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Generalization of Plasma Hybrid Simulation Model

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The hybrid simulation model has been widely used as one of the self-consistent simulation methods in investigating nonlinear space plasma phenomena, which treats ions as kinetic macro-particles whereas electrons are assumed to be an inertialess fluid. It can correctly simulate from magnetohydrodynamic to the ion inertia length scale. However, the assumption of the inertialess electron makes it sometimes numerically difficult to handle high-frequency whistler waves. We have recently shown that the problem may be resolved by appropriately including finite electron inertia effect, which also makes it possible to handle vacuum regions in a hybrid code. In this report, we discuss extension of the model which may be able to incorporate electron kinetic effect. Ignoring the displacement current and assuming charge neutrality, we adopt the Vlasov-Ampere system of equations. An equation to determine the electric field is derived from the basic equation without any approximations. We demonstrate that by using the equation, the electron cyclotron resonance can be properly included.

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