

**Ocean salinity science conference
9 november 2018**

Copernicus Imaging Microwave Radiometer (CIMR)

CIMR: a new low frequency microwave radiometer for an all-weather, high spatial resolution, and accurate estimation of ocean and sea-ice parameters.

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Georg Heygster, Craig Donlon,
and the CIMR team

CIMR is a High Priority Candidate Mission for **Copernicus** expansion designed to respond directly to the Integrated **EU Arctic Policy**.

- **CIMR** will provide :

First priority

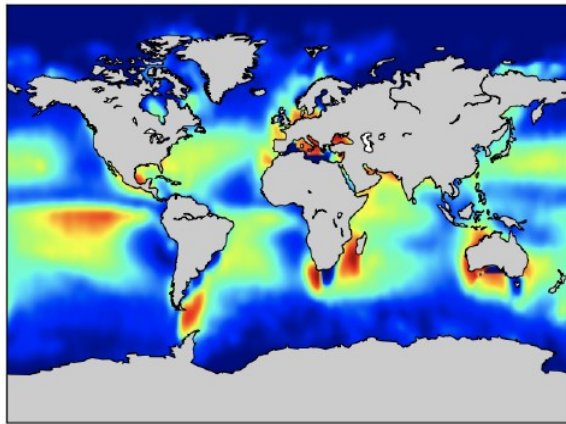
- **Sea Surface Temperature (SST)**
- **Sea Ice Concentration (SIC)**

Second priority

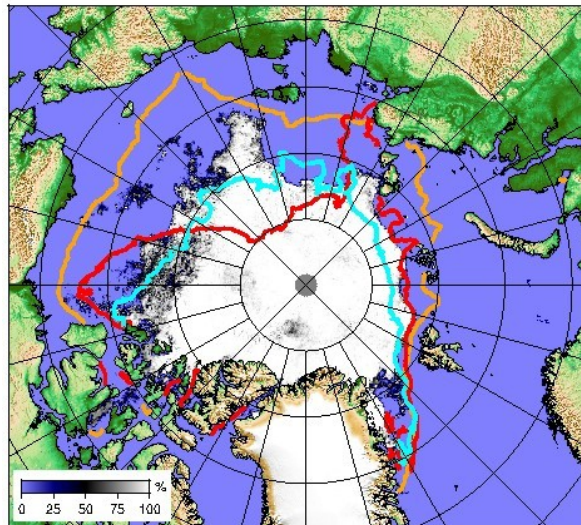
- **Sea Surface Salinity (SSS)**
- **Ocean Wind Speed (OWS)**
- **High Ocean Wind Speed (HOWS)**
- **Sea Ice Thickness (SIT)** (below 0.8 m)

And many other parameters...

Motivation



Mean clear sky probability (from ATSR)



— 1981–2010 Sep (NSIDC) — 2007 Sep — 2012 Sep

Sea Ice extent in Septembre for different years

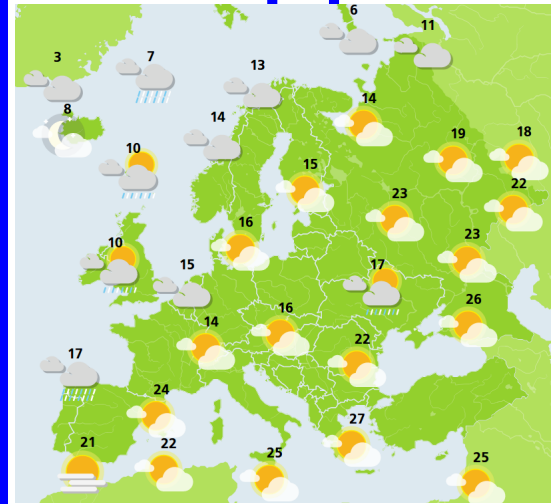
Current situation

- SST derived from IR under clear sky (<40% globally)
- SIC derived from VIS under clear sky and daylight only
- SST, and SIC derived from microwave sensors under cloudy condition and at night (e.g., AMSR2)
- SSS, HOWS and SIT derived from SMOS and SMAP

