What is the origin of low-energy electrons in the inner magnetosphere?

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A Warm Electron Cloak in the Magnetosphere?

The DENSITY of the overall electron population in the magnetosphere is dominated by the low-energies

***Chappell et al.*, 2008**
Warm plasma (ion) cloak - 10s eV - effects on dayside reconnection?

Is there an analagous "warm electron cloak" (10s-100s of eV)?

What effects does this population have (if any) on the magnetosphere?

What are the temporal and spatial dynamics of this population?

Wave-effects (e.g. whistler waves?)

Should we care.....?

Low Energy Electrons

- **Measuring the low energy (1-100s eV) electron population in the inner magnetosphere is DIFFICULT (surface charging - net negative charge in eclipse).**

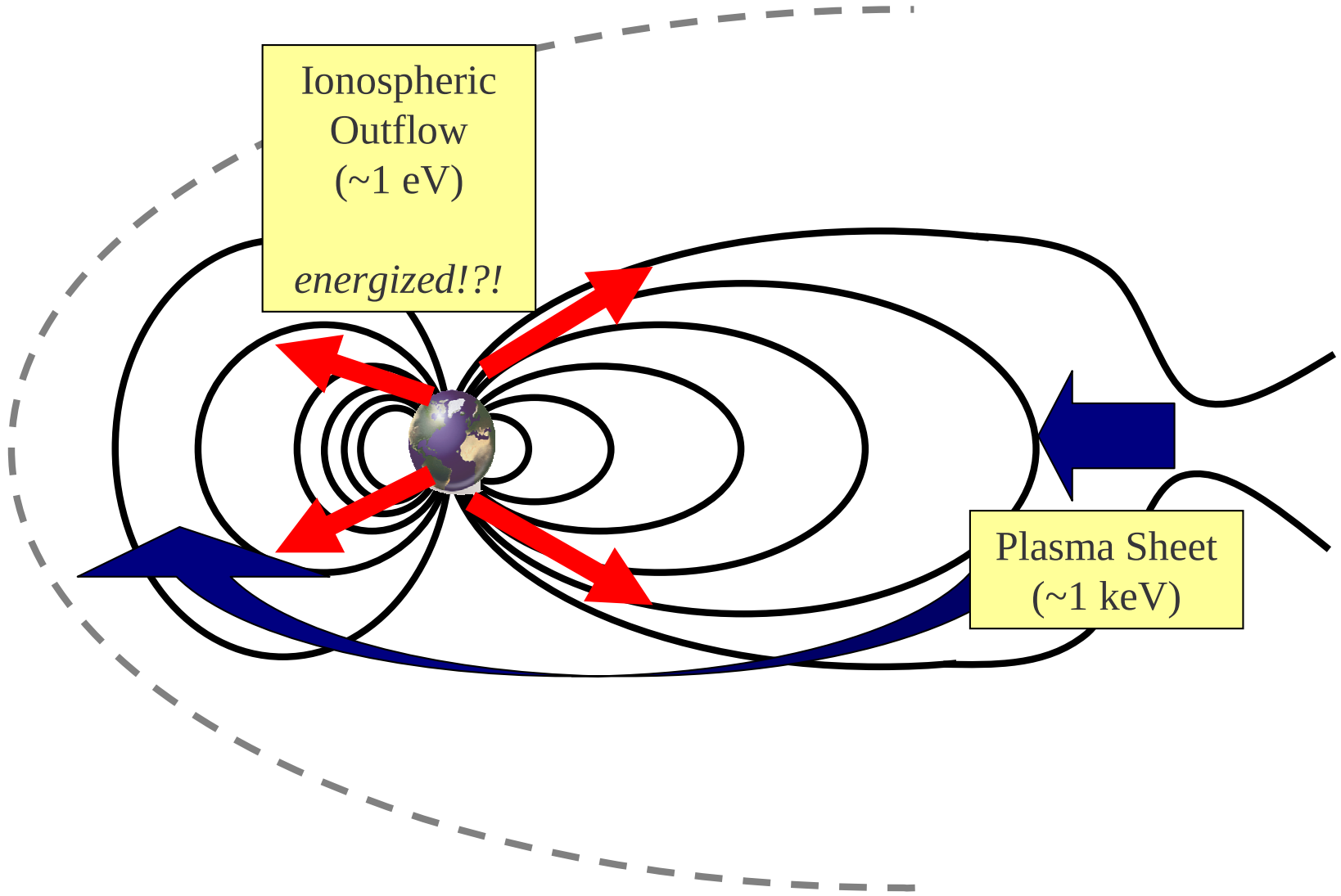
- **Spacecraft surfaces can charge either positively or negatively - in the absence of sunlight the spacecraft potential will be negative (e.g. *DeForest* [1972], *Garrett* [1981], *Farthing et al.* [1982], *Lanzerotti et al.* [1998], *Thomsen et al.* [2013]).**

- **Electrons with energies below the surface potential are repelled from on-board instrumentation. Any electrons detected will thus be "secondary-electrons" ejected from the spacecraft due to higher-energy particles impinging on the satellite surface.**

- **Electrons with energies from 10s to 100s eV have been poorly sampled in the past.**

