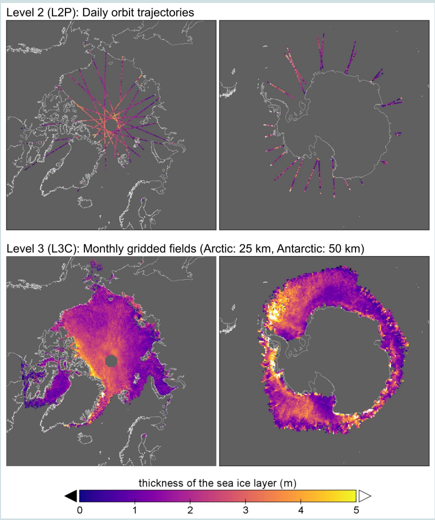
The Sea Ice ECV in CCI+

Thomas Lavergne (METNO), Eero Rinne (FMI), Dirk Notz (MPI-M), Stefan Kern (Univ Hamburg), Wiebke Kolbe (DMI), Ruth Mottram (DMI), Mari Anne Killie (METNO), Stefan Hendricks (AWI), Heidi Sallila (FMI), Atle M. Sørensen (METNO), Robert Ricker (AWI), Rasmus Tonboe (DMI), Henriette Skourup (DTU), Leif Toudal Pedersen (DTU), Roberto Saldo (DTU)

sea ice cci

Sea Ice Thickness

Climate Change Service
climate.copernicus.eu

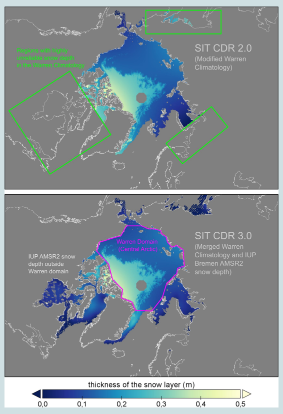


Sea Ice Thickness CDR

- Daily L2P orbit data
- Monthly L3C gridded data
- Both hemispheres (NH: Oct-Apr. only, SH: experimental)

Algorithm Improvements for CDR v3

Updated NH Snow Climatology



Range correction & freeboard to thickness conversion

Level-3 Uncertainties

Improved gridded uncertainty algorithm

Level-4 product

Gapless SIT for sea-ice volume estimation

General Improvements

Extending SIT record to ERS period (see below)

Various improvements in surface type classification, retracking and data filtering

Sea Ice Concentration

EUMETSAT OSI SAF

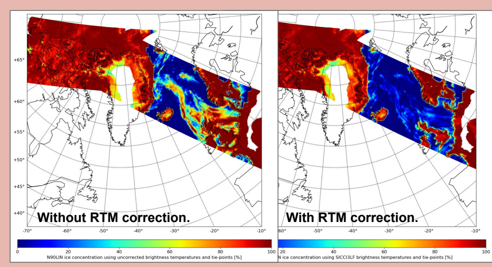
Climate Change Service
climate.copernicus.eu

A 30 years higher resolution timeseries.

An objective for CCI+ Sea Ice is to develop a ~30 years CDR of Sea Ice Concentration at a higher spatial resolution than currently available from EUMETSAT OSI SAF and US NSIDC.

Two-stage approach :

- Refine SIC algorithms using the near-90 GHz imagery of SSM/IS (starting in 1991). These microwave frequencies offer higher spatial resolution, but cause larger retrieval noise. We use an RTM-based correction scheme (and Copernicus ERA5 data) to dampen this noise.

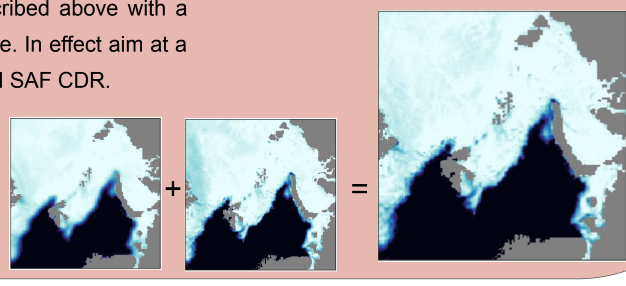


Above: unmasked SIC (intermediate product) from a near-90 GHz algorithm without RTM correction (left) and with RTM correction (right). Contrarily to with ERA-Interim, we find that ERA5's Cloud Liquid Water yields improved RTM correction.

- Combine the algorithm described above with a coarser (and lower noise) one. In effect aim at a sharpened version of the OSI SAF CDR.

Right: Illustration of the sharpening process applied to a mock OSI SAF field (left), using a near-90 GHz SIC (middle), and producing a "sharpened OSI SAF" data (right).

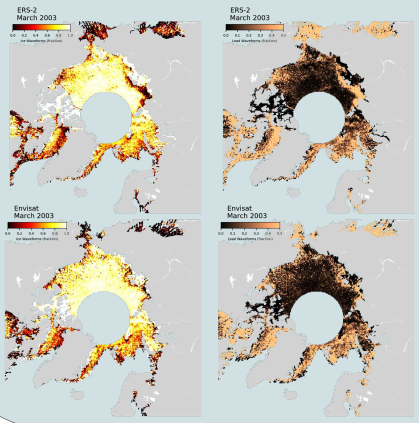
The method will be refined in Year 3 of CCI+.



