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PARALLEL RESOLUTION TECHNIQUES FOR THE 2D TRANSPORT EQUATION: COMPARISON OF EXPLICIT AND IMPLICIT METHODS

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Abstract. In this work, the performance of different methods for solving the 2D transport equation using parallel implementations is compared. Codes based on GPU (C+CUDA) and CPU (C+OpenMP and C+MPI) are utilized. The advection-diffusion equation is solved using the finite volume method on structured Cartesian grids. Different spatial schemes are implemented for the advective term, based on the Péclet number of the grid. Explicit schemes (Forward Euler and second-order Runge-Kutta) are compared with the implicit scheme (Crank-Nicolson). The resulting linear system from the implicit method is solved using the stabilized Bi-Conjugate Gradient method (BiCGStab) in parallel versions on GPU and CPU (CUDA, OpenMP, and MPI). The efficiency of numerical methods parallelizations is evaluated across distinct architectures, including Multi-core and Many-core processors, and different paradigms are considered based on the architecture (SIMD or MIMD with shared memory and distributed memory), comparing the computational speed and computing rates for different grid sizes. Convergence properties of the schemes are also analyzed about the spatial and temporal discretizations. This study provides guidelines for efficiency when selecting a combination of explicit or implicit methods depending on the parallel platform used.