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New turbidity current model based on high-resolution monitoring of the longest flow ever measured

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Turbidity currents transport large amounts of sediment from shallow waters towards deep ocean basins. Little is known about these flows, despite their potential hazard for damaging expensive and strategically important seafloor infrastructure. So far turbidity currents have been profiled in only 6 deep ocean locations worldwide. Our current knowledge of these flows is therefore mainly based on scaled-down experimental and computationally-limited numerical modelling. Here we present results from the monitoring of a one-week long turbidity current in the Congo Canyon that had a discharge close to that of the Mississippi River. Measurements taken every 5 seconds give the most detailed image yet of a turbidity current deep-water over an unprecedented duration.

Our analysis reveals a different flow structure than that presented in previous models. Classical models display a thick front of the flow followed by a thinner and faster flow, which gives way to a short and quasi-steady body. Instead, we observe a thin frontal cell that outruns a thicker (~80 m), long and slower quasi-steady flow. In contrast to the previous model, where the thinner faster flow feeds sediment into the head, the Congo Canyon turbidity current shows a frontal cell that feeds sediment into, and at the same time outruns, the succeeding quasi-steady flow. As a result of the faster moving frontal cell, the flow should continuously stretch and grow in length while propagating down the system. Within the quasi-steady body, the flow switches between what appears to be two stable flow modes. One mode exhibits a fast and thin velocity profile whose maximum is a low distance from the seabed and resembles Froude-supercritical flow conditions, while the other mode is similar to Froude-subcritical flow conditions as the flow is thicker and slower.

These first observations provide new insights into the behaviour of deep water long duration flows that differ from traditional models and provide an exciting chance to explore the full range of turbidity current behaviour in nature.