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

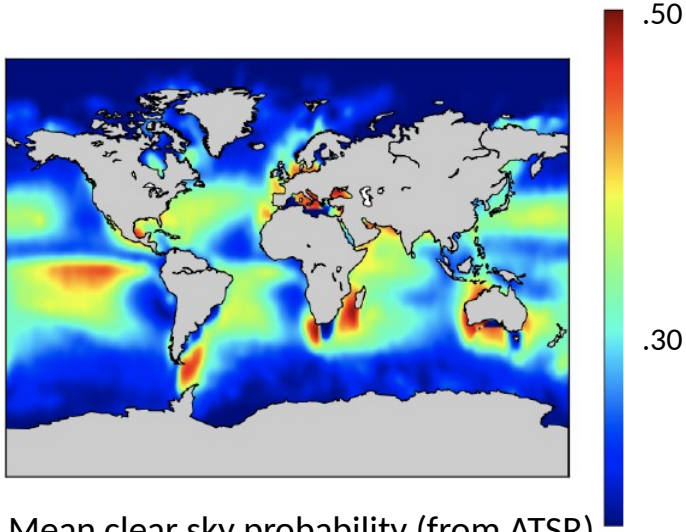
- **Sea Surface Temperature (SST)**
- **Sea Ice Concentration (SIC)**

Second priority

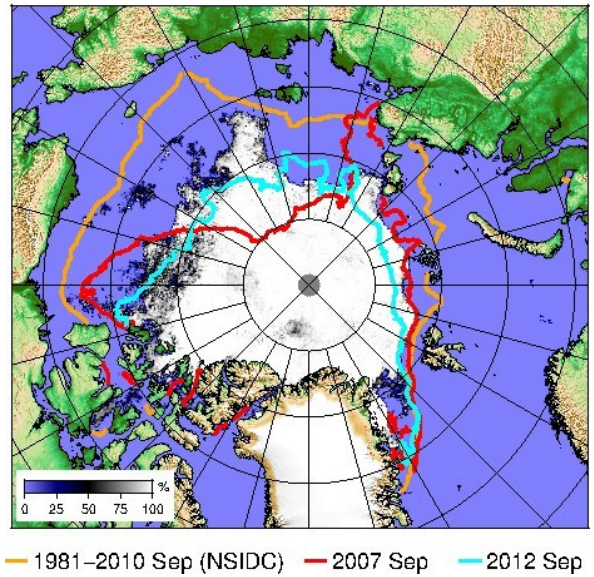
- **Sea Surface Salinity (SSS)**
- **Ocean Wind Speed (OWS)**
- **High Ocean Wind Speed (HOWS)**
- **Sea Ice Thickness (SIT)** (below 0.8 m)

And many other parameters...

Motivation



Mean clear sky probability (from ATSR)



