# Product User Manual for the Sea Ice Index, version 2.2

OSI SAF SII (OSI-420)

(**demonstration product**)

Version : 1.2

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## Document Change record

| Document version | Software version | Date | Author | Change description |
|---|---|---|---|---|
| 1.0 | 2.1 | 17.11.2020 | TL, SAA, SE | Initial version for the demonstration product in CDOP3. |
| 1.1 | 2.1 | 19.04.2021 | TL | Document data availability on THREDDS |
| 1.2 | 2.2 | 31.05.2023 | TL, SAA, SE | Switch to sea ice conc CDR and ICDR v3.0 as input. Addiotional subregions are included. |

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# 1. Introduction

## 1.1. The EUMETSAT Ocean and Sea Ice SAF

The Satellite Application Facilities (SAFs) are dedicated centres of excellence for processing satellite data – hosted by a National Meteorological Service – which utilise specialist expertise from institutes based in Member States. EUMETSAT created Satellite Application Facilities (SAFs) to complement its Central Facilities capability in Darmstadt. The Ocean and Sea Ice Satellite Application Facility (OSI SAF) is one of eight EUMETSAT SAFs, which provide users with operational data and software products. More on SAFs can be read at www.eumetsat.int.

The objective of the OSI SAF is the operational near real-time production and distribution of a coherent set of information, derived from earth observation satellites, and characterising the ocean surface and the energy fluxes through it: sea surface temperature, radiative fluxes, wind vector and sea ice characteristics. For some variables, the OSI SAF is also aiming at providing long term data records for climate applications, based on reprocessing activities.

The sea ice products include sea ice concentration, sea ice index, the sea ice emissivity at 50 GHz, sea ice edge, sea ice type, sea ice drift and sea ice surface temperature.

The OSI SAF consortium is led by Météo-France.The sea ice processing is performed at the High Latitude processing facility (HL centre), operated jointly by the Norwegian and Danish Meteorological Institutes.

## 1.2. Disclaimer

All intellectual property rights of the OSI SAF products belong to EUMETSAT. The use of these products is granted to every interested user, free of charge. If you wish to use these products, EUMETSAT's copyright credit must be shown by displaying the words "Copyright © <YYYY> EUMETSAT" or the OSI SAF logo on each of the products used.

Note: The comments that we get from our users is an important input when defining development activities and updates, and user feedback to the OSI SAF project team is highly valued.

**Acknowledgement and citation**

Use of the product(s) should be acknowledged with the following citation:

- EUMETSAT Ocean and Sea Ice Satellite Application Facility, Sea ice index 1978-onwards (v2.2, 2023), OSI-420, Data extracted from OSI SAF (FTP|THREDDS) server: ([extracted period],) ([extracted domains],)) accessed [download date]

For example:

- EUMETSAT Ocean and Sea Ice Satellite Application Facility, Sea ice index 1978-onwards (v2.2, 2023), OSI-420, Data extracted from OSI SAF FTP server: 1979-2019, Northen Hemisphere, Barents Sea, accessed 2020-11-19

When the data are used or displayed, they can be labelled as “OSI SAF Sea Ice Index v2.2” (alternatively “OSI SAF SII v2.2”, or the like).

An acknowledgement sentence could be:

- *The OSI SAF Sea Ice Index v2.2 is made available at [https://osisaf-hl.met.no/v2p2-sea-ice-index](https://osisaf-hl.met.no/v2p2-sea-ice-index).*

The above acknowledgement may be accompanied by a citation to Lavergne et al. (2019, 2023), that documents the Sea Ice Concentration Climate Data Records used in the Sea Ice Index, e.g.

- *The OSI SAF Sea Ice Index v2p2 is prepared using EUMETSAT OSI SAF Sea Ice Concentration data, with R&D input from the ESA Climate Change Initiative (ESA CCI) (Lavergne et al. 2019, Lavergne et al. 2023).*

## 1.3. Scope of this document

This documents provides information about the Ocean and Sea Ice Satellite Application Facility (OSI SAF) Sea Ice Index (SII), first-time released in November 2020 as a demonstrational product. This note covers the following information: what data are used as input, what methodologies are employed, and how the product is formatted (incl. file naming convention). Comparison to other similar indexes and a recap of the evolution of the OSI SAF Sea Ice Index are also presented.

## 1.4. Overview

The OSI SAF Sea Ice Index was developed at the Norwegian Meteorological Institute and is based on the OSI SAF Sea Ice Concentration products. A recap of the main evolutions is presented in section 7. In its present form, the Sea Ice Index is a collection of data and figure files, holding hemispherical and regional sea-ice climate indicators, including sea-ice extent and area. Both daily and monthly sea-ice index products are available.

At this stage (May 2023) the sea-ice index v2.2 has a **demonstrational status** because it is not fully integrated in the OSI SAF product porto-folio (review cycles, operational monitoring, etc.). The SII (v3.0) will be made a fully-fledged operational product in the next phase of the service, the Continuous Development and Operations Phase 4 (2022-2027).

## 1.5. Reference and applicable documents


[1] EUMETSAT OSI SAF
*OSI SAF CDOP 4 Product Requirements Document*
SAF/OSI/CDOP4/MF/MGT/PL/4-001, v1.0, 13/07/2022

[2] EUMETSAT OSI SAF
Product User Manual for the Global Sea Ice Concentration Climate Data Records,
SAF/OSI/CDOP3/MET/TEC/MA/288, v3.1, April 2023

[3] EUMETSAT OSI SAF
Validation Report for the Global Sea Ice Concentration Climate Data Records,
SAF/OSI/CDOP3/DMI/SCI/RP/285, v3.0, August 2022

# 2. DEFINITIONS

Sea Ice Concentration (SIC) is the fractional area (of an ocean grid cell) that is covered with sea ice. Sea Ice Extent (SIE) is defined as the area covered by a significant amount of sea ice, that is the area of ocean covered with more than 15% SIC. Sea Ice Area (SIA) is the total ocean area covered by any amount of ice (no SIC threshold applied, and the SIC value weights the grid cell area). At hemispherical scales, SIE is often reported with units of $10^6$ $km^2$ (millions square kilometers). Sea Ice Extent and Area do not include lake ice.

