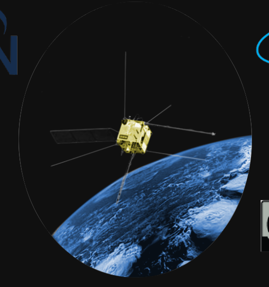

A TASTE OF CSES

Hunting early signatures of inner-magnetosphere rearrangement during geomagnetic storms

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Perusing Earth's magnetosphere

Earth's magnetosphere (MS): efficient trapping device for energetic particles. Its inner portion includes:

- Radiation belts (RBs): Magnetically-trapped relativistic electrons and high-energy ions. Relatively stable inner belt (IRB) at $L \sim 1-2$, and more dynamic outer belt (ORB) at $L > 3$. Ring-current (RC) torus inside the ORB, peaking at $L \sim 4$ in quiet time.
- Slot region (SR): Normally devoid of energetic electrons at $L \sim 2-3$, due to precipitation by wave-particle interactions.
- Plasmasphere (PS): Torus of cold plasma (~ eV) at a few R_E. Predominantly H^+ in quiet time. Highly dynamic outer boundary (plasmapause) in response to enhanced magnetic activity. PS overlapping with ORB, with generation of favored locations for wave growth.

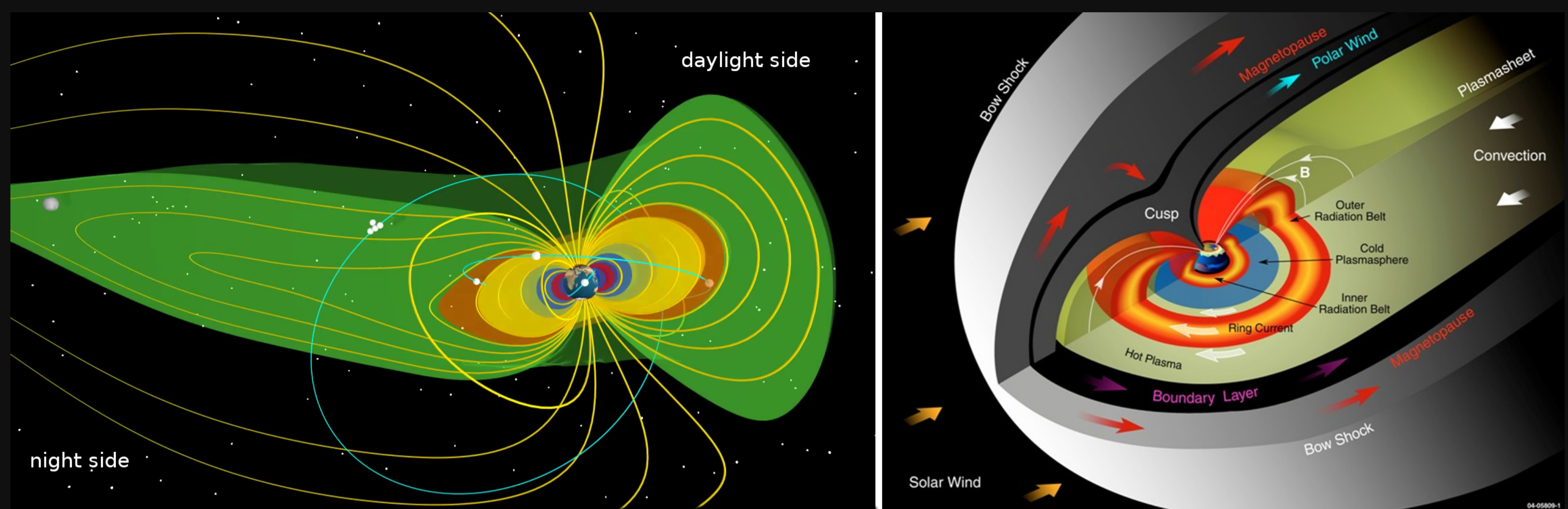

Figure 1 : Left: magnetosphere (yellow lines); plasmasphere (blue region); ring current (yellow region); radiation belts (orange region); plasma sheet (green region). Credits: UCL-MSSL/Chris Arridge (Cluster II Mission). Right: A more detailed view of magnetosphere regions.

The Aug 2018 storm

- Strong G3-class geomagnetic storm ($DST_{min} \sim -190$ nT). Main phase from Aug 25 (17:47:00 UTC) to Aug 26 (07:11:00 UTC), 2018. Minor CME, no SEPS emitted as confirmed by GOES and ACE instrumentation, great asymmetry of planetary impact.
- Rare occurrence at the minimum of the currently ongoing 24^{th} solar cycle.
- Compared to the super solar quiet (SSQ) period of Aug 9-11, 2018 (-10 nT $<$ DST $<$ 10 nT).

