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Air entrainment by wave breaking

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Breaking waves at the water surface is a striking example of turbulent mixing across a fluid interface. The impact of the jet generates turbulence, entrains air into the water and ejects droplets into the air. A fundamental understanding of the general multi-scale properties of the resulting multiphase turbulent flow is necessary to develop more accurate gas transfer or spray generation parameterizations.
In this talk, I will discuss a model for air entrainment by breaking waves in the ocean, based on laboratory experiments and direct numerical simulations at the wave and bubble scale, and then up-scaled to the ocean using measurements of the wave and wave breaking statistics. This approach leads to semi-empirical formulas relating wind and wave variable, such as wind speed and significant wave height, to air entrainment by breaking. I will discuss implications for air-sea exchanges of gases and marine aerosols, key to the climate system.