Detecting and Tracking Iceberg A76 with U-Net Deep Learning Model

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Background

- Icebergs endanger shipping routes, impact ocean circulation and ecosystems.
- Tracking iceberg can help alarm ship navigation and understand ocean currents along the iceberg path.

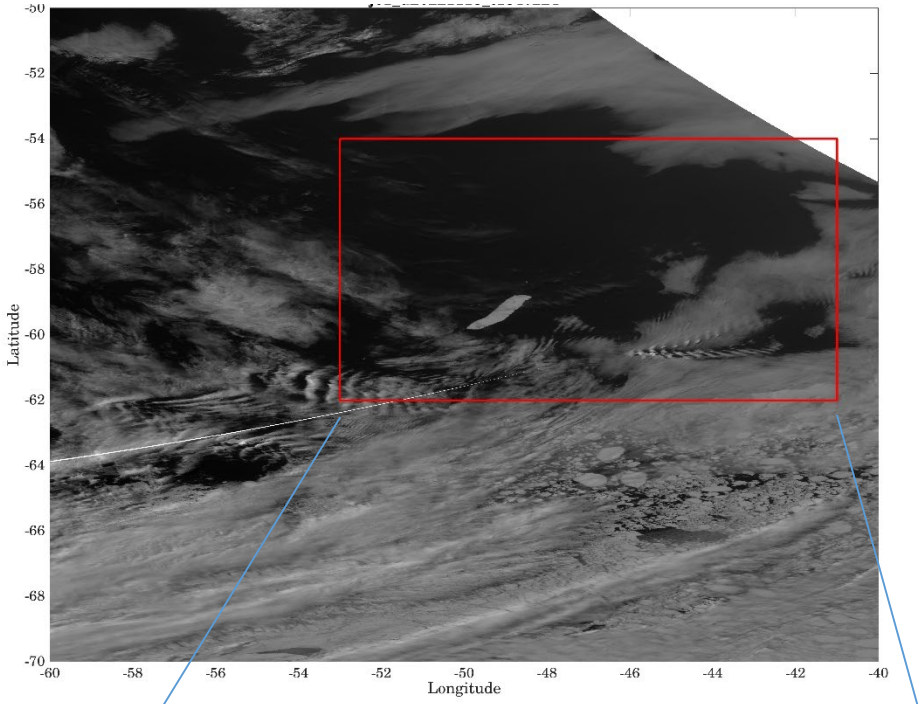
Objectives

- Test U-Net for object recognition with satellite images.
- Track the iceberg A76, calculate it's trajectory, size and rotation rate.

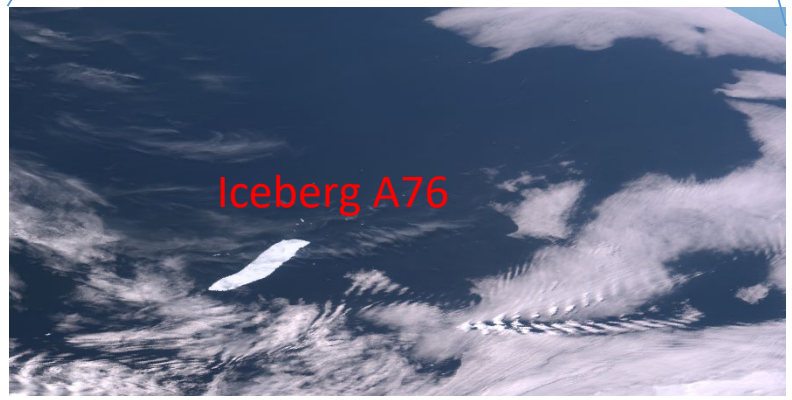
Data

True color images were generated from VIIRS datasets of NOAA-20 and SNPP satellites.

NOAA-20
VIIRS M3
(488 nm)

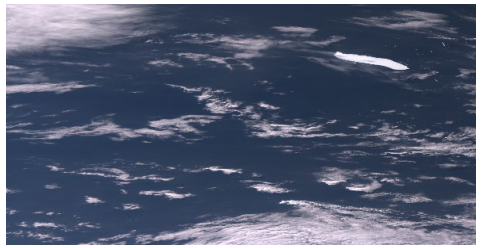


VIIRS M5,4,3
(RGB True
Color)

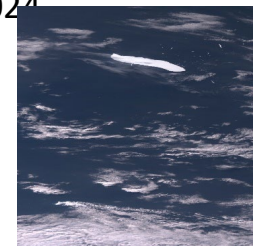


Methodology:

