Assessment of channel selection for the Copernicus Imaging Microwave Radiometer (CIMR) for retrieval of Sea Surface Temperature (SST)

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1. Introduction

Accurate all-weather sea surface temperatures (SST) are crucial in order to monitor, understand and predict the state of the ocean, atmosphere and sea ice. Passive microwave (PMW) observations allow observations through non-precipitating clouds and the impact of aerosols is small. Copernicus Imaging Microwave Radiometer (CIMR) is a polar mission, designed to observe all-weather, high-resolution, high-accuracy, sub-daily observations of SST and sea ice.

This study investigates the optimal channel selection for SST retrievals using two retrieval algorithms developed within ESA Climate Change Initiative (ESA-CCI) for SST. The first algorithm is an optimal estimation (OE) algorithm (Nielsen-Englyst et al, 2018), which inverts a forward model based on Wentz et al. (2000) to retrieve SST, total column water vapor (TCWV), total cloud liquid water (TCLW) and wind speed (WS) from AMSR-E. The second algorithm is a two-stage regression model, where stage one retrieves WS using AMSR-E observations and numerical weather prediction (NWP) data, and stage two applies localized algorithms to retrieve SST using AMSR-E observations, the retrieved WS from stage one and information from NWP. The results presented here are based on 1,411,699 matchups (Block et al., 2018) of AMSR-E observations and NWP information from the year 2010. The SST retrieved by the two algorithms is compared to independent in-situ SSTs to assess the most optimal channel selection for each of the two algorithms.

2. OE theoretical retrieval errors

The theoretical retrieval error (S) is estimated using first guess errors of: 3.3 K for SST, 1.3 m/s for wind speed (WS) and 20% for TCWV and TCLW for different conditions. We only take into account the instrumental noise (Se=diag([0.3 0.3 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6])

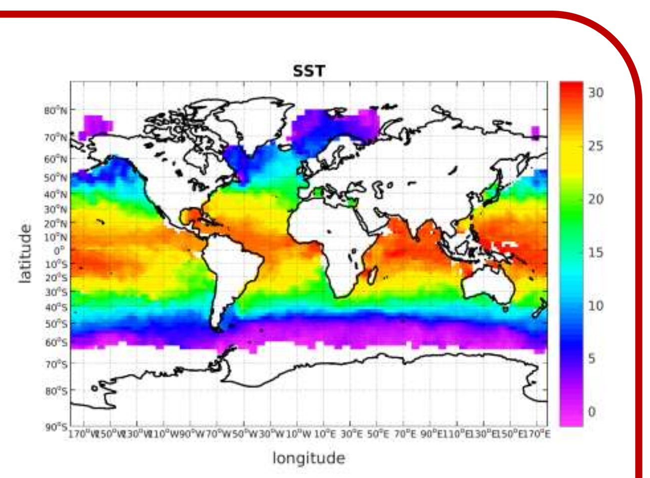


Figure 1: Example of OE retrieved SSTs from 2010.

