Use of Copernicus Imaging Microwave Radiometer (CIMR) in the Baltic Sea

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Aim and Outline

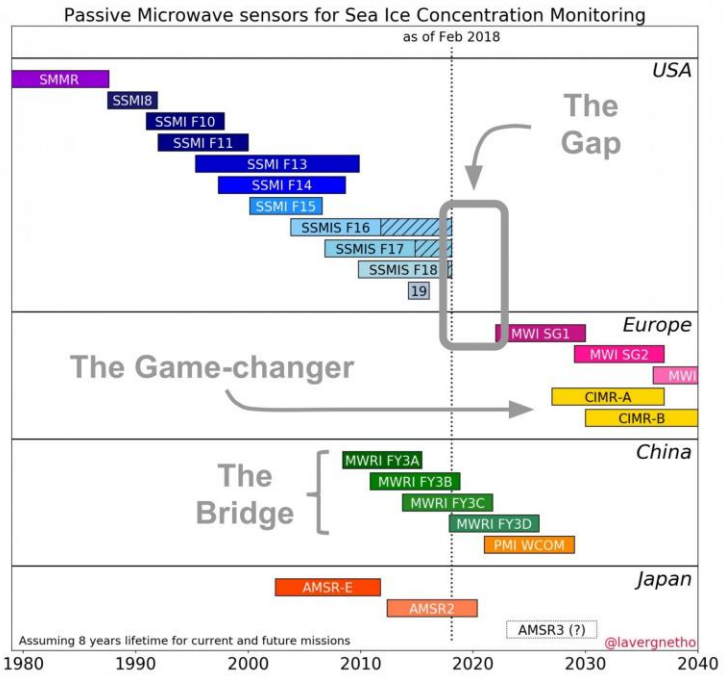
Identify challenges in the current satellite observing system and assess impact of the CIMR mission on the operational Copernicus CMEMS SST product in the Baltic Sea

Outline

- CIMR Intro + characteristics
- Challenges with existing satellite constellation
- Experiment setup
- Impact on CMEMS SST product
- Conclusions

Copernicus Imaging Microwave Radiometer (CIMR)

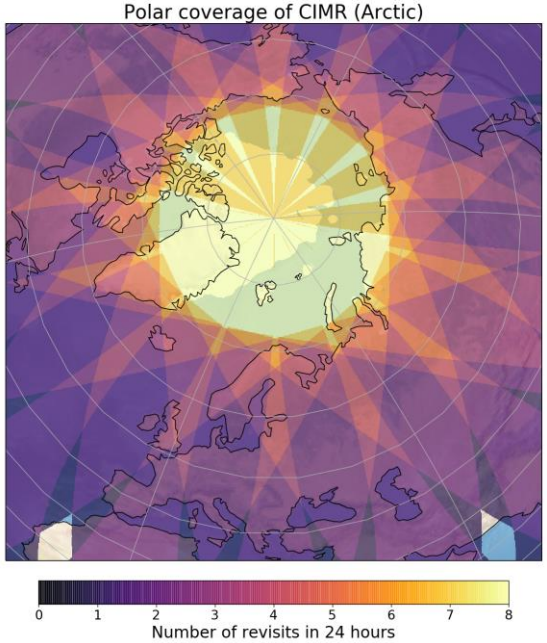
- CIMR Respond's directly to the ***Integrated EU Arctic Policy***
- Evolve the Copernicus monitoring program through:
  - CIMR: Copernicus High Priority Candidate Missions,
- Conically scanning multi-frequency microwave radiometer in a coordinated flight with MetOp-SG(1B)
- ~95% global coverage every day, mean 6 hourly-revisit in Arctic Areas, 06:00 dawn dusk orbit, no “hole at the pole”
- In Phase B1, Launch: 2026+



CIMR observation characteristics

- ***Two primary parameters***
- *Sea Ice Concentration (≤5 km, 5%)*
- *SST (15 km, <0.3 K)*

- ***Many secondary:***
- *Sea Surface Salinity*
- *Extreme Wind*
- *Soil Moisture*
- *Thin Sea Ice Thickness*
- *Terrestrial Snow extent*



