ESA Climate Change Initiative Phase-II

Sea Surface Temperature (SST)

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Optimal Estimation of Sea Surface Temperature from AMSR-E

Pia Nielsen-Englyst, Jacob L. Høyer, Leif Toudal Pedersen, Chelle Gentemann, Emy Alerskans, Tian Tian & Tom Block

Outline

- Motivation
- Multi-sensor matchup data base (MMD)
- Optimal estimation retrieval algorithm
- Performance
- Conclusion and way forward

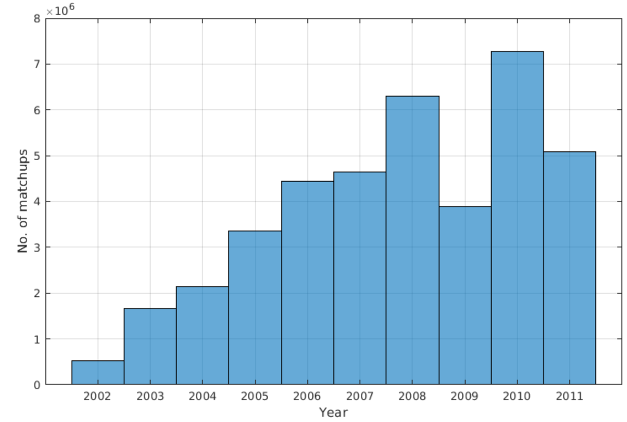
Motivation

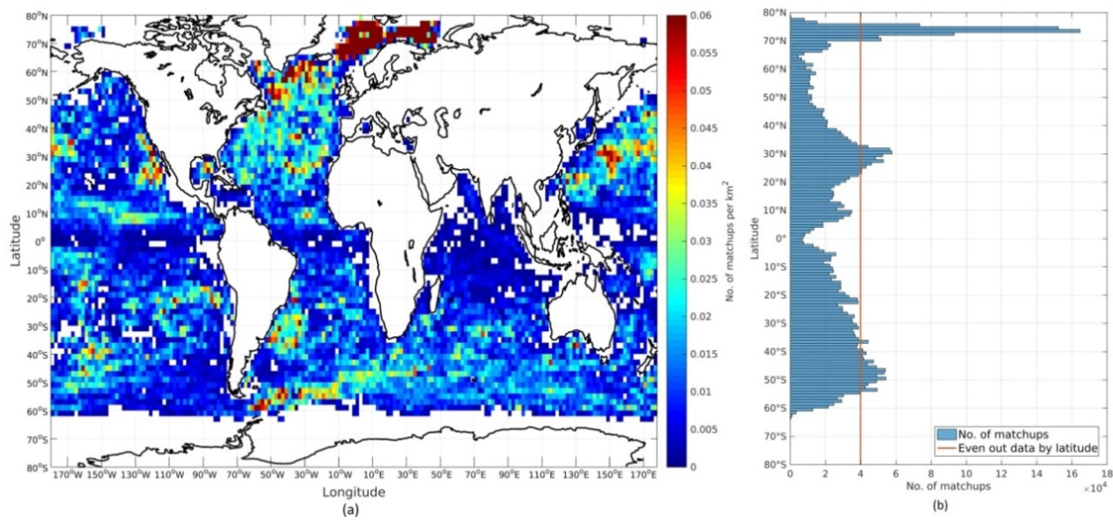
- Little European activity within the PMW SST retrieval work
- PMW SST retrievals are valuable supplement to IR SSTs due to the capability to see through clouds and small response to aerosols
- Optimal Estimation provides pixel-level information on the retrieval quality
- Optimal Estimation is currently being developed for Sea Ice within ESA CCI Sea Ice (SICCI) context
- A new PMW satellite (CIMR) is candidate for the Copernicus expansion mission

Multisensor Matchup Dataset (MMD6C)

