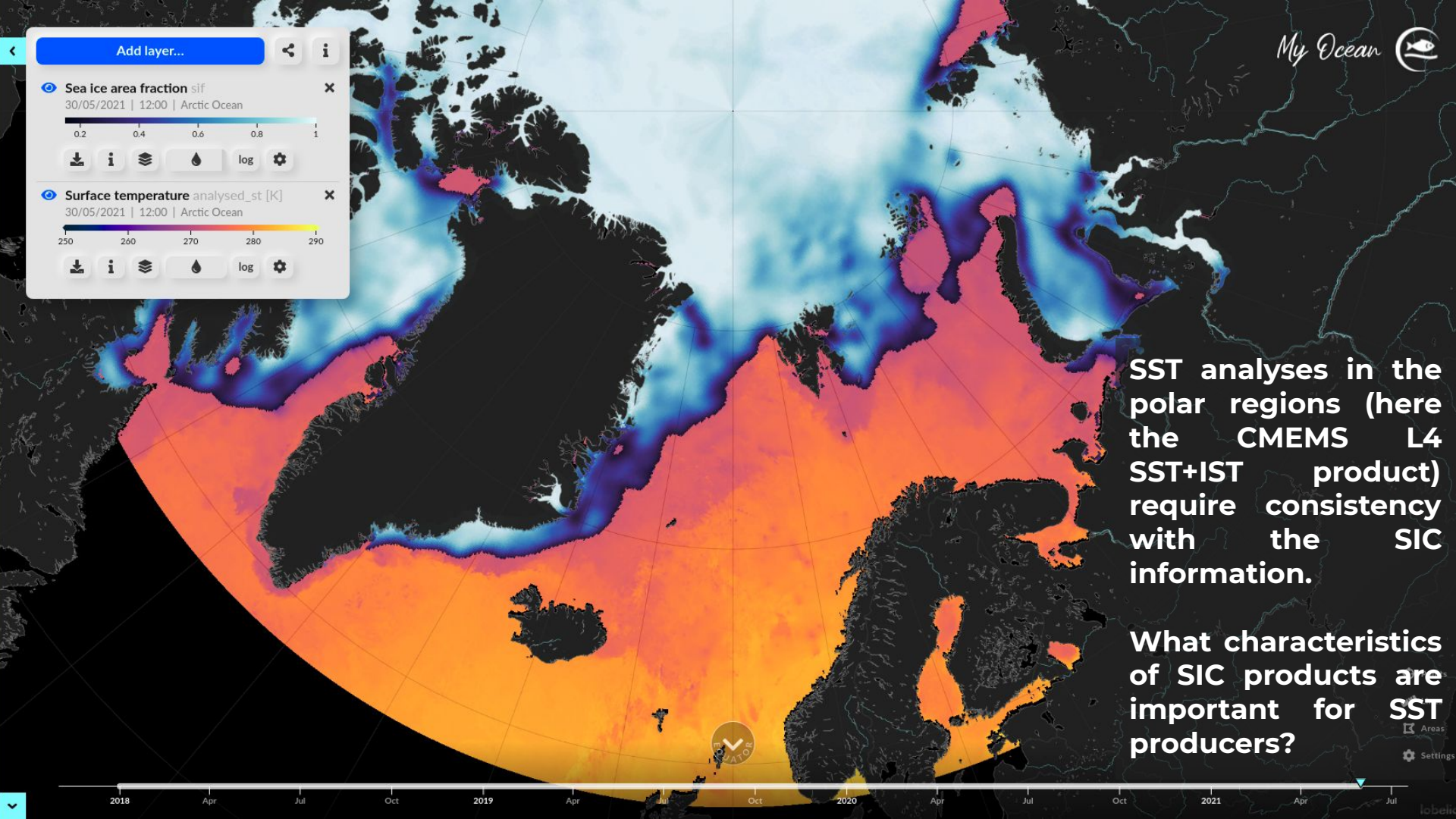
Status and plans for the sea-ice concentration data records from the EUMETSAT OSI SAF and ESA CCI: Possibilities for polar SST products