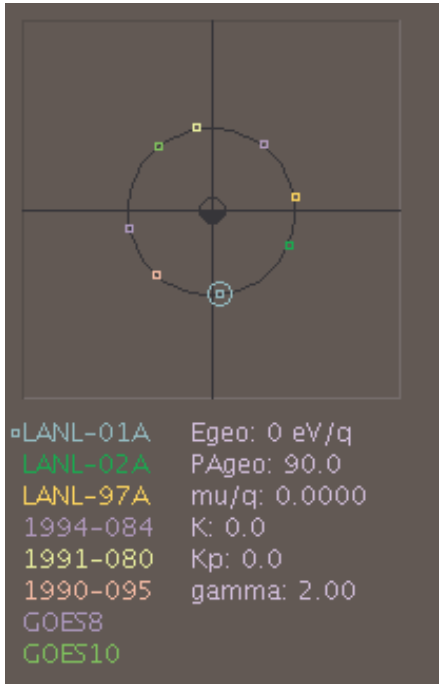
- **This population, its dynamics and evolution, has been neglected in comparison with other magnetospheric poulations such as the plasmasphere, the plasma sheet, the radiation belts, etc.**

Low Energy Electron Sources?



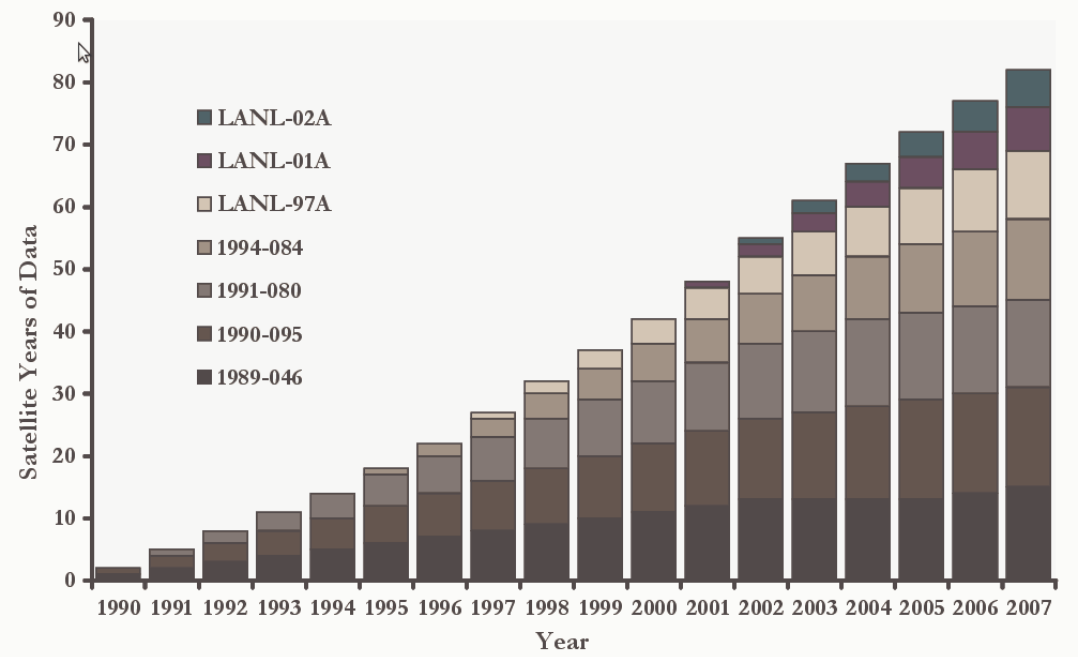
Observations from GEO

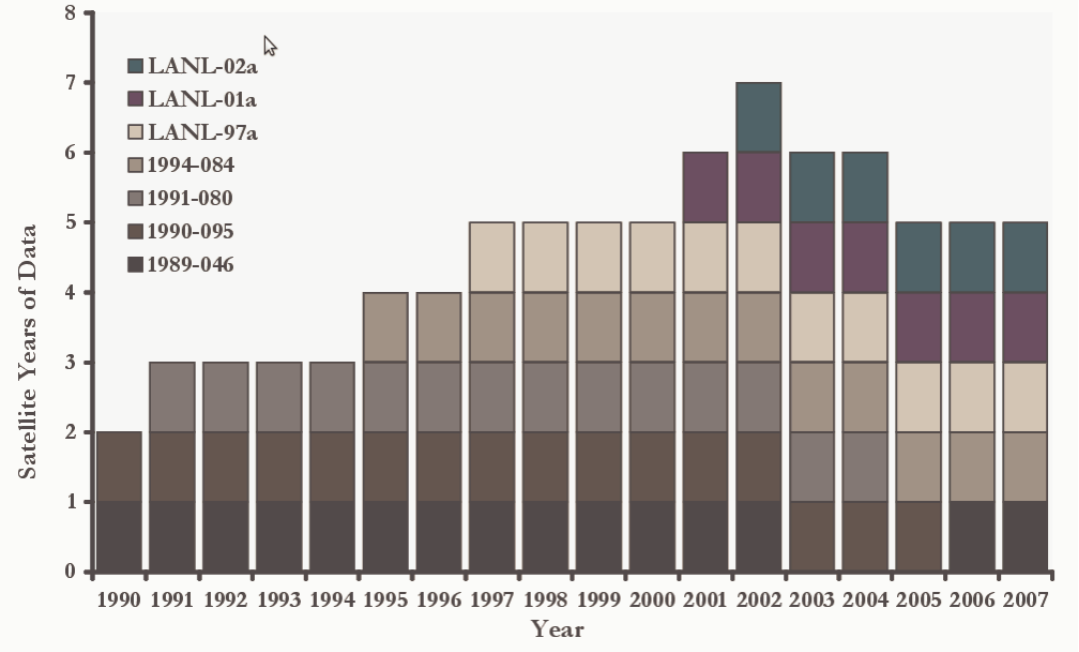
Use LANL/MPA data to explore population statistically