# 3. INPUT DATA

The OSI SAF Sea Ice Index v2.2 is computed from three SIC products:

- The "v3" Climate Data Record (CDR), covering Oct 1978 to Dec 2020 (OSI-450-a)
- The "v3" Interim Climate Data Record (ICDR), starting in Jan 2021, with a 16 days latency (OSI-430-a);
- A Near-Real-Time (NRT) product that uses the same processing chain as OSI-450-a and OSI-430-a, for the most recent 15 days (up-until yesterday).

The links above provide full documentation on the algorithms and processing details for these products, as well as URLs to access the SIC products, and to visualize examples maps of the products. See [2] for more information on the three SIC products.

All our SIC products are based on passive microwave sensors. The CDR uses data from the SMMR, SSM/I, and SSMIS instruments, while the ICDR and NRT products use SSMIS data only. In the processing algorithms from raw satellite observations (brightness temperatures TB) to SIC, atmospheric fields of wind speed, water vapour and 2 m temperature are used as well, all from the ECMWF (ERA-Interim and operational IFS).

# 4. METHODOLOGY

## 4.1. Daily values

Daily SIE and SIA values are computed from daily SIC maps. All sea-ice covered ocean is included, lake ice is not. SIE is computed as the sum of the total area of the grid cells that have a SIC value larger than 15%. SIA is the sum of the area of all grid cells weighted by the SIC values (no threshold on SIC).

In the daily SIE and SIA time series, the CDR OSI-450-a is always used from Oct 1978 to Dec 2020, then the ICDR OSI-430-a from Jan 2021 onwards. The last 15 days of the time series are always from the NRT SIC product.

On days when the SIC product is missing (e.g. every other day in most of the SMMR period, 1978-1987), missing SIE and SIA values are linearly interpolated in time. The interpolation is not conducted if more than 7 consecutive days are missing. Furthermore, up to 3 consecutive days of extrapolation of missing data are allowed at the beginning and end of each month.

A flag per daily value is added in the data files with information on which SIC product is used (CDR, ICDR, or NRT), and whether a missing value was interpolated, or extrapolated.

## 4.2. Monthly values

Monthly SIE and SIA values are computed as the monthly average of the daily SIE and SIA values. The interpolated and extrapolated daily data are used in the monthly average.

When interpolation and extrapolation are not possible (e.g. too many missing missing days), the monthly SIE and SIA are missing in the product files. The missing months are April, May, and June 1986, as well as December 1987.

## 4.3. Trends and reference period

The reference base period for all v2p2 data and plots is 1981 - 2010, as indicated in the figure text. This period is used to compute climatologies (e.g. median and percentiles in the daily plots, climatology mean for the monthly plots).

Monthly trends in SIE and SIA are reported in the figure text as thousands $km^2$ per year (e.g. -78,000 $km^2$ per year). They are also reported as percentage change per decade, relative to the mean over the 1981 - 2010 base period (e.g. -12% per decade).

All our trends are from least-square linear regression, with no consideration for potential statistical correlations between the points along the time series. As any other trend, they describe past changes, but should be used with caution when predicting future evolution.

## 4.4. Regions

Besides sea-ice indexes for entire hemispheres, regional indexes are also computed in order to see the temporal behavior in smaller scales. The calculation method is the same, but with a region mask applied to the daily SIC maps before entering the SIE and SIA computations. These region masks are derived from latitude-longitude bounding boxes, applied in the 25 km polar EASE2 grids used by the SIC products. In SII v2.1, three regional indexes were provided for the Barents Sea, the Svalbard region, and the Fram Strait region. In SII v2.2, more regional indexes are included in both Northern and Southern Hemisphere.

The following regions are defined and monitored with SII v2.2:

| | <area> | Latitude | Longitude |
|---|---|---|---|
| Northern Hemisphere | nh | [0 ; 90] | [-180 ; +180] |
| Southern Hemisphere | sh | [-90 ; 0] | [-180 ; +180] |
| Global | glb | [-90 ; 90] | [-180 ; +180] |
| Barents Sea | bar | [72 ; 82] | [10 ; 60] |
| Beaufort Sea | beau | [65.5 ; 80] | [-156.5 ; -122] |
| Chukchi Sea | chuk | [65.5 ; 80] | [-180 ; -156.5] |
| East Siberian Sea | ess | [65 ; 80] | [145 ; 180] |
| Fram Strait /Greenland Sea | fram | [70 ; 82] | [-20 ; 15] |
| Kara Sea | kara | [65 ; 75], [65 ; 81] | [57 ; 60], [60 ; 100] |
| Laptev Sea | lap | [65 ; 80] | [100 ; 145] |
| Svalbard region | sval | [72 ; 85] | [0 ; 40] |
| Amundsen-Bellingshausen Sea | bell | [-90 ; 0] | [-130 ; -60] |
| Indian Ocean | indi | [-90 ; 0] | [20 ; 90] |
| Ross Sea | ross | [-90 ; 0] | [-180 ; -130], [160 ; 180] |
| Weddell Sea | wedd | [-90 ; 0] | [-60 ; 20] |
| Western Pacific Ocean | wpac | [-90 ; 0] | [90 ; 160] |

