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Energy flux and characteristic energy of electrons over Jupiter's main auroral emission

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Abstract

Jupiter's powerful aurorae are caused by energetic electrons precipitating from the magnetosphere into the atmosphere where they excite the molecular hydrogen. These electrons are characterized over the auroral regions by the Jovian Auroral Distributions Experiment (JADE) and the Jupiter Energetic particle Detector Instrument (JEDI) on Juno. Derived energy spectra and pitch angle distributions help us understand how these aurorae are created and powered. Corresponding ultraviolet emissions from reconstructed images taken by the Ultraviolet Spectrograph (UVS) on Juno give us the context and allow us to match the electron observations with their impact on the atmosphere. In this study, we show how the electron energy flux and characteristic energy vary from the polar region, over the main emission, and equatorward of the main emission in relationship with the UV emissions. We focus on the closest passes which range from ~1.25 to 2 RJ. We find that while the >30 keV electrons dominate the energy flux in the polar regions and equatorward of the main emission, there is a region near the maximum UV brightness where: i) the characteristic energy decreases from more than ~100 keV to less than ~10 keV and ii) the maximum contribution to, or a significant fraction of, the total downward energy flux comes from <30 keV electrons. This pattern is present in all eight perijove passes for which JADE and JEDI have the best pitch angle coverage.

1. Introduction

In this study, we derive quantities such as the energy flux and the characteristic energy of precipitating electrons and put them into context using UV images as shown in Figure 1 where we map Juno's foot point with the most recent magnetic field model [1]. We also examine differences of energy flux and characteristic energy for electrons going towards and away from Jupiter. We illustrate the changes in the electron energy spectra and the pitch angle distributions as Juno flies over the main auroral emission regions. Finally, we look at the relationship between those quantities and the UV brightness measured at the magnetic footprint of Juno.

2. Summary and Conclusions

We summarize our findings here:

1) There is a region situated near the main emission or slightly equatorward of the main emission where the energy flux of precipitating electron is dominated by <30 keV electrons and the characteristic energy is below 30 keV. The minimum characteristic energy in the region was below 1 keV. This pattern is common to all perijove passes.

2) At higher latitudes than that region, the characteristic energy is usually above 30 keV and mostly around 100 keV.

3) The region where the 3-30 keV energy flux peaks has a variable lower M-shell of 18±9 and fairly constant upper M-shell of ~50.8±1.2.

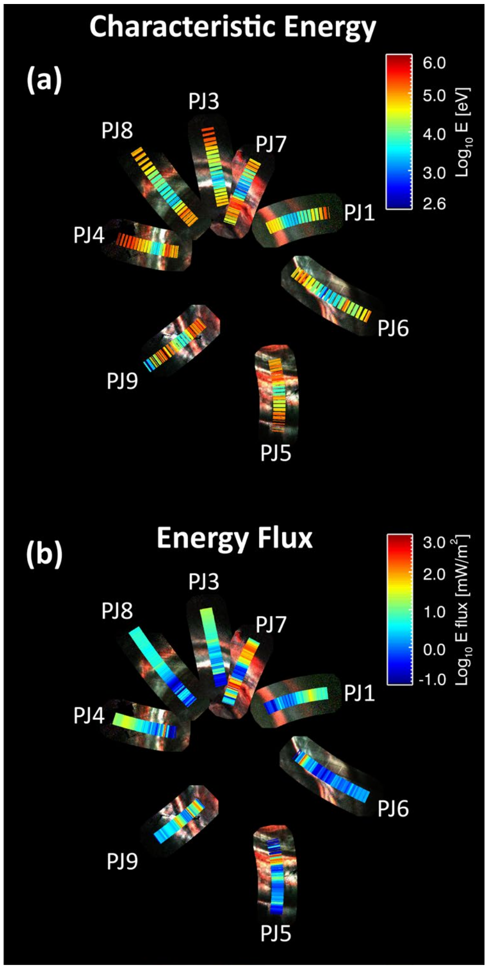

Figure 1: Characteristic energy (a) and energy flux (b) of precipitating electrons measured by JADE/JEDI projected onto UVS images for the north passes.

4) The upward electron beams (also previously reported [2,3]) are typically above 100 keV in the polar regions. Their energy decreases as the latitude decreases, and they are observed down to 100 eV. Downward electron beams are also observed, but less frequently. They are mostly seen in the lower energies (<~30 keV), but have occasionally been observed above 100 keV.

5) There is a qualitative agreement with the notion that a high characteristic energy corresponds to a high UV color ratio.

6) The downward energy flux is not always clearly correlated with the UV brightness when mapping Juno's magnetic footprint.

7) The upward to downward energy flux ratio shows that the upward flux clearly dominates in the polar region just before the main emission region and the downward flux slightly dominates near the main emission and equatorward.

8) Large variations of energy flux and characteristic energy are observed from pass to pass and even during a single pass. Those two quantities seem correlated at times and not so at other times.

9) There occasionally is a good correlation between the downward electron energy flux and the UV brightness (PJ3, 4, 5 north, 6 south, 9 north). When focusing on these passes only, we determine the relationship between the brightness per energy flux versus the characteristic energy. It peaks near 30 keV. The trend is in good agreement with a prediction from a previous model [4].

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