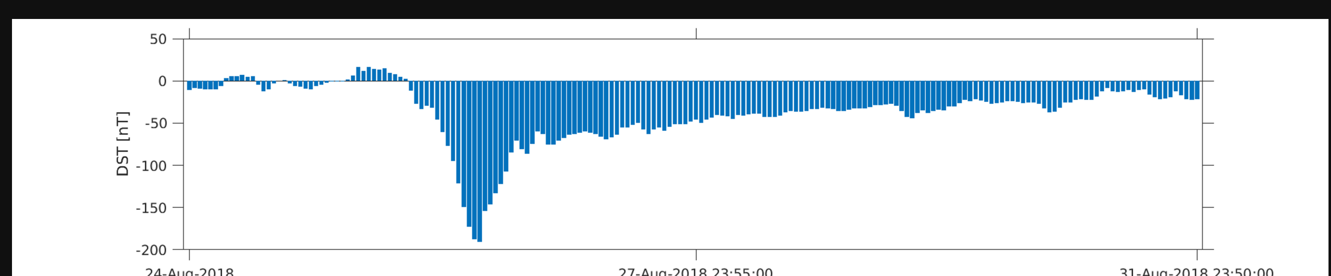

Figure 2 : The DST trend over the period Aug 24-31, 2018.

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Following RB population rearrangements in L

HEPP-H high-energy particle detector [*W. Chu et al., 2018*] monitoring electrons and protons in the lowest portion of its energy range.

- 1-5 MeV electrons: Two pre-existent belts in the ORB ($L \sim 4.5$, $L \sim 6$), seemingly overlapped with the PS, in the SSQ period. Expected e^- dropouts during main phase, with sharpening of belt boundaries; complementary PS erosion confirmed by data from Langmuir Probe on board CSES [*M. Candidi, EGU 2019, poster no. X3.203*]. During recovery, severe buildup of e^- count rates due to multiple re-circulation and radial-transport mechanisms [*Friedel et al, 2002*], and e^- injection into the SR ($L < 3$). Data consistent with older results from the Van Allen Probes [*Goldstein et al., 2016*] and EPT/PROVA-B missions [*Pierrard et al., 2016*].
- 10-40 MeV protons: Fairly stable protons in the IRB ($L \sim 2$) under SSQ conditions, expectedly going lost during main phase [*Engel et al., 2015*], with new, long-lived belt appearing near the inner boundary of the ORB ($L \sim 4.5$). Data consistent with older results from Polar + SAMPEX [*Lorentzen et al., 2002*], and EPT/PROVA-B [*Pierrard et al., 2016*]. Beyond-dipolar-approx refinement needed to fix anomalous results at high latitudes.