*Table 1: Definition of the hemispheric and regional boxes.*

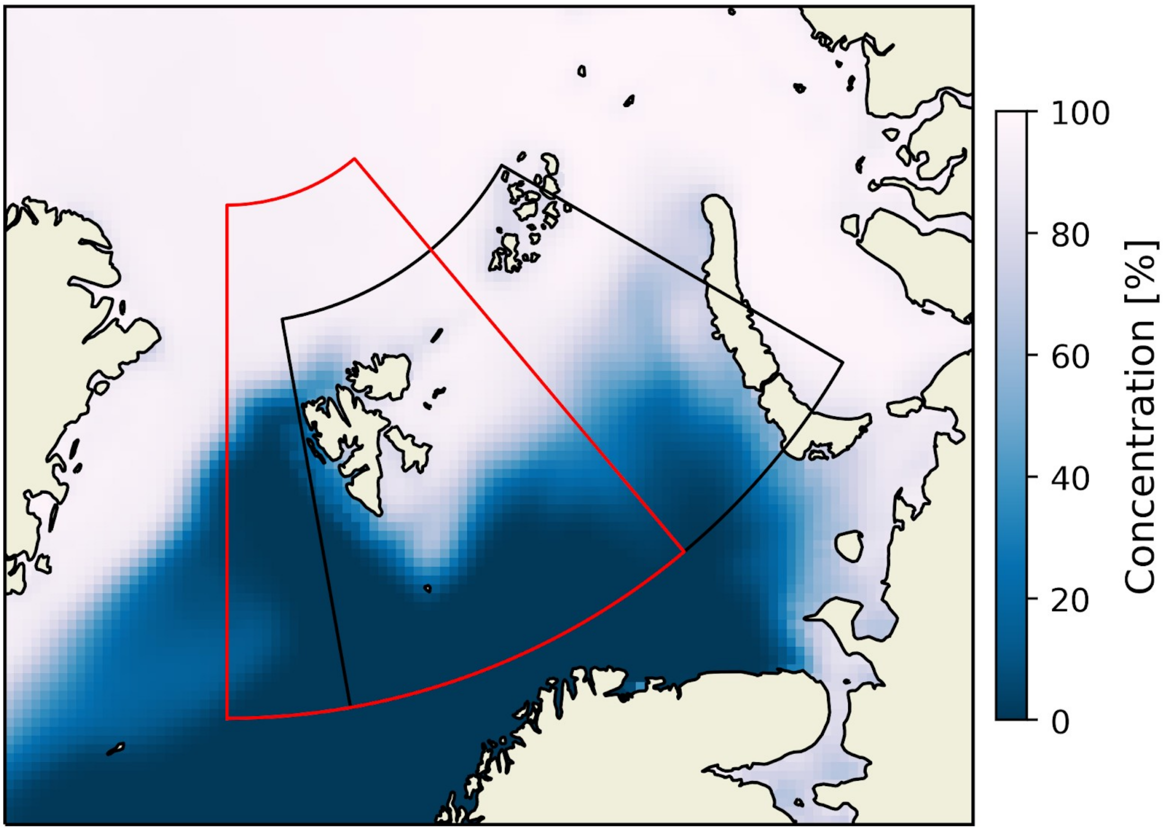


*Figure 1: Map illustrating the regional masks for computation of sea ice indexes for the Svalbard region (in red) and Barents Sea region (in black). Background ice information is March sea-ice concentration averaged over the base period 1981-2010.*

# 5. FILE NAMING CONVENTIONS AND FORMATS

The OSI SAF Sea Ice Index pertains of both plots (PNG format) and data files (ASCII and NetCDF formats).

## 5.1. File locations

Image and data files do not reside at the same locations:

| | Protocol | `<root-url>` |
|---|---|---|
| Image Files | HTTPS | `https://osisaf-hl.met.no/archive/osisaf/sea-ice-index/v2p2/` |
| Data files | FTP | `ftp://osisaf.met.no/prod_test/ice/index/v2p2` |
| | THREDDS | `https://thredds.met.no/thredds/osisaf/osisaf_seaiceindex.html` |

## 5.2. File naming convention

The file naming convention for figures in PNG-format is:

- `<root-url>/<area>/<language>/osisaf_<area>_<what>_<freq>-<qualif>.<ext>`

the file naming convention for data files is:

- `<root-url>/<area>/osisaf_<area>_<what>_<freq>.<ext>`

where:

| | |
|---|---|
| `<root-url>` | See section 5.1. |
| `<area>` | On FTP and HTTPS : an area code (e.g. nh) (see 1). On THREDDS : a longer area name (e.g. « Northern Hemisphere Sea Ice Index (OSI-420) »). |
| `<language>` | a language code (e.g. `en`, `no`, `dk`) |
| `<what>` | `sie` (Sea Ice Extent) or `sia` (Sea Ice Area) |
| `<freq>` | `daily` or `monthly` |
| `<qualif>` | a qualifier for the type of graphs (see list below) |
| `<ext>` | `png` for images, `txt` or `nc` for data files (on THREDDS : .nc only). |

Qualifiers <qualif> are only for the PNGs and depend on the frequency <freq>:

| `<freq>` | `<qualif>` |
|---|---|
| `daily` | • `all` : shows all years since 1978<br>• `2years` : show current year, plus two selected years (2012 & 2020 for all regions in NH and glb, 2014 & 2022 for all regions in SH);<br>• `5years` : shows current year, plus previous 5 years.<br>2years and 5years also contains all-time maximum and minimum values. |
| `monthly` | • `all` : shows monthly time series since 1978 of all months. In addition, two months representing maximum and minimum ice conditions, respectively March and September for all regions in NH and September and February for regions in SH are outlined.<br>• `01`, `02`, …, `12`: shows time series for January, February,…, December<br>• `ranks` : a table plot with SIE (or SIA) ranked by month shown with colors and labels.<br>• `values` : a table plot with SIE (or SIA) monthly values shown with colors and labels. |

## 5.3. File format

### *5.3.1. Text files*

The format of text files is described in a header appearing at the top of each file and introduced with the # symbol. Each data row in the file has information on the date (fractional year, year, month, day) followed by the SIE or SIA value (unit km²) and source for the data («daily» only). The newest date is at the bottom of the file.

Missing values are encoded with -999.

