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Rapidly detecting icebergs using ArcticDEM and Google Earth Engine

Connor Shiggins¹, James Lea¹, Dominik Fahrner^{1,2}, and Stephen Brough¹

¹Department of Geography and Planning, School of Environmental Sciences, University of Liverpool, Liverpool, L69 7ZT, United Kingdom.

²Institute for Risk and Uncertainty, University of Liverpool, Liverpool, L7 7BD, United Kingdom.

High resolution digital elevation models (DEMs) allow for the detection of icebergs and their size distribution, potentially giving insights into spatial and temporal changes in calving dynamics and iceberg cover. Here we present a fully automated tool for iceberg detection in glaciated fjords, utilising timestamped ArcticDEM tile data within the Google Earth Engine cloud computing platform. The automated tool requires only definition of a region of interest (ROI) through the following workflow:

1. Automatically filter timestamped ArcticDEM tiles to obtain only high-quality images with high data coverage within a ROI
2. Apply elevation correction to account for the geoid and tidal state, ensuring sea level is the equivalent to 0 m elevation
3. Apply an iceberg detection elevation threshold (any object at/or above 0.9 m)
4. Automatically delineate icebergs based on elevations above this threshold
5. Iceberg area, volume (total, below and above surface), freeboard height, mass and the ArcticDEM acquisition date are appended to each iceberg

This workflow allows for rapid, fully automated analysis of all available ArcticDEM tiles within a given ROI. The workflow does not require manual supervision, and can be easily related back to the original ArcticDEM data through Google Earth Engine. As an example, we apply our workflow to a 33 km² ROI at Nuup Kangerlua (Godthåbsfjorden), southwest Greenland, detecting a total of 57,735 icebergs from 6 images with an execution time of 19 minutes. This workflow will provide a user-friendly platform for users of any coding ability requiring a large data set of icebergs with an area size greater than approximately 40 m². Results obtained from these data will be utilised to identify potential seasonal to multi-annual timescale changes in calving behaviour, though is dependent on ArcticDEM data availability.