DovekSIE: a statistical model based on sea ice export through the Fram Strait

Contributor names & affiliations:

Charles Brunette[1], Bruno Tremblay[1], Erik Johnson[2]
[1]McGill University, Montreal, Canada
[2]University of Otago, Dunedin, New Zealand

Contact: charles.brunette@mail.mcgill.ca

SIO reporting schedule:

Include this submission in all three of the monthly reports (June, July, and August)

Type of your Outlook projection:

Statistical

2021 Outlook:

Pan-Arctic September monthly SIE: ***3.89 million km²***
September SIE from the trend: ***3.96 million km²***
September SIE anomalie: ***-0.07 km²***

Executive summary of our Outlook contribution:

Our research focuses on seasonal predictability of sea ice in the Arctic Ocean, using observations-based approaches. We are interested in the winter preconditioning effect on the pack ice before the summer melt. Specifically, we investigate how dynamic processes affect preconditioning, in other words, we ask how anomalies in the general circulation of sea ice will influence later conditions of the Arctic Ocean pack ice under a typical melt season. We investigate the skill of different sea ice predictors, including atmospheric forcing parameters that physically connect to wintertime sea ice dynamics.

The dovekSIE method builds on the correlation between winter Fram Strait sea ice export and the following September sea ice extent, via the mechanism of dynamical preconditioning (Williams et al., 2016; Brunette et al., 2019, Kim et al., 2021). A positive anomaly of the winter Fram Strait sea ice export is associated with enhanced circulation of ice through the Transpolar Drift Stream and positive anomalies of coastal divergence of sea ice along the Eurasian coastlines. Increased coastal divergence late in the winter causes anomalies of younger and thinner ice in the peripheral seas, which is more vulnerable to melting in the summer.

The dovekSIE forecasts are generated using the sea level pressure difference between Greenland and Svalbard as a proxy for area of ice exported through Fram Strait. Sea ice tends to flow parallel to isobars and the pressure difference across Fram Strait correlates with sea ice export (r=0.44). Sea level pressure fields are available in near-real-time and therefore enable the continuous update of dovekSIE forecasts during winter via the web app.

We are supporting the activities of the Sea Ice Prediction Network with great enthusiasm. This is our fifth contribution to the Sea Ice Outlook.

Brief explanation of the method:

The dovekSIE prediction for the 2021 monthly mean September ice extent is 3.89 million km^2. The dovekSIE prediction is computed as a sum of the linear trend (climatology) and departure from the trend (interannual variability). We take the long-term linear trend in a time series of the monthly mean September sea ice extent over the 1993-2020 period. The value of the linear trend for the September 2021 monthly sea ice extent is 3.96 million km^2. A negative departure from the trend of -0.07 million km^2 is projected for the September 2021. We use the integrated sea level pressure difference across Fram Strait from November 1 to May 31 in a linear least squares fit model as a predictor for the anomaly of monthly mean September sea ice extent.

Initial SIC/SIT datasets:

Sea ice concentration is not used as an initial condition (such as in a dynamical model). However, we use sea ice extent from the NSIDC Sea Ice Index to fit our statistical model.

