

Copernicus Imaging Microwave Radiometer (CIMR)

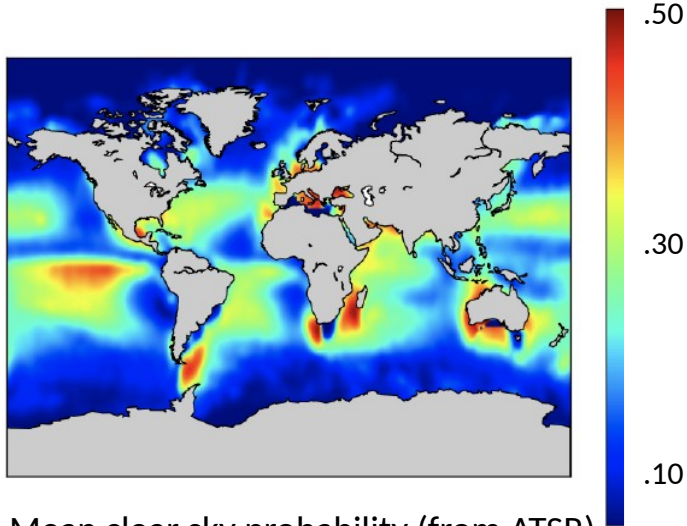
CIMR: a new low frequency microwave radiometer for an all-weather, high spatial resolution, and accurate estimation of ocean and sea-ice parameters.

Kilic Lise, Prigent Catherine, Aires Filipe, Boutin Jacqueline,
Heygster Georg, Meissner Thomas
and the CIMR team

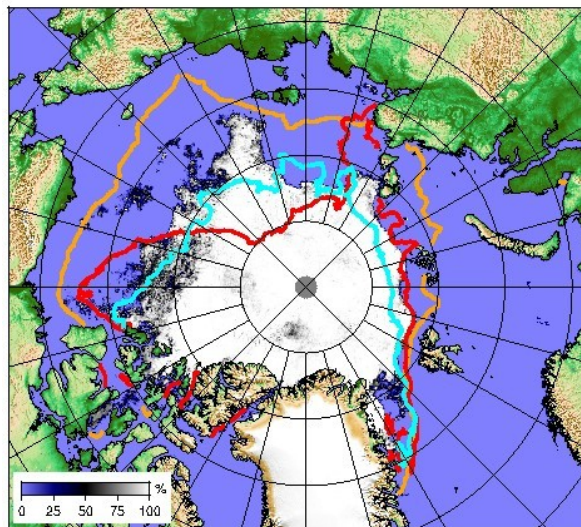
- **CIMR** is a High Priority Candidate Mission for **Copernicus** expansion designed to respond directly to the Integrated **EU Arctic Policy**.

CIMR will provide :

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



Mean clear sky probability (from ATSR)



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

Sea Ice extent in Septembre for different years

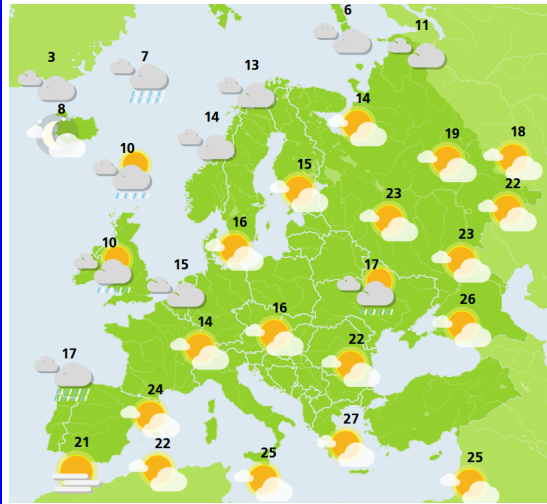
Current situation

- 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., AMSR)
- SSS derived from SMOS and SMAP