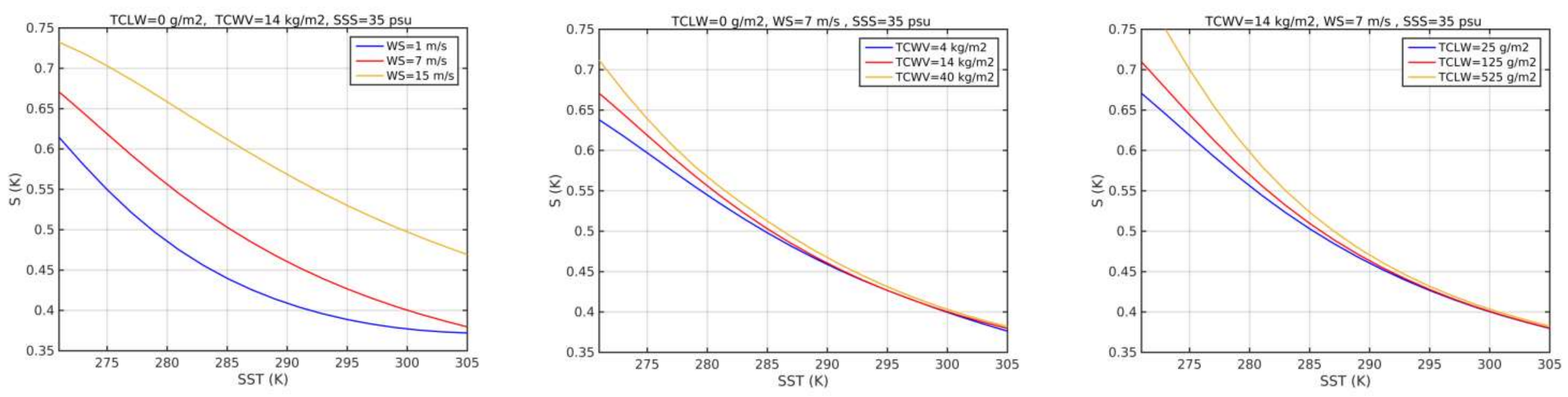
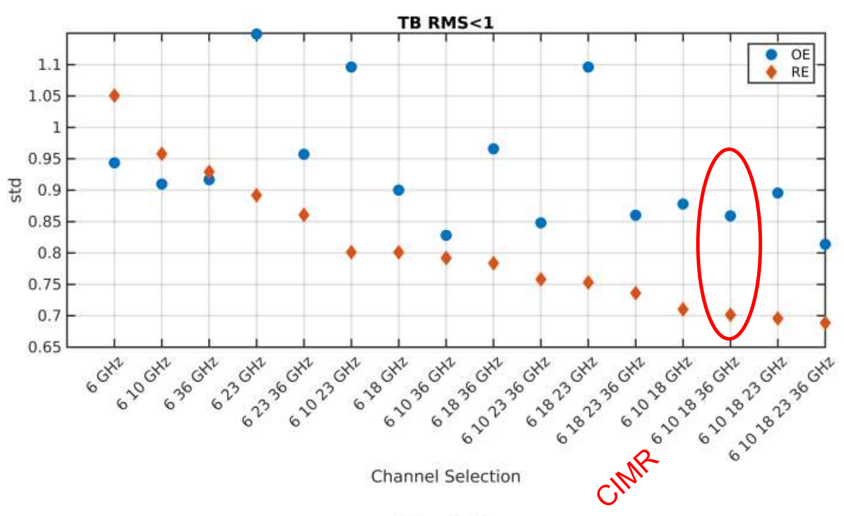


Figure 2: Estimated theoretical retrieval error standard deviations as a function of SST.

3. Channel selection

The OE setup is identical to Nielsen-Englyst et al., 2018, but with a first guess error standard deviation of 4 K for SST.

The same subset is used for all channel configurations, where a RMSE filter (<1K) has been applied using the simulated and observed brightness temperatures (TBs) from the all-channel (AMSR-E) configuration.



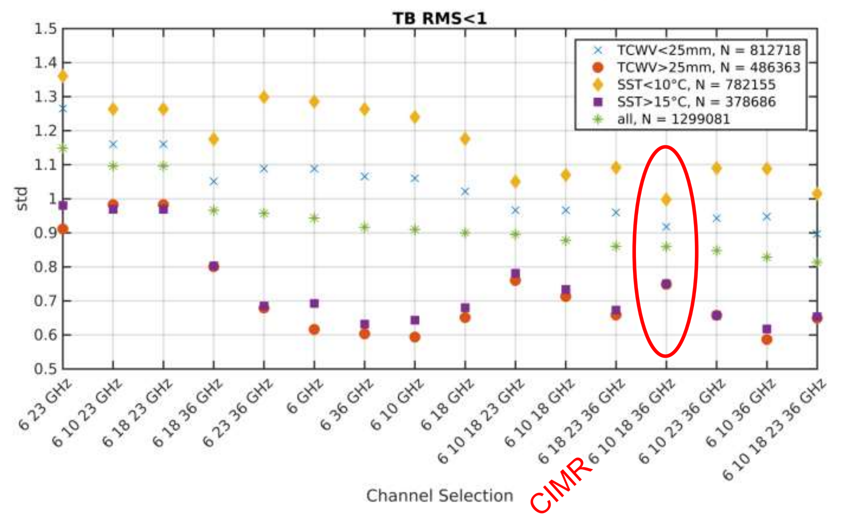


Figure 3: Standard deviations of retrieved minus drifter SSTs using OE and RE.

Figure 4: Standard deviations of OE retrieved minus drifter SST for different regions of TCWV and SST.

