Hall Physics Above the Lunar Surface and Implications for Magnetic Reconnection

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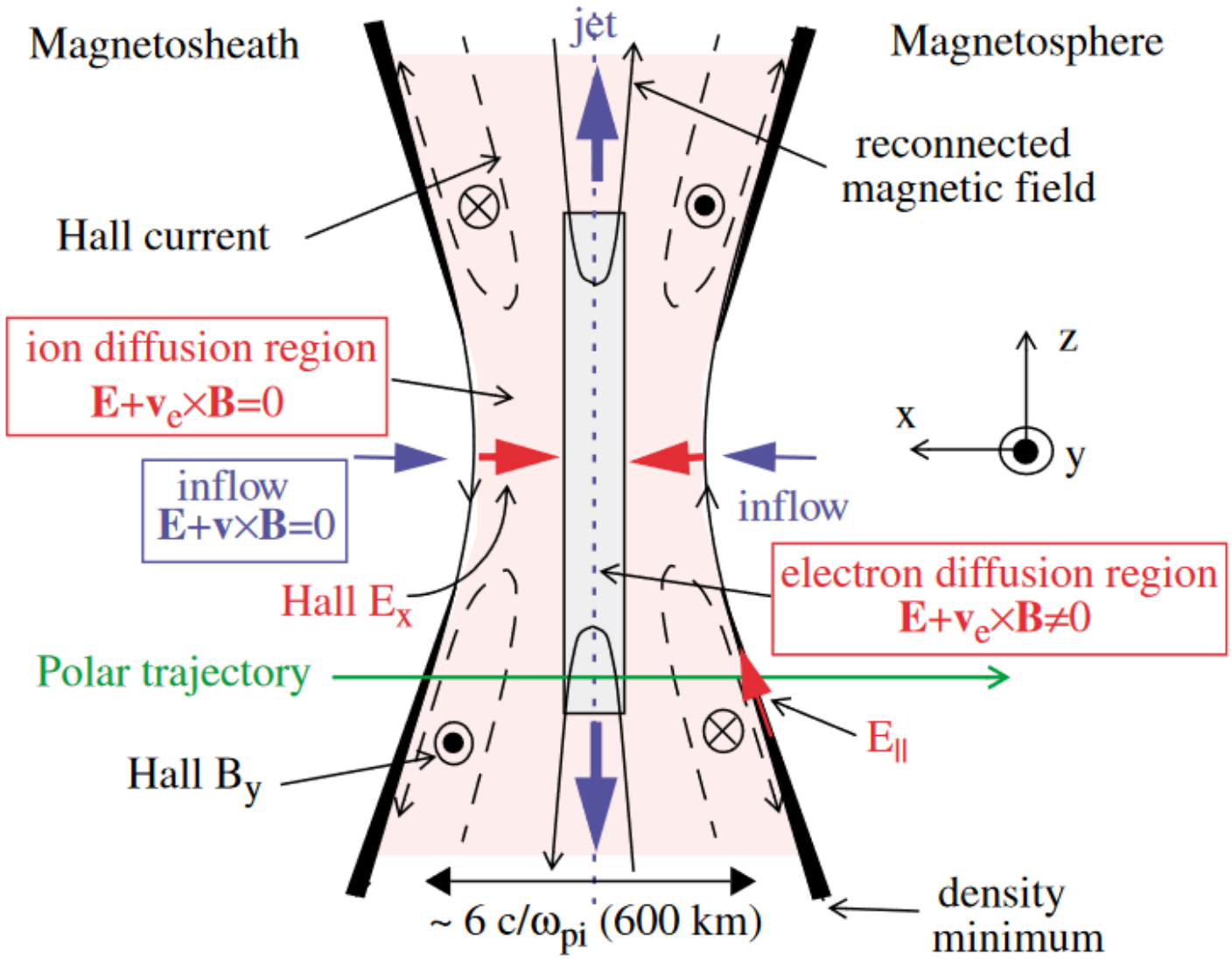
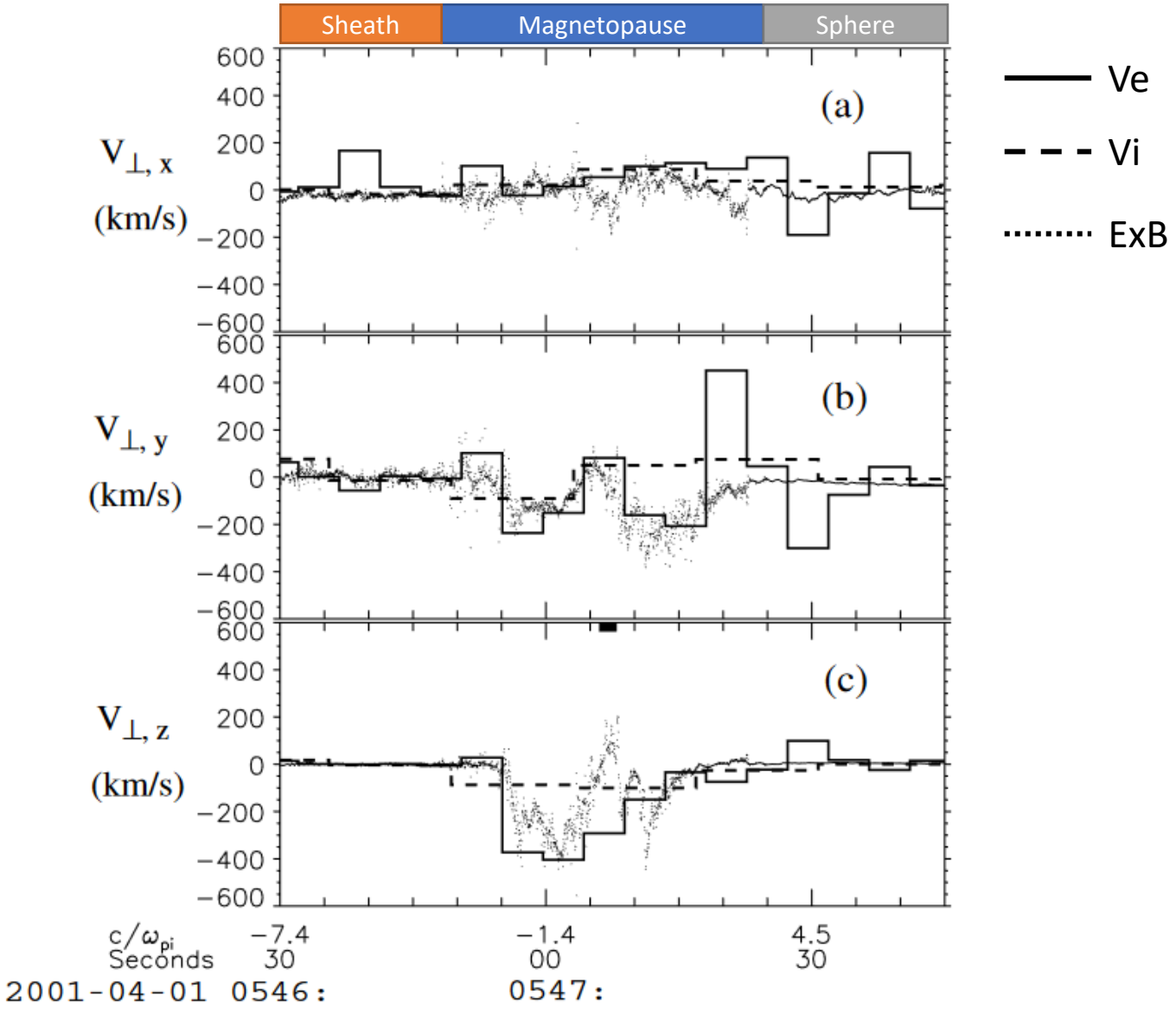
Standard Ion-Coupled reconnection picture, showing Hall E-field structure and diffusion regions.