### *5.3.2. NetCDF files*

The netCDF files are formatted as CF / ACDD files, using the CF :featureType=timeSeries formatting rules. The SIC threshold and area covered are encoded as variables in the file. Time are encoded as «days since 1970-01-01».

Missing values are reported with `_FillValue`.

# 6. COMPARISON TO OTHER SIMILAR INDEXES

There is a lack of ground-truth data for sea-ice indexes. See [3] in addition to Kern et al. 2019 and 2020 for validation studies of the underlying sea-ice concentration data. Instead, we compare the OSI SAF SII against other similar indexes.

Here, we document a comparison of the OSI SAF Sea Ice Index with the Sea Ice Index (v3) of NSIDC (Fetterer et al. 2017).

We note up-front that the OSI SAF Sea Ice Index values are not tuned towards the NSIDC values.

## 6.1. Comparison to the NSIDC Sea Ice Index

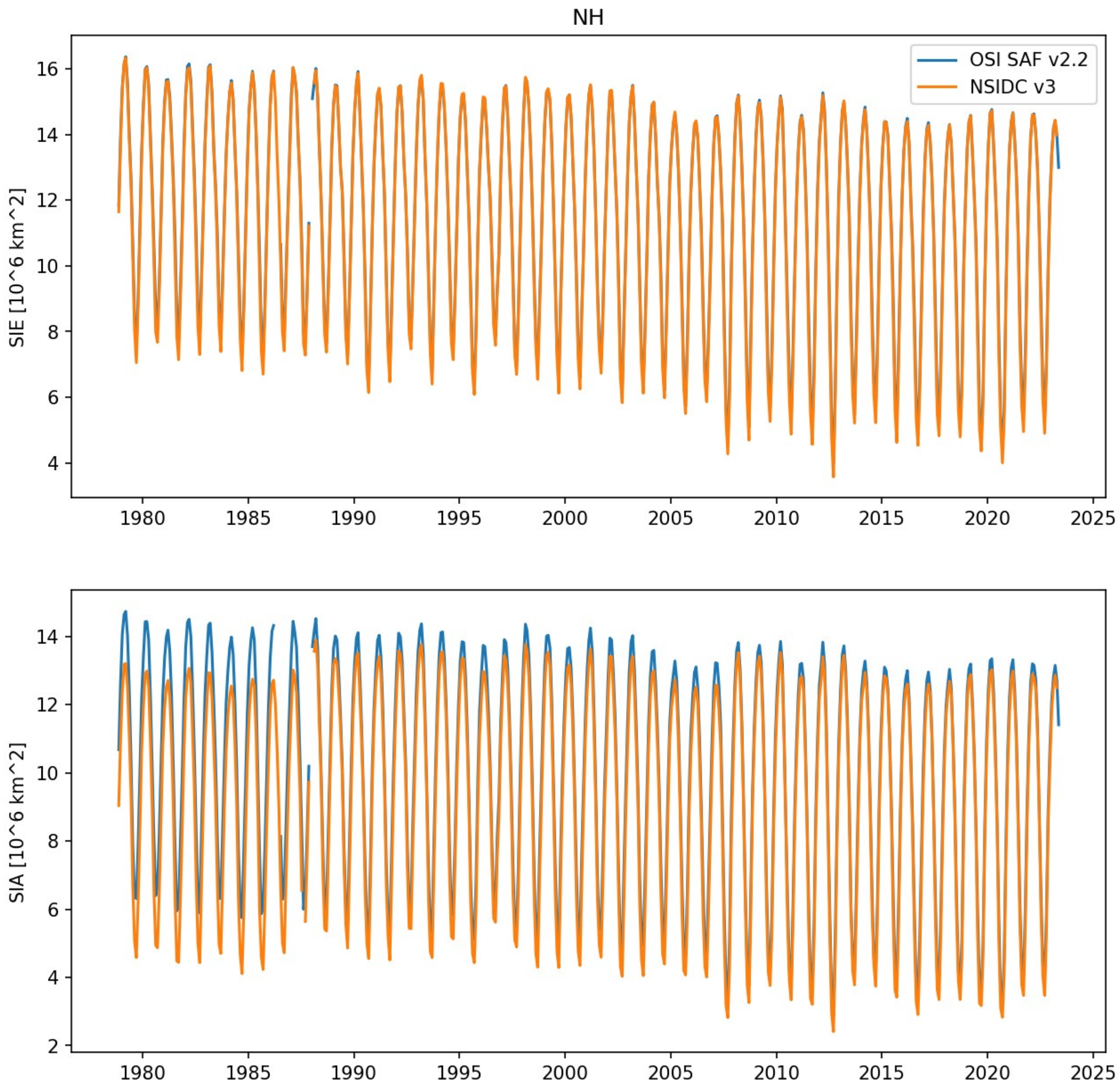


*Figure 2: Northern Hemisphere sea-ice indexes (top: SIE, bottom: SIA) for OSI SAF v2p2 (blue) and NSIDC v3 (orange).*

