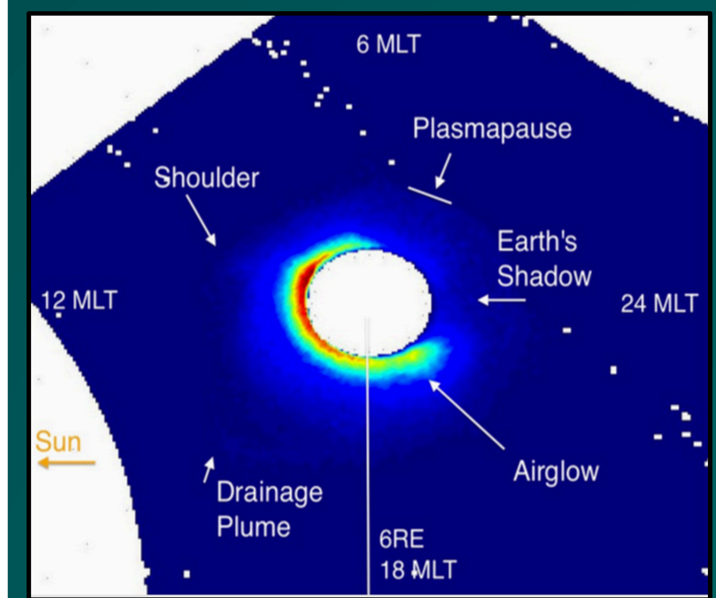
An Inner Magnetosphere Investigation with HOPE: Analyzing the Night Side Disappearance of the Plasmasphere in Van Allen Probes

[1]Lois Keller Smith, [1]Michael W. Liemohn, [1]Roxanne Katus, [2]Ruth Skoug, [1,3]Natalia Ganjushkina
[1]University of Michigan, [2]Los Alamos National Laboratory, [3]Finnish Meterological Institute

Motivation



From Roxanne Katus, IMAGE data

IMAGE EUV imaged the distribution of He^+ in the Earth's Plasmasphere to answer questions about plasmaspheric drivers and transport mechanisms.

We intended to use the Van Allen Probes, launched in 2012, to look at how the plasmapause varies by species, statistically over a year with Kp<3 (low convection).

Methodology

1. Sort RBSP HOPE (Helium Oxygen Proton Electron) instrument data from 2013-01-01 to 2014-04-01 by Kp Index > 3 and Kp < 3
2. Bin by 0.5 MLT and 0.25 L-Shell given in the HOPE CDF packages
3. Calculate the median flux of each bin.
4. Approximate plasma densities. The formula we used is:

$$n_s = \sum_i 4\pi \frac{1}{\sqrt{\frac{2E_i}{m_s}}} F_s \Delta E_i$$

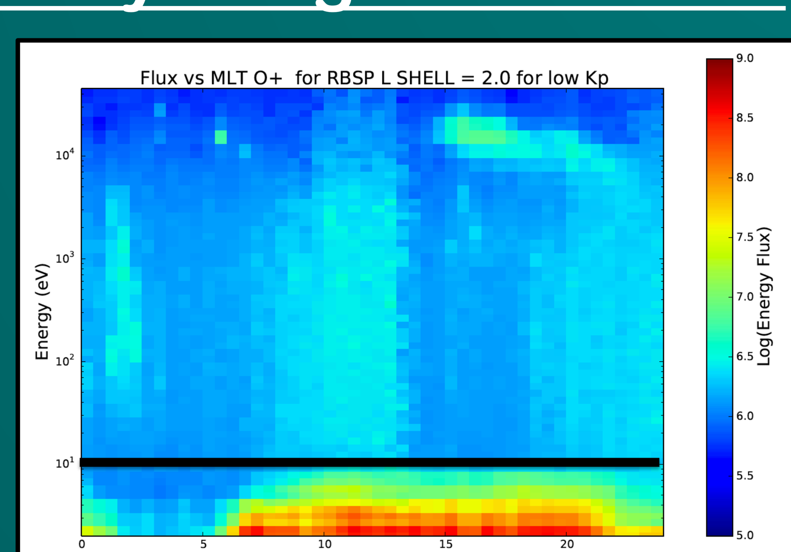
F_s = # Flux (cm^{-2} s^{-1} sr^{-1} keV^{-1})
E_i = median of Energy Channel
ΔE_i = Energy Channel upper bound – lower bound
m_s = mass of species