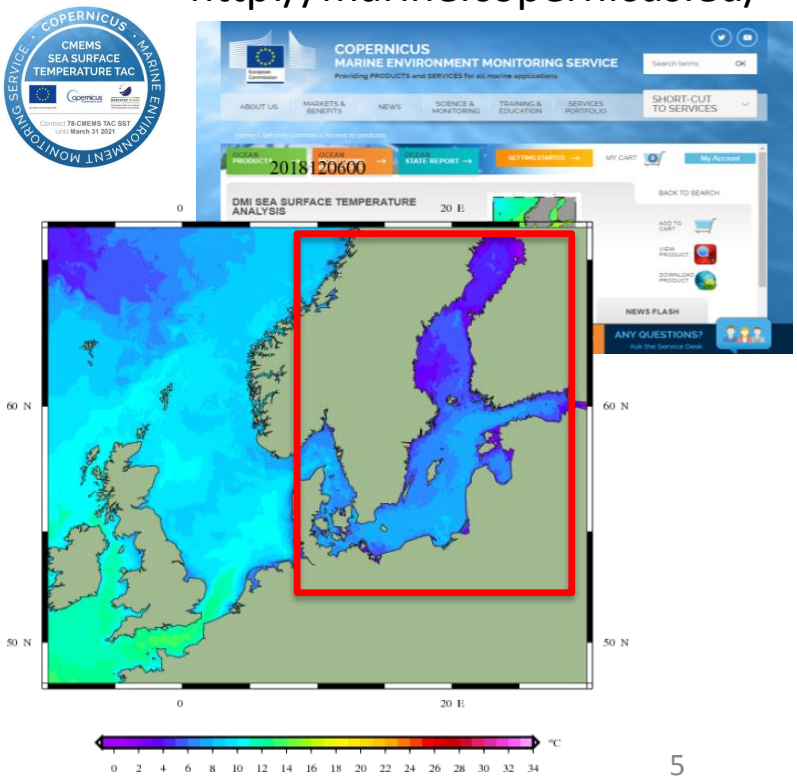
Channels (GHz, Full Stokes):	**1.4**	**6.9**	**10.65**	**18.7**	**36.5**
Resolution (km):	**≤60**	**≤15**	**≤15**	**≤5.5**	**≤5**
NEΔT (K @150K):	**≤0.3**	**≤0.2**	**≤0.3**	**≤0.4**	**≤0.7**
Swath	**>1900 km**				

Copernicus CMEMS product

http://marine.copernicus.eu/

The operational CMEMS Level 4 SST product:

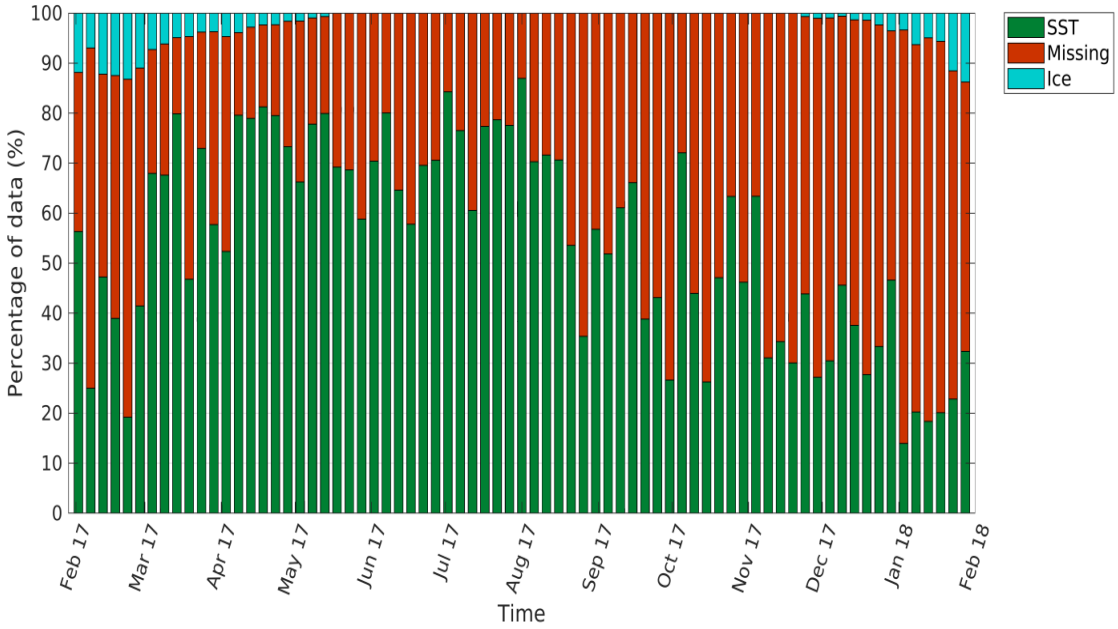
- Processing chain used for
  - Operational daily L4 SSTs (Høyer et al., 2014)
  - Reprocessed product 1982-present (Høyer and Karagali, 2016; OSR, JOO 2018)
- include SST from several IR sensors
- Sea ice from CMEMS SI TAC (FMI)
- One-year analysis: Feb 2017-Feb 2018
- Focus here on Baltic Sea



