



National Snow and Ice Data Center
ADVANCING KNOWLEDGE OF EARTH'S FROZEN REGIONS

Sea Ice Index Version 4 Analysis

Special Report #28

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Summary

In June 2025, NSIDC was informed that access to data from the Special Sensor Microwave Imager/Sounder (SSMIS) onboard the Defense Meteorological Satellite Program (DMSP) satellites would end on July 31 (NSIDC, 2025). To prepare for this, we rapidly developed version 4 of the Sea Ice Index. This new version transitions from using sea ice concentration fields derived from SSMIS data as input to using fields derived from the Advanced Microwave Scanning Radiometer 2 (AMSR2) sensor onboard the Global Change Observation Mission - W1 (GCOM-W1) satellite.

On 29 July 2025, we learned that the Defense Department decision to terminate access to DMSP data had been reversed and that data will continue to be available until September 2026. We are publishing Version 4, however, for these reasons:

- The SSMIS instruments are well past their designed lifespan and a transition to AMSR2 is inevitable. Unless the sensors fail earlier, the DoD will formally end the program in September 2026.
- Although access of SSMIS will continue through September 2026, the Fleet Numerical Meteorology and Oceanography Center (FNMOC), where SSMIS data from the DMSP satellite are downloaded, made an announcement that “Support will be on a best effort basis and should be considered data of opportunity.” This means that SSMIS data will likely contain data gaps.
- We have developer time to make this transition now and may not in the future.
- We are confident that Version 4 data are commensurate in accuracy to those provided by Version 3.

Sea Ice Index data are images of ice extent and ice concentration along with hemisphere-wide sea ice extent and area values. Other NSIDC products and tools, like those used by the [Sea Ice Today](#) site, use Sea Ice Index data.

Switching to AMSR2 as the input data source has slightly changed the sea ice extents that are calculated compared to what they would be from SSMIS. For the 1 January 2025 through 30 June 2025 period, the magnitude of the changes for each hemisphere are the following:

- Northern Hemisphere: The maximum differences are less than 0.2 mil km² with an average difference of 0.05 mil km².
- Southern Hemisphere: The maximum differences are less than 0.15 mil km² with an average difference of 0.04 mil km².

Below is a list of the main changes in Sea Ice Index Version 4.

Main Changes

- **AMSR2 data are used as input for the Sea Ice Index data record of images and extent/area numbers beginning on 1 January 2025:**
Sea Ice Index Version 4 will use the [AMSR2 Daily Polar Gridded Sea Ice Concentrations \(NSIDC-0803\)](#) data set (Stewart et al., 2025b) as input beginning 1 January 2025. Although SSMIS data continue later into the year, NSIDC chose to begin the AMSR2 record for the Sea Ice Index on 1 January 2025 so that we do not change sensors during the Arctic melt season. See [How AMSR2 Data Differ from SSMIS Data](#) section for details.
- **Elimination of the distinction between near-real-time (NRT) and final data:**
In previous versions of the Sea Ice Index, there were two input streams: NRT SSMIS sea ice concentrations and final SSMIS sea ice concentrations. The NRT input provided data quickly with a 1-day latency but could have spatial and temporal gaps and occasional spurious ice retrievals that were not removed by automated filters. The final input was available at approximately 6-to-12-month latency. NASA investigators manually removed erroneous data and filled data gaps, providing a more complete and “cleaner” product. When final data became available, NSIDC would reprocess the Sea Ice Index and release the final data.

For version 4, there is only one input data stream because there are no equivalent AMSR2 NRT and final input products. For images dated 1 January 2025 to present, the “near-real-time” and “final” designations that are present in the Version 3 images are not needed in the Version 4 images and so do not appear (See Figure 4 and Figure 7). However, images older than 1 January 2025 still say “final” because these were not reprocessed with the Version 4 release.

- **Temporal interpolation to fill gaps:**
The AMSR2 input data stream of gridded sea ice concentration fields sometimes has gaps due to missing data. To address this, Sea Ice Index processing fills gaps using temporal interpolation. The code checks for grid cells with missing data and then fills those grid cells with the average concentration using the concentration values from the day before the missing data and the day after. The now gap-filled fields are processed to create the Version 4 Sea Ice Index images and GeoTIFFs. Figure 1 shows an example of a Sea Ice Index ice concentration map image produced from AMSR2 data both without and with gap filling.

Note that when a day is first processed, only data for the previous day exists. If a gap is detected, the gap is simply filled with the concentration value from the previous day. On the next day, that gap is reprocessed with the average concentration from the day before and the day after to deliver a more accurate concentration estimate for that gap. Thus, there may be small changes in daily extent and area values a day after data is originally published.