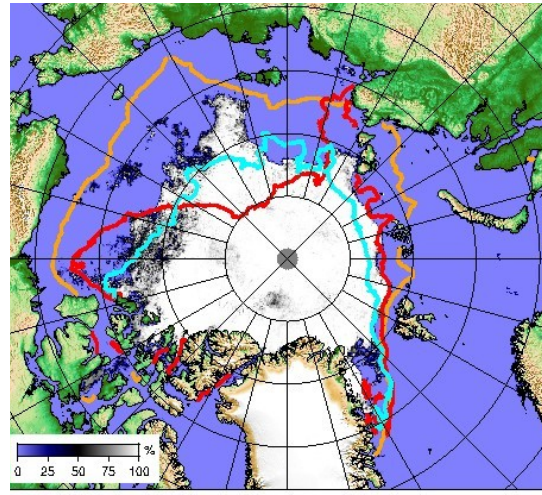
Limitations so far

- Microwave SST and SIC at low spatial resolution (~50 km using 6 GHz) and limited accuracy.
- No guarantee of continuation of the measurements for any of these products, with 6 and 1.4 GHz.

Applications of the CIMR mission

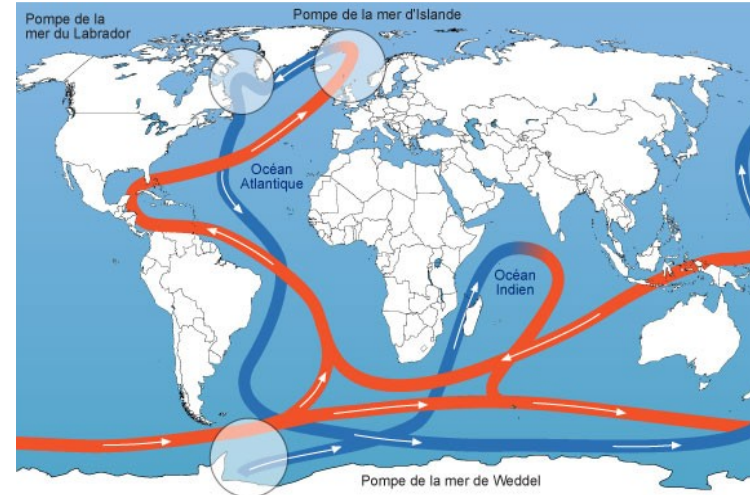


Numerical Weather Prediction



— 1981–2010 Sep (NSIDC) — 2007 Sep — 2012 Sep

Climate models



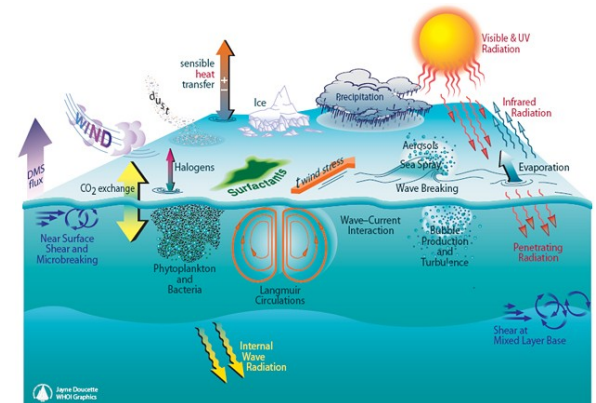
Study mesoscale variability
heat, and energy transport



Ship and offshore operations



Understanding marine ecosystem variability



Air/sea interaction
Physical and biogeochemical

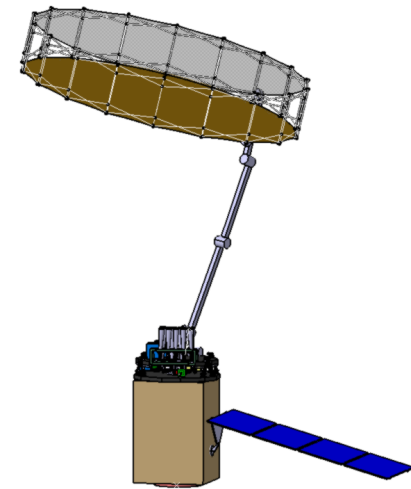
CIMR instrument concept

- Passive microwave conically scanning imager (**55°**)
- **5 channels** with dual polar (full polar?) receivers and RFI mitigation