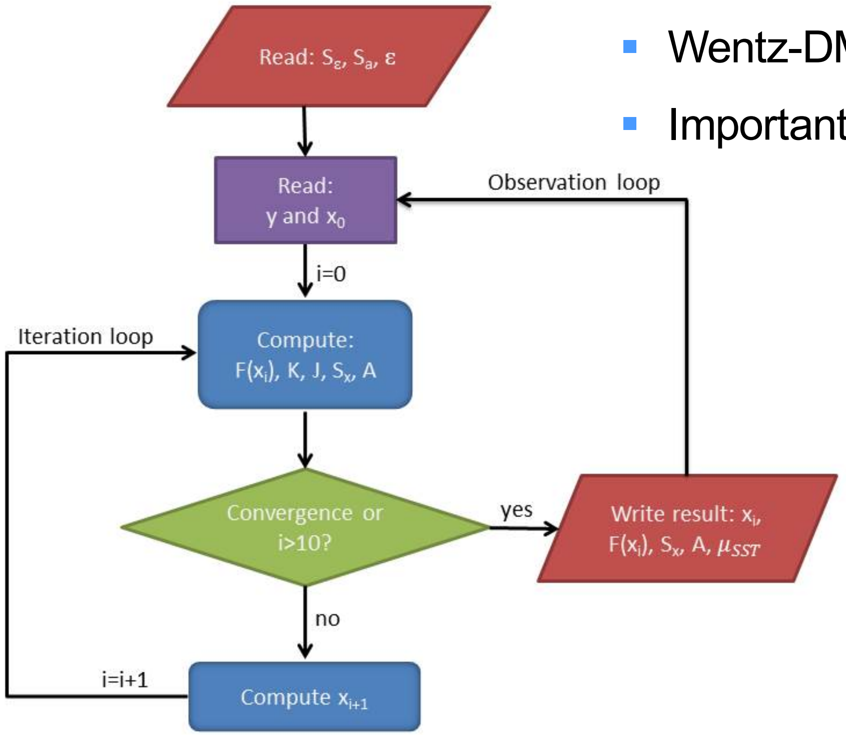
- **AMSR-E L2A TBs from RSS (NSIDC), version 7**
  - Resampled to resolution; 10 km, all channels
  - Orbit files, ascending and descending
- **Every matchup includes:**
  - 21x21 extract of AMSR-E TBs + aux info
  - 5x5 extract of NWP variables
  - 60 vertical layers for NWP
  - In situ SST history
  - 5x5 sea ice
- Netcdf format

