Acceleration and Transport to the Ring Current During a Small Storm

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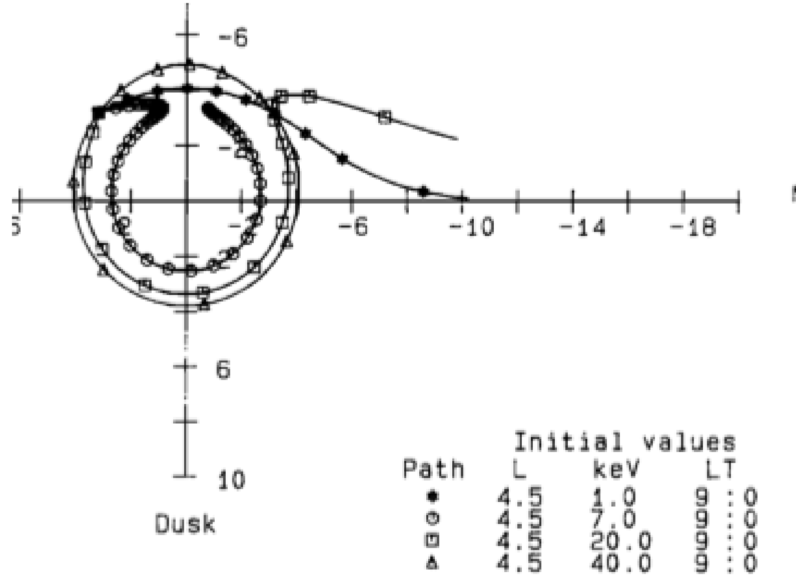
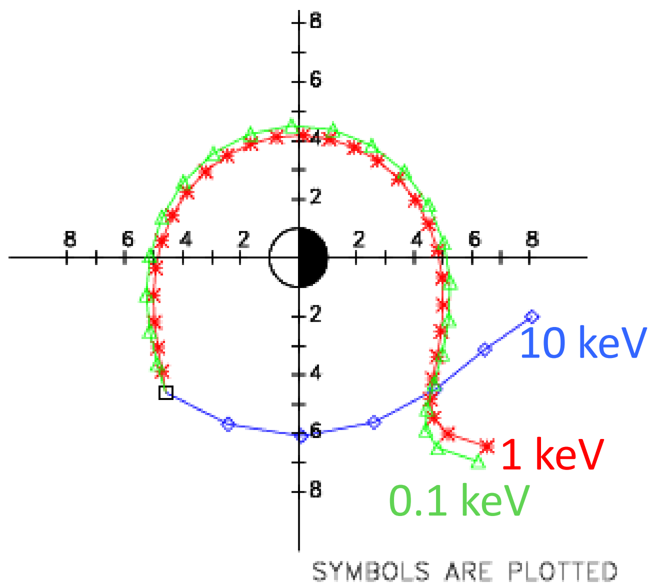
Motivation

- It is known that the O+/H+ ratio in the ring current increases significantly during storms. It is an open question exactly how this occurs.
- We will address this during a time when Cluster measures the composition change in the plasma sheet, while the Van Allen Probes measure the changes in the ring current during a storm main phase.
- Questions
  - How does the near-Earth plasma sheet composition (ie. the source of the ring current) change as the storm develops?
  - Is adiabatic inward transport of the near-earth plasma sheet sufficient to explain the inner magnetosphere composition?
  - Is there any evidence for an “inner source” of O+ (ie. directly injected from the ionosphere to the inner magnetosphere, or non-adiabatically accelerated in the inner magnetosphere)?

What can we learn from Energy Spectra?

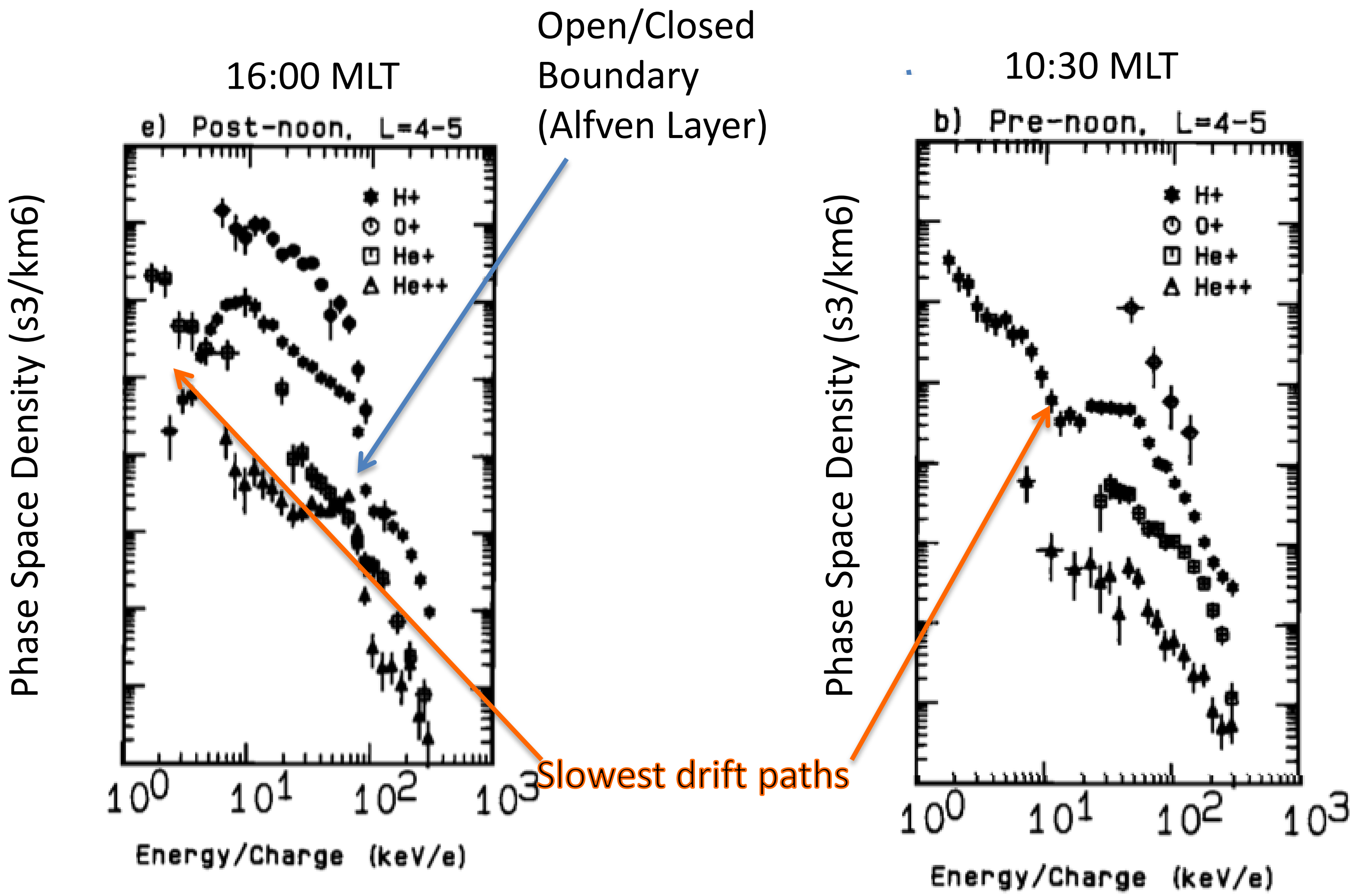
- Features due to
  - Which regions are accessible from the tail
    - At low energies, follow equipotentials – eastward drift.
    - Middle range has direct access, but details depend on MLT and L
    - At high energies, closed westward drift
    - Transition energies vary with convection field.
  - How long is the drift time to a location?
    - Long drift times due to ExB and grad B drifts almost cancelling lead to minima in the spectra.
- The drifts are a function of Energy/charge so all species should show the same features at the same E/q. However sources and losses can be different.





