

A polar bear is walking across a vast, fragmented expanse of sea ice. The ice consists of numerous white, irregular floes of varying sizes separated by dark blue, open water. The bear is positioned in the center of the frame, facing right. The scene is captured from a high angle, emphasizing the isolation and scale of the environment.

Still Frozen, But How Long?

Our Team



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What is Sea Ice?

Sea ice is frozen seawater that floats on the ocean/sea surface

Winter



Maximum Arctic sea ice extent in February/March

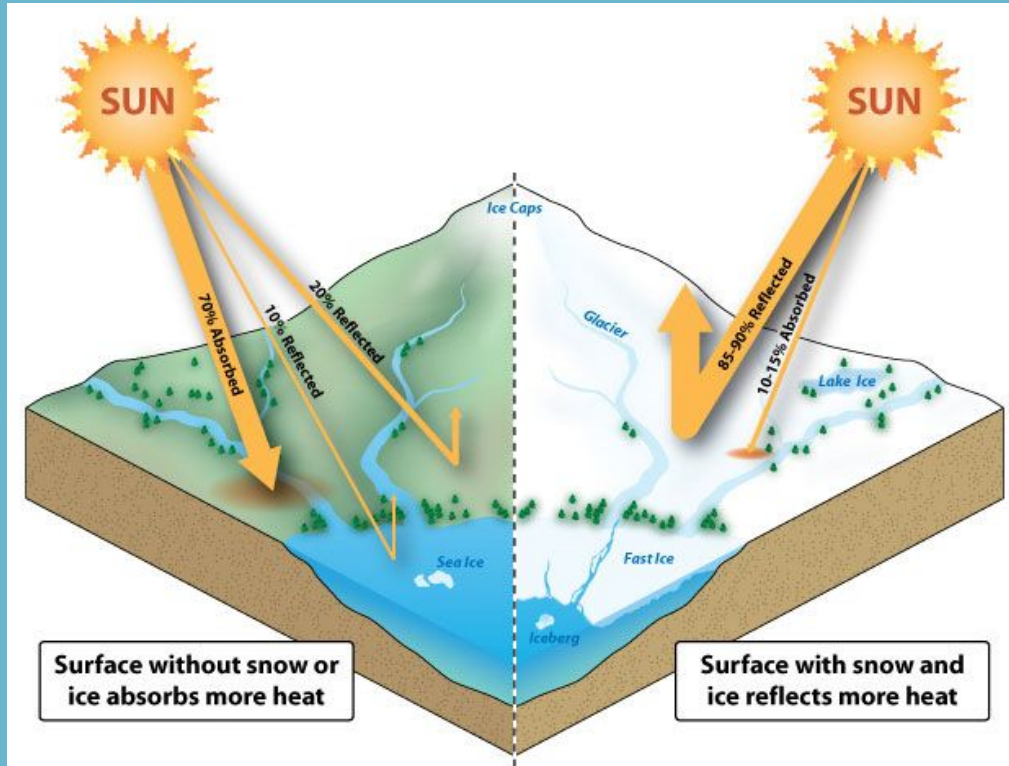
Summer



Minimum extent in September

Why is Sea Ice Important?

It influences our global climate



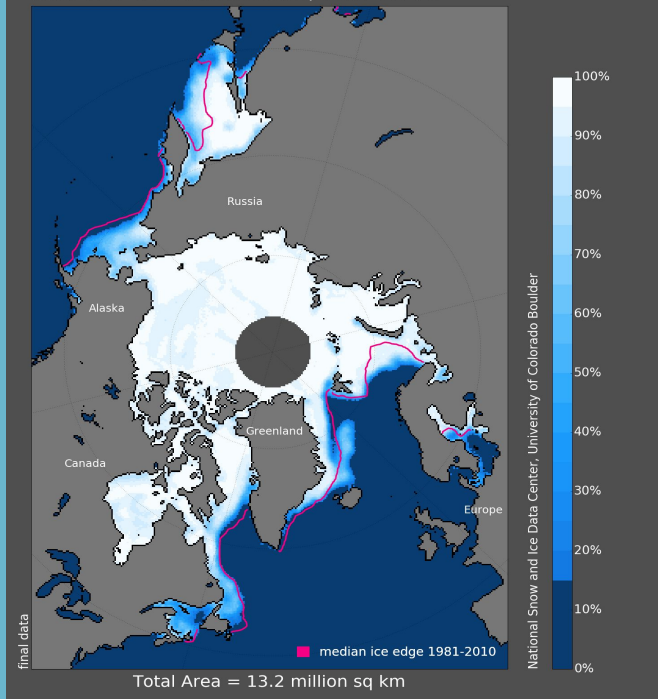
Source: the-m-factory.com

- Arctic sea ice is an important indicator of global climate change
- Important input parameter for climate models (radiation balance)
- The decline of sea ice can also affect the wildlife (polar bears, polar fox, etc) habitat