Challenges with IR data

5 days averages of Baltic Sea CMEMS coverage from 4 IR sensors(Viirs, SEVIRI (hourly), Metop-A, NOAA 19)

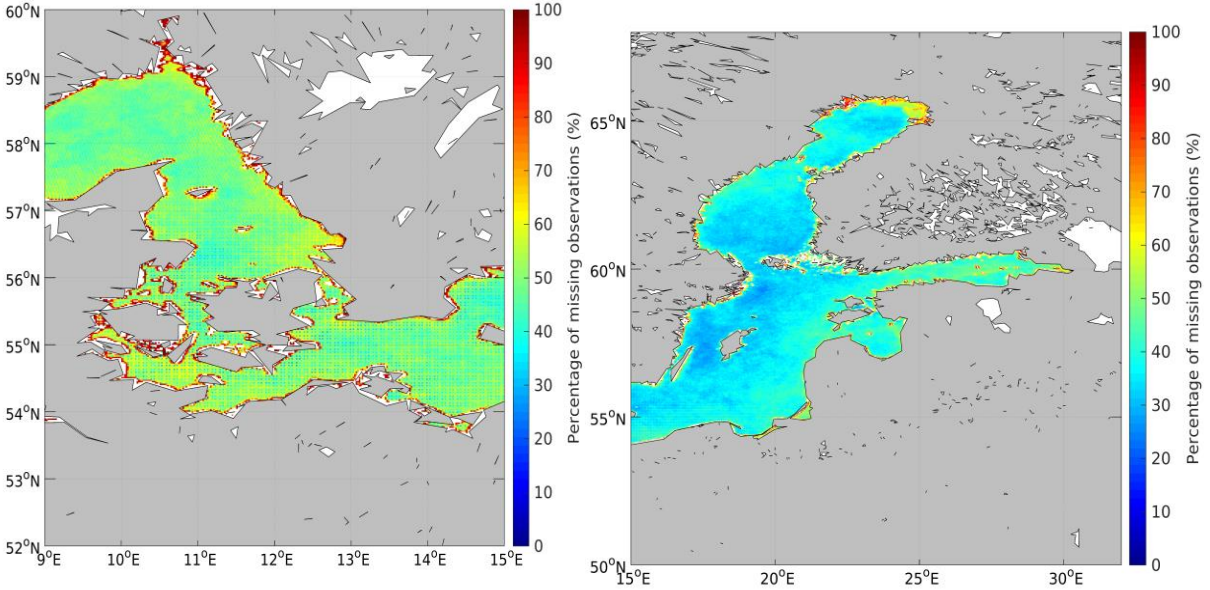
- Large seasonal variation
- ~20 % coverage in winter (Jan-Feb)



Geographical coverage

Day with no observations

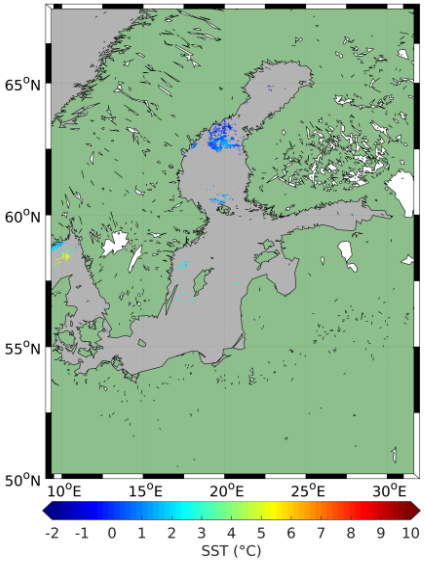
- 50-60% missing in Danish straits
- 35-50 % missing in Baltic Sea.