What can we learn from Energy Spectra?

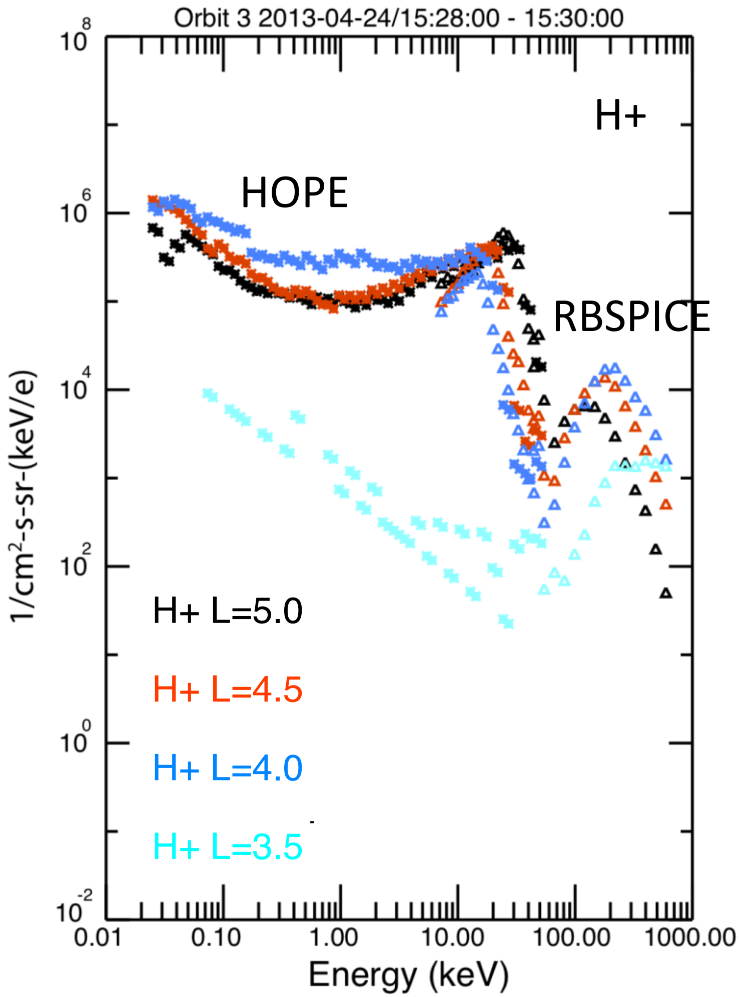
Examples from AMPTE/CHEM, L=4-5



Van Allen Probes Example

j vs E

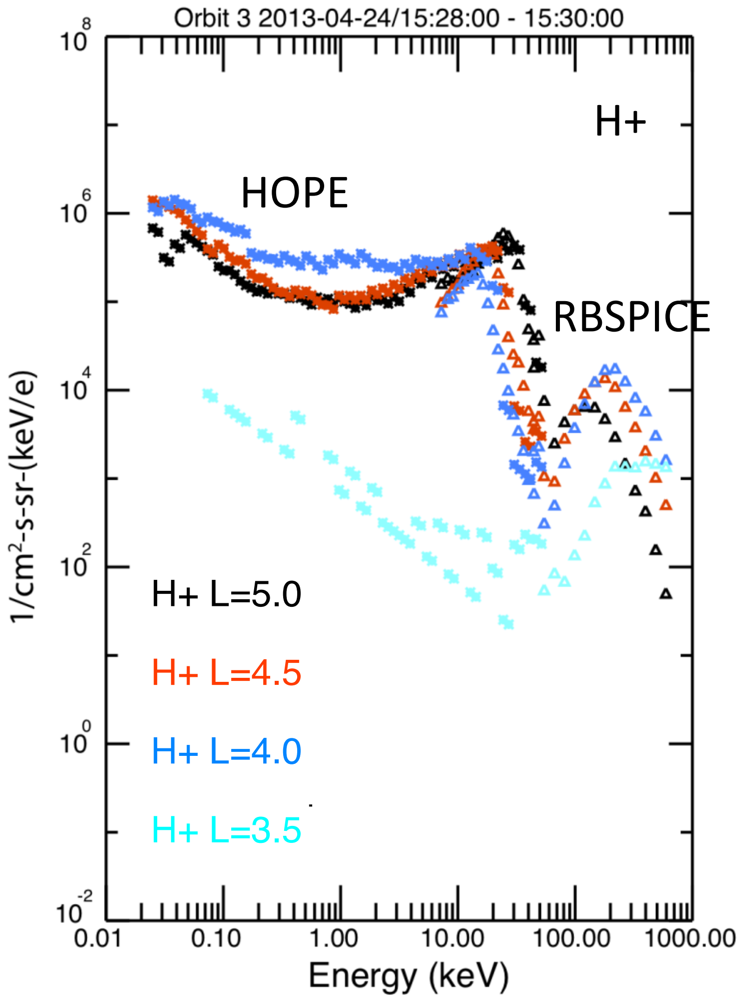
Inbound Pass, ~1:00 MLT



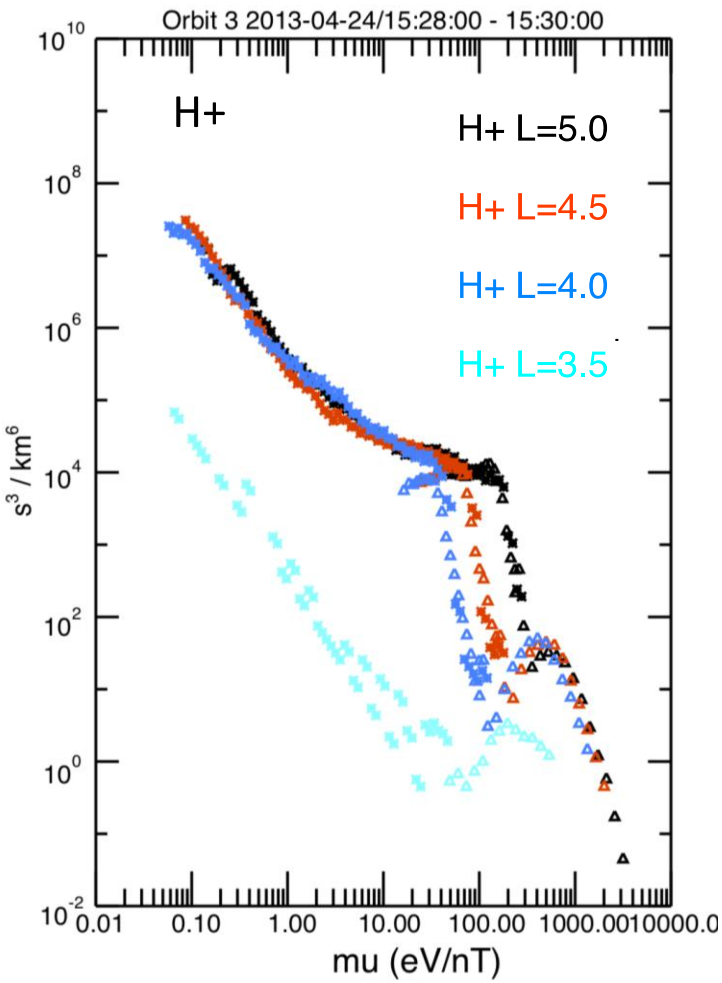
- Combining HOPE (0.02-60 keV) and RBSPICE (~10-600 keV) data.
- Sharp open/closed drift path boundary, decreasing in energy with decreasing L-value
