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The future of Antarctic meteorites

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THE FUTURE OF ANTARCTIC METEORITES

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Over 60% of all meteorites found on Earth are found in Antarctica. Antarctic meteorites are collected from so-called blue ice areas in the interior of the continent. In these blue ice areas, meteorological processes and a redirected ice flow lead to the removal of surface layers. All material that was once embedded in the removed layers of ice becomes exposed at the surface, including meteorites. Consequently, meteorite concentrations can be collected in the field, as the meteorites' dark color visually contrasts with the light-blue colored ice. However, meteorites can disappear from the surface when they warm up in the sun and melt the underlying ice. The dark meteorites warm up more than the ice as they absorb more solar radiation. As such, most of the ice remains frozen, but very local melt takes place directly under the meteorite. This melt creates a depression in the ice which over time deepens to a hole, and in conjunction with refreezing meltwater the meteorite fully disappears from the surface, hidden from sight during recovery missions. This process can explain why no meteorites have been found in areas where temperatures are relatively high [1]. Moreover, in a warming climate, meteorites are more prone to become unrecoverable.

Using a data-driven approach, we estimated that with the currently increasing surface temperatures, meteorite loss rates exceed recovery rates by a factor of five [2]. To estimate this loss rate, we first calculated the total number of Antarctic meteorites using a machine learning algorithm that identifies meteorite-rich sites using over 12,000 known meteorite finding locations and their corresponding properties such as ice flow velocity and surface temperature. Next, we used the same algorithm, but altered the surface temperature input based on regional climate model simulations. Consequently, we obtained the number of meteorites until the end of the century under a low and a high emissions scenario. Until mid-century, the projected losses are identical for the emissions scenarios, after which losses are reduced for the low emissions scenario and nearly constant for the high emissions scenario. By correlating meteorite losses directly to global temperature increases, we estimated that for every tenth of a degree of global warming 1-2% of the current number of meteorites is lost.

These future projections demonstrate how climate change threatens Antarctic meteorites. With temperatures remaining well below zero, even with several degrees of warming, meteorites are affected even by very minor (decimal) increases of surface temperatures during exceptionally warm events, which are expected to occur more frequently. These results motivate an intensification of Antarctic meteorite recovery missions, prioritizing the most prone low-elevation areas.

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