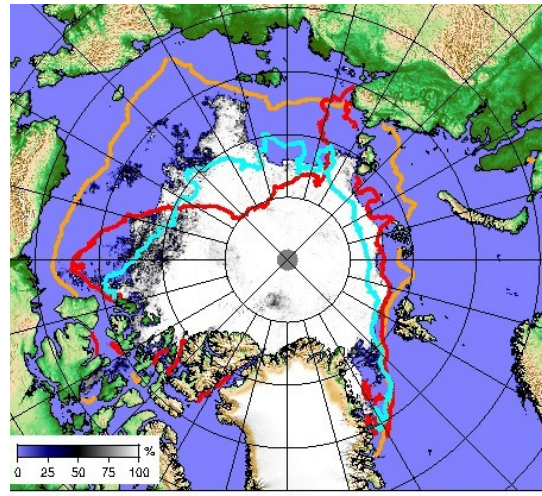
Limitations so far

- 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

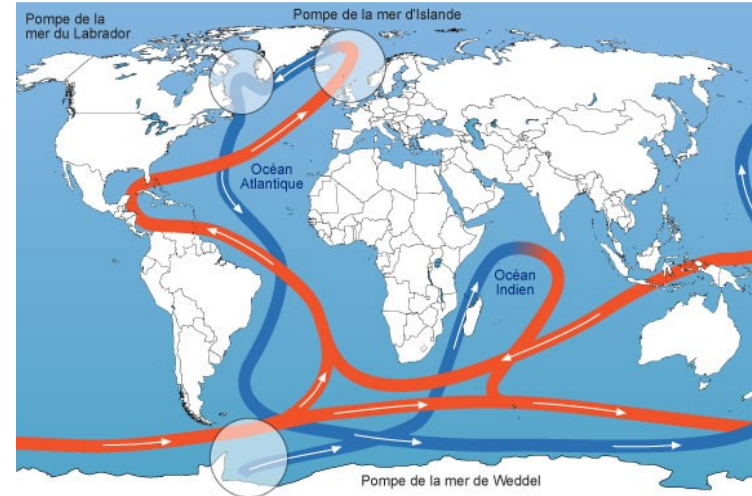


Numerical Weather Prediction



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

Climate models



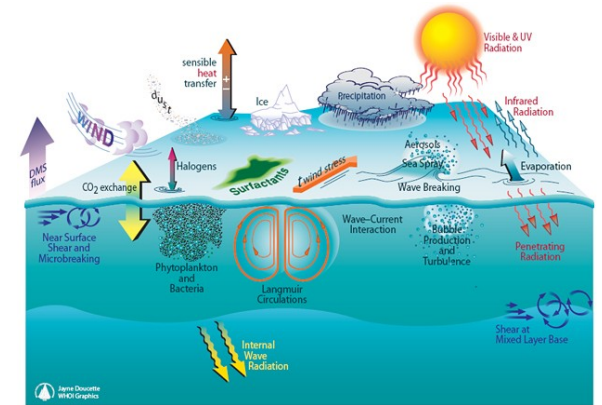
Study mesoscale variability
heat, and energy transport



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 receivers and RFI mitigation

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

- Very low noise receivers
- **7 m** mesh Large Deployable Reflector
- Polar orbit (close to MetOp-SG B)

Sea Surface Parameter Retrieval

Sea Surface Temperature

- Better spatial resolution (from 50 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