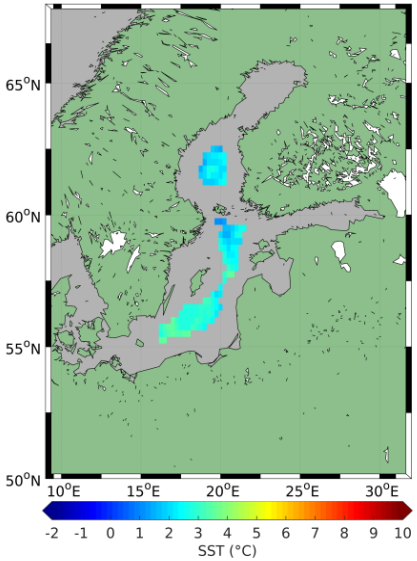
Challenges with IR SST data

- AMSR2 is not the solution

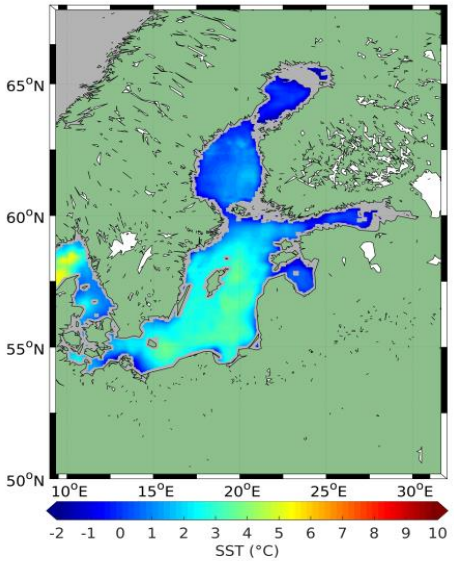
IR SST



AMSR2 SST

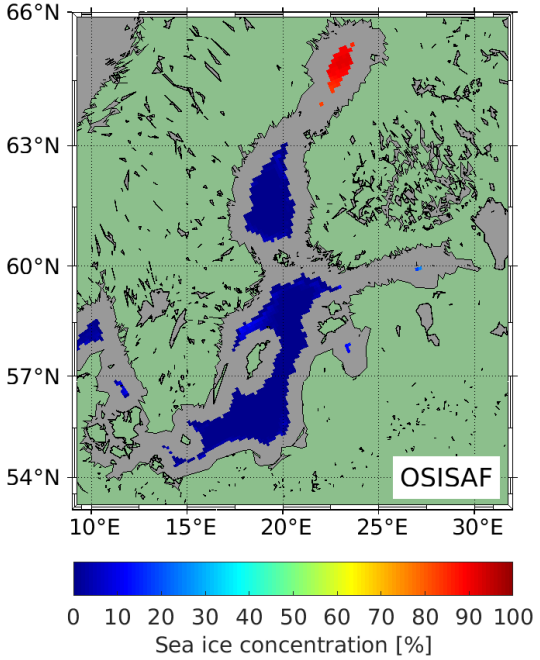


CIMR SST

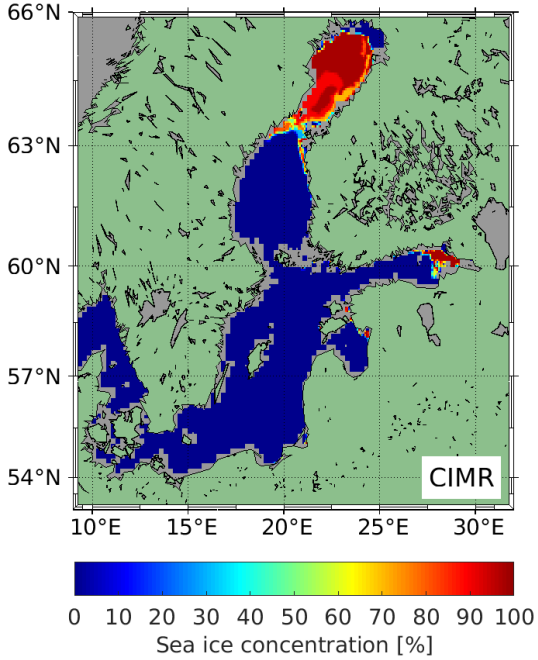


PMW Sea ice

OSI-SAF Sea ice

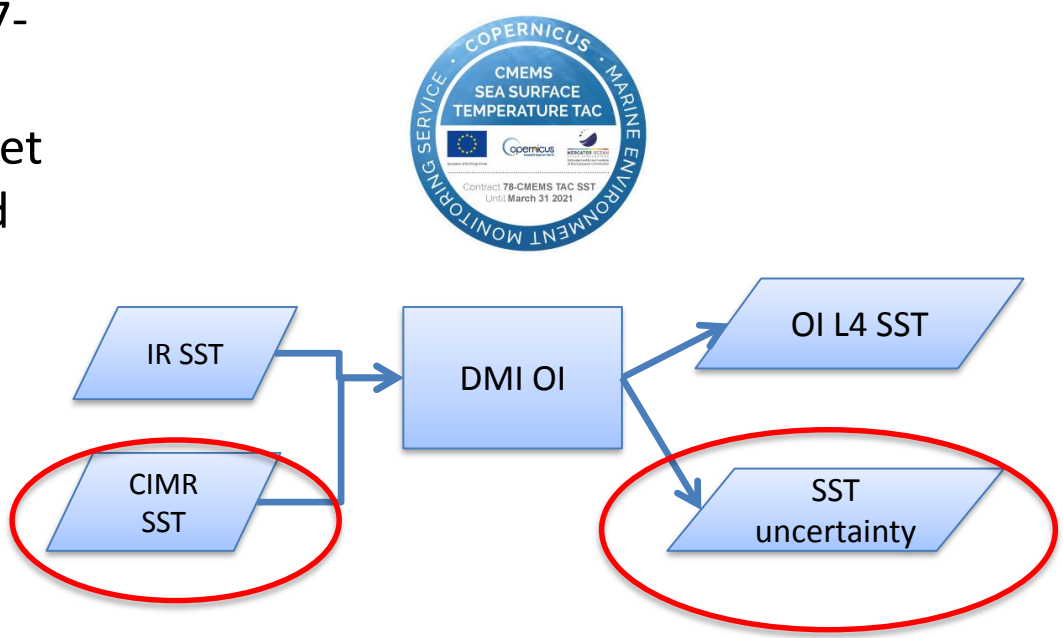


CIMR Sea ice



Experiment setup

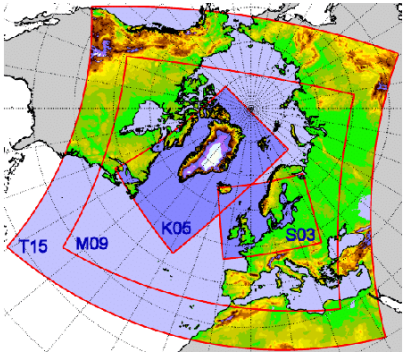
- One year of experiment (Feb 2017-Feb 2018)
- Reference run: Operational data set
- Test run: Included CIMR simulated data
- Impact: difference between two runs

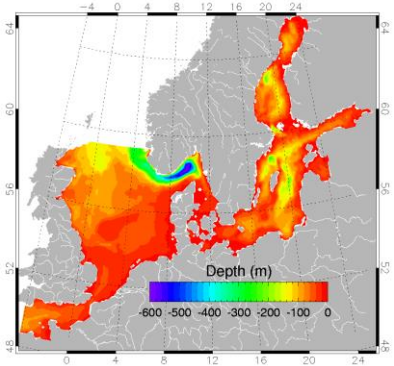


Simulated CIMR observations

- CIMR simulated data:
  - Rain filter using DMI NWP (2 mm/hour)
  - SST from DMI hydrodynamic model (CMEMS BALMFC)
  - 15 km land and ice mask
  - Spatial resolution: 15 km
  - SST uncertainty: 0.3 ^{o}C
  - Two passes a day: 6 and 18
- CIMR + IR data ingested in processing, assessing the L4 uncertainty

