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The boundary-constraint method for constructing vortex-surface fields

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Abstract

We develop a boundary-constraint method for constructing the vortex-surface field (VSF) in a three-dimensional fluid velocity–vorticity field. The isosurface of the VSF is a vortex surface consisting of vortex lines, which can be used to characterize the evolution of vortical structures in a Lagrangian sense. The evolution equation with pseudo-time is solved under the VSF boundary constraint to obtain a numerical solution of the VSF. Compared with the existing two-time method, the boundary-constraint method constructs the VSF from a single velocity dataset at a given time instead of a time series of velocity fields starting from a simple condition. This improvement significantly increases the applicability of the VSF method and reduces the demanding computational cost and required velocity data size. Using the boundary-constraint method, we construct the VSFs in Taylor–Green

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