

Oxygen Flux Variation During a Stormtime Substorm on May 6, 1988

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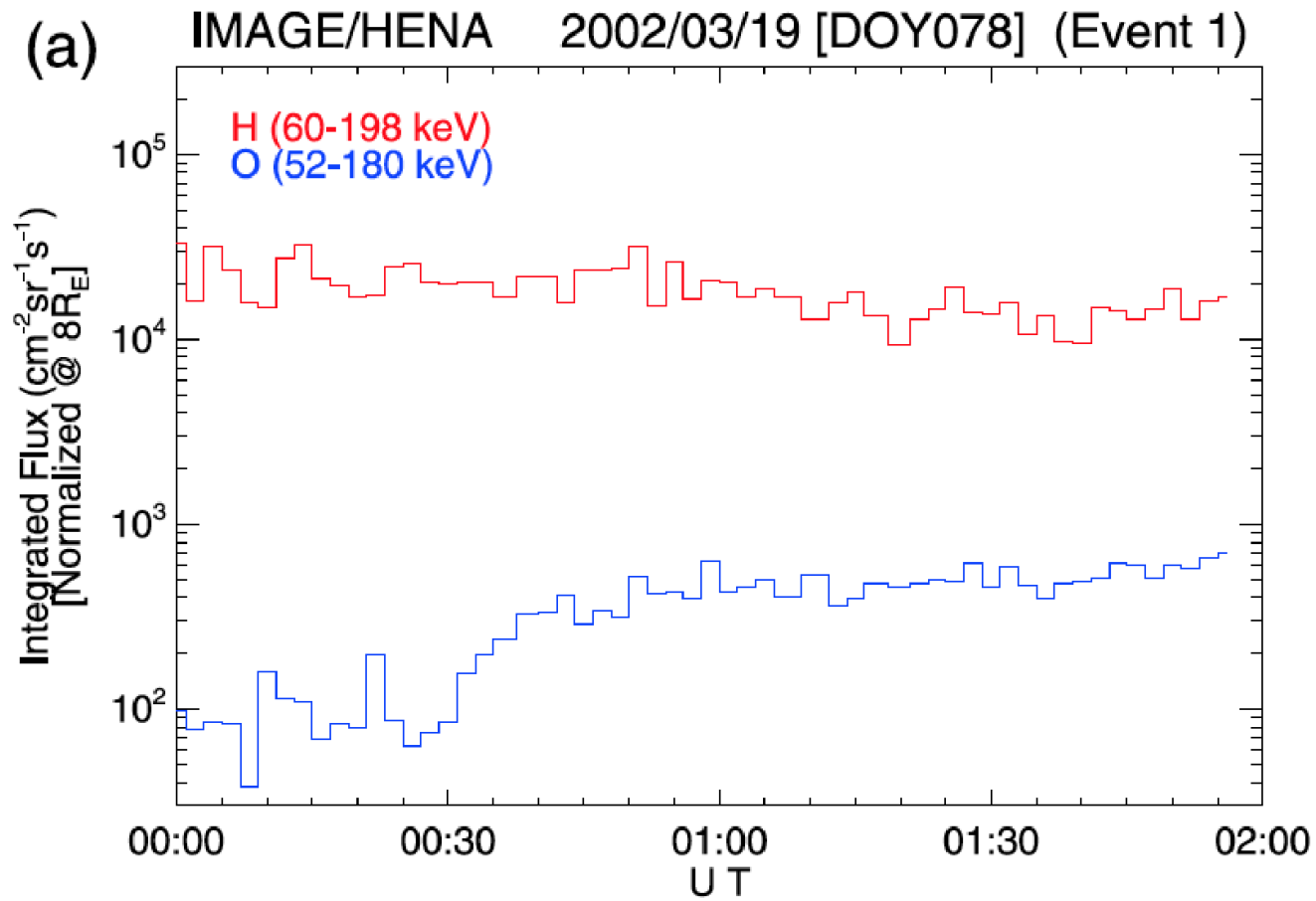
Outline

- Introduction
- Satellite data
 - Magnetic field
 - Particles
- Possible scenarios for O⁺ flux enhancement
- Summary

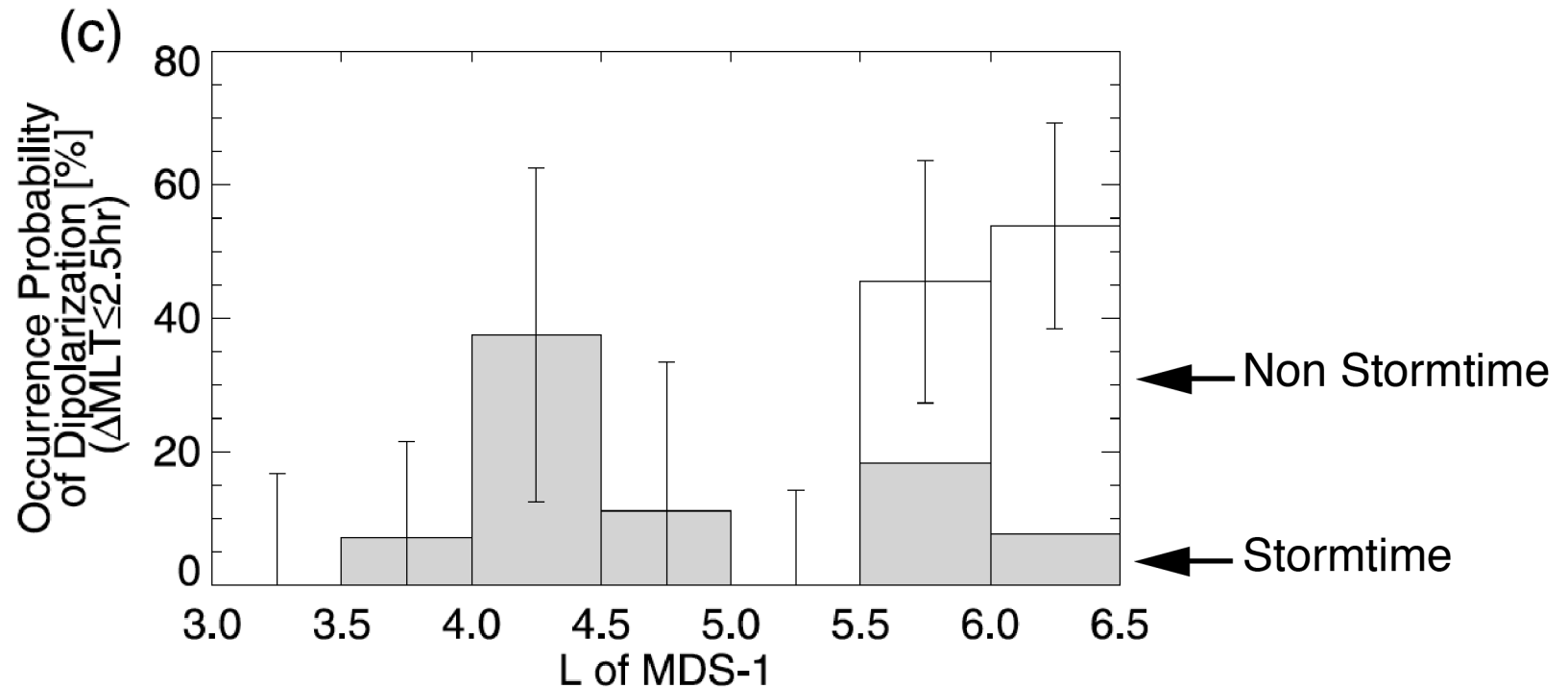
O⁺ flux enhancement during stormtime substorm