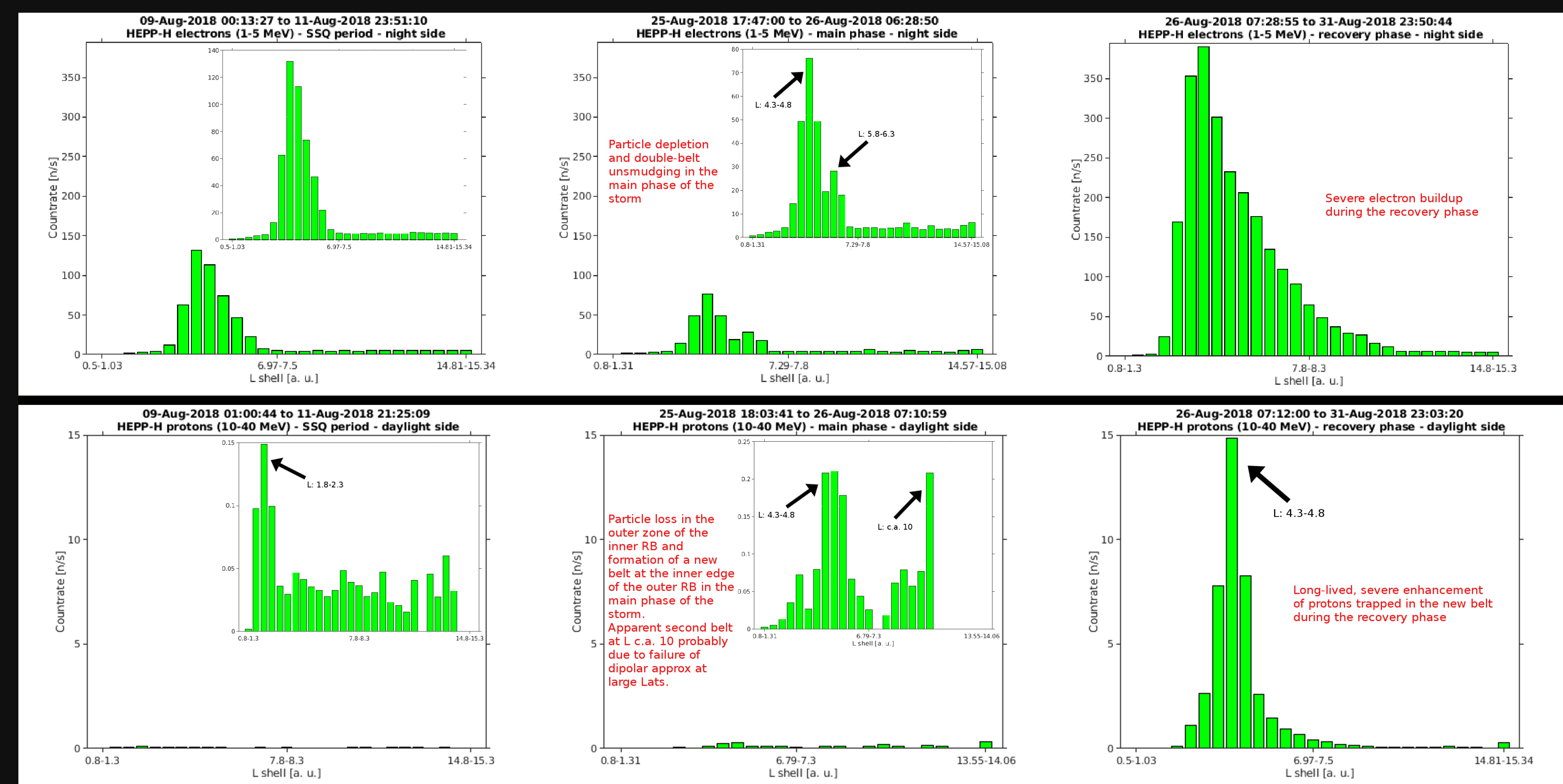

Figure 3 : Top: 1-5 MeV e^- CRs vs L (no SAA included) under SSQ conditions, and in the main and recovery phases of Aug 2018 storm (night side); zoomed trends in the insets. Bottom: Same plots for 10-40 MeV protons (daylight side).

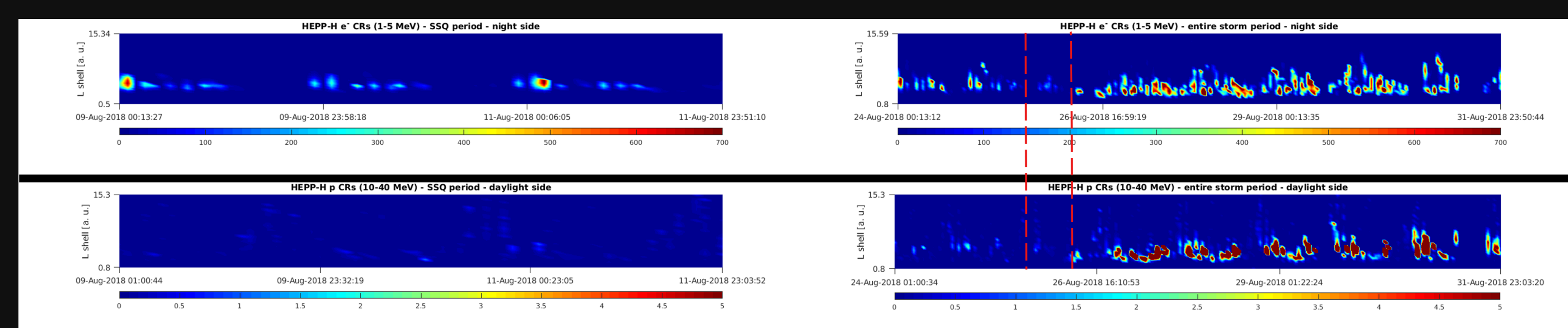

Figure 4 : Top: L-vs-UTC colormap of 1-5 MeV e^- CRs (no SAA included) under SSQ conditions, and over the entire duration of Aug 2018 storm (night side). Vertical red dashed lines enclosing main phase. Bottom: Same plots for 10-40 MeV protons (daylight side).