4. Channel selection - dependencies

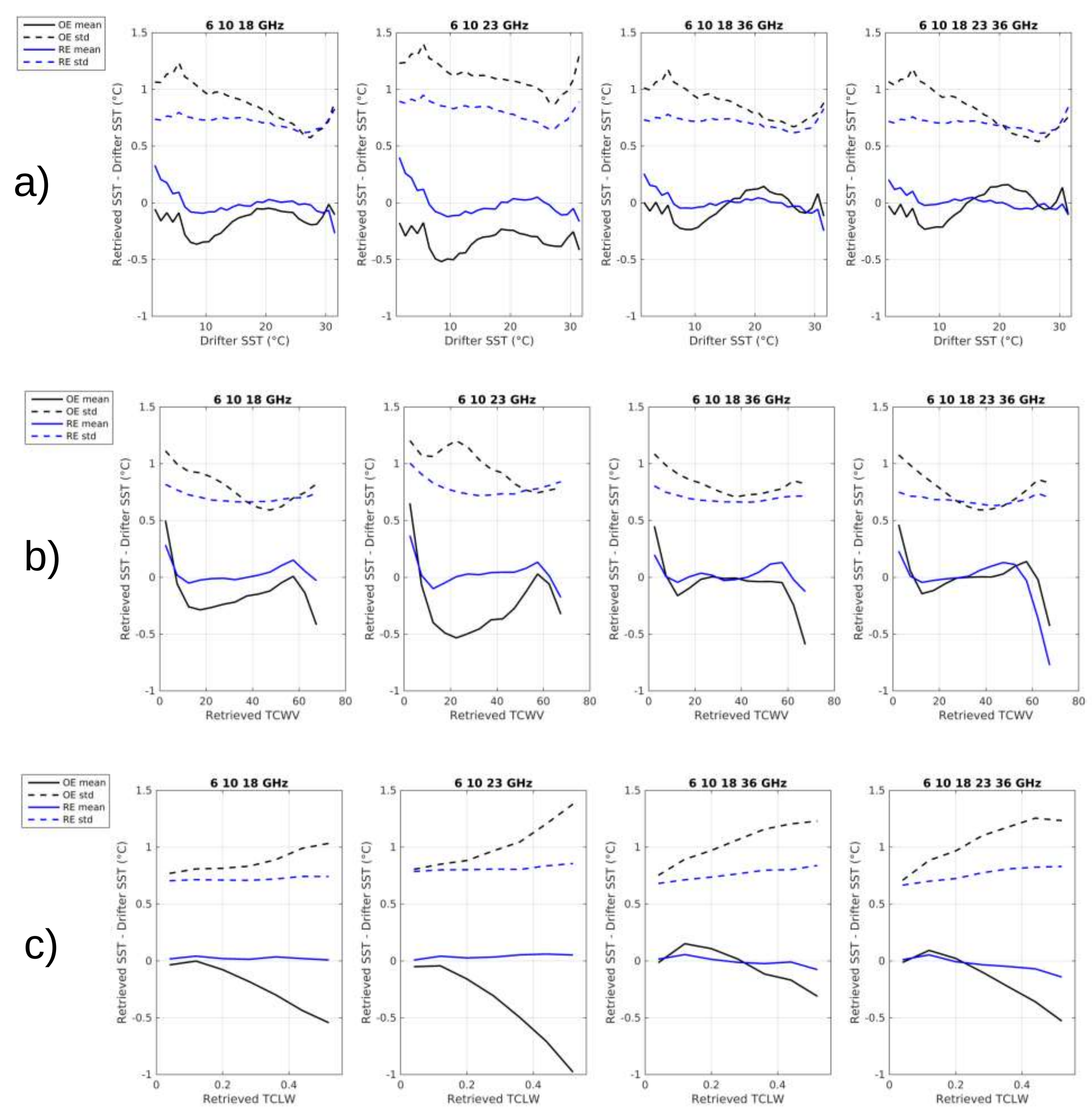


Figure 5: Retrieved (OE black, RE=blue) versus drifter SSTs for four channel selections as a function of a) SST, b) TCWV and c) TCLW.

Same filter is applied on all configurations requiring simulated minus observed TB difference less than 4σ for all channels.

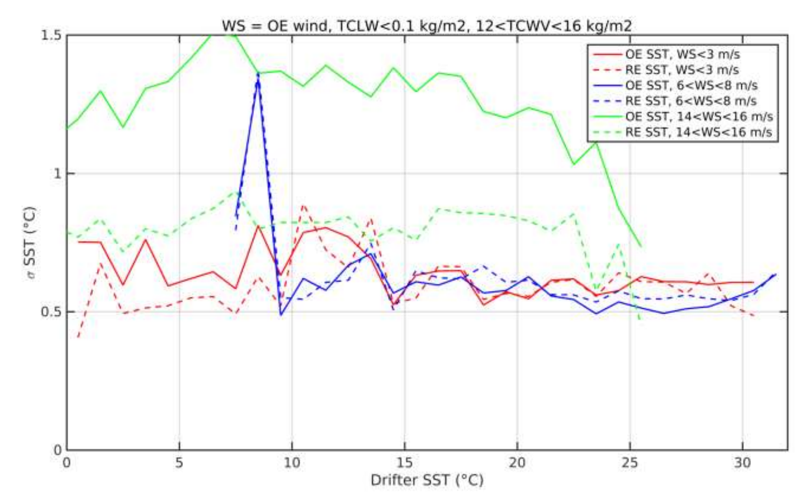


Figure 6: Standard deviations of retrieved (OE=solid, RE=dashed) minus drifter SSTs for different wind speeds using the all-channel configuration (AMSR-E).