5. Repeat process for each species

Choosing the Plasma Density Integration Limits

Plasmasphere energies for Van Allen Probes < 10 eV – this is how we chose our integration limit.

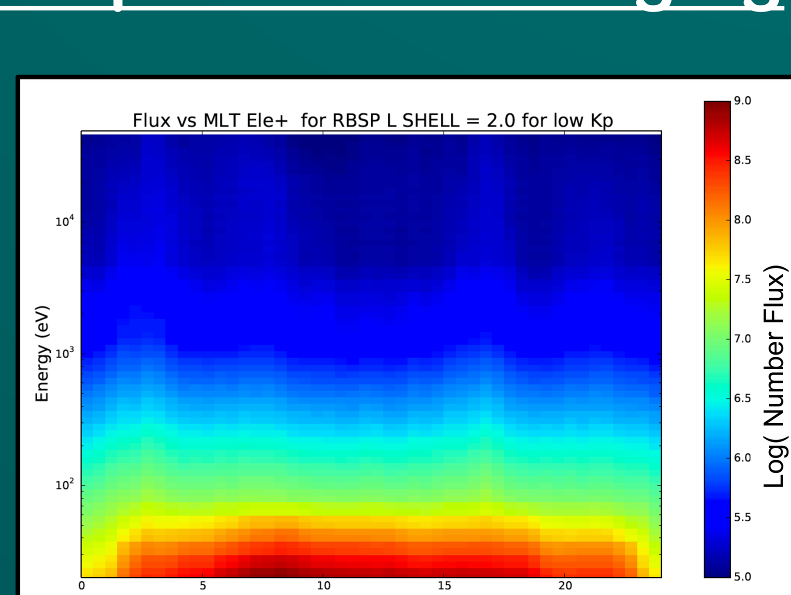
This plot shows data from both RBSP A and B.



Why (we think) This Is Not Spacecraft Charging

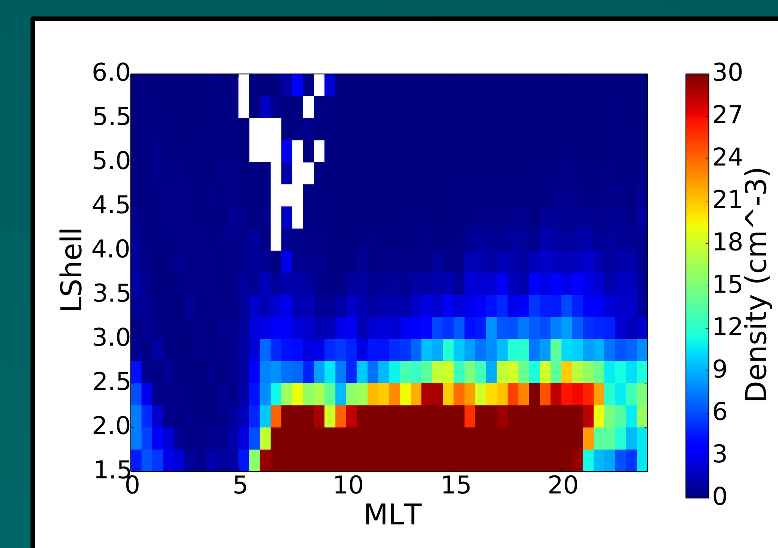
In the plasmasphere, the charging on the spacecraft surface between day and night is at most a few eV +/-.

