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The role of the scalar and enstrophy flux in entrainment processes

DHIREN MISTRY, JAMES R. DAWSON, NTNU — Turbulent entrainment is a multi-stage, multi-scale process that describes the growth of a turbulent region of flow. Ultimately, turbulent entrainment is achieved through viscous diffusion of vorticity, and molecular diffusion in the presence of scalars, with irrotational and unmixed regions of the flow at the smallest scales. We do not fully understand how these small-scale processes are coupled to or modulated by the large-scales of turbulence. This is partly because the mean entrainment rates in turbulent shear flows can be determined by considering large-scales quantities only. We present experimental evidence that the large-scale flux of enstrophy and scalar towards the turbulent/non-turbulent interface (TNTI) coincides with a local increase in the entrainment velocity along the TNTI. This is achieved using a passive scalar ($Sc \gg 1$) to identify the TNTI, and a time-resolved interface-tracking method to measure the local entrainment velocity. Our results indicate that the both scalar and enstrophy fluxes towards the TNTI increase the vorticity and scalar gradients increasing the local rates of diffusion. These results show how local processes of small-scale diffusion are modulated by the large-scale turbulence.

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