Thomas Lavergne (1), Atle Sørensen (1), Jacob Høyer (2), Pia Nielsen-Englyst (2), Gorm Dybkjær (2), Rasmus Tonboe (2) and Steinar Eastwood (1)

1: Norwegian Meteorological Institute, 2: Danish Meteorological Institute

@lavergnetho
thomas.lavergne@met.no

22ND GHRSST INTERNATIONAL SCIENCE TEAM MEETING (G-XXII) - June 2021


Add layer...
Sea ice area fraction sif
30/05/2021 | 12:00 | Arctic Ocean
0.2 0.4 0.6 0.8 1
log
Surface temperature analysed_st [K]
30/05/2021 | 12:00 | Arctic Ocean
250 260 270 280 290
log
My Ocean
SST analyses in the polar regions (here the CMEMS L4 SST+IST product) require consistency with the SIC information.
What characteristics of SIC products are important for SST producers?
Areas
Settings
2018 Apr Jul Oct 2019 Apr Jul Oct 2020 Apr Jul Oct 2021 Apr Jul

Outline

Four characteristics of SIC products:

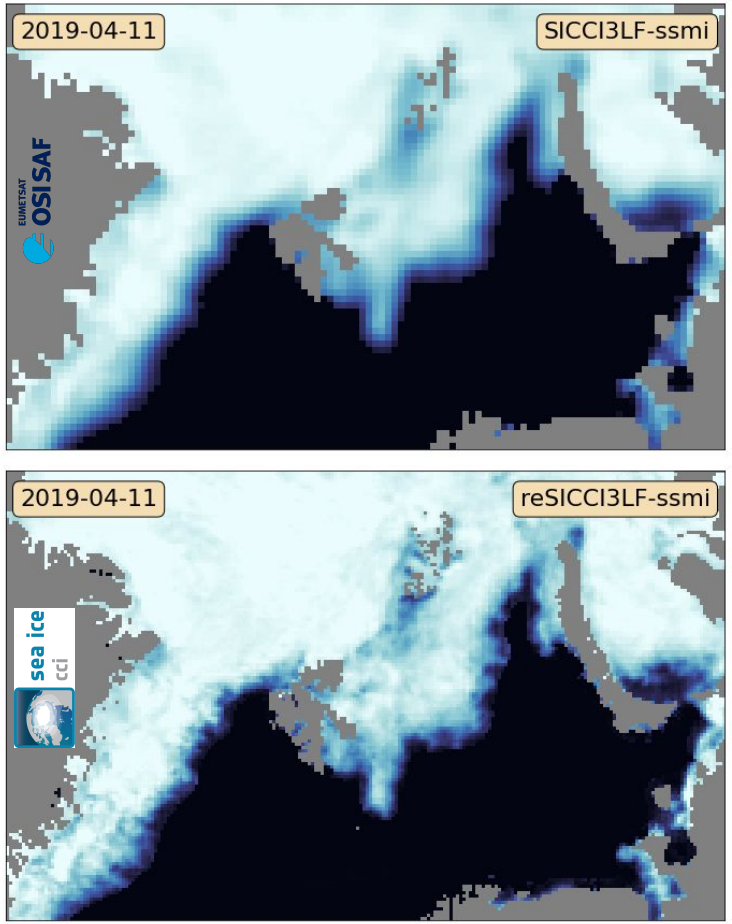
- Spatial resolution;
- Accuracy at low concentration range;
- Open Water Filters (aka Weather Filters);
- Land spill-over effects.