2002-2011

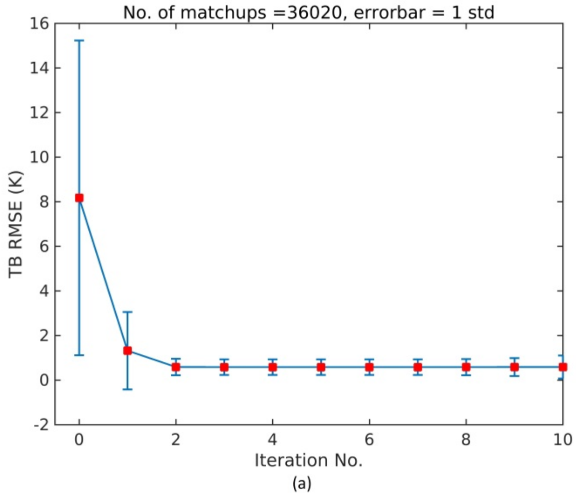


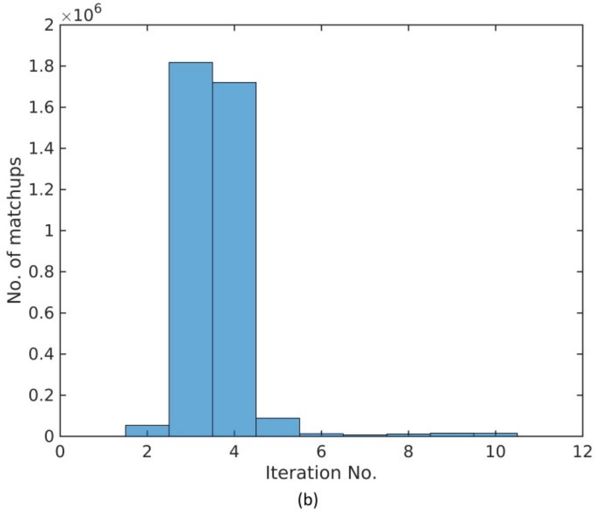


Optimal Estimation (OE) setup



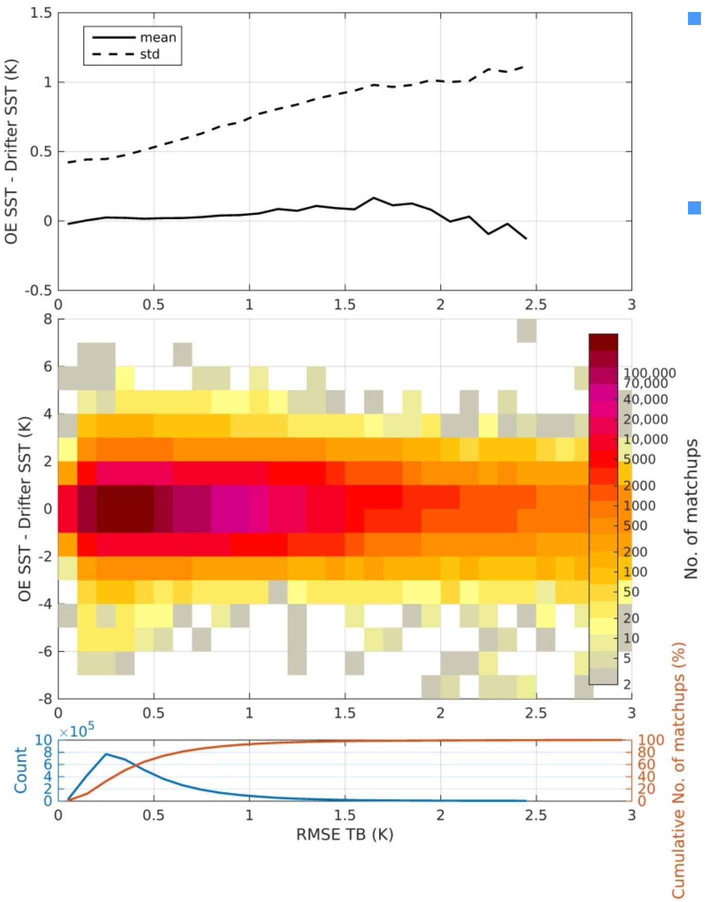
- Wentz-DMI FW model
- Important with iterations





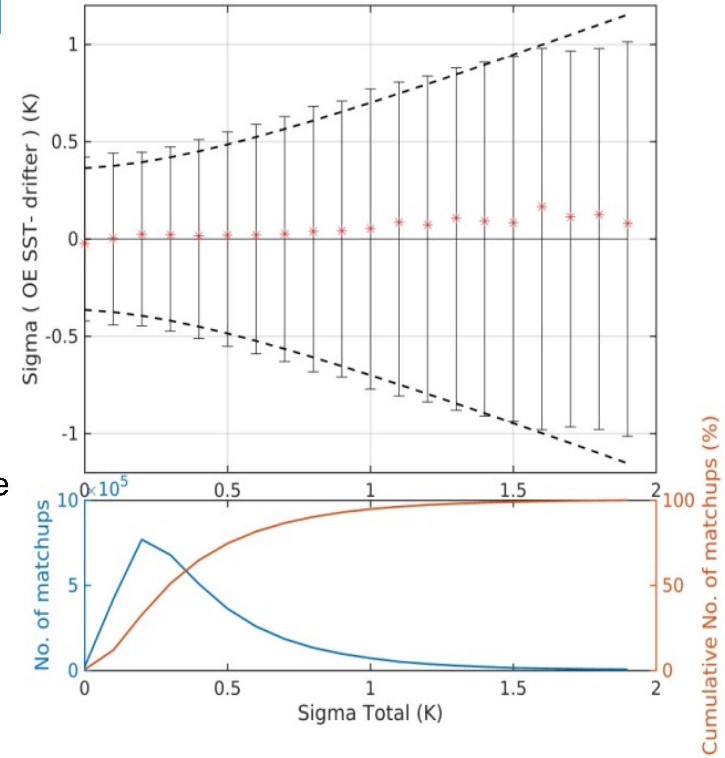
y: TBs (6V/H, 10V/H, 18V/H, 23V/H, 36V/H)
x : State vector (SST, TCWV, TCLW, WS)
S_e : Measurement and FW model error covariance
S_a : á priori error of state variables
x_0 : First Guess values

Uncertainty in SST retrieval



- RMSE TB as quality indicator
- Can be used for:
  - Filtering
  - Uncertainty estimate

OE SST uncertainty validation with respect to drifter SST.



Filter	Bias/K OE-Drifter	std/K OE-Drifter	N (10^6)	
Convergence test passed	0.02	0.57	3.7429	=100%
$RMSE_{TB}$ < 1 K	0.02	0.51	3.4329	=92%
$RMSE_{TB}$ < 0.50 K	0.02	0.47	2.3953	=64%
$RMSE_{TB}$ < 0.35 K	0.02	0.45	1.5681	=42%

Global validation

- High standard deviations in e.g.,
  - The Gulf Stream Extension
  - The Kuroshio Current
  - The Aghulas Retroflection areas
- OE SST better than NWP SST in mid-latitudes, while NWP SST is better in the tropics.

