Geophysical Research Abstracts, Vol. 8, 02159, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02159

Mixing by merging Kelvin-Helmholtz billows

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Quantitative time dependent measurements of the irreversible mixing caused by the development, saturation and turbulent breakdown of Kelvin-Helmholtz (KH) billows on an initially stable two layer stratification of miscible fluids are taken from a series of laboratory experiments. The experiments are carried out in a tilting tank. The initial conditions consist of a two layer stratification of fresh water, ρ_1, and a dyed saline solution, ρ_2, where $\rho_1 < \rho_2$. The evolution of the KH billows is recorded using a digital video camera. The results are post-processed using a light attenuation technique which relates the amount of light that passes through the dyed fluid directly and noninvasively to the spanwise-averaged time-dependent concentration field. Using the available potential energy framework of Winters et al. *J. Fluid Mech.* **289**, 115 (1995), the time-dependent mixing associated with the billows (as they develop streamwise secondary instabilities which trigger turbulence) is quantified. Two different types of KH development are identified quantitatively. Under certain circumstances, three billows merge in a largely symmetrical manner, having developed to an approximately equal saturated amplitude. However, it is also possible for the development of some billows to be stunted by more rapidly growing neighbours and the stunted billows then merge more rapidly. The mixing properties of these different life-cycles are qualitatively different, with the stunted billows leading to measurably more irreversible mixing due to the enhanced intensity of the transition to turbulence.