

The role played by the air entrainment in wave breaking events to the gas transfer process taking place at the ocean surface is investigated numerically by a multiphase flow solver. Waves of different initial steepness leading to regular wave patterns, mild spilling and intense plunging breakers are examined and comparisons in terms of the gas flux across the interface and the gas transfer velocity are established.

It is shown that the amount of gas transferred increases remarkably when wave breaking occurs, and a significant increase is found in presence of air entrainment. The availability of the gas concentration in the two fluids allows to compute the gas transfer velocity. In this respect, the availability of the actual area of the air-water interface, which is generally unavailable in experiments, is fundamental. The data indicate that the increase in the gas transfer velocity is higher than the increase in the area of the interface across which the exchange takes place, meaning that there is an additional effect related to the enhanced turbulence associated with the gas fragmentation process. It is also observed that, provided the actual area of the air-water interface is accounted for, the gas transfer velocity scales approximately as the one-fourth power of the dissipation rate of the energy content in water, which is consistent with previous theoretical predictions.