OE work is now published in:


remote sensing
MDPI
Article
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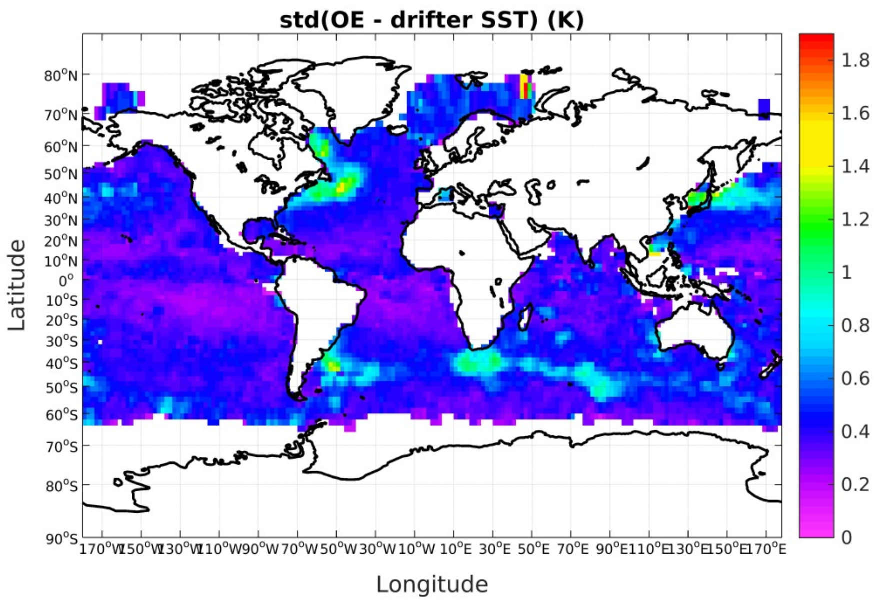
