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EGU22-679
https://doi.org/10.5194/egusphere-egu22-679
EGU General Assembly 2022

Experimental CO2-driven granular flows under Martian atmospheric conditions

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Martian gullies are alcove-channel-fan systems that have been hypothesized to be formed by the action of liquid water and brines, the effects of sublimating CO_2 ice, or a combination of these processes. Recent activity and new flow deposits in these systems have shifted the leading hypothesis from water-based flows to CO_2-driven flows, as it is hard to reconcile present activity with the low availability of atmospheric water under present Martian conditions. Direct observations of flows driven by metastable CO_2 on the surface of Mars are however nonexistent, and our knowledge of CO_2-driven flows under Martian conditions remains limited. For the first time, we produced CO_2-driven granular flows in a small-scale flume under Martian atmospheric conditions in the Mars Chamber at the Open University (UK). The experiments were used to quantify the slope threshold and CO_2 fraction limits for fluidization. With these experiments, we show that the sublimation of CO_2 can fluidize sediment and sustain granular flows under Martian atmospheric conditions, and even transport sediment with grain sizes equal to half the flow depth. The morphology of the deposits is lobate and depends highly on the CO_2-sediment ratio, sediment grain size, and flume angle. The gas-driven granular flows are sustained under low (<20º) flume angles and small volumes of CO_2 (around 5% of the entire flow). Pilot experiments with sediment flowing over a layer of CO2 suggest that even smaller percentages of CO_2 ice are needed for fluidization. The data further shows that the flow dynamics are complex with surging behavior and complex pressure distribution in the flow, through time and space.