- Energy/flux increase with decreasing L for the "closed drift path" particles

Van Allen Probes Example

j vs E

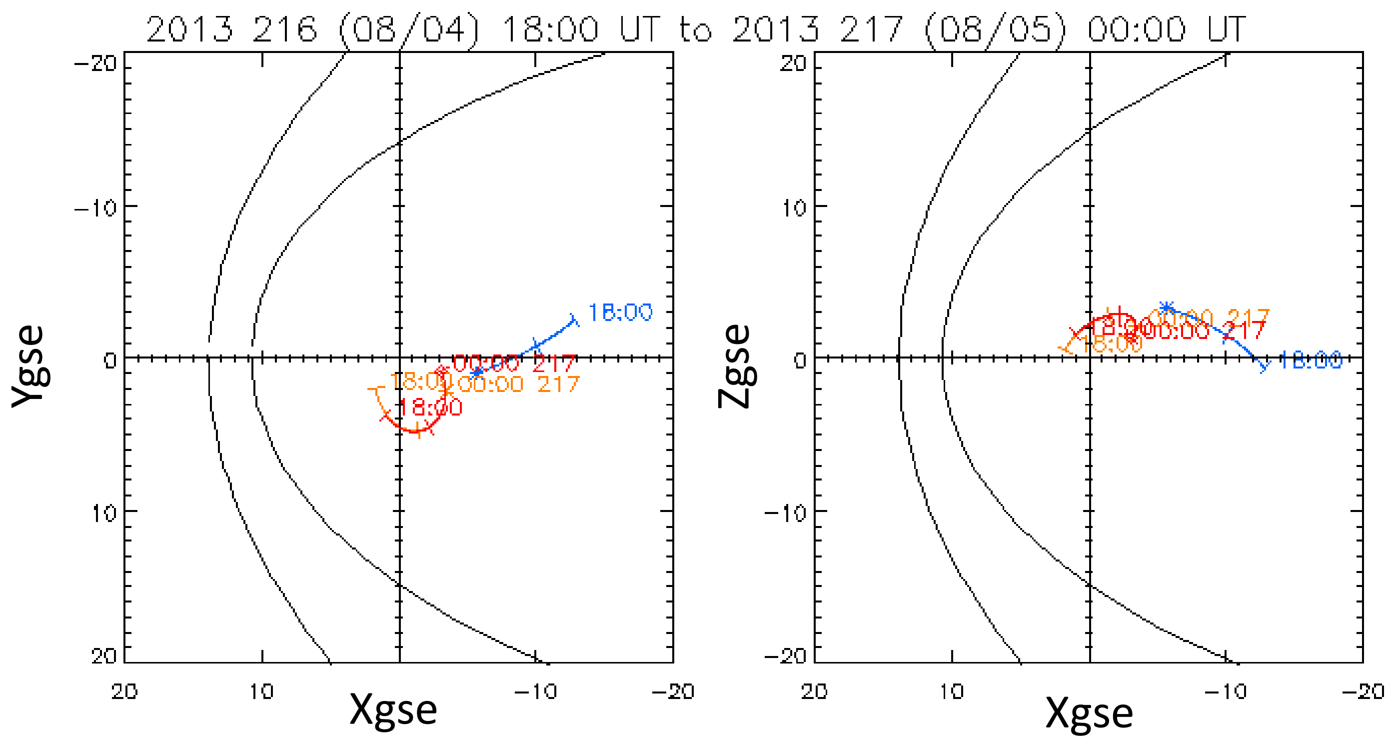


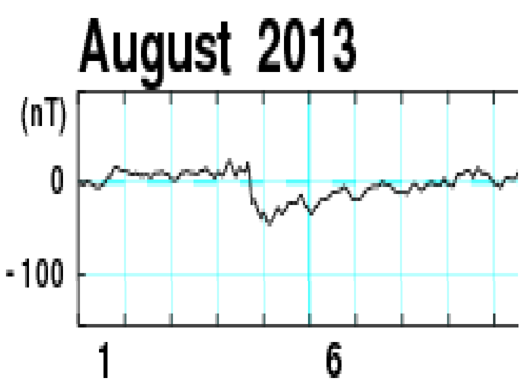
f vs mu



- Clear adiabatic inward transport – f vs mu is conserved
- Sharp open/closed drift path boundary, decreasing in mu with decreasing L-value
- Closed drift path region also shows adiabatic transport