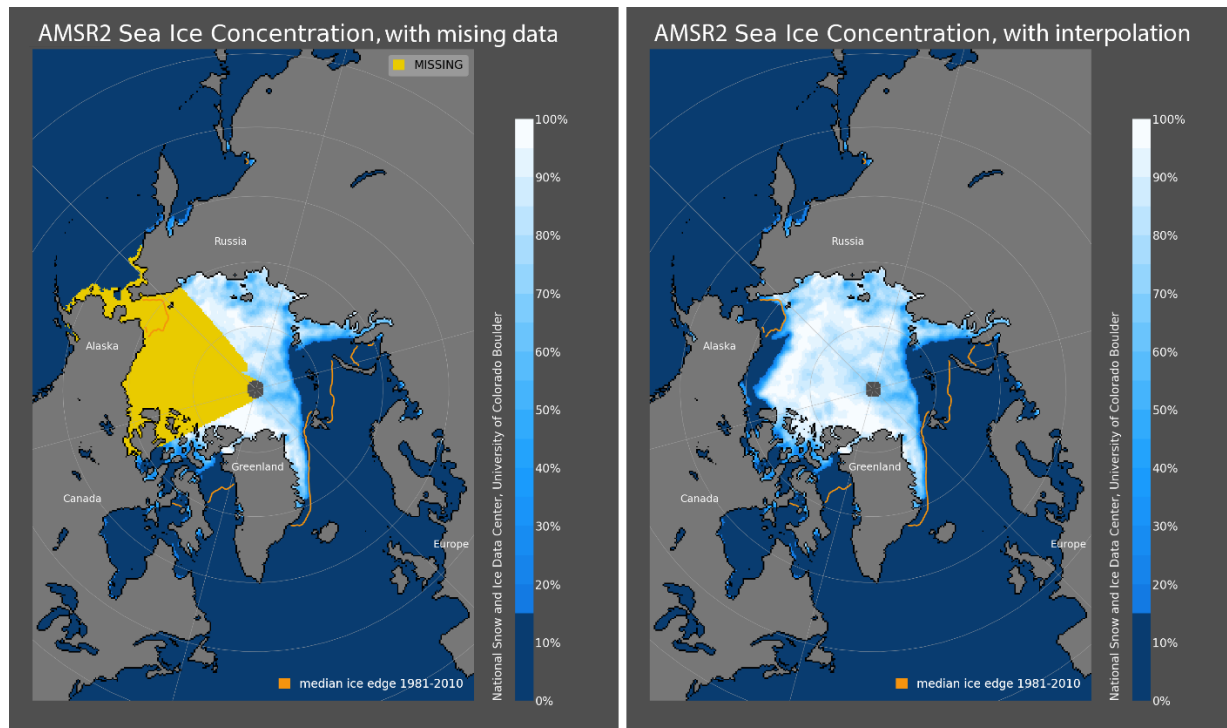


Figure 1. Sea Ice Index ice concentration images made from AMSR2 input fields with missing data (left) and with temporally interpolated data (right) for 30 October 2024. Note that this date is outside the period where AMSR2 is used in this product. This is simply an example to show the interpolation.

- **Small change in pole hole size for the Arctic:**

The Arctic pole hole for the AMSR2 data is slightly larger and has a different shape than the SSMIS one. This is due to the resampling of AMSR2 brightness temperature data to make it more like SSMIS brightness temperature data. This resampling happens in the production of the [AMSR2 Daily Polar Gridded Brightness Temperatures \(NSIDC-0802\)](#) data set (Stewart et al., 2025a). NSIDC-0802 is used to make NSIDC-0803, which in turn is the input for the Sea Ice Index Version 4. See [How AMSR2 Data Differ from SSMIS Data](#) section for details. Figure 2 shows the SSMIS and AMSR2 pole holes.

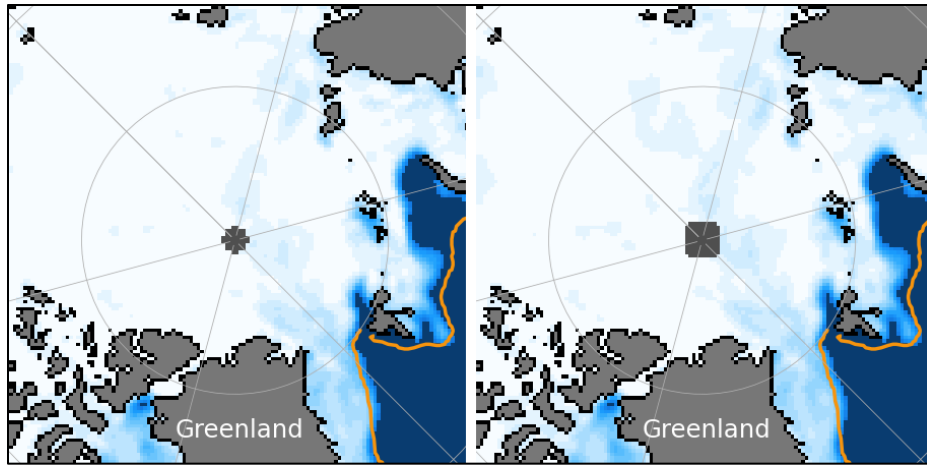


Figure 2. Difference between the SSMIS pole hole (left) and the AMSR2 pole hole (right) for 15 March 2025.

How AMSR2 Data Differ from SSMIS Data

Each channel of the AMSR2 instrument has a smaller instantaneous field of view (IFOV), and thus smaller sensor footprint, than similar-frequency SSMIS channels. See Table 2 in Meier et al. (2024), for a listing of these IFOVs. This smaller sensor footprint means that to add AMSR2 sea ice concentrations to the Sea Ice Index, AMSR2 had to be adjusted to match SSMIS's coarser resolution.

The AMSR2 sea ice concentration data used as input to the Sea Ice Index comes from NSIDC's [AMSR2 Daily Polar Gridded Sea Ice Concentrations \(NSIDC-0803\)](#) data set (Stewart et al., 2025b), which are gridded onto a 25 km polar stereographic grid. These fields are derived from JAXA Level 1R resampled brightness temperatures that are published as part of NSIDC's [AMSR2 Daily Polar Gridded Brightness Temperatures \(NSIDC-0802\)](#) data set (Stewart et al., 2025a). These brightness temperatures have been resampled and have had a spatial smoothing filter applied to make the brightness temperature data consistent with brightness temperatures from SSMIS. Consequently, the gridded AMSR2 sea ice concentration fields are more consistent with those from SSMIS, although the match is not perfect.