Mozer et al., 2002

Ion diffusion region encounter near the magnetopause by Polar

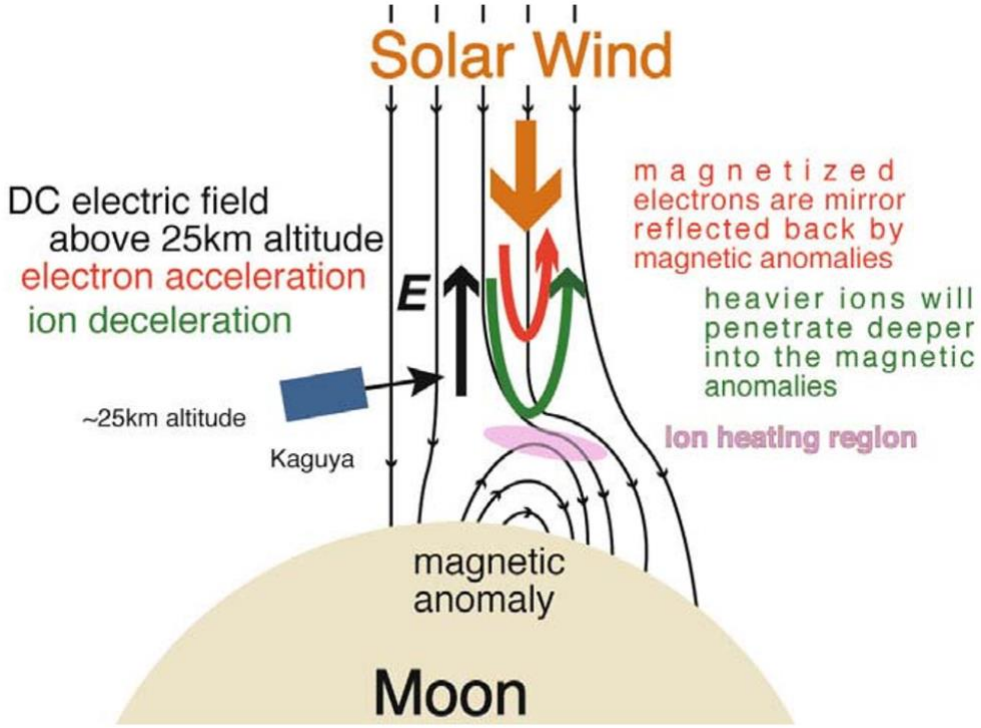
Polar magnetopause crossing showing evidence of demagnetized ions and magnetized electrons.