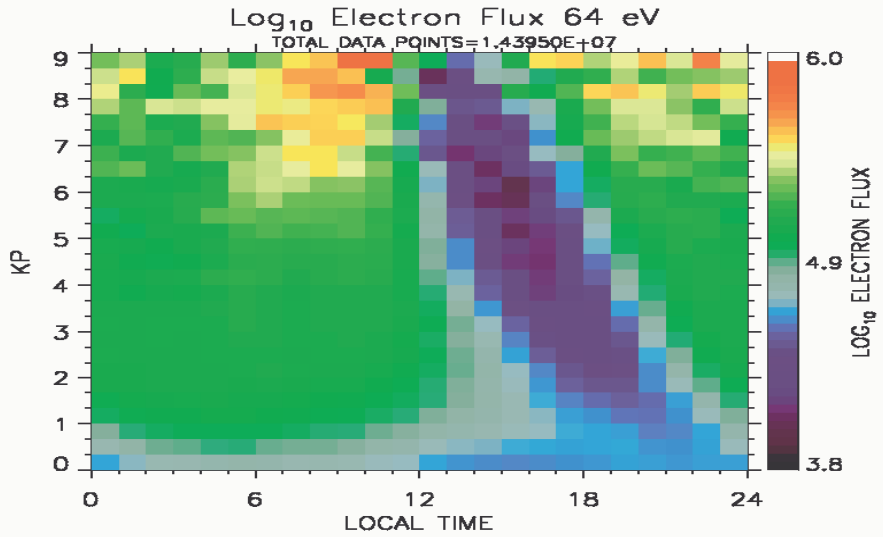
MPA is susceptible to severe negative spacecraft charging

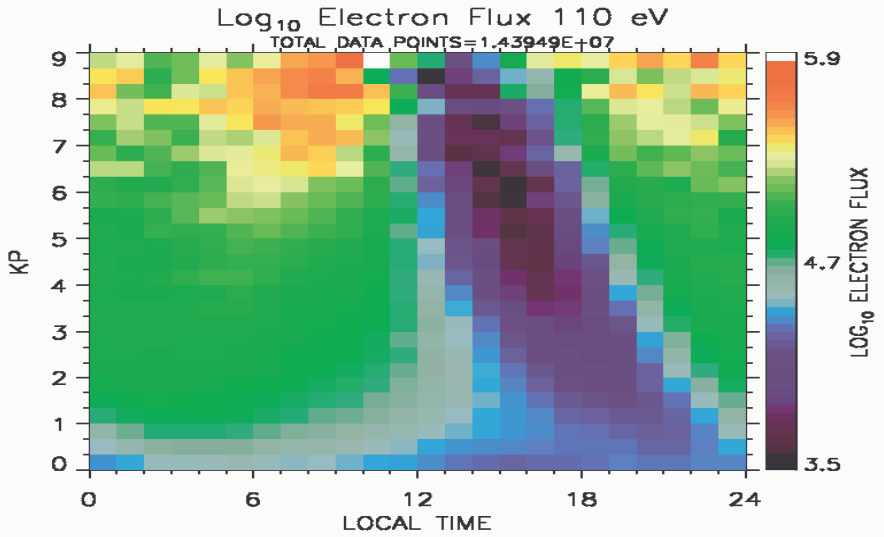
We restrict analysis to times when charging is >-40 V

