Spectral modelling for unstably stratified homogeneous turbulence

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Unstably stratified homogeneous turbulence (USHT) is a idealized framework introduced to study mixing induced by buoyancy. This concept is aimed at analysing the properties of turbulent fluctuating quantities developing in Rayleigh-Taylor mixing zones or in turbulent convection. In particular, it is dedicated to investigate the unsteadiness and anisotropy of the flow, while getting rid of inhomogeneity effects. USHT has been explored extensively through numerical simulations [2] and theoretical studies [3] which focus particularly on the self-similar aspects of this flow. These works have shown the fundamental importance of large scales in the time evolution of turbulent quantities. They also have proved the limitations of simulations, due to confinement effects induced by the growth of energetics scales fed by constant injection of potential energy. In order to overcome this difficulty, we develop a spectral model based on an Eddy-Damped Quasi-Normal Markovian [1] method which takes into account energy production by buoyancy terms. This two-point statistical model describes axisymmetric turbulence through a set of velocity-density correlation spectra. In our talk [4], we will introduce the equations for the model and we will confront its results with high resolution DNS of USHT (Fig. 1(a)). Also results about the final self-similar regime at high Reynolds number (Fig. 1(b)) will be presented as well as anisotropy effects (Fig. 1(c)) and kinetic energy spectra (Fig. 1(d)).

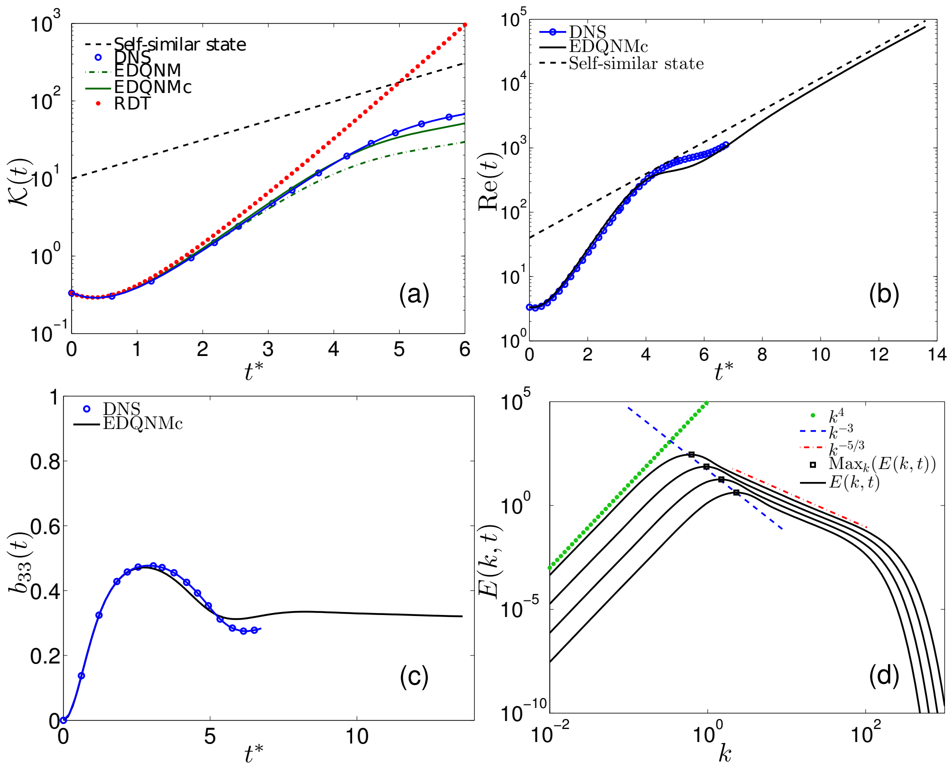

Fig. 1: (a) Comparison between linear solution (red), DNS (blue) and EDQNM (green). (b) Reynolds number evolution with self-similar regime. (c) Vertical component of the deviatoric part of the Reynolds stress tensor. (d) Self-similar evolution of the kinetic energy spectra.

References

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