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Adaptive reconnection-based arbitrary Lagrangian Eulerian method: A-ReALE

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We present a new adaptive reconnection-based arbitrary Lagrangian Eulerian: A-ReALE method. The main elements in a A-ReALE method are: An explicit Lagrangian phase on arbitrary polygonal mesh in which the solution and positions of grid nodes are updated; a rezoning phase in which a new grid is defined - number of mesh cells, their location and connectivity (it is based on using Voronoi tessellation) in rezoned mesh is changing and a remapping phase in which the Lagrangian solution is transferred onto the new grid. The rezoning strategy was based on following design principles: Using monitor (error indicator) function based on Hessian of some flow parameter(s), which is measure of interpolation error; using equi-distribution principle for monitor function as criterion for creation of adaptive mesh; using weighted centroidal voronoi tessellation as a tool for creating adaptive mesh; modification of the raw monitor function-we scale it to avoid very small and very big cells and smooth it to create smooth mesh and allow to use theoretical results related to weighted centroidal voronoi tessellation. In A-ReALE both number of cells and their locations allowed to change at rezone stage on each time step to create mesh which satisfies equi-distribution principle for monitor function. The number of generators was chosen to guarantee required spatial resolution where the modified monitor reaches its maximum value. We present all details required for implementation of new adaptive ReALE methods and demonstrate their performance in comparison with standard ReALE method on series of numerical examples.

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Comparison of analytical vortex models to experimentally modeled tornado-like vortices

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The structure of a full-scale tornado is highly complex, showing a three-dimensional flow field, instabilities, singularities and non-linear effects. Mathematically a tornado is considered as a concentrated vortex. In the past, several simplified analytical models have been developed to represent concentrated vortices. Whether an idealized mathematical vortex model can represent the complexity of a real tornado depends on the similarity of the model solution to the full-scale case. However, data sets of full-scale tornadic events are very limited and for that reason tornado-like vortices are modeled experimentally in laboratories to provide a statistical representative validation data set for different vortex models. In this paper, a new physical vortex generator is tested to generate tornado-like vortices. The simulator consists of two chambers, a convection chamber and a convergence chamber. Angular momentum is imposed by guide vanes around the convergence chamber. Different vortex structures can be produced by changing the guide vane angle. The effect of different swirl ratios on the flow characteristics and a comparison study between different analytical tornado vortex models and the experimentally obtained results are presented in this paper. The similarity of both model solutions is discussed in detail.

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