Cluster/RBSB, Aug 4-5, 2013

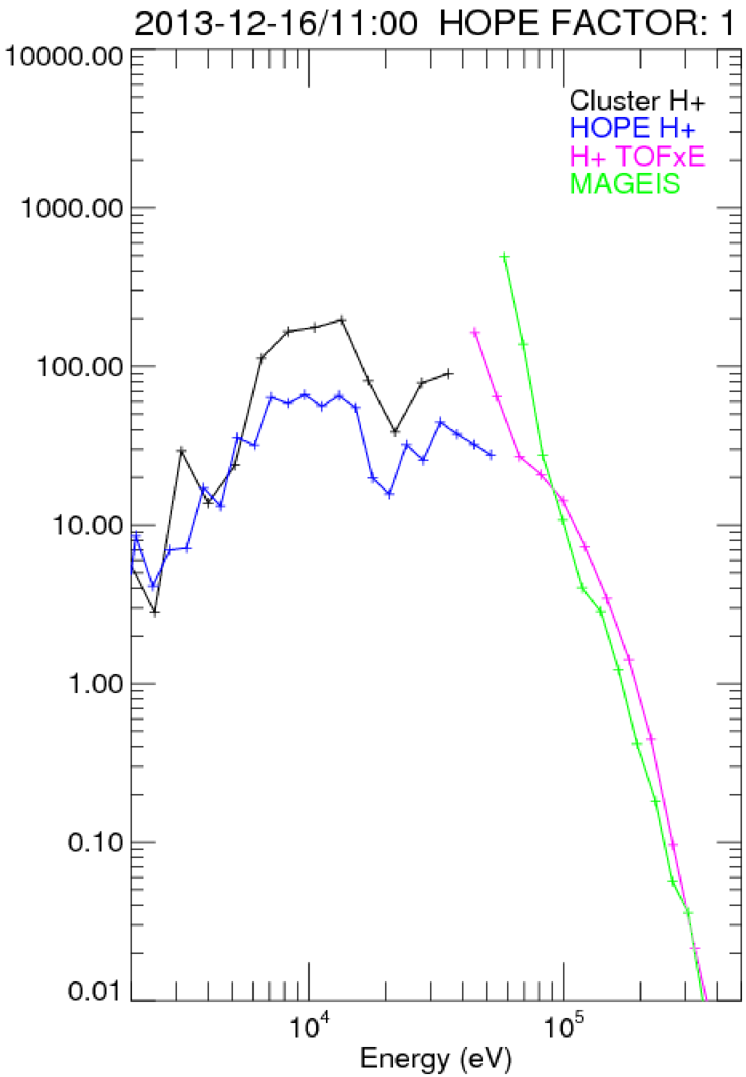




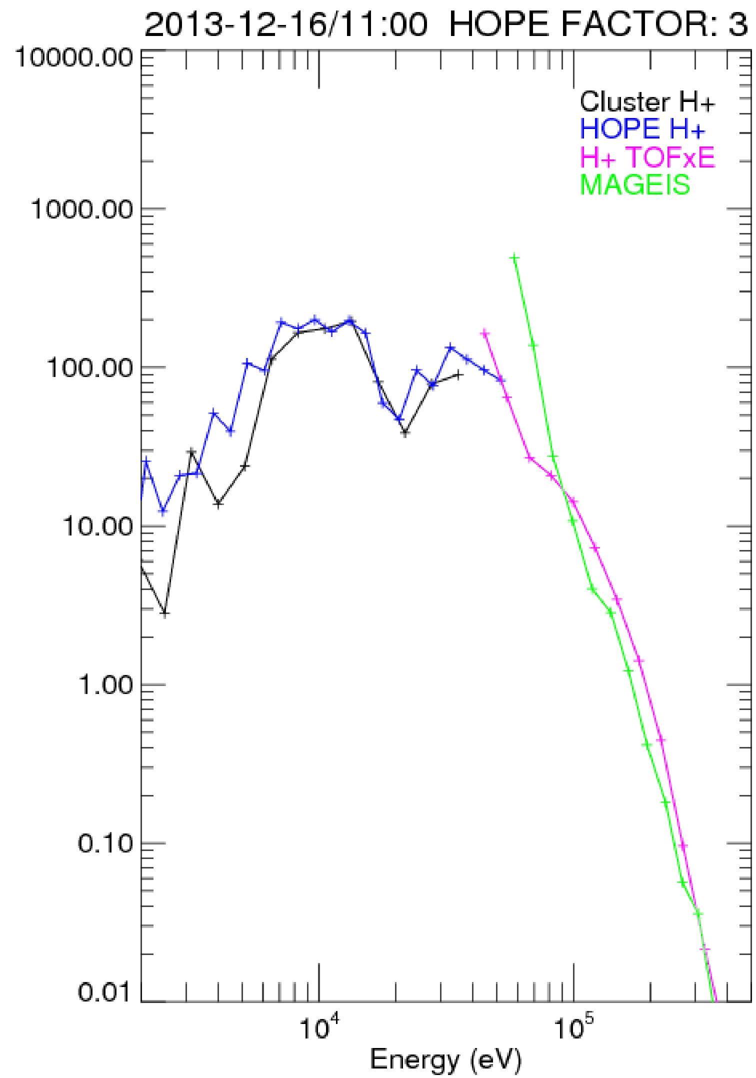
- Cluster Spacecraft close to the equator, inbound , in the midnight plasma sheet during the storm main phase.
- RBSP apogee on the dusk side.
- Spacecraft both close to midnight at ~00:00 UT on Aug 5th.