Sea Ice extent in Septembre for different years

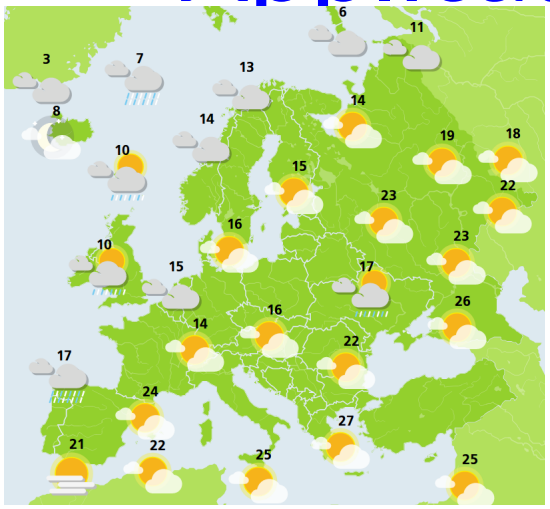
Current situation

- 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

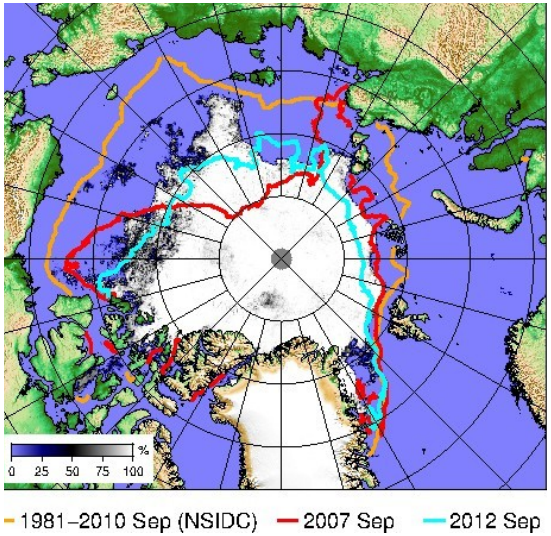
Limitations so far

- 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.

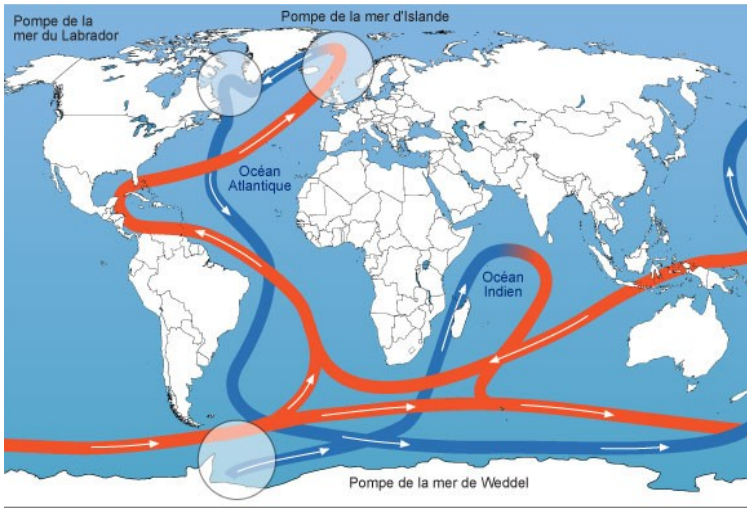
Applications of the CIMR mission



Numerical Weather Prediction



Climate models

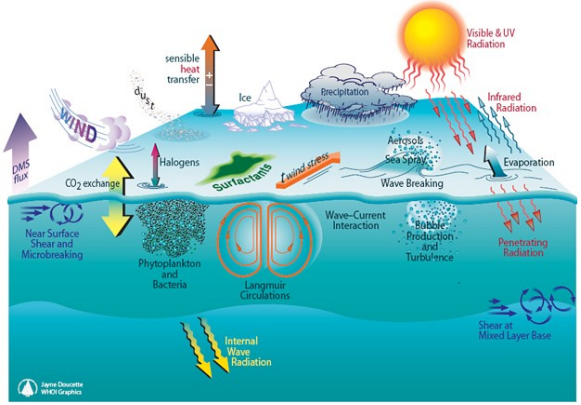


Study mesoscale variability

heat, and energy transport

Ship and offshore operations

Understanding marine ecosystem variability



Air/sea interaction

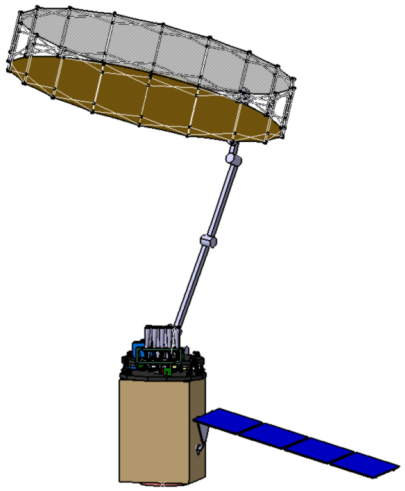
Physical and biogeochemical

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)