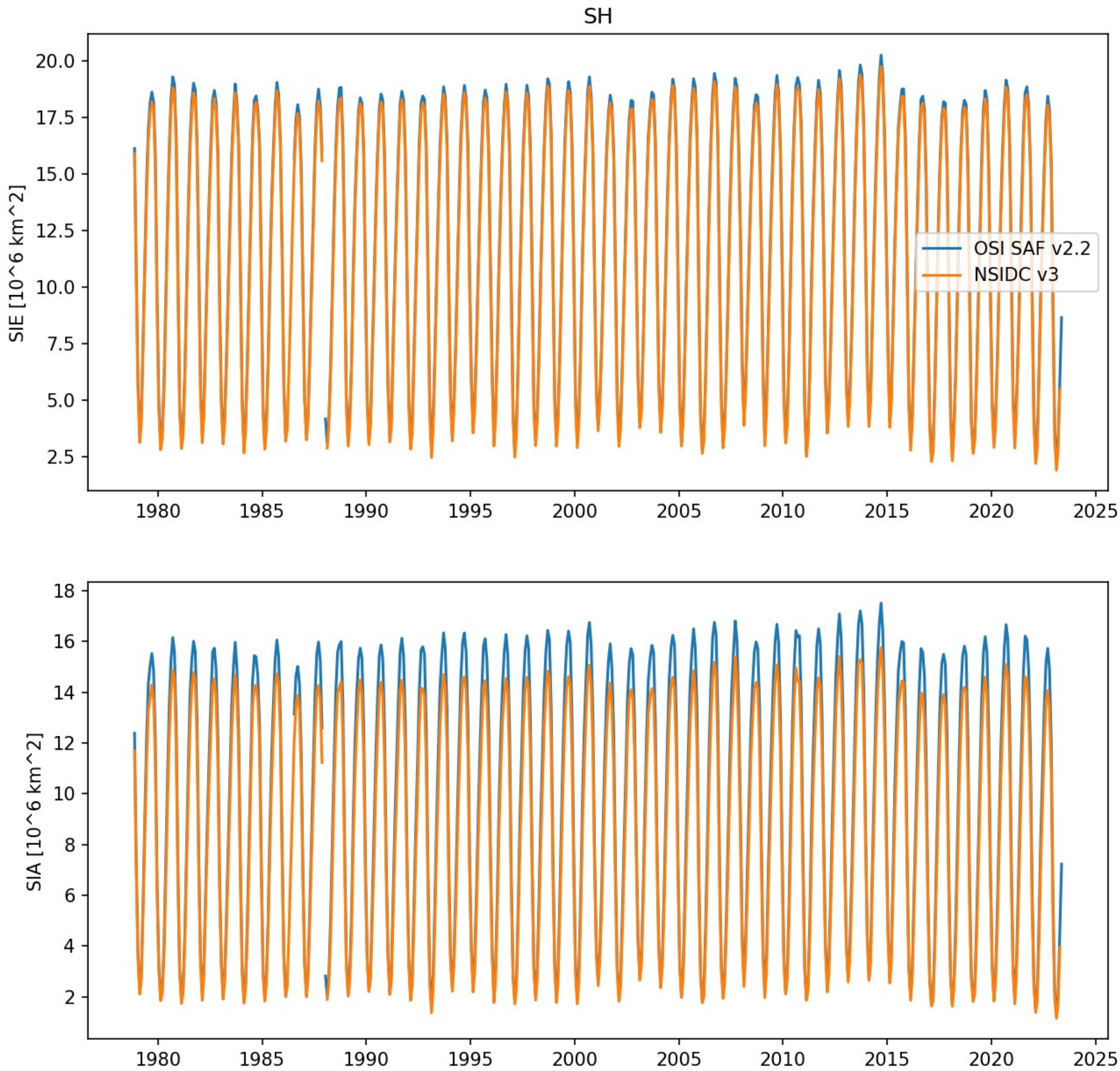


*Figure 3: Southern Hemisphere sea-ice indexes (top: SIE, bottom: SIA) for OSI SAF v2p2 (blue) and NSIDC v3 (orange).*

Figure 2 (resp. Figure 3) shows the OSI SAF and NSIDC time-series of sea-ice extent and area for the Northern Hemisphere (resp. Southern Hemisphere). In the Northern Hemisphere (Figure 2), SIE apparently matches quite well, but not SIA. The SIA reported by NSIDC is substantially lower than that of the OSI SAF in the first part of the time series (1978-1987). This difference is attributed to the polar observation hole (down to 84N in the 1978-1987 period). The polar observation hole is treated differently by the two services. Indeed, the SIC maps used as input for the OSI SAF SII are spatially interpolated on a daily basis to close the polar observation hole. These spatially interpolated values contribute to the SIE and SIA time series. Conversely, the SIC maps used as input for the NSIDC SII are not interpolated: the polar observation hole does not contribute to SIA, but is counted as "ice-covered" for the SIE.

In the Southern Hemisphere (Figure 3), we also observe a better agreement between the two products in SIE than in SIA. However, the NSIDC SIA seems to report lower values than OSI SAF throughout the years. We suspect this difference is due to the NSIDC SIC maps being processed with the Nasa Team algorithm (Cavalieri et al. 1997), which is known to underestimate SIC in the Southern Hemisphere, especially during the Austral winter season (see e.g. Fig. 14b and Fig. 7a in Kern et al. 2019).

Figure 4 (resp. Figure 5) show comparison between OSI SAF SII v2p1 (y-axis) and NSIDC SII v3 (x-axis) for the Northern Hemisphere (resp. Southern Hemisphere) Sea Ice Extent (left) and Area (right) over the period 1979-2020.

