Sea Ice Outlook
2020 August Report
Individual Outlook

Name of contributor or name of contributing organization:

IceNet1 (Andersson et al.)

Is this contribution from a person or group not affiliated with a research organization?

Name and organization for all contributors. Indicate primary contact and total number of people who may have contributed to your Outlook, even if not included on the author list.

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Do you want your June contribution to automatically be included in subsequent reports? (If yes, you may still update your contribution via the submission form.)

Include this submission in the August report only.

What is the type of your Outlook projection?

Other

Starting in 2017 we are accepting both pan-Arctic and pan-Antarctic sea ice extent (either one or both) of the September monthly mean. As in 2016, we are also collecting Alaskan regional sea ice extent. To be consistent with the validating sea ice extent index from NSIDC, if possible, please first compute the average sea ice concentration for the month and then compute the extent as the sum of cell areas > 15%.

a) Pan-Arctic September extent prediction in million square kilometers.

4.21

b) same as in (a) but for pan-Antarctic. If your method differs substantially from that for the Arctic, please enter it as a separate submission.

c) same as in (b) but for the Alaskan region. Please also tell us maximum possible extent if every ocean cell in your region were ice covered.

"Executive summary" of your Outlook contribution (using 300 words or less) describe how and why your contribution was formulated. To the extent possible, use non-technical language.

IceNet is an interdisciplinary data science project aimed at improving Arctic sea ice forecasts and understanding, with a team of both sea ice and computer science experts. IceNet is currently at version 1, and the model is called IceNet1. The design of IceNet1 is inspired by AI Γ ÇÖs ability to automatically learn complex relationships between variables from large amounts of raw data. In particular, IceNet1 takes the form of a U-Net architecture - a model that receives image inputs and produces image outputs - which has achieved widespread success in medical imaging segmentation problems. IceNet1 is trained to predict the future 12 months of spatial pan-Arctic sea ice classification maps based on the past 12 months of SIC, as well as the past few months of other climatological variables (such as atmosphere and ocean temperature anomalies, sea level pressure, and surface wind). IceNet1 was presented at a SIPN2 Webinar, available from this link at 35.07: https://youtu.be/l-R8PNL5Hdo?t=2107. Note that at the time of writing IceNet is under continual development and results from a research project funded by the Alan Turing Institute Γ ÇÖs Data Science for Science programme.

Brief explanation of Outlook method (using 300 words or less).

At each 25x25 km ocean grid cell in the Arctic and at each forecast leadtime from 1 to 12 months ahead, IceNet1 produces a probability that the SIC will be less than 15% (no ice), between 15% and 80% (marginal ice), or above 80% (full ice). To compute the sea ice probability (SIP) for this SIO submission, we sum the probability of the two ice classes to obtain the probability that SIC > 15%. To compute the SIE, we sum the area of grid cells whose SIP > 0.5. IceNet learns to predict sea ice through gradient descent optimisation with over 10 million free parameters. This process is called training, and attempts to minimise the error between

predictions and reality over a training dataset. To account for the limited amount of observational months available, we leverage >10,000 months of climate model data by pre-training IceNet1 on historical and future scenario runs from the MRI-ESM2.0 climate model, a concept known as transfer learning. After pre-training, we fine-tune IceNet1 Γ ÇÖs parameters on the observational data record from 1979-2011. We use NSIDC NASA Team for the SIC data and ERA5 reanalysis for the climatological data. The observational data period from 2012-2017 is held out and used to assess IceNet1 Γ ÇÖs hindcast predictive skill during the development process. IceNet1 contains over 43 million trainable parameters and comprises an ensemble of four neural networks trained with different parameter initialisations. The ensemble member predictions are averaged to produce the final prediction.

Tell us the dataset used for your initial Sea Ice Concentration (SIC).

NSIDC NASA Team, https://nsidc.org/data/nsidc-0081, https://doi.org/10.5067/U8C09DWVX9LM.

Tell us the dataset used for your initial Sea Ice Thickness (SIT) used. Include name and date.

If you use a dynamic model, please specify the name of the model as a whole and each component including version numbers and how the component is initialized:

[DynamicModelType]

If available from your method.
a) Uncertainty/probability estimates:

Median

Ranges

3.74-4.68

Standard Deviations

0.47

b) Brief explanation/assessment of basis for the uncertainty estimate (1-2 sentences).

This is the standard deviation of the September SIE error when initialised in August, computed over the 6 held-out validation years from 2012-17

c) Brief description of any post processing you have done (1-2 sentences).