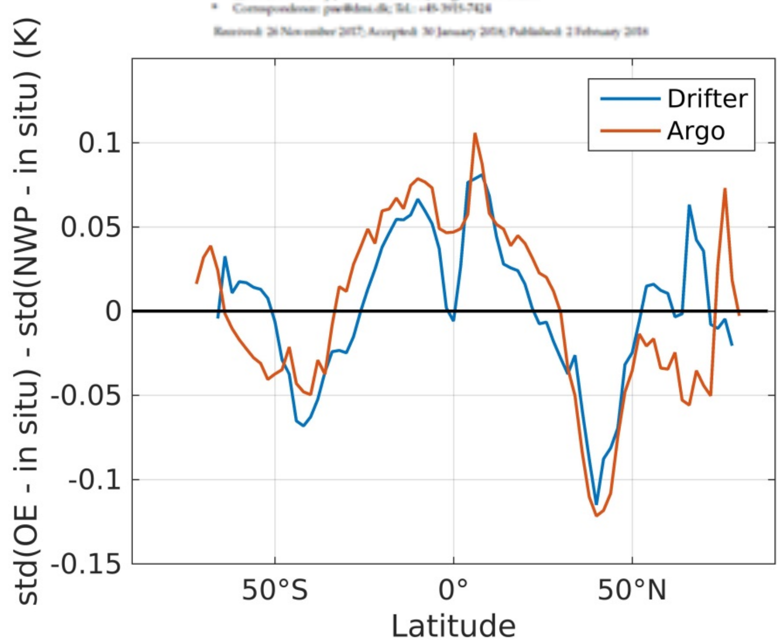
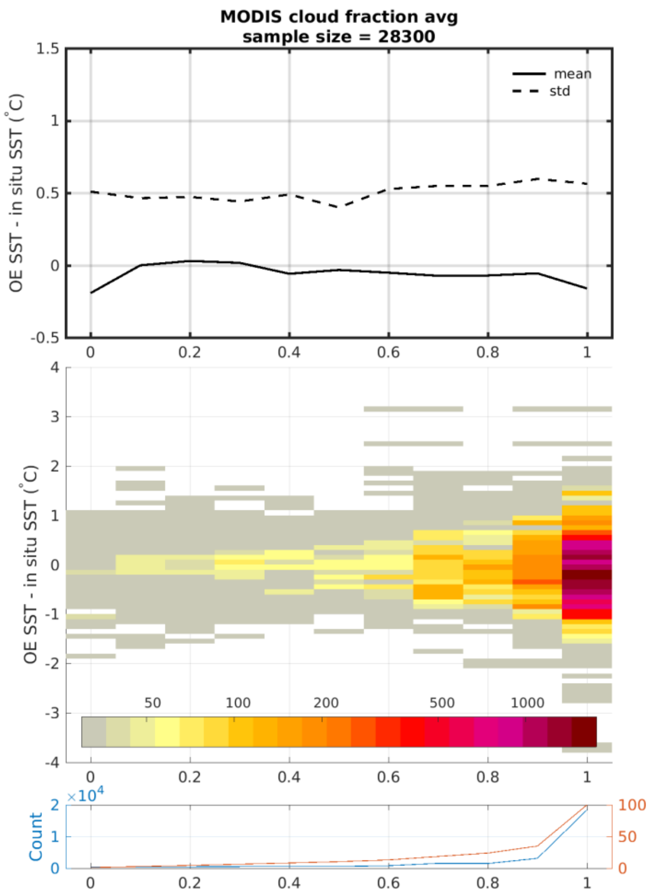
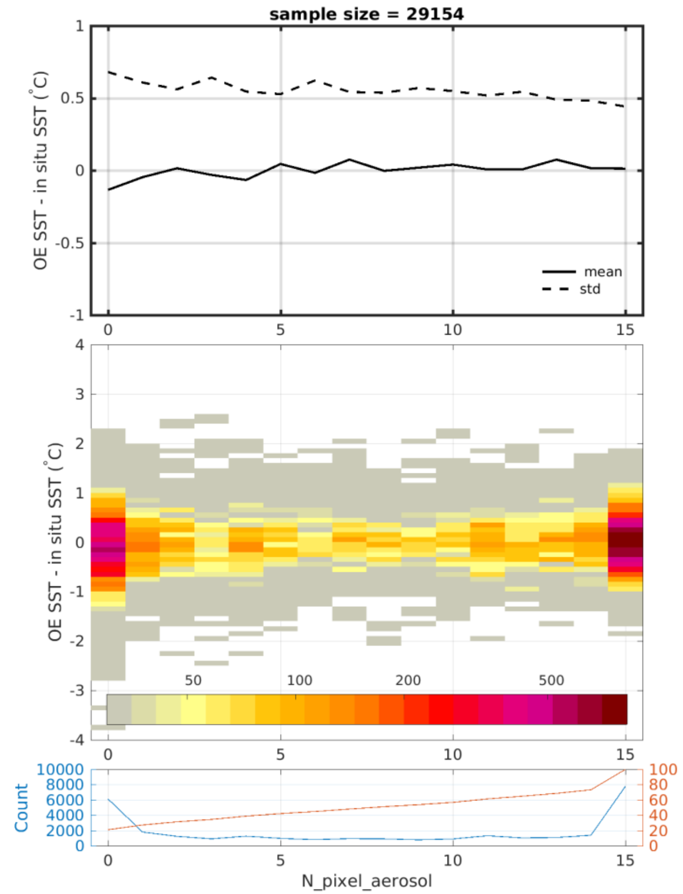