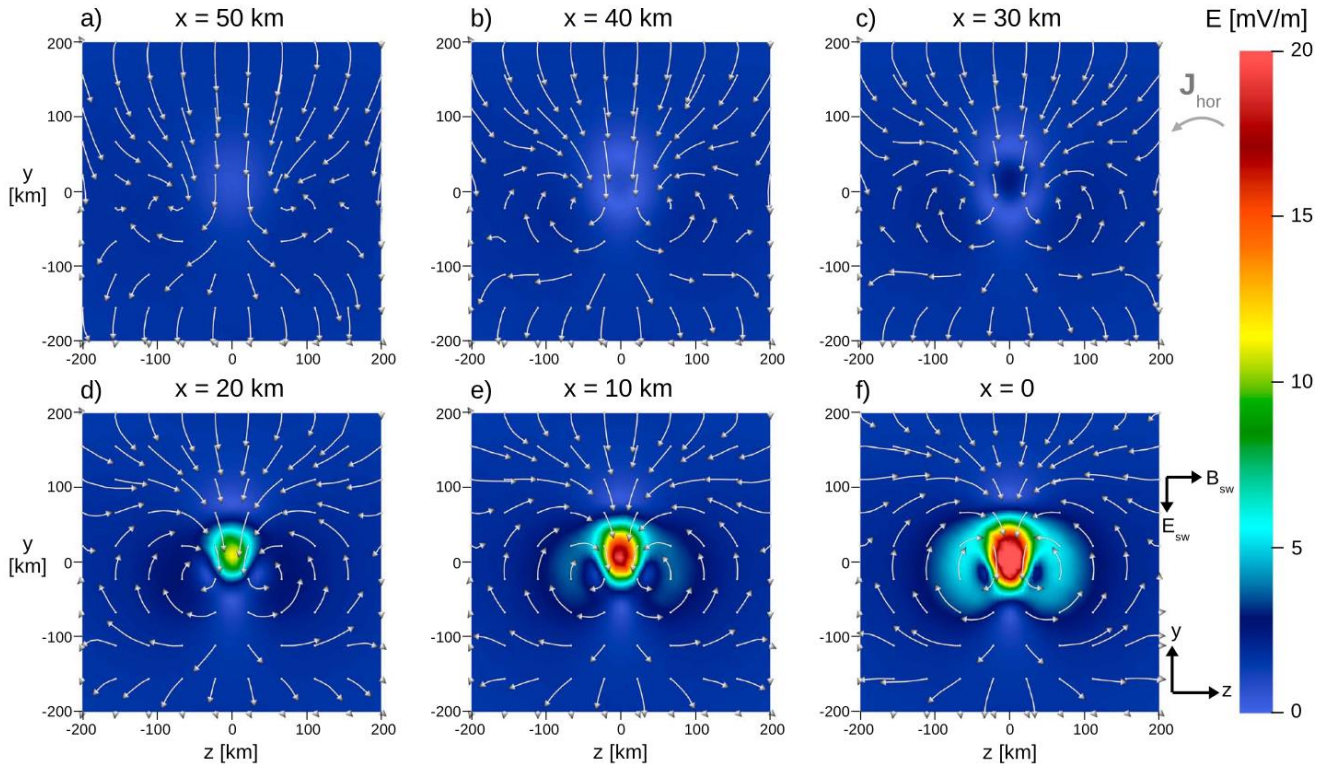
Mozer et al., 2002

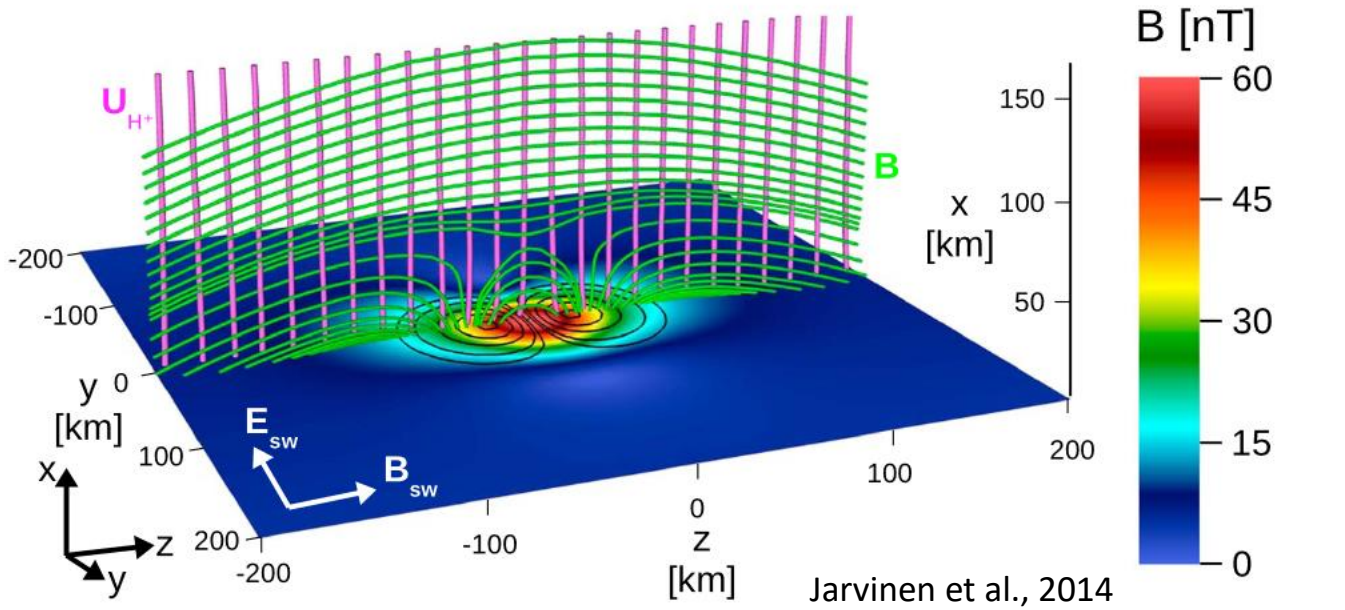
How does the near lunar surface environment compare?

Results from Saito et al., 2012 consistent with Hall MHD, and simulations from Jarvinen et al., 2014 show a similar field structure.



