ECV Sea Ice

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Introduction and recent highlights.

Sea Ice CCI covers 2 variables:
- Sea Ice Concentration (SIC) from Passive Microwave Radiometer (PMR) data (1970s onwards).
- Sea Ice Thickness (SIT) from Radar Altimeter (RA) data (1993 onwards).

Sea Ice CCI data and R&D have successfully been transfered to:
- SIC: EUMETSAT OSI SAF (R&D), C3S and CMEMS (datasets)
- SIT: C3S (R&D and data) and CMEMS

Highlighted recent Sea Ice CCI contributions:
- IPCC AR6 WGI report (August 2021): D. Notz Lead author Chapter 9, our sea-ice data are cited and plotted in Chapter 2 and Chapter 9.
- The GCOS Status Report 2021 (September 2021): acknowledges the contribution of ESA CCI for improving the maturity of SIC and SIT observation records.
- Contributed to recent BAMS and WMO Statement of the Climate reports.
- CCI SIC data are Input to the C3S Arctic Regional Reanalysis (CARRA).
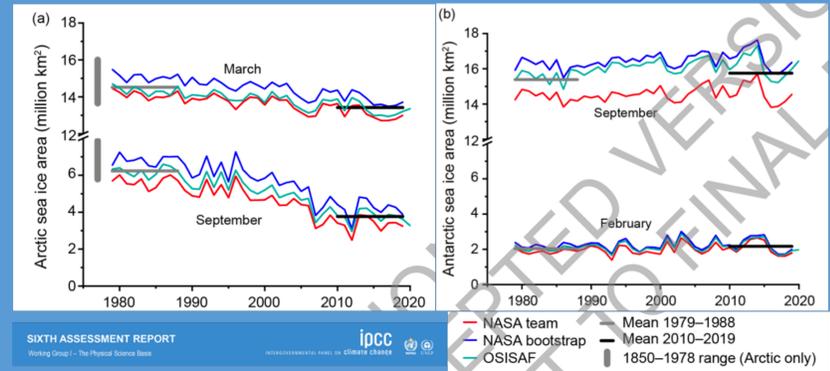
FIGURE: Arctic (left) and Antarctic (right) trends in sea-ice area as in the 6th IPCC Assessment Report (adapted from Chapter 2, Figure 2-20). The OSI SAF data (with R&D input from ESA CCI) is plotted together with two datasets from the USA.

Sea Ice Thickness.

Gridded and trajectory SIT data in the Arctic and Antarctic [Access: CCI Data Portal]
(Full retrieval from radar altimeter and auxiliary source data):
- Envisat (Oct. 2002 – Mar 2012) | CryoSat-2 (Nov. 2010 – Apr. 2017 [CCI SIT CDR v2.0])
- Files contains sea-ice freeboard, snow depth and sea ice thickness
- Operational continuation in C3S CDS with time delay of 1 month [Arctic SIT grids only]
- Northern Hemisphere: 25 km grid | winter month: October – April
- Southern Hemisphere 50 km grid | year-around

Key facts of SIT CDR
- Arctic winter SIT trends **are underestimated** (no dynamic snow load, Envisat data less accurate)
- Antarctic data is less mature than Arctic data set

Work in Progress scheduled for release in 2022 (SIT CDR v3.0)
- Adding ERS-1 (Oct. 1993 – April 1996) & ERS-2 (Oct. 1995 – April 2003)
- Extension of CDR to April 2021
- Improved snow climatology and uncertainty estimation
- Single time series from merged data (L3S) | Sea-ice volume from gap-filling (L4)
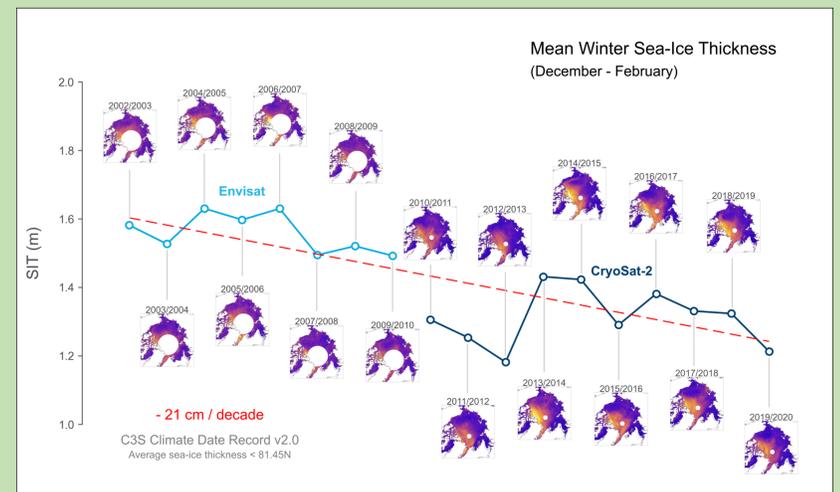
FIGURE: Dec. – Feb. mean winter SIT time series from Envisat & CryoSat-2 (source C3S SIT CDR) for latitude <81.45N. SIT Trend based on snow climatology and does not take different biases of Envisat and CryoSat-2 into account. It is highly likely that the trend underestimates the true thickness loss.

