Characteristics of the equilibrium basal driving layers of turbidity currents

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We use a numerical model to describe the temporal evolution of a turbidity current toward steady state. At the beginning of the simulation, the effect of turbulence-driven upward mixing prevails over sediment settling, producing an upward dispersion of the sediment and an increased thickness of the current. The settling velocity limits the increase in thickness and dissipation. As a result, the turbidity current asymptotically partitions itself into two layers as it flows over a constant bed slope under condition of zero net sediment flux at the bed.

The lower ‘driving layer’ approaches an invariant flow thickness, velocity profile, and suspended sediment concentration profile within which nearly all of the suspended sediment is sequestered. The upper ‘driven layer’ carries a highly dilute suspension of sediment. This partition is a likely candidate for the mechanism by which the driving layer is able to run out long distances, keeping confined within a leveed subaqueous channel of its own creation.

The thickness of the driving layer provides a scale for channel characteristics. We show that this thickness and the average velocity of the driving layer mainly depend on two parameters: the dimensionless settling velocity and the shear Richardson number, that is a measure of the degree of stratification. Increasing dimensionless fall velocity and shear Richardson number result in a steady state solution characterized by concentration profiles that are more biased toward the bed, with the bulk of the volume of the suspended sediment confined within an ever thinner layer. The average velocity of the driving layer decreases for higher values of fall velocity and increases for lower values of shear Richardson number.

Keywords: turbidity current, steady state, driving layer