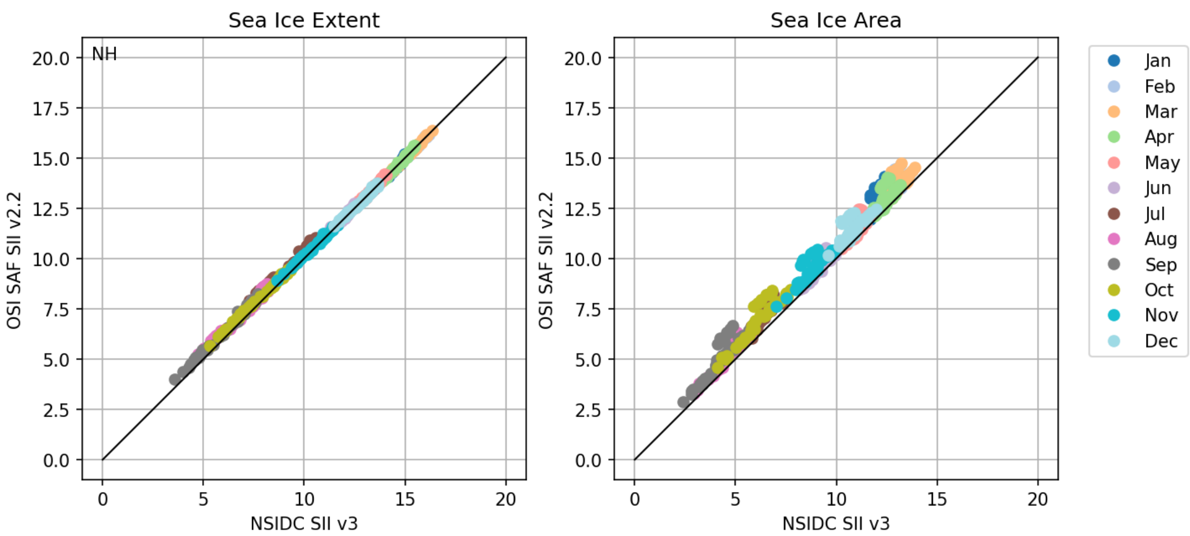


*Figure 4: Northern Hemisphere scatterplot of OSI SAF SII (y-axis) vs NSIDC SII v3 (x-axis) SIE (left) and SIA (right). The pairs are colored by month.*

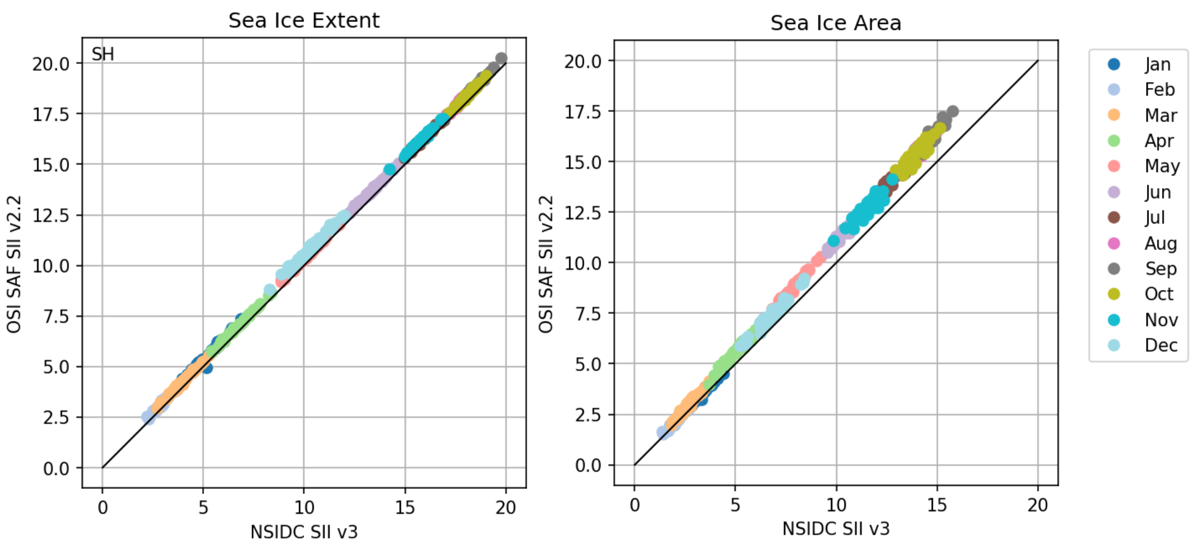


*Figure 5: Southern Hemisphere scatterplot of OSI SAF SII (y-axis) vs NSIDC SII v3 (x-axis) SIE (left) and SIA (right). The pairs are colored by month.*

For SIA (right panels), we observe the consequences of underestimation in the Northern Hemisphere (Figure 4) by NSIDC SII v3 in the 1979-1987 period (see Figure 2). In the Southern Hemisphere (Figure 5), we observe the underestimation by the NasaTeam algorithm (used in the NSIDC SII) that increases in the austral Winter (e.g. Sept and Aug).

In terms of Sea Ice Extent (left panels), we confirm the general impression from Figure 2 and Figure 3 that the two sources agree rather well. The symbols (colored by months) are aligned along the 1:1 line, yet slightly above that line: the OSI SAF SII values are generally larger than those of the NSIDC SII v3. This is confirmed by an analysis (not shown) of the mean Sea Ice Extent values for the period 1981-2010 : the OSI SAF values are in general larger than those of NSIDC, with differences reaching 0.5 millions $km^2$ in Northern Hemisphere summer. Average differences in the Southern Hemisphere are about 0.3 millions $km^2$ in all months.

In the Northern Hemisphere (especially in summer), we suspect the OSI SAF values are somewhat high due to land spill-over effects: at the microwave frequencies used by the SIC algorithms entering the OSI SAF and NSIDC data, land masses have similar emissivities than sea ice and can trick the sea-ice algorithms along the complex coastlines of the Arctic (e.g. in the Canadian Archipelago). Both the OSI SAF and NSIDC use special algorithms to detect and correct such land spill-over effects (see e.g. sections 3.6 and 4.3 in Lavergne et al. 2019), but it would seem the current OSI SAF implementation leaves too much false sea-ice along the coasts. This effect is exacerbated during the summer months when a longer coastline is ice-free.

In the Southern Hemisphere, we suspect that the NSIDC values are low due to the general underestimation of SIC by the NasaTeam algorithm (Kern et al. 2019).

### 6.2. Comparison to other sources

Many investigators have compared sea-ice extent and area time-series. In a recent study, Kern et al. (2019), ten established sea-ice concentration climate data records are intercompared with each others and also compared to ground-truth data.

Part of their analysis forcus on an intercomparison of monthly averaged SIE and SIA for both hemisphere. For example, we reproduce here their Fig. 6 panel (d): September sea-ice extent in the Northern Hemisphere.

