

The Impacts of Substorms on the Ring Current

*Jasmine Kaur Sandhu¹, I. J. Rae¹, M. Gkioulidou², C. Forsyth¹, G. D. Reeves³, M. P. Freeman⁴, K. R. Murphy⁵, M.-T. Walach⁶, H. E. Spence⁷

1. Mullard Space Science Laboratory, University College London, UK., 2. Applied Physics Laboratory, John Hopkins University, USA., 3. Los Alamos National Laboratory, USA., 4. British Antarctic Survey, UK., 5. University of Maryland, USA., 6. Lancaster University, UK., 7. University of New Hampshire, USA.

Substorms are a highly dynamic process that result in the global redistribution of energy within the magnetosphere. The occurrence of a substorm can provide the inner magnetosphere with hot ions and consequently intensify the ring current population. However, substorms are a highly variable phenomenon that can occur as an isolated event or as part of a sequence. In this study we determine the extent to which substorms enhance the ring current energy content and compare how the energy enhancement varies with substorm type.

Using ion observations (H^+ , O^+ , and He^+) from the RBSPICE and HOPE instruments onboard the Van Allen Probes, we quantify how the total ring current energy content changes during the substorm process. A statistical analysis demonstrates the impact of a typical substorm on the ring current region. We find that ~5% of the total energy released at substorm onset is transferred into the ring current population, and energises the ring current by 12% on average. The features of the energy enhancement correlate well with the expected properties of particle injections into the inner magnetosphere, and large enhancements in the O^+ contribution to the energy content suggest important compositional variations.

Analysis also reveals that the ring current response to substorms is strongly dependent upon the type of substorm activity. The results show that substorms followed by a series of successive substorms are associated with significantly different ring current conditions and enhancements compared to isolated substorms. We present clear magnitude and local time differences that illustrate the complexity and variability of the substorm-ring current coupling, along with an interpretation of the details of this relationship.

Keywords: Ring Current, Substorms, Van Allen Probes, Magnetosphere