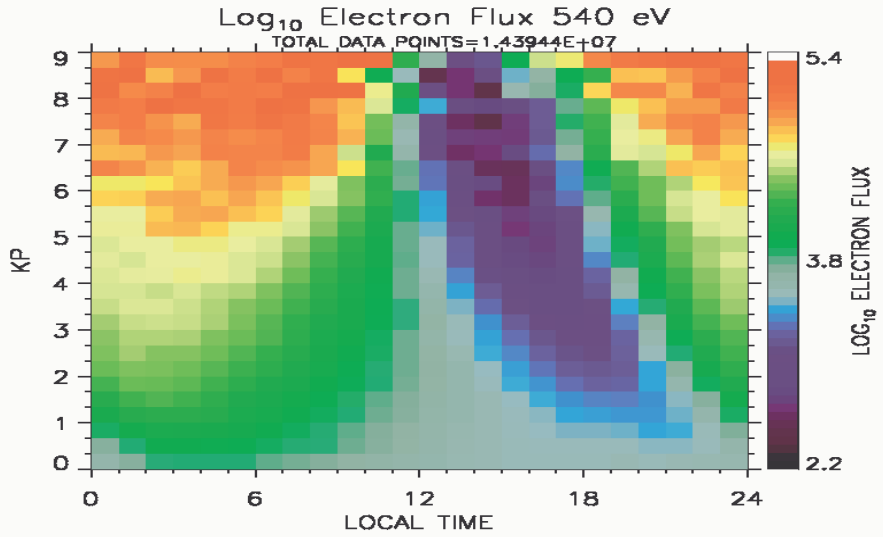


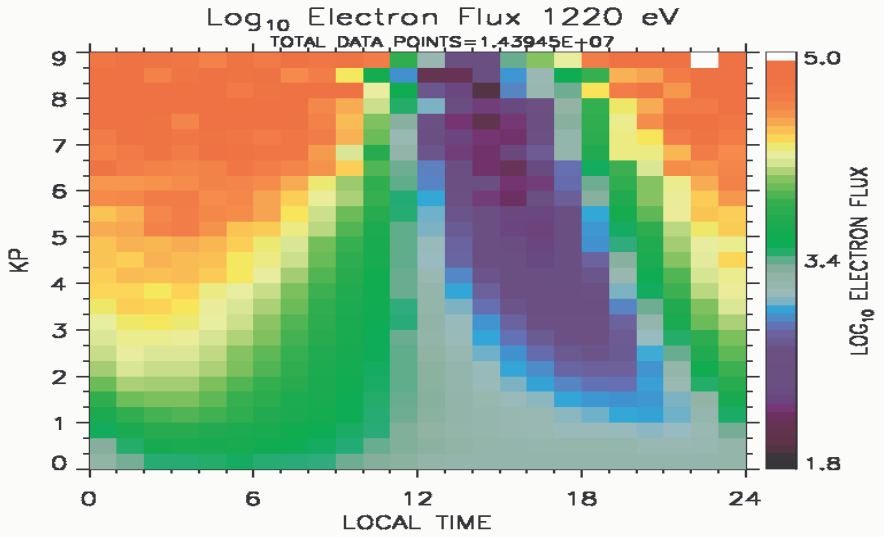


Low Energy Electrons









At GEO the electron population with energies 10s-100s of eV is mostly comprised of the low energy tail of the plasma sheet.

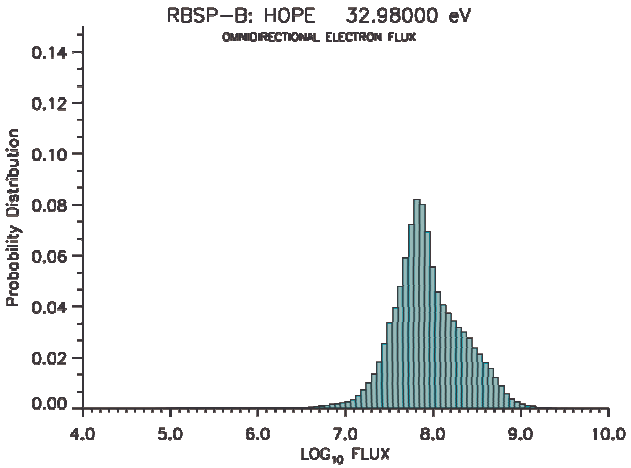
RBSP/HOPE

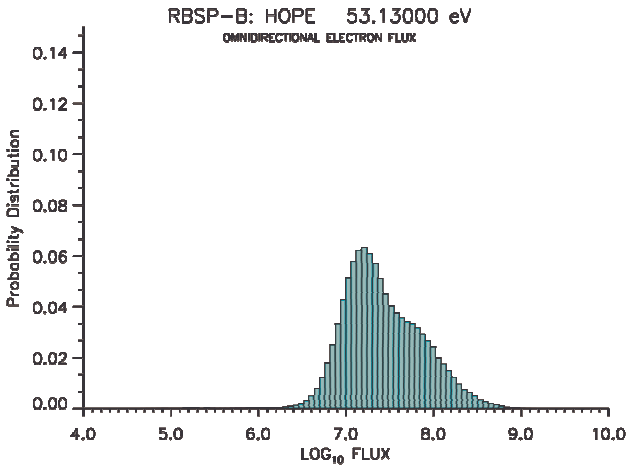
For lower energies, we can now use HOPE electron observatations to explore inwards of GEO.

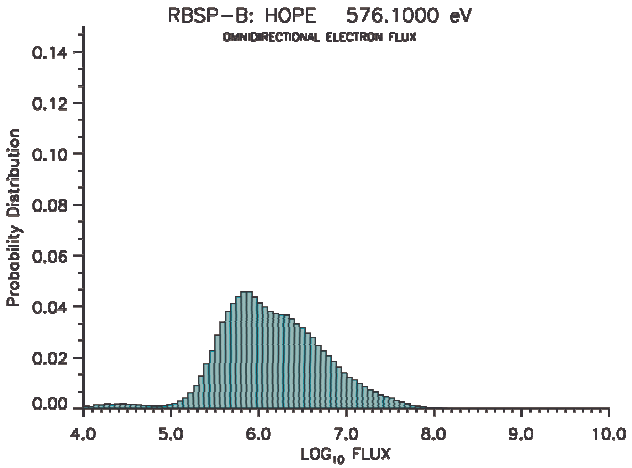
RBSP designed to minimize spacecraft charging (also it has been a mostly benign environment since launch)

From 2013 to 2015 there were only 30 instances where the satellite charged to a potential below -50 V (usually a few volts negative)

RBSP/HOPE







Probability distributions of electron flux over full mission (All L, All LT).

Appearence is suggestive of a superposition of two populations...