microwat
support to science element

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

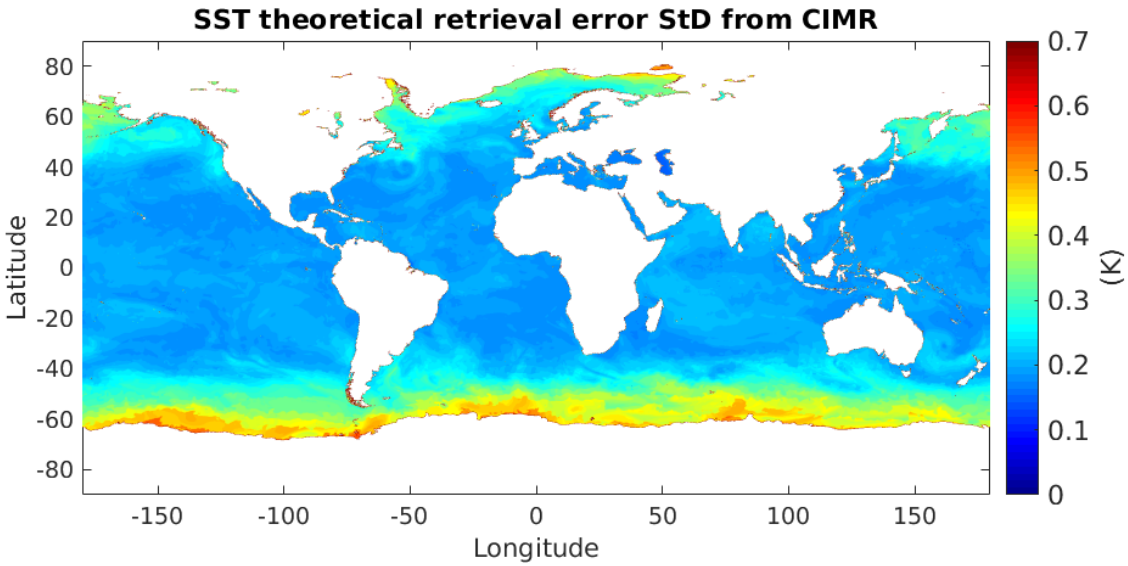
Sea Surface Salinity

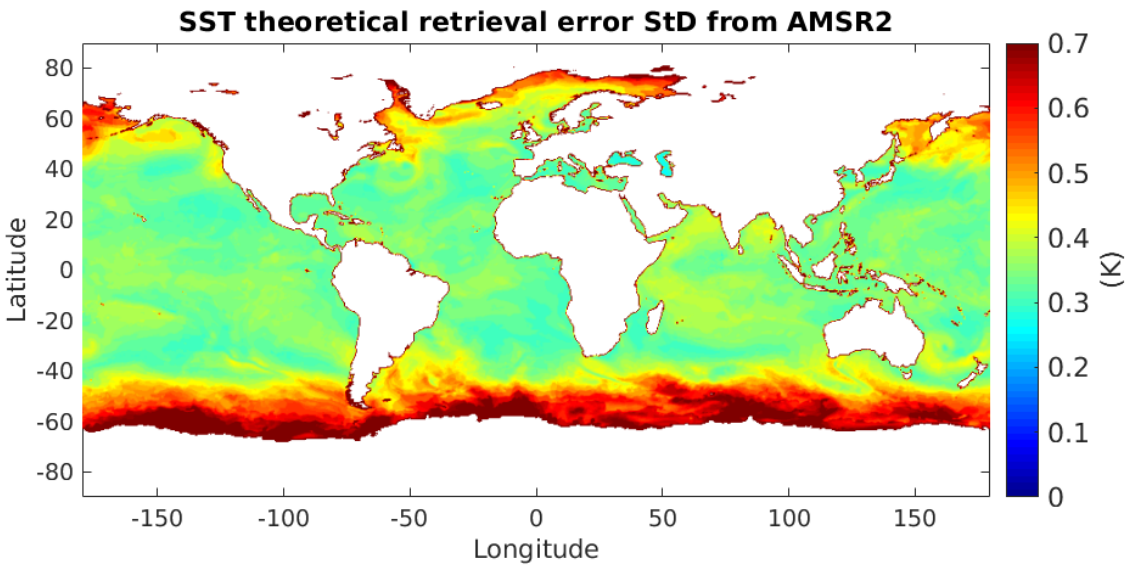
- High radiometric sensitivity to provide a theoretical precision of ~0.3 psu instantaneously
- Coincident analysis of the SST, OWS, SIC, and SSS
- Spatial resolution of ≤55 km but possibility to benefit from the oversampling at 1.4 GHz.