Comparison of Sea Ice Index V3 and Sea Ice Index V4 Ice Extents

Here we compare sea ice extent calculated from Sea Ice Index V3, which uses SSMIS, and Sea Ice Index V4, which uses AMSR2, over the period 1 January 2025 through 30 June 2025 for the Northern and Southern Hemispheres.

Northern Hemisphere

The top graph in Figure 3 shows the sea ice extent calculated from Sea Ice Index V3 and Sea Ice Index V4 and the bottom graph shows the difference between the two (V4 minus V3). For the Northern Hemisphere, approximately 80% of the values are negative. Where the difference is negative, AMSR2 provides a lower extent. For the 1 January 2025 through 30 June 2025 period, the maximum differences are less than 0.2 mil km² with an average difference of 0.05 mil km².

Figure 4 and Figure 5 show concentration maps of the Sea Ice Index Version 3 and Version 4 for 10 July 2025. The difference in ice extent for that date is -0.120 million square kilometers.

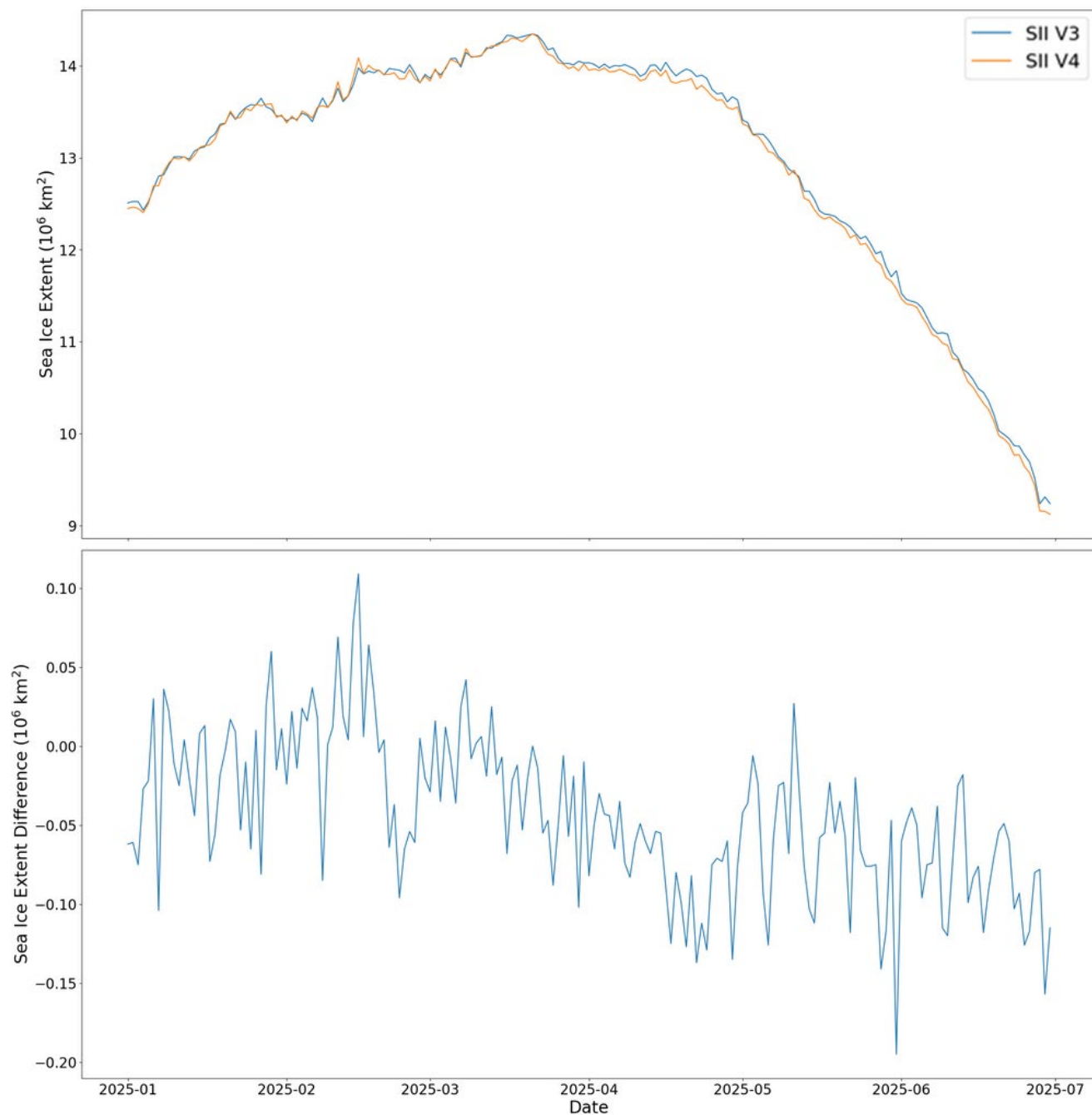


Figure 3. Comparison of Northern Hemisphere extent from V3 and V4 (top) and extent difference (V4 minus V3) (bottom) for 1 Jan 2025 to 30 Jun 2025

