Quantifying Iceberg Distribution in Rink Fjord using Satellite Remote Sensing

Siddharth Shankar, Leigh A. Stearns

Department of Geology, The University of Kansas, Lawrence, KS

s.shankar@ku.edu

Abstract

Icebergs are an important part of Earth's freshwater cycle, affecting fjord circulation, marine biology, and nutrient flux. However, very little is known about iceberg distribution patterns, especially how iceberg sizes vary from glacier termini to the open ocean. Such information is critical for freshwater budgets and ocean circulation models.
In this study, we quantify iceberg size and distribution in Rink Fjord, West Greenland during the summer of 2015. We show how the iceberg distribution changes throughout the summer season using Landsat 8, panchromatic images at 15 m resolution. The project algorithm runs on QGIS, ArcGIS, Python 2.7, and GDAL. We are working to automate the process so we can expand the study both spatially and temporally. The resulting dataset will help in understanding calving dynamics of different marine terminating glaciers and provide critical information for ocean and fjord models.

Objectives

- Develop an algorithm that detects icebergs in an open fjord.
- Extract information about the number of icebergs and their individual size.
- Calculate iceberg characteristics at distances from the glacier terminus.

Study Area

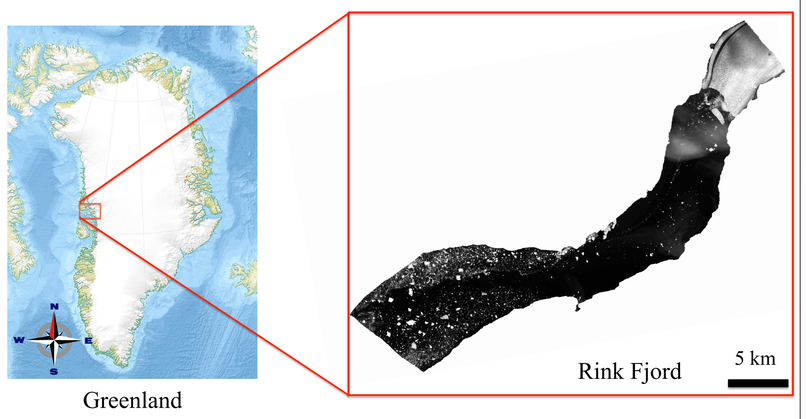

Figure 1: A Greenland map, highlighting Rink Fjord.

Iceberg Distribution

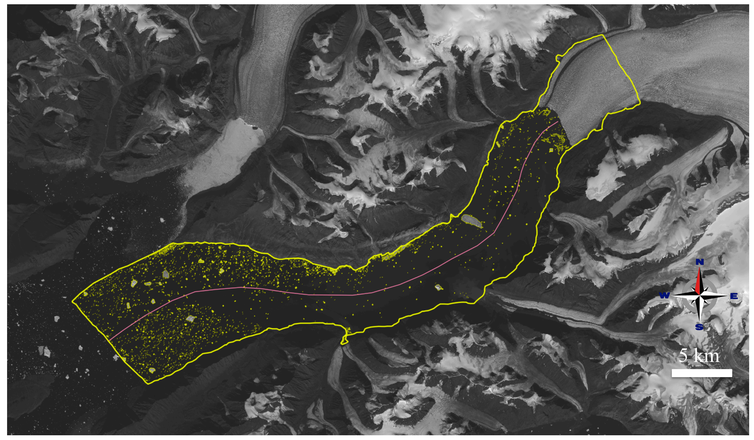

Figure 2: Icebergs detected in Rink Fjord, from a Landsat 8 image on July 18th, 2015. The icebergs that are automatically detected are highlighted in yellow. The pink line in the center of the fjord is used to calculate the iceberg distance from the terminus.

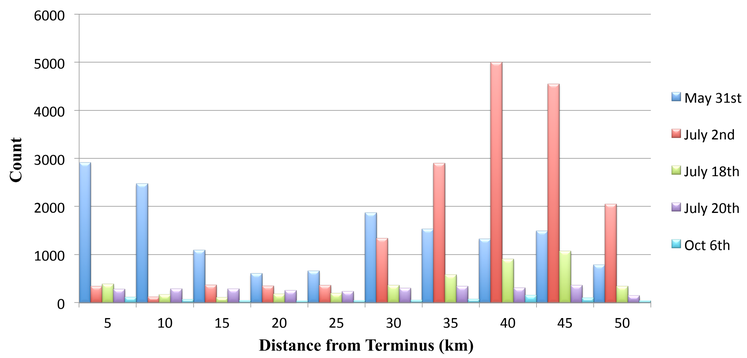

Figure 3: Categorization of icebergs based on their distance from Rink Isbrae terminus. The icebergs are binned in 5 km sections for the days of May 31st, July 2nd, July 18th, July 20th and October 6th.

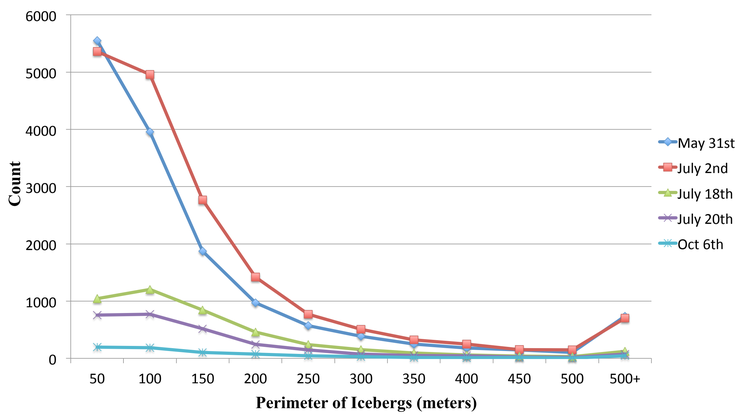

Figure 4: Iceberg size distribution for the days of May 31st, July 2nd, July 18th, July 20th and October 6th.

Methodology

We use cloud-free Landsat 8 OLI imagery, freely available at http://earthexplorer.usgs.gov, in our iceberg detection algorithm. The Landsat 8 has a repeat cycle of 16 days which yields roughly two images per month for a particular path and row.
Due to heavy cloud cover, there are no viable images in June, August, and September. Iceberg detection relies on brightness values in the images.A brightness threshold, which is independently set for each image due to radiometric differences, is applied to each image to isolate reflective icebergs from the dark ocean. Each iceberg is then converted to a polygon. The centroid of each polygon is used to calculate the point of intersection with the centerline. Once the icebergs are detected and isolated in the image, we determine their distance along the centerline in the fjord. We then categorize them based on size and distance, in 5 km sections, from the glacier terminus.

Conclusions

- In May, the number of icebergs is highest near the terminus, possibly due to high calving rates in early summer.
- In July, the majority of icebergs are near the end of the fjord, suggesting that the calving rate has decreased since May.
- Iceberg distribution in October is low throughout the fjord, which implies low calving rates combined with short residence times in the fjord.
- The majority of the icebergs detected in Rink Fjord have a perimeter of 50 -100m, this is especially true in May and early July.

Future Work

- Full-automation of the algorithm.
- Refine the algorithm to detect icebergs in sea ice or in a mélange.
- Design the algorithm to handle larger data sets, so it can be expanded both temporally and spatially.