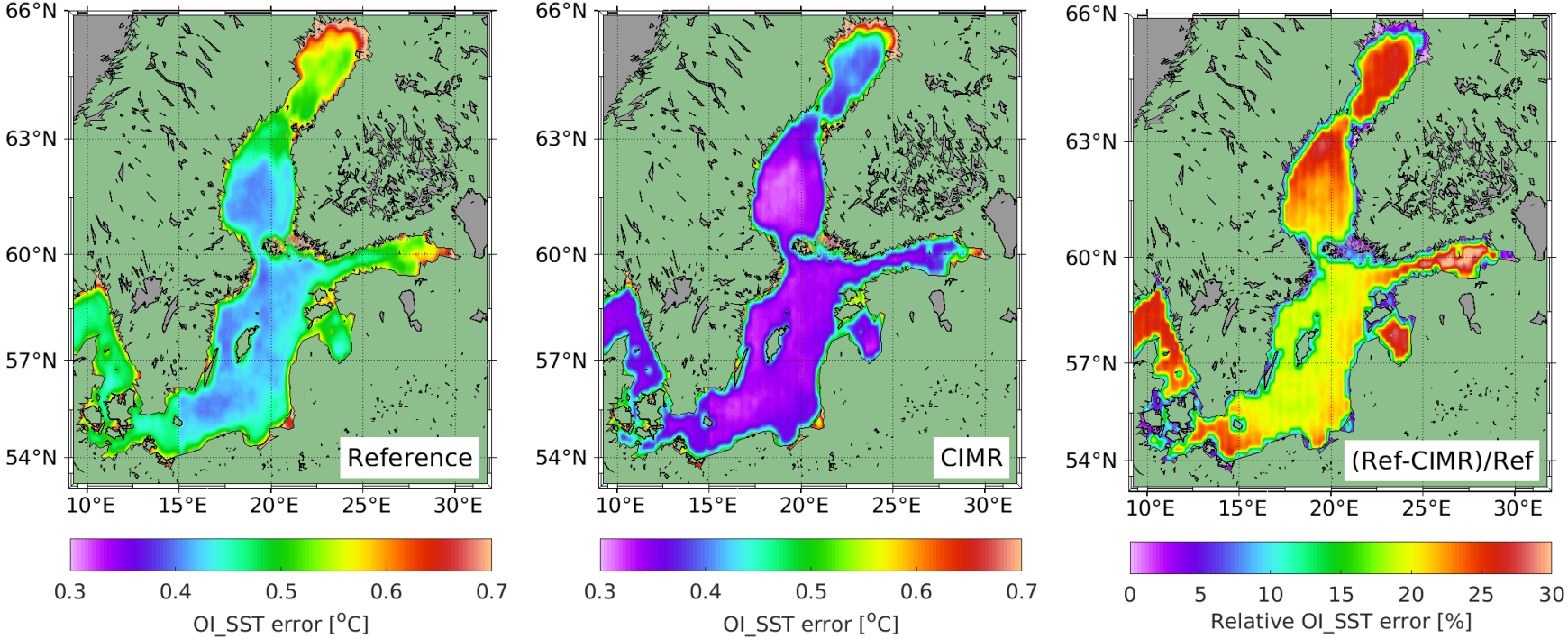
Hirlam NWP





HBM ocean model

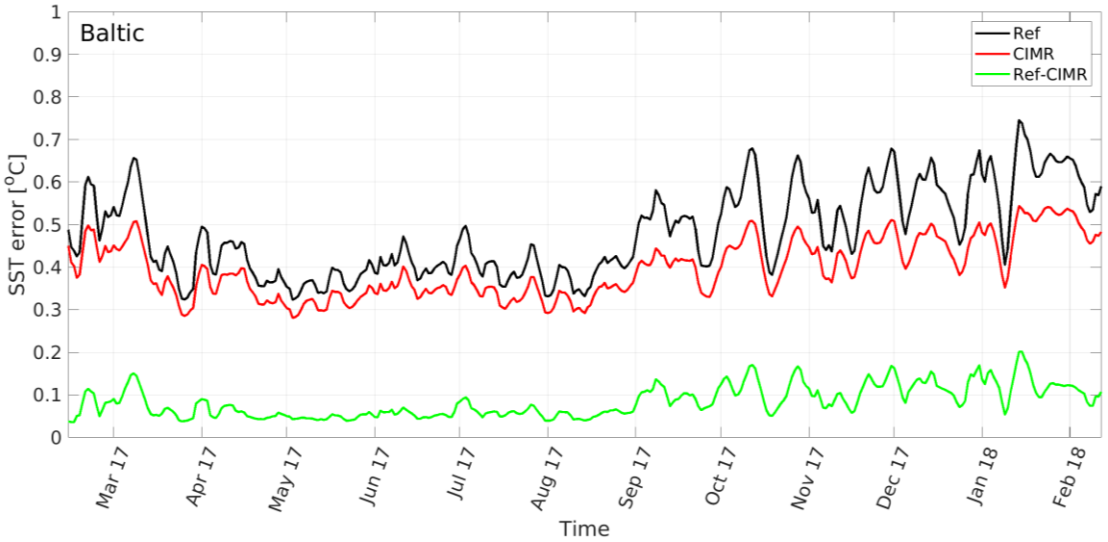
Impact of CIMR obs



Impact of CIMR obs

- Improvements throughout the year
- Largest improvement in winter
  - Related to low IR coverage
  - Important for extreme weather events

