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Snow spikes: formation of laboratory penitentes

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Spike-shaped structures are produced by light-driven ablation in very different contexts. Penitentes 1-4 m high are common on Andean glaciers, where their formation changes glacier dynamics and hydrology. Laser ablation can produce cones 10-100 microns high with a variety of proposed applications in materials science. We report the first laboratory generation of centimeter-scale snow and ice penitentes. Systematically varying conditions allows identification of the parameters controlling the formation of ablation structures. We demonstrate that penitente initiation and coarsening require cold temperatures, so that ablation leads to sublimation. Once penitentes have formed, further growth of height can occur by melting. The penitentes initially appear as small structures (3 mm high) and grow by coarsening to 1-5 cm high. Our results are an important step towards understanding ablation morphologies.