Using an SST product to filter SIC products

Upcoming SIC Climate Data Records from OSI SAF and ESA CCI+

Four characteristics of SIC products:
1. Spatial resolution

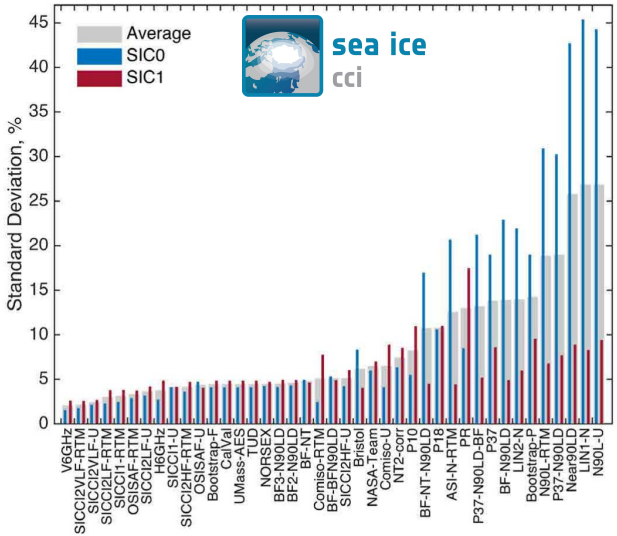
- Different SIC algorithms, using different microwave imagery channels, result in different spatial resolutions.
- Figure: example fields of (upcoming) SIC data records from OSI SAF (top) and ESA CCI (bottom). The OSI SAF algorithm will use only the 19 & 37 GHz channels (>=*1978*), the ESA CCI algorithm will also use the ~90 GHz channels (>=*1991*).
- Higher resolution (still ~10 km) allows SST products to come nearer the true sea-ice edge.
- ⚠️ higher-resolution channels can bring higher SIC retrieval noise ⚠️ (until we get EU CIMR).

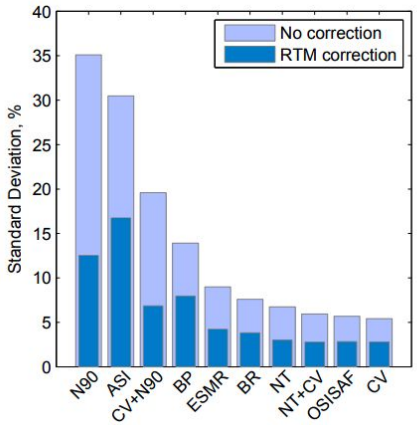


Note: from development versions of the "v3" OSI SAF and CCI+ SIC products, to be released late 2021.

Four characteristics of SIC products: 2. Retrieval accuracy

- Different SIC algorithms, using different microwave imagery channels result in different accuracy.
- Various techniques exist to reduce the retrieval noise. Over open water, atmospheric correction with Radiative Transfer Models is adopted by OSI SAF and CCI.
- Figures (top): Intercomparison of many SIC algorithms, ranked by retrieval accuracy (std-dev), (bottom): Impact of RTM correction on selected algorithms (both Ivanova et al., 2015).
- The OSI SAF and ESA CCI CDRs typically have ~2-3% residual RMSE over open water.