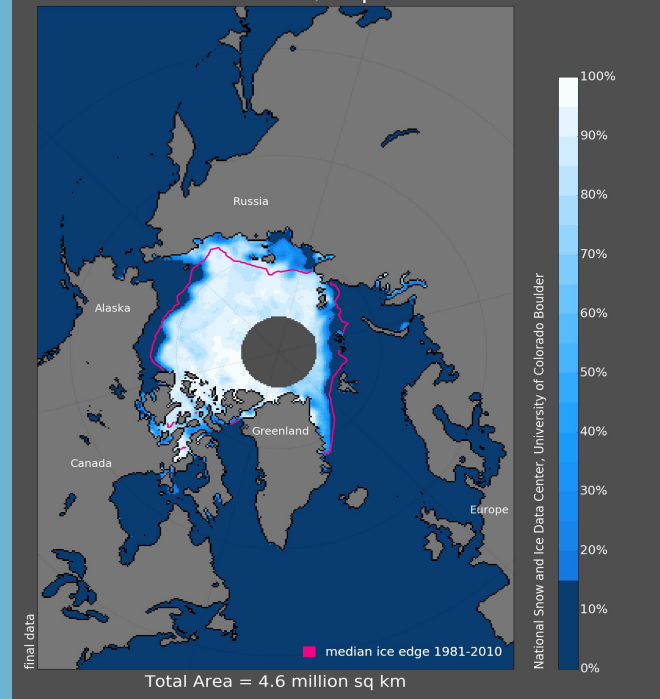
Sea Ice in Northern Hemisphere

Sea Ice Concentration, Mar 1979



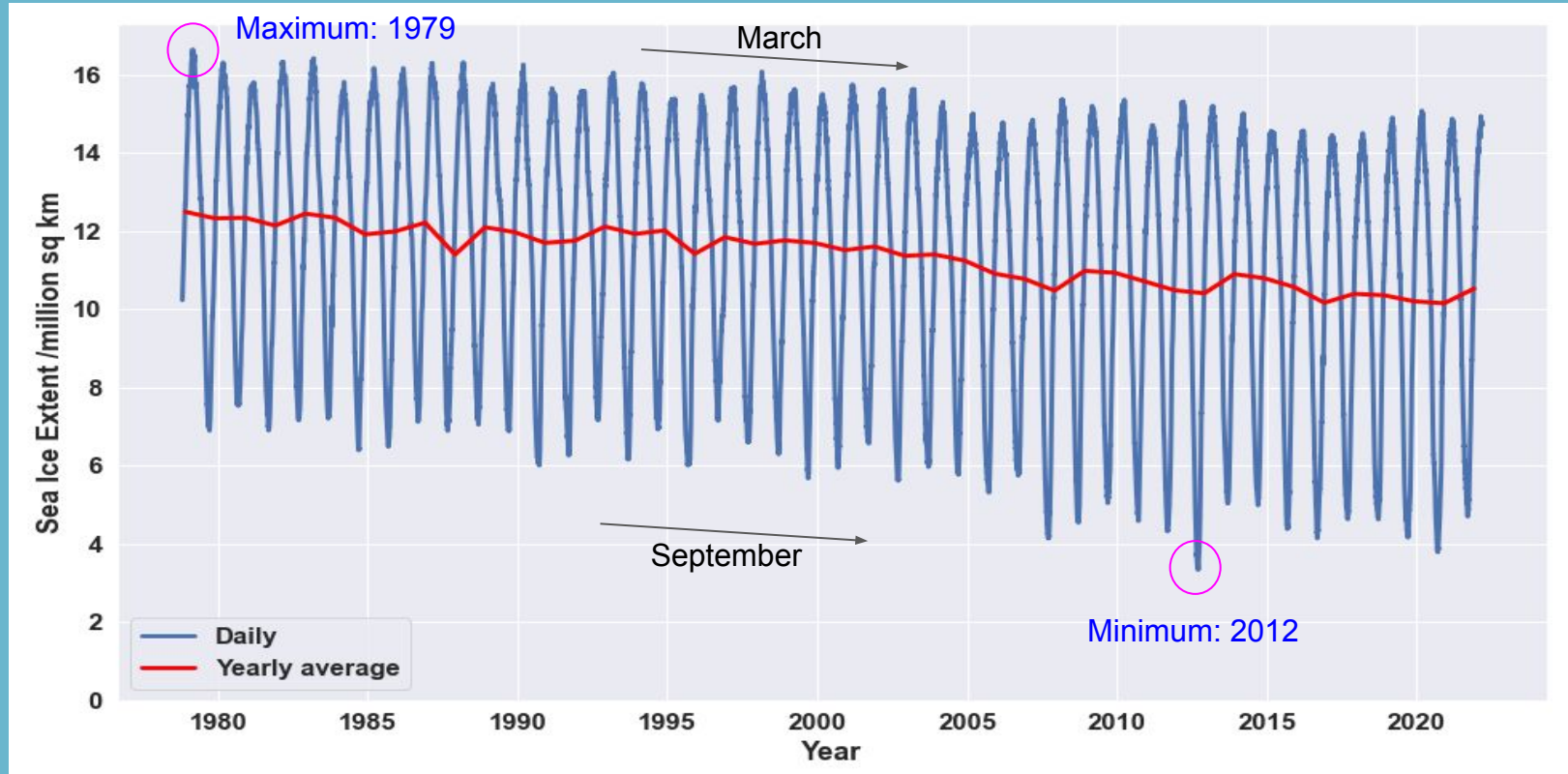
- Source: National Sea Ice & Data Center (NSIDC)
- Measurements of Sea Ice extent depend on the Sea Ice concentration
- Since 1978 for the whole Northern Hemisphere
- Data for regional seas in Arctic ocean since 2006

Sea Ice Concentration, Sep 1979



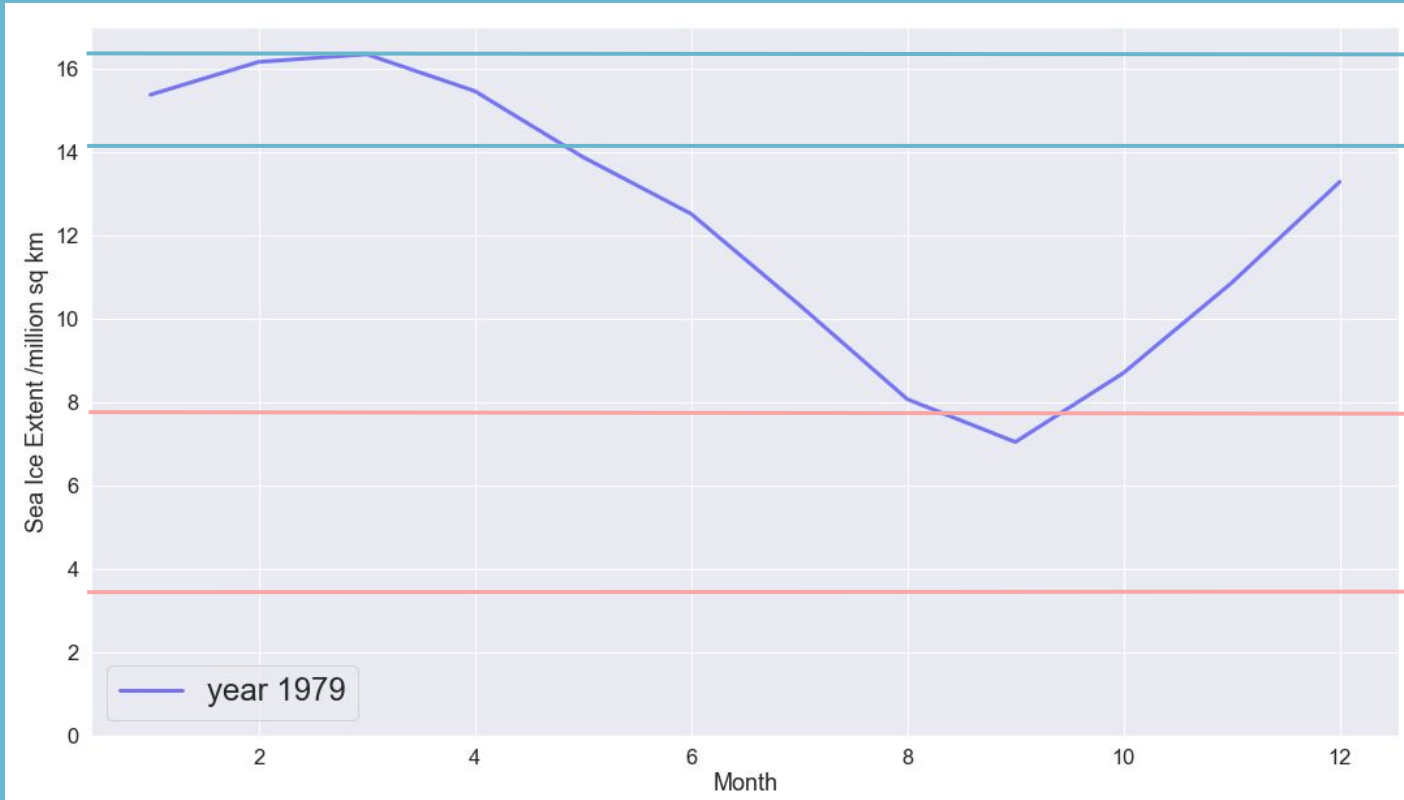
What does the data tell us?

