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Numerical Capture of Wing-tip Vortex Using Vorticity Confinement BAILI ZHANG, JING LOU, CHANG WEI KANG, Instiute of High Performance Computing, Singapore, ALEXANDER WILSON, Rolls-Royce Marine, UK, JOHAN LUNDBERG, Rolls-Royce Hydrodynamic Research Centre, Sweden, RICKARD BENSOW, Chalmers University of Technology, Sweden — Tracking vortices accurately over large distances is very important in many areas of engineering, for instance flow over rotating helicopter blades, ship propeller blades and aircraft wings. However, due to the inherent numerical dissipation in the advection step of flow simulation, current Euler and RANS field solvers tend to damp these vortices too fast. One possible solution to reduce the unphysical decay of these vortices is the application of vorticity confinement methods. In this study, a vorticity confinement term is added to the momentum conservation equations which is a function of the local element size, the vorticity and the gradient of the absolute value of vorticity. The approach has been evaluated by a systematic numerical study on the tip vortex trailing from a rectangular NACA0012 half-wing. The simulated structure and development of the wing-tip vortex agree well with experiments both qualitatively and quantitatively without any adverse effects on the global flow field. It is shown that vorticity confinement can negate the effect of numerical dissipation, leading to a more or less constant vortex strength. This is an approximate method in that genuine viscous diffusion of the vortex is not modeled, but it can be appropriate for vortex dominant flows over short to medium length scales where viscous diffusion can be neglected.

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