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Initiation and flow conditions of contemporary flows in Martian gullies

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Understanding the initial and flow conditions of contemporary flows in Martian gullies, generally believed to be triggered and fluidized by CO_2 sublimation, is crucial for deciphering climate conditions needed to trigger and sustain them. We employ the RAMMS (RApid Mass Movement Simulation) debris flow and avalanche model to back-calculate initial and flow conditions of recent flows in three gullies in Hale crater. We infer minimum release depths of 1.0–1.5 m and initial release volumes of 100–200 m^3. Entrainment leads to final flow volumes that are 2.5–5.5 times larger than initially released, and entrainment is found necessary to match the observed flow deposits. Simulated mean cross-channel flow velocities decrease from 3–4 m s^{-1} to ~1 m s^{-1} from release area to flow terminus, while flow depths generally decrease from 0.5–1 m to 0.1–0.2 m. The mean cross-channel erosion depth and deposition thicknesses are _0.1–0.3 m. Back-calculated dry-Coulomb friction ranges from 0.1 to 0.25 and viscous turbulent friction between 100–200 m s^{-2}, which are values similar to those of granular debris flows on Earth. These results suggest that recent flows in gullies are fluidized to a similar degree as are granular debris flows on Earth. Using a novel model for mass-flow fluidization by CO_2 sublimation we are able to show that under Martian atmospheric conditions very small volumetric fractions of CO_2 of ~1% within mass flows may indeed yield sufficiently large gas fluxes to cause fluidization and enhance flow mobility.