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Convergences and divergences and thin layer formation and maintenance

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ABSTRACT: The formation and maintenance of thin layers in the presence of turbulent diffusion is considered through the development of a formal framework that evaluates the balance between convergence mechanisms and the diffusive effects of turbulence. Turbulent diffusion acts to broaden layers, thus a convergence is required to produce a persistent and stable layer structure. Convergence mechanisms considered here include straining by a sheared velocity profile, organism motility, and particle buoyancy. The balance between each of these convergences and turbulent diffusion results in a scale estimate for the layer thickness that depends on local conditions. Comparison of these layer thickness scales for each of the three mechanisms enables us to evaluate which mechanism is likely to be dominant in particular situations. An example application of the framework is based on observations of thin layers in East Sound, Washington, for which we conclude that either the buoyancy or straining mechanism could contribute to the maintenance of the layer. Finally, the analytic framework itself provides insights into thin layer dynamics, including the prediction of a finite layer lifetime for shear-driven layers and the effects of mixing events on the convergence mechanisms acting to maintain the layers.

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Return to Table of Contents