5. Geographical performance

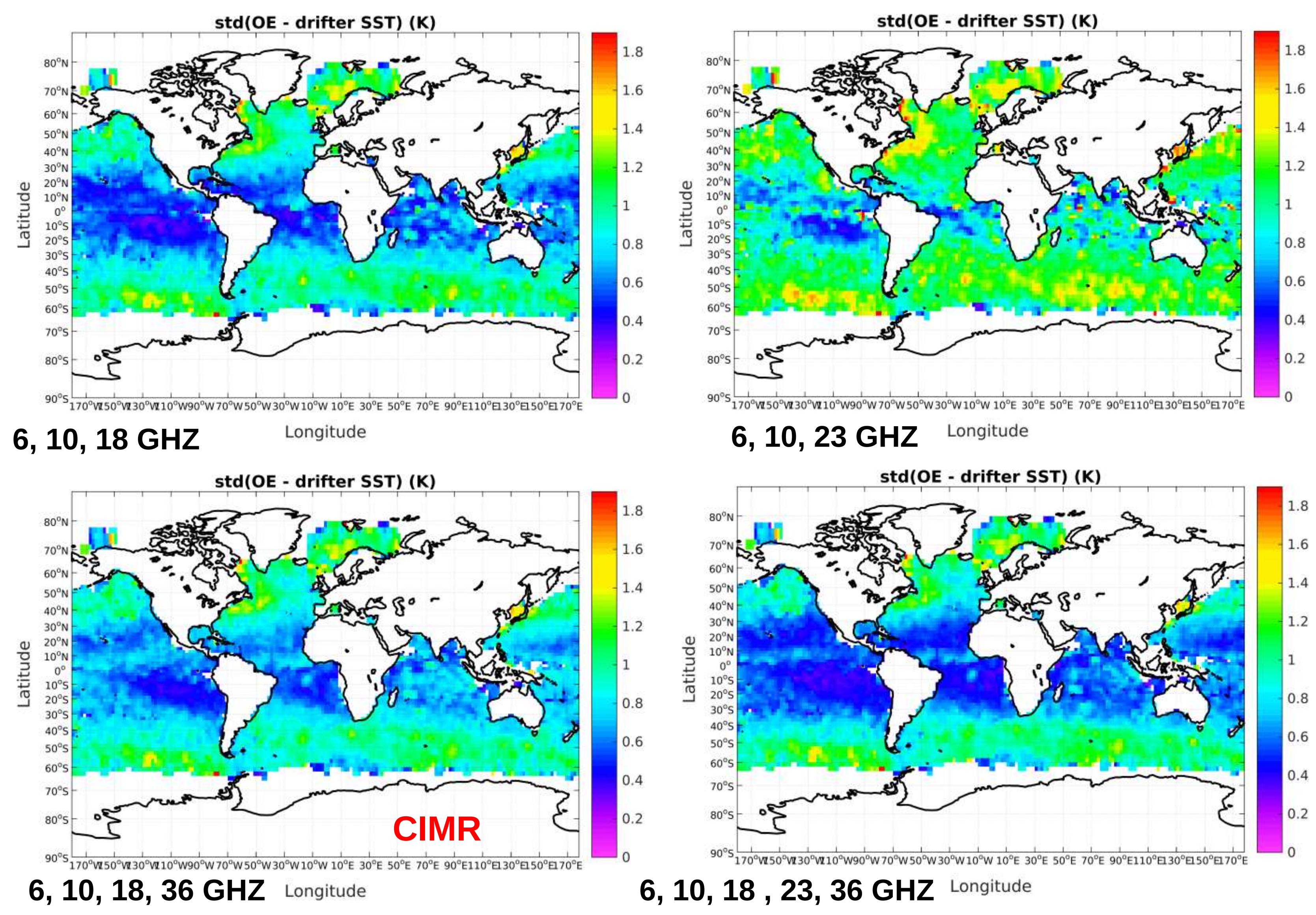


Figure 7: Standard deviations of OE retrieved minus drifter SST for different channel selections.

6. Conclusions

- SST retrievals for different channel combinations have been tested against independent in situ observations using OE and Regression retrieval algorithms on AMSR-E observations.
- In the current OE setup, addition of the 23 GHz channel does not improve the retrievals, except if the 36 GHz is included as well.
- CIMR channel selection performs similar to AMSR-E for both algorithms, but slightly worse in low latitudes.
- Important to assess performance of channel combinations using both theoretical and in situ derived uncertainties.

Acknowledgements

The work is part of the ESA CIMR Algorithm Development and Performance Evaluation (APE) Project.

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For more information on CIMR: see: https://cimr.eu/