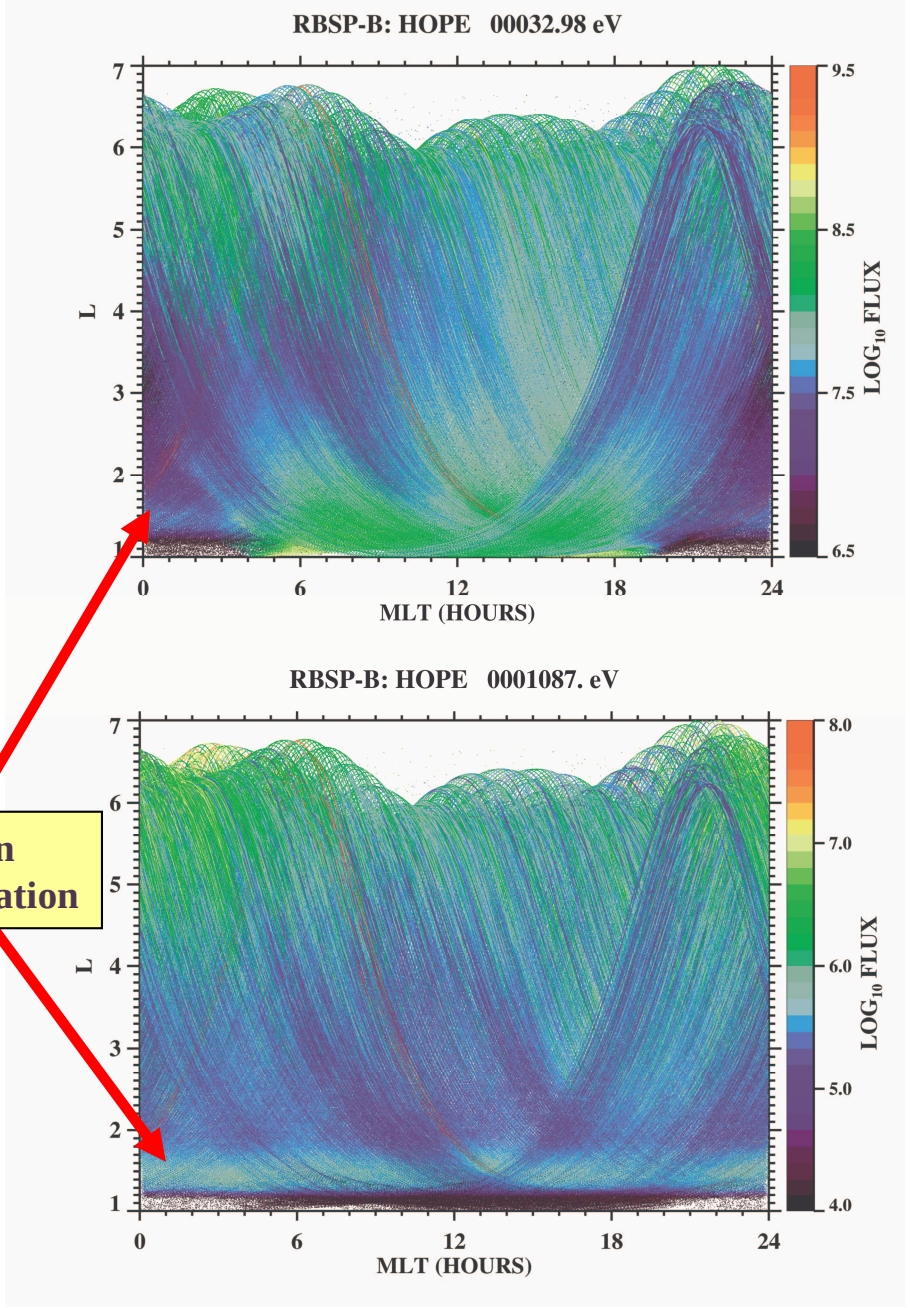
RBSP/HOPE

Every (omni-directional) electron data point plotted as a function of L and MLT.