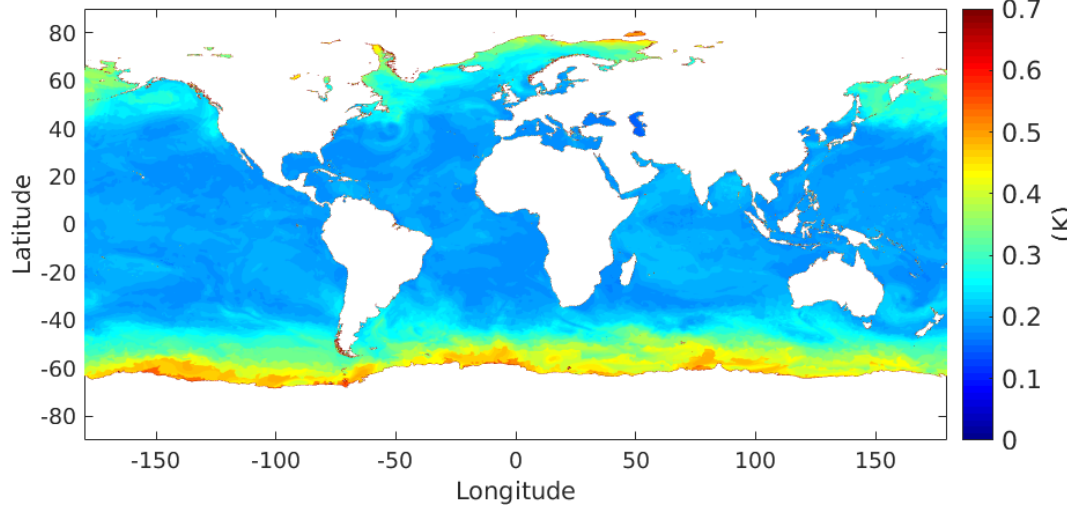
- High radiometric sensitivity to provide a precision of ~0.3 psu instantaneously
- Coincident analysis of the SST and SSS

High Sea Surface Wind Speed

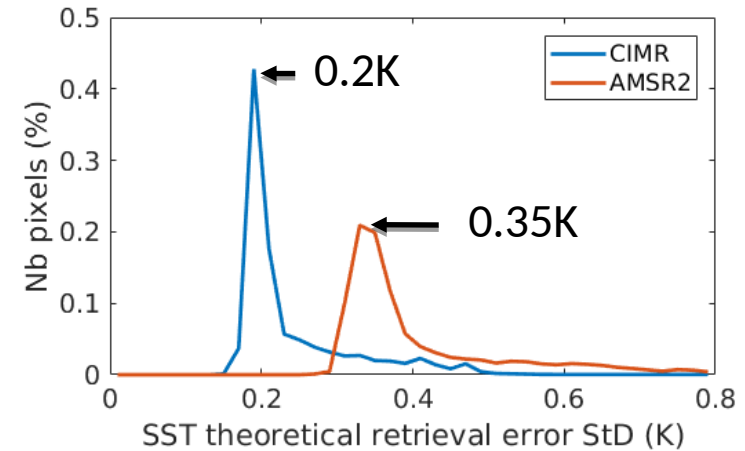
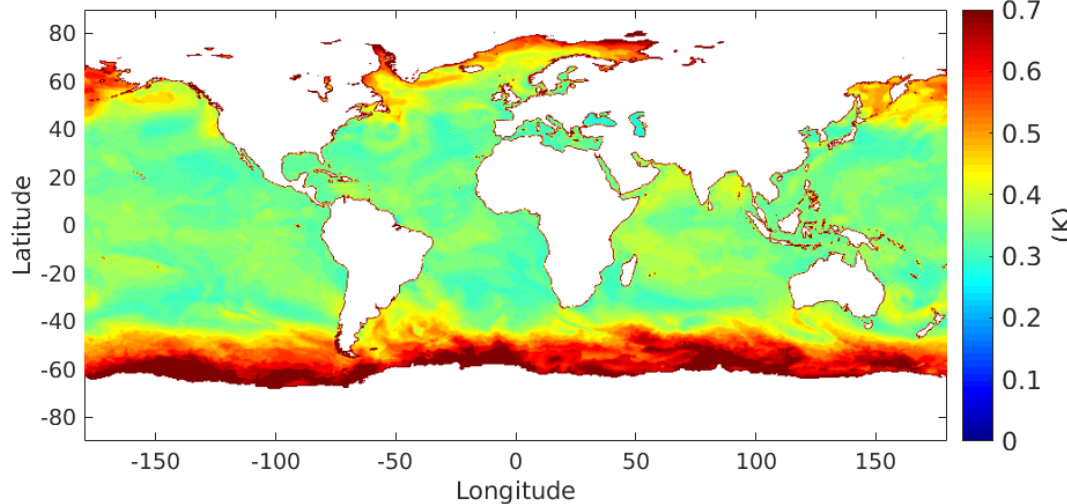
- Unique estimation of the high surface wind speed with the 1.4 GHz.

