Walt Meier, NSIDC, September 2024 Sea Ice Outlook Contribution

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Executive Summary: This method applies daily ice loss rates to extrapolate from the start date (September 1) through the end of September. Projected September daily extents are averaged to calculate the projected September average extent. Individual years from 2005 to 2023 are used, as well as averages over 1981-2010 and 2007-2023. The 2007-2023 average daily rates are used to estimate the official submitted estimate.

The predicted September average extent for 2024 is 4.31 (±0.10) million square kilometers. The minimum daily extent is predicted to be 4.18 (±0.10) million square kilometers and occurs on 16 September. These numbers are substantially (~500,000 square kilometers) above the August submission, indicative of slower ice loss during August. The range of the estimates has decreased, which reflects less potential variability in ice loss rates over the final month of the melt season. Based on the last 19 years (2005-2023), there is a 0% chance that 2024 will be lower than the current record low September extent of 3.57 million sq km in 2012.

Using the same method, the predicted Antarctic average extent for September 2024 is 17.10 (±0.25) million square kilometers. The maximum daily extent is predicted to be 17.18 (±0.29) million square kilometers and occurs on 27 September. These are also substantially higher than the August prediction.

Outlook type: Statistical

Initial SIC data set used: NASA Team algorithm extents from the NSIDC Sea Ice Index, Version 3 (http://nsidc.org/data/seaice_index/).

Initial SIT data used: N/A

Prediction of September pan-Arctic extent: 4.31 (±0.10) million square kilometers
Prediction of September pan-Antarctic extent: 17.11 (±0.25) million sq km

September pan-Arctic Anomaly Forecast: +0.18 million square kilometers (2024 trend extrapolation value = 4.13 million square kilometers)

Prediction of week that minimum daily extent will occur: Week of 12 September (specific day predicted is 16 September).

Outlook Description: This method applies daily ice loss rates to extrapolate from the start date (September 1) through the end of September. Projected September daily extents are averaged to calculate the projected September average extent. Individual years from 2005 to 2023 are used, as well as averages over 1981-2010 and 2007-

2023. The 2007-2023 average daily rates are used to estimate the official submitted estimate. The method essentially provides the range of September extents that can be expected based on how the ice has declined in past years, though it is possible that record fast or slow daily loss rates may yield a value outside the projected range. It also can provide a probability of a new record by comparing how many years of loss rates yield a record relative to all years. It has the benefit that it can easily and frequently (daily if desired) be updated to provide updated estimates and probabilities and as the minimum approaches the "window" of possible outcomes narrows.

Detailed Description and Discussion

This method is a simple statistical method that uses previous years' daily rates of extent change to project the 2024 daily extent through the end of September. The monthly average is then calculated from the September daily extents. This year, the last 17 years (2007 – 2023) are used for the projection because these years are more representative of recent conditions than using all years in the 45-year time series.

Year	September Extent	Daily Minimum Extent
2005	4.36	4.24
2006	4.30	4.11
2007	4.18	4.05
2008	4.24	4.14
2009	4.37	4.23
2010	4.16	3.92
2011	4.37	4.17
2012	4.36	4.19
2013	4.36	4.19
2014	4.27	4.08
2015	4.49	4.33
2016	4.52	4.21
2017	4.41	4.27
2018	4.28	4.14
2019	4.29	4.12
2020	4.24	4.07
2021	4.31	4.13
2022	4.22	4.03
2023	4.20	4.05
Average 2007-2023	*4.31*	*4.18*
Average 1981-2010	*4.36*	*4.24*

Table 1. Predicted 2024 September extent and daily minimum extent using ice loss rates from different years or multi-year averages. Values in **bold** represent cases that would set new record lows.

This method yields a September 2024 extent of 4.31 (±0.10) million square kilometers. This is substantially higher (~500,000 sq km) than the August estimate, reflecting relatively slower August ice loss. The relatively range in values, calculated from the standard deviation of the 17 years, has narrowed is due to the limited amount of variability in daily extent change rates between 1 September and 30 September. Using the standard 30-year 1981-2010 climatology, the projected September extent is 4.36 million sq km. The lowest projected extent (from the last 19 years), which is from the 2010 rates, is 4.26 million sq km, while the highest, from 2016 rates, is 4.52 million square kilometers. The daily extent trajectories for the two averages and the high and low years from the last decade are provided in the figure below and the prediction using the rates for each of the last 19 years are provided in Table 1.