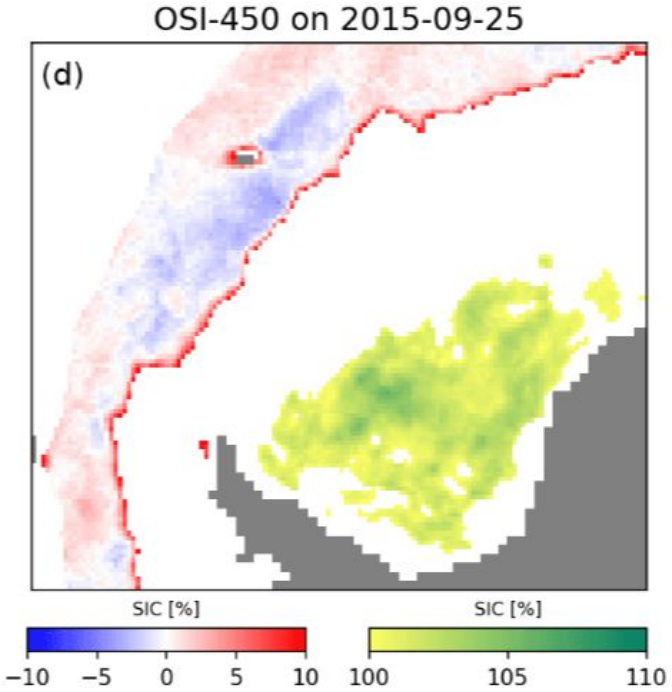




Ivanova et al.: Inter-comparison and evaluation of sea ice algorithms: towards further identification of challenges and optimal approach using passive microwave observations, The Cryosphere, 9, 1797–1817, https://doi.org/10.5194/tc-9-1797-2015, 2015.

Four characteristics of SIC products:
3. Open Water Filter (1 / 2)

- All SIC data producers apply a filter to remove the residual noise over open water, called an Open Water Filter (*aka* Weather Filter).
- OWFs will also remove some true ice along the edge. The greediness of the filter can be controlled (Lavergne et al., 2019).
- Fig: “raw_ice_conc_values” variable from the EUMETSAT OSI SAF CDR files (Weddell Sea). The zone with max ~10% SIC along the ice edge can be true ice, clipped by the Open Water Filter.

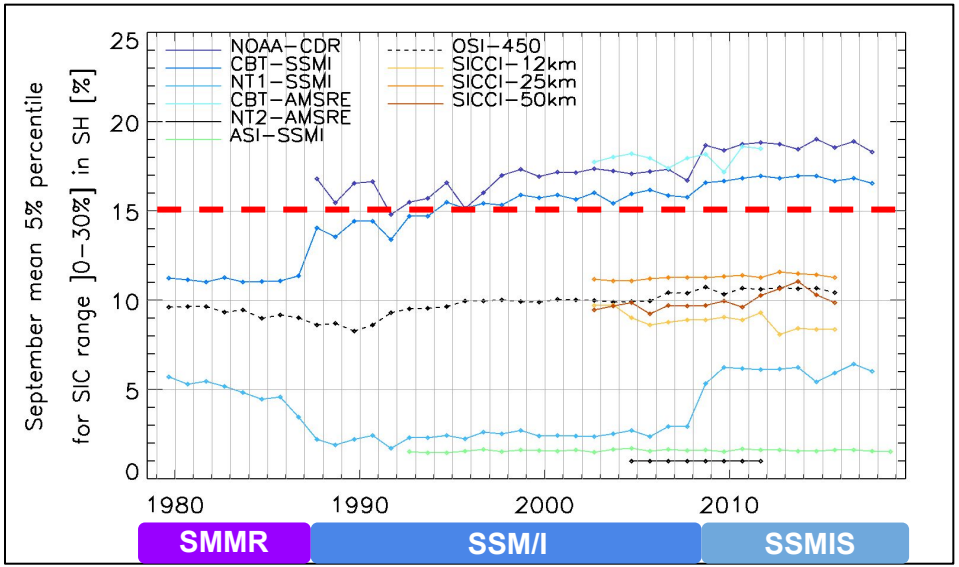


Lavergne, T., et. al.: Version 2 of the EUMETSAT OSI SAF and ESA CCI sea-ice concentration climate data records, The Cryosphere, 13, 49–78, https://doi.org/10.5194/tc-13-49-2019, 2019.

Four characteristics of SIC products:
3. Open Water Filter (2 / 2)

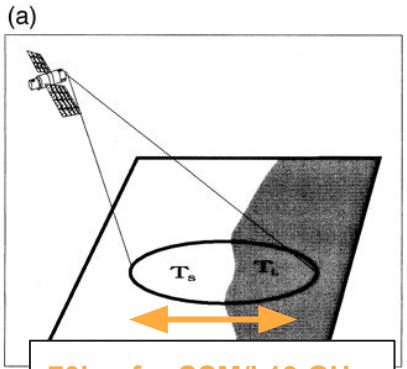
- For SST Climate Data Records, check if the greediness of the filters are consistent across satellite missions!

