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Suspended sediment dynamics in a large-scale oceanic turbidity current: Direct measurements from the Congo Canyon

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Turbidity currents transport prodigious volumes of sediment to the deep ocean, depositing a greater volume of sediment than any other process on Earth. Thus far, only a handful of studies have reported direct measurements of turbidity currents, with typical flow durations ranging from a few minutes to a few hours. Consequently, our understanding of turbidity current dynamics is largely derived from scaled laboratory experiments and numerical models. Recent years have seen the first field-scale measurements of depth-resolved velocity profiles, but sediment concentration (a key parameter for turbidity currents) remains elusive. Here, we present high resolution measurements of deep-water turbidity currents from the Congo Canyon; one of the world's largest submarine canyons.

Direct measurements of velocity and backscatter were acquired along profiles through the water column at five and six second intervals by two acoustic Doppler current profilers (ADCPs) on separate moorings suspended 80 m and 200 m above the canyon floor, at a water depth of 2000 m. We present a novel inversion method that combines the backscatter from the two ADCPs, acquired at different acoustic frequencies, which enables the first high resolution quantification of sediment concentration and grain size within an oceanic turbidity current. Our results demonstrate the presence of high concentrations of coarse sediment within a fast moving, thin frontal cell, which outruns a slower-moving, thicker, trailing body that can persist for several days. Thus, the flows stretch while propagating down-canyon, demonstrating a behavior that is distinct from classical models and other field-scale measurements of turbidity currents. The slow-moving body is dominated by suspended clay-sized sediment and the flow structure is shown to be influenced by interactions with the internal tides in the canyon.