Turbulent mixing induced by surface waves in stratified fluids

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Standing waves can be observed at the interface between two miscible fluids of small density contrast (liquid-liquid) when subject to a time-periodic vertical acceleration *via* the Faraday instability. A turbulent mixing zone $L(t)$ may develop, grow in size and eventually saturate when the mixing layer is no longer excited by the periodic forcing. Depending on the control parameters, the final transition to turbulence can be explained by breaking process of Faraday waves[1−2].

For this work, we study the influence of a free-surface (liquid-gas) near the miscible interface using the experimental measurements of the FARAMIX2 project. Because of the small density contrast, surface waves may drive the interface, but the interface has no effect on the free-surface. This leads to two additional scenarios for the transition to turbulence. In the first one, internal waves are excited (indirectly) by the surface waves through a parametric instability. In the second one, turbulent mixing is controlled directly by large-amplitude droplet-ejecting surface waves (fig. 1a).

The complex fluid dynamic process during drop ejection and bursting is simulated using two-phase DNS with a volume-of-fluid method implemented in Basilisk[3]. If the surface waves are sufficiently close to the interface, they can eat into stratified fluid (fig. 1b), effectively pushing the interface downwards until reaching an asymptotic state. Finally, we present a model based on conservation laws to predict the acceleration rate and the final position of the interface.

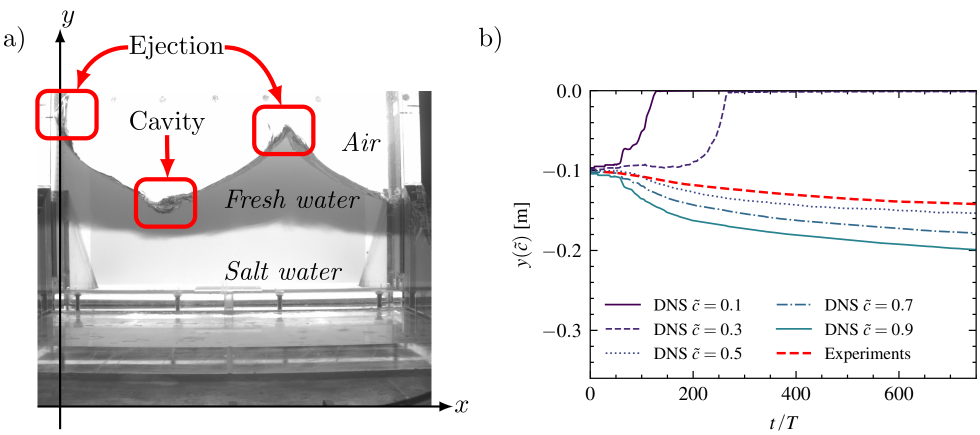

Figure 1: (a) Droplet-ejecting surface waves observed for strong vertical forcing. (b) Position of several isopycnals as function of time compared with experimental measurements.

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[3]Basilisk C, http://basilisk.fr/