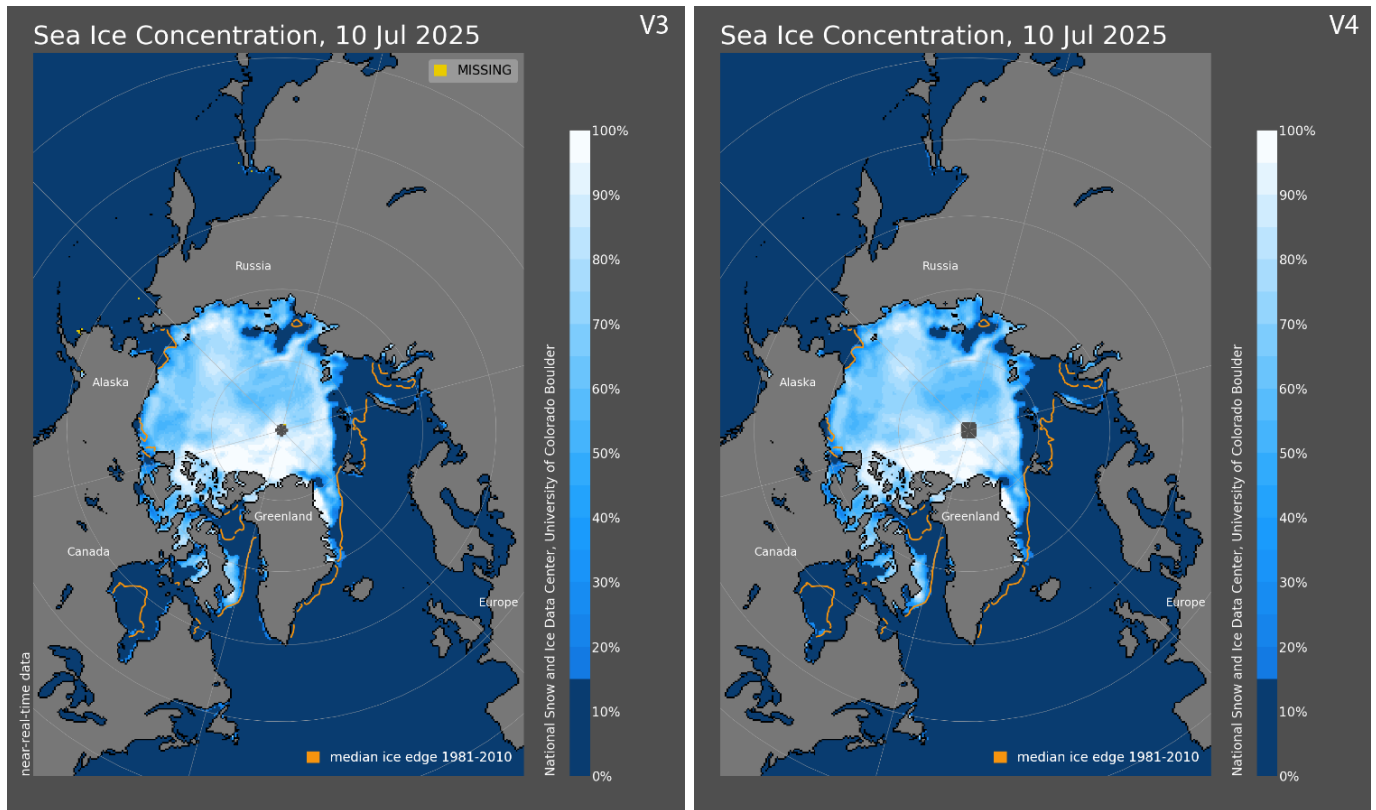


Figure 4. Comparison of Northern Hemisphere concentration maps from Sea Ice Index V3 using SSMIS (left) with Sea Ice Index V4 using AMSR2 (right) for 10 July 2025. The difference in ice extent (V4 minus V3) is -0.120 mil km².

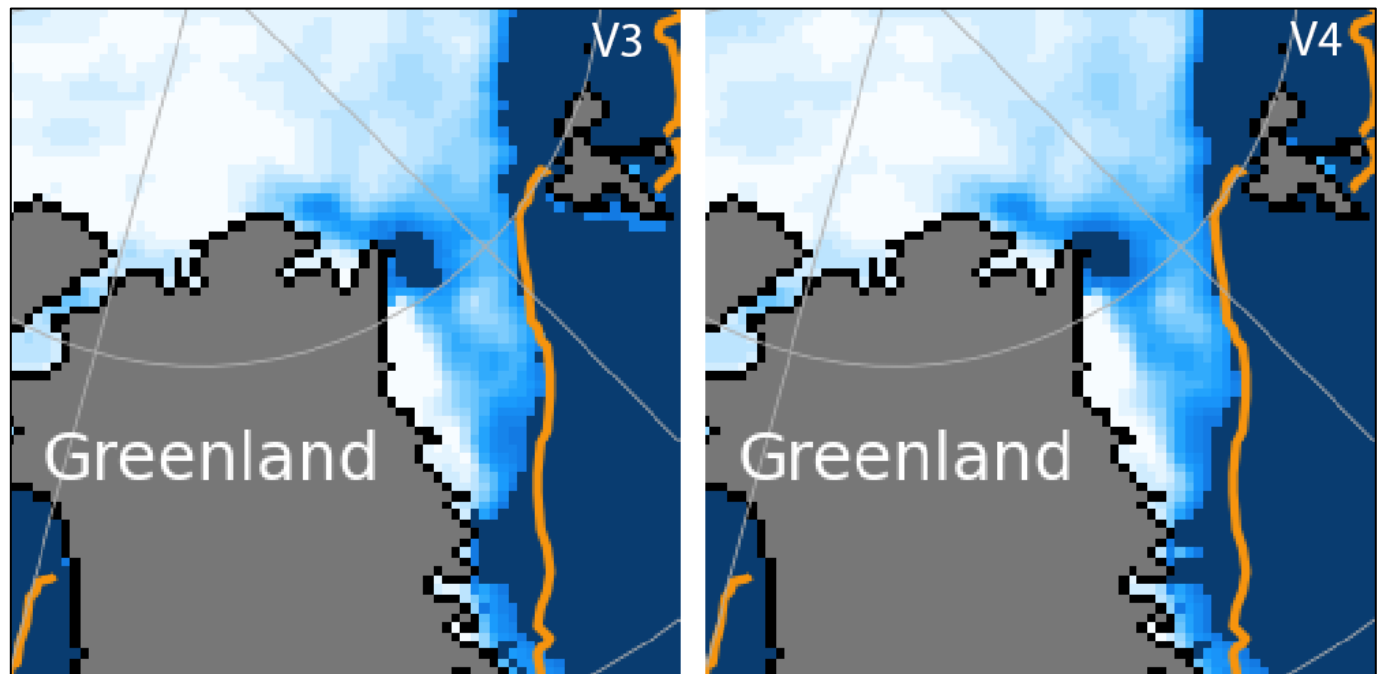


Figure 5. A zoomed in view of Arctic sea ice concentration around the northern tip of Greenland for Sea Ice Index V3 (left) and V4 (right). Note the slight differences in placement of the ice edge along the east coast, differences in concentration, and the different shape of the polynya.