Priority	secondary	primary	primary	primary	primary
Frequency (GHz)	1.4	6.9	10.65	18.7	36.5
Footprint (km)	≤55	≤15	≤15	≤5	≤5
NeDT (K)	0.3	0.2	0.3	0.3	0.7

 *Figures from CIMR mission requirements document*

- Very low noise receivers
- **~7 m** mesh Large Deployable Reflector
- Full coverage of the poles (no hole)
- Sun synchronous polar orbit (close to MetOp-SG B)



Sea Surface Parameter Retrieval

Sea Surface Temperature

- Better spatial resolution (from 48 to ≤ 15 km)
- Better cover of coastal areas (down to 20 km)
- Higher retrieval precision (around 0.2 K)
- Account for the wind speed from MetOp-SG B

Sea Surface Salinity

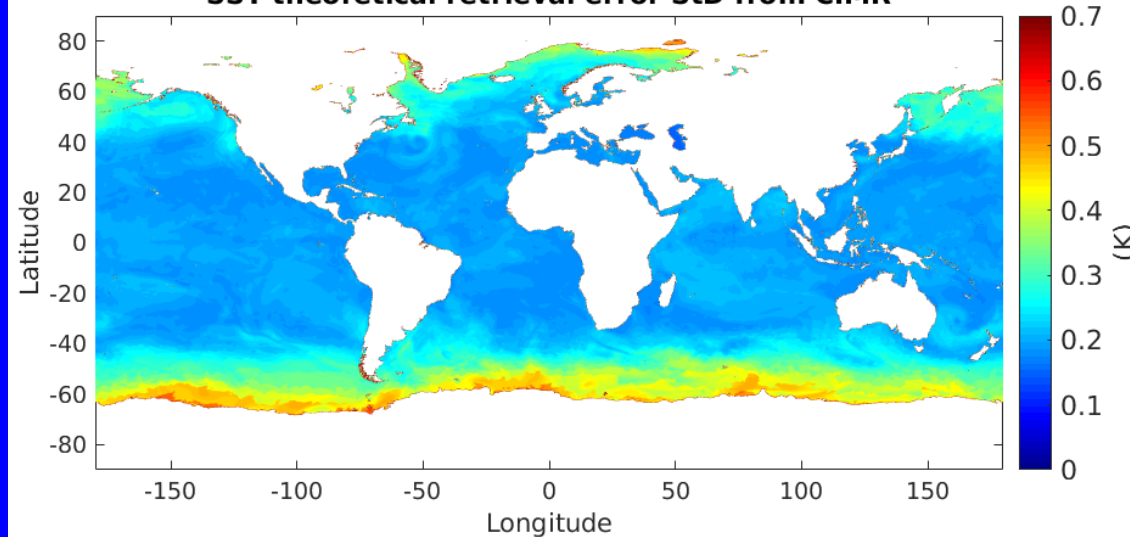
- High radiometric sensitivity to provide a theoretical precision of ~ 0.3 psu instantaneously
- Coincident analysis of the SST, OWS, SIC, and SSS
- Spatial resolution of ≤ 55 km but possibility to benefit from the oversampling at 1.4 GHz.

