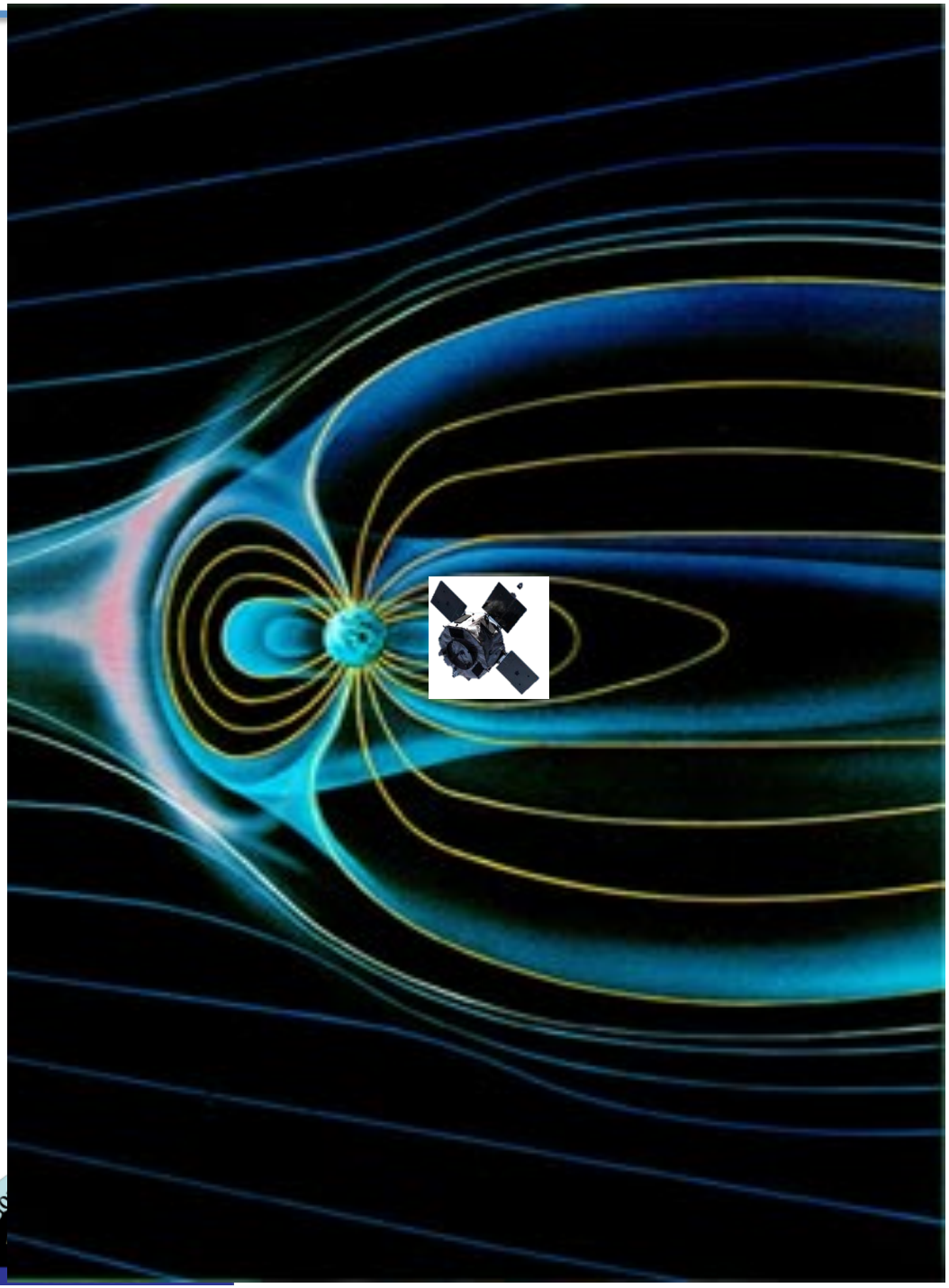
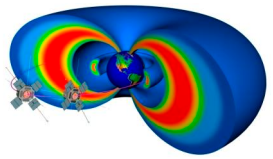