Southern Hemisphere

The top graph in Figure 6 shows the sea ice extent calculated from Sea Ice Index V3 and Sea Ice Index V4 and the bottom graph shows the difference between the two (V4 minus V3). In contrast to the Northern Hemisphere, here only approximately 20% of the values are negative, reflecting lower AMSR2 extent. For the 1 January 2025 through 30 June 2025 period, the maximum differences are less than 0.15 mil km² with an average difference of 0.04 mil km². The sharp dip on 18 May 2025 is the result of unfiltered weather effects in the NRT SSMIS data that caused the ice extent from SSMIS to be erroneously large.

Figure 7 and Figure 8 show concentration maps of Sea Ice Index Version 3 and Version 4 for 3 February 2025. The difference in ice extent for that date is -0.026 million square kilometers.

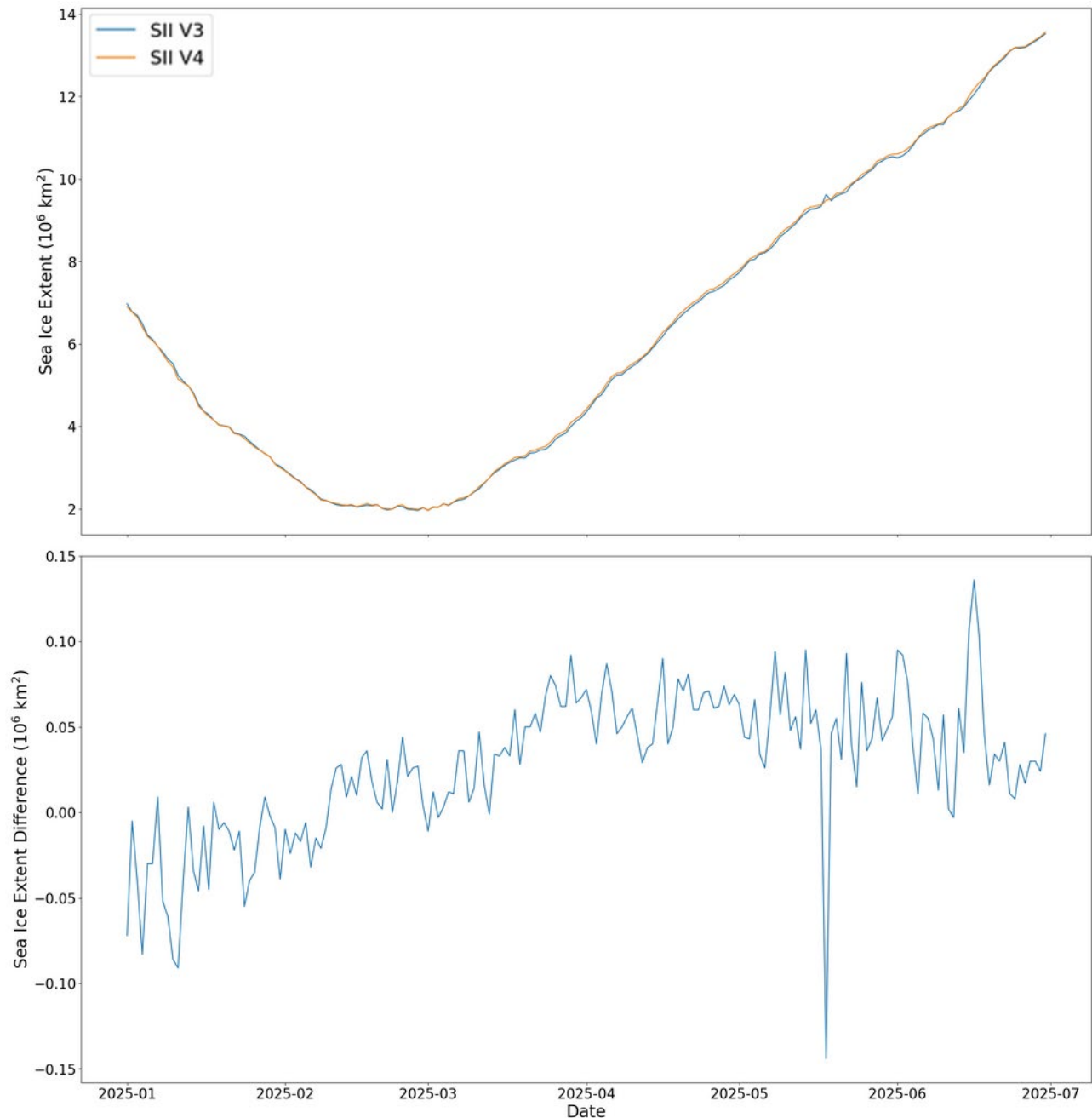


Figure 6. Comparison of Northern Hemisphere extent from V3 and V4 (top) and extent difference (V4 minus V3) (bottom) for 1 Jan 2025 to 30 Jun 2025