High Ocean Surface Wind Speed

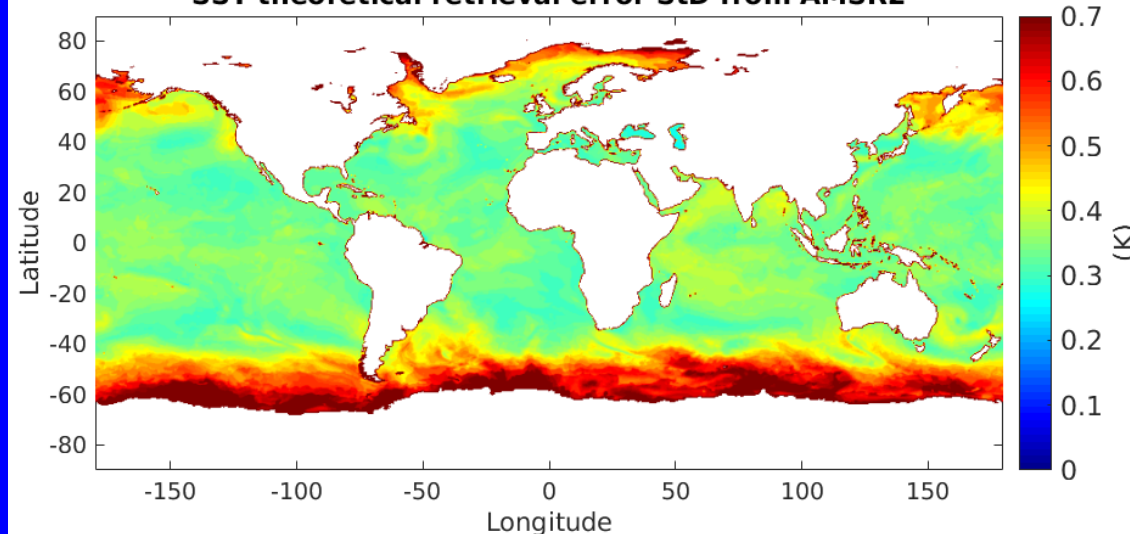
- Unique estimation of the high surface wind speed with the 1.4 GHz (in addition to regular OWS...).

Sea Surface Temperature Retrieval

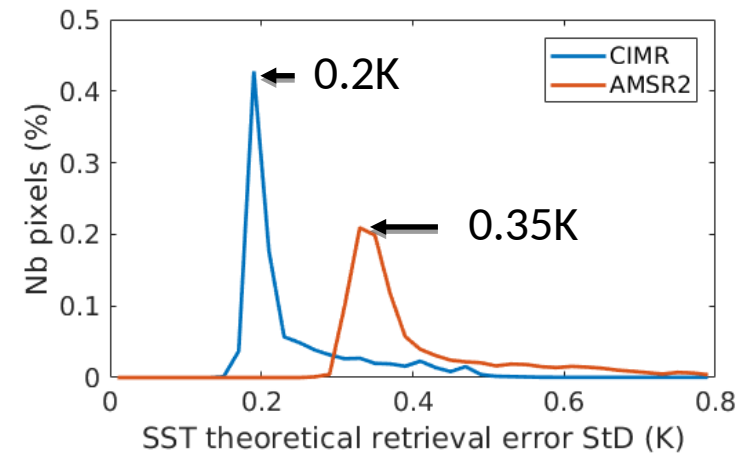
SST theoretical retrieval error StD from CIMR