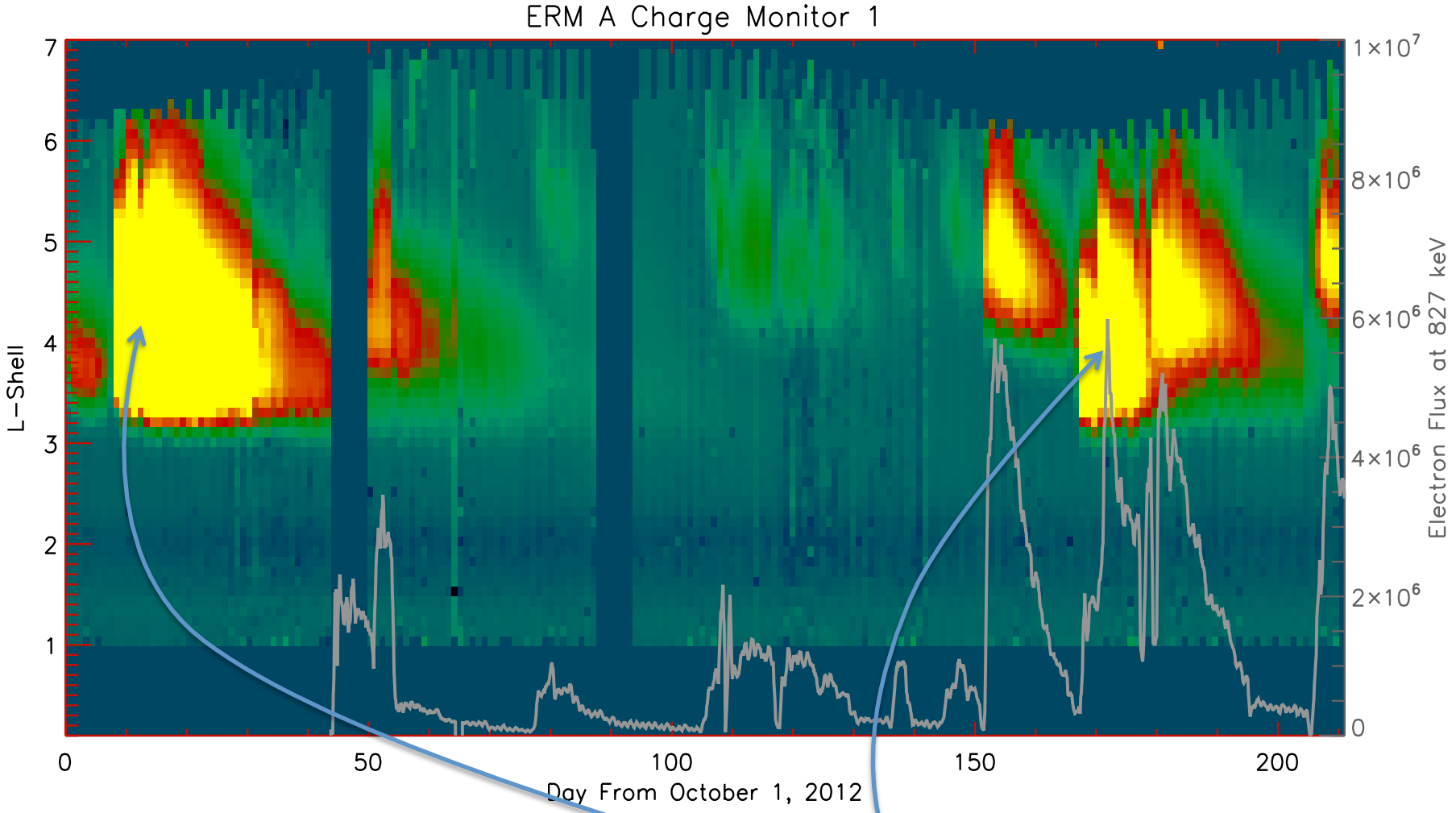
Cautionary Note