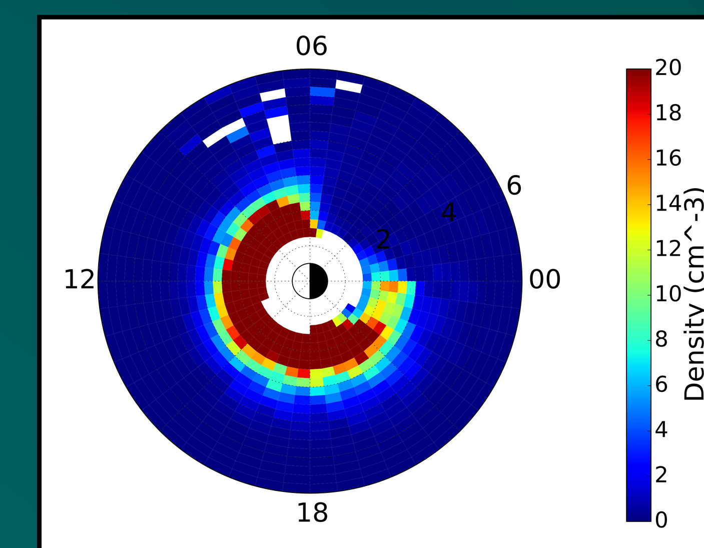
Electrons in the keV range are of concern, but here the number flux is consistent across all MLTs.