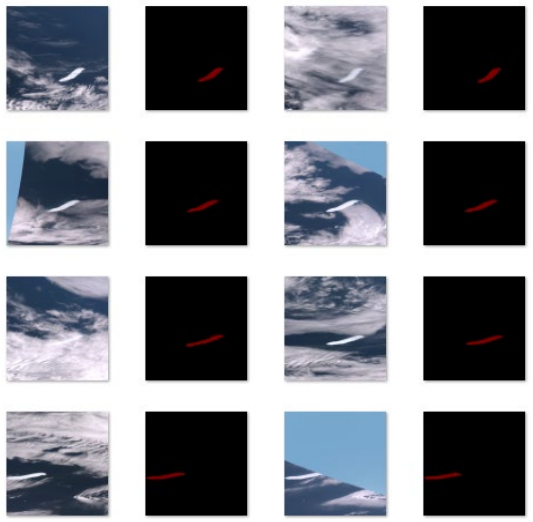
SNPP/NOAA-20 VIIRS Image (2048x1024) 2022-10 to 2023-04



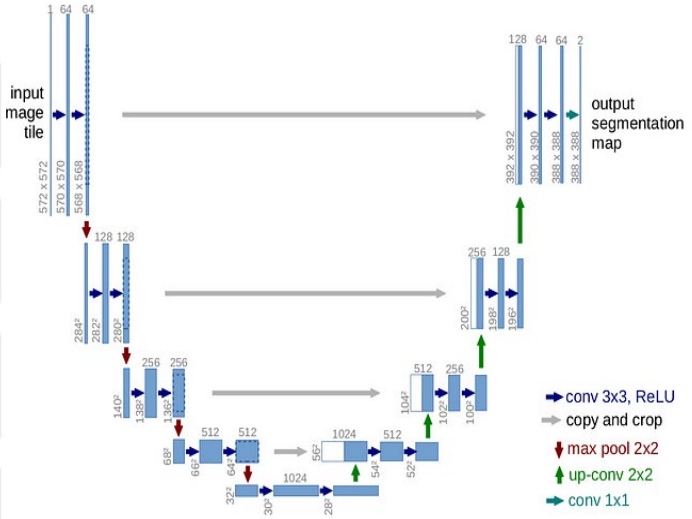
Crop to 1024x1024



Label selected training images using Labelme

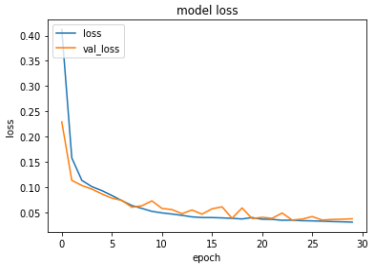


U-Net
image segmentation

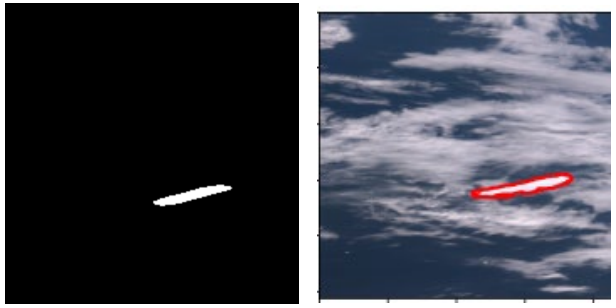


Olaf Ronneberger et al. 2015

Loss Curve



Prediction: Iceberg boundary extraction for further analysis

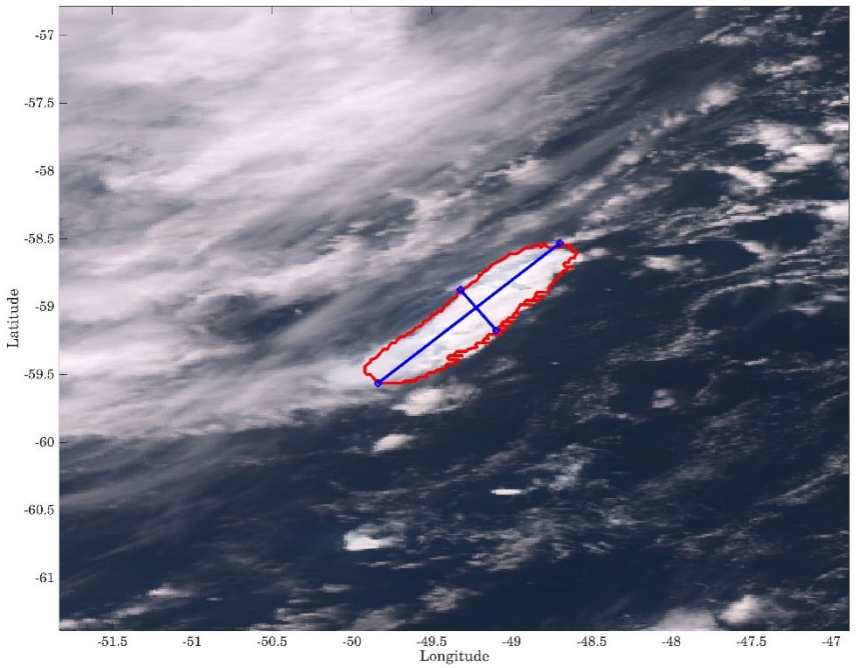


Challenges faced:

- Trade-off between image size and processing time
- Model had trouble differentiating between clouds and the iceberg
- Model got progressively worse at differentiating in later months
- Images of a cloud and images of an iceberg looked the same, had to be chosen by hand