- Fig: Time series of “smallest non-filtered SIC” for the Antarctic in September for ten SIC products:
  - Datasets do not define the same ice/no-ice contour line;
  - Some datasets exhibit jumps across sensor series (e.g. in 1987 and 2008).

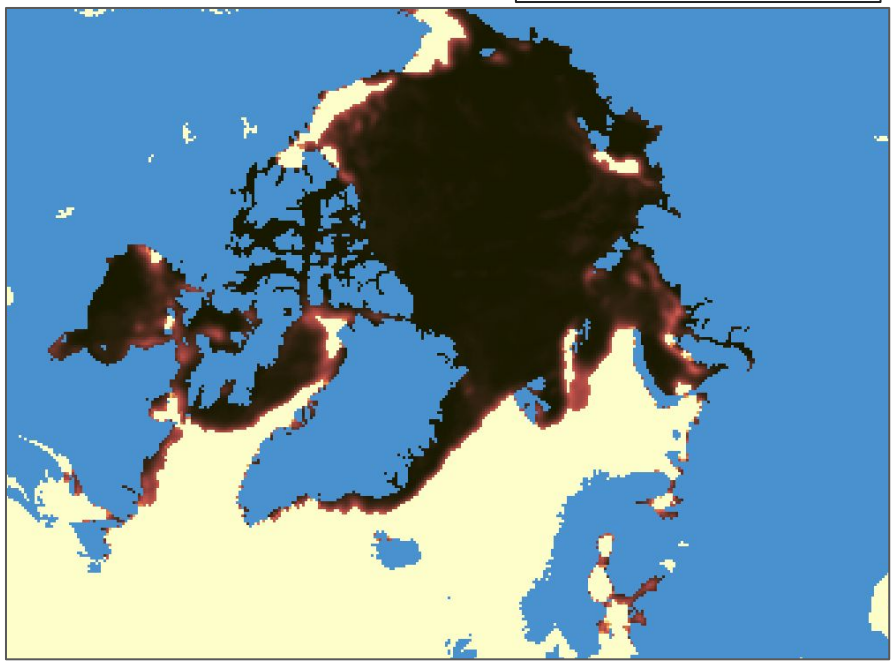


Kern, S., et al.: Satellite passive microwave sea-ice concentration data set intercomparison: closed ice and ship-based observations, The Cryosphere, 13, 3261–3307, https://doi.org/10.5194/tc-13-3261-2019, 2019.

Four characteristics of SIC products: 4. Land spill-over effects



- The coarse resolution of the PMR instruments leads to land spill-over in coastal regions.
- Land emissivity is similar to sea-ice emissivity for the microwave frequencies we use in SIC algorithms: a contamination by land looks like fractional sea-ice.
- Algorithms exist to mitigate the issue, but many datasets have remaining SICs along the coast (and too aggressive a filtering is not a solution).
- Fig: OSI SAF SIC (based on SSM/I) with a colormap that exagerates the low concentration range (and brings forward the coastal noise).