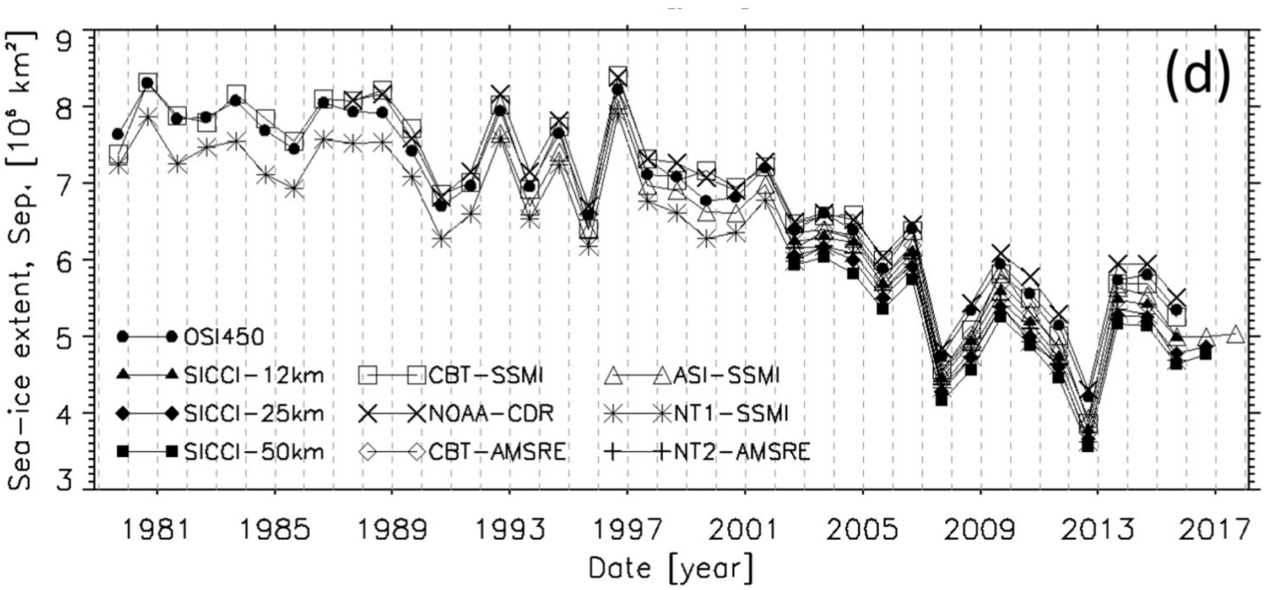


*Figure 6: Northern Hemisphere sea-ice extent for September months computed from ten sea-ice concentration data records (reproduced from Fig. 6 of Kern et al. 2019).*

From this figure, it is clear that NT1-SSMI (star symbols, the base for NSIDC SII v3) is at the lower end of the ensemble of other sources, while OSI-450 (black dot symbols, the base for OSI SAF SII) is at the higher end. Another widely used sea-ice concentration data, the Bootstrap data (CBT-SSMI, squares) is more in agreement with OSI-450 than with NT1-SSMI. The difference between the high-end and low-end of this ensemble of curves is larger (in the first half of the period) and in the same order (in the second half) as the difference we documented between the OSI SAF SII and the NSIDC SII (~0.5 millions km²).

We finally underline that there are no direct correspondance between the values of the OSI SAF SII (v2p1) and NSIDC SII (v3) data on the one hand, and the curves displayed for the OSI-450 and NT1-SSMI on Figure 6 on the other hand. This is because Kern et al. (2019) re-computed all sea-ice extent and area from the sea-ice concentration maps, and that this process included regridding to a common mask. This section is nevertheless an interesting indication that different algorithms and datasets return different sea-ice extent and area values.

## 6.3. Comparing trends

Finally, we compare the monthly trends of Sea Ice Extent (not Area) obtained from the two time series. The trends are summarized in 2 and 3.

*Table 2: Monthly Northern Hemisphere Sea Ice Extent trends observed by the OSI SAF SII v2p2 and NSIDC SII v3. Both absolute trends (expressed in thousands km$^2$ per year) and trend relative to the 1981-2010 period (expressed in % per decade).*

| | OSI SAF (abs) | NSIDC (abs) | OSI SAF (rel 1981-2010) | NSIDC (rel 1981-2010) |
|---|---|---|---|---|
| | [1e3 km$^2$ / year] | | [% / decade] | |
| **Jan** | -42.8 | -42.8 | -3.0 % | -3.0 % |
| **Feb** | -42.1 | -42.5 | -2.8 % | -2.8 % |
| **Mar** | -38.9 | -39.1 | -2.5 % | -2.5 % |
| **Apr** | -38.6 | -38.1 | -2.6 % | -2.6 % |
| **May** | -33.9 | -33.7 | -2.5 % | -2.5 % |
| **Jun** | -43.3 | -45.6 | -3.7 % | -3.9 % |
| **Jul** | -64.0 | -68.4 | -6.5 % | -7.2 % |
| **Aug** | -71.5 | -72.6 | -9.5 % | -10.1 % |
| **Sep** | -80.7 | -79.0 | -11.9 % | -12.3 % |
| **Oct** | -75.5 | -80.2 | -8.8 % | -9.6 % |
| **Nov** | -48.2 | -51.6 | -4.5 % | -4.8 % |
| **Dec** | -42.8 | -44.3 | -3.3 % | -3.5 % |

