Hybrid MHD-kinetic simulations of an Alfvén wave pulse

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Observations have linked Shear Alfvén waves on the earth's dipolar magnetic field lines to the formation of auroral arcs. Associated with these waves is a parallel current density carried primarily by electrons. We use a self-consistent 2-D hybrid MHD-kinetic model incorporating kinetic electrons to simulate an Alfvén wave pulse propagating in a constant magnetic field. The pulse is rectangular in shape so that the perpendicular and parallel current regions are distinct. We consider two regimes: the large scale limit where the perpendicular scale length $L_\perp \gg \lambda_e$ and the inertial limit ($L_\perp \leq 10\lambda_e$) where $\lambda_e = \sqrt{m_e/(\mu_o n e^2)}$ is the electron inertial length. The structure of the parallel electric field is highlighted along with the evolution of the electron distribution function in the parallel current region. Comparisons are made between the simulation parallel electric fields and those determined from a potential-current relation derived using electron energy conservation in the wave frame. An examination of the relative energy densities between the MHD components and the electrons will be made as well.