Sea Ice Outlook
2017 July Report
Individual Outlook

Name of contributor or name of contributing organization:

Lamont (Yuan 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.

Xiaojun Yuan (primary contact), Cuihua Li and Lei Wang

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

What is the type of your Outlook projection?

Statistical

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.

5.14

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.

20.41

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.

A Linear Markov model is used to predict monthly Arctic sea ice concentration (SIC) at all grid points in the pan Arctic region. The model is a stochastic linear inverse model that is built in the multi-EOF space and is capable to capture the co-variability in the ocean-sea ice-atmosphere system. September pan Arctic sea ice extent is calculated from predicted sea ice concentration. The model predicts negative SIC anomalies throughout the pan Arctic region. Large negative sea ice concentration anomalies (larger than -40%) will occur in the Chukchi Sea, E. Siberian Sea and Laptev Sea; and moderate negative anomalies (-24% to -40%) in the Kara Sea in September 2017. Negative SIC anomalies in other areas will be smaller than 24%. These anomalies are relative to the 1979-2012 climatology. The September mean pan Arctic sea ice extent (SIE) is predicted 5.14 million squared kilometers with a RMSE of 0.61 million square kilometers. The September mean pan Antarctic SIE is predicted to be 20.41 million square kilometers with RMSE of 1.75 million square kilometers by a similar linear Markov model.

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

The linear Markov model has been developed to predict sea ice concentrations in the pan Arctic region at the seasonal time scale. The model employs 3 variables: NASA Team sea ice concentration, sea surface temperature (ERSST), and surface air temperature (NCEP/NCAR reanalysis) for the period of 1979 to 2012. It is built in multi-variate EOF space. The model utilizes first 11 mEOF modes and use a Markov process to predict these principal components forward one month at a time. The pan Arctic sea ice extent forecast is calculated by summarizing all cell areas where predicted sea ice concentration exceeds 15%. Bias corrections have been applied to ice concentration predictions at grid points as well as the total sea ice extent prediction. The predictive skill of the model was evaluated by anomaly correlation between predictions and observations, and root-mean-square errors (RMSE) in a (take one-year out) cross-validated fashion. On average, the model is superior to the predictions by anomaly

persistence, damped anomaly persistence and climatology (Yuan et al, 2016). For the three-month lead prediction of September sea ice concentrations, the model has higher skill (anomaly correlation) and lower RMSE in the Chukchi Sea and Beaufort Sea than in other regions. The skill of the three-month lead prediction of the pan Arctic sea ice extent in September is 0.78 with a RMSE of 0.61 million squared kilometers.

Tell us the dataset used for your initial Sea Ice Concentration (SIC). Include name and date (e.g., "NASA Team, May 2017"). We also encourage you to submit initial fields to the dropbox, see https://www.arcus.org/sipn/sea-ice-outlook/2017/june/call in the section on "Submitting Figures and Gridded Data of Full Spatial Fields (Optional) of Forecasts and Initial Conditions" for detailed instructions. Required if sea Ice concentration is used.

We used NASA Team sea ice concentration in June 2917 to initialize the prediction.

Dataset of initial Sea Ice Thickness (SIT) used (include name and date):

N/A

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:

N/A

If available from your method for pan-Arctic extent prediction, please provide

a) Uncertainty/probability estimate such as median, ranges, and/or standard deviations (specify what you are providing).

The forecast uncertainty is measured by RMSE. The RMSE of the September Arctic SIE 3-month lead prediction is 0.61 million square kilometers. The RMSE of the September Antarctic SIE 3-month lead prediction is 1.75 million square kilometers.

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

Cross-validated experiments of 3-month lead forecasts for September Arctic SIC were performed over 34 years with bias correction at grid points. The September Arctic SIE was then calculated from the SIC predictions and predicted SIE bias was corrected through a linear regression fit of prediction errors as function of initial conditions. The bias between model grid and observation

grid was then corrected. The uncertainty (RMSE) was calculated based on on 34 years of predicted and observed September SIEs. For the Antarctic SIE prediction, the RMSE was estimated from the errors of the last ten years of forward predictions and observations, which is 1.75 million square kilometers.

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

The predictions of Arctic SIC anomalies were corrected for biases at grid points and combined with climatology to generate SIC forecasts. The SIE forecast was then constructed (area of SIC > 15%) from predicted SIC and SIE biases were corrected to form the final prediction.