The geographic outlook

SSQ CR maps consistent with SPENVIS model [`https://www.spenvis.oma.be/`] and SAMPEX data [`http://lasp.colorado.edu/home/sampex`]. Comparison of main+recovery and recovery data consistent with corresponding L and L-vs-UTC maps.

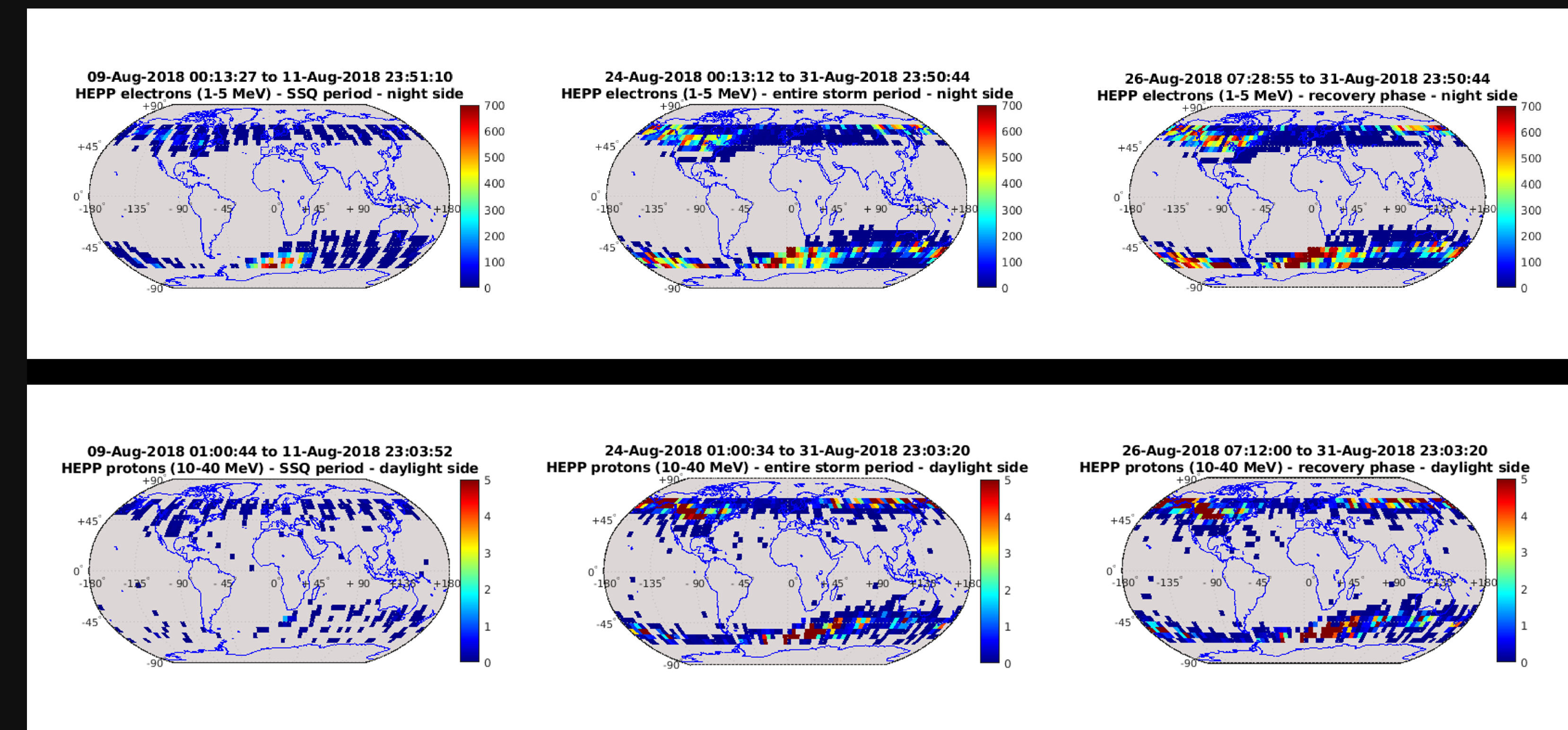

Figure 5 : Top: Geomap of 1-5 MeV e^- CRs (no SAA included) under SSQ conditions, and over the entire duration and recovery phase of Aug 2018 storm (night side). Bottom: Same plots for 10-40 MeV protons (daylight side).