SST theoretical retrieval error StD from AMSR2

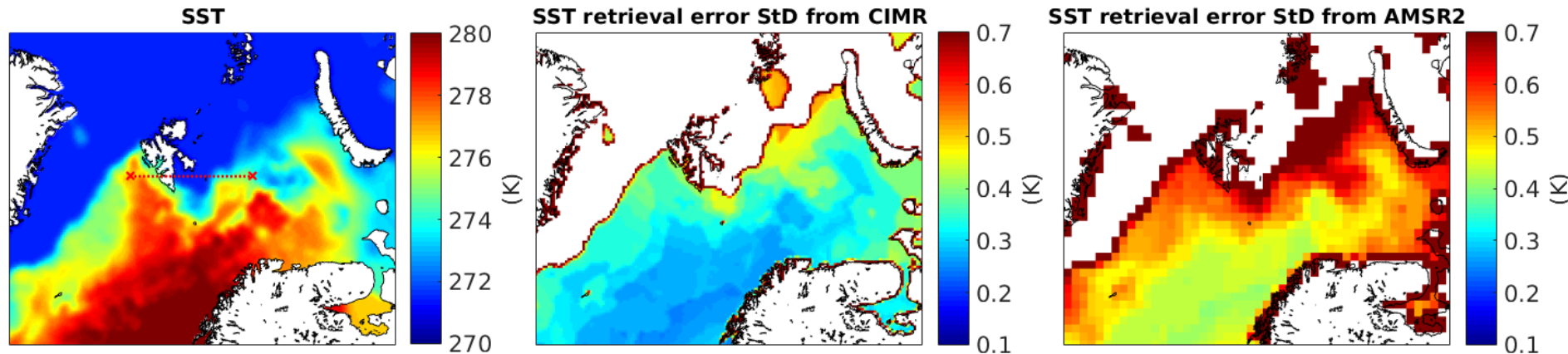


From careful information content analysis built upon up-to-date radiative transfer and realistic hypothesis

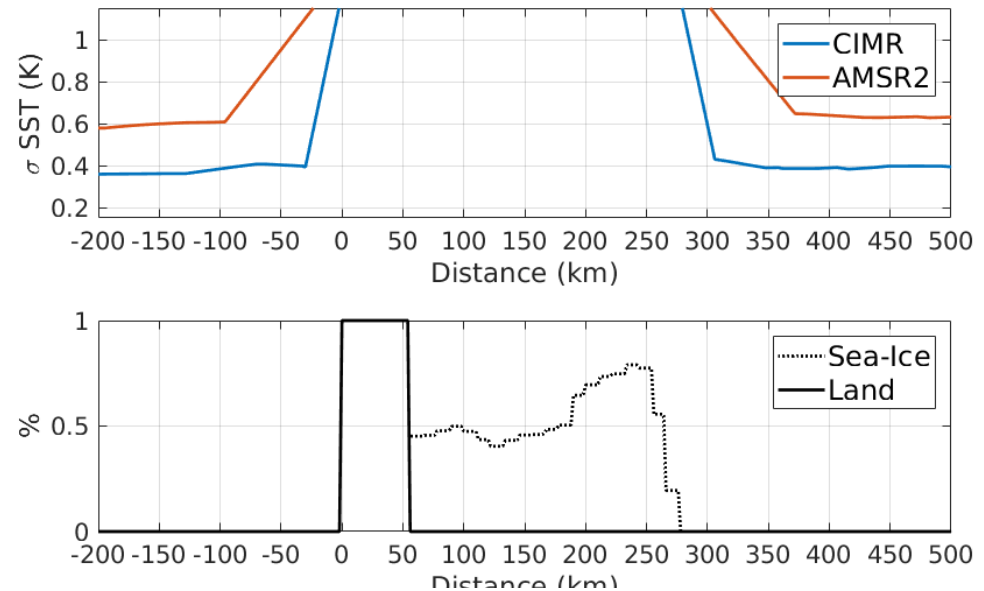


- The spatial resolution and the precision of the SST retrieval are largely improved with CIMR (≤ 15 km and 0.2 K) compared to AMSR2 (48 km and 0.35 K)