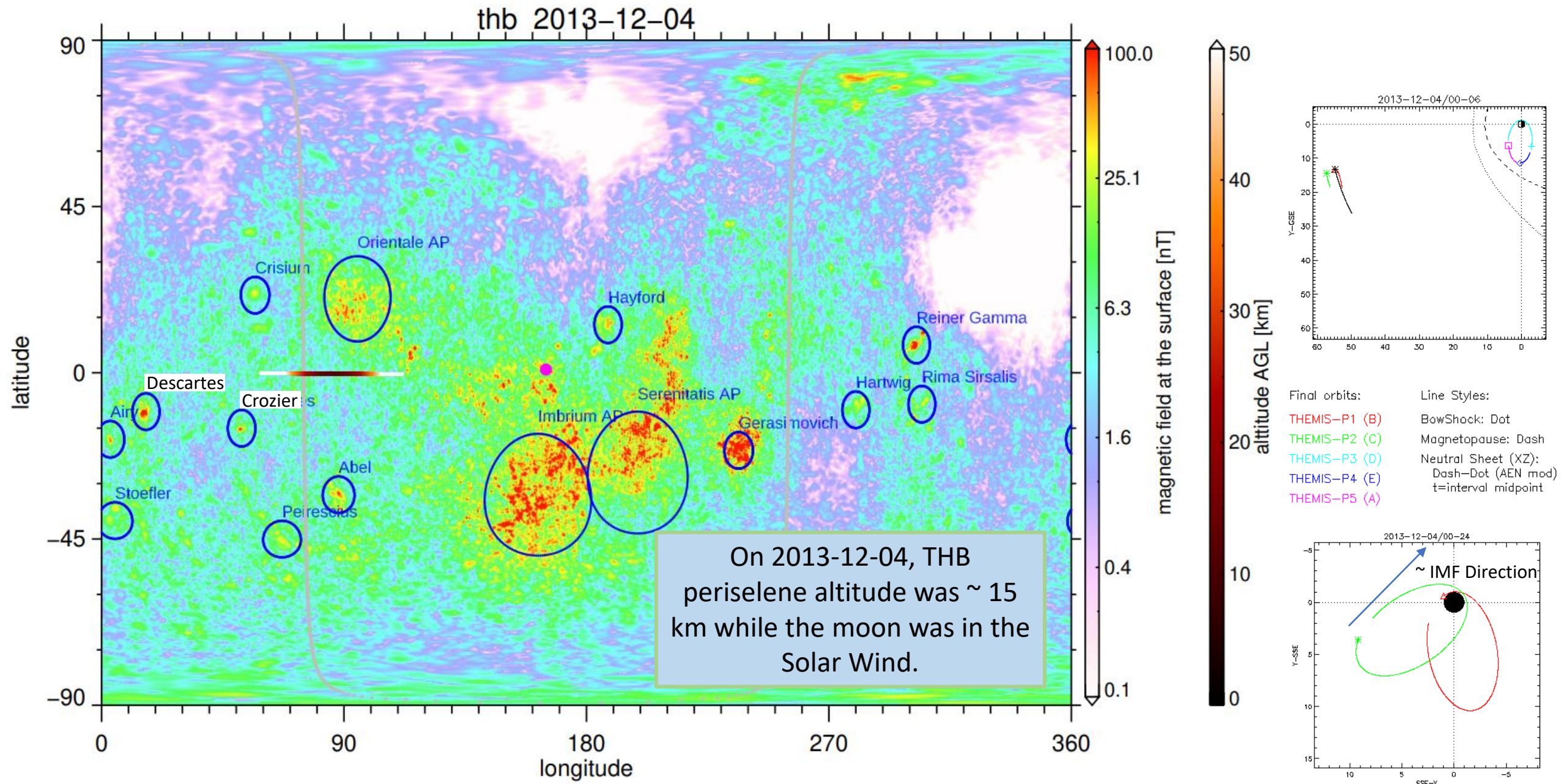
Saito et al., 2012





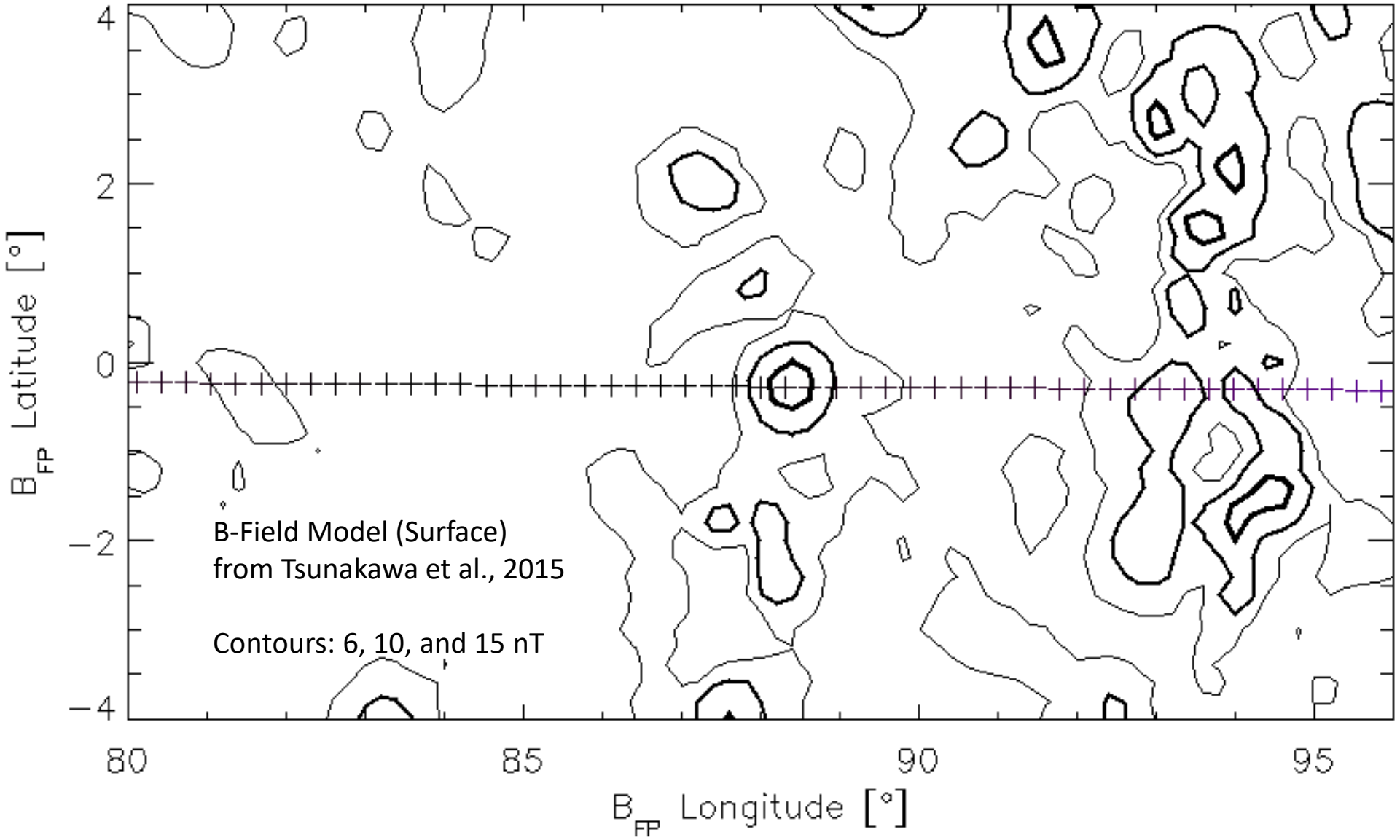
Jarvinen et al., 2014

Where was THEMIS-ARTEMIS in its orbit?

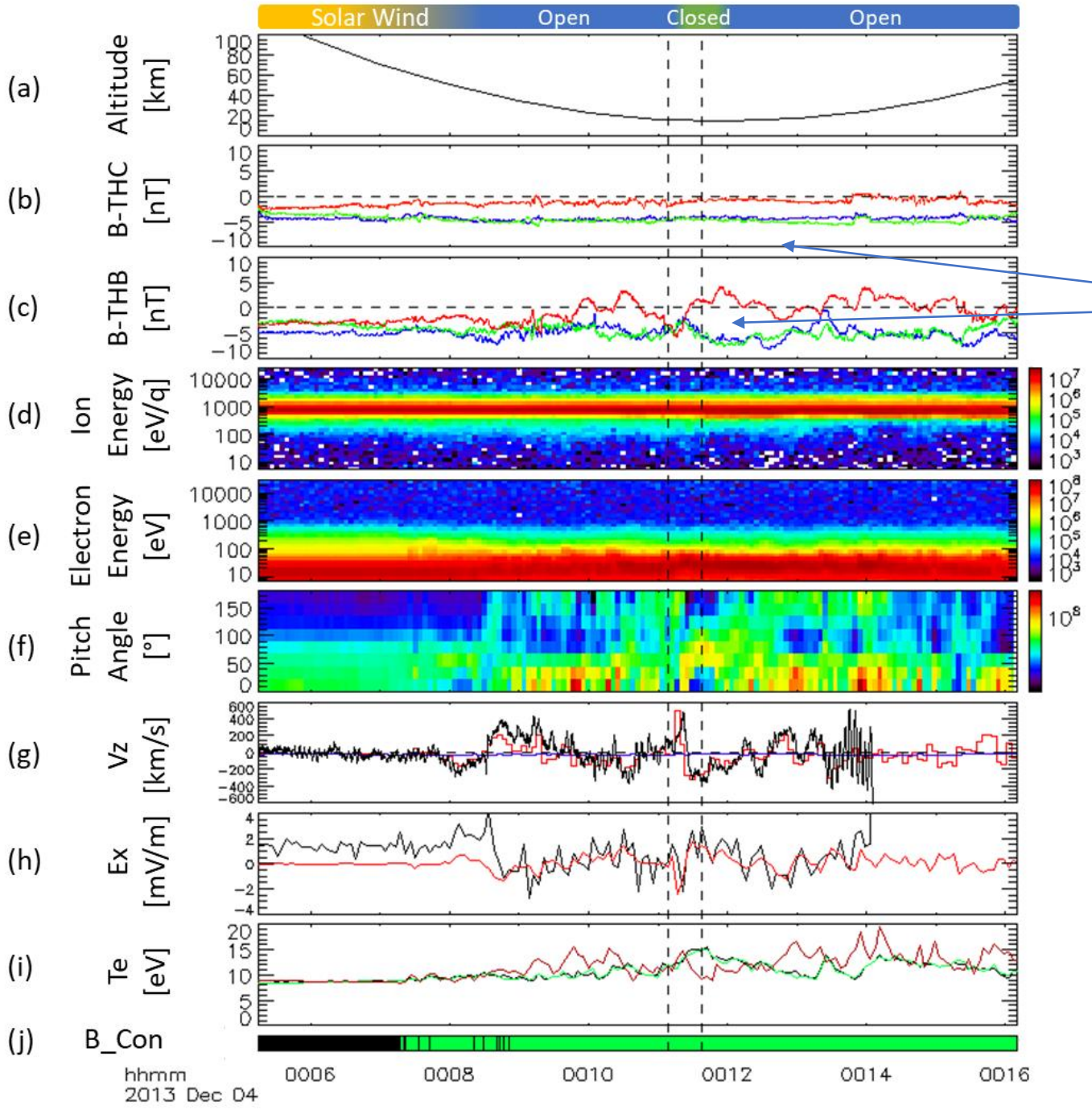


Credit: K. H. Glassmeier

Where was THEMIS-ARTEMIS in relation to the crustal fields on the surface?



