IMEX Rosenbrock methods for solving the compressible Euler equations

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Nowadays numerical weather prediction are performed by solving the compressible Euler equations. Due to the appearance of sound waves and and isotropic grids the equations contain solution parts of different time scales. Implicit explicit (IMEX) time integration methods are a common choice to handle these different time scales in an efficient way. To avoid the solution of nonlinear systems the implicit integrator can be chosen as a linear implicit integration method. Different type of Rosenbrock IMEX methods are presented for this application. Order conditions up to order three are derived. The stability of the methods is tailored with respect to the linearized shallow water equation in the low Mach regime. To find optimal methods the stability restrictions and order conditions are recast into a sparse nonlinear optimization problem. The order oft the methods is confirmed by numerical results. Comparison with fully implicit methods and split explicit methods are presented for a gravity wave generator and different type of warm and cold bubbles.