- Flux of ring-current energy O⁺ increases after substorm onset during storms
- Remote sensing (IMAGE ENA) provides global view of O⁺ enhancements
- In situ measurements are sparse
- The mechanisms are not well established
- High-quality measurements are expected with the RBSP mission
- Get ready for the RBSP mission by visiting old events

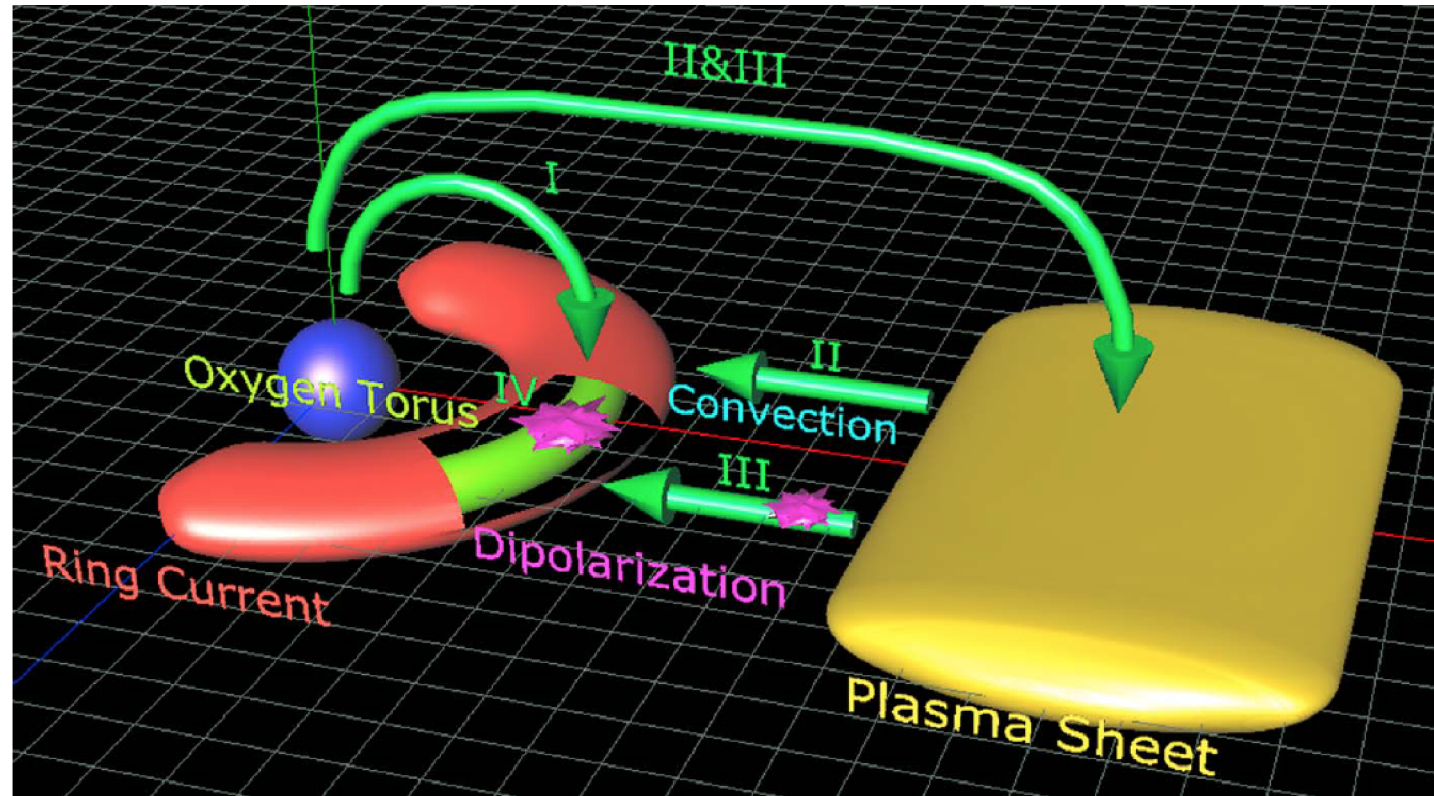
ENA remote sensing of storm time ions



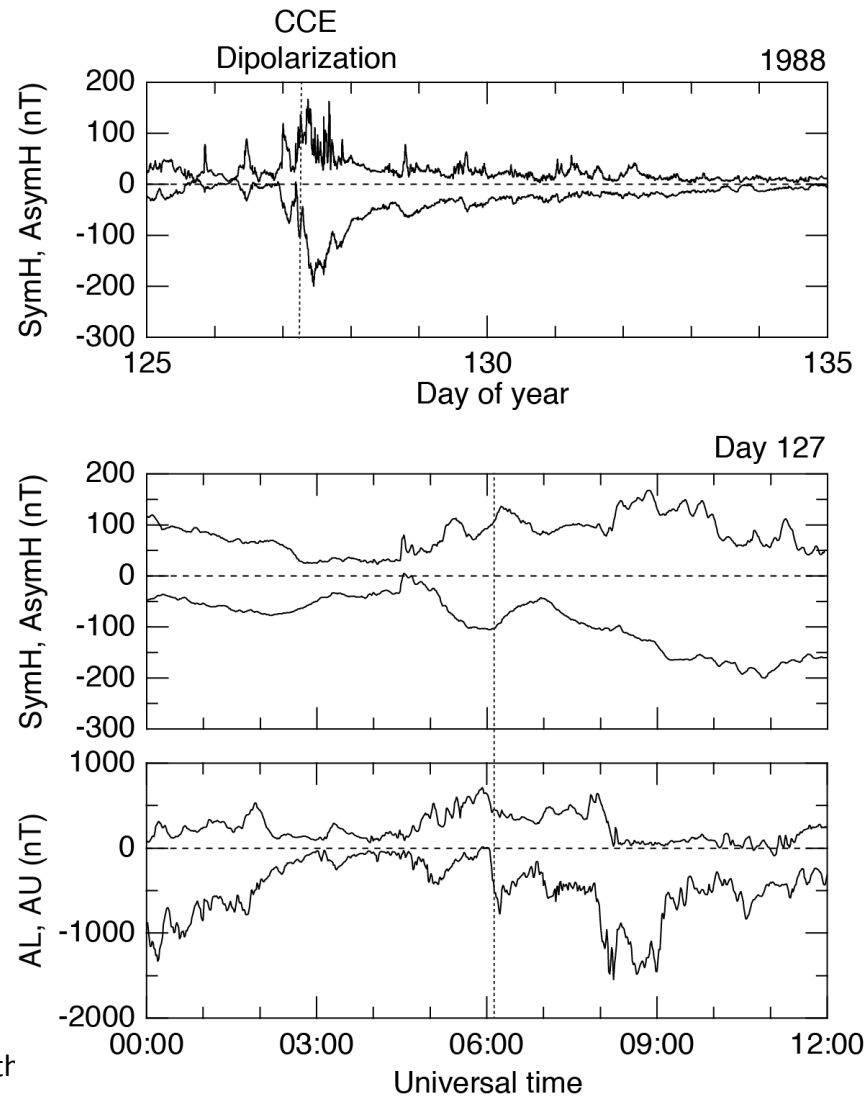
Dipolarization occurrence



O^+ transport and acceleration

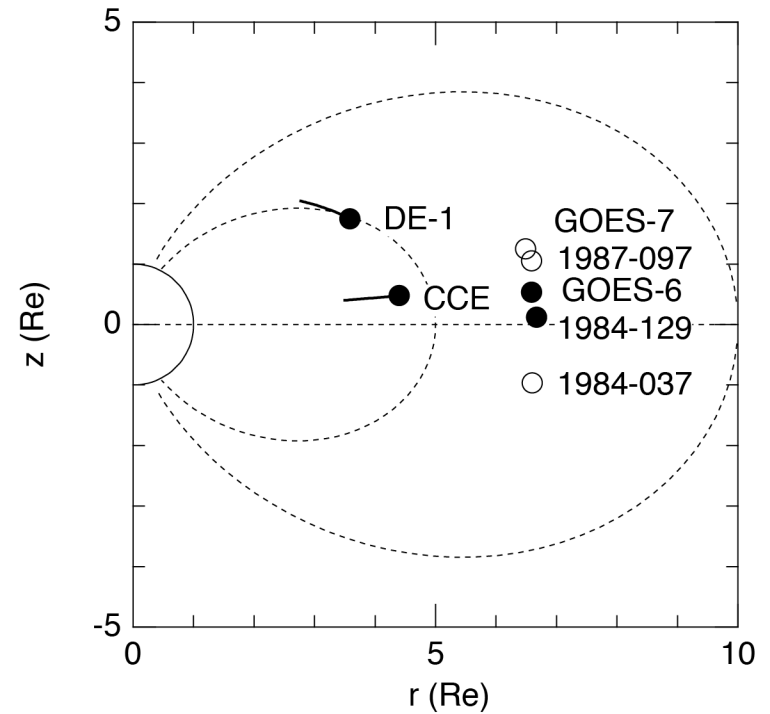
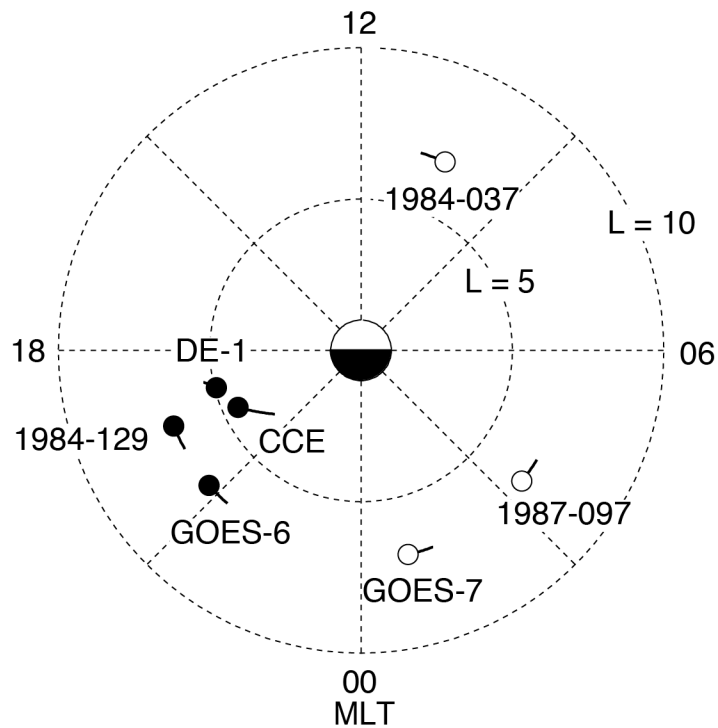