Sea Surface Temperature Retrieval

SST theoretical retrieval error StD from CIMR



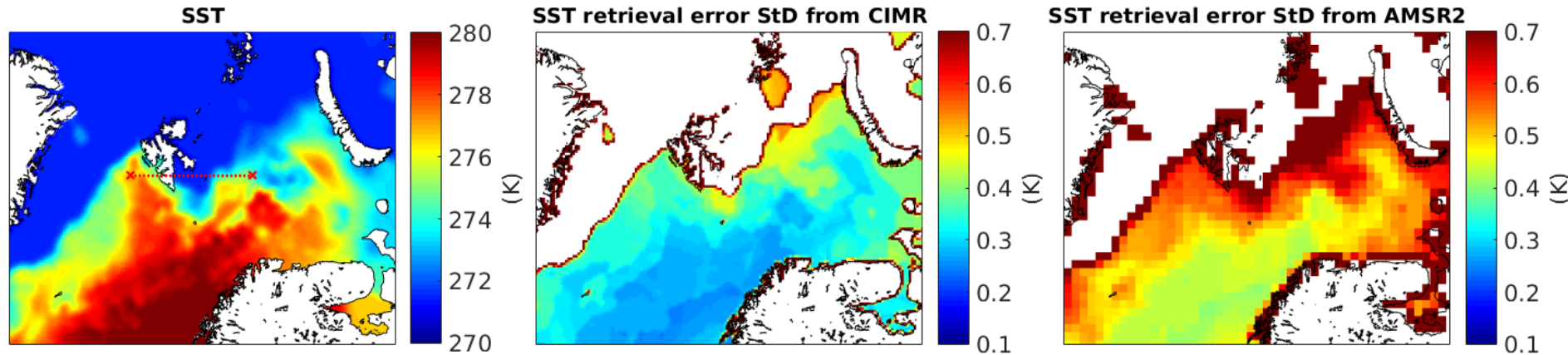
SST theoretical retrieval error StD from AMSR2



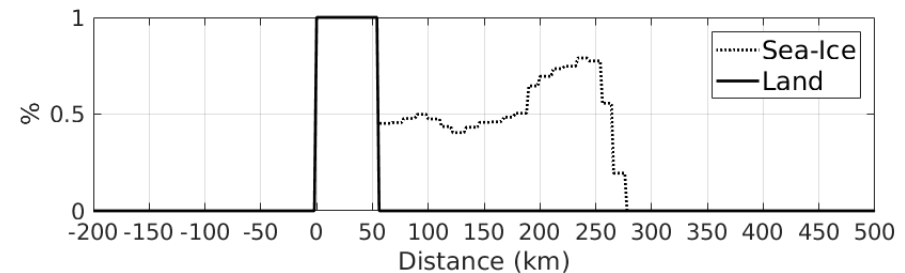
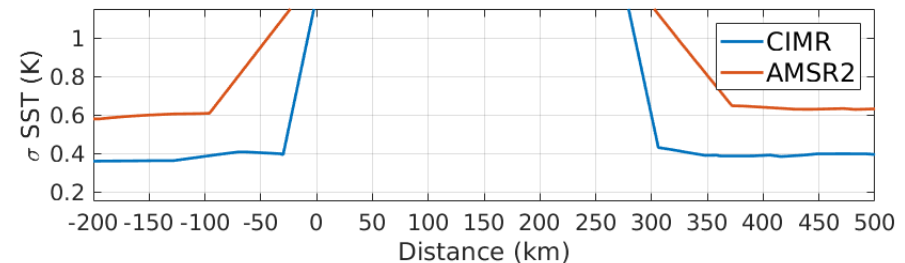
- The spatial resolution and the precision on the SST retrieval are largely improved with CIMR (15 km and 0.2 K) compared to AMSR2 (48 km and 0.35 K)