An alternative view: Solar Magnetic reference system

Long-lived packing down of e^- and p CR distributions on the xy plane after the arrival of the storm, with enhancement of the "plume" along the z axis and approximately annular enhancement around the Earth (possible proxy of storm-induced current-system rearrangement). Sun along positive x direction, after rotation around y axis by dipole tilt angle.

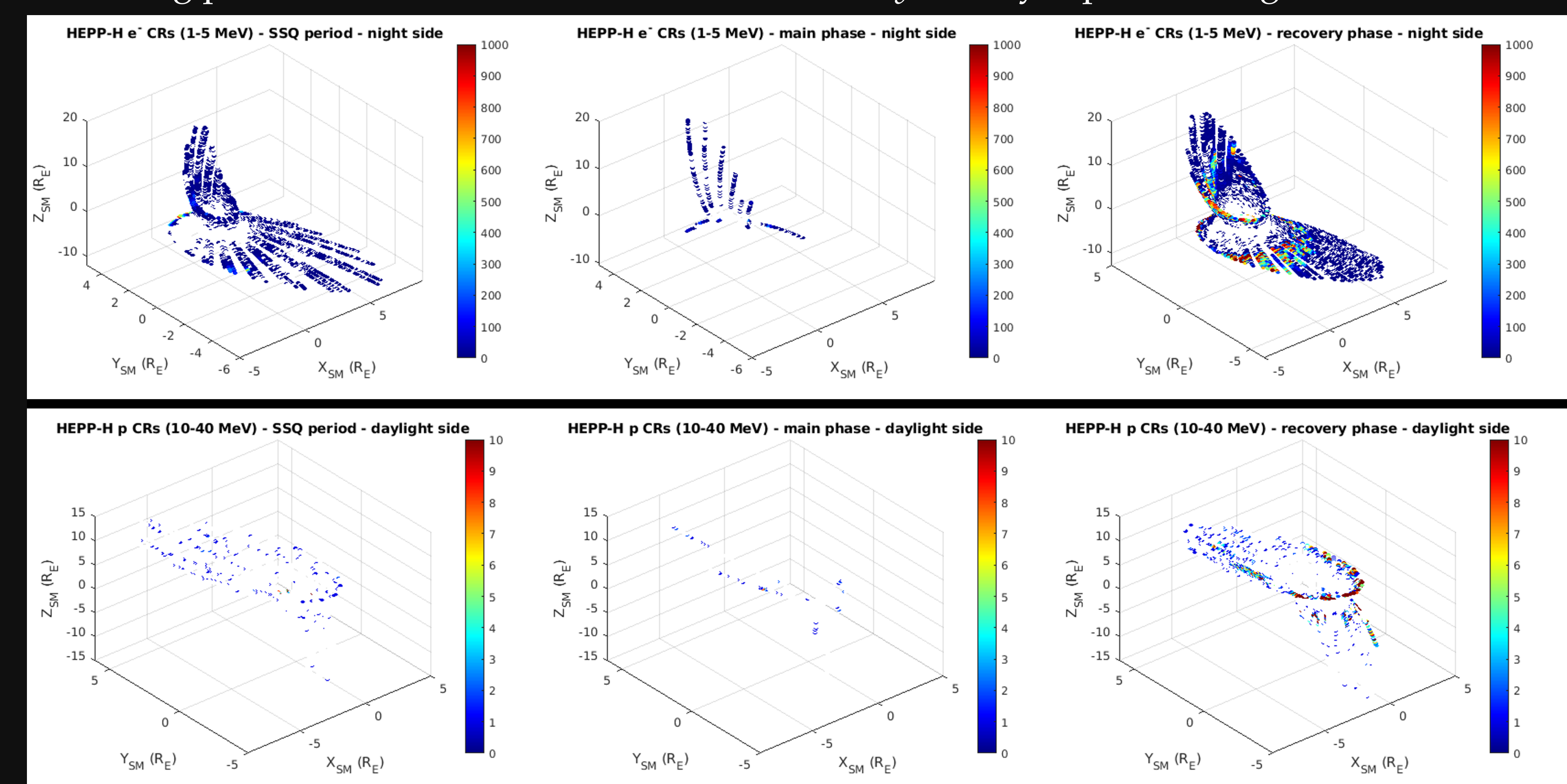

Figure 6 : Top: 1-5 MeV e^- CR in the SM reference system (no SAA included) under SSQ conditions, and in the main and recovery phases of Aug 2018 storm (night side). Bottom: Same plots for 10-40 MeV protons (daylight side).

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