Uncertainties / probabilities estimates

RMSE: 0.46 million km^2

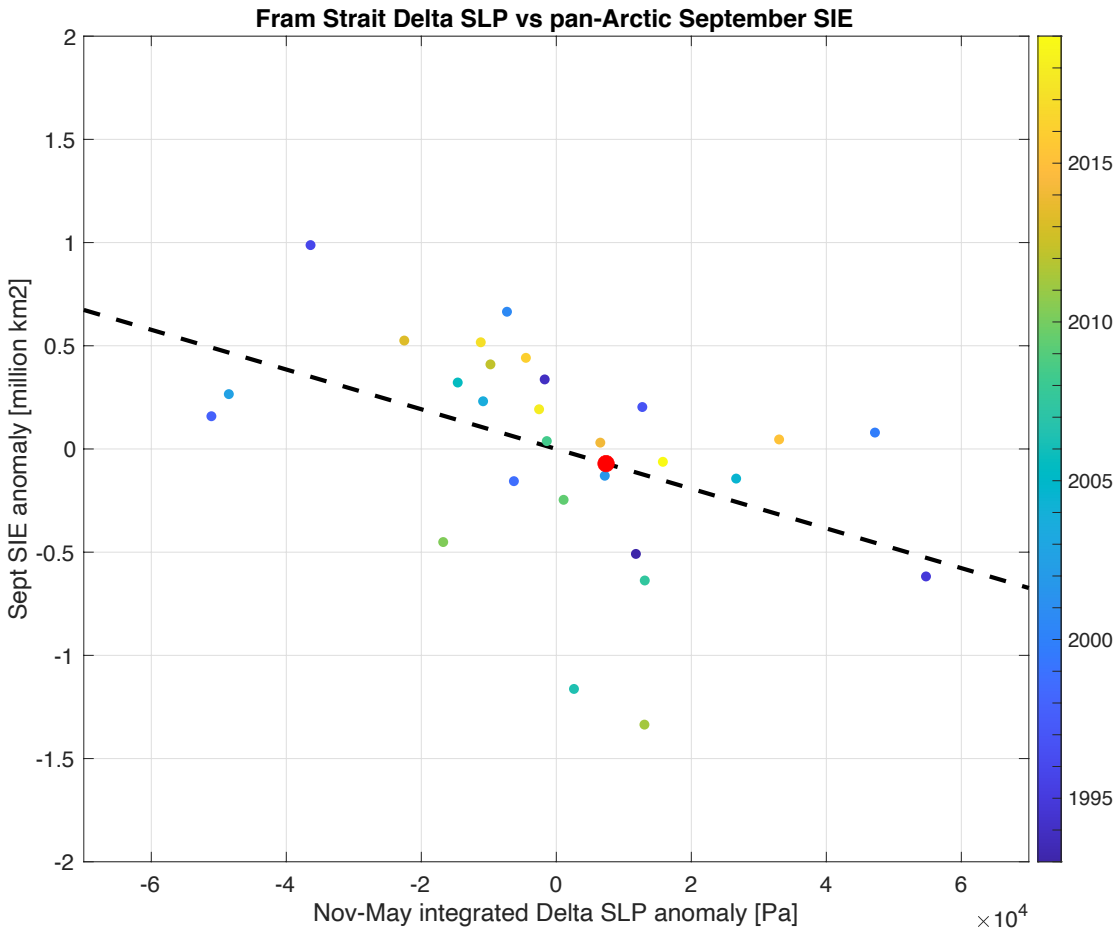
We compare hindcasts to the observed mean September sea ice extent for the 1993-2020 period and calculate the root mean squared error.

References:

