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A numerical model of a 3-dimensional low-density turbidity current in the deep ocean: testing hypotheses on turbidity currents in deep detail

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Turbidity currents are submarine density flows that very efficiently transport vast amounts of sediment towards the deep ocean. They are highly energetic and capable to damage human-made infrastructures laid on the seabed. They consecutively erode, transfer and deposit large volumes of sediment so that they eventually determine hydrocarbon reservoir distribution and define environmental conditions of underwater habitats. The processes that control turbidity currents are, however, still poorly understood mainly because measuring and characterising them is extremely challenging. This difficulty in monitoring turbidity currents in the field has prompted their study through other approaches such as numerical modelling. Numerical models can provide the highest temporal and spatial resolution of mechanisms that drive turbidity currents. These models also calculate in detail the stratigraphic effect that modelled turbidity currents induce on the seabed. Numerical models calculate these changes based on the formulation of equations which parameterize the processes that occur in the flow-seabed system. Defining adequate parameter values is key to obtaining results that either support or reject postulated hypotheses on the turbidity current behaviours and implications.

We model a 3-dimensional low-density turbidity current in the deep ocean using, for the first time, the process-based model Delft3D software. This work shows the variation in flow behaviour and seabed composition when varying environmental parameters such as turbulence and sediment composition. We identify erosional and depositional patterns and relate them to differences in flow characteristics. Further validation of this Delft3D model with experimental and field measurements of turbidity currents would offer an exceptional tool to confirm previous hypotheses and reveal new insights into turbidity current and seafloor interactions, and into the morphological changes of the seafloor that can be expected in different spatial and temporal scales.