Geomagnetic condition

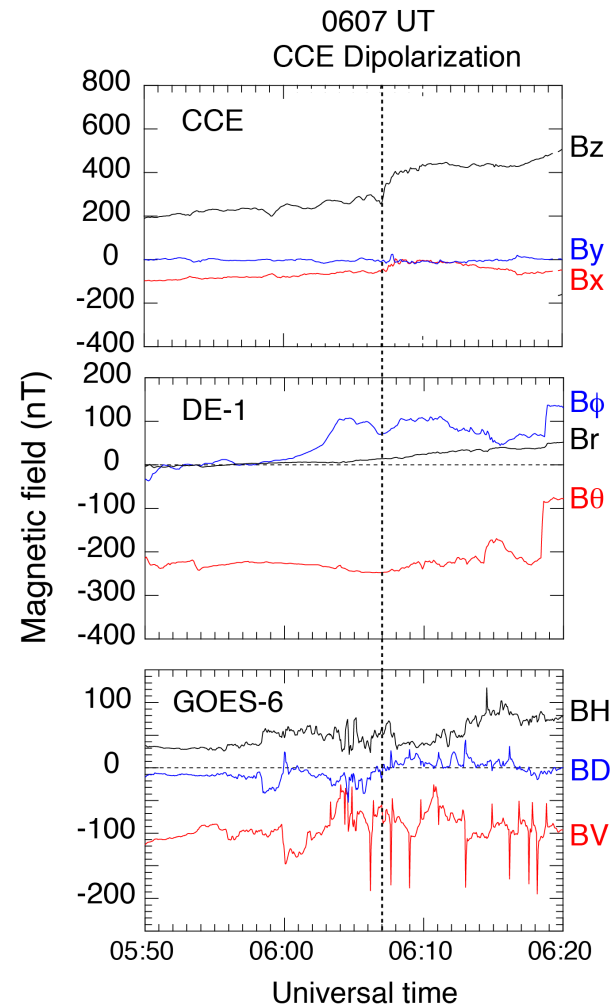
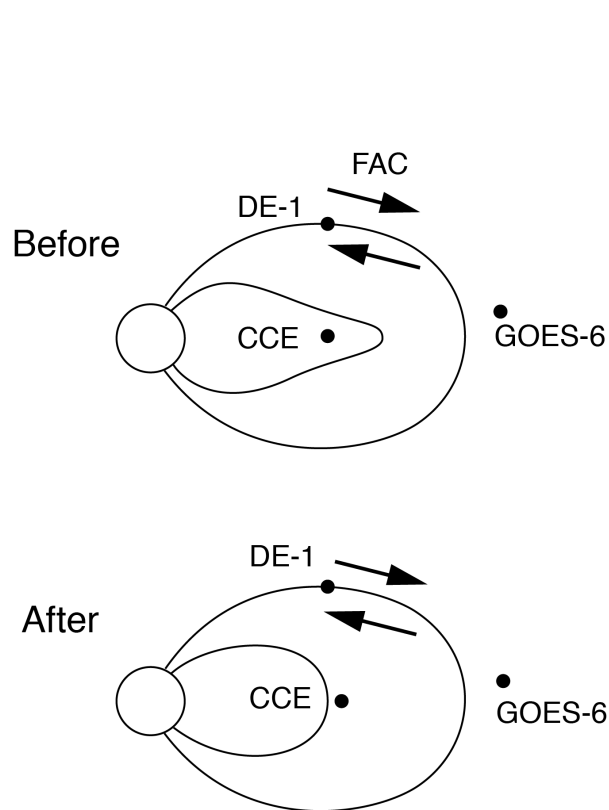


Satellite positions

1988 May 6 (Day 127) 0550-0620 UT



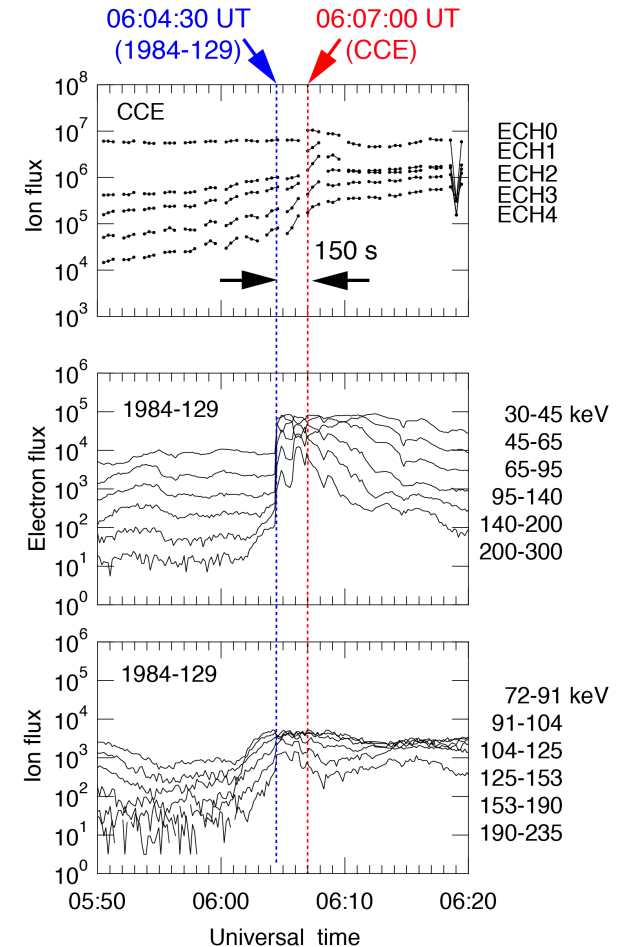
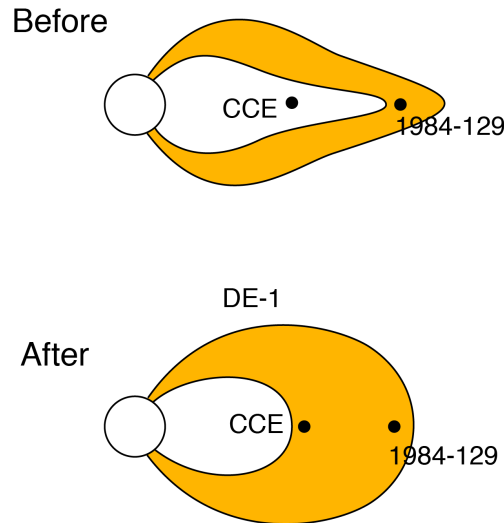
Magnetic field variations