THEMIS-ARTEMIS observations of field line modification



Bx_sse
By_sse
Bz_sse

Bx_sse
By_sse
Bz_sse

Ion Energy Flux [eV/eV cm^2 sr s]

Electron Energy Flux [eV/eV cm^2 sr s]

Electron Energy Flux [eV/eV cm^2 sr s]

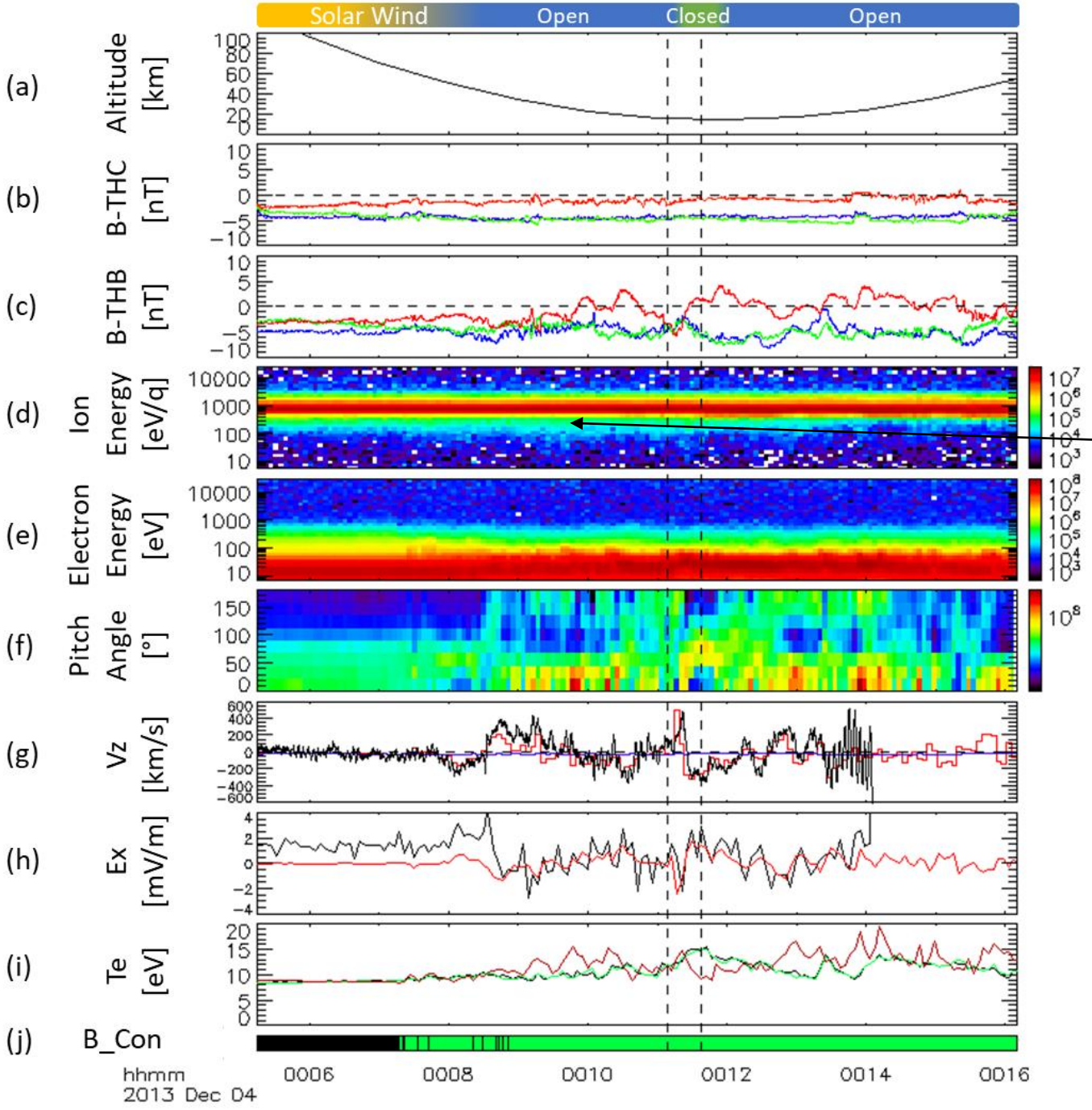
$V_{e\_z,sse}$
$V_{i\_z,sse}$
$E\_0xB_{z,sse}$

$(JxB/ne\_Plasma)_{x,sse}$
$(E + V_i xB)_{x,sse}$

Te_para
Te_perp1
Te_perp2

Clear indication of modification by crustal magnetic field in the magnetometer data.

THEMIS-ARTEMIS observations of solar wind ion reflection



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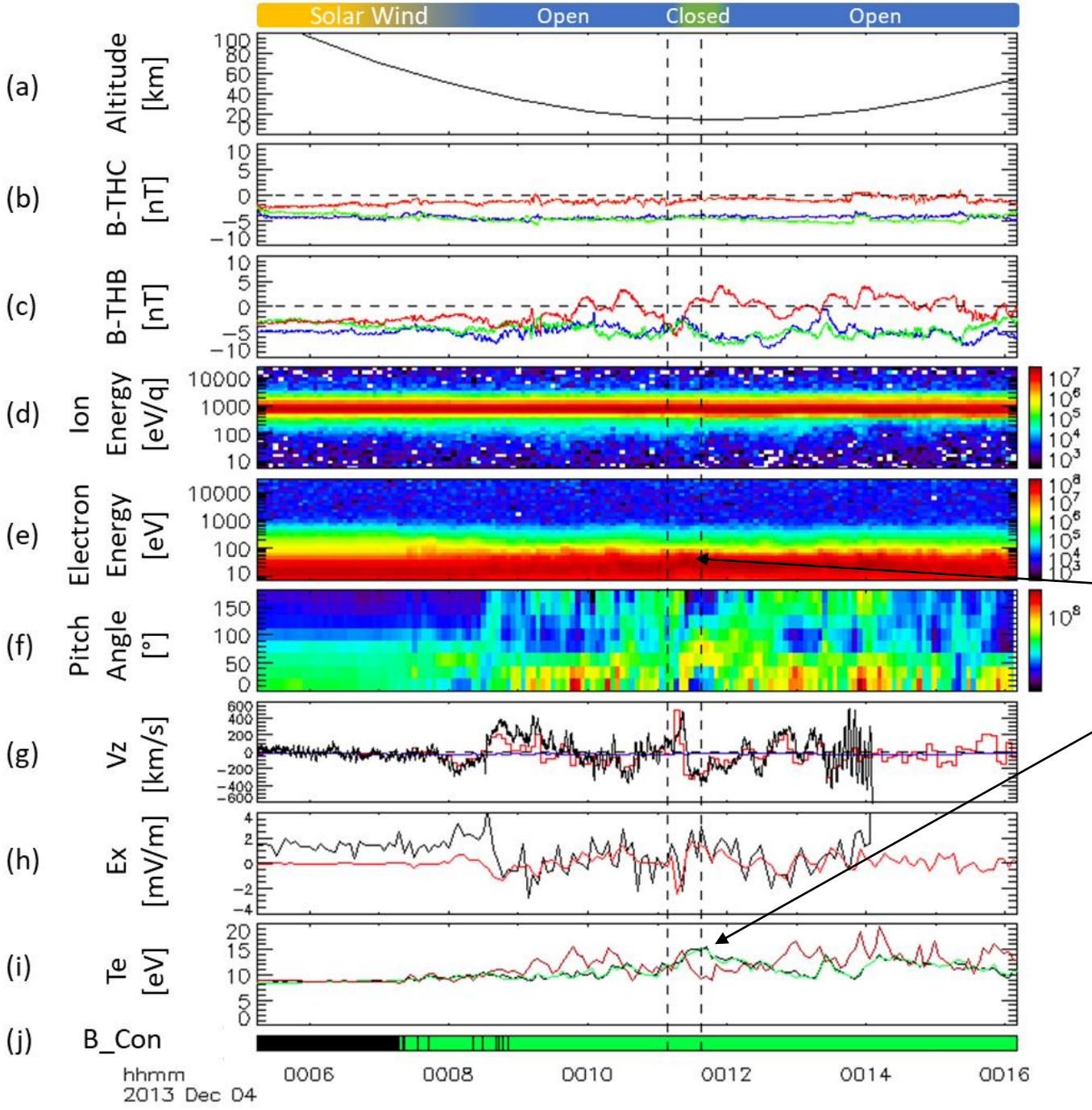
Reflected ion signature