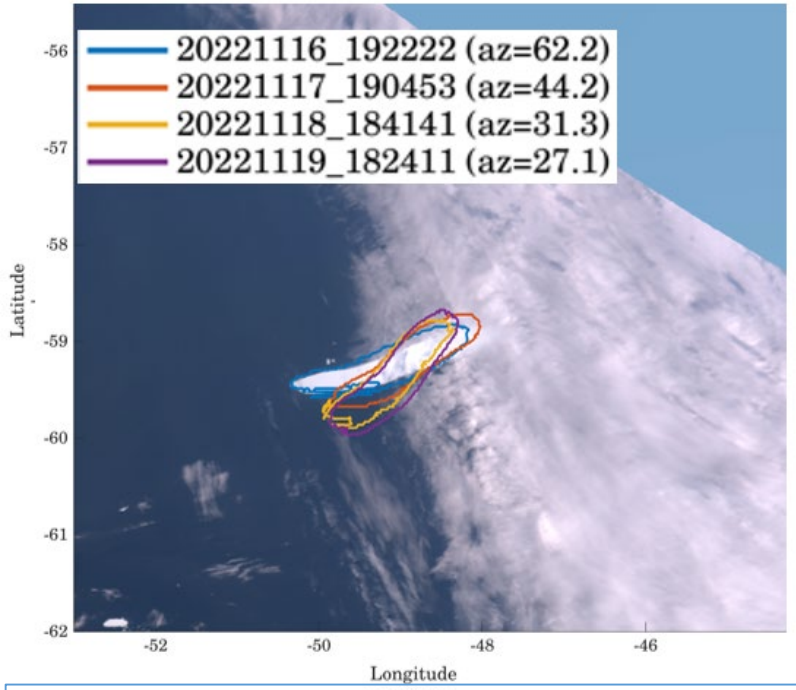
Results:

Iceberg A76 Size Estimation



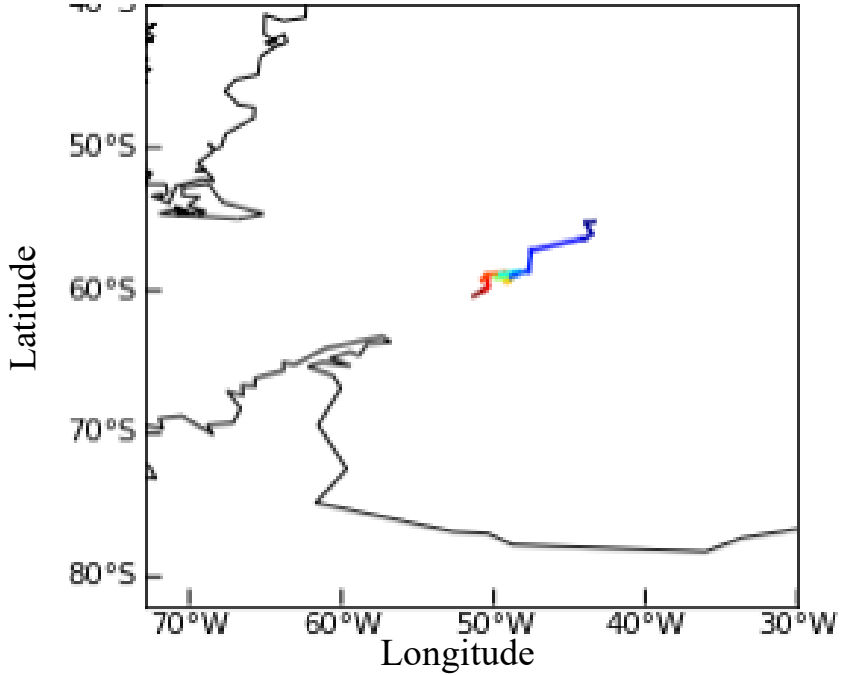
- Estimated Iceberg A76 Length: ~115 km; Width: ~35 km on Nov. 18, 2022

Iceberg A76 Rotation Estimation



- Iceberg A76 can rotate 35.1 degree over ~four days

Iceberg A76 Centroid Drift Tracking



Iceberg A76 traveled from 51.3 west, 60.4 south to 43.4 west, 55.2 south, a total distance of 724.2048 kilometers, from October 3rd, 2022 to April 24th, 2023

- Future improvements:
  - Provide more varied training images; the present ones were mostly clear sky
  - Increase resolution.

Bibliography:

NASA 22, 10-31-2022, "Iceberg A-76A in the Drake Passage," No Publication, https://earthobservatory.nasa.gov/images/150559/iceberg-a-76a-in-the-drake-passage

Ronneberger, O., Fischer, P., Brox, T. (2015). U-Net: Convolutional Networks for Biomedical Image Segmentation. In: Navab, N., Hornegger, J., Wells, W., Frangi, A. (eds) Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015. MICCAI 2015. Lecture Notes in Computer Science(), vol 9351. Springer, Cham. https://doi.org/10.1007/978-3-319-24574-4_28