High Ocean Surface Wind Speed

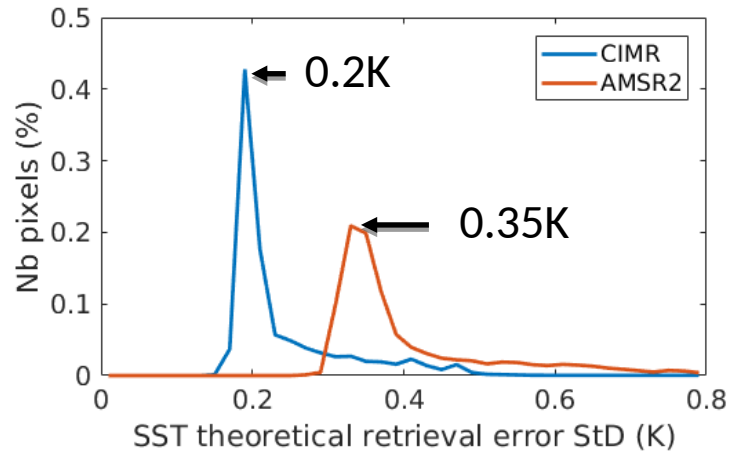
- Unique estimation of the high surface wind speed with the 1.4 GHz (in addition to regular OWS...).

Sea Surface Temperature Retrieval



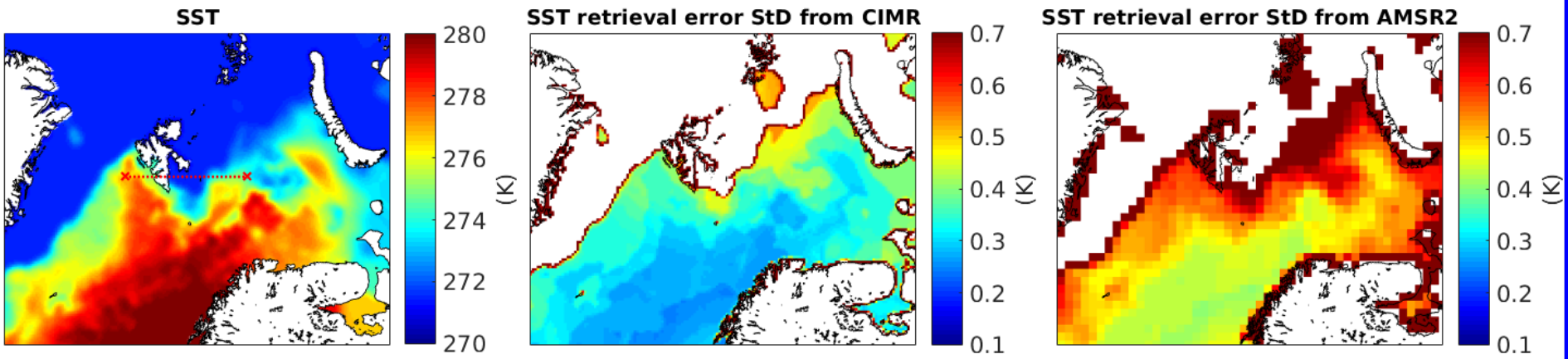


From careful information content analysis built upon up-to-date radiative transfer and realistic hypothesis

