Simulation on 3D structure of auroral electrojet

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We developed a simplified Hall-MHD simulation to understand the magnetosphere-ionosphere coupling in the polar region during the auroral substorm. The governing equations were derived from the law of conservation of momentum of ions and electrons, the equation of continuity of plasma, the law of Ohm, the law of Ampere, and the law of Faraday. The Hall effect is included because it retains the Hall term in the governing equations. The advection in the governing equations were solved by using the Lax-Wendroff scheme and the Superbee limiter function. We imposed a flow shear on the topside boundary to excite Alfven wave. First, we ran the simulation under the condition that the ionospheric plasma density is uniform in the horizontal space. The Alfven wave propagates downward, and reflected at altitude being lower than the peak of the Pedersen conductivity. It was confirmed that the FACs were closed by the Pedersen current in the lower ionosphere. Secondary, we introduced a high-density channel. The secondary electric field is confirmed to appear due to blockage of the Hall current (polarization), which intensifies the ionospheric current. The direction of ionospheric current depends on altitude. The current is intensified at specified altitudes. This is similar to the auroral electrojet.

