Correlation between Poynting flux and soft electron precipitation around the cusp region

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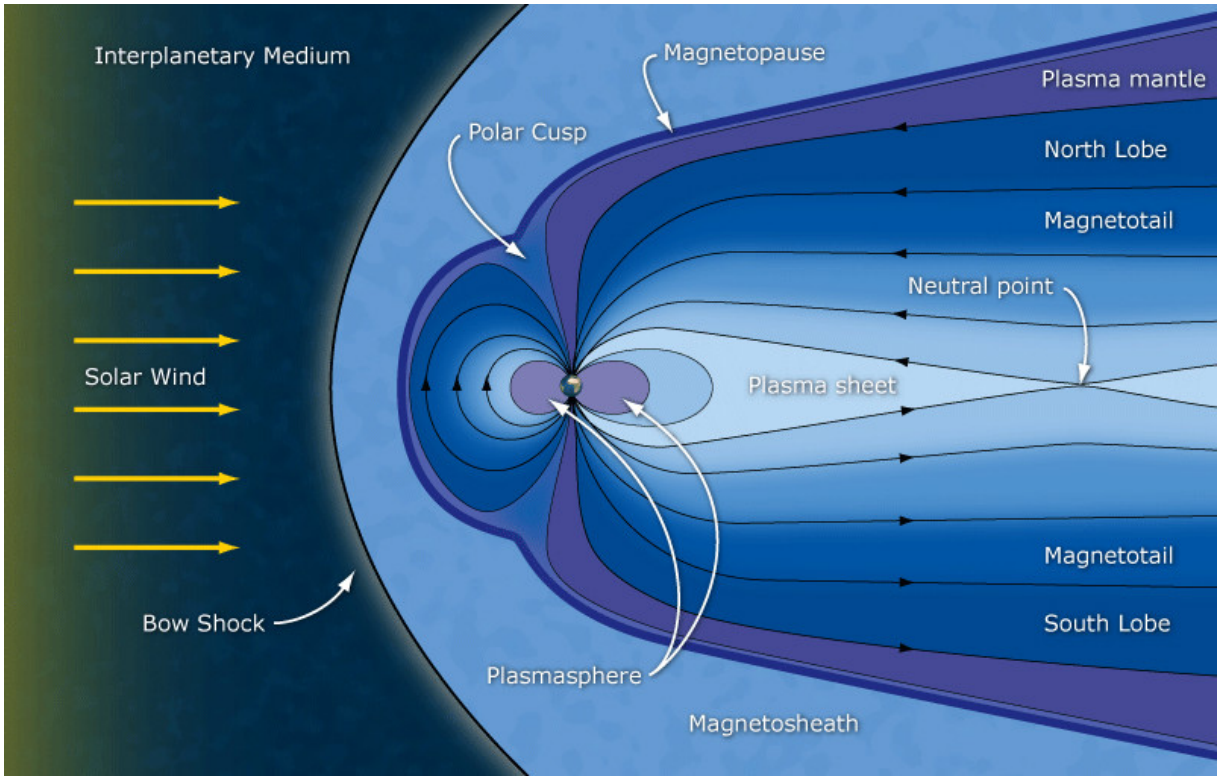
Background: the Earth's Cusp

- A special region with open magnetic field lines
- Poynting flux
- Particle precipitation



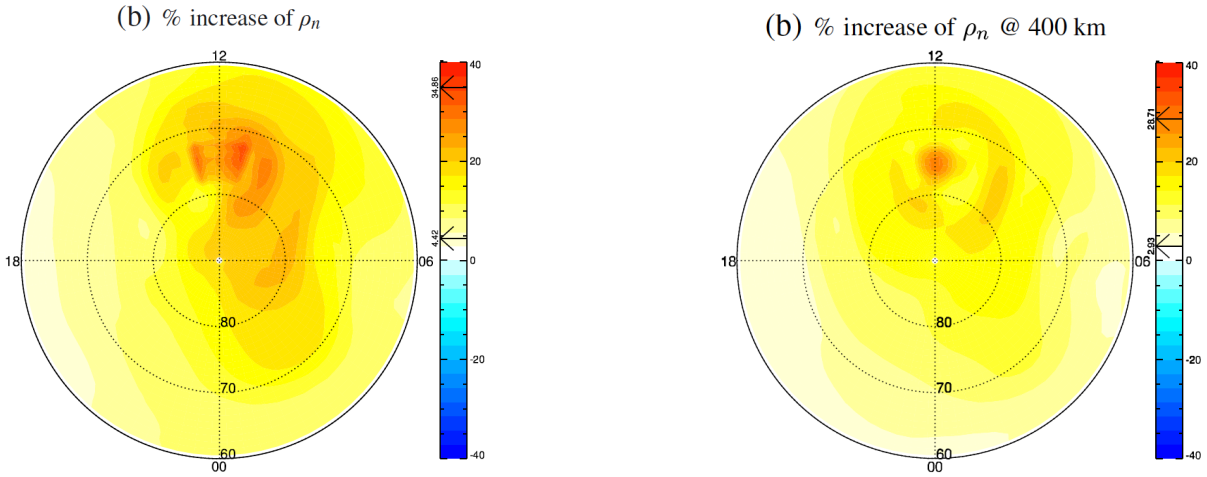
Credit: ESA (adapted from picture courtesy C. Russel)