- Phase 1: Interplanetary structure enters Earth's space environment
- Phase 2: ???
- Phase 3: Spacecraft Charging



Two CMEs





CME-associated

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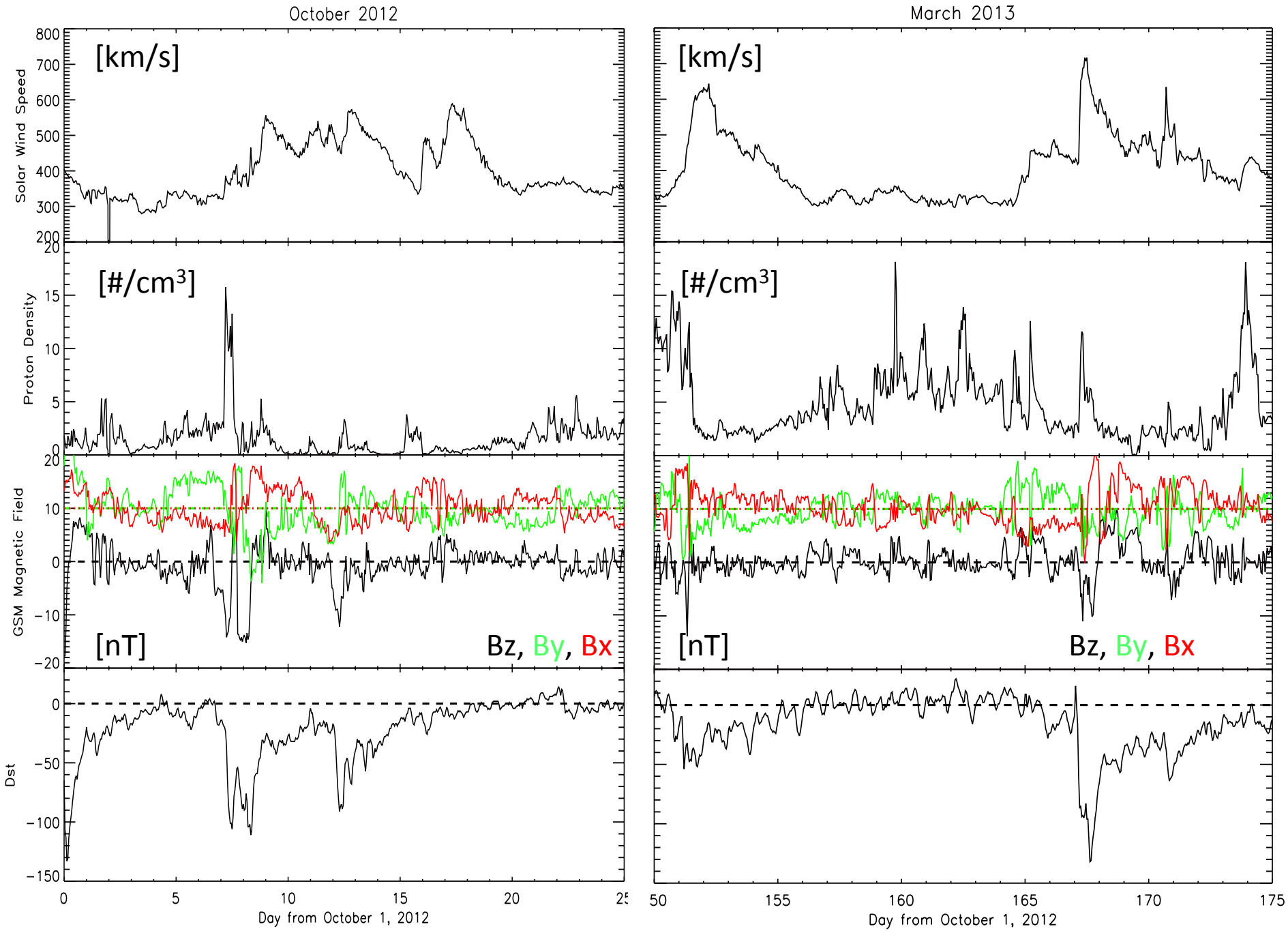
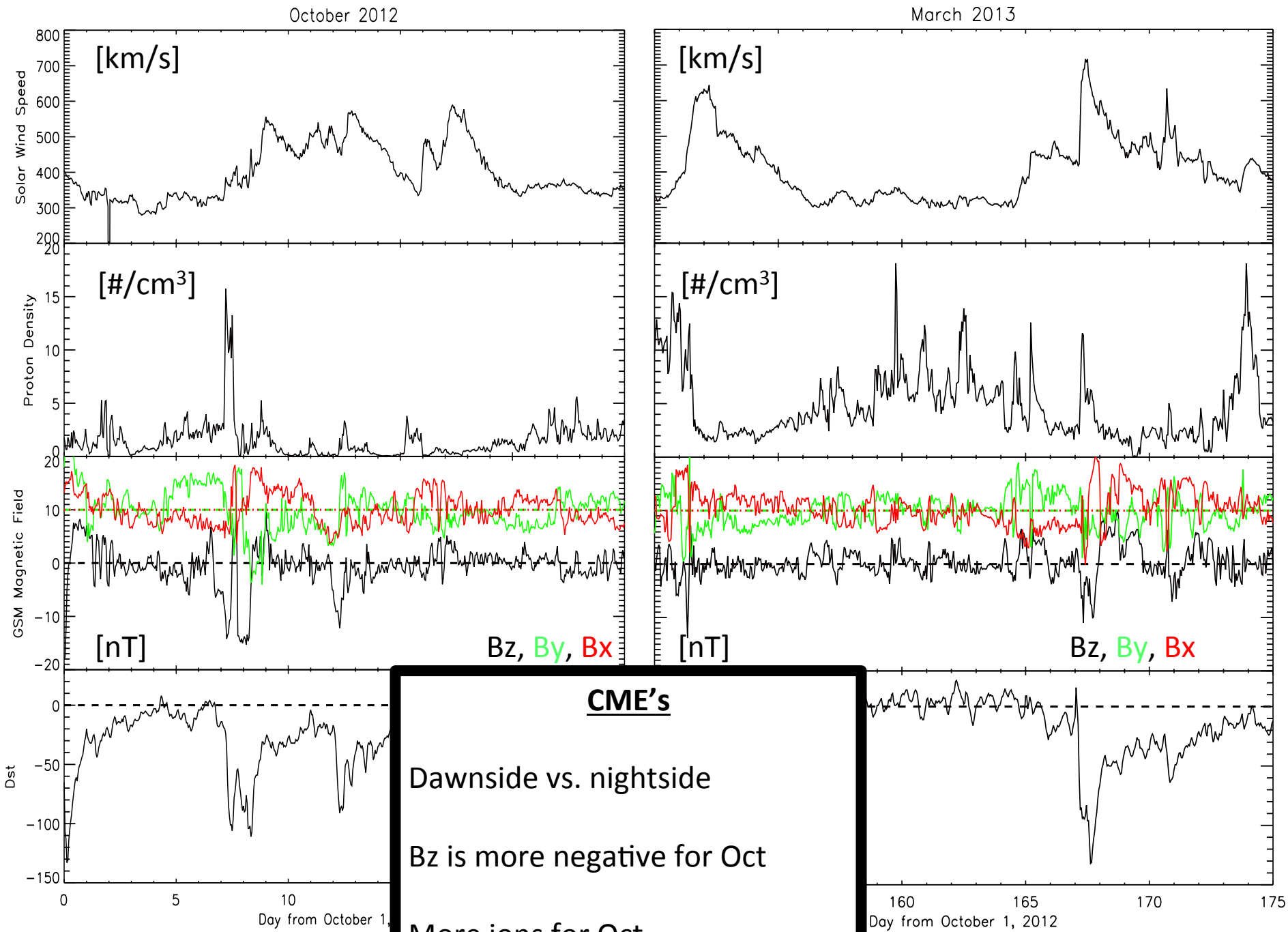