*Table 3: Monthly Southern Hemisphere Sea Ice Extent trends observed by the OSI SAF SII v2p2 and NSIDC SII v3. Both absolute trends (expressed in thousands km² per year) and trend relative to the 1981-2010 period (expressed in % per decade).*

| | OSI SAF (abs) | NSIDC (abs) | OSI SAF (rel 1981-2010) | NSIDC (rel 1981-2010) |
|---|---|---|---|---|
| | [1e3 km² / year] | | [% / decade] | |
| **Jan** | 3.3 | -1.2 | 0.6 % | -0.2 % |
| **Feb** | -1.2 | -0.9 | -0.4 % | -0.3 % |
| **Mar** | 3.4 | 3.9 | 0.8 % | 1.0 % |
| **Apr** | 4.7 | 6.2 | 0.7 % | 0.9 % |
| **May** | 4.1 | 6.8 | 0.4 % | 0.7 % |
| **Jun** | 3.6 | 6.2 | 0.3 % | 0.5 % |
| **Jul** | 4.3 | 5.6 | 0.3 % | 0.3 % |
| **Aug** | 5.7 | 6.9 | 0.3 % | 0.4 % |
| **Sep** | 6.0 | 6.7 | 0.3 % | 0.4 % |
| **Oct** | 6.0 | 6.0 | 0.3 % | 0.3 % |
| **Nov** | -4.0 | -4.8 | -0.2 % | -0.3 % |
| **Dec** | 0.9 | -2.0 | 0.1 % | -0.2 % |

The monthly trends are similar between the two indexes, especially relative to the 1981-2010 period (last two columns). Both time series capture the decline of Sea Ice Extent in all months in the Northern Hemisphere (with faster decline in the summer months). In the Southern Hemisphere, the two time series agree well and the monthly trends are very small in both of them.

In the Northern Hemisphere, the relative trends reported by the NSIDC SII time series are equal or greater than those reported by the OSI SAF SII. An analysis of the month-by-month time series (not-shown) suggests that the difference in relative trends arise from the early period of the time series (i.e. 1979-1987) that enter the climatology value: the NSIDC SII v3 values is lower /and flatter (relative to the later period).

This period corresponds to the Scanning Multi-channel Microwave Radiometer (SMMR) sensor, an early satellite with different characteristics (scanning, wavelengths, resolution) than the later Special Sensor Microwave Imager/Sounder (SSM/IS) missions. Kern et al. (2019) documented how the Weather Filters implemented in the Nasa Goddard NasaTeam data (NSIDC-0051) used as input to the NSIDC Sea Ice Index v3 act differently in the SMMR period than in the SSM/IS periods (see Fig. 1 g in Kern et al. 2019).

## 6.4. Conclusion of the intercomparison

We conducted a comparison of monthly SIE and SIA values between the OSI SAF SII and NSIDC SII v3 times series. We note up-front that this does not constitute a validation, since there is no ground-truth for such indicators. We also note that we do not tune the OSI SAF SII values towards the NSIDC SII values.

We observe that the two time series agree in terms of Sea Ice Extent trends in both hemispheres, with the NSIDC data showing slightly larger relative trends than OSI SAF during summer, mostly due to the early period in the time series (1979-1987).

The OSI SAF SII reports rather consistently larger Sea Ice Extent values than NSIDC SII v3, both in the Northern and Southern hemispheres, with differences reaching 0.5 million km^2 (average over the 1981-2010 period). In the Northern Hemisphere, we suspect that the OSI SAF SII v2p2 suffers more from land spill-over effects than NSIDC SII v3, and that the OSI SAF SIE values are probably too high. In the Southern Hemisphere however, we suspect the NSIDC SII v3 values to be too small, following the general underestimation of SIC by the NasaTeam algorithm (in the Southern Hemisphere only).

In terms of Sea Ice Area, the OSI SAF SII v2p1 are more realistic than those of in the NSIDC SII v3 : in the Northern hemisphere the NSIDC time series does not fill the polar observation hole (OSI SAF interpolates SIC data there), in the Southern hemisphere, the underestimation of SIC by the NasaTeam algorithm has a strong effect (stronger than for Sea Ice Extent).

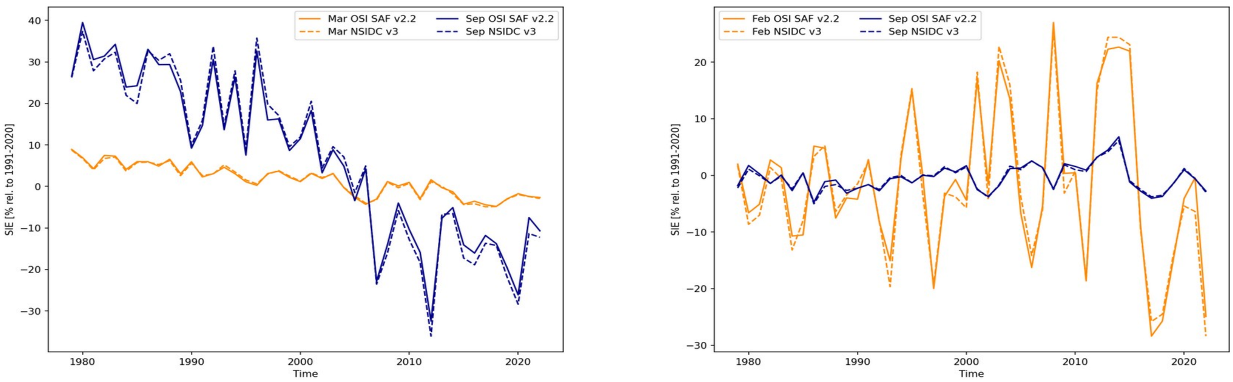


*Figure 7: Comparing the relative trends of OSI SAF and NSIDC SII timeseries.*

As far as the relative trends of minimum and maximum sea-ice extent in both hemispheres, the agreement between the two datasets is remarkable as is illustrated in Figure 7.

# 7. EVOLUTION FROM EARLIER VERSIONS

Earlier versions of this indicator included:

- **v2.1** was based on SIC CDR/ICDR v2, while **v2.2** is based on CDR/ICDR v3. Otherwise, they use the same algorithm.
- **v2** was based on the same SIC data, but without temporal interpolation of missing days, no SIA, and 1981-2000 as a base period; no sub-regions, and no data files.
- **v1** : based on “v1” SIC data (Tonboe et al. 2016): OSI-409, OSI-430, and OSI-401.

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