Motivation

- Simulations have shown that both Poynting flux and soft electron precipitation in the cusp have strong impacts on the neutral dynamics.

Poynting flux (75 mW/m^2)

Soft electron precipitation (100 eV, 2 mW/m^2)



Deng et al., 2013

- In simulations, Poynting flux and soft electron precipitation are usually added in at the same time and same location.
- But in real, what's the correlation between Poynting flux and particle precipitation in the cusp region?

Data

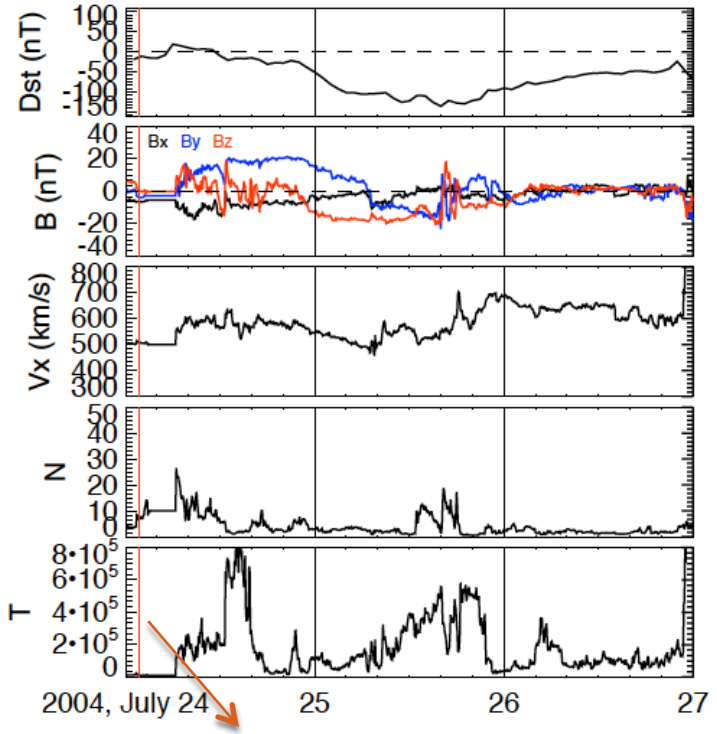
- DMSP observations
  - in 2004 and 2005
  - during storm periods

- Cusp definition (*Newell and Meng*, 1988)
  - If $E_e < 200$ eV, $E_i < 2700$ eV, $j_e > 6 \times 10^{10}$ eV/cm^2 s sr, and $j_i > 10^{10}$ eV/cm^2 s sr, the region is identified as the cusp.

- 24 cusp crossings from our data base
- Two categories
  - 'Match'Event
  - 'Not Match' Event

