Relative displacement of conjugate point during a course of substorm in a global MHD simulation

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It is generally considered that auroral particles guided along geomagnetic field lines fall into the Earth's atmosphere. Thus we can expect that nightside auroras appear simultaneously at both footprints of the field lines. However, auroras do not always simultaneously appear at the geomagnetic conjugate points. There are some possible explanations for asymmetric (non-conjugate) auroras. We can divide them into two categories.

The first category is relative displacements of the geomagnetic conjugate points. The second category is north–south asymmetry of the acceleration conditions in the magnetosphere. To investigate the relative displacements of the geomagnetic conjugate points, we trace both footprints of the geomagnetic field lines during the magnetospheric reconfiguration. The empirical models are insufficient for reproducing the local and transitional magnetospheric configuration changes during a substorm. In this study, we reproduce the magnetospheric reconfiguration under a southward and duskward interplanetary magnetic field (IMF) condition by a numerical magnetohydrodynamics (MHD) simulation. Several substorm-like features, namely the formation of a near Earth neutral line, fast Earthward flow and tailward release of the plasmoid, occur about 1 hour after a southward turning of the IMF. The surveyed field line traced from the near-Earth magnetotail was strongly distorted toward dusk in the north and toward dawn in the south after the `substorm' onset. The maximum of the relative displacement of both footprints is 4.5 in MLT (magnetic local time) in the geomagnetic longitude.

While observational studies have indicated that the IMF orientation is the main controlling factor of the relative displacement of the conjugate points, this simulation study with constant IMF orientation shows for the first time that the substorm-related changes in the magnetic field and the field aligned current (FAC) are likely to be major controlling factors of the relative displacement of conjugate points..