Modeling and Predicting Changes in Arctic Sea Ice Thickness from NASA's ICESat-2 Launch

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Abstract

- Look further into the changing environment in the Arctic region using data from the National Snow and Ice Data Center (NSIDC)
- Provide insight on the changes that have already happened and predict what the future may look like
- NASA launched its laser ICESat-2 satellite in 2018 to collect elevation data from all over the world

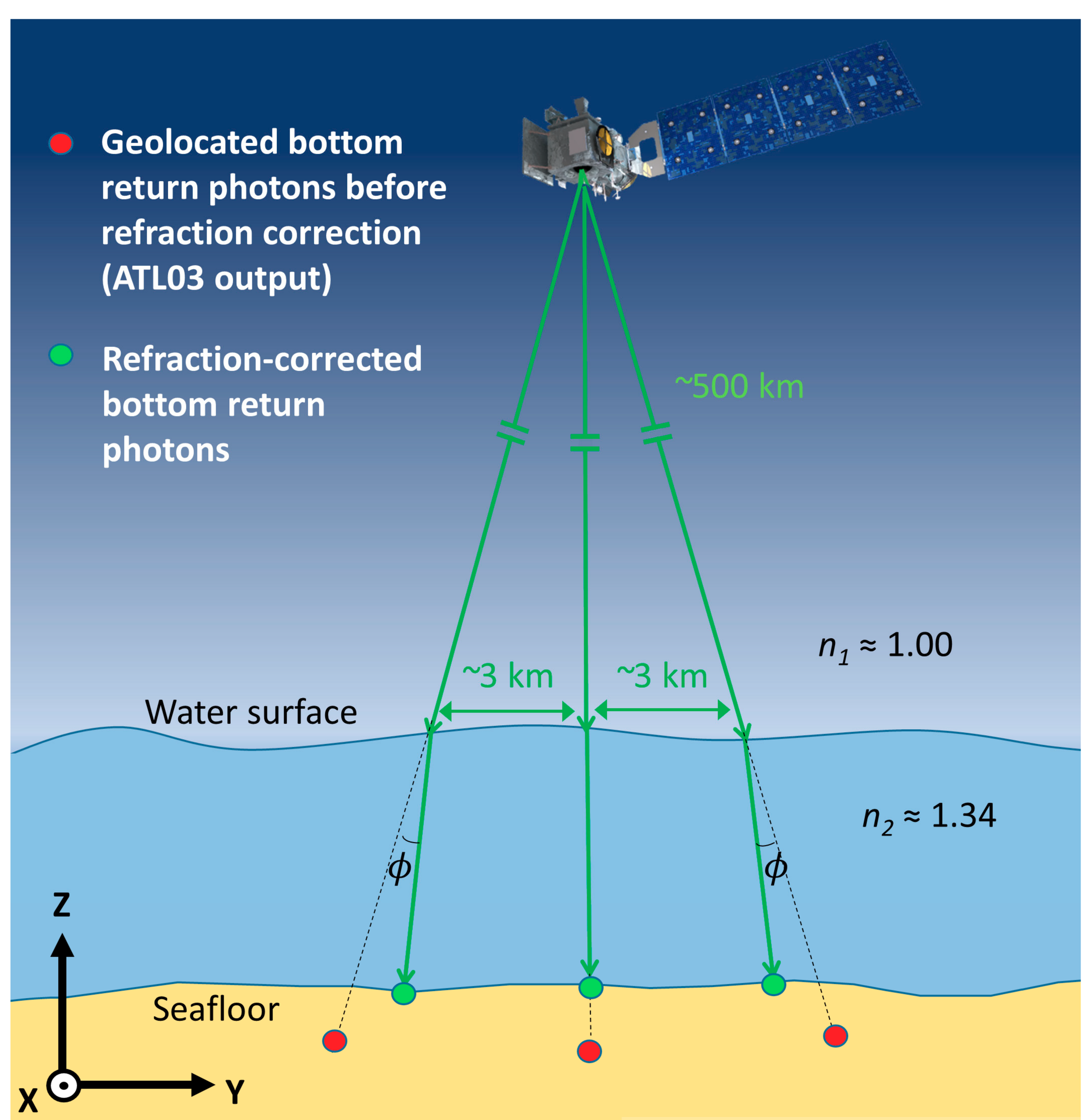

Figure 1:ICESat-2 ATLAS satellite set-up

Motivation

- Growing concern of sea ice melting which is causing both environmental and societal impacts
- Over their 42-year satellite record, the NSIDC has reported a loss of about 1.36 million square kilometers of sea ice since 1979

