A Missing Dusk-side Loss Process in the Electron Ring Current

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Motivation

- Ring current simulations tend to overestimate the 10-50 keV electron flux at low L significantly during intense geomagnetic storms
- This effect occurs systematically and is not event specific
- Explaining this discrepancy is an essential step towards understanding the electron dynamics during storm onset

Methods

- The VERB-4D model solves the Fokker-Planck equation in four dimensions (*MLT*, *R*, *V*, *K*), where *V* and *K* are modified adiabatic invariants:

$$\frac{\partial f}{\partial t} = \langle v_\varphi \rangle \frac{\partial f}{\partial \varphi} + \langle v_R \rangle \frac{\partial f}{\partial R} - \frac{f}{\tau_{wave}}$$

- Wave-particle interactions are incorporated through parameterized electron lifetimes due to Hiss and Chorus wave scattering.
- The RBSP satellites located at 00-01 MLT allow us to validate the incoming electron flux during storm onset, while the POES satellites allow us to validate the number of precipitated electrons.
- Location of missing loss is identified by calculating drift trajectories of electrons at constant μ, which are dependent on real Kp history

Results

- Overestimations on both the dawn and dusk-side are likely caused by the same missing loss process located on the dusk-side
- Additional loss in the pre-midnight sector has to be applied to reproduce trapped and precipitated electron flux observations
- This results in very fast scattering of <10 keV electrons, reaching the limit of strong diffusion in the pre-midnight region

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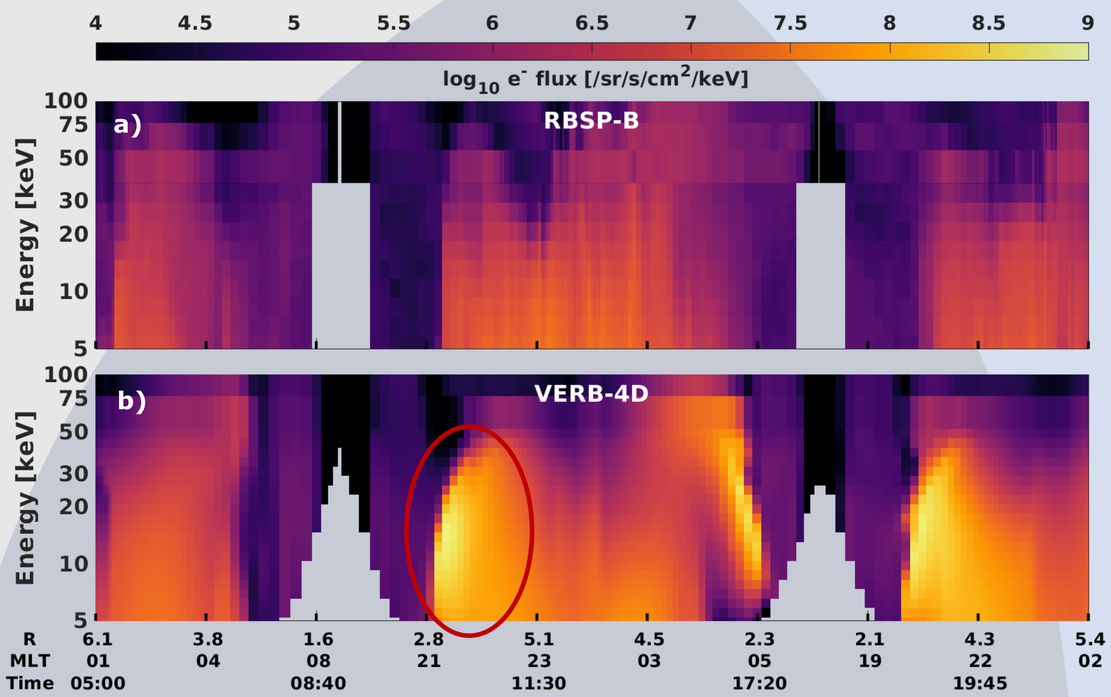
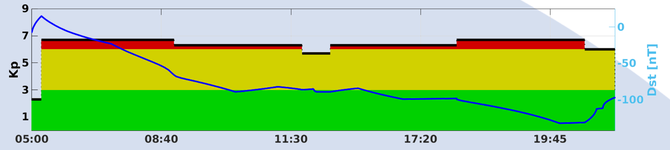
St. Patrick's Day storm in 2013

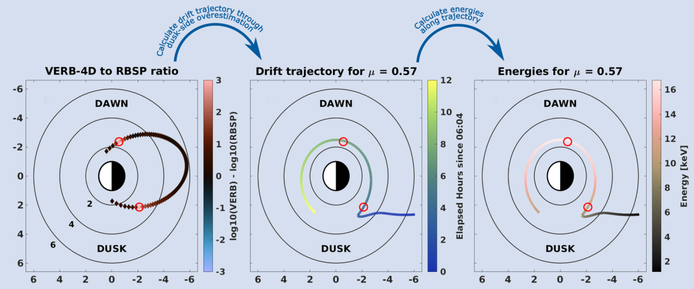


Additional loss in the dusk sector is required to reproduce observations

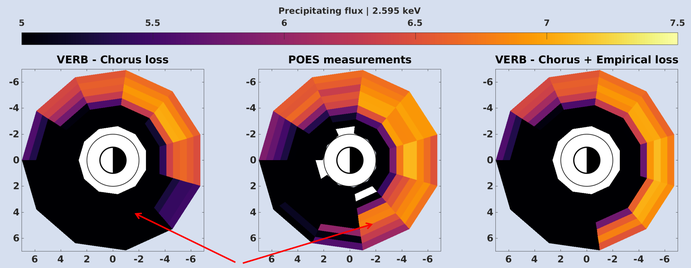
Observations and simulation results along the RBSP-B orbit on 17 March 2013. a) RBSP-B HOPE and Mageis observations; b) VERB-4D results without additional loss; c) VERB-4D results including additional loss in the dusk sector. The additonal empirical determined loss term helps to reproduce observations by a large margin.



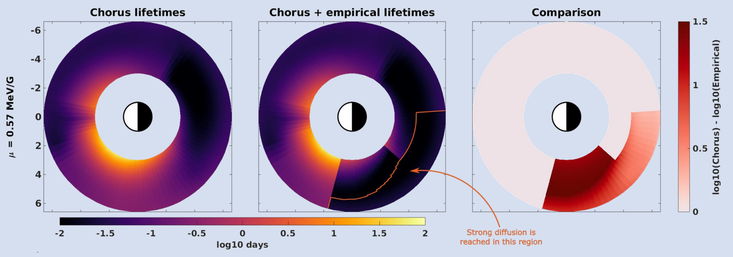
On 17 March 2013, a strong geomagnetic storm with a Dst minimum of ~130 and a Kp maximum of 7- occured.



The left panel shows the comparison between VERB-4D and RBSP observations for 10 keV electrons. Electrons with energies ~2 keV must be scattered in the pre-midnight sector before causing the 10 keV overestimation on the dusk-side.



The missing loss is also visible in measurements of precipitating particles taken at LEO orbit. Each L-MLT bin shows the average precipitating flux measured by the T0 telescope of the TED instrument for the first 6 hours during the main phase of the storm.



The addition of empirical determined lifetimes causes very strong scattering in the pre-midnight sector reaching the theoretical limit of strong diffusion.