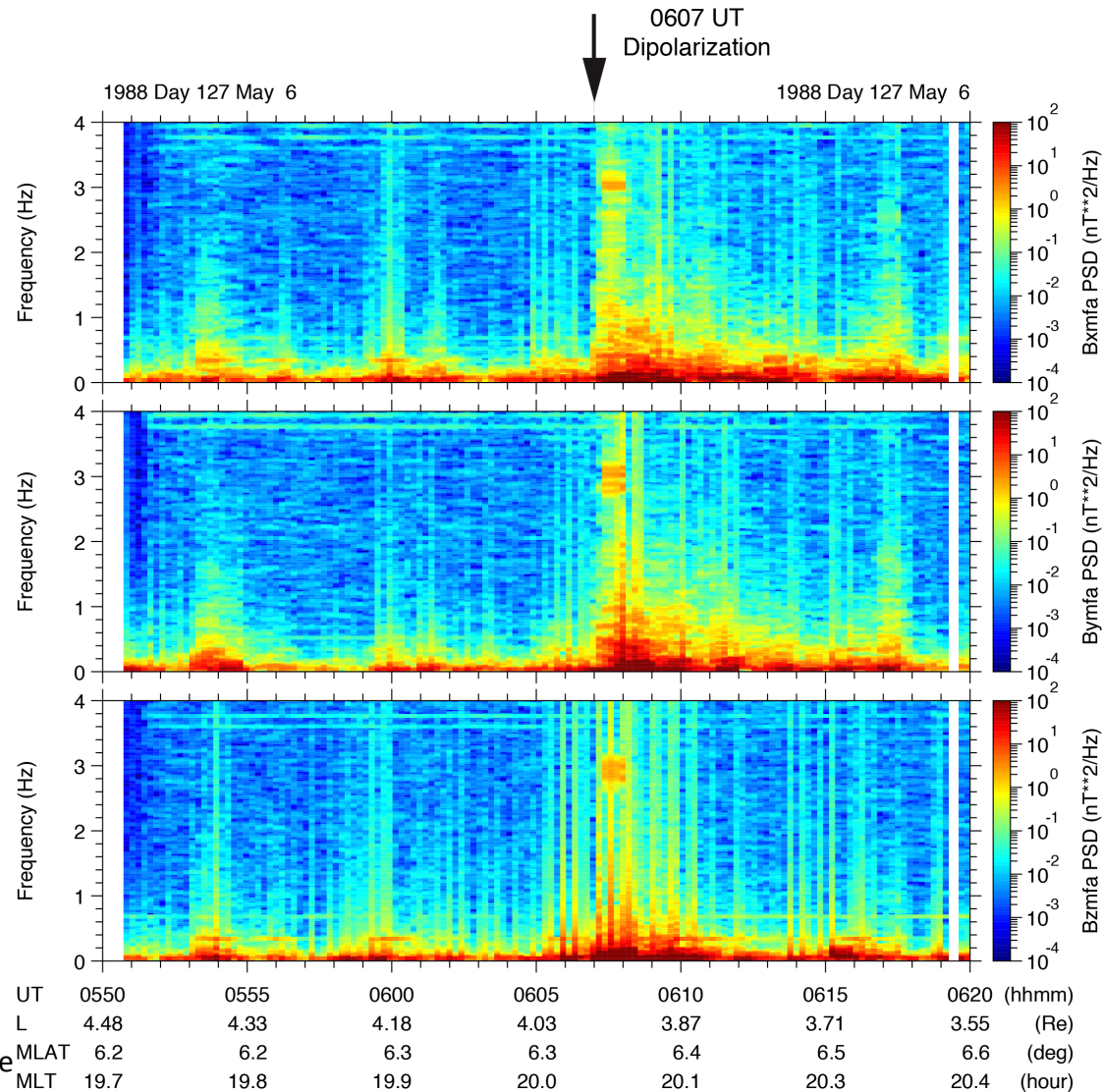
Energetic particle flux variations

- Dispersionless injection at 1984-129
- Apparent inward propagation of the “injection front”
- $V_{\text{injection Front}} \sim 110 \text{ km/s}$

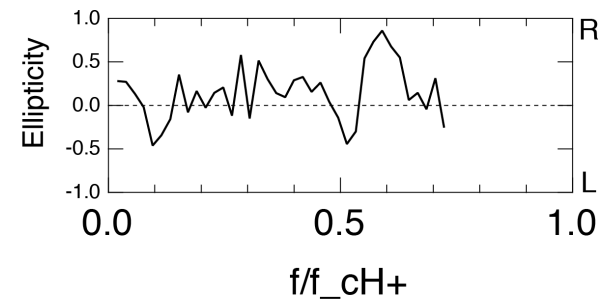
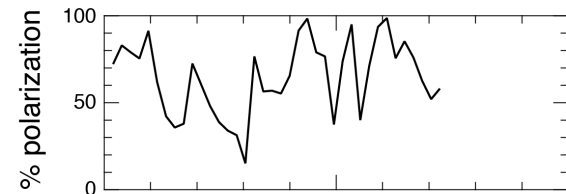
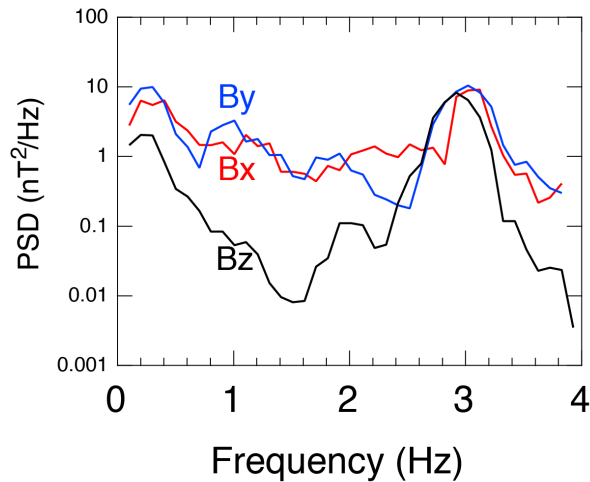
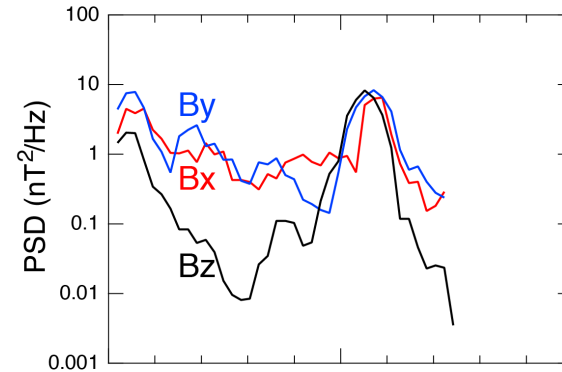
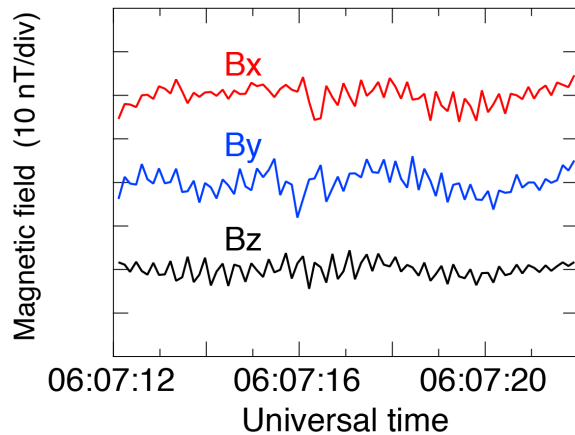
1988 May 6 (Day 127)