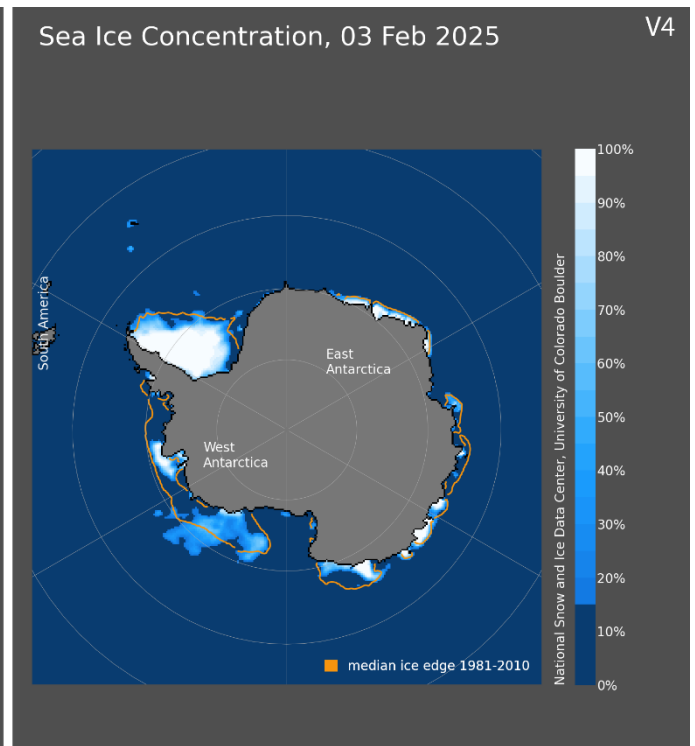
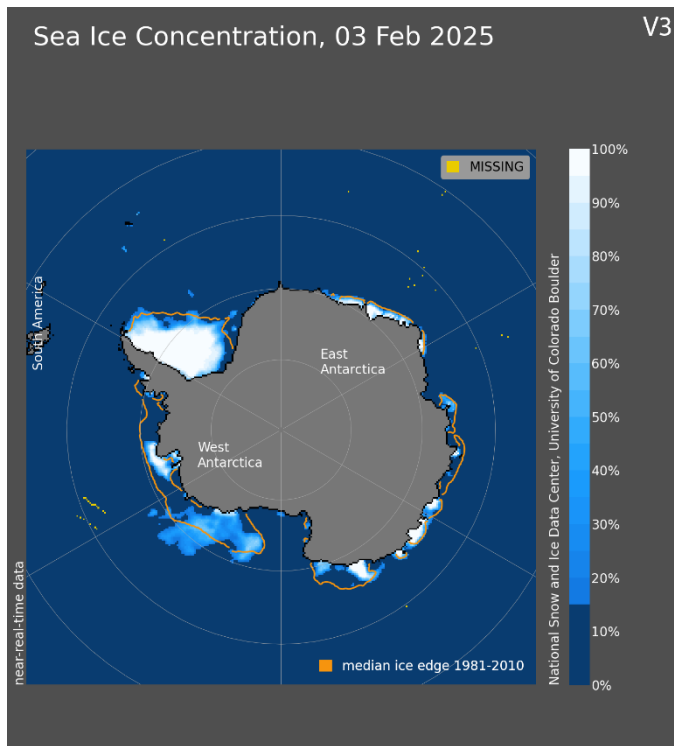


Figure 7. Comparison of Southern Hemisphere concentration maps from Sea Ice Index V3 using SSMIS (left) with Sea Ice Index V4 using AMSR2 (right) for 3 Feb 2025. The difference in ice extent (V4 minus V3) is -0.026 mil km².

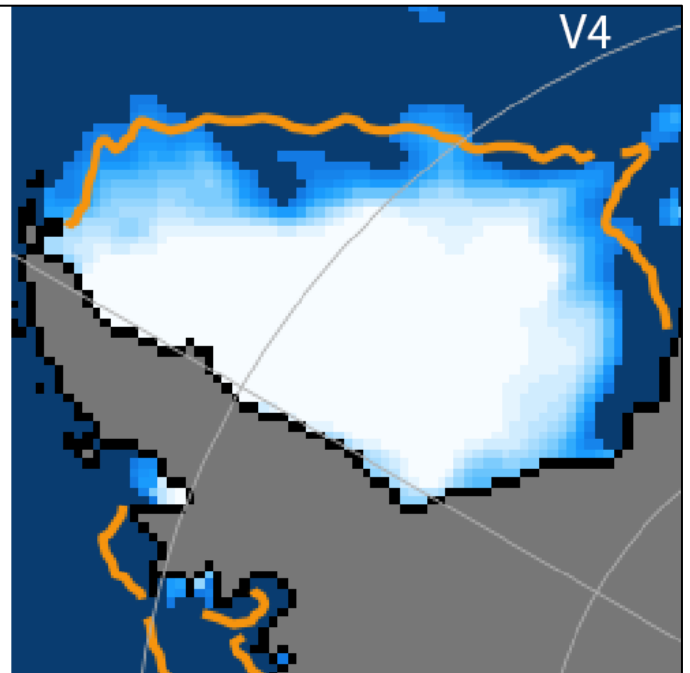
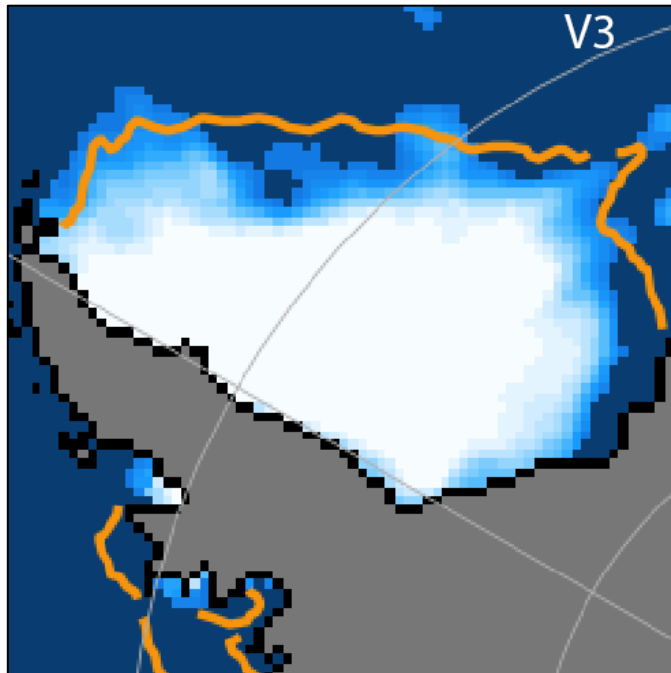


