The effects of rainfall on the ocean at low wind speed

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The top few meters of the oceanic boundary layer, or surface-wave zone, play a crucial role in the transfer of momentum, heat and mass (gas and aerosol) between the atmosphere and the ocean. These exchanges are essential to weather, global climate and the general circulation of both the atmosphere and the ocean. In general, the surface-wave zone is well mixed by the wind which generates waves and shears currents and thus provides the necessary energy input and turbulence to produce significant mixing. However, our knowledge of the effect of rain on near surface dynamics is extremely poor. The available data are, for the most part, focused on the damping of the wave field by rainfall. Indeed, among the sea-going community, it is well known that rain has the unexpected effect of ``calming the sea", but the scientific community has yet to clearly identify a mechanism, despite the dramatic implications for ocean surface remote sensing.

We present results from laboratory experiments on the generation of turbulence and the damping of the wave field by rainfall. These experiments were conducted in the wind-wave flume at the University of Delaware's Air-Sea Interaction Laboratory. The turbulence was measured using optical particle image velocimetry and the effects on the wave field were recorded with single point surface slope measurements. We have conducted experiments for several low wind speed conditions and for different rain rates of the order O(100)mm h^{-1} corresponding to conditions that would be typical of the tropics. We find that rainfall generates intense turbulence and mixing. Incidentally, this leads to kinetic energy dissipation levels in this shallow layer that are comparable to those typically found in active surface breaking conditions. We explore the possible links between the turbulence and the wave damping and will also discuss the results in the context of surface turbulence and mixing with its implications in air-sea heat and gas transfers.