Northern Hemisphere



Annual Changes of Sea Ice Extent

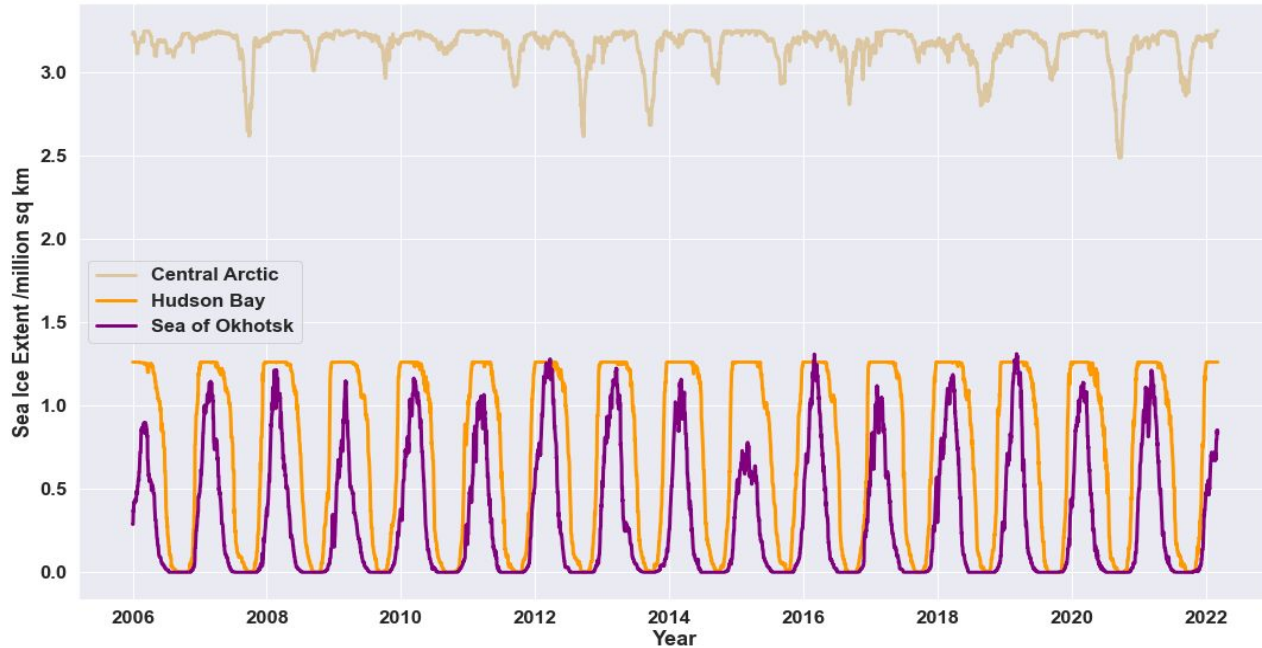
Difference between total sea ice extent in 1979 and 2022



- Reduction of sea ice extent for all months
- Steep slope for the minimum in september
- No complete recovery of the sea ice extent in winter

Local Changes in Arctic Regions

Comparison of Sea Ice Extent



Dashboard to visualize all regions:

<https://sea-ice-extent.herokuapp.com/>

Modelling



Baseline

Monthly mean as prediction for test data



SARIMAX

Seasonal Autoregressive Moving Average with Integrating part



Prophet

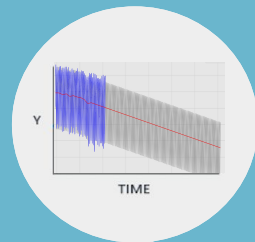
An additive model with several seasonal and trend components



NeuralProphet

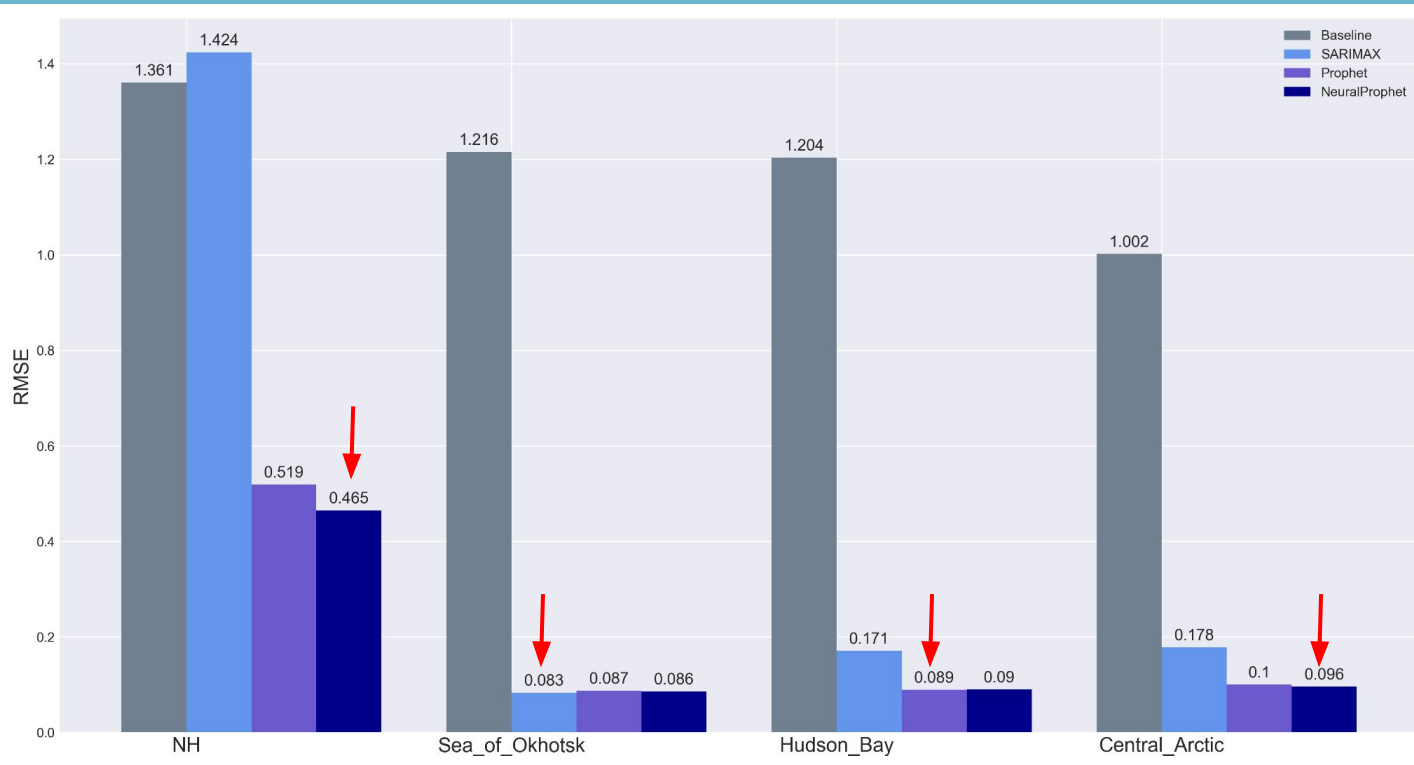
A decomposable model with the components, trend, seasonality, auto-regression, special events, future regressors and lagged regressors