THEMIS-ARTEMIS observations of solar wind electron heating



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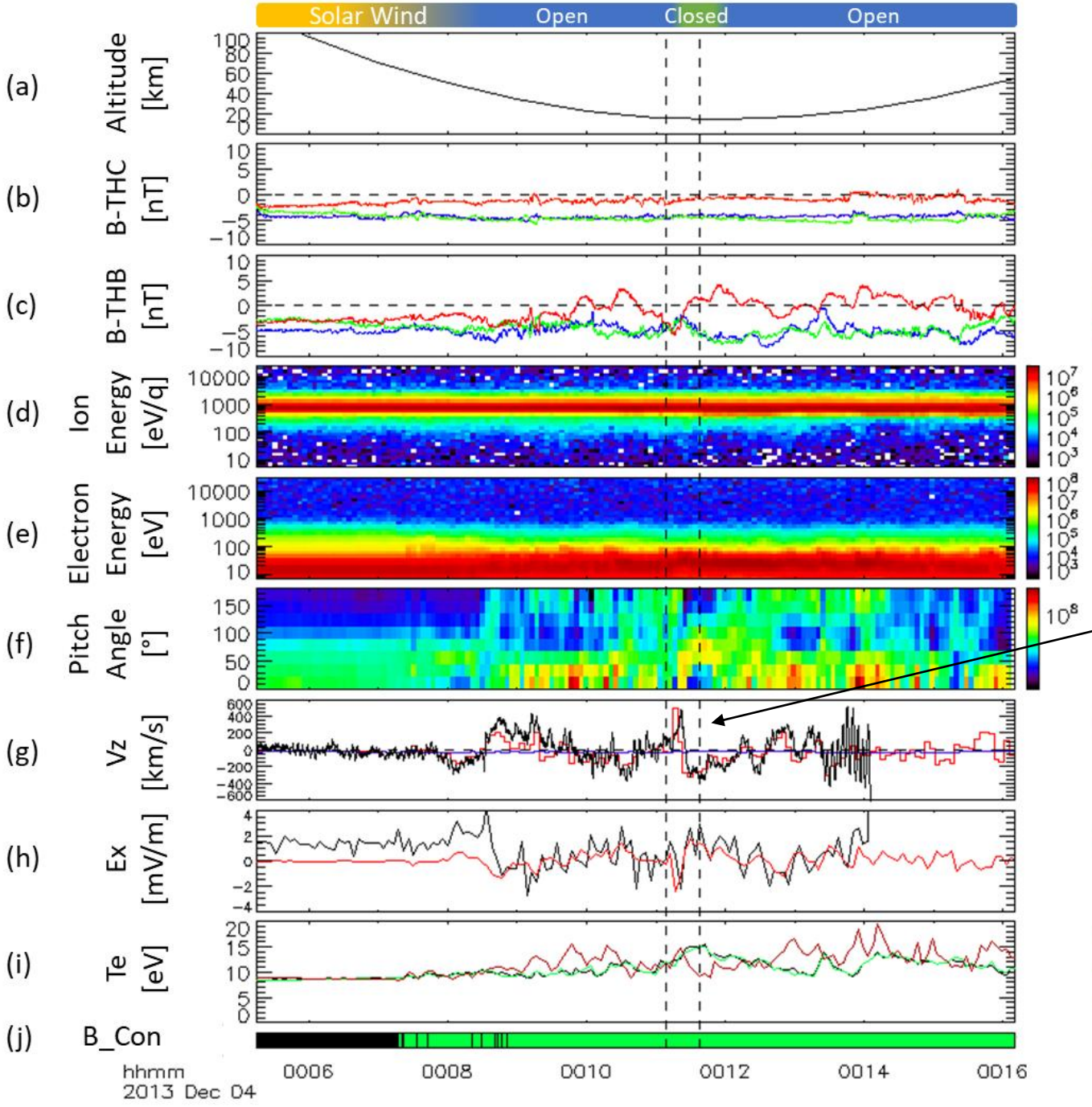
Electron heating

Result 1:
THEMIS-ARTEMIS observations of demagnetized ions and magnetized electrons



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Agreement between Vez and ExBz indicating magnetized electrons with demagnetized ions

