

Snow coincidences

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As I write this editorial, my adopted hometown of Washington, DC, is recovering from its second heaviest snowstorm ever. Even though the snow stopped falling four days ago, schools in some of the city's surrounding suburbs remain closed.

Nicknamed Snowzilla, the storm was at risk of being under-measured, at least for the District of Columbia. Although the

depth of snow piled on streets, buildings, and backyards is a worthwhile metric, meteorologists favor determining how much snow falls from the sky. They do so by recording the accumulation on a flat, horizontal board every six hours, after which they wipe the board clean. Incremental measurements avoid the snow being compressed by its own weight.

It turned out that the observers at the District's official weather station, Reagan National Airport, lost their snowboard. Their original measurement of 17.8 inches was later corrected to 22.1 inches. Thus Snowzilla moved up the rankings from fourth to second.

The tale of compacted snow brought to mind a news story I wrote about the discovery of a region of warm bedrock beneath the Greenland ice sheet (see *PHYSICS TODAY*, March 2002, page 17). Snow falls throughout the year in Greenland. Because snow crystals are larger and fluffier in summer than in winter, the ice pack that forms from the accumulated snow develops semiannual layers. As you might imagine, those layers can be used to determine an age–depth relation for core samples extracted from the ice sheet. Layers also manifest themselves in reflections from ice-penetrating radar. By flying a radar-equipped plane over the ice sheet, glaciologists can extend their sampling from a few isolated cores to long continuous swaths.

The addition of fresh snow to Greenland's ice sheet is offset by the loss of ice to the Arctic Ocean at the termini of glaciers. That balancing flow can be linked to an age–depth relation through a rheological model. When glaciologist

Mark Fahnestock and his colleagues did just that, they found that the ice didn't always flow like a stiff, non-Newtonian solid as expected. In one region, the ice behaved as if it were sliding on a layer of meltwater.

Back in 2002 the nature of the heat source

was uncertain. One possibility was a volcano buried under the ice, but Greenland is distant from plate boundaries where volcanoes are typically found.

Out of curiosity, I contacted the researchers. The case for a volcano remains unclinched, but by coincidence, I learned that a new study of the Greenland ice sheet was about to be published. A different set of researchers used radar-derived age–depth relations to deduce that the ice in the middle of the island is creeping toward the coast at a rate that's slower now than it has been over the past 9000 years.¹

A difference in snow composition seems to account for the deceleration. Glacial ice made of snow that fell during the last glacial period is softer than the more recent ice that overlies it, because the old snow was dustier. As Greenland's ice is gradually renewed, it becomes stiffer and slower.

Further curiosity about snow prompted me to wonder how many articles that have “snow” in their title have been published in the *Physical Review* family of journals. The answer is 16. The first, from 1903, was written by S. J. Allan, who worked with Ernest Rutherford at McGill University in Canada. Having heard that C. T. R. Wilson of Cambridge University had determined that freshly fallen rain exhibits short-lived radioactivity, Allan looked for the same signal, and found it, in freshly fallen snow.²

Wilson was awarded the 1927 Nobel Prize in Physics for developing the cloud chamber. By coincidence, his invention appeared in the most recent of the 16 *Physical Review* snow papers. In their 2013 *Physical Review E* paper, Jiansheng Liu of China's State Key Lab of High Laser Field Physics in Shanghai and his collaborators sent high-power laser pulses into a chilled cloud chamber. Laser-induced filaments of plasma engendered the formation of ions and vortices, both of which nucleated snow crystals. At the bottom of the cloud chamber the researchers found a small, oval-shaped pile of snow.³

References

1. J. A. MacGregor et al., *Science* **351**, 590 (2016).
2. S. J. Allan, *Phys. Rev.* **16**, 306 (1903).
3. J. Ju et al., *Phys. Rev. E* **88**, 062803 (2013).



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