<u>Two populations:</u>

IONOSPHERIC OUTFLOW

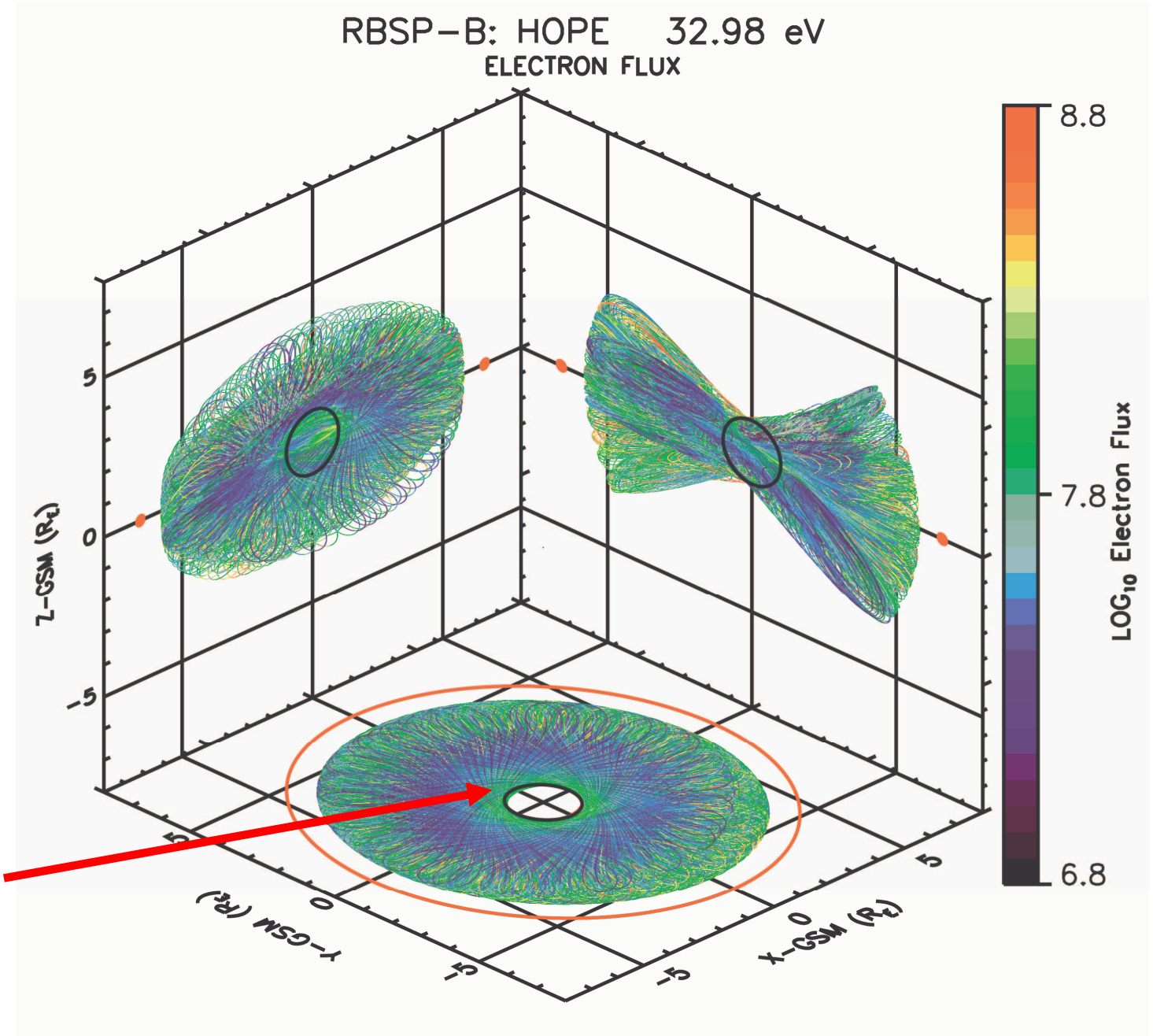
PLASMA SHEET ENTRY



RBSP/HOPE

Omni-directional electrons as a function of GSM

Off-equator variation ot the population



RBSP/HOPE

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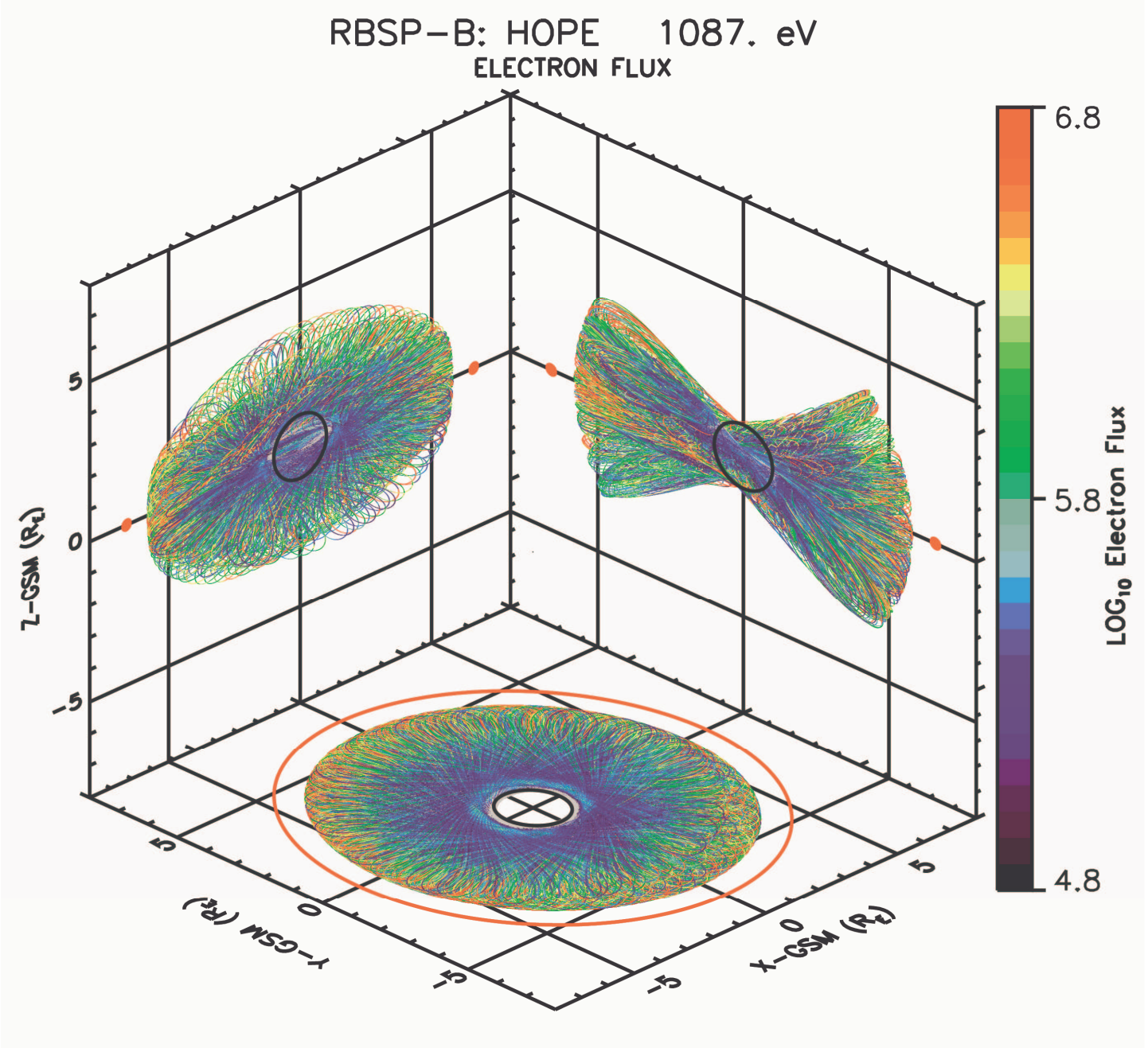
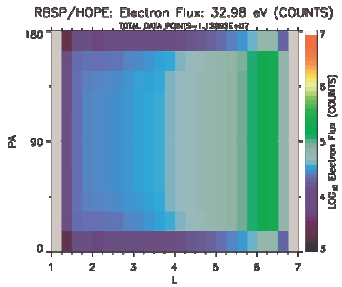


