



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 CO₂ 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 m³. 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 CO₂ sublimation we are able to show that under Martian atmospheric conditions very small volumetric fractions of CO₂ of <1% within mass flows may indeed yield sufficiently large gas fluxes to cause fluidization and enhance flow mobility.