Impact from clouds and aerosols (1)

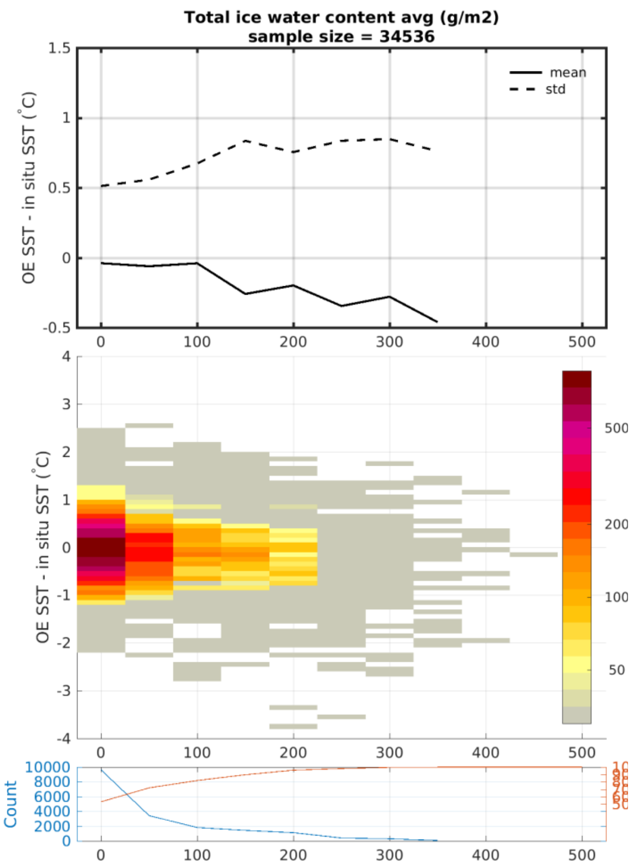


Modis cloud fraction

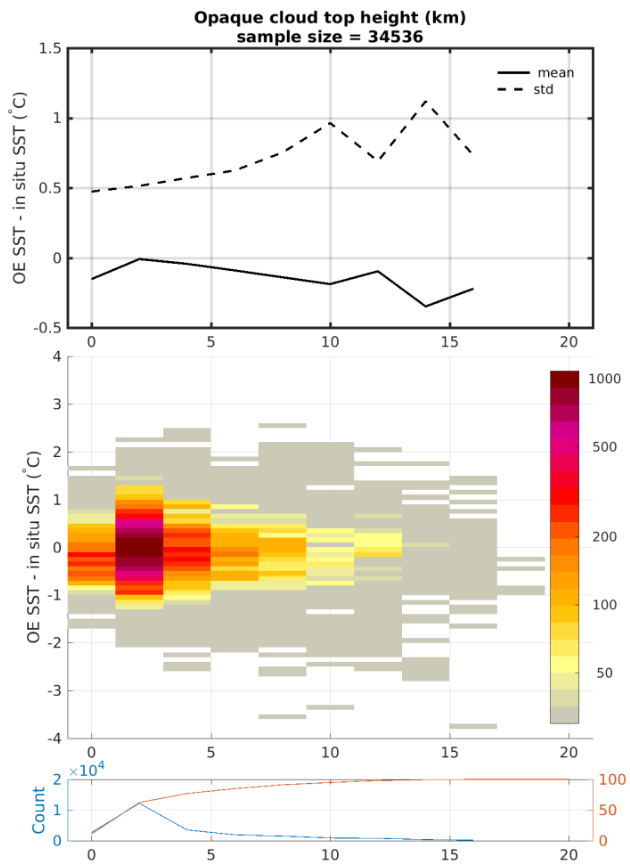


Number of pixels containing aerosols (1-15)

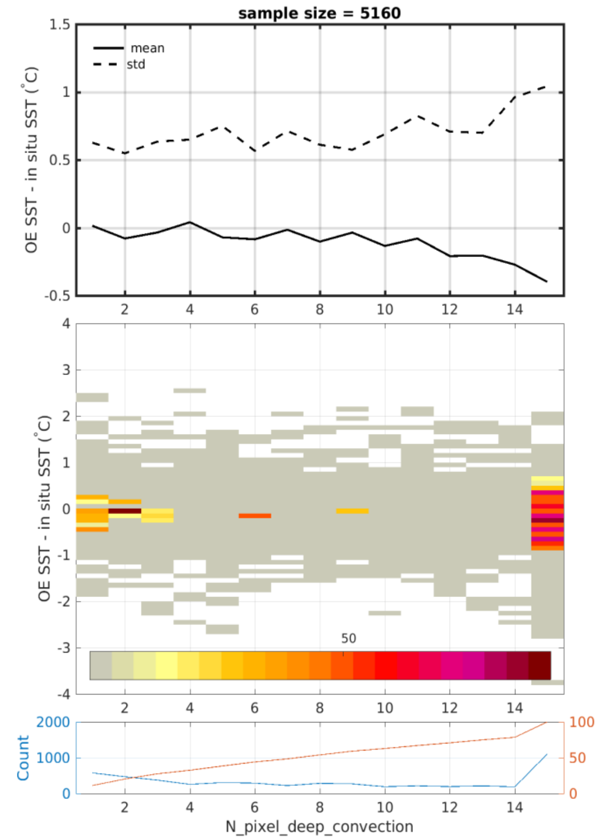
Impact from clouds and aerosols (2)



Total ice water content (TIWC; g/m^2)