Bennartz, R. (1999). On the Use of SSM/I Measurements in Coastal Regions, JOAT

SST and SIC consistency

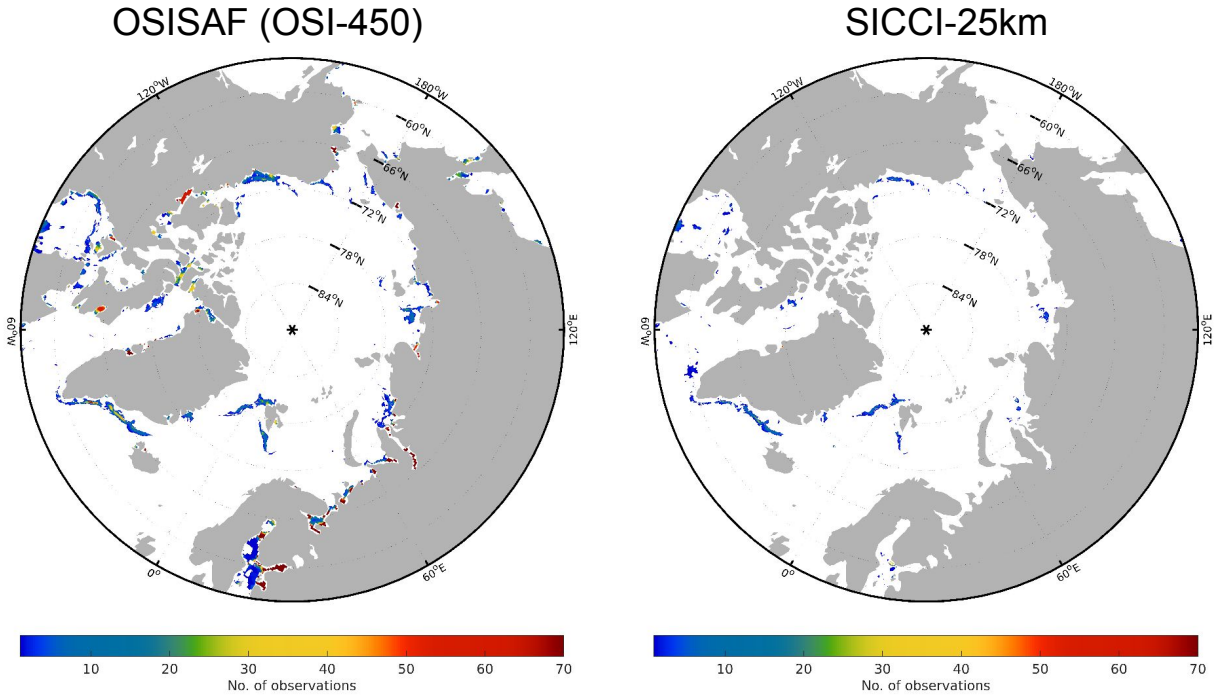


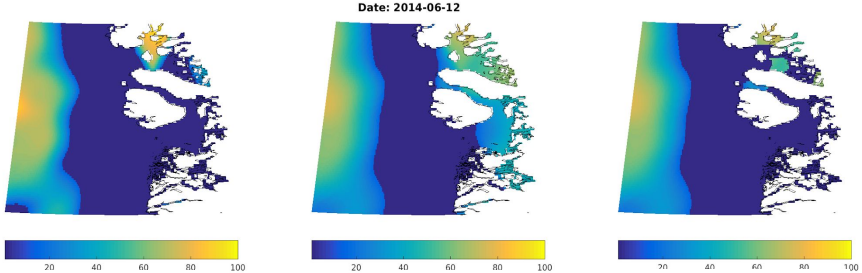
Fig: Number of cases with coincident CCI/OSTIA SST > 3°C and SIC>15 % for OSI-450 and SICCI-25km during 2009.

OSI-450 is based on SSM/IS while SICCI-25km is based on AMSRs.

Sea ice filtering using SST

C3S CARRA and CMEMS use SST information to:

- Remove spurious sea ice
- Increase consistency between OSI-450 and SICCI-25km

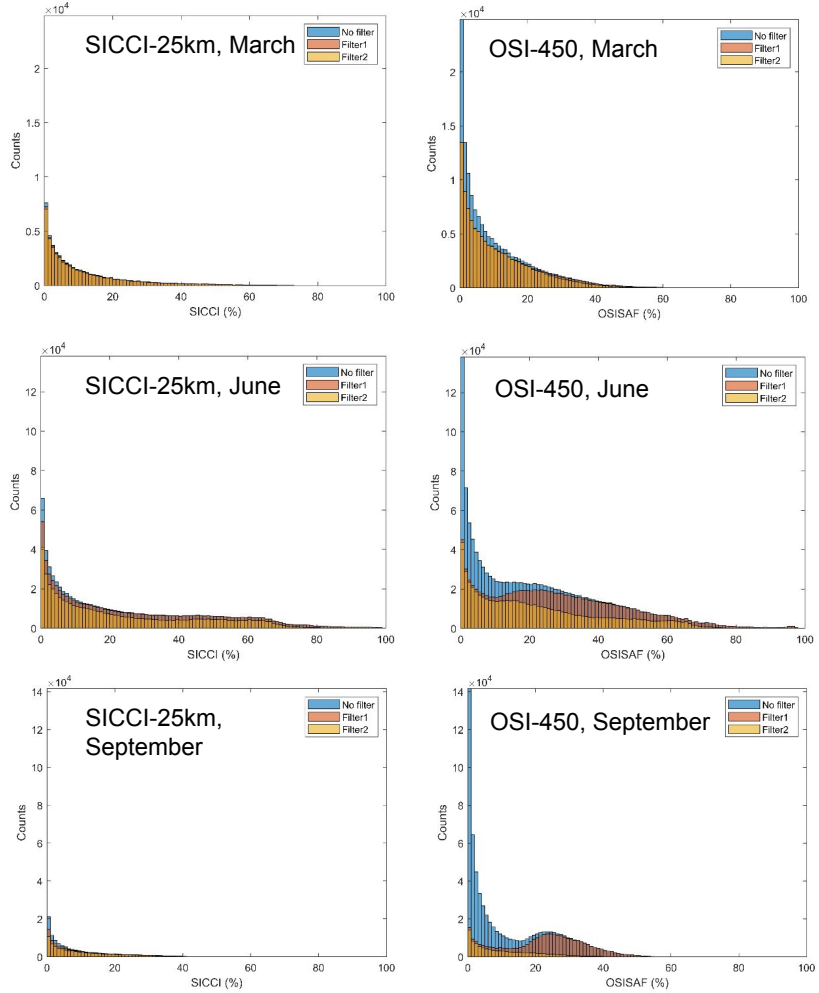


SICCI-25km | OSI-450 | OSI-450 filtered

- Filter 1: Ice is removed if land and ocean both occurs within 75km
- Filter 2: Ice is removed if land occur within 75 km and SST exceeds the linear SSTt (1.5-2.5°C for 1995-2017, based on CCI/OSTIA trend).

See poster by Pia Nielsen-Englyst et al.

Sea ice & SST>3°C, 2014



Present and upcoming SIC CDRs

Already available: “v2”

- OSI SAF v2 (1979-today, 25-50 km): http://www.osi-saf.org/
- SICCI-25km (2002-2017, 25 km resolution): climate.esa.int/data

In preparation: “v3”

- OSI SAF v3:
  - 1978-today, 25-50 km resolution from SSM/IS
  - 2002-2020, 25 km resolution from AMSRs

- CCI+ Sea Ice v3:
  - 1991-2020, 12.5 km resolution from SSM/IS and AMSRs
  - 1972-1976 from ESMR Nimbus-5

v3 release late 2021, for information contact thomas.lavergne@met.no

Summary

- Several characteristics of SIC products are of interest to the SST community when using these as masks in the polar regions:
  - Spatial resolution;
  - Accuracy of the SICs at low concentration range;
  - Beware of the Open Water Filters and their greediness;
  - Land spill-over correction.
- SST data records can be used to improve the SIC CDRs (e.g. coast and MIZ region, bc. higher spatial resolution or IR SSTs).
- SIC CDRs “v2” are available from OSI SAF and ESA CCI.
- Future work:
  - SIC : better land spill-over correction and spatial resolution for upcoming v3 SIC CDRs;
  - SST : Operational CMEMS and CARRA products will include the SIC filtering.