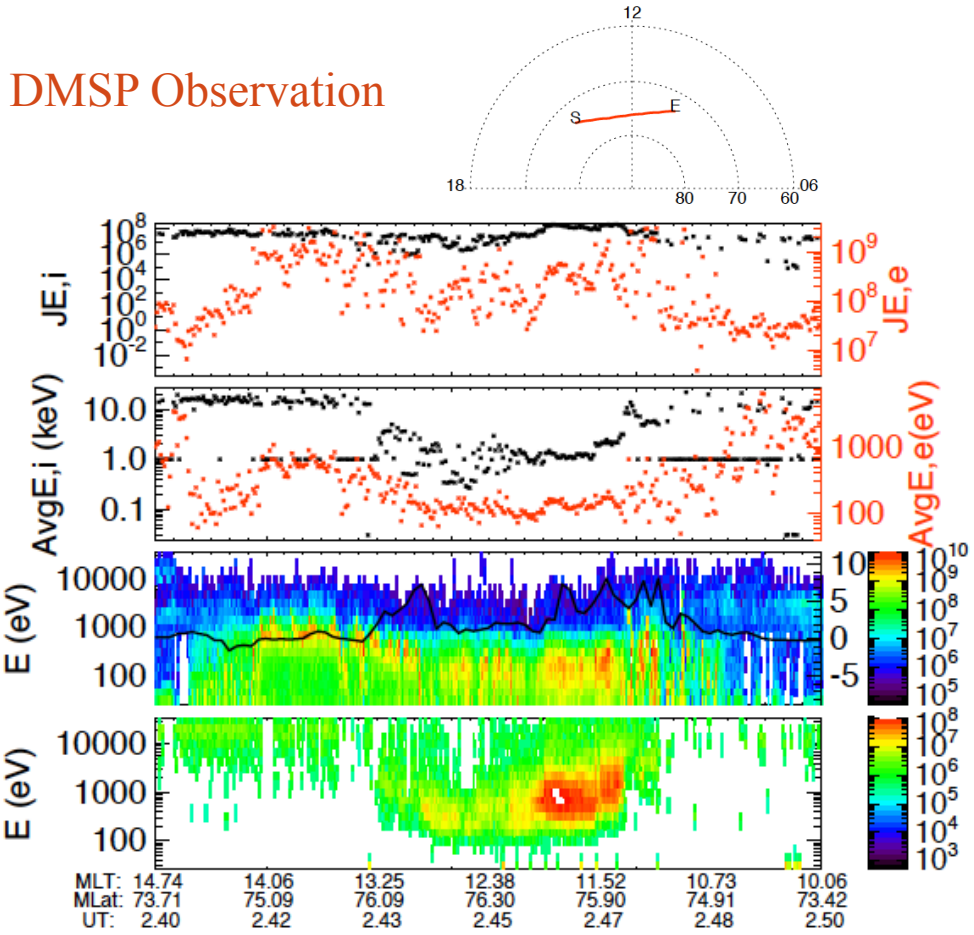
The July 24, 2004 Event ('Match' Event)