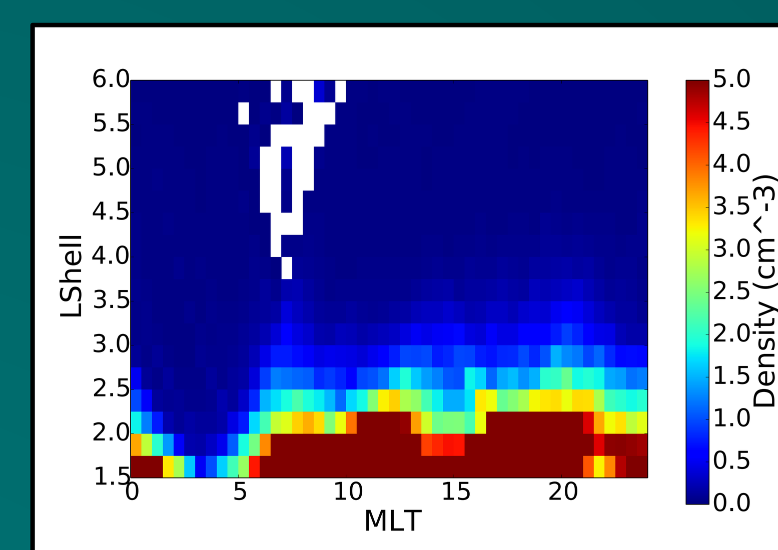
Plasmasphere Density Results

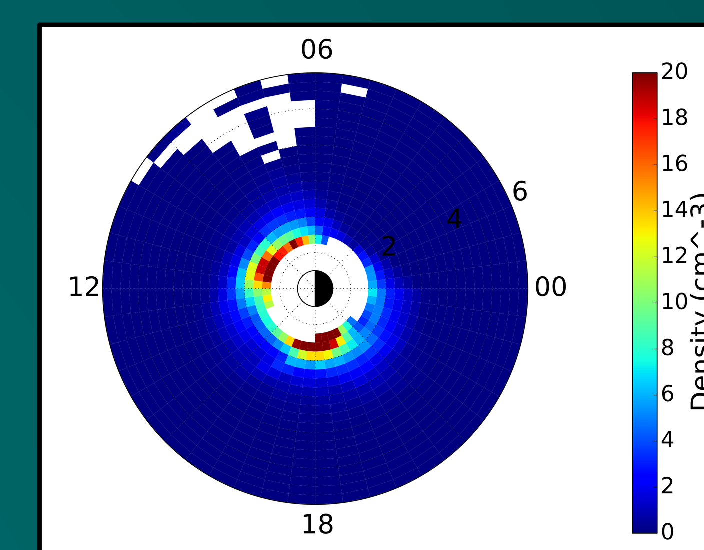
H^+ Plasma Density



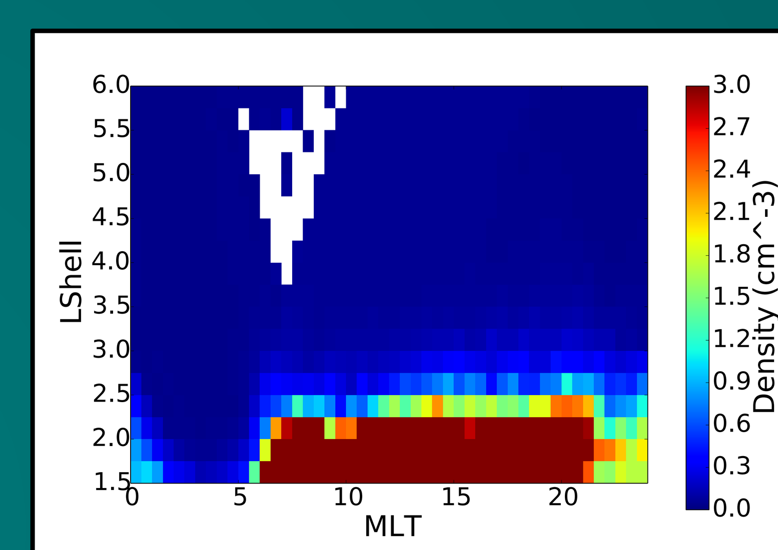


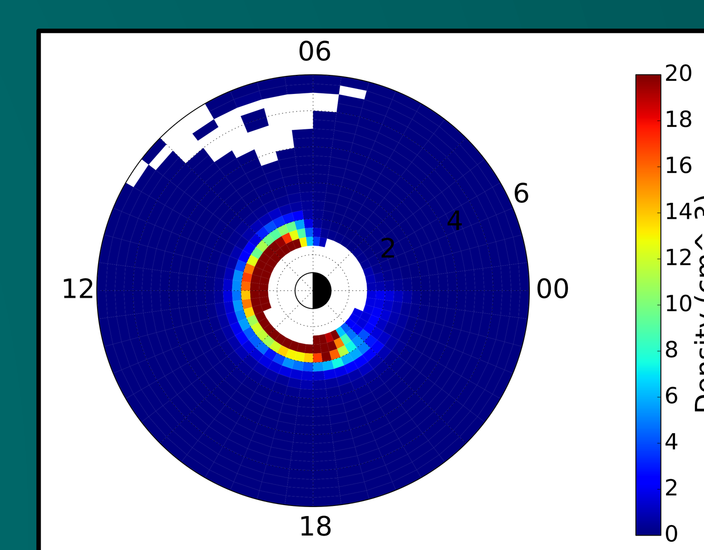
He^+ Plasma Density



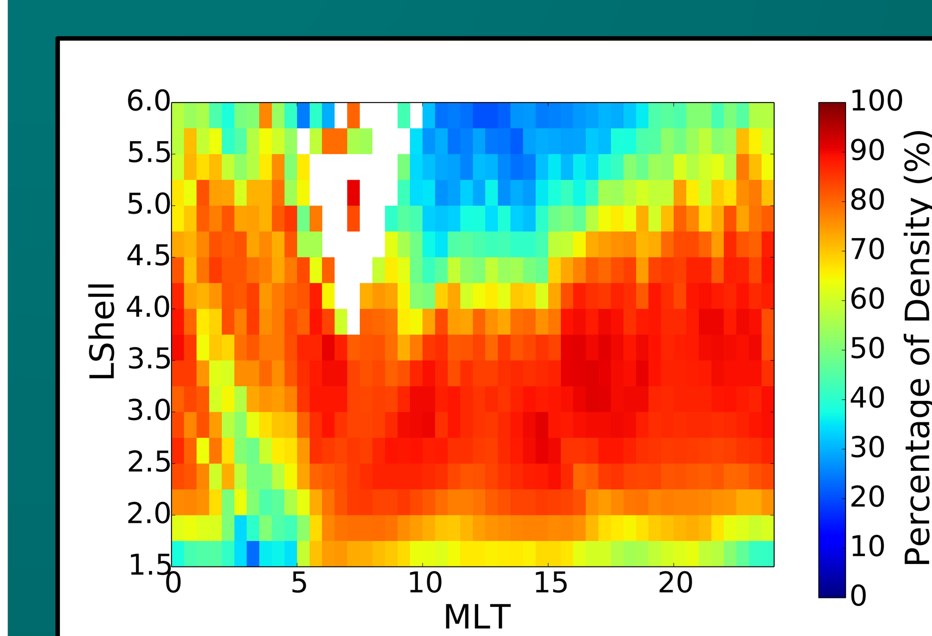


O^+ Plasma Density

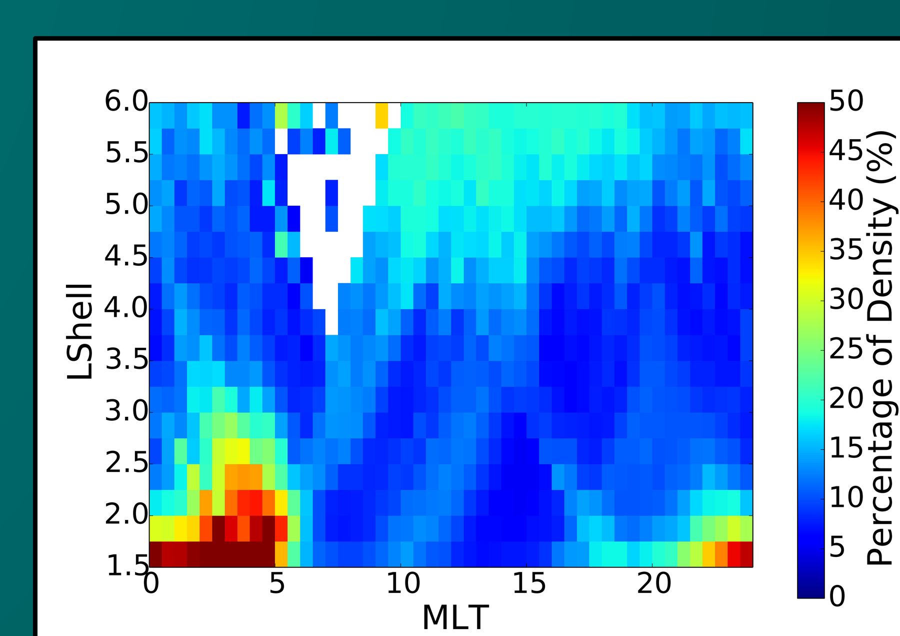




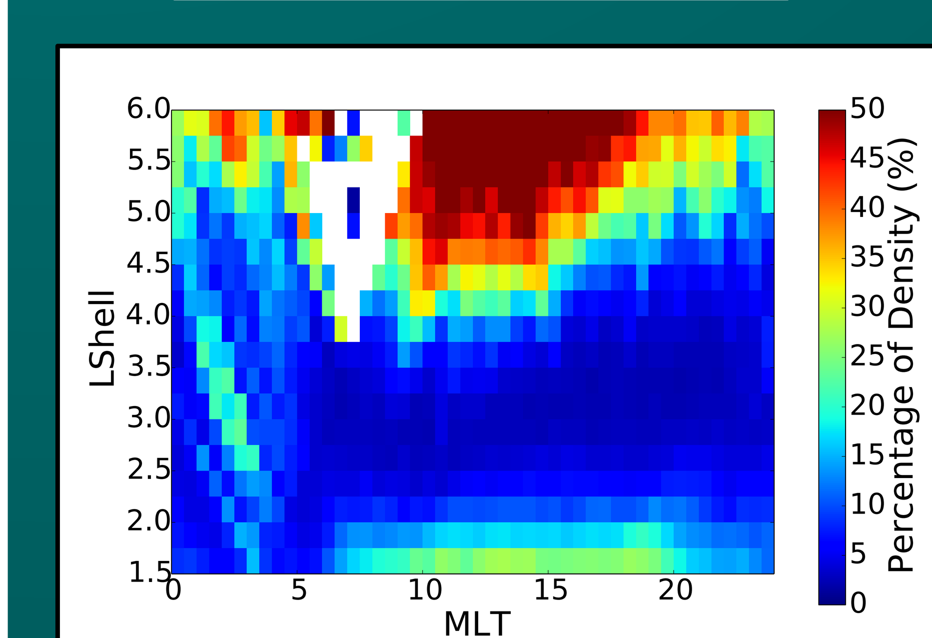
Ion Composition % H^+



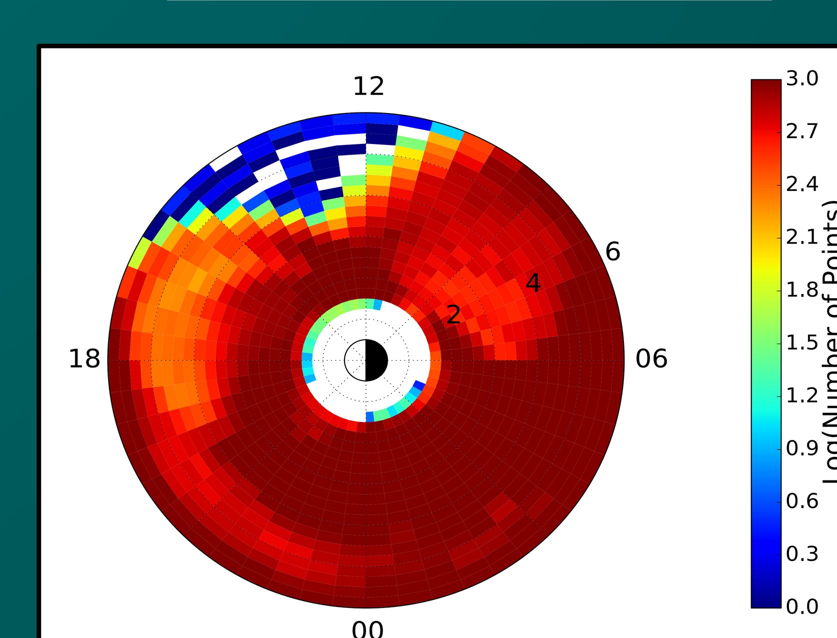
Ion Composition % He^+



Ion Composition % O^+



Number of Points



Future Directions

- Confirm with EMFISIS electron density measurements for space craft charging assumptions made in the post midnight sector
- Define a plasmapause boundary based on species and density
- Explore physics behind the observations, explaining why the plasmapause and/or spacecraft charging is species dependent

Conclusions

1. HOPE has excellent resolution in the 1-10 eV range; however, plasma densities are too low to reflect the entire plasmasphere – we are seeing the high energy tail.
2. There is night side ion loss and it appears to be species dependent, with He^+ surviving the best and H^+ and O^+ experiencing the most loss. Initial examinations show that this is not due to spacecraft charging.
3. The L extent of the plasmapause is mass dependent, with H^+ extending the farthest, followed by He^+ and O^+. Interestingly, O^+ dominates again high L Shells.

Thanks

Thanks go out to Raluca Ilie, Shaosui Xu, Daniel Welling, Michael Hartinger, and Mark Moldwin for their insights and contributions. Also, we would like to thank the Rackham Graduate School for sponsoring this work.