Sea Ice Concentration.

Existing data:

Coarse (25-50km) daily global SIC fields from 1979 to today
(EUMETSAT OSI SAF data with R&D input from ESA CCI):
- OSI-450 CDR (1979-2015)
- OSI-430-b ICDR (2016 onwards, 16 days latency)
- Prototype «fasttrack» ICDR (the last 16 days)
- All three available from https://osi-saf.eumetsat.int/

Medium (25km) daily global SIC fields from 2002 to today
- SICCI2-25km CDR (2002-2017), + plus ad-hoc extensions for C3S
- This data was used in C3S for the Arctic Regional Reanalysis

Integrated climate indicators
- OSI SAF Sea Ice Index (extent + area) (1979-today)
- Sea Ice Area data from Univ. Hamburg (1979-2020) from multiple sources for evaluation of climate simulation.

On-going developments with CCI+:

**Improve the spatial resolution of SIC fields from PMR.**
- We use the high-frequency imagery (from 1991) for higher resolution.
- The challenge is to not introduce (too much) retrieval noise.
- This R&D leads **to new data** from CCI+ Phase 1 (early 2022), especially high(er) spatial resolution (**12.5 km**) from PMRs (1991-2020).

Extend the SIC to the early 1970s with ESMR.
- SIC datasets traditionaly start in 1978 with SMMR;
- The Electronically Scanned Microwave Radiometer (**ESMR**) sensor was on board Nimbus-5 and collected science data 1972-1976.
- It is a single-channel sensor, so new algorithms are needed.
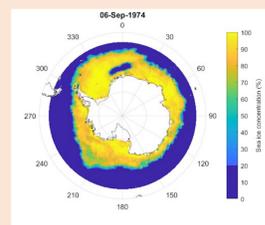
(Left): Example SIC map from ESMR. The map here is from Sept. 1974 and shows an occurence of the Weddell Sea Polynya.
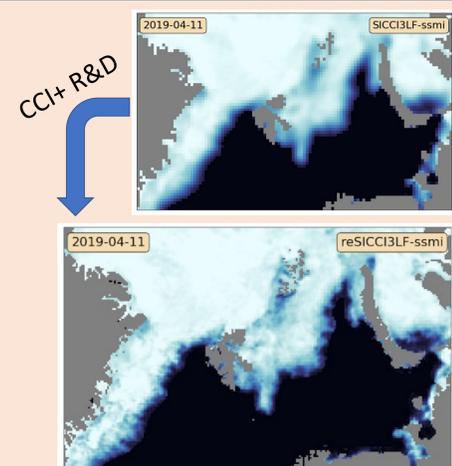
(Above): Improvement in spatial resolution from an OSI SAF CDR (top) to the upcoming CCI+ CDR (bottom). The CCI+ CDR is shorter (starts in 1991 vs 1978).

The other Sea Ice variables, future work.

- The GCOS Sea Ice ECV is today an umbrella-ECV with 4 quite different variables (sea-ice **Concentration**, **Thickness**, **Edge/Extent**, and **Drift**).

- In addition, sea-ice **Age** & **Type**, **Albedo** (incl. contribution from **melt-ponds**), surface **Temperature** (incl. **Melt/Freeze onset**), **snow-depth** are required and feasible.

- Observations of these variables are *relevant*, *feasible*, and *cost-effective* and thus qualify for being GCOS **Essential Climate Variables**.

- The future ESA Climate programme should address these additional variables.

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