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Surface Waves Enhance Particle Dispersion MOHAMMAD FARAZMAND, THEMIS SAPSIS, MIT — How quickly does a point source of pollution spread in a fluid flow? Taylor's single-particle dispersion theory predicts that, in homogeneous isotropic turbulence, the tracer variance $\langle |X(t)|^2 \rangle$ grows quadratically for short times ($\langle |X(t)|^2 \rangle \sim t^2$) and linearly for large times ($\langle |X(t)|^2 \rangle \sim t$). We show that these predictions break down for tracers dispersed on the free surface of a gravity wave. Using an exact nonlinear model to advect the tracer particles, we show that the nonlinear effects significantly enhance the dispersion. In particular, the tracer variance grows as $\langle |X(t)|^2 \rangle \sim t^4$ for times t less than one wave period. In the asymptotic limit, as t increases beyond one wave period, the variance grows quadratically with time, i.e., $\langle |X(t)|^2 \rangle \sim t^2$. We show that this super-diffusive behavior is a result of the long-term correlation of the Lagrangian velocities of fluid parcels on the free surface.

Mohammad Farazmand
MIT

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