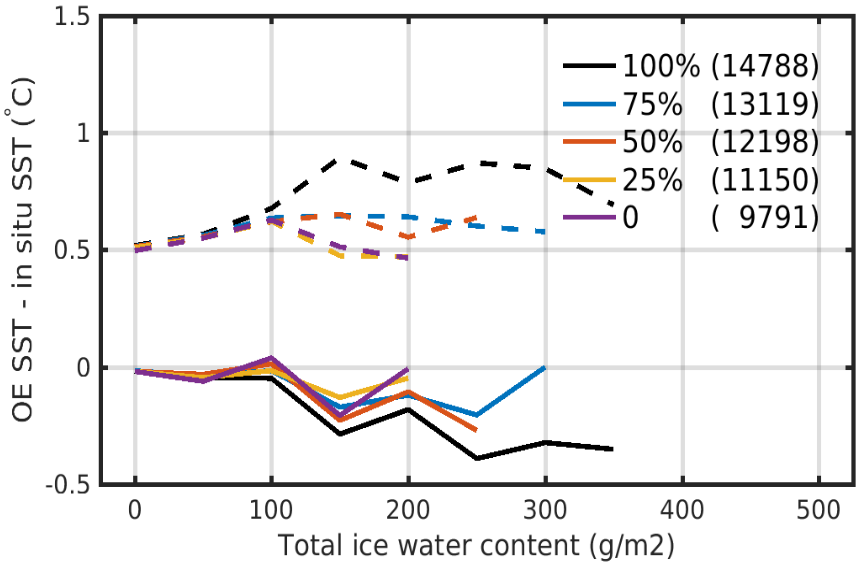


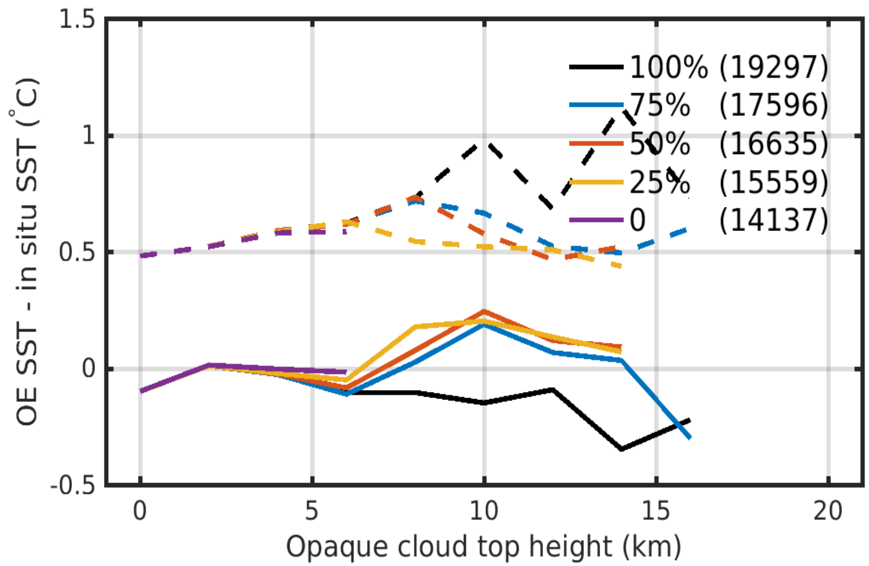
Opaque cloud top height (CTH; km)



Number of pixels containing deep convective clouds (1-15)

