

Is intensity of auroral electrojet predictable?

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A large amount of energy (of the order of 10^{11} W) is consumed in the auroral ionosphere as Joule dissipation during the substorm expansion phase. The origin of the energy consumed in the auroral ionosphere is in the solar wind, but the energy flow and conversion in between are problematic. Previously, the energy consumed in the ionosphere is thought to consist of the directly driven (DD) component and the loading and unloading (UL) component. The DD component is thought to respond to the magnetic energy entering the magnetosphere, and hence, the DD component is probably predictable. The UL component, on the other hand, is thought to be unpredictable because it might depend on the amount of released energy in the lobe. On the basis of the global magnetohydrodynamics (MHD) simulation, we show that the maximum intensity of the auroral electrojet (and the Joule dissipation rate) during the substorm expansion is well correlated with the magnetic energy entering the magnetosphere. The correlation coefficient between them is 0.90 (and 0.97). There are a few key reasons. First, the amount of the released energy from the lobe increases with the southward component of interplanetary magnetic field (SBZ) and the solar wind velocity, meaning that the amount of the released energy is regulated by the solar wind parameters. Secondly, the magnetic energy released from the lobe goes into the near-Earth reconnection region, and seems not to contribute significantly to the generation of the field-aligned current associated with the substorm expansion. Thirdly, the release of the energy lasts for ~10 minutes, whereas the auroral electrojet keeps developing for 15 minutes and more. Fourthly, 40-90% of the magnetic energy entering the magnetosphere comes from the solar wind kinetic energy for the southward IMF. About 2% of the entering energy goes into the ionosphere during the expansion phase. The ratio is almost independent of the solar wind condition. These simulation results may suggest that the maximum intensity of the auroral electrojet (and the Joule dissipation rate) is predictable when the magnetic energy entering the magnetosphere is adequately predicted.

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