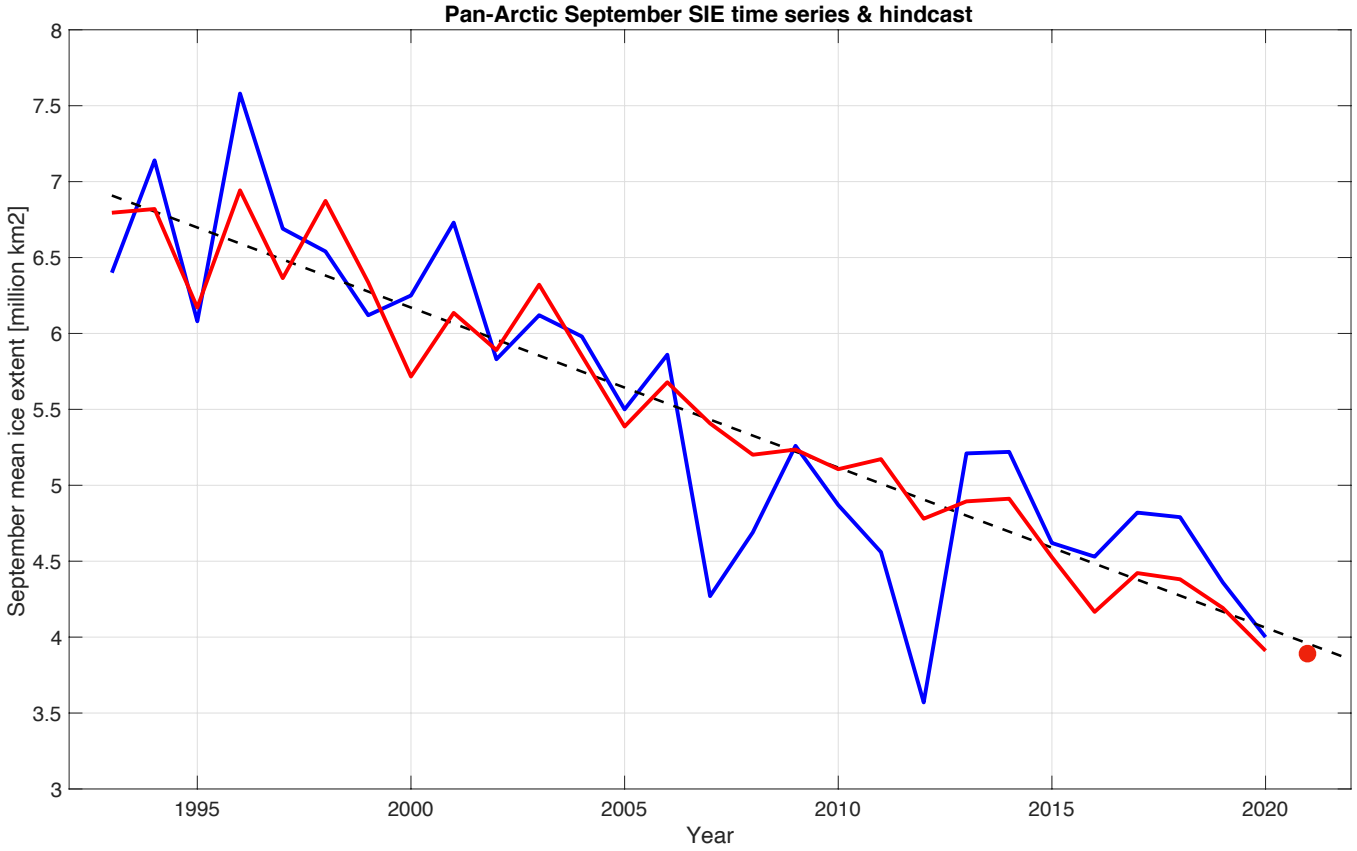
Williams, J., Tremblay, B., Newton, R., & Allard, R. (2016). Dynamic preconditioning of the minimum September sea-ice extent. Journal of Climate, 29(16), 5879-5891, doi: 10.1175/JCLI-D-15-0515.1

Brunette, C., Tremblay, B., & Newton, R. (2019). Winter coastal divergence as a predictor for the minimum sea ice extent in the Laptev Sea. *Journal of Climate*, *32*(4), 1063-1080, doi: 10.1175/JCLI-D-18-0169.1

Kim, R., Tremblay, L. B., Brunette, C., & Newton, R. (2021). A Regional Seasonal Forecast Model of Arctic Minimum Sea Ice Extent: Reflected Solar Radiation versus Late Winter Coastal Divergence. *Journal of Climate*, *34*(15), 6097-6113, doi: 10.1175/JCLI-D-20-0846.1



Scatter plot of the anomaly of the time integrated sea level pressure difference between Greenland and Svalbard and the anomaly of the mean pan-Arctic September sea ice extent. The coefficient of correlation between the two is r=-0.45. The dashed line represents the best linear fit going through zero. The red dot indicates the sea level pressure difference anomaly for 2021.



Time series of observed mean September sea ice extent (blue) and dovekSIE hindcasts (red) over the 1993-2020 period. The dashed black line indicates the 1993-2020 mean September sea ice extent trend based on the observations. The red dot represents the September 2021 forecast (3.89 million km^2).