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

Sea Surface Temperature Retrieval

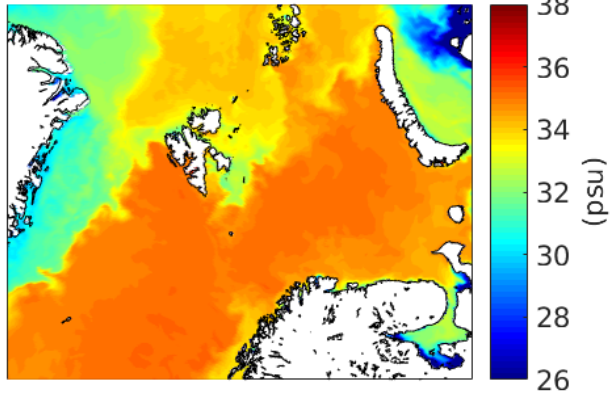


- SST retrieval precision is improved especially for cold water where the retrieval is difficult.
- Improvement close to the coasts and sea ice margins.

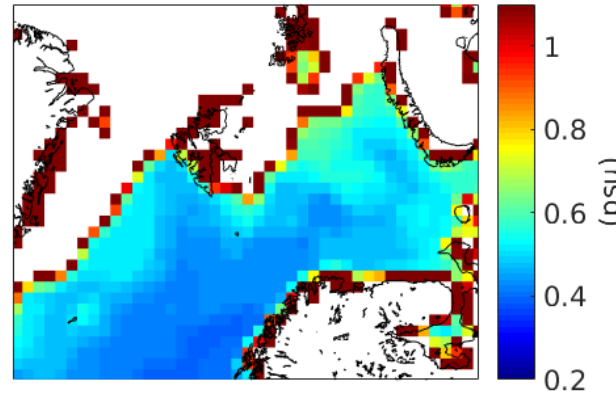


Sea Surface Salinity Retrieval

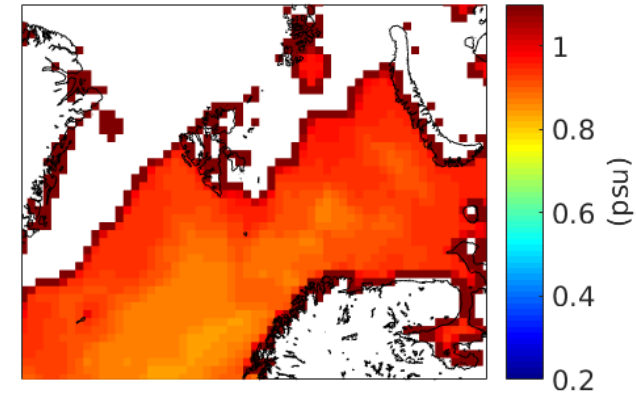
SSS



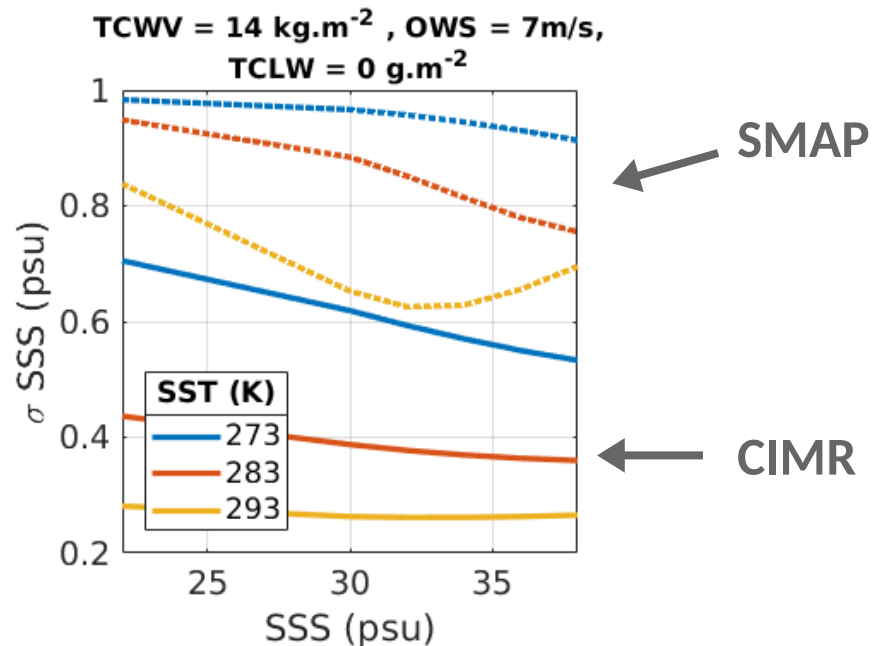