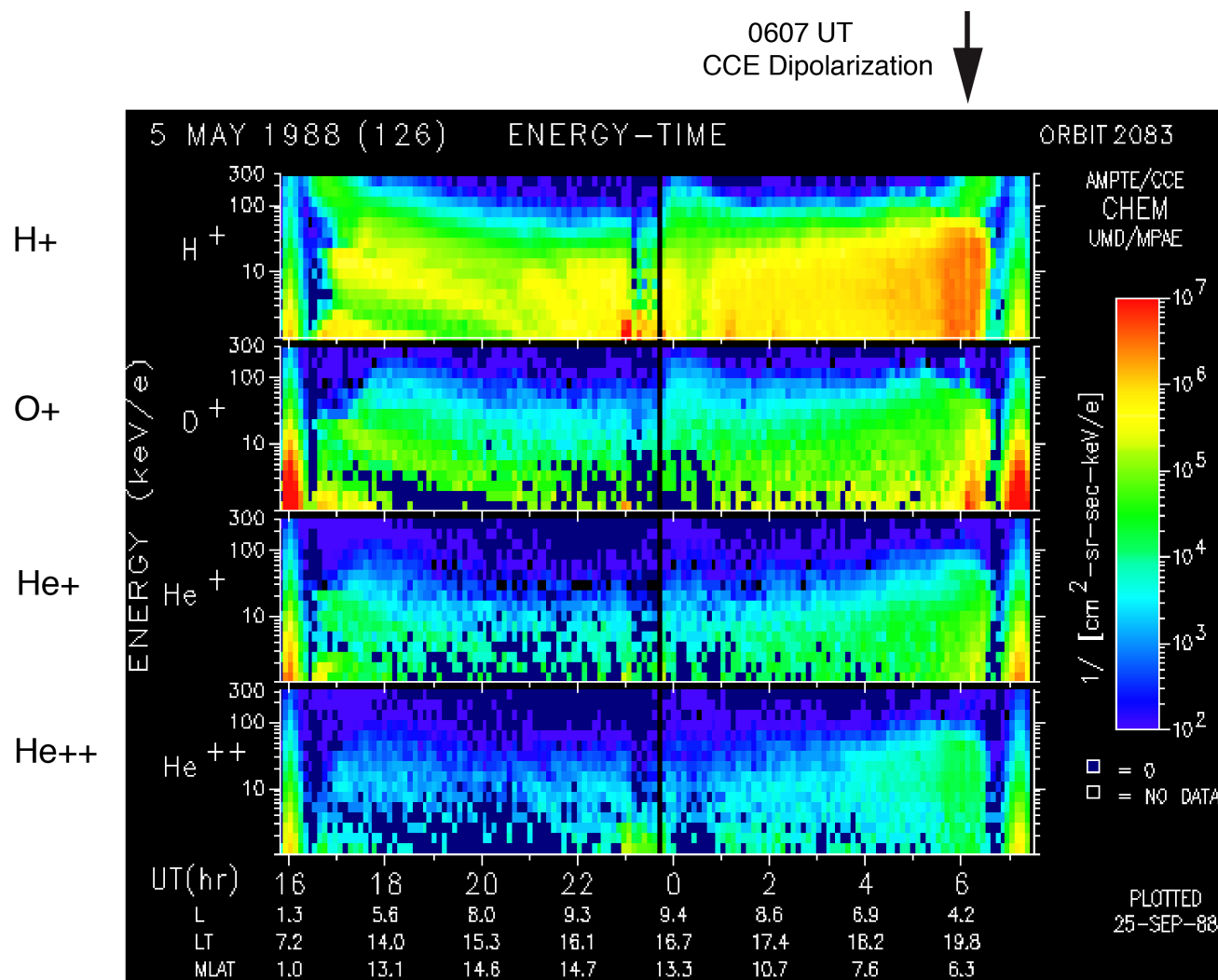
Magnetic field spectra at CCE



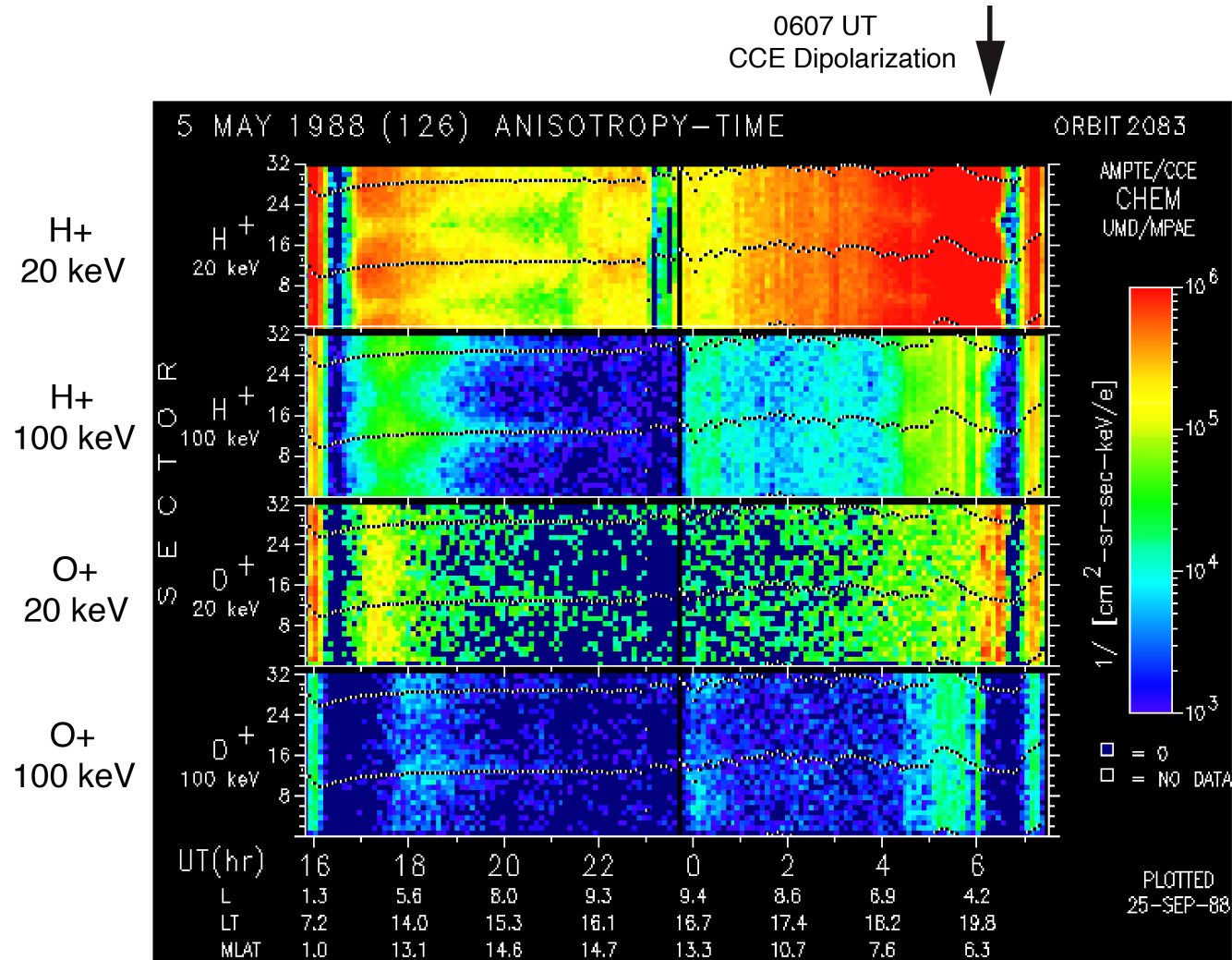
EMIC waves at CCE



CHEM energy vs time spectrogram

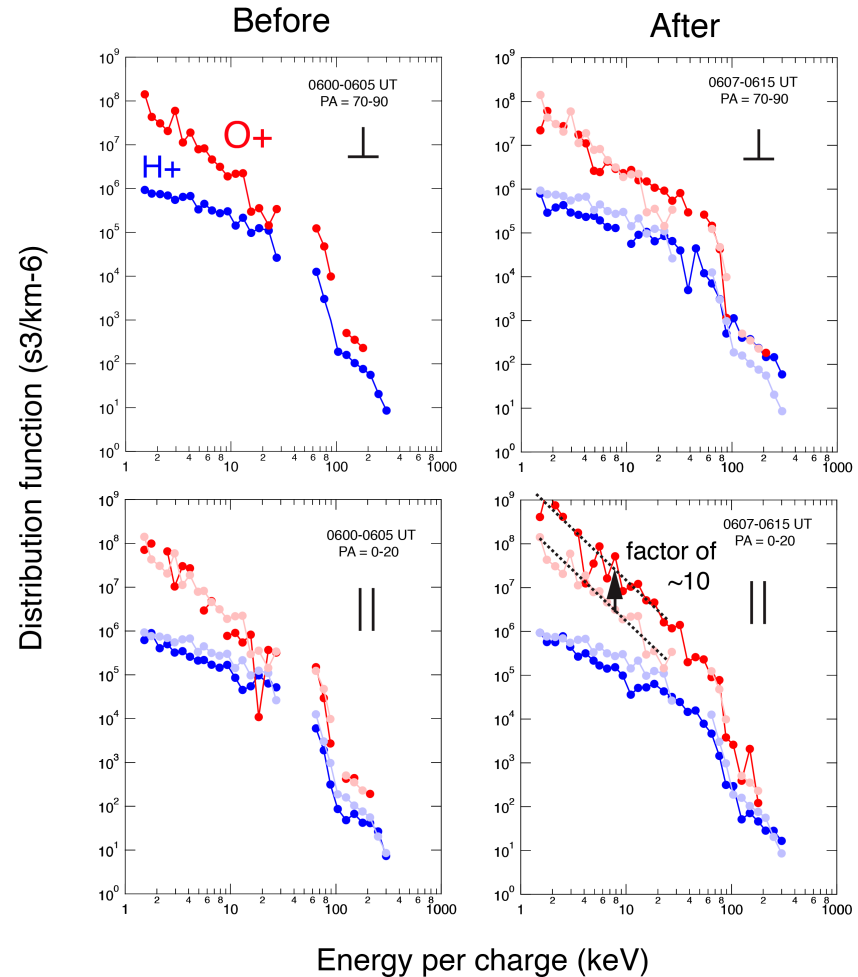


CHEM pitch angle vs time spectrogram



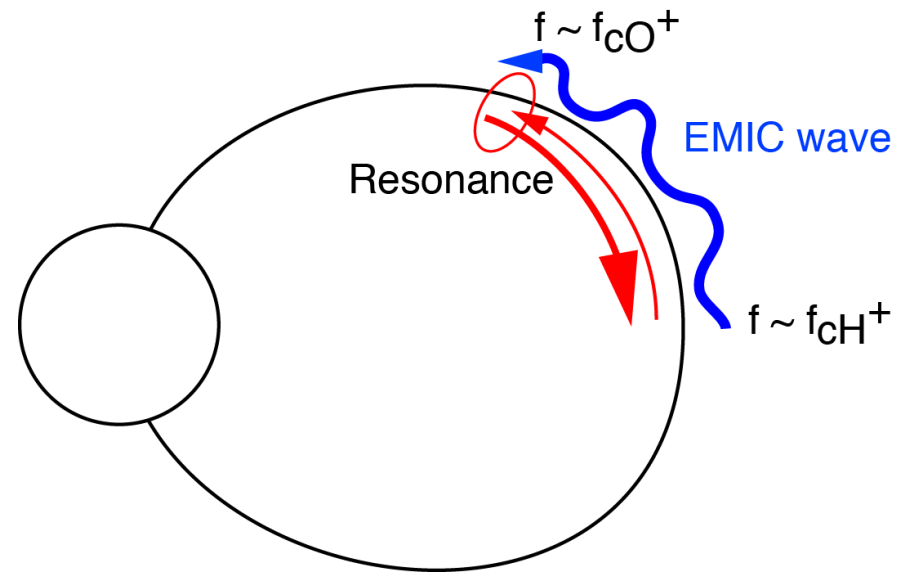
CCE CHEM phase space density

- H^+ PSD unchanged
- O^+ PSD elevated by a factor of ~ 10
 - at $E < 30$ keV
 - at $PA < 20$ deg



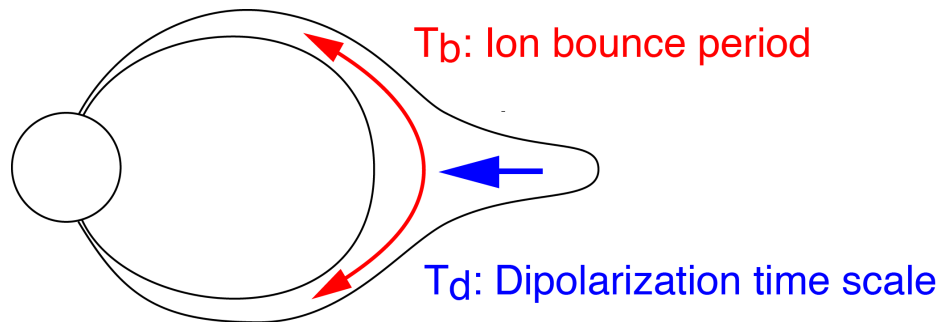
Possible scenario: 1

- Equatorial excitation of EMIC wave by H^+ temperature anisotropy
