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Wave-supported sediment gravity flows currents: effects of fluid-induced pressure gradients

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Equilibrium shelf morphology offshore of rivers reflects a balance between the input rate of fluvial sediments, and their transport rate by submarine processes. Researchers have proposed that sediment-charged rivers form bottom gravity currents that transport sediment to the shelf-slope break. However, conditions conducive to such hyperpycnal flows are rare. Recent measurements indicate that wave suspension of fine sediment, in tandem with shelf currents, induce subaqueous gravity currents capable of transporting sediment across the shelf. Building on previous conceptual models, we present a generalized mathematical model for wave supported gravity flows in which: (i) waves provide an external source of bed shear; (ii) the sediment gravity flow momentum is balanced by gravity, internal fluid pressure (i.e. density contrast) and friction; and (iii) the lateral spreading into and vertical entrainment of ambient water is taken into account. Using this model, we explore the role of wave parameters, gravity current characteristics, and sea bottom slope in determining the critical conditions for bypass of wave-supported gravity flows.