DNS AND LES OF THE TURBULENT ENTRAINMENT IN JETS: physics and subgrid-scale modeling

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ABSTRACT

The physical mechanisms taking place at the turbulent/nonturbulent (T/NT) interface dividing irrotational from turbulent flow in mixing layers, jets, and wakes is important to many natural and engineering flows since important exchanges of mass, momentum and passive or active scalar quantities take place across this interface. It was assumed in the past that the turbulent entrainment is caused by ”engulfing” motions governed by the large scale flow vortices, but recent experimental and numerical works showed that the entrainment is primarily associated with small scale (”nibbling”) eddy motions.

In this talk we present and discuss several new results regarding the role of the large and the small scales of motion in this complex flow region. The results are based on a recent direct numerical simulation (DNS) of a turbulent plane jet at $Re_\lambda \approx 120$. Specifically, we analyze the detailed enstrophy and kinetic energy dynamics and the role of the intense vorticity structures (IVS), as defined by Jiménez *et al.* (*JFM*, vol. 255, 1993), in order to analyze the interplay between the large and the small scales of the flow during the turbulent entrainment. The presentation will focus on how the presence of these IVS commands the evolution of many small scale quantities and ultimately imposes the entrainment rate. Finally, recent results dealing with the effect of the SGS models on this new and challenging modeling problem are discussed.