Motivation

- NSIDC also predicts a 2.7% linear rate decline in sea ice since 1979
- We wanted to look into this particular area using the data provided by the ICESat-2 satellite and create a machine learning model to predict return photon height based off of location
- Also created a vector autoregressive (VAR) model to show the differences in sea ice based off of the season

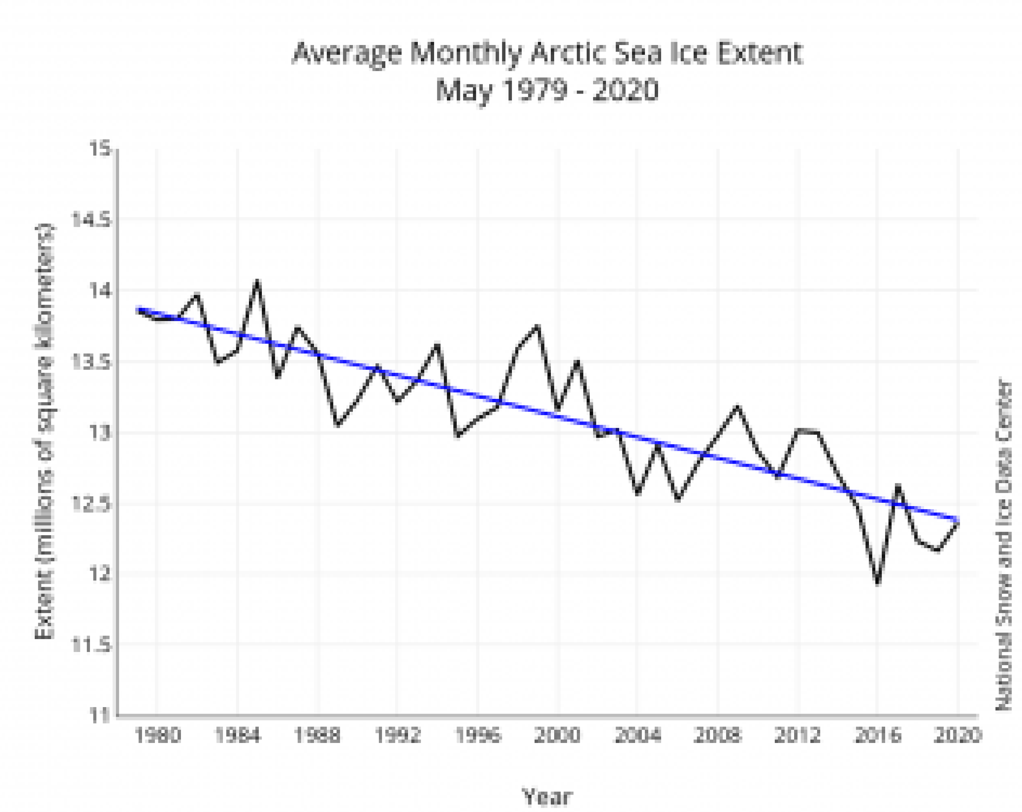

Figure 2:Sea Ice Extent shows a steady decline since 1979

Data

- The NSIDC utlizies Open Altimetry technology to allow for public access and to view specific regions of the world
- An elevation profile of the region selected is provided and you can view corresponding ATL03 data product which provides information about the geolocated photons
- Data from ATL03 is then inputted to create higher level data products that provide more customized algorithms based off specfic surface type