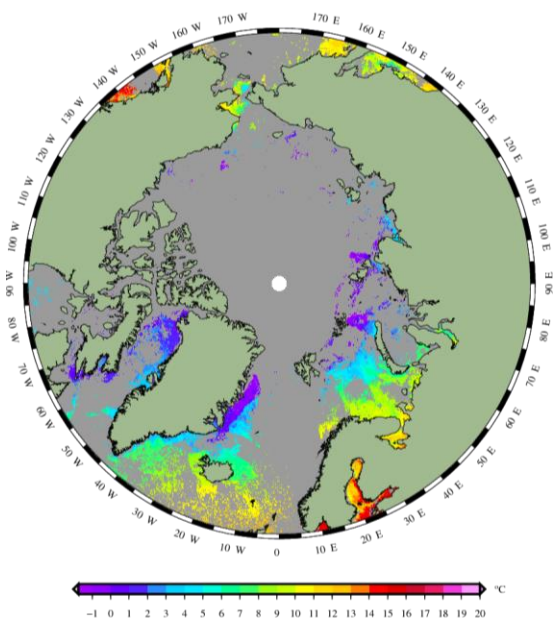
Region	Improvements
Danish waters	15 %
Eastern Baltic Sea	18 %
Danish waters+Baltic Sea	17 %



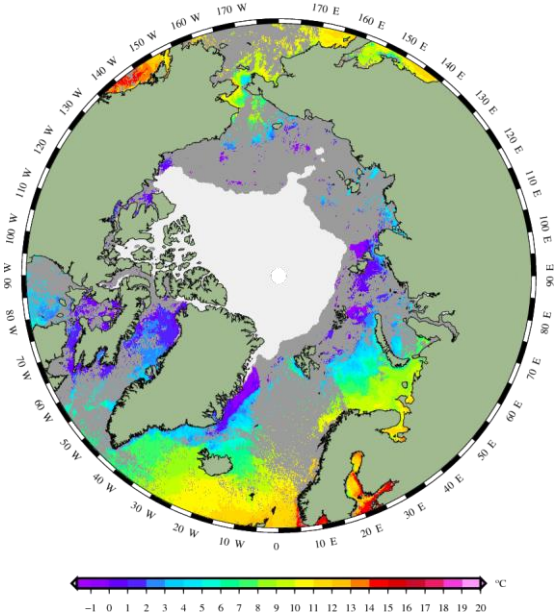
CIMR in Arctic

- Similar issues in the Arctic

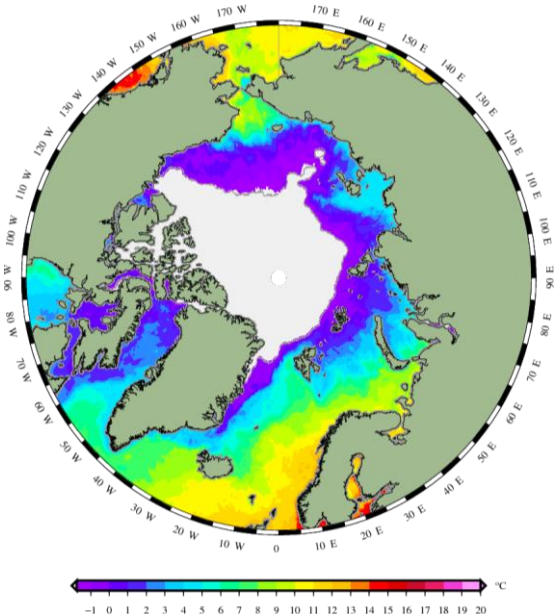
Metop AVHRR



All IR satellites



CIMR



Conclusions

- Infrared satellite observations of SST have limitations in the Baltic Sea region
- Not feasible to use current Microwave products
- CIMR SST observations have large potential
- Simulated CIMR SST observations show significant improvements
  - 17 % overall improvement in uncertainty (>25 for Danish Straits + Gulf of Finland)
  - Largest impact during winter

- **CIMR will facilitate the use of PMW SSTs for coastal and shelf seas.**
- **Important for the future improvement in Copernicus CMEMS satellite products**