





Introduction

Overall, Arctic sea ice extent is declining and Antarctic sea ice extent has a near-zero trend over the past 40+ years. Passive microwave data have been critical for tracking these changes. Several algorithms have been developed to derive sea ice concentration, including two (NASA Team and Bootstrap) developed at NASA Goddard and distributed by the NASA Snow and Ice DAAC at NSIDC. The NOAA/NSIDC Climate Data Record uses these algorithms as a foundation, but is processed to meet NOAA CDR standards. Here we present a new version (Version 4) of the NOAA/NSIDC CDR that has considerable enhancements over the earlier version and compare it to the NASA Bootstrap (BT) and NASA Team (NT) products. New region masks have also been produced to conduct regional comparisons.

New features of NOAA/NSIDC CDR

- Scanning Multichannel Microwave Radiometer (SMMR) added to the record, extending CDR fields from August 1987 back to November 1978
- Interpolation of bi-daily SMMR fields to daily fields
- Spatial and temporal gap-filling to provide complete coverage for nearly all of the record (currently Nov 1978 – May 2021)
- Gap-filled pole hole to provide concentrations around pole in the Arctic
- Enhanced automatic quality control processes, including daily valid-ice masks for SMMR and enhanced weather and land-spillover filters
- Updated NetCDF4-CF metadata

Key takeaways

- The NOAA/NSIDC CDR Version 4 includes significant enhancements, including updated software, spatial and temporal interpretation to fill data gaps, and improved automated quality control.
- The CDR concentrations and extent and area trends are in good agreement with the Bootstrap (BT) product; discrepancies occur primarily near the ice edge.
- The CDR concentrations and extent and area trends have less consistency with the NASA Team (NT) product; this is expected because the CDR algorithm uses mostly BT inputs.
- While overall trends agree reasonably well, differences in algorithm coefficients, sensor calibrations, and quality control measures result in differences that may be important, especially for the small magnitude trends in the Southern Hemisphere.
- Examining regional trends highlights variability in the trend agreement between products due to more local characteristics of the ice cover.

Datasets

- NOAA/NSIDC Climate Data Record of Passive Microwave Sea Ice
 Concentration, Version 4; Meier et al., 2021; doi:10.7265/efmz-2t65.
- Bootstrap Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSMI-SSMIS, Version 3; Comiso, 2017; doi:10.5067/7Q8HCCWS40R.
- Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSMI-SSMIS Passive Microwave Data, Version 1; Cavalieri et al., 1996; doi:10.5067/8GQ8LZQVL0VL. (NASA Team product)

Comparison of long-term hemispheric and regional sea ice extent trends from passive microwave sea ice climate records

Walter N. Meier, J. Scott Stewart, Ann Windnagel, and Florence M. Fetterer

Northern Hemisphere Extent CDR —— ——— BT _____ NT Northern Hemisphere Extent Difference CDR minus BT CDR minus NT -----sensor calibration between BT and NT

2020 CDR minus BT Concentration Difference (%) 1985 CDR minus B 985 CDR minus N 2020 CDR minus BT



Hemispheric extent and area trends and differences between products

Northern Hemisphere Area



Northern Hemisphere Area Difference

Trends and 2X trend st. dev. (% decade⁻¹) (relative to CDR 1981-2010 average)

Extent Trend		North			South	
(±2 St Dev range)	All	Mar	Sep	All	Mar	Sep
CDR	-5.04 (1.93)	-2.84 (0.43)	-13.7 (2.02)	-0.14 (3.51)	1.47 (3.43)	0.41 (0.57)
вт	-4.71 (1.90)	-2.65 (0.44)	-13.9 (2.20)	-0.18 (3.48)	1.05 (3.34)	0.35 (0.58)
NT	-4.48 (1.93)	-2.50 (0.43)	-12.7 (1.99)	0.13 (3.47)	1.65 (3.36)	0.50 (0.57)
CDR-BT	-0.32 (0.07)	-0.20 (0.07)	0.15 (0.44)	0.04 (0.05)	0.42 (0.20)	0.06 (0.04)
CDR-NT	-0.56 (0.05)	-0.35 (0.07)	-0.98 0.21	-0.27 (0.06)	-0.18 (0.22)	-0.09 (0.07)

NH trends are **significant (p<0.05)**

- SH trends not significant
- CDR trends agree better with BT than with NT, as expected

Area Trend		North			South	
(±2 St Dev range)	All	Mar	Sep	All	Mar	Sep
CDR	-5.65	-2.90	-17.9	0.11	1.74	0.54
	(2.34)	(0.50)	(2.63)	(3.82)	(3.85)	(0.66)
вт	-5.40	-2.71	-17.8	0.31	1.85	0.69
	(2.34)	(0.50)	(2.76)	(3.81)	(3.82)	(0.67)
NT	-4.99	-2.33	-15.0	0.32	2.05	0.47
	(2.39)	(0.52)	(2.20)	(3.38)	(3.43)	(0.65)
CDR-BT	-0.26	-0.19	-0.10	-0.20	-0.10	-0.15
	(0.04)	(0.05)	(0.29)	(0.04)	(0.20)	(0.06)
CDR-NT	-0.67	-0.57	-2.88	-0.21	-0.31	0.06
	(0.13)	(0.16)	(0.73)	(0.45)	(0.66)	(0.21)



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walt@colorado.edu



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- Differences between CDR and BT and NT trends vary with region. Smaller trend differences
- between CDR and BT. Northern Hemisphere
- trends are all statistically significant (p<0.05).
- CDR trends generally slightly smaller, likely due to quality control procedures.
- NH area and extent trend characteristics similar.
- **Central Arctic CDR-NT** has a positive trend, indicating a decrease in NT concentration over the timeseries, perhaps due to summer surface melt.
- SH trends positive, except Bellingshausen-Amundsen, but not statistically significant. • SH has larger extent trend differences, due to sensitivity to ice edge • SH area trend
- differences are small.
- Analysis uses new region masks
- NH mask follows Int'l Hydro. Org.
- conventions where reasonable Created as shapefile polygons Available soon at NSIDC!



