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Wavelet-based adaptive simulations of flapping insects[1] THOMAS ENGELS, LMD-CNRS,Ecole Normale Superieure-PSL, KAI SCHNEIDER, Aix-Marseille Univ, JULIUS REISS, Technische Univ, MARIE FARGE, LMD-CNRS, Ecole Normale Superieure-PSL, DMITRY KOLOMENSKIY, Japan Agency for Marine-Earth Sci and Tech (JAMSTEC) — We present a novel wavelet-based approach to compute multiscale flows generated by complex, time-dependent geometries, motivated by the spectacular flight capabilities of flying insects. Our framework is inherently based on dynamically evolving grids. To this end, we develop a datastructure based on locally regular Cartesian blocks, which are indexed in a tree-like fashion. The blocks are distributed among MPI processes and allow an efficient parallelization for large scale supercomputers. To avoid solving elliptic problems, we approximate an incompressible fluid using the method of artificial compressibility. Since our grid is locally Cartesian, we use the volume penalization method to include moving obstacles without the need for a boundary-conformal grid. We employ biorthogonal interpolating wavelets as refinement indicators and prediction operators, and combine them with a 4th order finite difference discretization. Using thresholding of wavelet coefficients, we show that the precision of the underlying uniform discretization is maintained on our adaptive grids, while reducing the computational effort. We derive scaling relations for the numerical parameters, and present validation cases to assess its accuracy and performance on massively parallel computer architectures.

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