MHD and non-MHD simulations of planetary magnetospheric phenomena based on semi-discrete central schemes

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We have developed MHD and non-MHD simulation codes based on semi-discrete central schemes, which are applicable to a wide variety of planetary magnetospheric phenomena (also applicable to ionospheric and atmospheric phenomena). Semi-discrete central schemes do not require the use of computationally expensive Riemann solvers and spectral decomposition into characteristic waves, and hence are easily implemented into MHD as well as non-MHD codes. Although central schemes are generally more dissipative than upwind schemes, there has been remarkable progress in developing less dissipative central schemes since a new class of central schemes was proposed by Kurganov and his coworkers in 2000. The original version of the central scheme proposed by Kurganov and his co-workers was able to capture shocks with less numerical dissipation, but it still had a difficulty in resolving small amplitude/linear waves, especially those with a high wavenumber. Recently, we have developed a new fourth-order semi-discrete central scheme with a uniform non-oscillatory (UNO) limiter and a piecewise cubic polynomial for spatial reconstruction, and found it capable of resolving small amplitude/linear waves with a high wavenumber while retaining a shock-capturing capability. We will show some numerical tests of the central schemes and present results of applications to planetary magnetospheric problems.