Exponential Rosenbrock integrators for accurate simulation of atmospheric flows

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I will present results of work in collaboration with F.X. Giraldo (NPS Monterey). The perspectives for the application of exponential Rosenbrock integrators to the numerical solution of the equations of motion of atmospheric flows will be assessed. In particular, I will present the results of a comparison with usual explicit and semi-implicit techniques on two dimensional test problems representative of large scale and mesoscale atmospheric flows. The exponential Rosenbrock methods have been coupled to high order continuous and discontinuous finite element discretizations in the framework of the NUMA model, see e.g. [1]. Consistently with the findings in [2], significant accuracy increase can be achieved with respect to many standard discretization approaches. However, the approximation approach of exponential matrices of large sparse systems based on the use of Krylov spaces appears to imply a computational cost per time step that is higher than that of standard semi-implicit schemes. Some perspectives for the reduction of the computational cost will then be discussed.

1 JF Kelly, FX Giraldo, Continuous and discontinuous Galerkin methods for a scalable three-dimensional nonhydrostatic atmospheric model: Limited-area mode, Journal of Computational Physics 231 (24), 7988-8008, 2012

2 F. Garcia, L. Bonaventura, M. Net, J. Sanchez, Exponential versus IMEX high-order time integrators for thermal convection in rotating spherical shells, Journal of Computational Physics, in press, 2014