Sea Ice Thickness

ERS-1 and ERS-2

- To extend the sea ice thickness records back to 1990's the Sea Ice CCI+ uses data from the **ERS-1** and **ERS-2** satellites.
- A consecutive thickness record has been established in the previous CCIs for **CryoSat-2** and **Envisat**.
- ERS has specific challenges, mainly in **pulse blurring** and **surface type classification**. Also, ERS **documentation** has proved hard to find.
- ERS lessons learned from sea ice processing are **highly relevant for other CCI projects** using altimeter data.



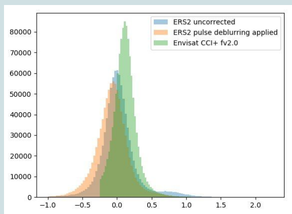


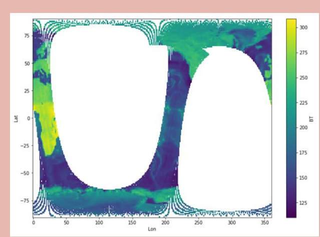
Figure (right): Example of initial ERS-2 **pulse deblurring** applied on the freeboard. Note the reduction of high values.

Figure (left): Example of ERS-2 (top) **surface type** results vs Envisat (bottom) surface types for the overlap period in March 2003. Columns are for fractions of ice (left), and lead (right) waveforms.

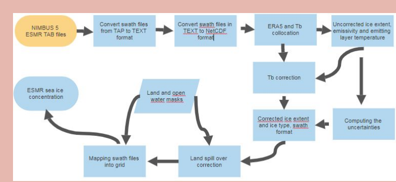
Sea Ice Concentration

ESMR on NIMBUS-5

- The ESMR instrument on board the NIMBUS 5 satellite was a one channel 19.35 GHz horizontally polarised microwave radiometer operating from Dec. 1972 to May 1977. Data from a single orbit is shown in the **figure (left)**.
- The Level 1 data have recently been made available by NASA and we are using modern algorithms for processing the data and estimating the sea ice extent for this important period before modern multifrequency radiometers. The **figure (right)** shows the data-processing flow chart.



The figure shows one ESMR swath from a single orbit. The swath width is about 2600 km and coverage of polar regions is complete in only 6 orbits (about ½ day). Radiometric contrast between ice and water is excellent (about 100 K).



The flowchart shows the ESMR data processing steps: first the data are converted to NetCDF format for internal storage and easier handling in the next processing steps. The brightness temperatures (Tb) are collocated with numerical weather prediction (NWP) data and a first guess sea ice concentration is computed and then a Tb correction is applied using a radiative transfer model and the NWP data. The corrected Tb data are then used for computing the sea ice extent. Post-processing steps include land-spill-over correction, climatological masking, gridding and estimation of the uncertainty.

A common sea ice mask for the ocean ECVs?

- Ocean ECVs use auxiliary sea ice masks in their algorithms and/or output products.
- Existing data records of SIC do not agree on the ice/no-ice contour. Some exhibit trends or jumps.
- What is the impact on Ocean ECVs? Can CCI benefit from a common sea ice mask?

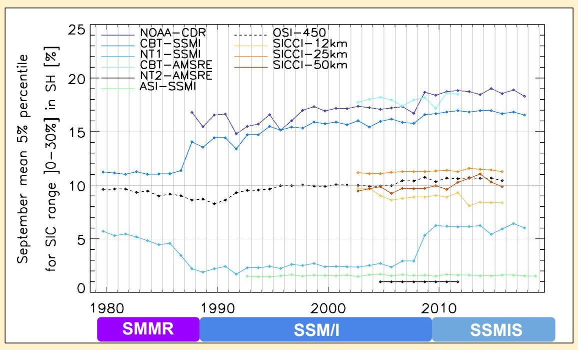


Figure: Time series of "smallest non-filtered SIC" for the Antarctic in September for ten SIC products:

1) Datasets do not define the same ice/no-ice contour line;
2) Some datasets exhibit jumps across sensor series (e.g. 1987 and 2008)

From *Kern et al. 2019.*

Kern, S., Lavergne, T., Notz, D., Pedersen, L. T., Tonboe, R. T., Saldo, R., and Soerensen, A. M.: Satellite Passive Microwave Sea-Ice Concentration Data Set Intercomparison: Closed Ice and Ship-Based Observations, The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-120, 2019.

ocean colour cci | sea surface salinity cci | sst cci | sea level cci | sea state cci

Contact:
thomas.lavergne@met.no
@lavergnetho

Website:
http://cci.esa.int/seaice

Norwegian Meteorological Institute · AWI · FMI · Danmarks Meteorologiske Institut · Max-Planck-Institut für Meteorologie · DTU