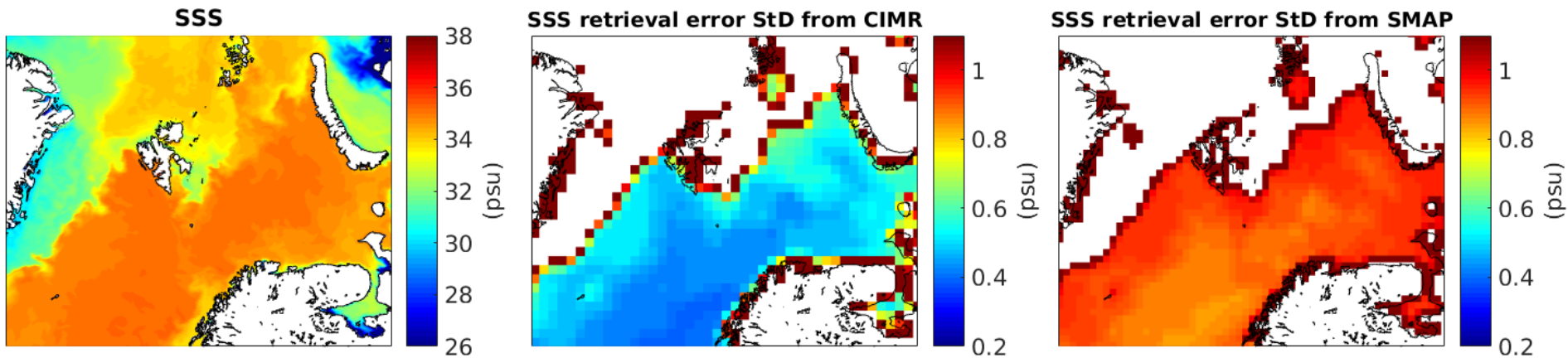
Sea Surface Temperature Retrieval



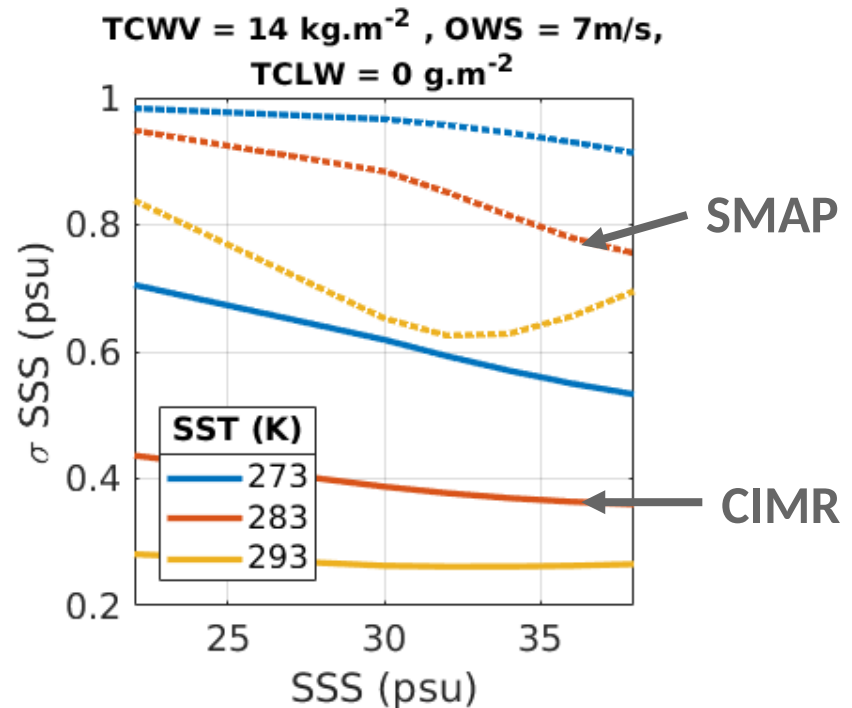
- SST retrieval precision is improved especially for cold water where the retrieval is difficult.
- Improvement close to the coasts and sea ice margins.