Prediction



Performance of the Models

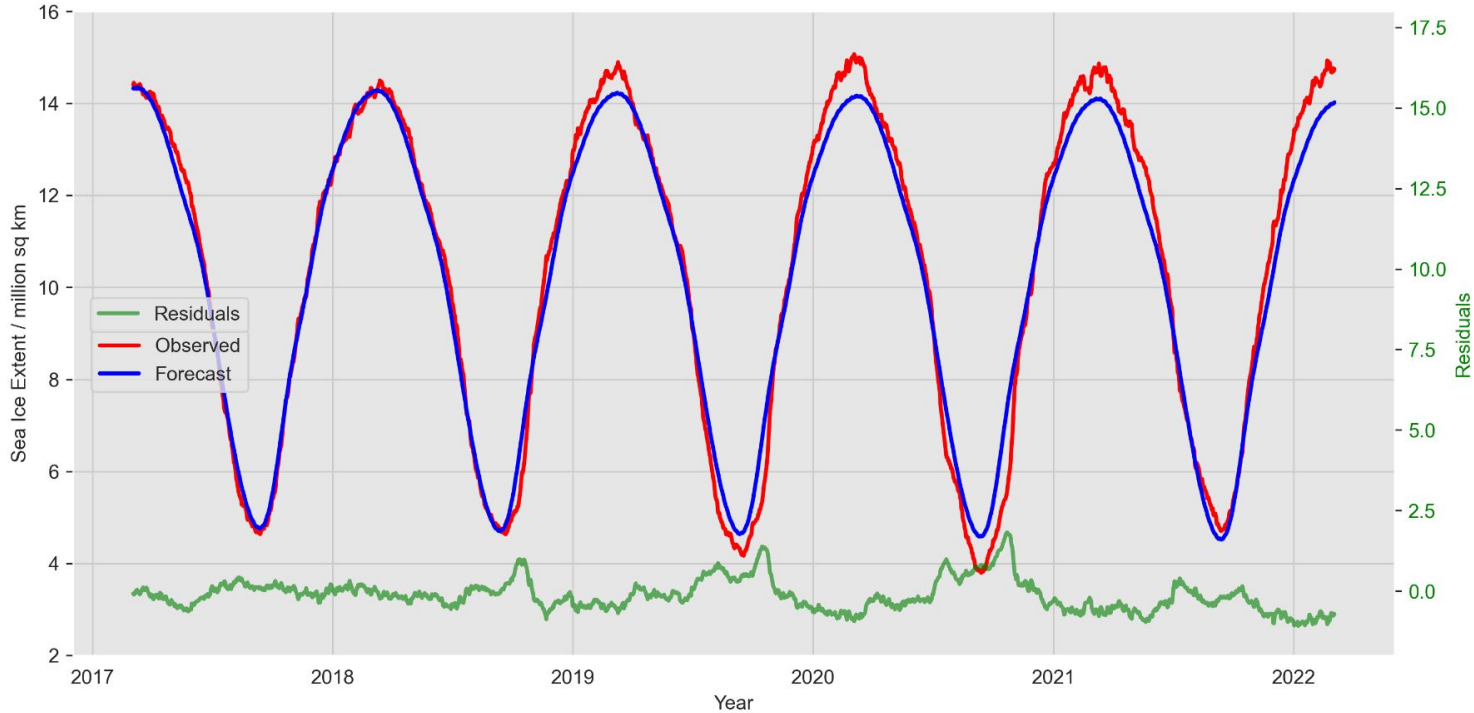
Comparison of RMSE (Root-Mean-Squared Error) values



- Highest RMSE for Northern Hemisphere data for every model
- Ensemble better than single model