IMF/SW



T1-45 min

DMSP Observation

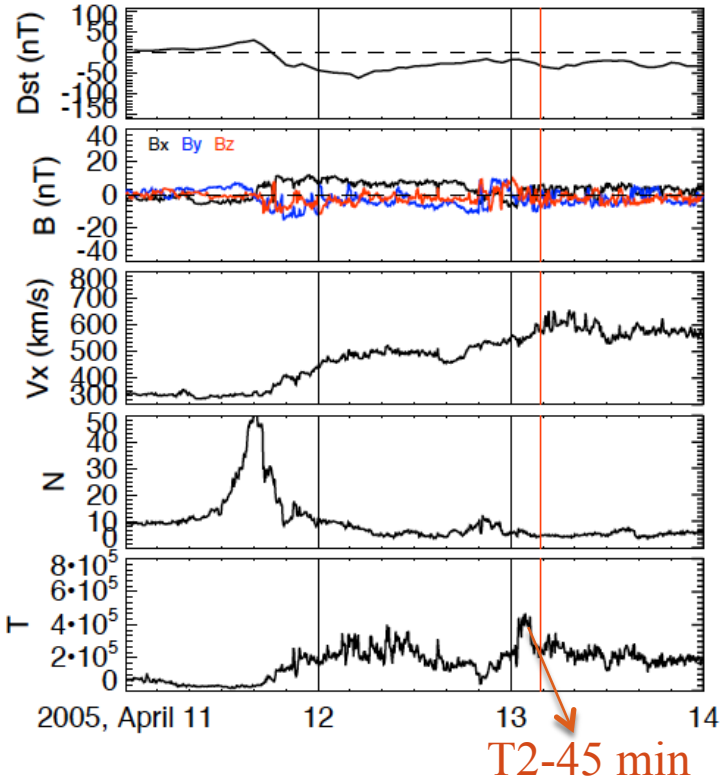


T1

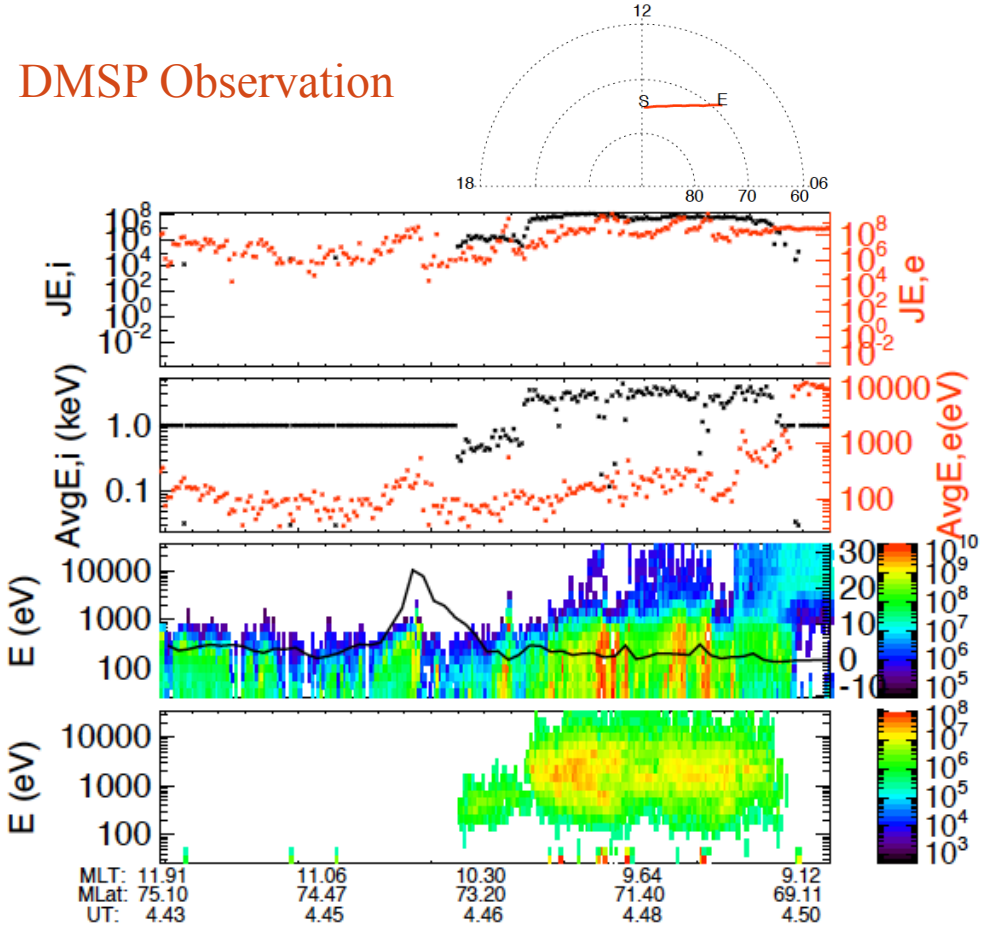
- T1 is the start time of cusp crossing. The red vertical line in the figure marks the time forwarding T1 by 45 minutes.
- Poynting flux enhancement matched very well with particle precipitation, and the maximum of Poynting flux is ~10 mW/m^2.

The April 13, 2005 Event ('Not Match' Event)

IMF/SW



DMSP Observation



- T2 is the start time of cusp crossing.
- particle precipitation happened after Poynting flux enhancement with a delay of ~36 s, or ~1° in magnetic latitude.
- The maximum of Poynting flux is ~25 mW/m^2.

Summary

- From our data base, totally 24 cusp crossings have been identified. In about half of them Poynting flux enhancement and particle precipitation match very well, and in the other half they do not.
- The maximum of Poynting flux enhancement ranges from 5 mW/m^2 to 80 mW/m^2.
- The displacement between Poynting flux enhancement and particle precipitation also varies. It can be as large as 1° in magnetic latitude. The energy deposit processes around the cusp need to be studied in more detail to explain the displacement.

REFERENCE

- Deng, Yue, et al. "Theoretical study: Influence of different energy sources on the cusp neutral density enhancement." Journal of Geophysical Research: Space Physics 118.5 (2013): 2340-2349.
- Newell, Patrick T., and Ching-I. Meng. "The cusp and the cleft/boundary layer: Low-altitude identification and statistical local time variation." Journal of Geophysical Research: Space Physics (1978–2012) 93.A12 (1988): 14549-14556.