

On the formation of overshielding triggered by a substorm onset: Global MHD simulation study

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The dawn-dusk convection electric field is a significant driver of transport of charged particles in the inner magnetosphere. When the dawn-disk convection electric field is enhanced, the ring current is developed, and the plasmasphere is shrunk. Ground-based observations have shown that, sometimes, the polarity of the convection electric field is reversed after a substorm onset. The presence of the dusk-dawn electric field is called an overshielding condition. Here, we demonstrate that the overshielding condition can appear after a substorm onset on the basis of a global MHD simulation. Immediately after the substorm onset manifested by a sudden decrease in the AL index and auroral brightening, the plasma pressure is enhanced in the inner magnetosphere. The simulated magnetic field on the ground shows a negative excursion in the polar cap, a positive excursion at auroral latitudes, and a negative excursion at sub-auroral latitudes at dusk. At noon and at equator (0 MLAT), the eastward electrojet starts to decrease just after the onset, and the westward electrojet appears about 10 min after the onset. All these variations are consistent with the observations. We discuss generation mechanisms, evolution of the overshielding condition in the ionosphere and the magnetosphere, and the redistribution of the charged particles trapped in the inner magnetosphere during the overshielding condition on the basis of the simulation solving drift transport equations.