October 2012
March 2013
Solar Wind Speed
[km/s]
Proton Density
[#/cm3]
GSM Magnetic Field
[nT]
Bz, By, Bx
Dst
Day from October 1, 2012
Day from October 1, 2012



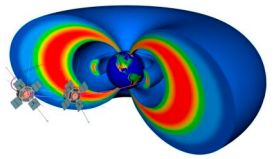
CME's

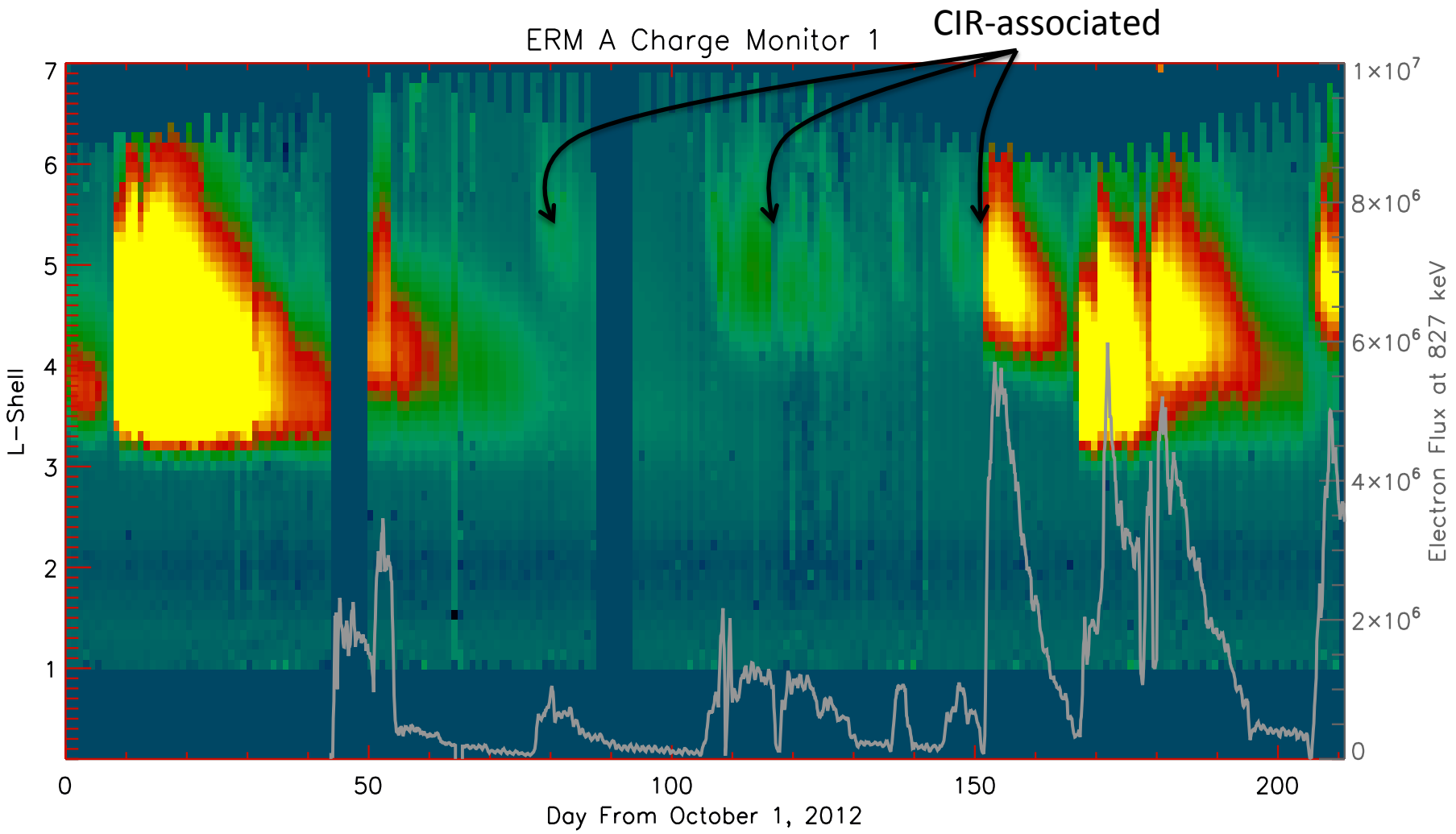