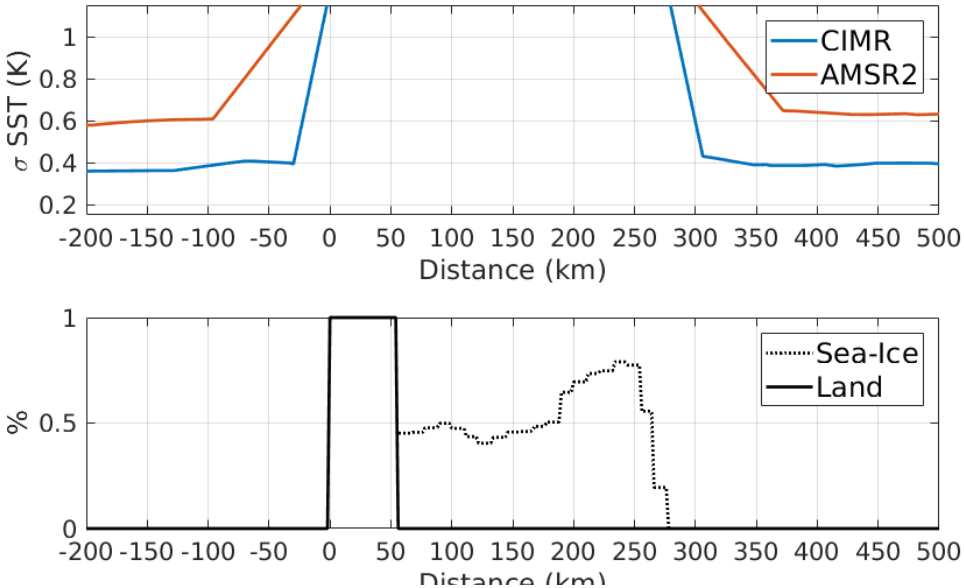


- The spatial resolution and the precision of the SST retrieval are largely improved with CIMR (≤15 km and 0.2 K) compared to AMSR2 (48 km and 0.35 K)

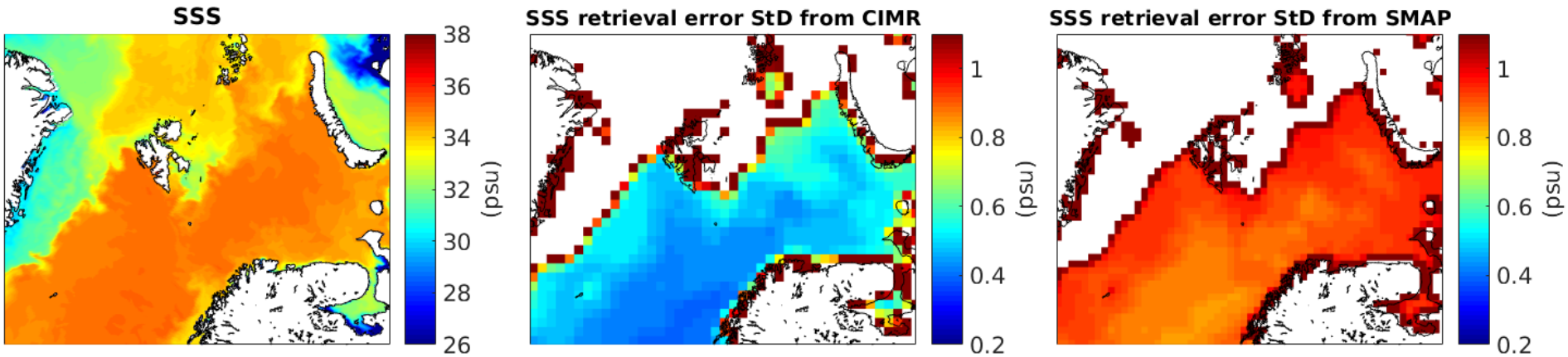
Sea Surface Temperature Retrieval



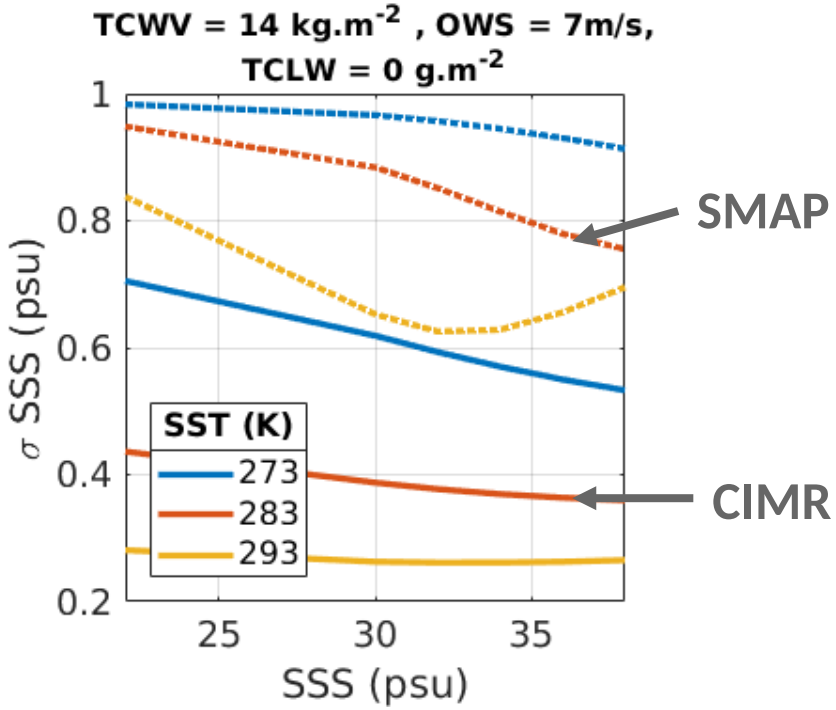
- SST retrieval precision is improved especially for cold water where the retrieval is difficult.
- Improvement close to the coasts and sea ice margins.