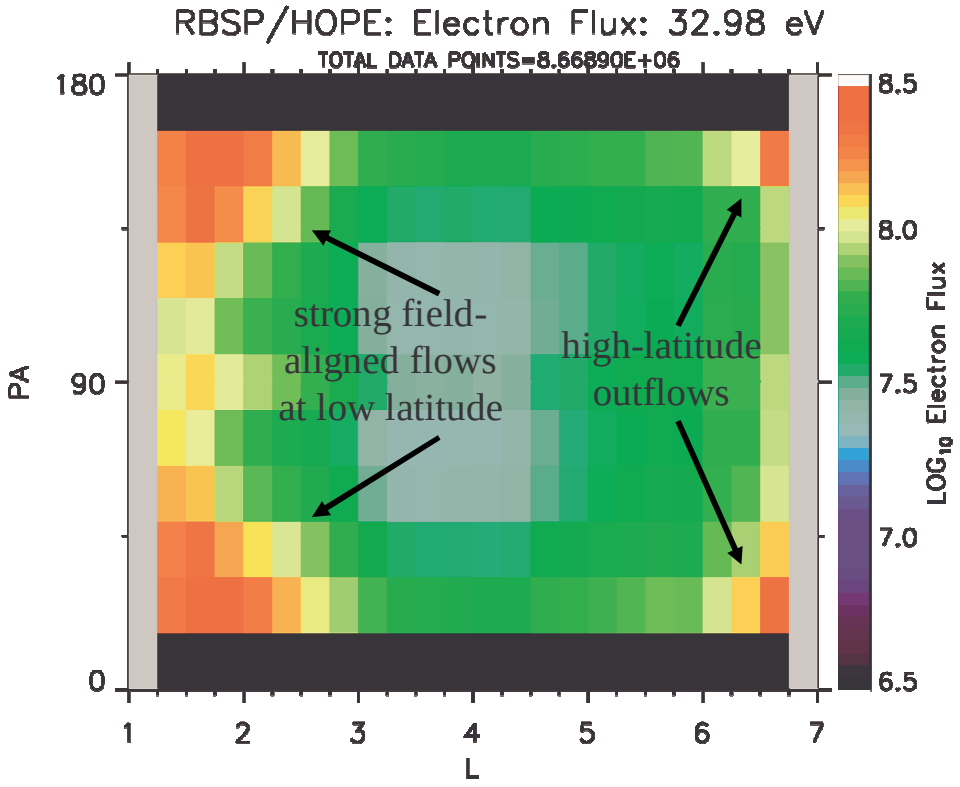
RBSP/HOPE

Pitch-angle distributions of the electrons sorted by MLT.

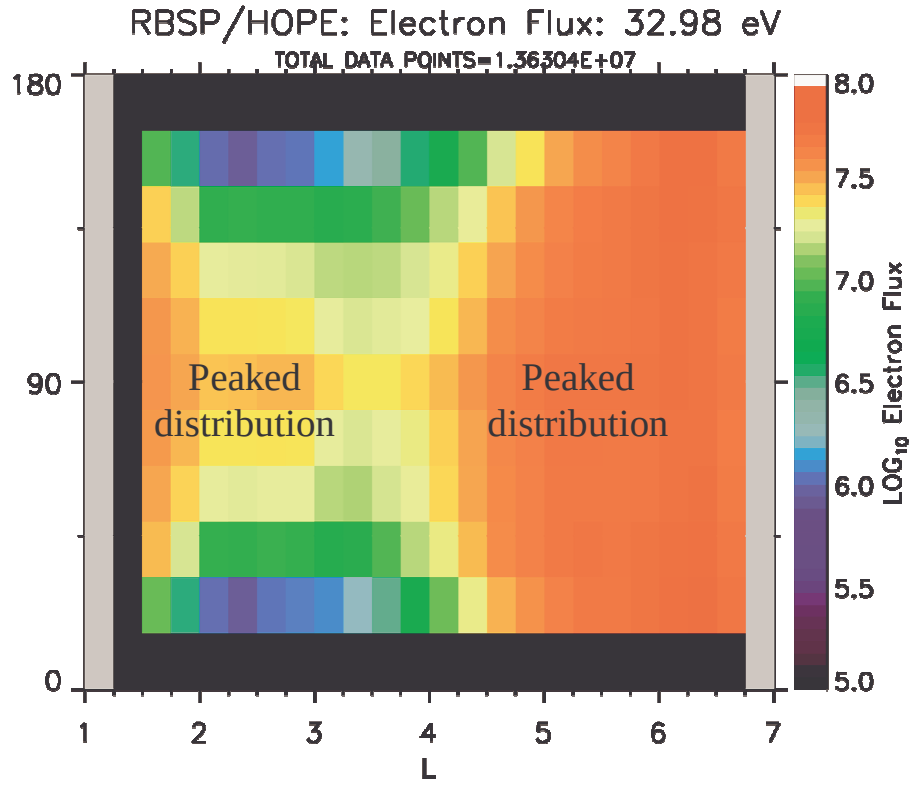
Log (counts)