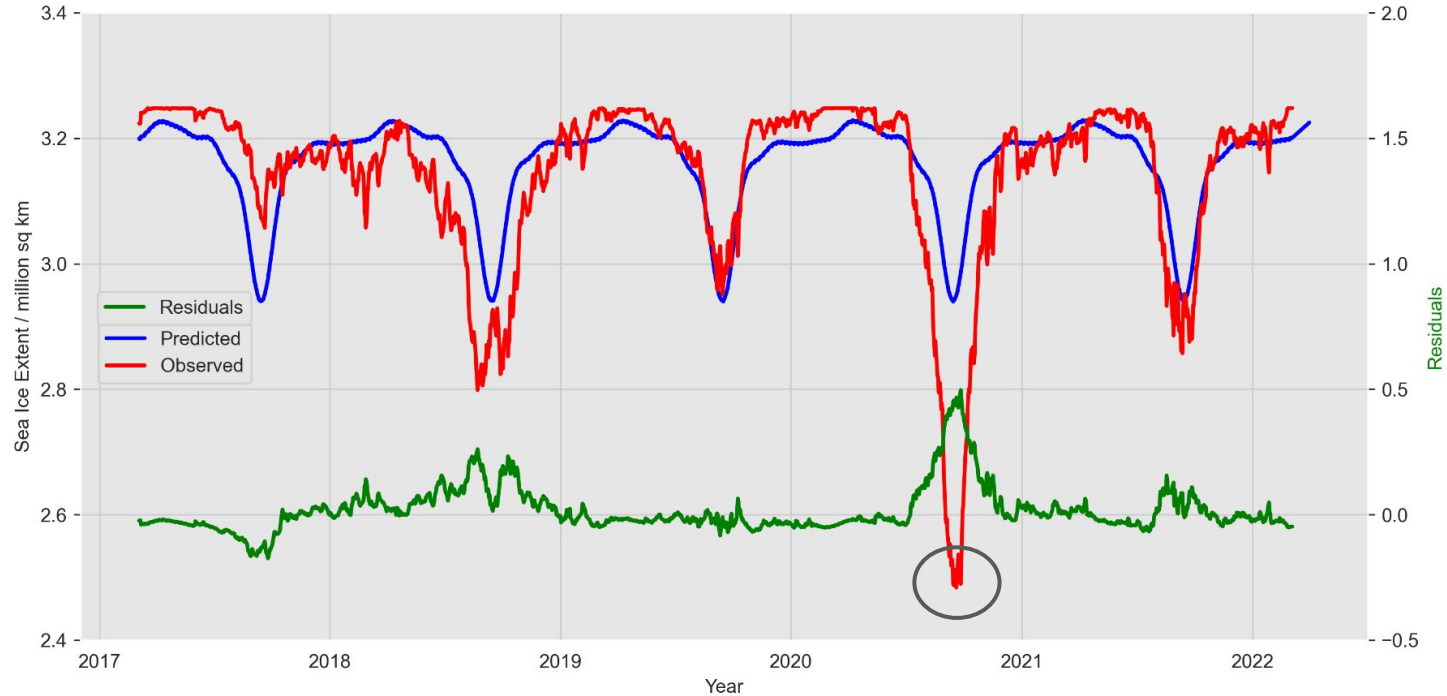
Model vs. Observations

Northern Hemisphere, NeuralProphet



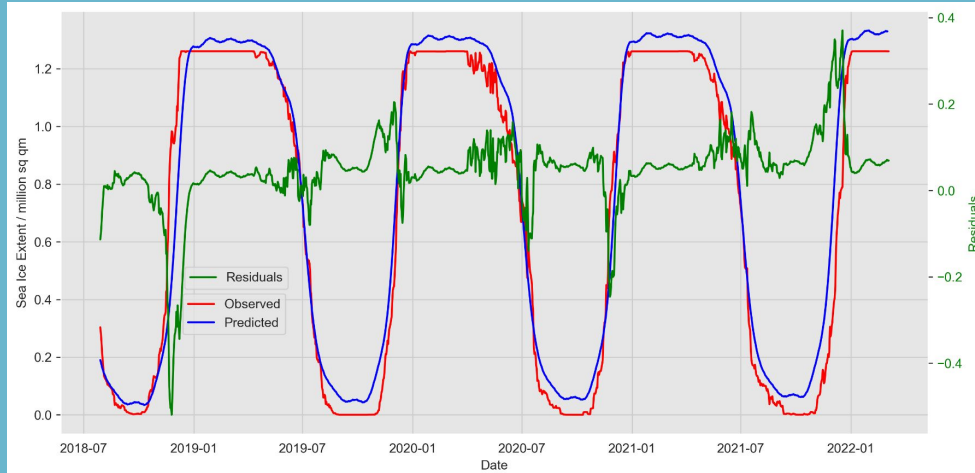
Model vs. Observations

Central Arctic, NeuralProphet



2020 - Siberian heat wave

Model vs. Observations



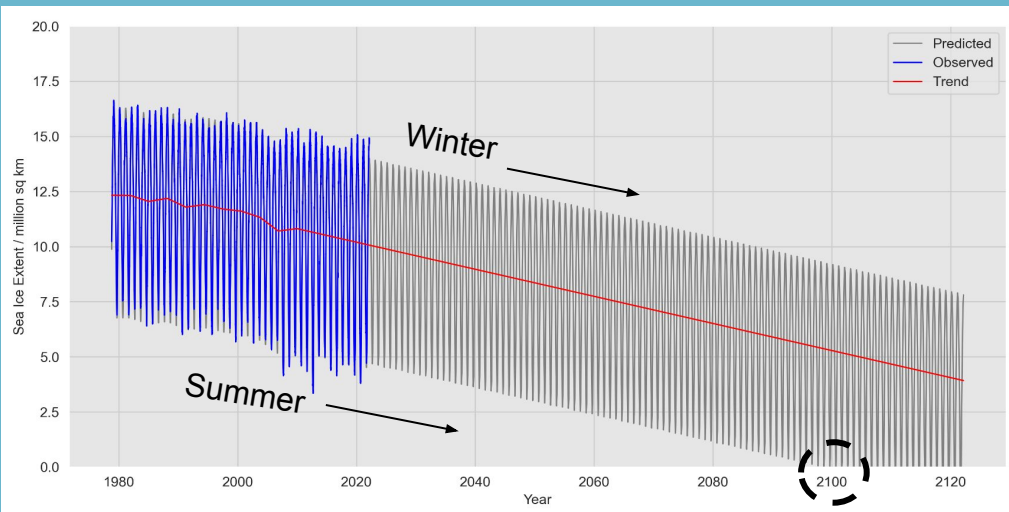
← Hudson Bay, Prophet

Sea of Okhotsk, SARIMAX →



Forecast of Sea Ice for Next 100 Years

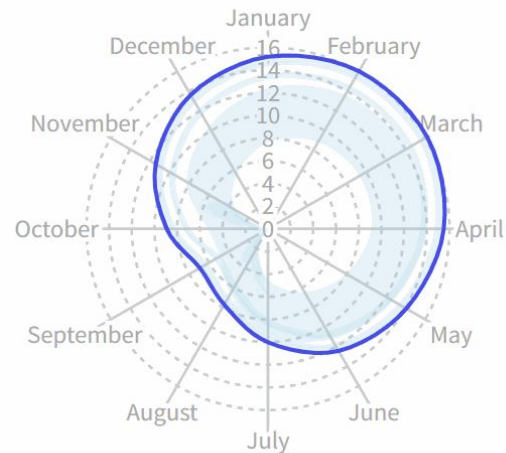
Summer sea ice - free szenario in Northern Hemisphere using NeuralProphet



- Ice free summer begins in 2090s

Arctic Sea Ice Extent Prediction (1979 - 2125)

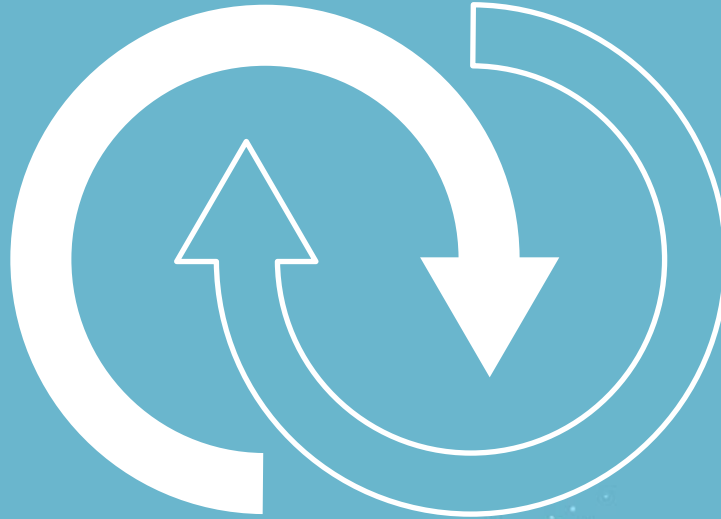
1981



Future Work

Comparing with Antarctic

Visualize actual data and predict future Sea Ice Extent for the Antarctic region to see if there is a similar trend



Improve dashboard

Implementing model in the dashboard to show a short period prediction for the regions



Thank You!

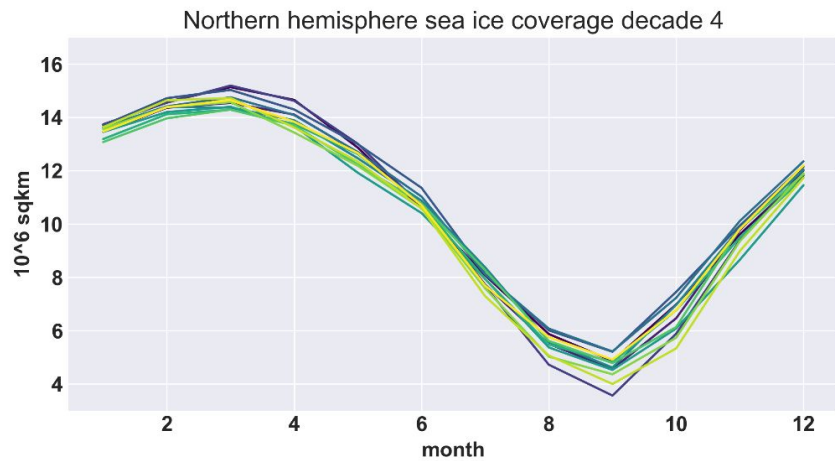
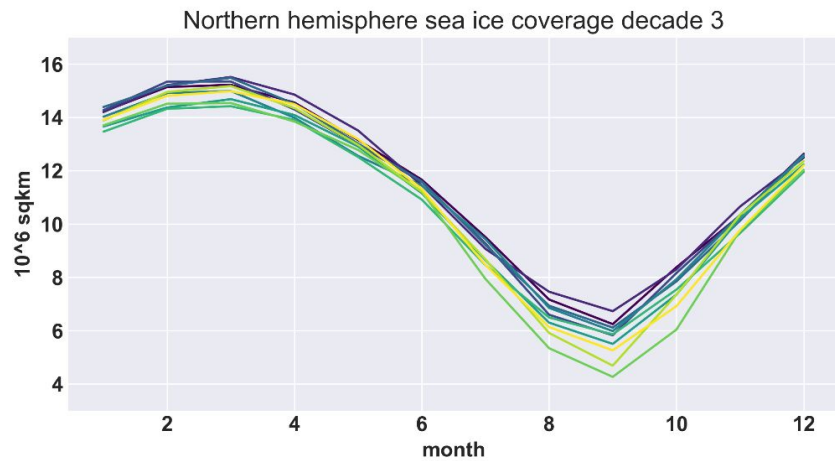
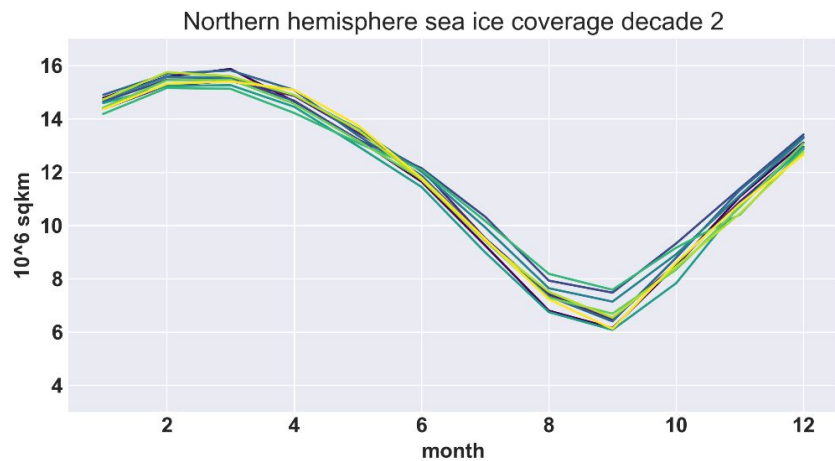
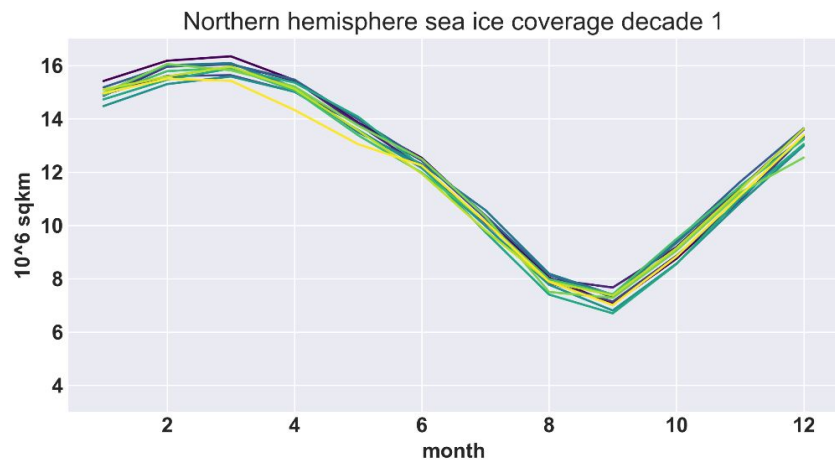
Credits

