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Efficient particle simulations based on combining the Vortex-In-Cell and the Parallel Fast Multipole methods GREGOIRE WINCKELMANS, ROGER COCLE, GOERIC DAENINCK, Universite catholique de Louvain (UCL), FRANCOIS THIRIFAY, CENAERO and UCL — Particle methods are quality methods for simulating unsteady, convection dominated, flows, as they have negligible dissipation and dispersion. The vortex particle method is used for incompressible flows; also for buoyancy-driven flows by adding the temperature. The method can also be used for combustion, by using variable volume particles with vorticity, velocity divergence, temperature and species mass fractions. Quality particle methods also require interpolation/redistribution schemes. We here consider the Vortex-In-Cell (VIC) approach, where all operations, except convection, are done using a grid: Poisson solver, stretching, diffusion, etc. The vorticity field is also maintained divergence free by projection when required (which also requires solving a Poisson equation). In our implementation, we use the Fast Multipole method to obtain the boundary condition for solving the Poisson equation: this allows for a grid that tightly contains the particles. The method is also parallelized: the Parallel Fast Multipole (PFM) code provides the proper boundary condition on each subdomain, without iteration. Illustrative results will be presented in DNS and LES (also using multiscale models): vortex rings, wake vortices (also with ground effects), combustion.

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