NOON (10-14 MLT)

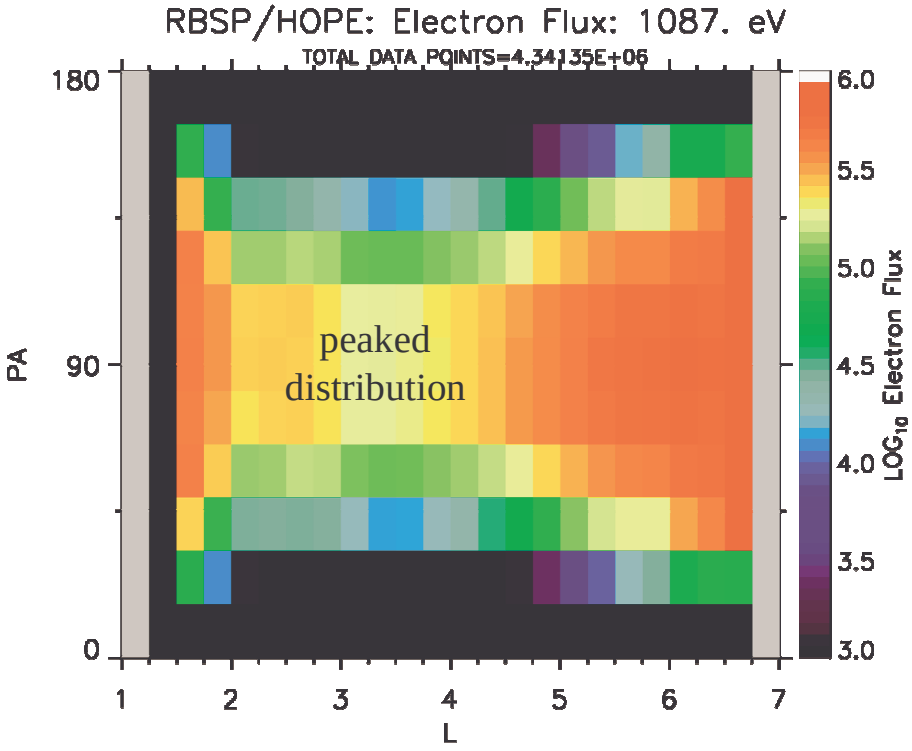


MIDNIGHT (22-02 MLT)



RBSP/HOPE

NOON (10-14 LT)



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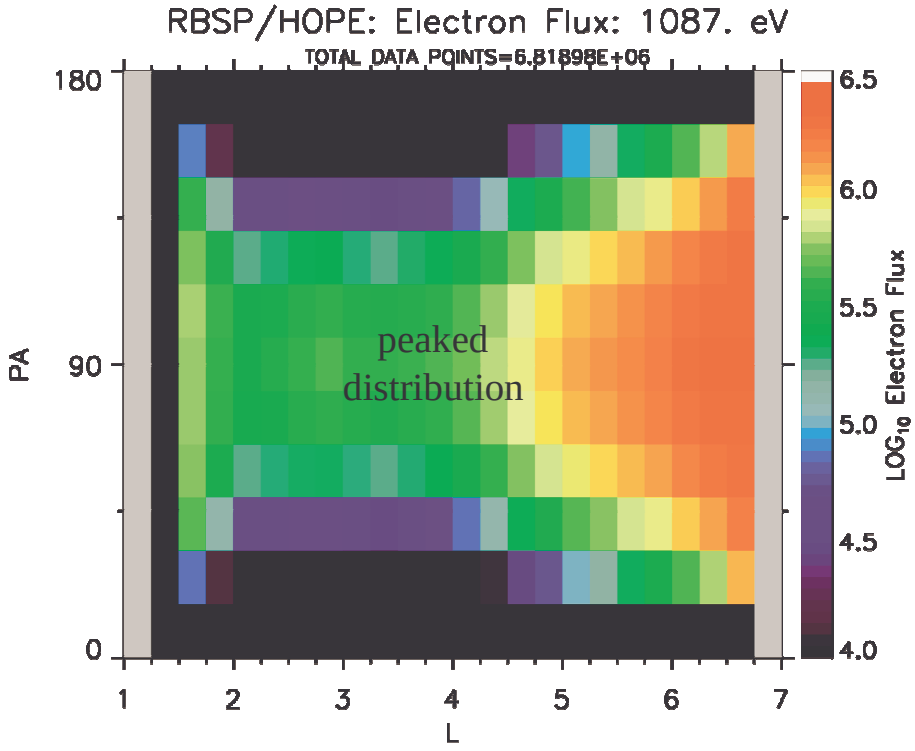

However, this picture is somewhat misleading.

High field-aligned fluxes ARE observed, but not all the time...

Questions

⊙ Can we quantify the conditions that cause field-aligned outflow??

⊙ How important is this population for wave growth??

⊙ Do we understand the dynamics....should we care??