Cross-calibration –RBSP/Cluster Conjunction H+

2013-12-16 11:00

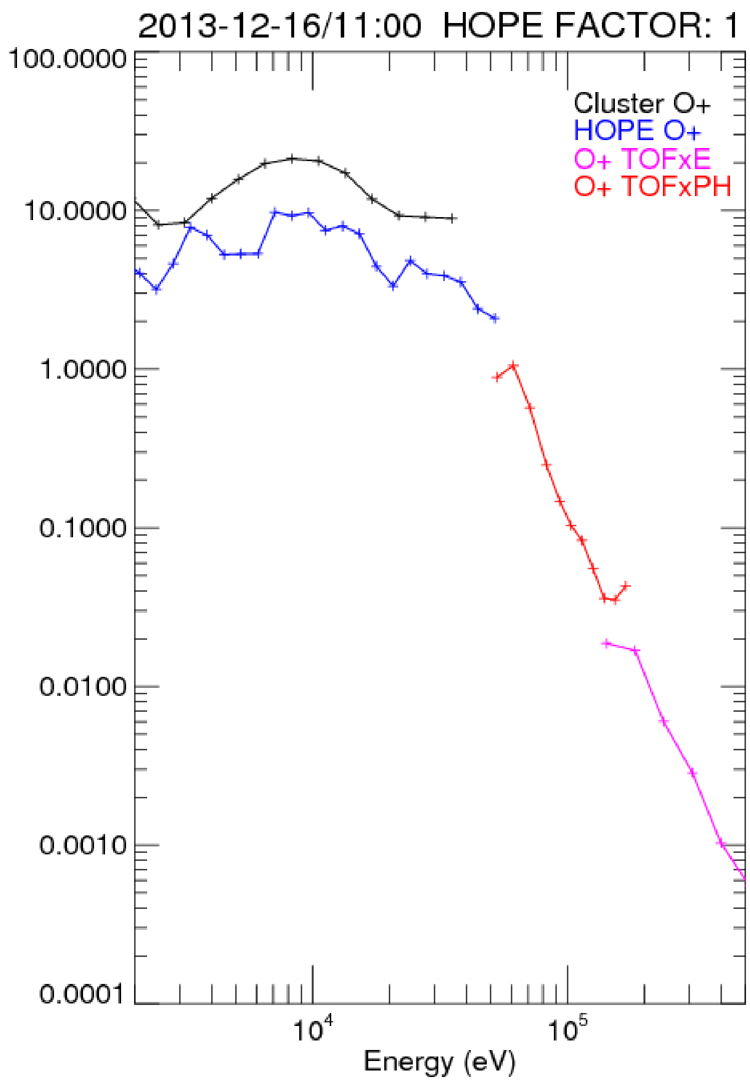


Hope multiplied by 3

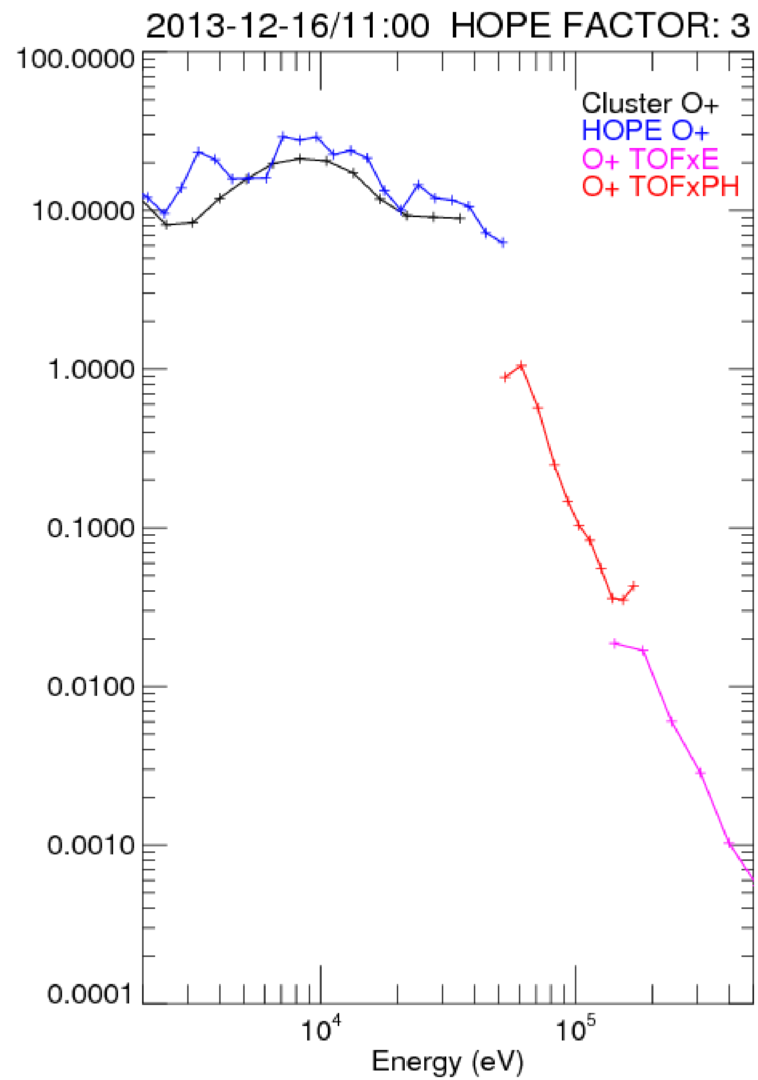


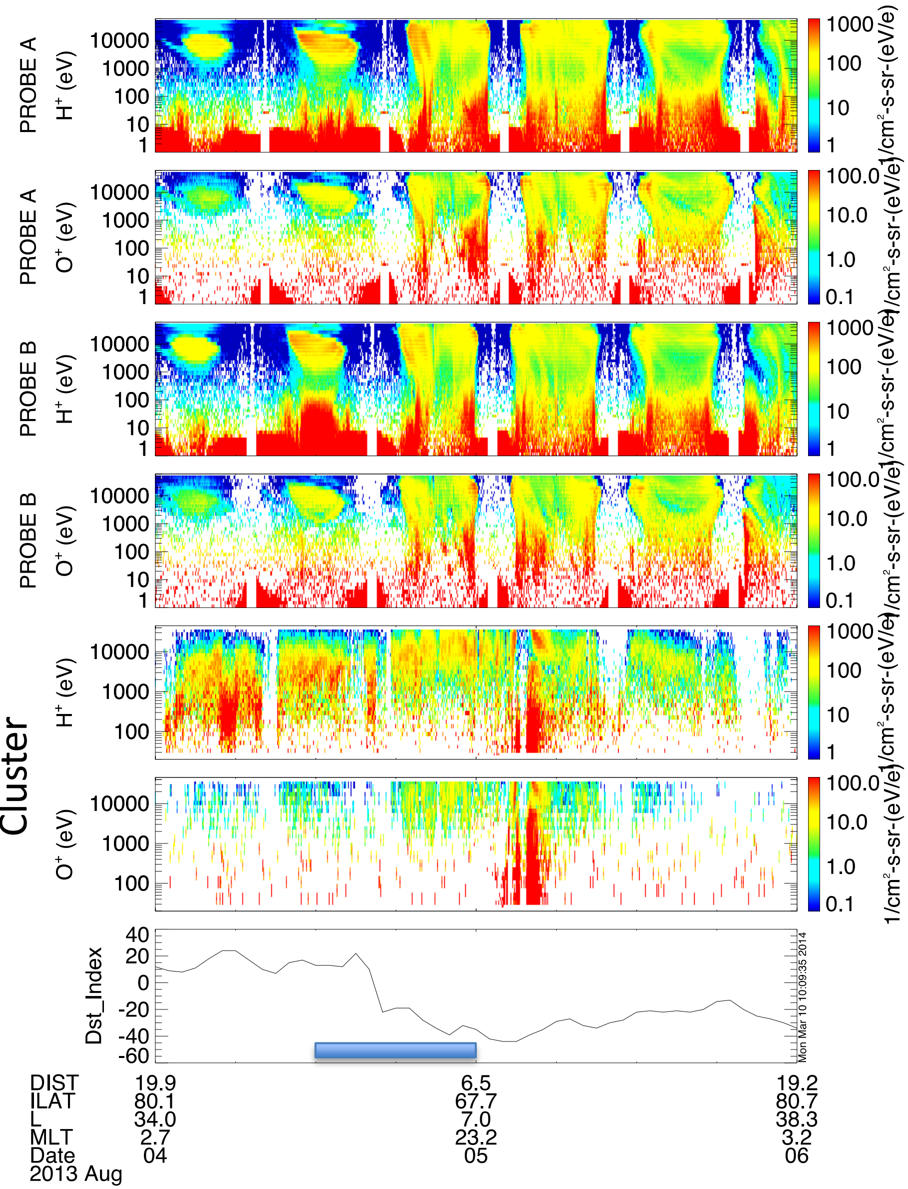
Cross-calibration –RBSP/Cluster Conjunction O+