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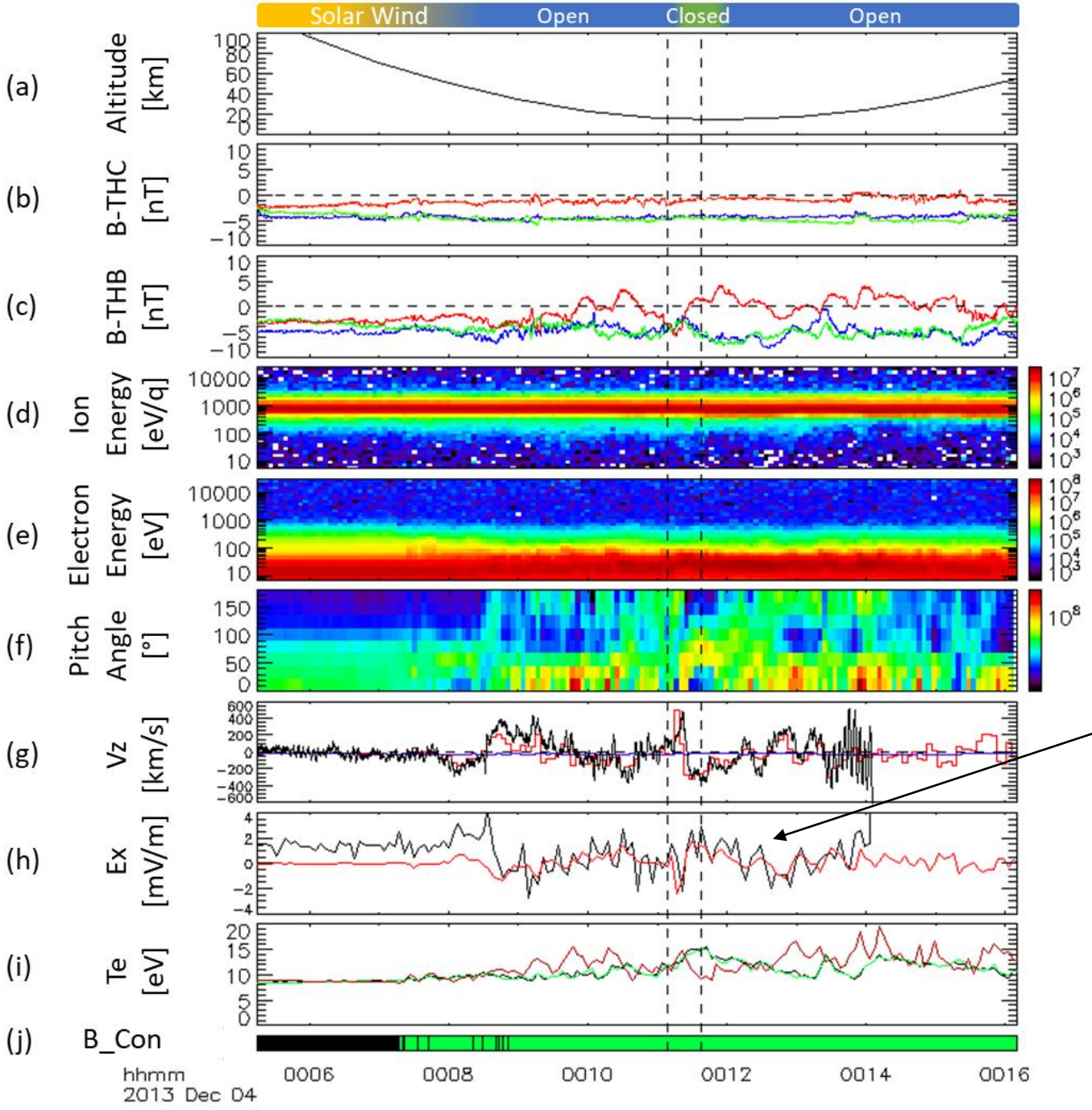

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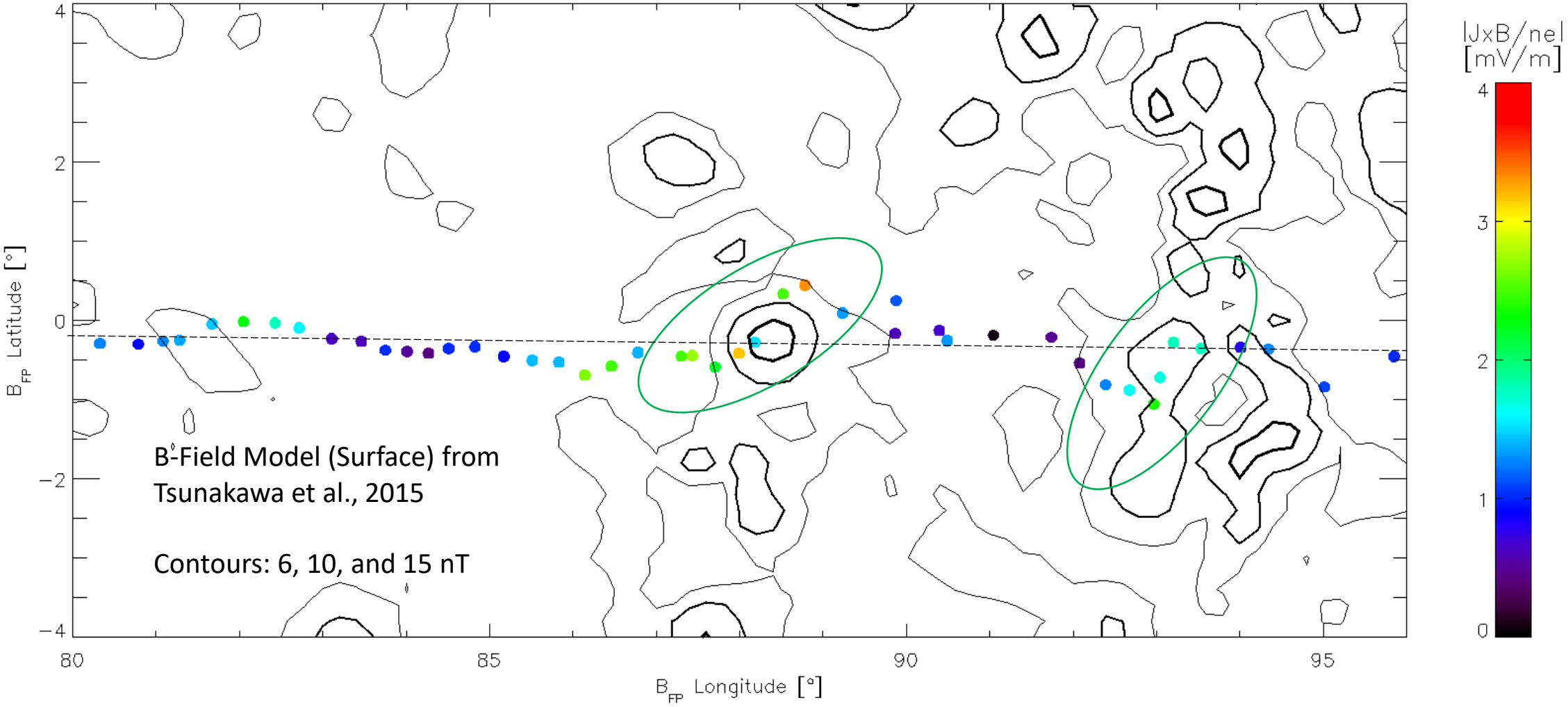
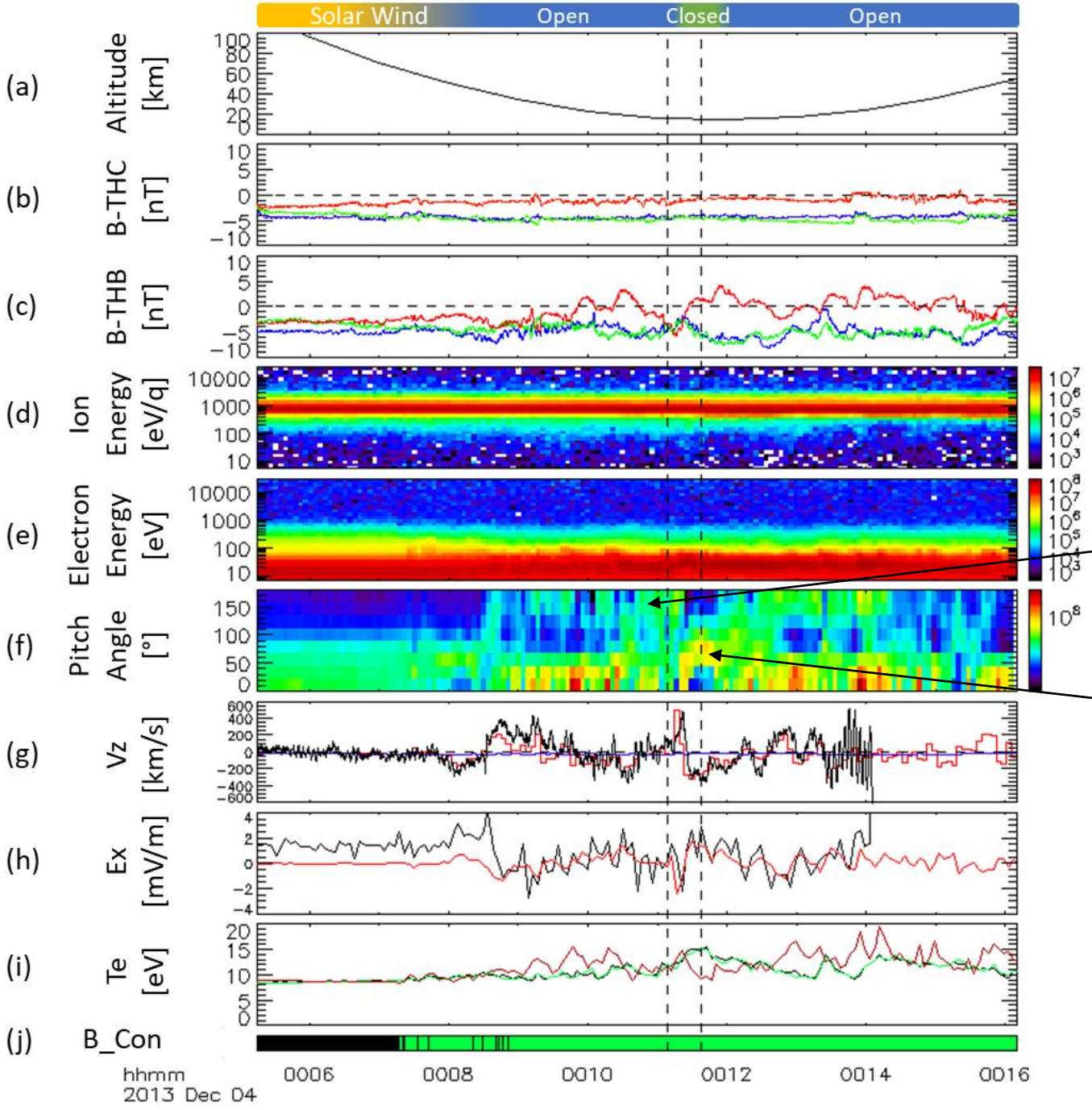
Te_perp1
Te_perp2

