REDUCING NUMERICAL DIFFUSION AND ITS EFFECTS ON THE MAGNETOSPHERE-IONOSPHERE COUPLING IN GLOBAL MAGNETOSPHERE SIMULATIONS

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Coupling the magnetosphere with the ionosphere in global magnetosphere numerical models is a non-trivial problem. Typically the magnetosphere is represented by a magnetohydrodynamics (MHD) code, in our case BATSRUS, that calculates field-aligned currents (FAC) at some distance from the Earth and it can also calculate the field line topology (open-closed field lines). The FAC is mapped down to the ionosphere model and scaled appropriately. The ionosphere model uses the FAC as source terms of a Poisson-type equation. The diffusion coefficients are the Pedersen and Hall conductances estimated from various empirical relationships. The solution of the Poisson equation provides the electric potential. This electric potential is then used to calculate the ExB drift that is applied at the inner boundary of the MHD code. The system may also include an inner magnetosphere model that uses the electric potential as well as the magnetic topology provided by the MHD code to calculate the high energy particle distribution which is then used to nudge the MHD pressure in the closed field line region. We are investigating the effects of numerical diffusion in the MHD code on this complex model coupling. The numerical diffusion affects the amplitude and structure of the FAC as well as the coupling of ExB drift velocity at the inner boundary or the effects of nudging the pressure. We compare different ways of reducing the numerical diffusion: (1) increased grid resolution (2) the semi-relativistic Boris correction with an artificially reduced speed of light and (3) reduced dissipative fluxes in the fully implicit numerical scheme. Increasing grid resolution is the best approach in principle, but it is limited by computational resources. The Boris correction is routinely used in magnetosphere codes, but it may introduce some unphysical behavior in the time-dependent solution due to the artificial limiting of the wave propagation speeds. The new third approach only affects the numerical scheme and it does not modify the equations solved, however it requires a fully implicit time integration algorithm to ensure numerical stability. We will compare these methods on idealized problems as well as on magnetic storm simulations.

Numerical methods, magnetosphere-ionosphere coupling

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