



Examination of Radiation Belt Dynamics during Substorm Clusters: Magnetic Local Time Variation and Intensity of Precipitating Fluxes

Craig J. Rodger*⁽¹⁾, Mark A. Clilverd⁽²⁾, Aaron T. Hendry⁽¹⁾, and Colin Forsyth⁽³⁾

(1) Department of Physics, University of Otago, Dunedin, New Zealand; e-mail: craig.rodger@otago.ac.nz; aaron.hendry@otago.ac.nz

(2) British Antarctic Survey (NERC), Cambridge, United Kingdom; e-mail: macl@bas.ac.uk

(3) UCL Mullard Space Science Laboratory, Dorking, United Kingdom; e-mail: colin.forsyth@ucl.ac.uk

Substorms are short-lived but significant reconfigurations of the geomagnetic field during which energetic particles are injected into the inner magnetosphere close to magnetic midnight. There is currently a need to quantify substorm-driven energetic electron precipitation (EEP) to better understand its role in radiation belt dynamics and to quantify its impact on the atmosphere. As substorm injections trigger chorus waves, which have strong MLT, AE, and L -shell dependence, we investigate the dependence of EEP in terms of these variables.

We utilize many decades of low Earth orbit satellite observations to examine the typical statistical variability around substorm events identified by the Substorm Onsets and Phases from Indices of the Electrojet (SOPHIE) algorithm. In contrast to trapped flux enhancements, enhanced EEP is found to occur even for the quietest AE range of those considered ($AE \leq 100$ nT, $100 \text{ nT} < AE \leq 300$ nT, $AE \geq 300$ nT). The MLT-dependent analysis for all AE-ranges shows a well-defined variation in >30 keV EEP magnitude, with a maxima in the mid to late morning sector (6-12 MLT), and a distinct and deep minimum in the late afternoon sector (15-18 MLT). The patterns show similarities to previously published whistler-mode lower band chorus distributions with MLT.

Clusters of substorms reliably produce enhancements in electron precipitation for >30 keV and >300 keV, with steadily increasing peak precipitation magnitudes with increasing AE. The peak precipitation flux L -shell also moves inwards with increasing AE, in a similar way for the two energy ranges.

This study builds upon previous work investigating the variations of trapped electron radiation belt fluxes using the same epochs, based on trapped low Earth orbit POES measurements as well as medium Earth orbit GPS measurements [1]. The current work, focused on precipitation variation, has recently been published in JGR [2].

References

- [1] C. J. Rodger, A. T. Hendry, M. A. Clilverd, C. Forsyth, and S. Morley, Examination of Radiation Belt Dynamics during Substorm Clusters: Activity Drivers and Dependencies of Trapped Flux Enhancements, *J. Geophys. Res.*, **127**, 2022, e2021JA030003, doi:10.1029/2021JA030003.
- [2] C. J. Rodger, M. A. Clilverd, A. T. Hendry, and C. Forsyth, "Examination of Radiation Belt Dynamics during Substorm Clusters: Magnetic Local Time Variation and Intensity of Precipitating Fluxes", *J. Geophys. Res.*, **127**, 2022, e2022JA030750, doi:10.1029/2022JA030750.