Modelling Turbiditic Currents Based on the Minimization of Energy: Importance of the Turbulent Energy Budget

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The Cellular Automata for Turbidite Systems (CATS) model was developed at IFP is a process-based 3D model of multi-lithology submarine turbidity currents. Its aim is to reproduce detailed description of reservoir architecture and heterogeneity of deep-offshore fields by simulating turbulent turbiditic flows and associated sedimentary processes. This model is based on cellular automata concepts: each cell of the regular mesh is an automaton whose attributes describe local physical characteristics of the bed and the flow. Neighboring automata exchange matter and energy through local interactions. Their energetic and physical states evolve trough time according to internal transformations. Local interactions and internal transformations are the local implementation of the modelled physical processes: downslope flow, run-up due to kinetic energy, erosion and deposition of several lithologies and entrainment of ambiant water by the flow. The CATS model simulates through time the full three dimensional stratigraphic architecture of turbiditic channels, levees, mud-plugs and lobes and their facies partitioning and sediment sorting.
The flow simulation is based on an algorithm of local energy minimization between neighbouring cells. The energy considered in this method includes both kinetic and potential energies in order to take into account both gravitational and inertial effects when computing the flow over a given topography. The other processes (erosion/deposition and water entrainment) also modify the energy balance.

We will discuss the relevance of considering specifically a turbulent energy budget in the turbulent framework and its impact on the flow simulation and on the deposition/erosion feedbacks. We will present how these concepts can be handled when considering the extension of the model to granular flow.