Towards a New Theory of Snow Friction

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ABSTRACT

The mechanics of snow friction are central to competitive skiing, safe winter driving, avalanche dynamics, and efficient Polar sleds. For nearly 80 years, prevailing theory has postulated self-lubrication: dry-contact sliding warms snow-grains to the melting point, and further sliding produces melt-water that lubricates the interface. We recently published micro-scale interface observations that contradicted this explanation: contacting snow grains abraded and did not melt under a polyethylene slider, despite low friction values. We obtained coordinated infrared, visible-light, and scanning-electron micrographs that confirm that the evolving shapes observed during our tribometer tests are contacting snow grains polished by abrasion, and that the wear particles can sinter together and fill the adjacent pore spaces. Furthermore, dry-contact abrasive wear reasonably predicts the evolution of snow-slider contact area and sliding-heat-source theory confirms that contact temperatures would not reach 0°C during our tribometer tests. Importantly, published measurements of interface temperatures also indicate that melting did not occur during field tests on sleds and skis. We postulate that abraded ice crystals form a dry-lubricant layer that makes contacting snow-grains slippery and are currently undertaking additional observations and theoretical analyses to assess this hypothesis.

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