On the role of large-anisotropic and small-isotropic motions on turbulent entrainment and mixing

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Numerical experiments on turbulent entrainment and mixing of scalars in planar jets have been performed[1]. These simulations are based on a scale decomposition of the velocity field, thus allowing for the establishment of the dynamical evolution of different scalar fields under the separate action of large-scale coherent motions and small-scale fluctuations, see Fig. 1(a). The turbulent spectrum can be split into active and inactive flow structures. The large-scale engulfment phenomena actively prescribe the mixing velocity by amplifying inertial fluxes and by determining the area and the geometry of the scalar interface[2]. On the contrary, small-scale isotropic nibbling phenomena are essentially inactive in the mixing process but adapt themselves to the conditions imposed by the coherent anisotropic motion at large scales. The effectiveness of the large-scale motions in prescribing a large scalar interface area and in maintaining steep scalar gradients resulted in a faster growth in entrained volume and jet width with respect to the one induced by small-scale fluctuations, see Fig. 1(b). The present results may have strong repercussions for the theoretical approach to scalar mixing[3], as anticipated here by simple heuristic arguments which are shown able to reveal the rich dynamics of the process. Interesting repercussion are also envisaged for turbulence closures, in particular for Large-Eddy Simulation where only the large scales of the velocity field are resolved.

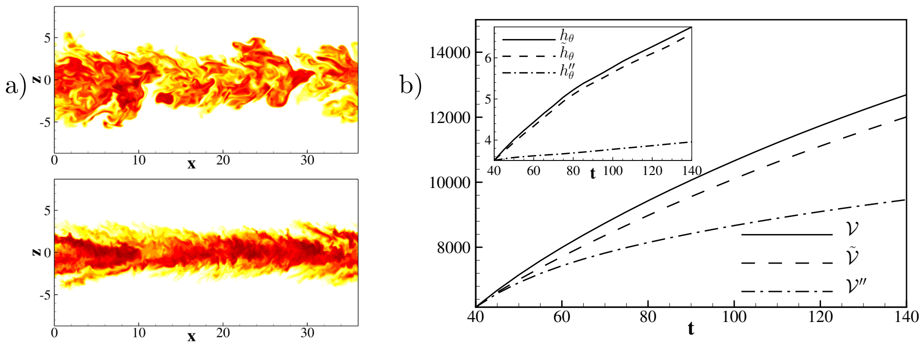

Figure 1: (a) Flow realization of the scalar field driven by large-scale coherent anisotropic motions (top) and by small-scale isotropic fluctuations (bottom). (b) Entrained volume $\mathcal{V}$ and interface position h_θ and its variation due to large-scale ($\widetilde{\mathcal{V}}$ and $\widetilde{h_\theta}$) and small-scale motions ($\mathcal{V}''$ and h''_θ).

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[1]Cimarelli and Boga, *J. Fluid Mech.* **927**, A34 (2021).

[2]Sreenivasan et al., *Proc. R. Soc. Lond. A* **421**, 79108 (1989).

[3]Van Reeuwijk and Holzner, *J. Fluid Mech.* **739**, 254-275 (2014).