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Quantifying entrainment in pyroclastic density currents from the Tungurahua eruption, Ecuador: Integrating field proxies with numerical simulations

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Abstract

The entrainment of air into pyroclastic density currents (PDCs) impacts the dynamics and thermal history of these highly mobile currents. However, direct measurement of entrainment in PDCs is hampered due to hazardous conditions and opaqueness of these flows. We combine three-dimensional multiphase Eulerian-Eulerian-Lagrangian calculations with proxies of thermal conditions preserved in deposits to quantify air entrainment in PDCs at Tungurahua volcano, Ecuador. We conclude that small-volume PDCs develop a particle concentration gradient that results in disparate thermal characteristics for the concentrated bed load (>600 to ~800 K) and the overlying dilute suspended load (~300–600 K). The dilute suspended load has effective entrainment coefficients 2–3 times larger than the bed load. This investigation reveals a dichotomy in entrainment and thermal history between two regions in the current and provides a mechanism to interpret the depositional thermal characteristics of small-volume but frequently occurring PDCs.

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