Agreement between EFI E-field data and plasma derived hall field.



Localized enhancement of Hall E-Field coincident with crustal magnetization.

Result 2:
THEMIS-ARTEMIS observations of field line topology change



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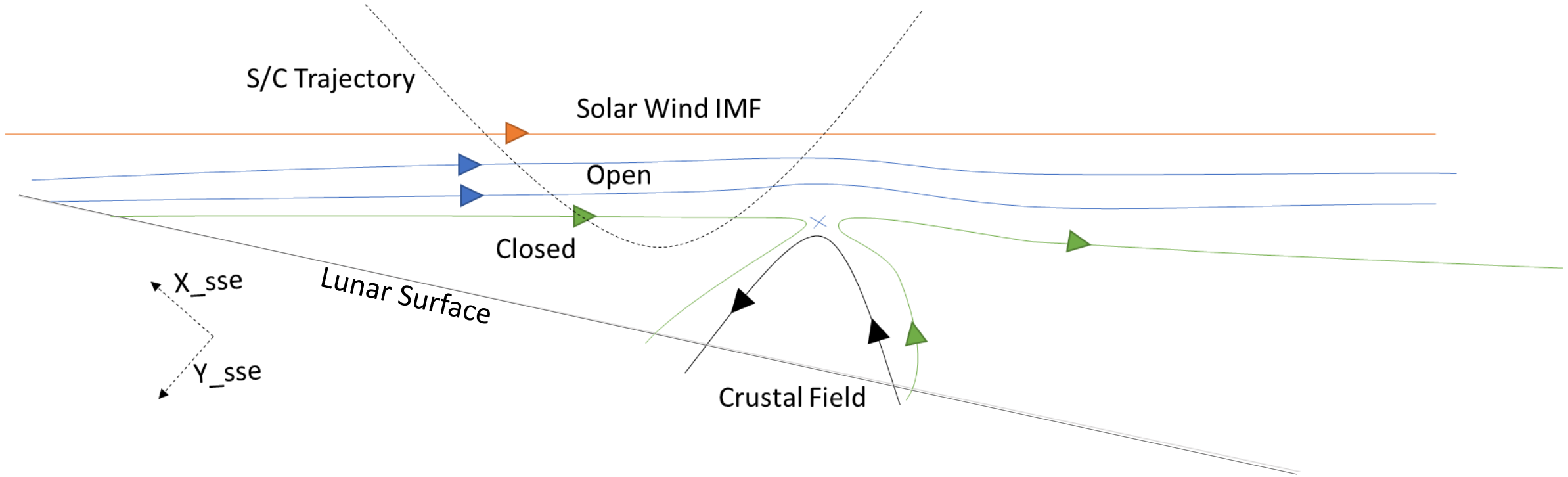
Counter-streaming electron beams indicative of “open” field line topology

Double-sided loss cone distribution indicative of a “closed” field line topology

Change in topology driven by reconnection between the IMF and crustal magnetic fields?

Result 2:
Reconnection may be Contributing to the Closed Field Line Topology Observations



Solar wind IMF reconnected with a crustal field leading to a closed field line topology.

In Conclusion…

- THEMIS-ARTEMIS observations confirm that ions become demagnetized near crustal magnetic fields.
  - The generated Hall E-field is concentrated near regions of crustal magnetization.
- THEMIS-ARTEMIS electron pitch angle distributions suggest that within this region a field line topology change was traversed.
  - The change in field line topology was shown as a transition from counter-streaming electron beams to a double-sided loss cone distribution.
  - The change in field line topology may have been facilitated by the reconnection between IMF and crustal magnetic fields, most likely through electron-only reconnection.

Thank you for your time!

Questions?