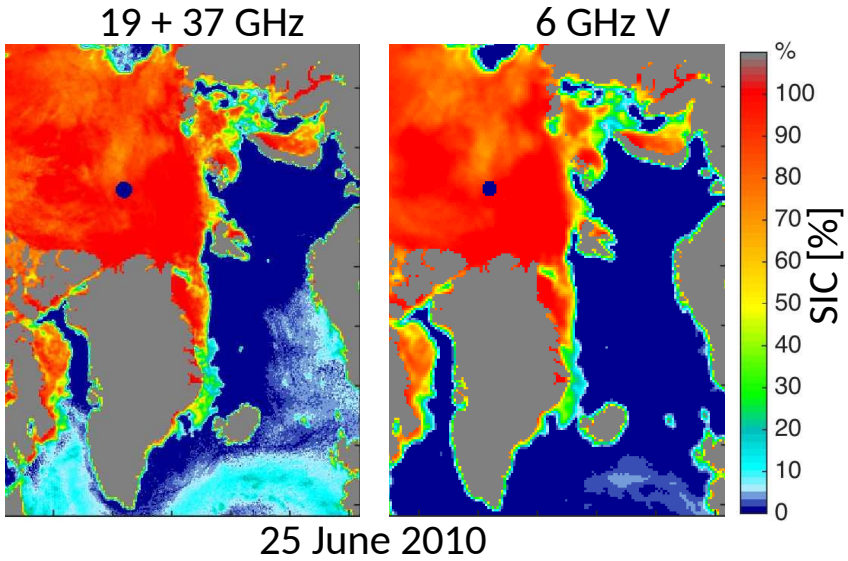
Sea Surface Salinity Retrieval

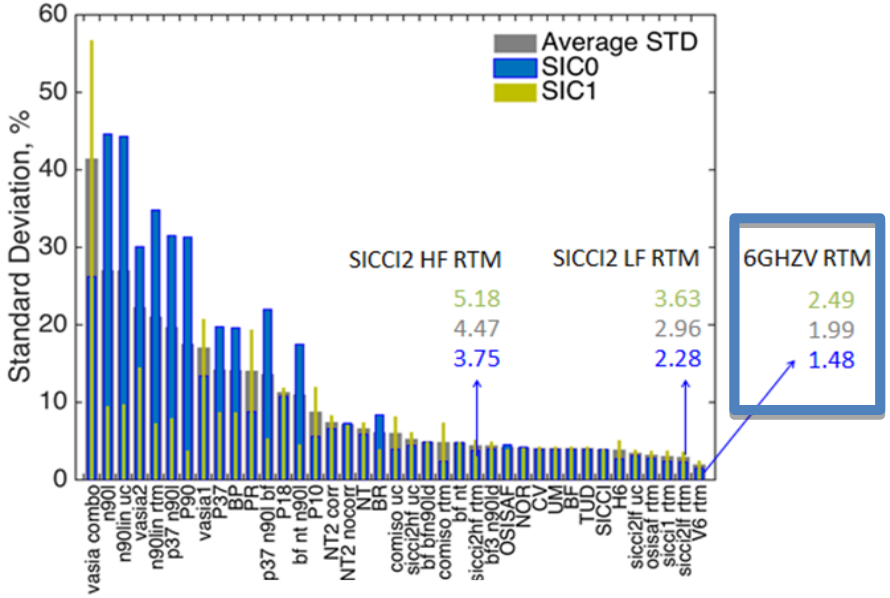


- SSS precision is improved (0.3 psu) due to the CIMR low noise receivers and to the better sensitivity to SSS at 55° incidence angle.
- The spatial resolution is large (≤55 km) due to the incidence angle of 55° needed to cover entirely the poles.