Dawnside vs. nightside

Bz is more negative for Oct

More ions for Oct

CIRs





CME-associated

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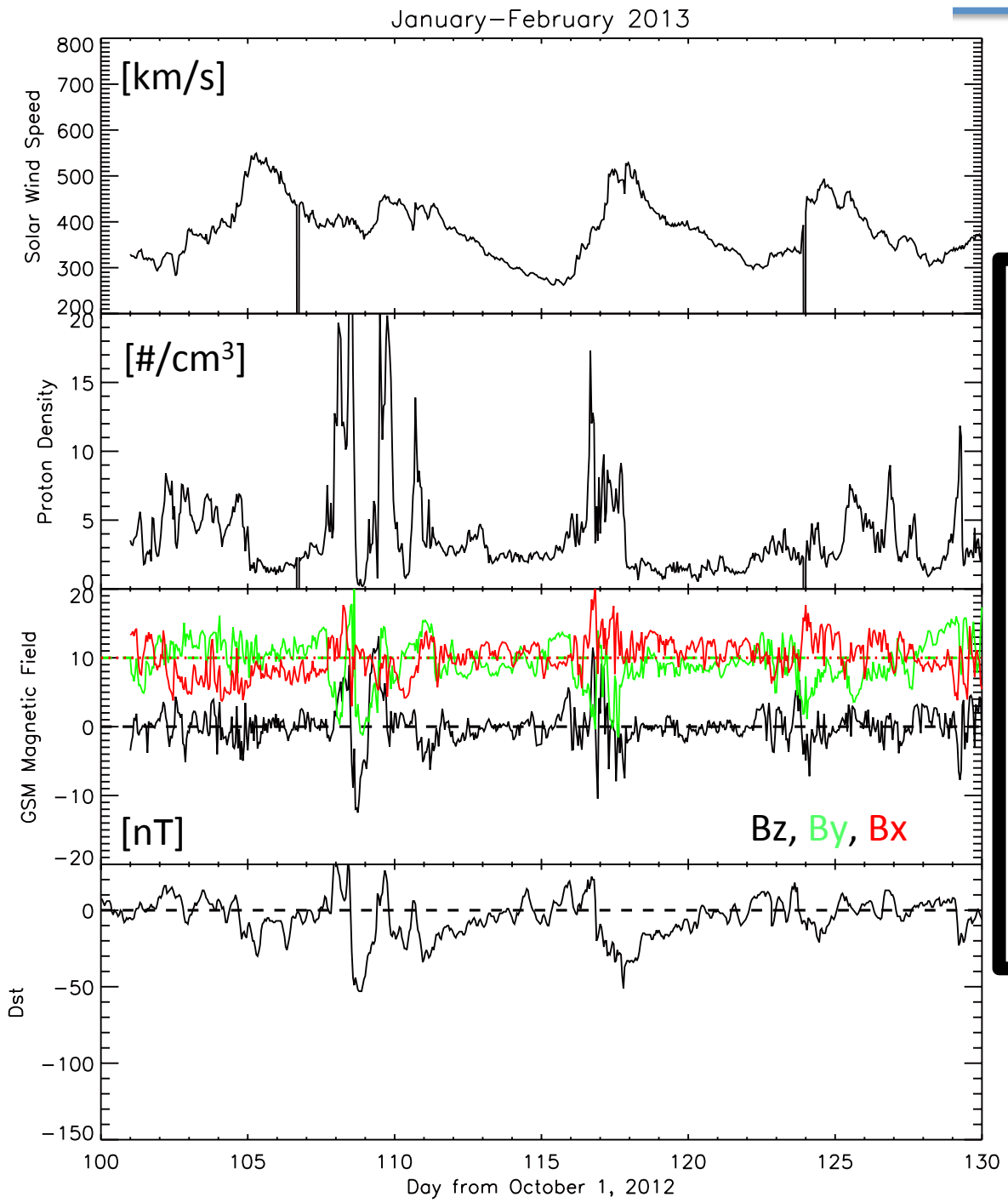
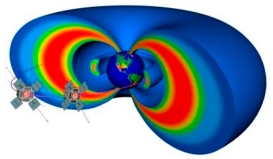




