Plume dispersion on a fringing coral reef system

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ABSTRACT: A field program was implemented on a fringing reef located on Oahu, Hawaii, to investigate the dispersion characteristics of near-bed dye plumes, tracked using an autonomous underwater vehicle (AUV) with an onboard fluorometer. The combination of moored and AUV-based measurements collected synchronously in this study allowed us not only to observe the dispersion characteristics of individual plumes, but importantly to isolate the flow structures directly responsible for dispersion under a variety of forcing conditions. The evolution of several plumes was observed, each influenced by different wave (surface and internal), current, and stratification conditions. The observed dispersion was caused by both turbulent dispersion and plume meandering. Lateral turbulent dispersion coefficients were roughly an order of magnitude greater than previous observations on sandy beach sites, which is likely attributable to the enhanced surface wave-induced mixing and the large physical roughness of the reef. For a large portion of the 2-week experiment the effects of meandering dominated over turbulent dispersion (on average 1.5 times greater). The meandering was the result of large-scale cross-reef current variability. Moored thermistor chain data on the forereef suggest that the source of this cross-reef flow variability were packets of solitary waves that accompanied the propagation of baroclinic bores up the reef slope. Baroclinic bores dissipated before they reached the inner reef when surface wave conditions were large, resulting in the reduction of plume meandering during this period.