Sea Ice Parameter Retrieval





Figures courtesy of Sea Ice CCI team

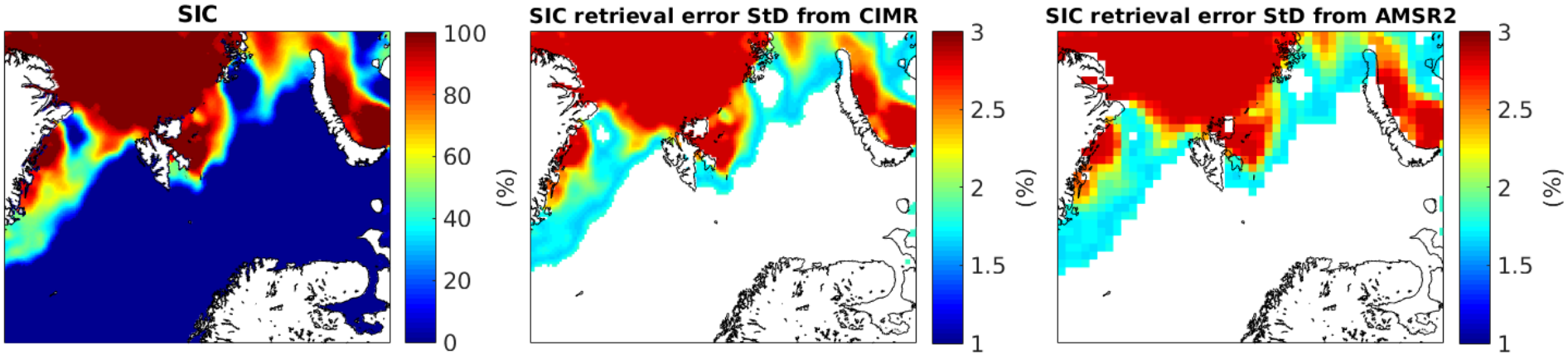
Sea Ice Concentration

- 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

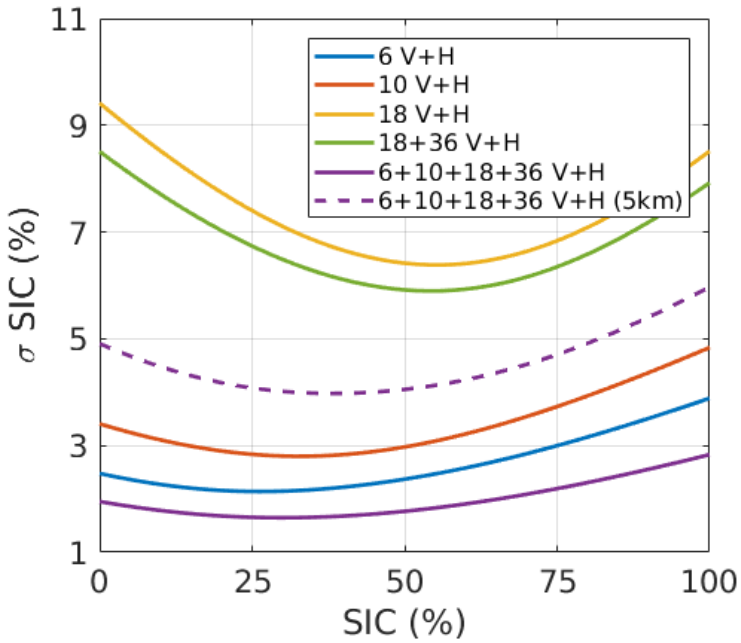
Sea Ice Concentration Retrieval



- 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 !