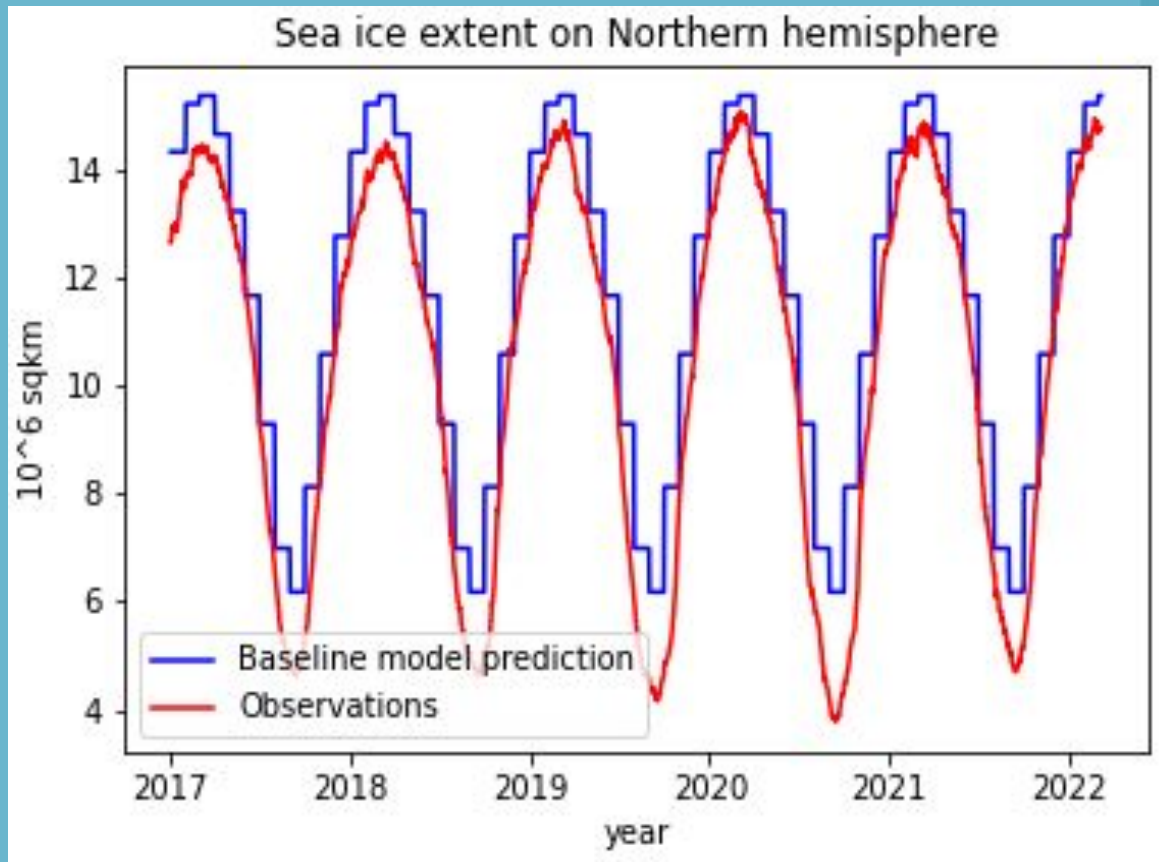
The data is provided by [NSIDC.org](https://nsidc.org)

The polar chart was prepared by using <https://flourish.studio/>

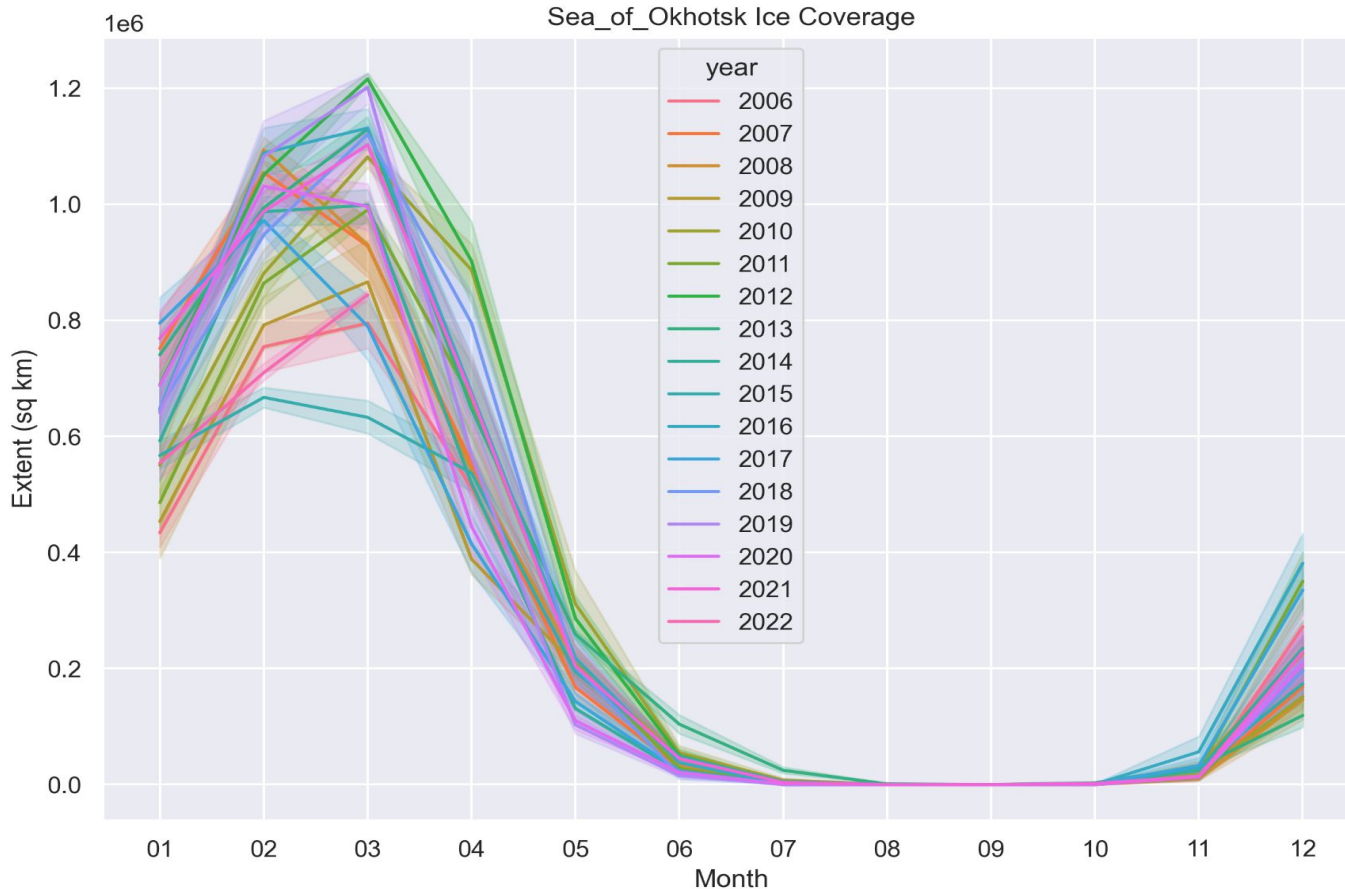
This presentation template created by [GoogleSlidesppt.com](https://www.google.com/slides/ppt.com)

