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Thermal Effects in the Turbulent Wake of a Heated Bluff Body

SAMUEL WHITMAN, JAMES BRASSEUR, PETER HAMLINGTON, University of Colorado, Boulder — We investigate the impact of heat transfer from a triangular prism bluff body on the development of turbulent wake dynamics, and specifically focus on the relative effects of varying fluid density, viscosity, diffusivity and local Reynolds number caused by this heating. We perform three simulations for bluff body temperatures of 310K (the bulk inflow temperature), 900K, and 1500K to examine changes in the flow structure and dynamics over a range of heating intensities. The simulations are performed using the PeleC code, which incorporates adaptive mesh refinement (AMR) to locally resolve the physics of interest. We find that higher bluff body temperatures create strong gradients along the boundary and shear layers, affecting the dynamical importance of specific terms in the turbulence kinetic energy and vorticity transport equations, such as pressure-dilatation and baroclinic torque effects. At the same time, shear layer instabilities drive entrainment and mixing, pulling cold air into the wake and smoothing out initial gradients. We also examine the effects of heat transfer on turbulence intensity, correlations, and anisotropy throughout the wake, and highlight the importance of capturing strong gradients in simulations of such flows, enabled here by the use of AMR.

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