2013-12-16 11:00

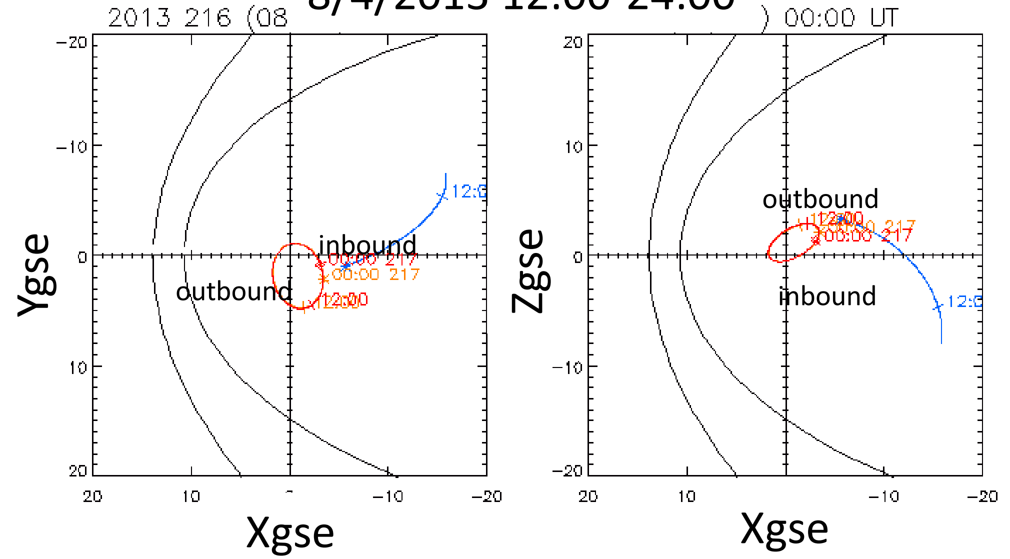


Hope multiplied by 3



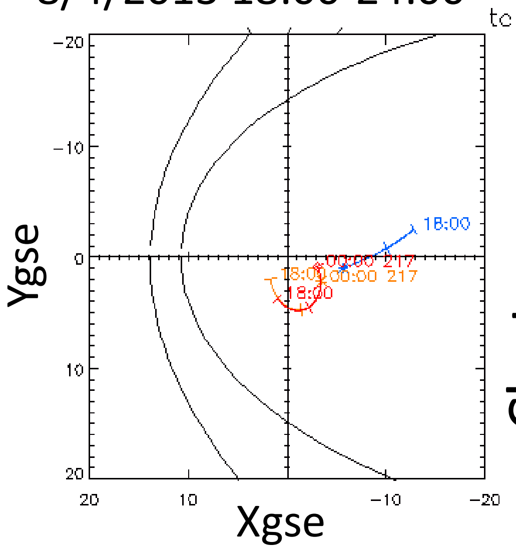


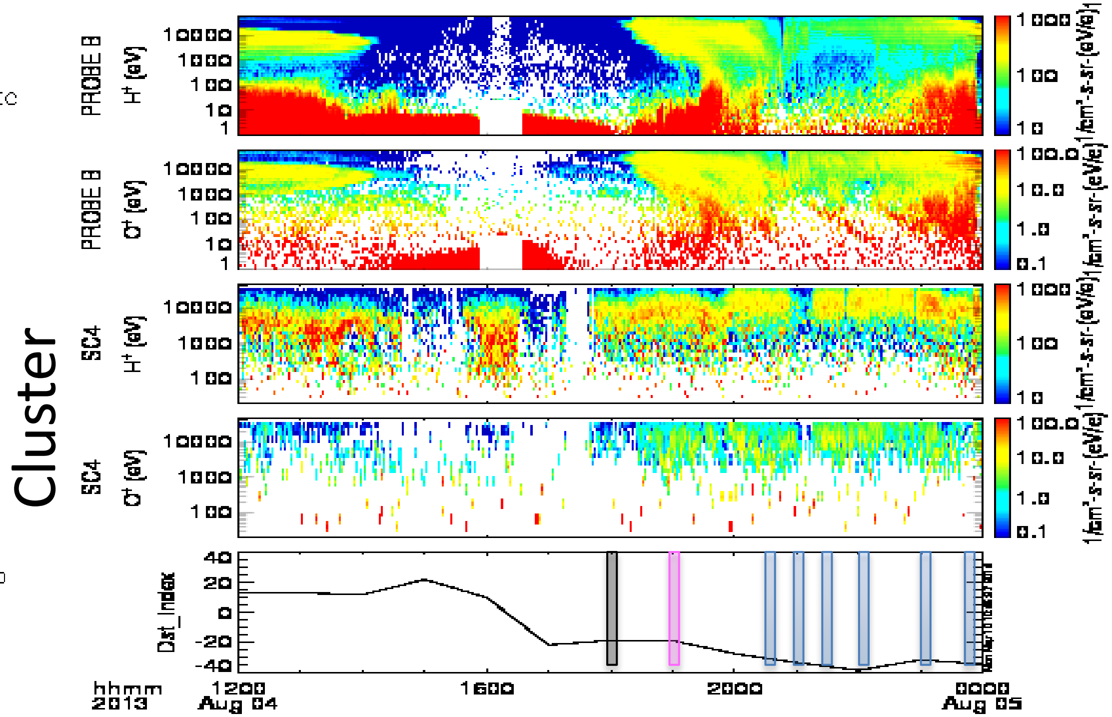
8/4/2013 12:00-24:00



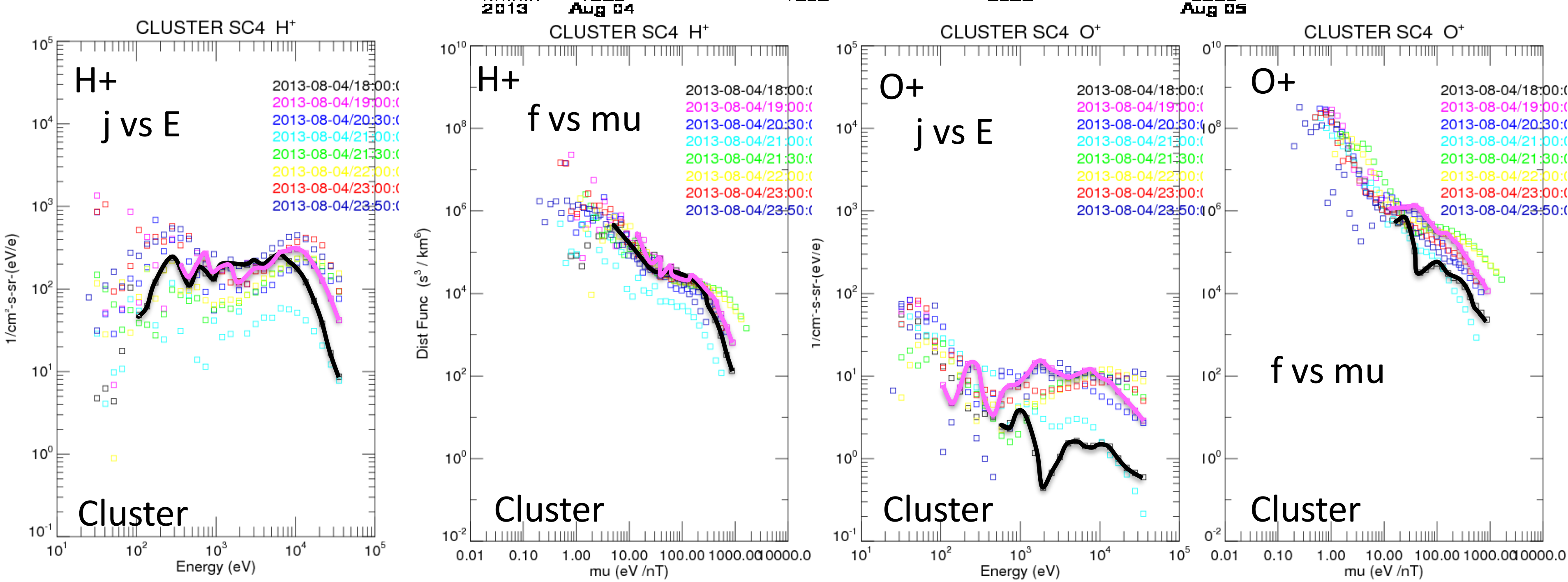
- The two Van Allen Probe spacecraft are in phase - I will only show B from now on.
- Van Allen Probes spectra change significantly at storm main phase. Both H+ and O+ increase.
- Cluster observes a large increase in O+ in the storm main phase.
- Does the composition at Cluster explain the spectra at Probe B?

