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A coarse-grid projection method for accelerating incompressible flow computations OMER SAN, ANNE STAPLES, Virginia Tech — We present a coarse-grid projection (CGP) algorithm for accelerating incompressible flow computations, which is applicable to methods involving Poisson equations as incompressibility constraints. CGP methodology is a modular approach that facilitates data transfer with simple interpolations and uses black-box solvers for the Poisson and advection-diffusion equations in the flow solver. Here, we investigate a particular CGP method for the vorticity-stream function formulation that uses the full weighting operation for mapping from fine to coarse grids, the third-order Runge-Kutta method for time stepping, and finite differences for the spatial discretization. After solving the Poisson equation on a coarsened grid, bilinear interpolation is used to obtain the fine data for consequent time stepping on the full grid. We compute several benchmark flows: the Taylor-Green vortex, a vortex pair merging, a double shear layer, decaying turbulence and the Taylor-Green vortex on a distorted grid. In all cases we use either FFT-based or V-cycle multigrid linear-cost Poisson solvers. Reducing the number of degrees of freedom of the Poisson solver by powers of two accelerates these computations while, for the first level of coarsening, retaining the same level of accuracy in the fine resolution vorticity field.

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