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Process-Based Numerical CATS Model and Its Application to the 1979 Nice Turbidity Event

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ABSTRACT

To reproduce the complex architecture and facies distribution of turbidite systems, IFPEN has developed an innovative process-based numerical model named CATS (Cellular Automata for Turbidite Systems). It models the gravity-driven sediment-laden flow and associated processes (entrainment of ambient water, erosion and deposition of particles). The flow distribution is computed through the local algorithm of "minimization of height differences" developed first for landslides by Di Gregorio et al. (1997, 1999) and adapted for turbidity currents by Salles et al. (2007). The algorithm seeks the equilibrium of both potential and kinetic energies, to take into account both gravitational and inertial effects. Sediments are defined in as many discrete classes of particles (grain size and composition) as needed to describe the sedimentary system. Sediment erosion and deposition rules consider the flow capacity to carry sediments in suspension rather than its competence (Hiscott, 1994) as well as shear-stress thresholds (Teles et al. 2016). To validate this model, its application to the 1979 Nice turbidite event is presented. On October 1979, the airport new embankment collapsed into the sea and developed into a turbulent turbidity current. The current flowed downslope along the Var canyon then along the Middle Var Valley. It broke two submarine cables 3h45 and 8h after collapse respectively at 90 km and 110 km from the slide area. With these constraints, several authors have estimated velocities along the flow path (Mulder et al. 1997; Hugot et al. 2001; Migeon et al. 2001). Flow behavior was reconstructed from data including diving observation, bathymetric/backscatter and side-scan sonar data, and cores. Erosive features on the middle canyon flanks constrain the flow minimum thickness to 40-50 m. Then, in the lower canyon, the flow spilled over a 70-m high terrace. Along the Valley, the flow did not overtop the Western Var Ridge (Migeon et al. 2012) but overflowed the eastern part leaving erosional scours, suggesting the flow thickness ranged between 300 and 60 m. Core data showed few cm thick fine-sand deposits in the Middle Valley, 5-9 cm thick fine-medium sand deposits in the eastern end of the Ridge and up to 50 cm of medium sand in the distal lobe. We compare the CATS simulation results against these data on both flow dynamics and deposit thickness distribution to discuss its validity.