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Do substorms energise the ring current?

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The substorm phenomenon is a highly dynamic and variable process that results in the global reconfiguration and redistribution of energy within the magnetosphere. There are many open questions surrounding substorms, particularly how the energy released during a substorm is distributed throughout the magnetosphere, and how the energy loss varies from one substorm to the next. In this study, we explore the role of substorms in energising the ring current.

Using observations of the particle energy flux from Van Allen/RBSP, we are able to quantitatively observe how the energy is distributed spatially and across the different ion species (H+, He+, and O+). Furthermore, we can observe how the total energy content of the ring current changes during the substorm process, using substorm phases defined by the SOPHIE algorithm. We show that the ring current energy is significantly enhanced in the expansion phase compared to the growth phase, with the energy enhancement persisting into the recovery phase. The characteristics of the energy enhancement suggest the injection of energised ions from the tail plasma sheet at substorm onset, with features associated with wave-particle interactions observed in the afternoon sector. Furthermore, the analysis provides information on how different ion species in the ring current are energised by the substorm process. We present results that illustrate the complexity and variability of the substorm-ring current coupling, along with an interpretation of the details of this relationship.