# PARTICLE ENTRAINMENT THROUGH A TURBULENT/NON-TURBULENT INTERFACE.

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Turbulent entrainment is an important process closely linked to the dynamics of the Turbulent/Non-Turbulent Interface (TNTI) [1]. In this work we study entrainment in terms of fluid element trajectories at the vicinity of the TNTI which may or may not be crossing it. We run Direct Numerical Simulations (DNS) of turbulent planar jets at inlet Reynolds number $Re = 4000$ and integrate fluid element as well as particle trajectories in the DNS velocity fields with and without gravity. Our results reveal the existence of both detrainment and entrainment events across the TNTI. There are also many fluid elements which stay in the vicinity of the TNTI for significantly long times. Depending on Stokes and Froude numbers, this can also be the case for inertial particles. This barrier effect of the TNTI causes its own clustering and preferential concentration effects.

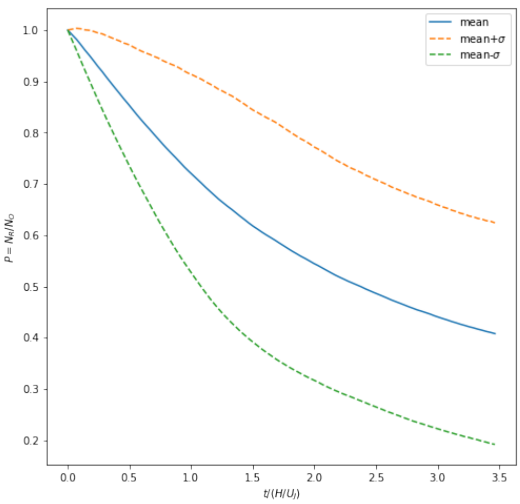


Figure 1: Fluid element persistence plotted against time. Persistence $P$ is defined as $P = N_R/N_O$ where $N_R = N_R(\omega_{th,L}, \omega_{th,H}, t)$ is the number of particles remaining between original thresholds of $\omega^2_{th,L} < \omega^2 < \omega^2_{th,H}$ and $N_O = N_O(\omega_{th,L}, \omega_{th,H}, t_0)$ is the number of particles originally seeded in this threshold range. $\omega^2_{th,L}$ and $\omega^2_{th,H}$ are chosen within the TNTI. Time $t$ is normalized by $H/U_J$ where H is the width of the planar jet opening and $U_J$ is the inlet velocity of the jet.

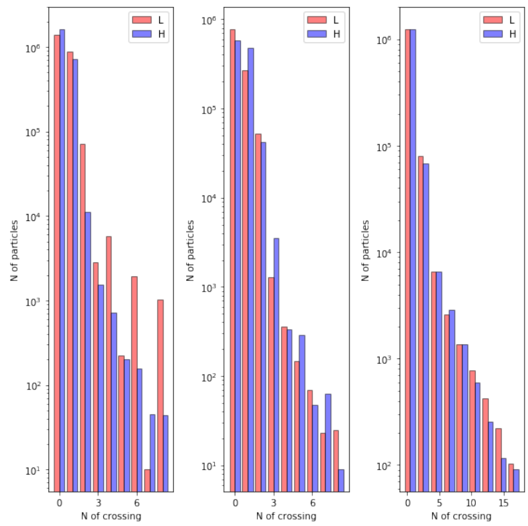


Figure 2: The plots in this figure are histograms of the number of times a particle at the vicinity of the TNTI crosses particular enstrophy thresholds from the range of thresholds which define the TNTI. $\omega^2/\omega^2_{max} = 10^{-8}$ (left), $\omega^2/\omega^2_{max} = 10^{-6}$ (middle) and $\omega^2/\omega^2_{max} = 10^{-4}$ (right). Red: crossings towards the potential side, Blue: crossings towards the turbulent side.

## References

[1] Carlos B. da Silva, Julian C.R. Hunt, Ian Eames, and Jerry Westerweel. Interfacial Layers Between Regions of Different Turbulence Intensity. *Annual Review of Fluid Mechanics*, **46**(1):567–590, 2014.