Sea Ice Outlook
2018 June Report
Individual Outlook

Name of contributor or name of contributing organization:

UNCW (McNamara & Wagner)

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

No

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.

Dylan McNamara and Till Wagner* (both University of North Carolina Wilmington, Department of Physics and Physical Oceanography)

*primary contact

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.)

No

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.

4.61

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.

We use a so-called genetic algorithm to predict the September sea ice extent. The algorithm is based on a non-linear forecasting technique that focuses on past system behavior to predict future states. As input to the algorithm we provide following variables: 1) Sept sea ice extent of the past 2 years, 2) May sea ice extent this year (2018), 3) mean Surface Air Temperature over the past year (June - May), measured at 6 Arctic Meteorological stations, and 4) mean SST north of the Arctic circle over the past year (June - May). Following a set of 'genetic' rules, and training itself on the 35-year time period from 1983-2017 (when data of all 4 variables is available), the algorithm identifies a combination of the variables that best predicts future Sept sea ice extents.

The algorithm identifies the following map as most predictive:
SIE(t) = 0.89*(SIE(t-1)-0.64) + SIE(t-2) / ((SST(t)+SIE(t-1))*SIE(t-1)/SIE(t-2)).

Here t is the year (in this case 2018), SIE is Sept sea ice extent, and SST is Arctic mean sea surface temperature (June 201- May 2018). The first term represents a linear trend from the previous trend (89% of last year's SIE with 0.64 loss, in million km^2). The second term is an adjustment that depends on SST (and previous Sept SIE). As SST gets larger (warmer), the denominator in the second term gets larger, thus making the fraction smaller, and the amount added to the first term decreases.

We note that this map does not make use of May 2018 sea ice conditions (nor SATs).

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

The algorithm relies on the deterministic nature of the system dynamics (as opposed to dynamics dominated by noise). This aspect of determinism can be expressed by relating values of the time series at a time t, to previous values in the time series through a nonlinear map (Takens, Springer, 1981).

The map function is typically not known a priori and a systematic search through all possible map functions is not feasible. A genetic algorithm has been proposed as a tool that looks for such a map function (Szpiro, Phys Rev E, 1997; Lopez et al, PRL, 2000).

The genetic algorithm optimizes the accuracy of possible prediction equations by evolving a group of potential solutions for the map function and selecting those that best represent the observed data. More specifically, the genetic algorithm produces an initial population of solutions and then tests them on the data to see how accurately they predict changes. Those with the best prediction accuracy, or fitness, are copied and then allowed to reproduce with their choice of mate equations left in the population of solutions, while those with the worst fitness are discarded. Mutations occur in a fraction of the reproduced equations. These steps are repeated until an equation is found that optimizes predictability. Previously, the genetic algorithm has been successfully applied to predicting an artificially generated chaotic time series and to predicting the occurrence of sunspots in a physical data set. Other natural time series that have been predicted with this technique include summer rainfall over India (Kishtawal et al., GRL, 2003), Indian Ocean wave heights (Basu et al. , GRL, 2005), and coastline change (Grimes et al., Chaos, 2016). Here we explore the algorithm's ability to forecast the September sea ice extent.

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

We didn't use SIC fields, only the monthly Sea Ice Index.

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:

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

Median

Ranges

Standard Deviations

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

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