The uncertainty estimate is based on a statistical model that incorporates a range of factors, including initial conditions and model physics. The model is designed to simulate the evolution of sea ice concentration and extent over time, taking into account various external influences such as atmospheric conditions and ocean dynamics.

The method uses data from multiple sources, including satellite observations, model simulations, and in-situ measurements. It involves a series of steps, such as data assimilation, model initialization, and forecasting. The model is run on a daily basis, and the results are compared against observed data to assess the accuracy of the predictions.

The results are then used to produce forecasts for the upcoming months, providing valuable information for stakeholders involved in planning and decision-making.

The model is continually improved and updated based on new data and advances in climate science.

For more information, please visit the official website: [modelwebsite.com](http://www.modelwebsite.com)
The Arctic sea ice extent September 2022 minimum is 4.06 ± 0.17 million square kilometers.

4.56 ± 0.25 million square kilometers.

The initial sea ice conditions in September 2022 were almost the same as the mean over the period of 1989-2020, but the raw melt extent was 0.14 ± 0.32 million square kilometers. The corresponding number for the previous year was 4.06 ± 0.17 million square kilometers, which is the minimum for the period of 1989-2022. For 2022, the Arctic sea ice extent September minimum is 4.06 ± 0.17 million square kilometers.

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### Lamont (Yuan and Li) UPenn-UQAM Group

IceNet1 Dynamic Model

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>Value 2</th>
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<tr>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Dynamic Model

**IceNet1**

- Independent machine learning component
- Predicts sea ice concentration (SIC) at all grid points in the pan-Arctic region
- Uses SIC, 11 climate variables, and SST as inputs
- Produces a small 2-member ensemble of 210-day forecasts
- Obtained from a learning stage during March and April with respect to June
- Evaluated using *NSIDC's Sea Ice Index (as all ice concentration product 430b) at https://www.nature.com/articles/s41467-021-25257-4. IceNet is a sea ice forecasting AI system which predicts pan-Arctic sea ice concentration at the seasonal time scale. IceNet is a part of the group's **UPenn-UQAM Group** which includes economists and other researchers in climate science.

**Ocean and sea ice are hard coupled. Atmosphere and sea ice are also hard coupled. The combined ocean/ice and atmosphere system is initialized using Met Office operational numerical weather prediction (NWP) 4D-Var data assimilation system [Rawlins et al., 2007]. The ocean setup is derived from the BOM model (SAF). A combination of historical station data and Global Land 7.0 configuration [Walters et al., 2019]. Initialised using the offline operational societal earth system (OSES) version 3.0 of the Met Office model system. The **IceNet1** component is coupled to the **NAOSIM** model [Hendricks et al., 2008] using Global Oceanic 7.0 configuration [Steele et al., 2019]. Initialised using the offline operational societal earth system (OSES) version 3.0 of the Met Office model system.

**NAOSIM**

- Integrated Global Ocean (IGOS) version 3.0
- Predicts ocean and sea ice concentration along with SST
- Initialization requires historical data from the September SIE and global average, and the Arctic amplification in surface air temperature, introducing a 0.10 longitude reduction in Northern sea ice. This loss of sea ice is in part due to melting of marginal ice, or above 80% (full ice). To compute the SIP map for each day, the September SIE bias is accounted for.

**Sea Ice**

- For the present outlook the coupled sea ice-ocean model NAOSIM has been run with prognostic sea ice concentration (SIC) and have been applied to Arctic SIC observations, and associated sea ice extent, and for the Arctic SIE forecast. The prediction has been performed using the **IceNet1** component.

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We estimate our uncertainty with root-mean-square-error (RMSE) calculated from 1979-2019 hindcast.

A multivariate linear Markov model is used to predict monthly sea ice concentration (SIC), from which sea ice extent prediction of monthly September 2021 in Arctic is calculated. The estimated September 2021 sea ice extent is predicted to be 4.63±0.51 million square kilometers, and the Alaskan regional SIE is predicted to be 0.71±0.25 million square kilometers.

The multivariate linear Markov model is a statistical model that combines principal component analysis and linear Markov model together. It can identify the large scale atmospheric and oceanic variability through principal component analysis and make linear Markov predictions. The model predicts time and space correlated time series data, and uses these Markov models to predict the target time series. Besides the parameters used in Yuan et al. (2016), e.g., sea ice concentration (SIC), sea surface temperature (SST), surface air temperature (SAT), here we further use monthly surface net radiation flux (NR) data from 1979 to 2019 to train our model. For this attempt, we use 2021 May monthly mean SIC data to initiate our model and make monthly SIC and SIE prediction.