SSS retrieval error StD from CIMR



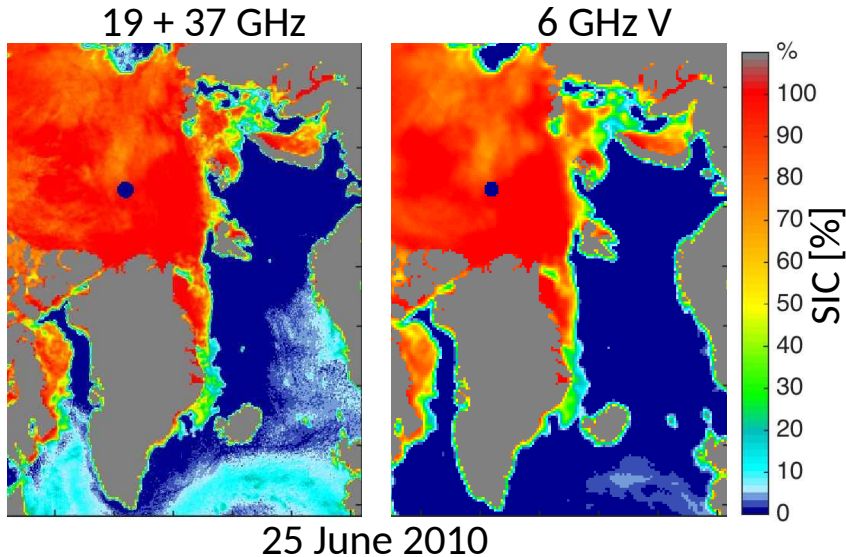
SSS retrieval error StD from SMAP



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

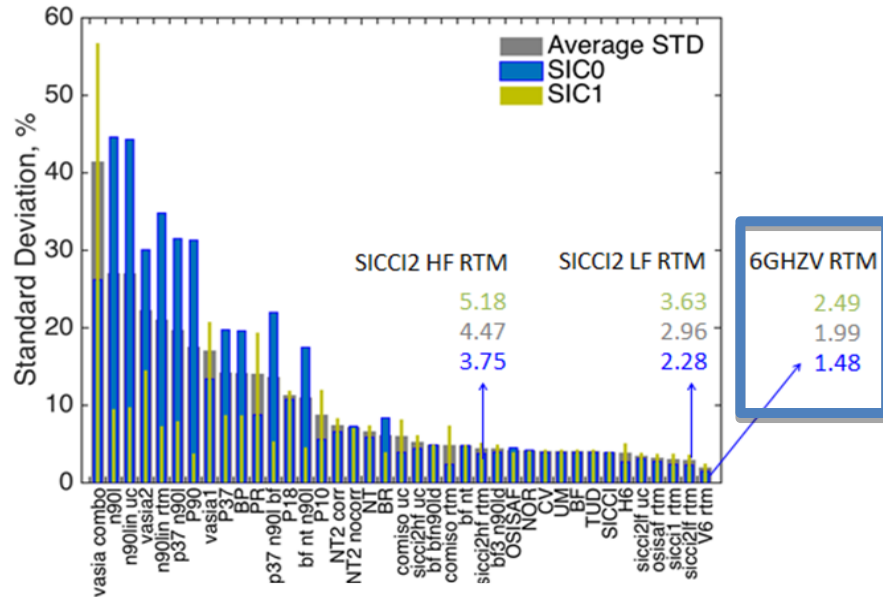


Sea Ice Parameter Retrieval



Sea Ice Concentration

- Retrieval with 6 GHz performs best with less atmospheric contamination.
- Possibility to retrieve lower SIC values
- Better coverage of coastal areas