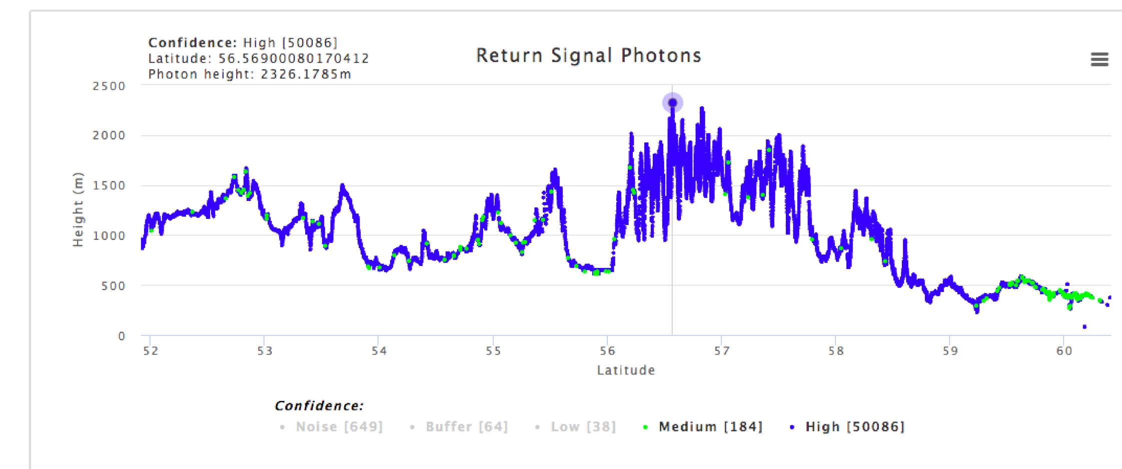

Figure 3:Elevation Profile of returned photons

Methods

- Use regression analysis to examine the relationship between the location of the photon and returned photon height
- Built a neural network with latitude and longitude being the input features and photon height being the output and fitting the model to a Gaussian distribution
- 20% of the stored data will be used and test data and 80% will be used as training data, evaluated with mean squared error (MSE)

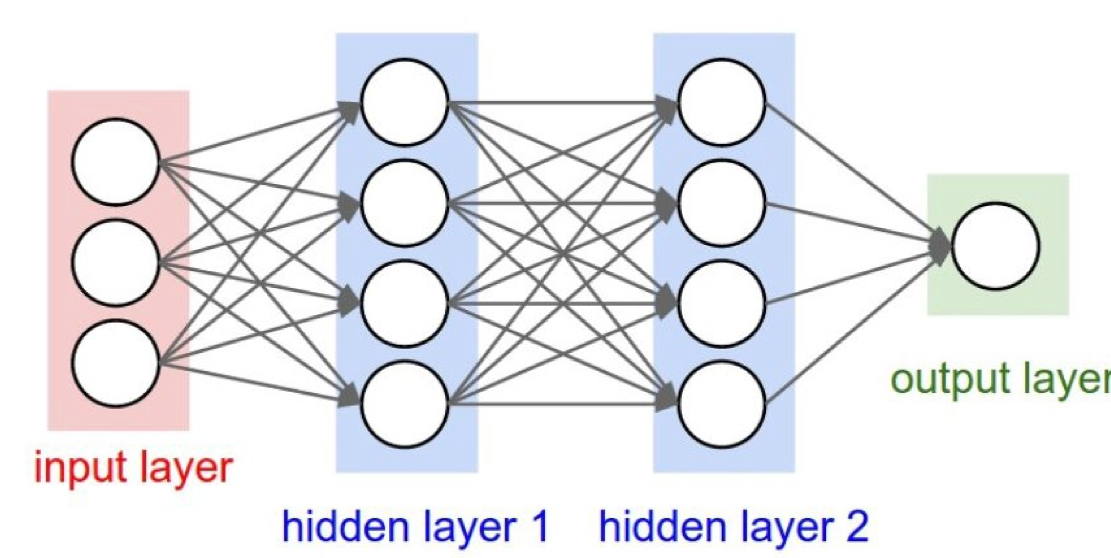

Figure 4:Representation of Neural Network

- Create a vector autoregressive (VAR) model to capture the time series of the returned photon heights during seasons
- Take data from the same region of the Arctic in each of the 4 seasons, each representing a time series in the model
- Use location to accurately predict and forecast photon height across seasons

Results

- Our model uses MSE as its loss function and after 10 epochs, it is about 0.0392, indicating that our model is running as intended
- Been able to utilize VAR to capture and model the returned photon height in each of the 4 seasons
- Created a matrix of the impulse responses, as a function of time, and shows the response variable being affected

Conclusion & Future Work

- We will improve models and further analyze them to understand the effects changing sea ice is having over time and analyze other regions to create more holistic results
- Work on creating an algorithm to differentiate between solid sea ice and open water leads

References

- Wang, L., X. Yuan, M. Ting, and C. Li, 2016: Predicting Summer Arctic Sea Ice Concentration Intraseasonal Variability Using a Vector Autoregressive Model. J. Climate, 29, 1529–1543

Acknowledgments

This work was made possible by the National Science Foundation under Grant 19508264. I would like to acknowledge Marquette University, MSCS, and mentor Dr. Satish Puri along with Dr. Praveen Madiraju and Dr. Dennis Brylow for organizing the REU. I would also like to acknowledge Anmol Paudel for helping with machine learning model.

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