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Simulation study of the current-voltage relationship of the Io tail aurora

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Subcorotation of Iogenic plasma in the Io plasma torus has been understood as electric drift by a perpendicular electric field with respect to the Jovian magnetic field. It has been considered that a part of the radially integrated electric field would be imposed along the magnetic field lines and would cause the Io's trailing tail aurora. Observations have been shown that the Io tail aurora extends for approximately 100 degrees downstream in longitude from the Io's magnetic footprint. It remains unresolved why the precipitating electron energy corresponding to the voltage is constant with longitude despite the decreasing parallel current density. The purpose of this study is to clarify how the current-voltage relationship of the Io tail aurora realizes.

We applied a semi-discrete central scheme to extended multi-magneto-fluid equations which include the electron convection term and investigated the relationship between a parallel current density and voltages of transition layers in the Io-Jupiter system. If the ionospheric proton density decreases at the same rate as the parallel current density, the timescale on which the high-altitude transition layer disappears is consistent with the longitudinal extent of the Io tail aurora. The voltages of the high- and low-altitude transition layers remain constant until the auroral cavity disappears, as expected from observations. These results suggest that the origin of the current-voltage relationship of the Io tail aurora is the same decrease rate of the ionospheric proton density as the parallel current density.