DATA AND MACHINE LEARNING TO AID THE SEARCH FOR ANTARCTIC METEORITES

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Antarctica is the most productive region for collecting meteorites, as the visually contrasting meteorites are easily detectable and tend to concentrate at specific areas exposing blue ice. Blue ice areas act as meteorite stranding zones if the flow of the ice sheet and specific geographical and climatological settings combine favorably. Previously, possible meteorite stranding zones were identified by chance or through visual examination of imagery, which limits the discovery of new locations for future meteorite searching campaigns.

In this study, various state-of-the-art datasets are combined using machine learning to estimate the likeliness of finding meteorites in any area in Antarctica. Input data on meteorite finding locations to train the algorithm is retrieved from the meteoritical bulletin database. To this end, ca. 13,000 meteorite finds with location information are reprojected on a 450 meter resolution grid. Through an exhaustive feature selection procedure, four features are selected, representing the typical conditions in which meteorites are found: exposure of blue ice (radar backscatter), cold surface conditions and negative surface mass balance (surface temperature and surface slope), and almost stagnant ice flow (surface velocities). With these features, the probability of the presence of meteorites is computed for each grid cell on blue ice areas and their direct surroundings (Figure 1). In the post-processing, the pixels that likely contain meteorites are clustered, resulting in over 600 potential meteorite stranding zones larger than 4 km^2 (see http://wheretocatchafallingstar.science/).

An evaluation of the model performance with independent test data indicates that this first continent-wide meteorite stranding zone classification is over 80% accurate [1]. The results reveal the existence of unexplored meteorite stranding zones, some of which are in close proximity to existing research stations. The quest to collect the meteorites remaining at the surface of the ice sheet, the number of which is estimated to be over 300,000, may greatly benefit from our newly provided meteorite map. Moreover, the data-driven approach illustrates the potential of data and machine learning to aid meteorite missions.

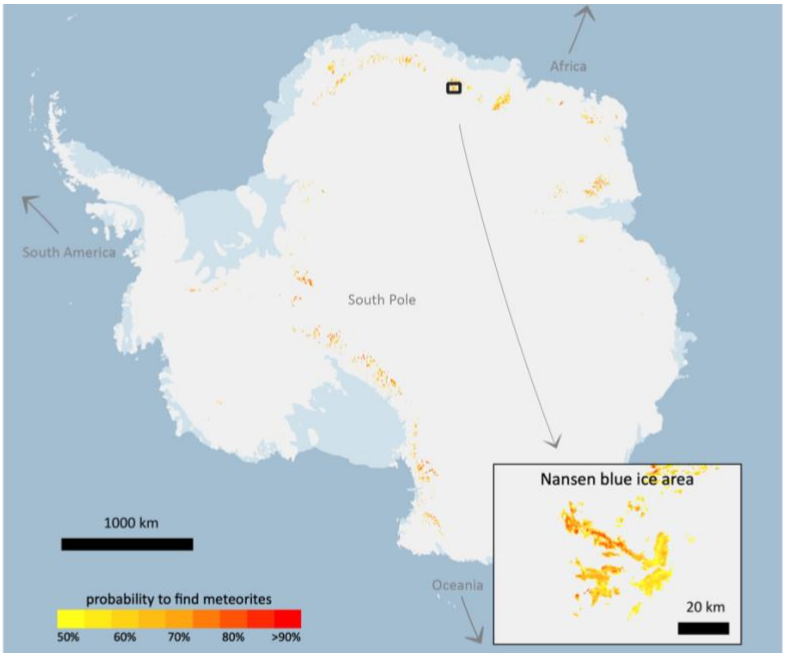

Figure 1: Continent-wide predictions of potential meteorite stranding zones. The insert shows the predictions over the Nansen blue ice area, where over 2000 meteorites have been found during Japanese/Belgian missions.

[1] Tollenaar V., Zekollari H., Lhermitte S., Tax D.M.J., Debaille V., Goderis S., Claeys P., Pattyn F. (2022) *Science advances* 8(4):abj8138.