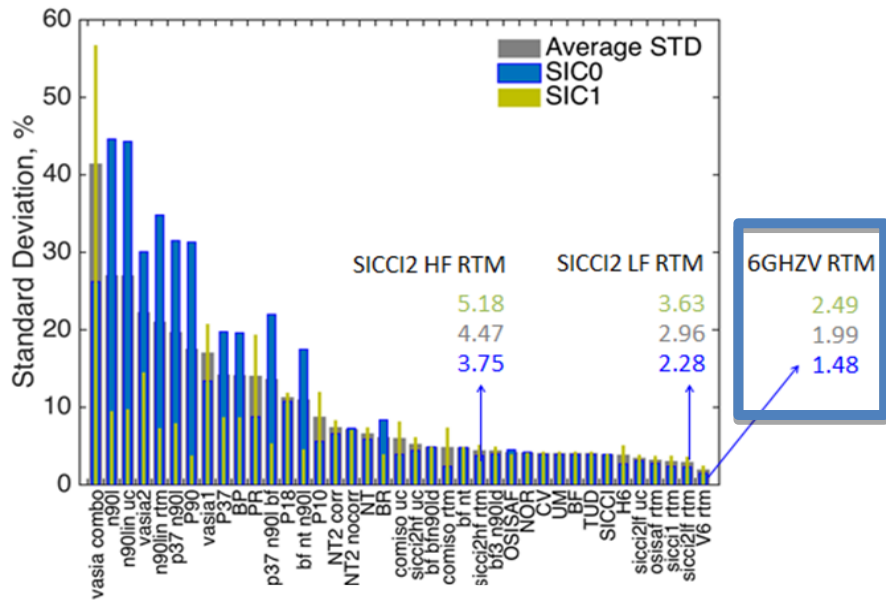
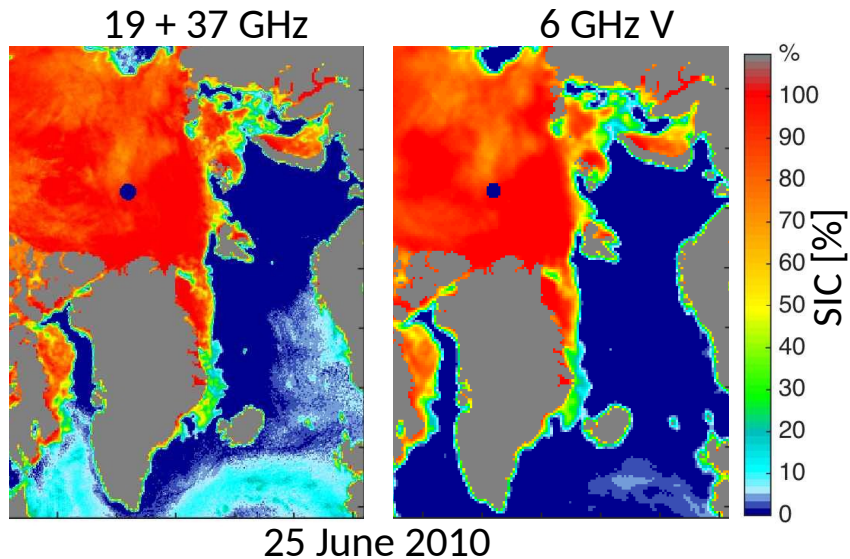
Sea Surface Salinity Retrieval



- SSS precision is improved (0.3 psu) due to the CIMR low noise receivers and to the better sensitivity to SSS at 55° incidence angle.
- The spatial resolution is large (≤ 55 km) due to the incidence angle of 55° needed to cover entirely the poles.



Sea Ice Parameter Retrieval



Figures courtesy of Sea Ice CCI team

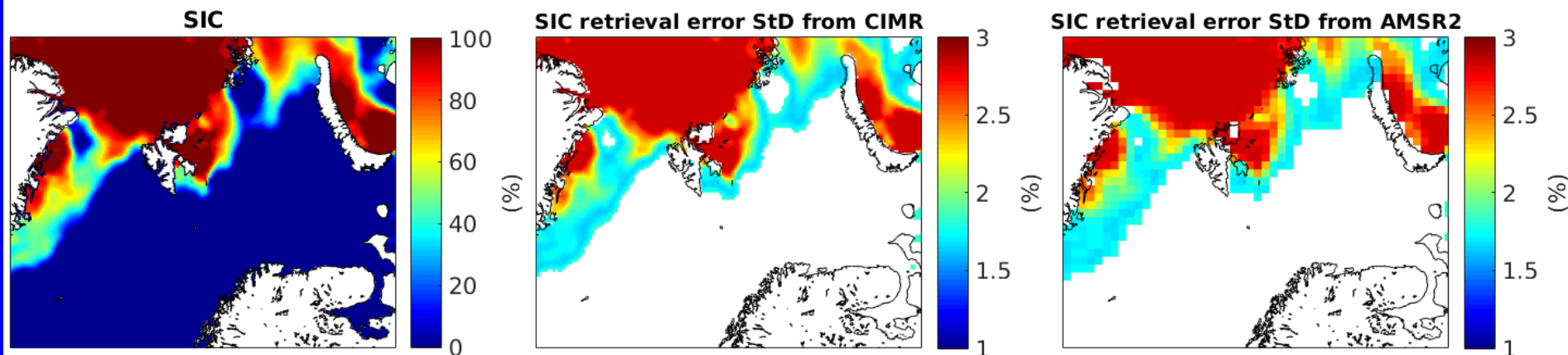
Sea Ice Concentration

- Retrieval with 18 GHz and 36 GHz combination at better spatial resolution.
- Retrieval including the 6 GHz performs best with less atmospheric contamination.
- Better coverage of coastal areas