Figure 8. Close up of Antarctic sea ice concentration around the Antarctic Peninsula for Sea Ice Index V3 (left) and V4 (right). Note the slight differences in placement of the ice edge and differences in concentration.

A Note on Sea Ice Extent Trends

Here we compare V4 AMSR2-derived ice extent data with V3 SSMIS-derived ice extent data for the period 1 January 2024 through 30 June 2025. Note that this is for comparison purposes only and that Sea Ice Index Version 4 begins using AMSR2 data on 1 January 2025. However, looking at differences over a longer period is informative for understanding how ice extent trends seen using V4 data may differ from V3 trends as the Sea Ice Index continues to use AMSR2 data.

Figure 9 shows the differences in ice extent (V4 minus V3) for the Northern Hemisphere. Again, approximately 80% of the AMSR2 values are lower. The spike in early 2024 is a result of unfiltered weather in the AMSR2 data that is erroneously adding to the ice extent value for that day.

Figure 10 shows the differences in ice extent (V4 minus V3) for the Southern Hemisphere. For this longer period, approximately 70% of the AMSR2 values are lower.

On average, sea ice extents from the NSIDC-0803 AMSR2 ice concentration product used here are slightly lower than extents from SSMIS, and this will affect derived ice extent trends. Because the AMSR2 data have been resampled to be more like SSMIS, ideally, the difference between AMSR2 and SSMIS ice extents should have a mean of zero and ice extent trends would match. However, the resampling method used for input data does not completely achieve this. NSIDC investigators for NSIDC-0802 and NSIDC-0803 plan on improving the match with SSMIS in future versions.

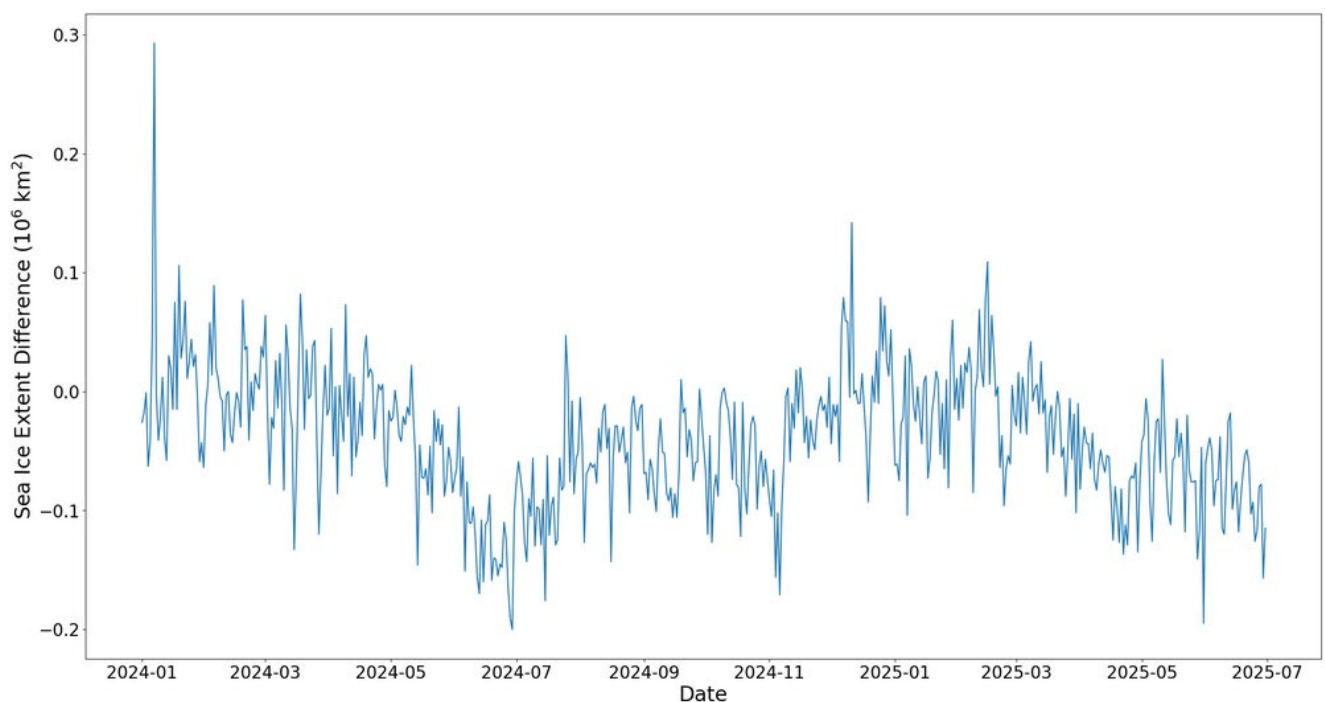


Figure 9. Differences in Northern Hemisphere ice extent (V4 minus V3) for 1 Jan 2024 to 30 Jun 2025