Additional slides



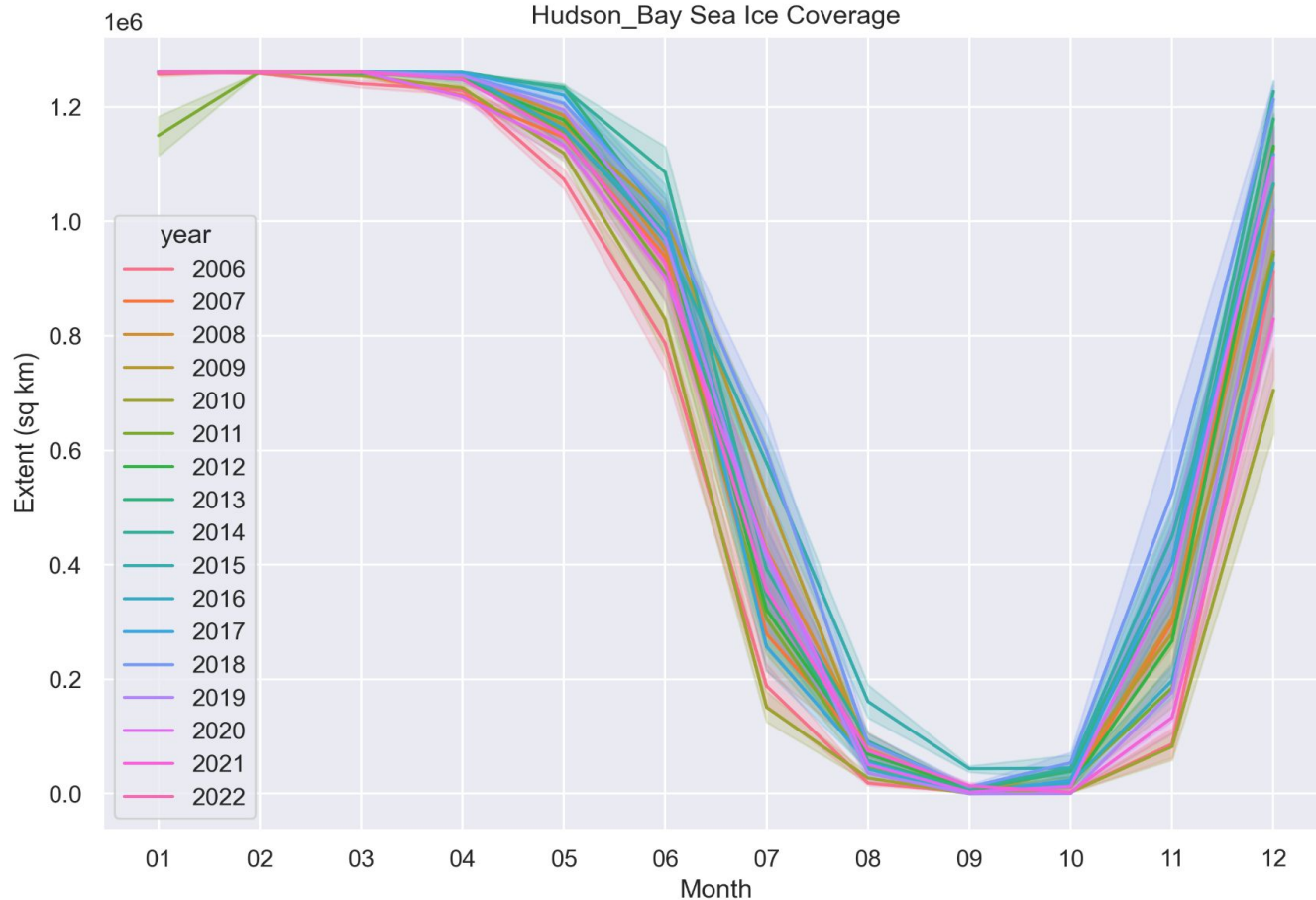


Sea of Okhotsk



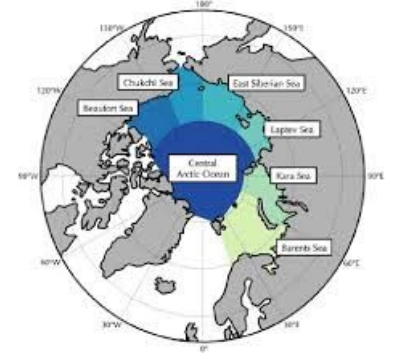
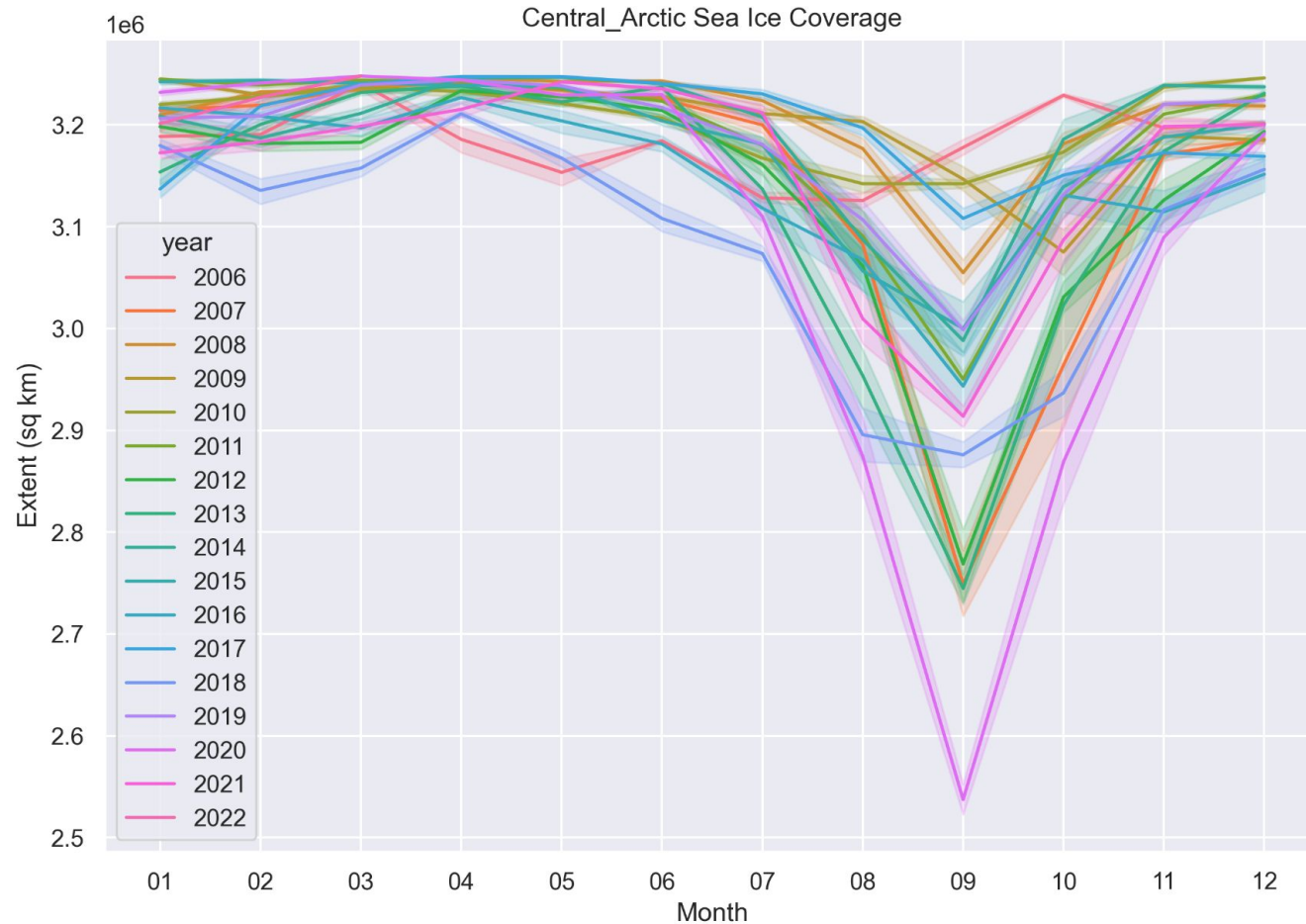
- Year-dependent deviation
- 2012 highest and 2015 lowest extent in winter
- Ice free in summer (July/August to October)