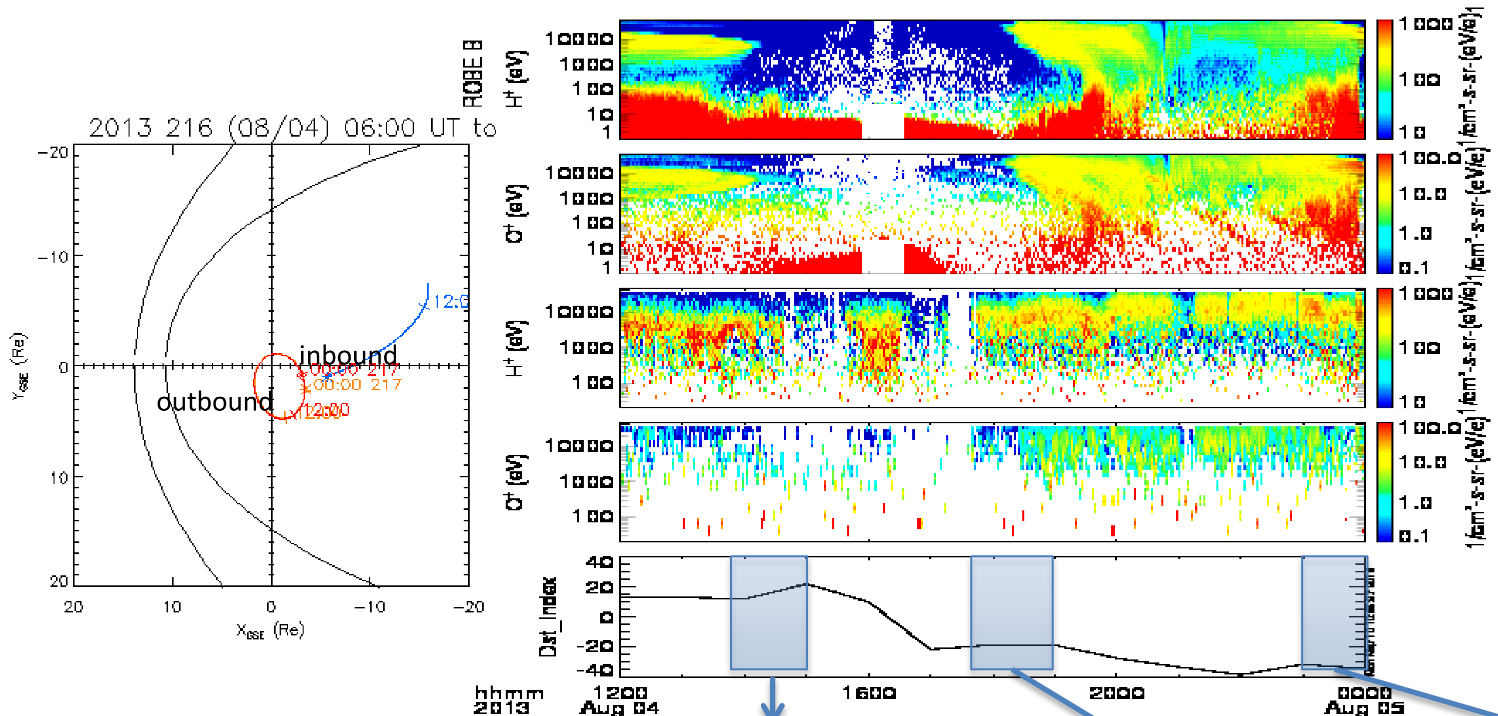
8/4/2013 18:00-24:00



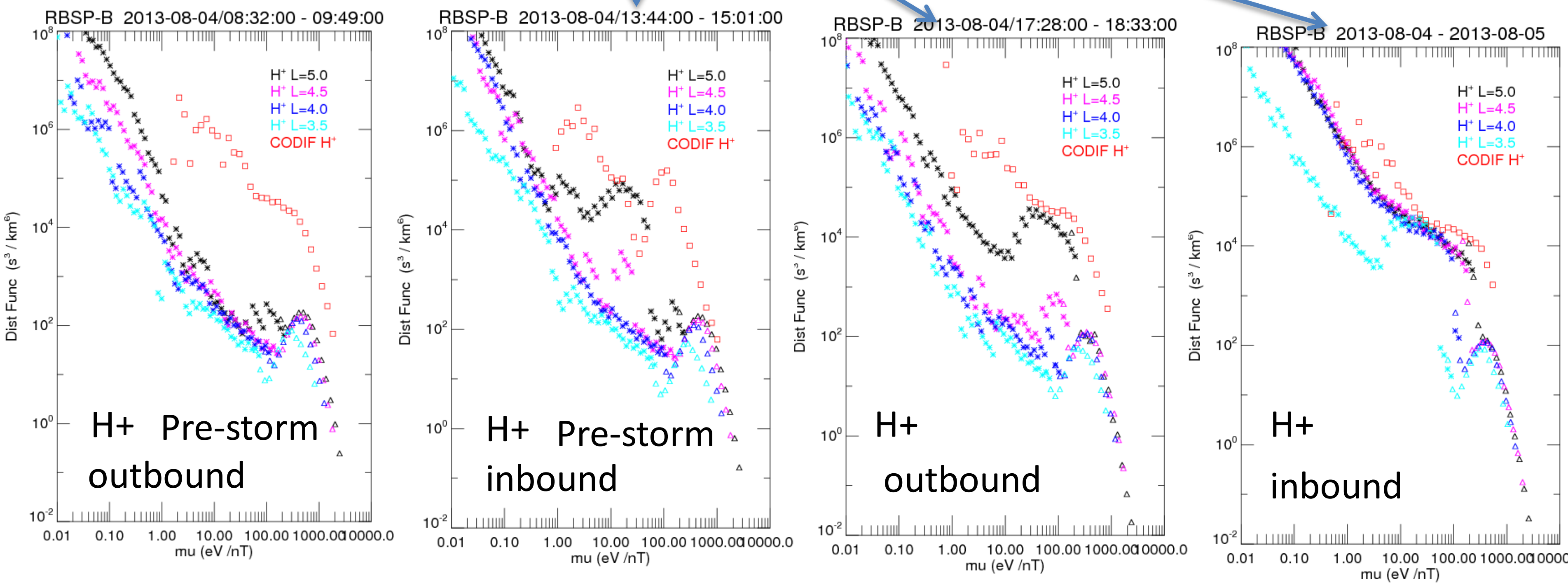


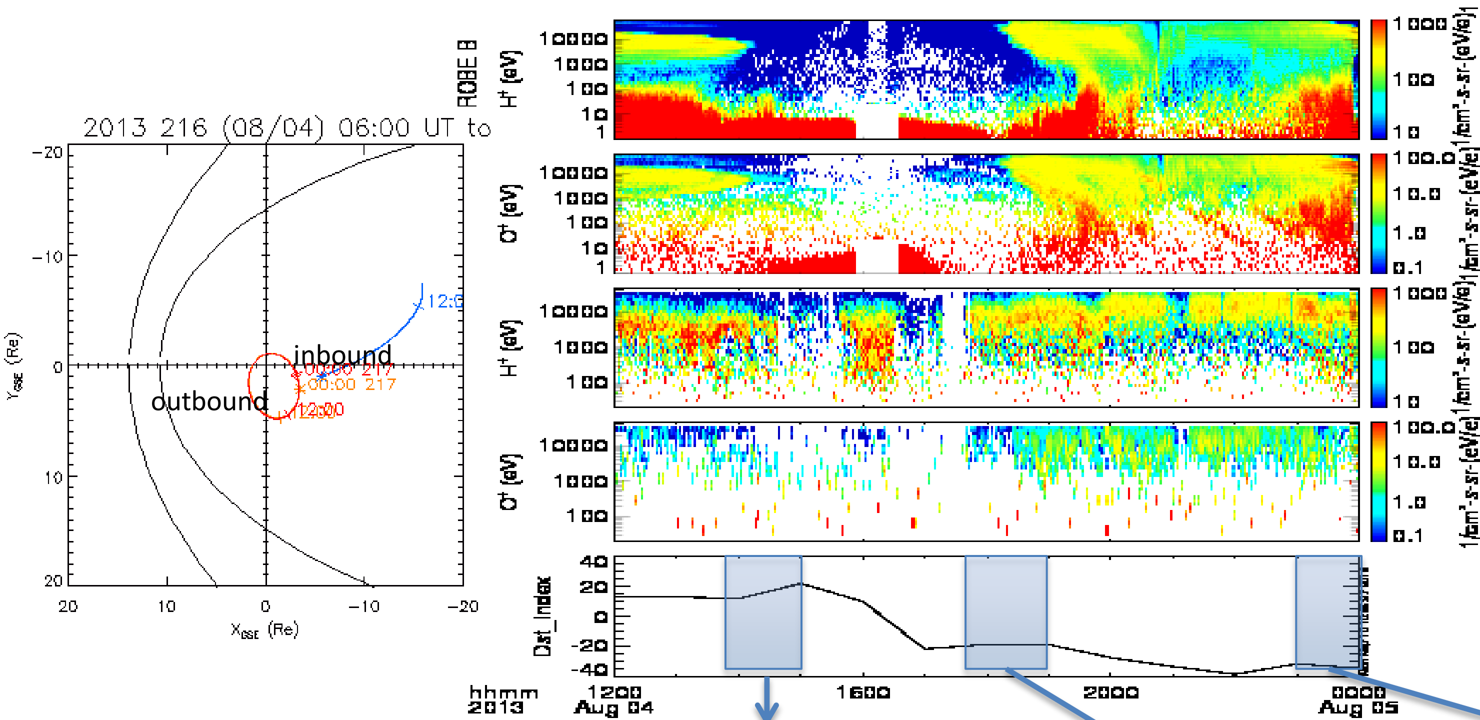
O+ in the plasma sheet shows a large (x10) non-adiabatic increase during the storm main phase.



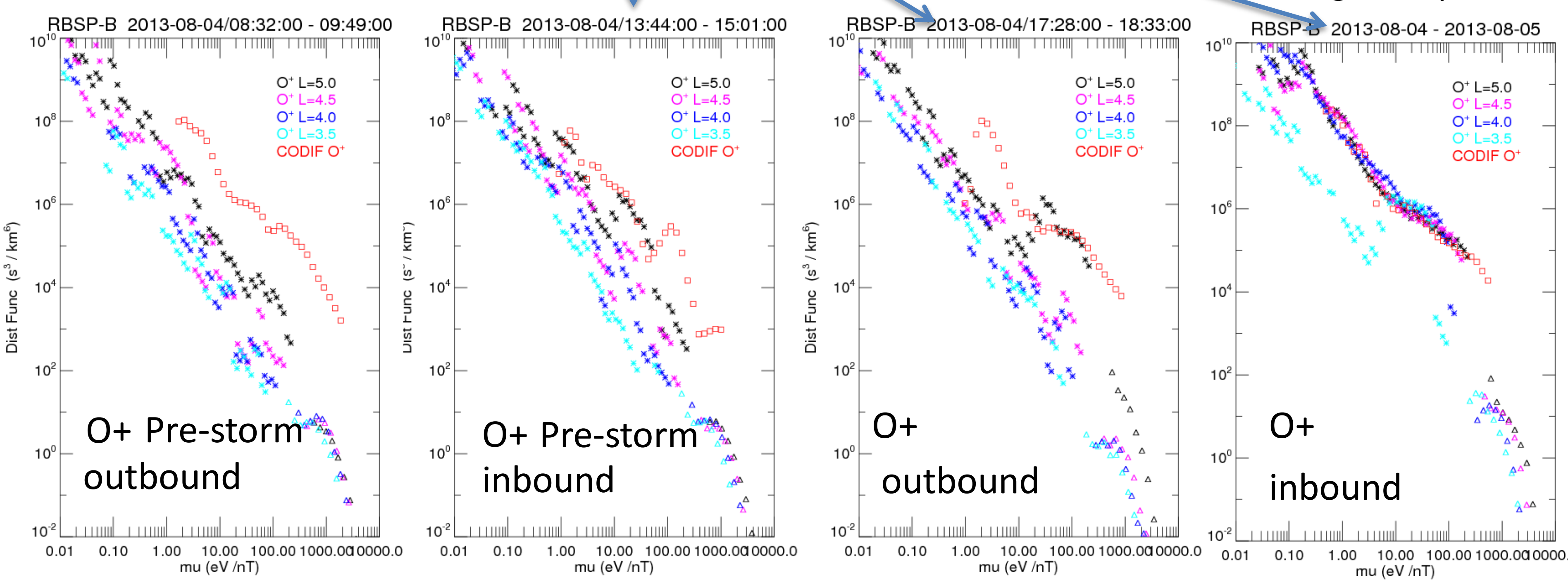


During the main phase, convection brings the plasma sheet H+ into the inner magnetosphere.





Similarly, convection brings the plasma sheet O+ into the inner magnetosphere. The increased O+ in the plasma sheet now populates the inner magnetosphere.



Conclusions

- Source: The change in the source population in the near-earth plasma sheet during the storm is clearly observed
  - The near-earth plasma sheet shows a non-adiabatic increase in the O+, a greater increase than is observed for H+.
- Transport: As Dst decreases, strong convection brings both H+ and O+ into the inner magnetosphere (L=3.5). The transport is clearly adiabatic (f vs mu conserved) and shows a sharp open/closed drift path boundary. As convection weakens the new population will be on closed drift paths.
- Inner Source: For this storm, there is no evidence for any source other than the near-earth plasma sheet entering the inner magnetosphere.
- Future work: Perform same analysis on larger storms.