The expected skill by early September is greater than earlier months because the time window of potential variability is closing. The method now provides a reasonable envelop of physically realistic September extents, with a small range (0.1 million square kilometers) of variability.

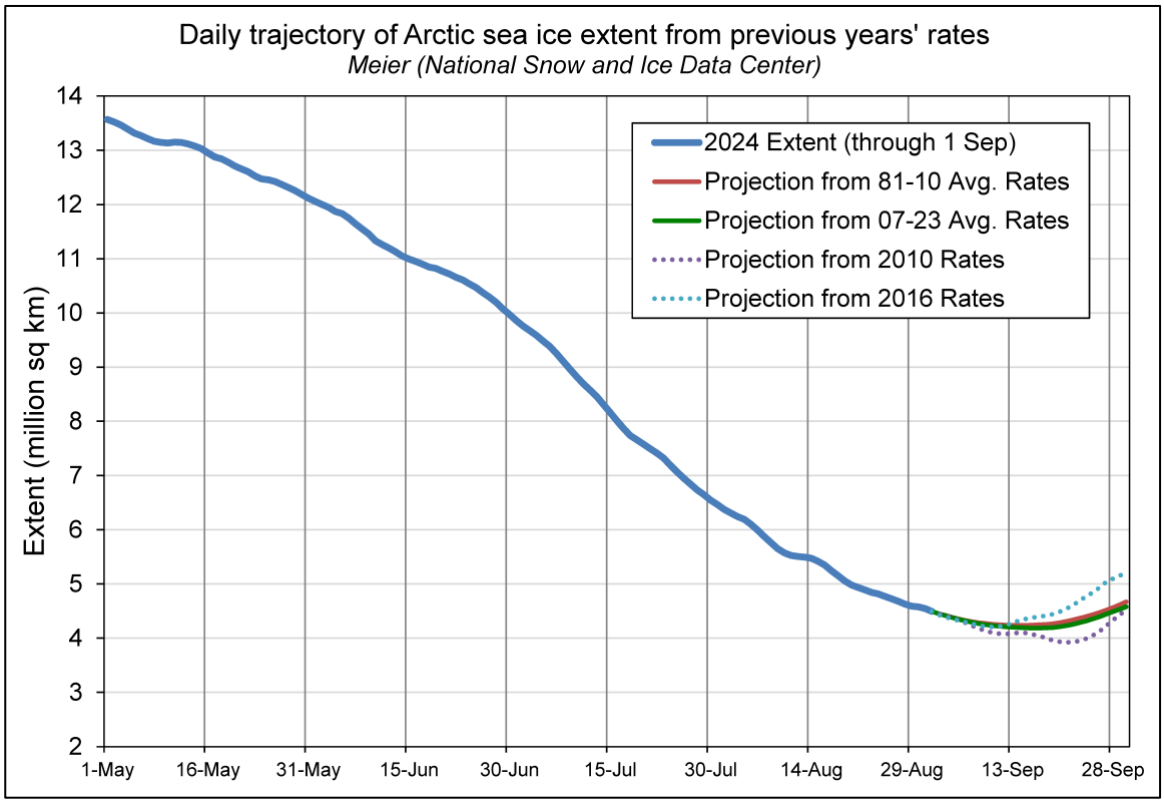

Figure 1*. Predicted Arctic trajectories from the 1 September observed extent. The official estimate is based on the projection used the average of the last 17 years (2007-2023, green solid line) and for the 1981-2010 average (solid red line). The rates for 2016 and 2010 (dotted lines) yield the highest and lowest predicted extents respectively.*

We use the same methodology for the Antarctic. However, since the trend has not particularly accelerated there isn't a reason to use any particular subset of years. It

is clear from Figure 2 that there is very little difference between using the thirty-year average versus the 16-year (2007-2023) average employed for the Arctic. So, the projection for the Antarctic is based on the daily rates of change for the 2007-2023 average to be consistent with the Arctic. The highest project results from using 2012 rates and the lowest projection comes from 2016 rates.