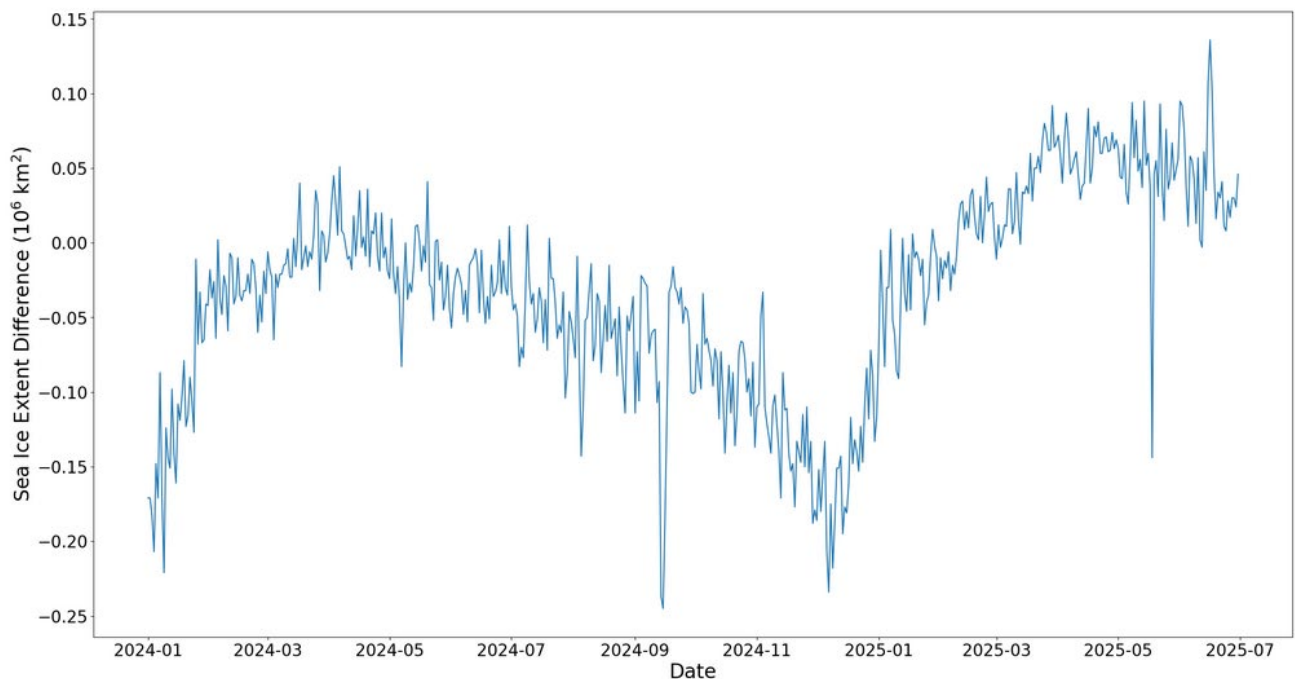


Figure 10. Differences in Southern Hemisphere ice extent (V4 minus V3) for 1 Jan 2024 to 30 Jun 2025

Conclusion

With one month's notice that the SSMIS data stream would cease, NSIDC worked quickly to achieve the release of Sea Ice Index Version 4 using AMSR2. We then learned that SSMIS will continue but are publishing V4 for the reasons outlined in the Summary. We will keep users informed of any revisions that may need to be made to the product or this document as we continue to assess the input AMSR2 data stream. Please register as a user of the Sea Ice Index by sending a request to NSIDC User Services at nsidc@nsidc.org to be alerted of updates.

References

- Fetterer, F., Knowles, K., Meier, W. N., Savoie, M., Windnagel, A. K., & Stafford, T. (2025). *Sea Ice Index*. (G02135, Version 4). [Data Set]. Boulder, Colorado USA. National Snow and Ice Data Center. <https://doi.org/10.7265/a98x-0f50>.
- Meier, W. N., Windnagel, A., & Stewart, S. (2024). Sea Ice Concentration - Climate Algorithm Theoretical Basis Document (C-ATBD), NOAA Climate Data Record Program CDRP-ATBD-0107, Rev. 11. NOAA NCEI CDR Program. <https://nsidc.org/sites/default/files/documents/technical-reference/cdrp-atbd-rev11-sic-cdrv5-final.pdf>.
- NSIDC. 2025. User notice: SSMIS data processing extended through 31 July 2025 - NSIDC DAAC Data Sets. NSIDC Data Announcements 30 June 2025. <https://nsidc.org/data/user-resources/data-announcements/user-notice-ssmis-data-processing-extended-through-31-july-2025-nsidc-daac-data-sets>.

Stewart, J. S., Meier, W. N., Wilcox, H., Scott, D. J. & Marowitz, R. (2025a). *AMSR2 Daily Polar Gridded Brightness Temperatures*. (NSIDC-0802, Version 1). [Data Set]. Boulder, Colorado USA. National Snow and Ice Data Center. <https://doi.org/10.5067/XB4WCE7O0PVV>.

Stewart, J. S., Meier, W. N., Wilcox, H., Scott, D. J. & Marowitz, R. (2025b). *AMSR2 Daily Polar Gridded Sea Ice Concentrations*. (NSIDC-0803, Version 1). [Data Set]. Boulder, Colorado USA. National Snow and Ice Data Center. <https://doi.org/10.5067/EH83VPG97LTP>.