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磁気流体シミュレーションで再現されたオーロラ爆発のエネルギー収支
Energy budget of the plasma sheet during auroral substorms

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Where is the magnetic energy for the expansion phase of auroral substorms accumulated? This question was raised by Akasofu (2013), and it was concluded that the magnetic energy must be accumulated in the plasma sheet within a distance of 10 Re to meet the large total energy consumption by the ionosphere. Many different features of substorms are reasonably reproduced by the new global MHD simulation (Tanaka et al., 2010), where high-pressure regions such as cusps and inner plasma sheet are essentially important to maintain the enhanced Region1 and Region2 field-aligned current systems. Both magnetic energy and thermal energy are therefore important to understand the energy budget during the substorm, and that is the motivation of the present study. The purpose of this paper is to evaluate the energy budget of the plasma sheet in a simulated substorm. Magnetic energy and thermal energy of the plasma sheet, as well as the energy consumption by the ionosphere are evaluated. Possible important role of dipolarization in the energy conversion is also discussed.

Using the global MHD simulation, it is found that magnetic energy release rate and thermal energy accumulation rate are balanced in the plasma sheet during the early expansion phase of the simulated substorm. Around the peak of the expansion phase, energy release rate in the plasma sheet does not meet the energy consumption rate in the ionosphere. External energy source from outside of the plasma sheet is needed to maintain the high auroral activity. The JxB force of the dipolarization does the work to increase the thermal energy inside. This is how the accumulated magnetic energy within a distance of 10 Re is converted into the thermal energy during the early expansion. The increase of the thermal energy is the source of enhanced Region-2 field-aligned current system. Region1 field-aligned current must be supplied from outside of the plasma sheet to maintain the high auroral activity in the ionosphere. The dynamo of Region1 is slow-mode expansion in the cusp-mantle region. The enhanced conductivity plays the essential role to introduce the large Region 1 field aligned current because the dynamo has the nature of voltage-generator.

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