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Fine-scale turbulence induced axial flow and instability of a vortex column

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Interaction of fine-scale turbulence with a coherent vortex column and its possible induction of axial flow leading to column instability is studied using direct numerical simulations. Vortex threads form from the fine-scale turbulence due to mean strain of the column and self-advect in the (primarily) axial and radial directions. Self-advection depends on the thread circulation and orientation, and radial advection causes similar threads with opposite circulations to radially separate, resulting in an axial flow. As axial flow increases both with Reynolds number ($\equiv$vortex circulation/viscosity) and in time, instability due to axial flow (indicated by the ratio of maximum azimuthal velocity to maximum axial velocity, or the q criterion) can cause perturbation growth. For the simplified perturbation of two oppositely oriented vortex threads, axial flow is generated and, at sufficient amplitudes, perturbation amplification occurs, possibly leading to instability.

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