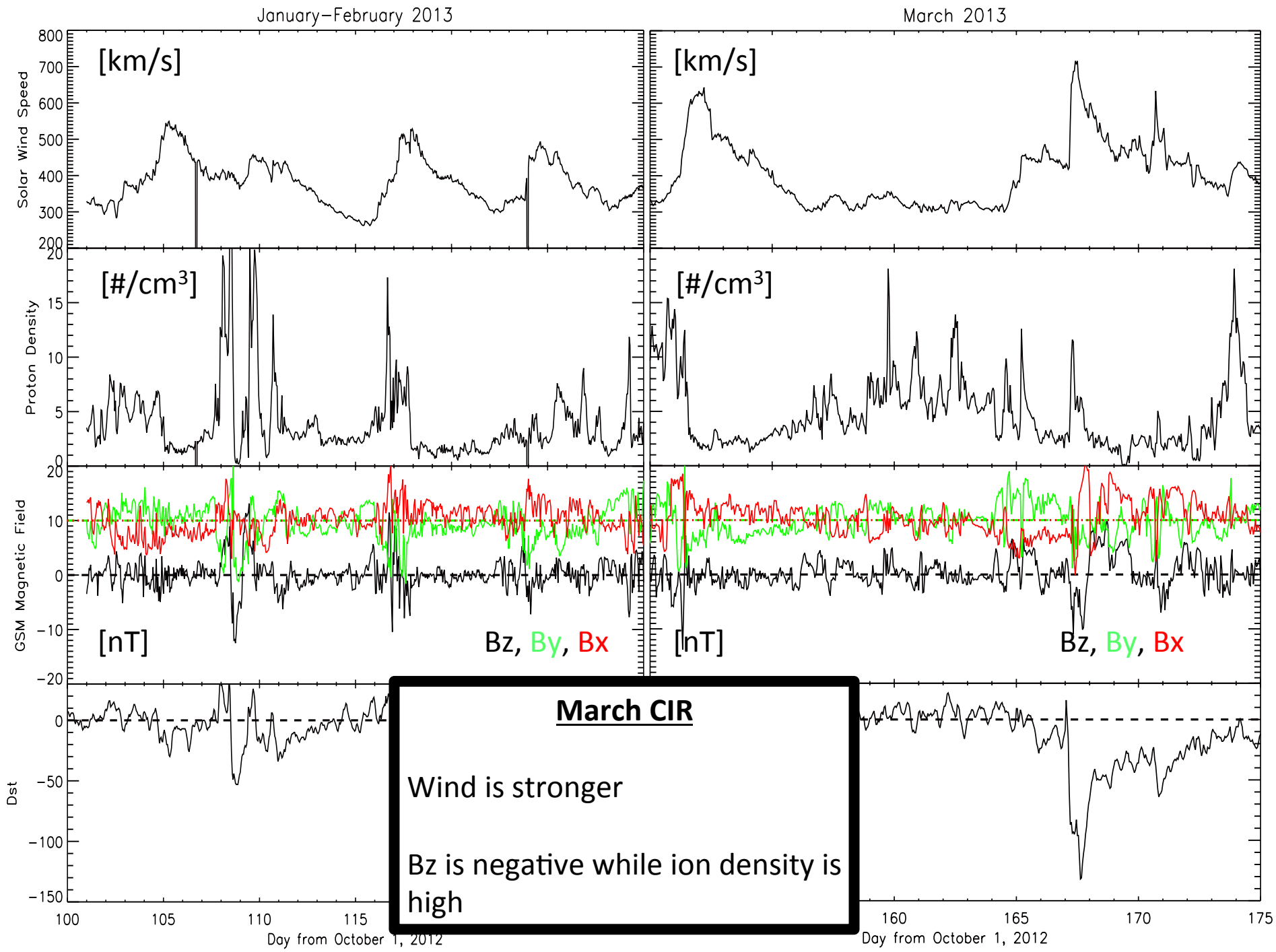
CIRs

Dawnside to nightside

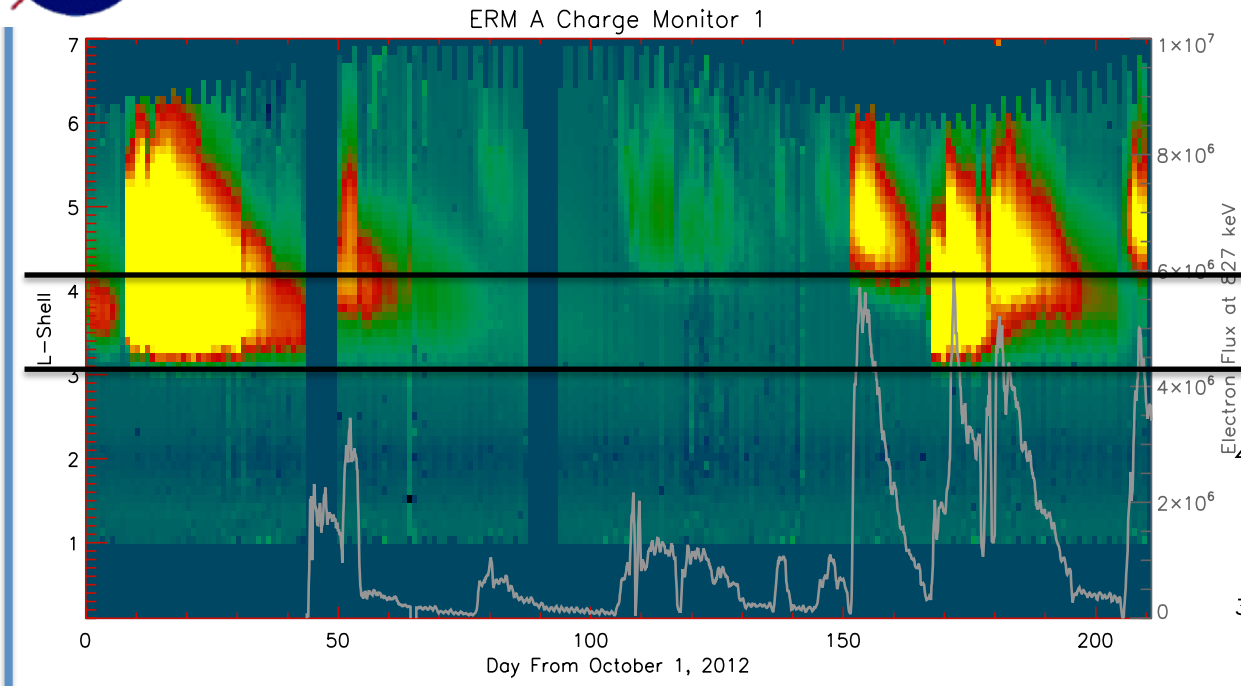
Bz is nominally 0, or negative during low ion densities

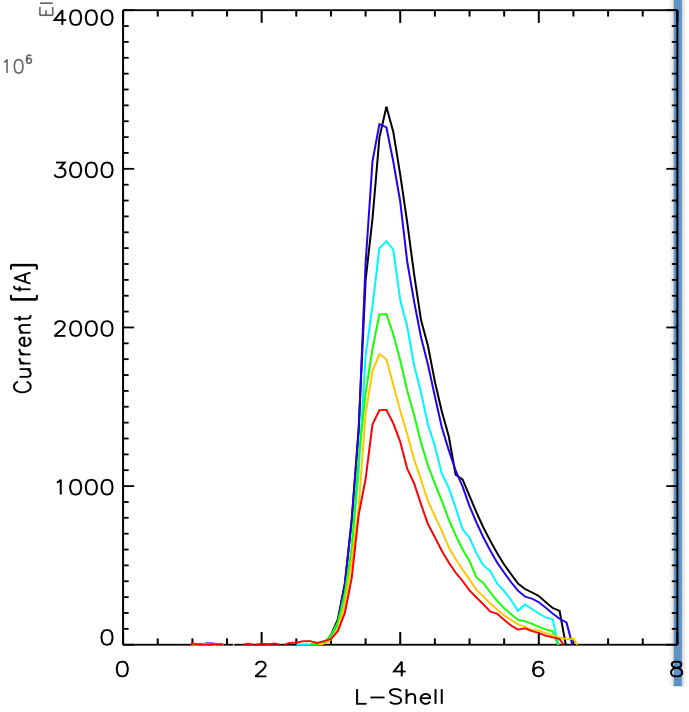
Compression region “driving” more ions into magnetosphere.

March CIR much more effective..


January–February 2013
March 2013
Solar Wind Speed
[km/s]
[km/s]
Proton Density
[#/cm³]
[#/cm³]
GSM Magnetic Field
[nT]
Bz, By, Bx
[nT]
Bz, By, Bx
Dst
March CIR
Wind is stronger
Bz is negative while ion density is high
Day from October 1, 2012
Day from October 1, 2012

“Charge Floors”





- L~3.2 floor expected due to slot region associated with these energies
- Unclear as to the L~4 floor…

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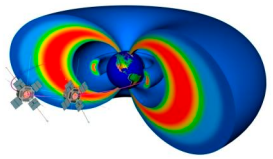
Conclusions To Date



- The next generation of spacecraft charging models (e.g., AE9 “V.20”) will require synoptic charging data.
- The VA Probes ERM can provide such data.
- Already have ongoing catalog of CMEs, CIRs, and ULF associated charging
- As VA Probes precess through one complete orbit of Earth [and more], we will be able to address location dependence

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