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Field observations of the mixed layer depth in the Indian Ocean: effect of wave-induced turbulence

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Recent theoretical and experimental studies seem to suggest that turbulence generated by non-breaking surface waves may substantially affect the ocean mixed layer depth. Here, field observations of water temperature profiles in the Indian Ocean off the North-West coast of Australian (provided by Woodside Energy Ltd.) are used to corroborate this conjecture. Measurements show that the generally thin mixed layer depth is subjected to a rapid and substantial deepening during intense tropical storms. This appears to be consistent with a rapid and significant intensification of wave-induced turbulence through the water column, which overcomes the turbulence production from background currents by few orders of magnitude. Under these circumstances, the observed mixed layer depth is in good agreement with estimates of a wave-induced mixed layer depth, which is calculated with a wave-amplitude-based Reynolds number. Deepening of the mixed layer are observed to occur within a relatively short time scale of a few tens of hours after harshening of the wave activity and vanish soon after the decay of storm activities. This rapid development excludes any significant contribution of wave-breaking in the observed phenomenon. Vertical diffusivity of wave-breaking-induced turbulence would in fact require much longer time scales (few days) to justify the observed mixing layer depth.