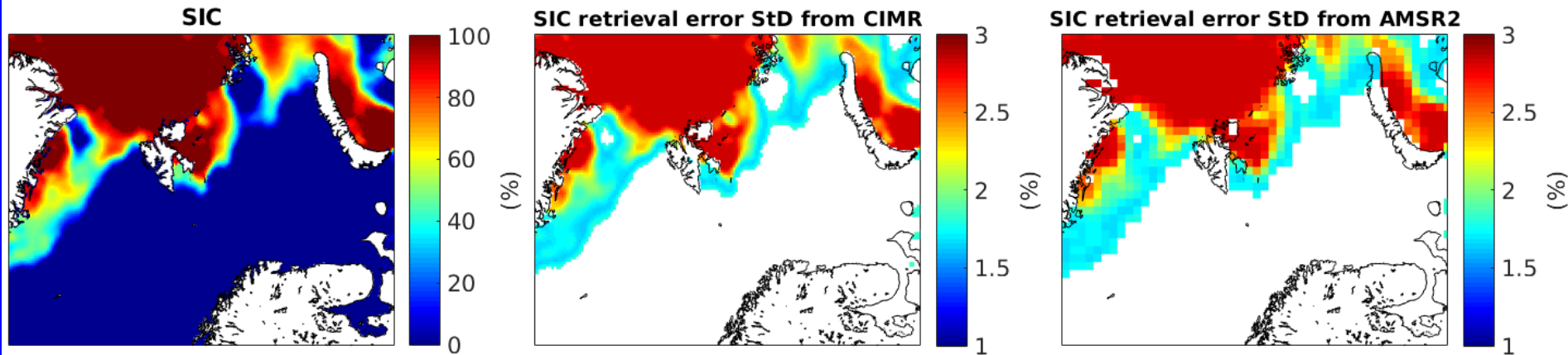


Figures courtesy Sea Ice CCI team

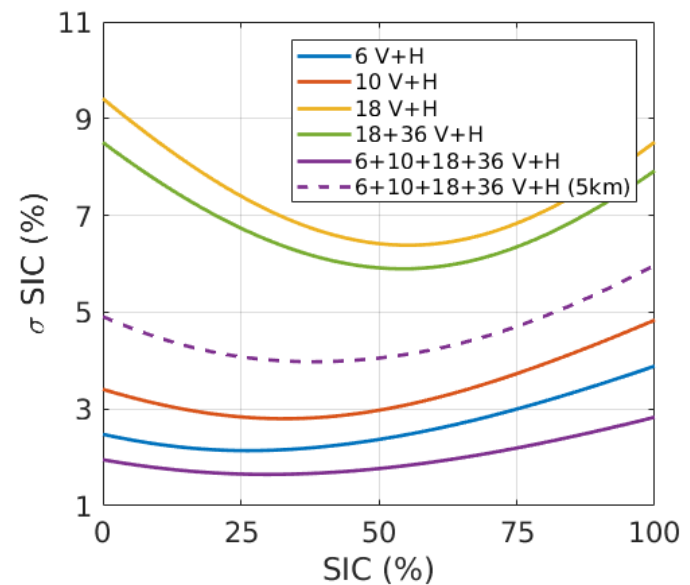
Thickness of thin sea ice at 1.4 GHz

- Demonstrated with SMOS

Sea Ice Concentration Retrieval



- Improved spatial resolution and possibility to analyse the ice margin
- Refinement of the retrieval methodology under way to benefit from the lower instrument noise



CIMR products

- All-weather global retrieval, twice daily
- Spatial resolution of 15 km for SST and SIC
- SST with 0.2 K accuracy
- SIC with 3% accuracy without atmospheric contamination
- SSS with an accuracy 0.3 psu instantaneously at 55 km spatial resolution
- Coincident SST, SIC, and SSS

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	15	3 %	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 spatial resolution, and available close to the coasts**
- **With no guarantee of continuation of low frequency measurements (after AMSR-2, SMOS, and SMAP), it will insure continuity, with much improved products**
- **Needless to say, it will also benefit the land surface community (soil moisture, surface waters, vegetation characterization...)**
- **An innovative instrument with low noise radiometers and a large deployable antenna, to complement / fly with MetOp-SG B**