Using the 2007-2023 rates, the projected Antarctic September average is 16.48 (±0.36) million square kilometers. This is a substantial decrease from the July estimate. Over the last 19 years, the highest September extent of 17.06 million square kilometers came from using 2020 rates, and the lowest September extent, using 2008 rates is 16.20 million square kilometers. The very large spread between the highest and lowest is not surprising given the high interannual variability in Antarctic sea ice. Since the Antarctic sea ice at its maximum encircles the entire continent over a thousand kilometers from the coast in most regions, even relatively small differences in ice edge location can result in large differences in total area. The maximum daily extent is predicted to be 16.56 (±0.35) million square kilometers and occurs on 27 September.

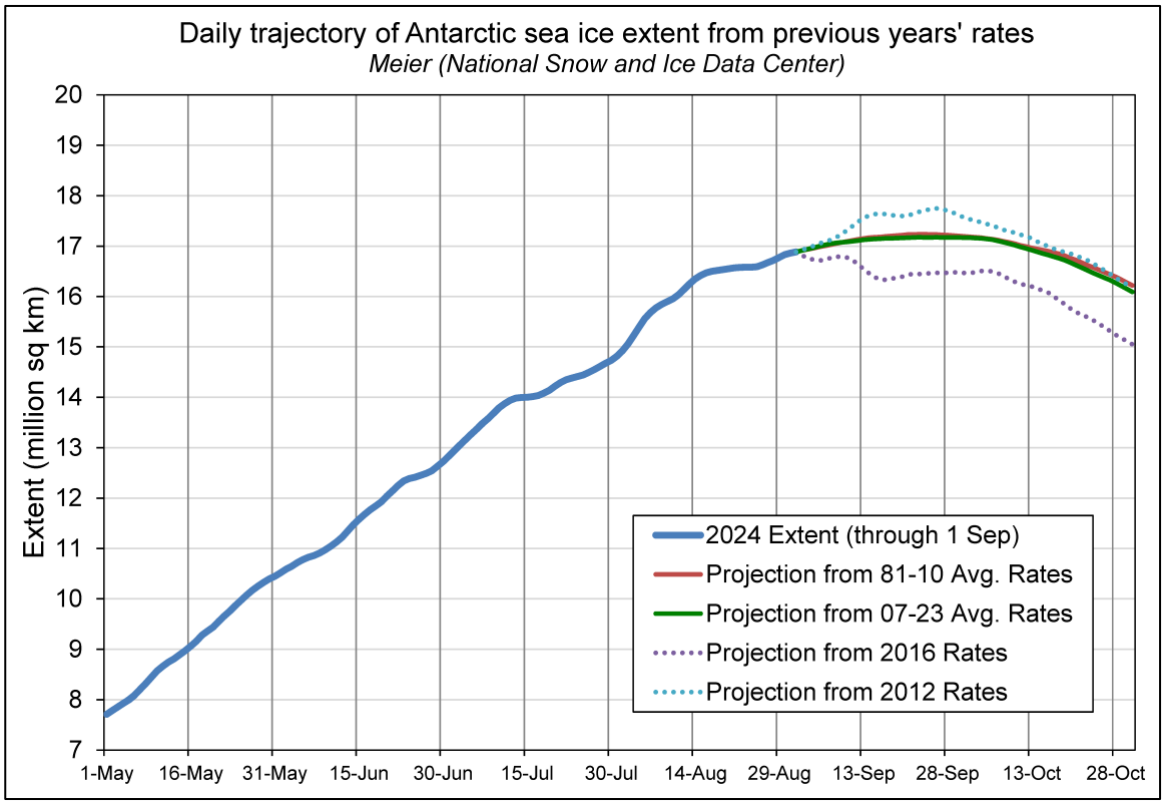

Figure 2. *Predicted Antarctic trajectories from the 1 September observed extent. The official estimate is based on the projection used the average of the last 17 years (2007-2023, green solid line) and for the 1981-2010 average (solid red line). The rates for 2012 and 2016 (dotted lines) yield the highest and lowest predicted extents respectively.*

Input Data Set References

Maslanik, J. and J. Stroeve. 1999, updated daily. Near-Real-Time DMSP SSMIS Daily Polar Gridded Sea Ice Concentrations, Version 1. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/U8C09DWVX9LM.

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