Thickness of thin sea ice

- at 1.4 GHz
- Demonstrated with SMOS and SMAP

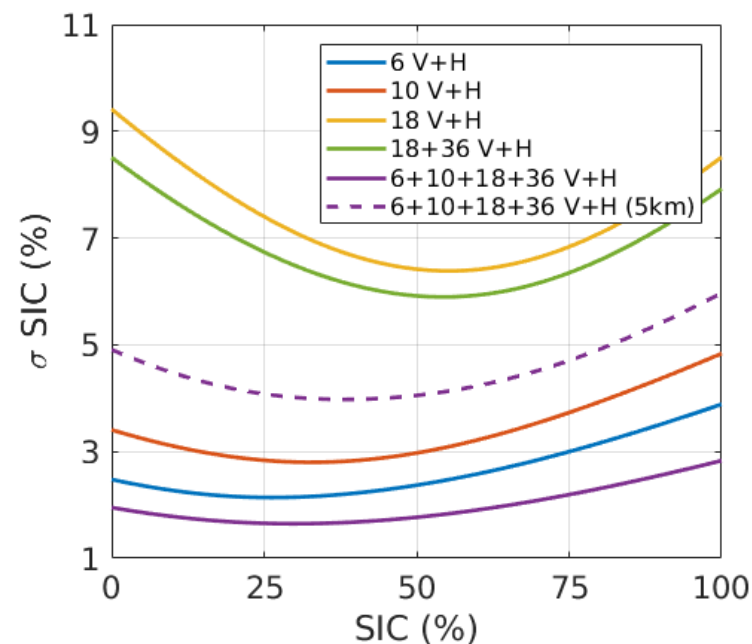
Sea Ice Concentration Retrieval



- Improved spatial resolution (≤ 5 km) and possibility to analyse the ice margin
- SIC retrieval precision is around 5 % when including the low frequencies
- Refinement of the retrieval under way to benefit from :

(1) the high sensitivity of the low frequencies

(2) the high spatial resolution of the high frequencies



CIMR products

- All-weather global retrievals, twice daily
- SST with 0.2 K precision at ≤ 15 km spatial resolution
- SSS with a precision of 0.3 psu instantaneously at ≤ 55 km spatial resolution
- SIC with 5% precision at ≤ 5 km spatial resolution
- Coincident SST, SSS, OWS, HOWS, SIC, and SIT

Parameters	Spatial resolution (km)	Precision (instantaneously)	Time sampling
Sea Surface Temperature	≤ 15	0.2 K	Twice daily
Sea Surface Salinity	≤ 55	0.3 psu	Twice daily
Sea Ice Concentration	≤ 5	5 %	Twice daily

CIMR: Conclusion

- Measurements of key oceanic variables for meteorology, oceanography, and climate analysis, with unique synergies.
- A design for the observations of polar regions.
- All weather products, with better quality and/or spatial resolution, and available close to the coasts.
- With no guarantee of continuation of low frequency measurements (after AMSR2, SMOS, and SMAP), it will insure continuity, with much improved products.
- An innovative instrument with low noise radiometers and a large deployable antenna.
- **Publication**

Kilic, L., Prigent, C., Aires, F., Boutin, J., Heygster, G., Tonboe, R. T. et al. (2018). ***Expected performances of the Copernicus Imaging Microwave Radiometer (CIMR) for an all-weather and high spatial resolution estimation of ocean and sea ice parameters.*** *Journal of Geophysical Research: Oceans*, 123. <https://doi.org/10.1029/2018JC014408>

Thank you for your attention !

Artist view !