- O^+ resonance with the wave at high latitude
- Discussed by Thorn and Horn [1997]



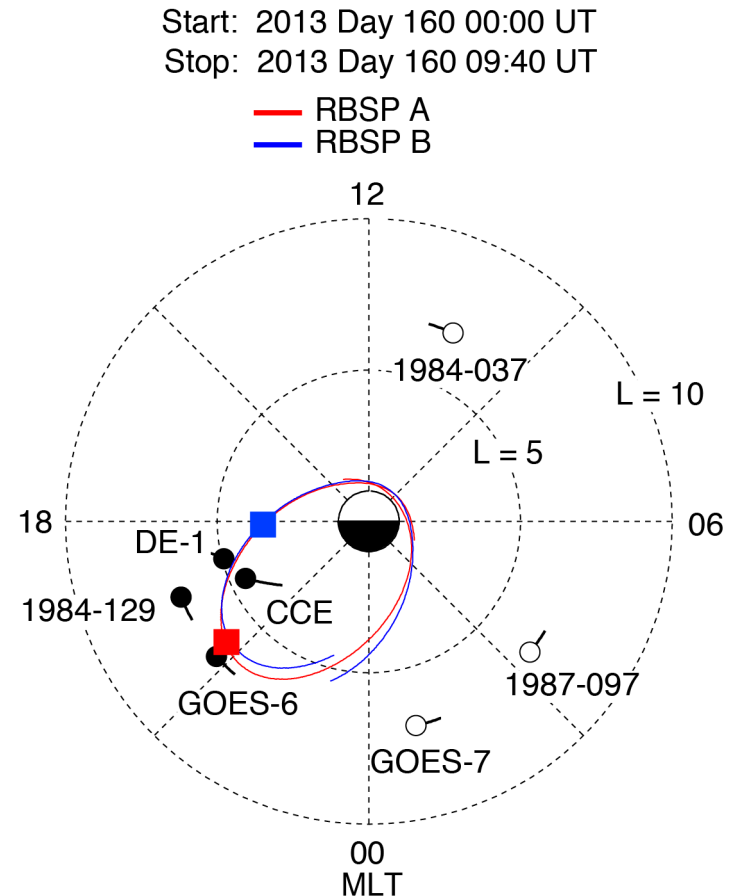
Possible scenario: 2

- Violation of the second adiabatic constant
- Effective if bounce period (T_b) is longer than dipolarization time scale ($T_{\text{dip}} \sim 1\text{-}3 \text{ min}$)
- At $L \sim 4$, $T_b \sim 3 \text{ min}$ for 20 keV O^+
- Discussed by Jones et al. [2006]



RBSP observations

- 2 identical SC on identical orbits (with time delay)
- Superior instrumentation
 - Plasma
 - Energetic particles
 - Ion composition
 - E and B fields (DC + waves)
 - 12-s particle duty cycle
(vs 3 min for CCE CHEM)



Summary

- CCE detected dipolarization at $L \sim 4$ during a strong storm
- EMIC waves occurred
- O^+ flux enhancement at < 30 keV and small pitch angle
- Possible O^+ acceleration mechanisms
 - Off-equator resonance with EMIC waves
 - Violation of the second adiabatic constant by rapid reconfiguration of the magnetic field
- Important science target for RBSP mission