Quantification and Analysis of Icebergs Distribution around Greenland using Sentinel SAR images

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Introduction

Icebergs transport freshwater from the Greenland Ice Sheet to the surrounding fjords and ocean basins at rates that are poorly quantified.

The rate of iceberg production is largely modulated by ice sheet dynamics, and the rate at which they melt can influence fjord circulation. As a result, when climate models do not include variable iceberg properties, they poorly constrain the atmosphere-ice sheet-ocean relationship.

Here, we investigate how iceberg distributions vary both spatially and temporally. We apply a new iceberg detection algorithm to satellite radar imagery within 100 km of the Greenland coastline (Figure 1). Results can then be incorporated into coupled ice sheet-climate models.

Algorithm and Initial Results

We modified the Constant False Alarm Rate (CFAR) algorithm to automate the identification of icebergs around the coast of Greenland. The CFAR algorithm isolates icebergs from surrounding open water or sea ice based on brightness threshold (T).

False alarm rate value helps to nullify the effect of noise in data and thus improves the accuracy of iceberg detection.

\[ T = -\mu \ln(\alpha) \]

where

- \( T \) = brightness threshold
- \( \alpha \) = false alarm rate (0.001)
- \( \mu \) = mean of 2D image array.

The threshold is compared against each pixel (Pi).

\[ \text{if } (Pi > T): \]
\[ Pi = \text{iceberg pixel} \]
\[ \text{else:} \]
\[ Pi = \text{ocean water} \]

To assess the accuracy of our CFAR technique, we compare the CFAR detected icebergs with a selection of those we manually detected.

Conclusion and Future Analysis

The initial results show that:

i) The CFAR algorithm correctly identifies all of the icebergs in our test scenes.

ii) The CFAR algorithm calculates iceberg area with correlation value of 0.71.

Future Work:

i) Time-series analysis of iceberg distribution.

ii) Changes in iceberg distribution due to characteristics.

iii) Estimate freshwater flux based on the iceberg distribution.

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