Hudson Bay



- Year-dependent deviation
- Nearly ice free in summer (August to October)
- Plateau in winter (February - March/April)

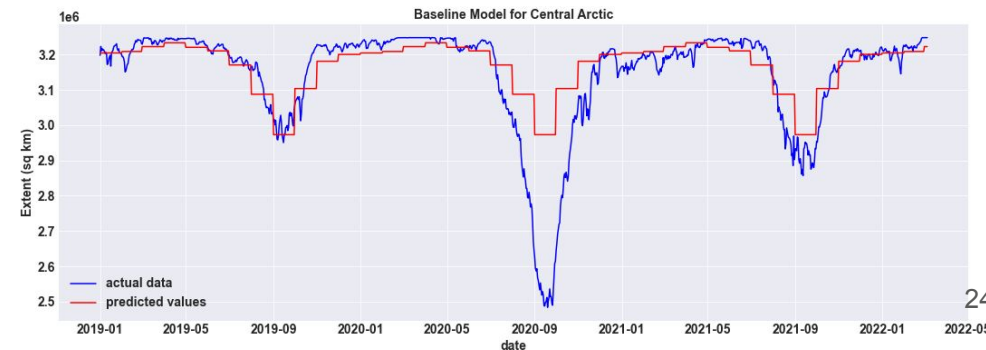
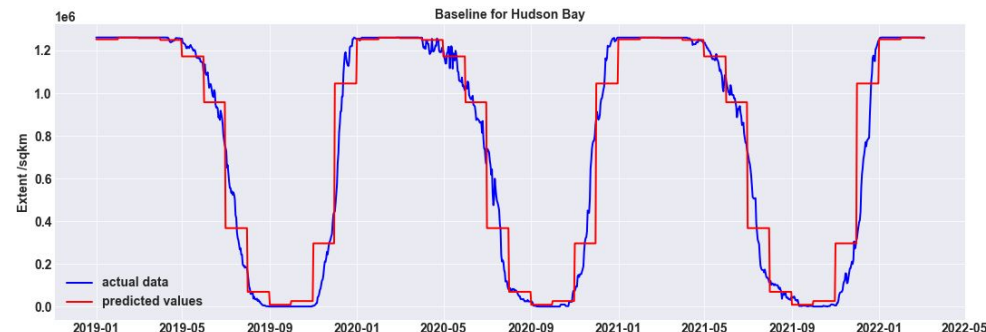
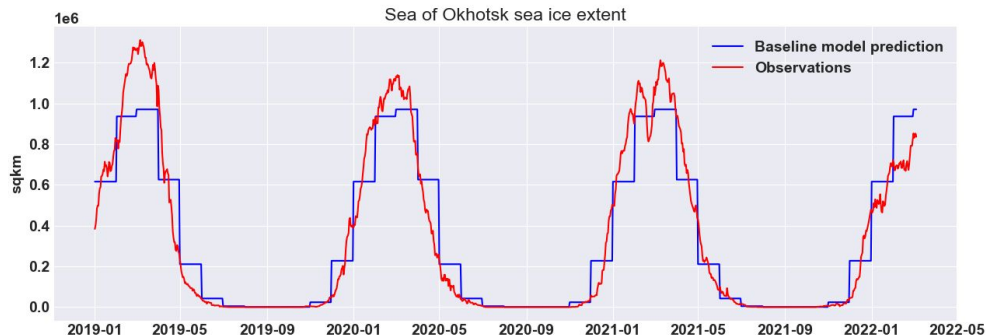
Central Arctic



- High variation of ice coverage in summer
- Lowest sea ice in september 2020

Baseline models for regions

- Monthly average for the train dataset (until 2018) as annual variation
- RMSE (Sea of Okhotsk): 121600 sqkm
- RMSE (Hudson Bay): 120400 sqkm
- RMSE (Central Arctic): 100200 sqkm

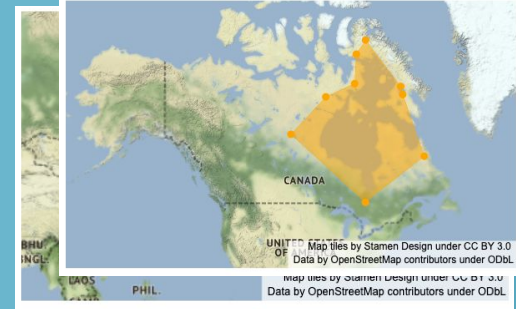
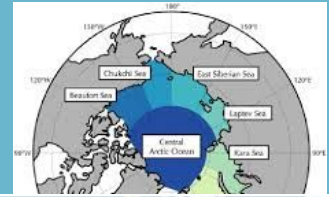


Neural Prophet

What has Changed from Prophet

NeuralProphet has a number of added features with respect to original Prophet. They are as follows.

- Gradient Descent for optimisation via using PyTorch as the backend.
- Modelling autocorrelation of time series using AR-Net
- Modelling lagged regressors using a sepearate Feed-Forward Neural Network.
- Configurable non-linear deep layers of the FFNNs.
- Tuneable to specific forecast horizons (greater than 1).
- Custom losses and metrics.



Regions of Interest

For the analysis of sea ice extent in different regions



- The Multisensor Analyzed Sea Ice Extent Data since 2006
- Important 16 Arctic regions
- 11 - Central Arctic
- 14 - Sea of Okhotsk
- 10 - Hudson Bay