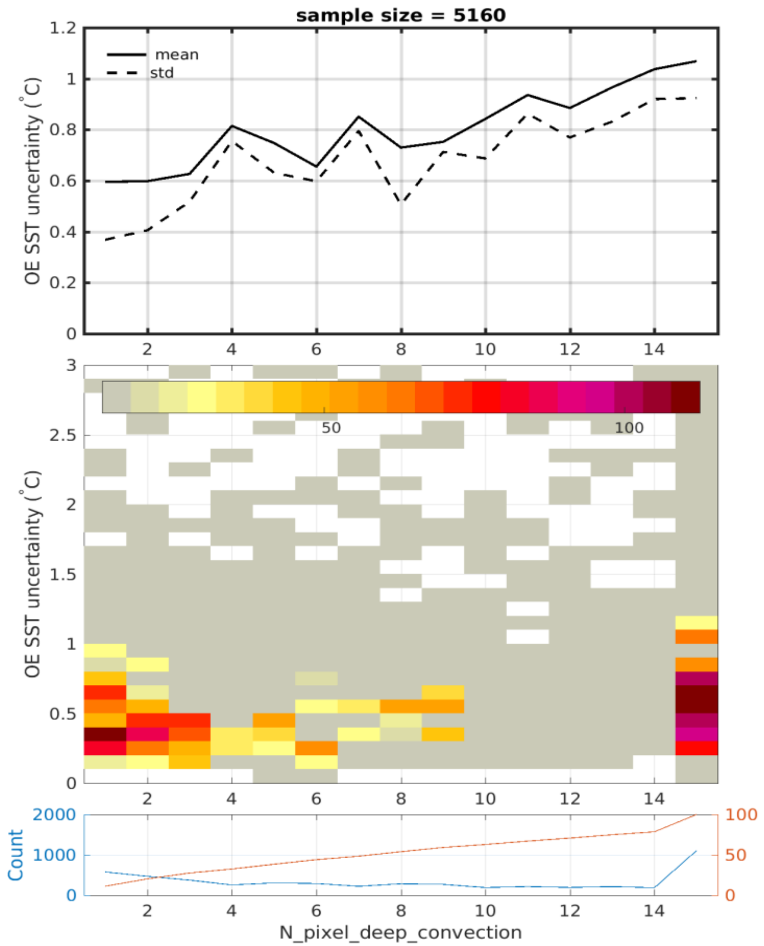
Performance and filtering effects



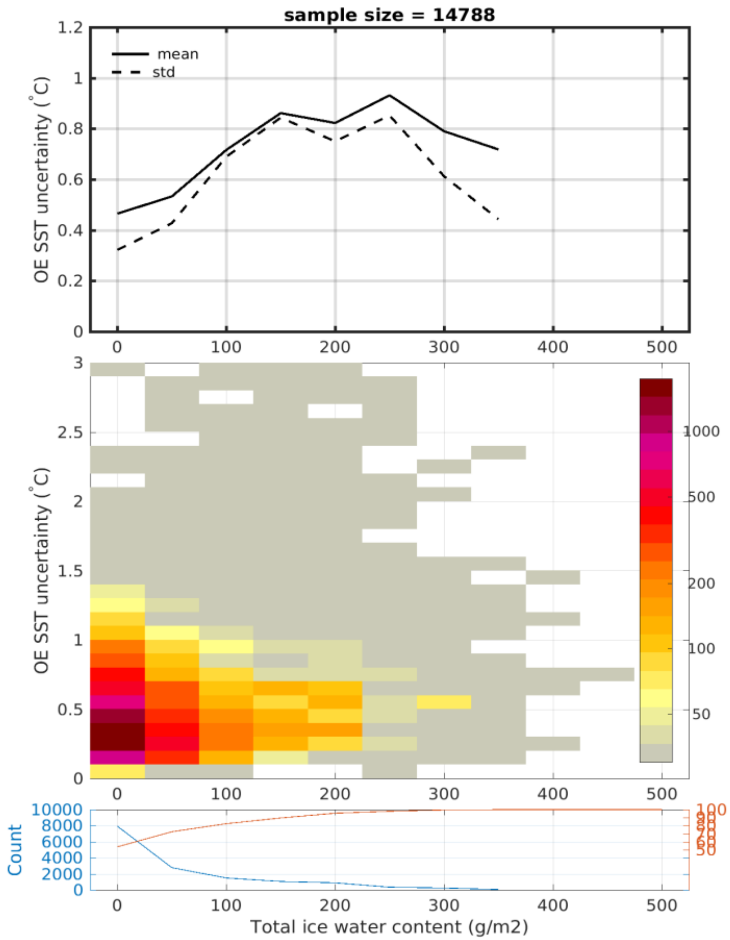


SST (OE-In situ)	Calipso (100 %)	Calipso (50 %)	Calipso (0 %)
Mean	-0.02	-0.00	-0.00
Std	0.56	0.51	0.50
Num	29,154	26,492	23,994

SST uncertainty vs. cloud parameters



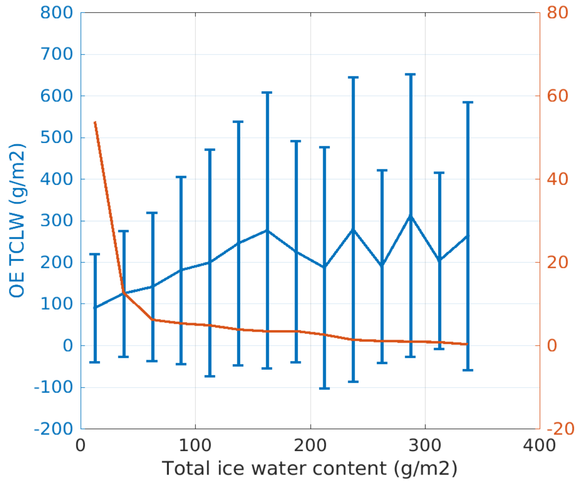
Number of pixels containing deep convective clouds

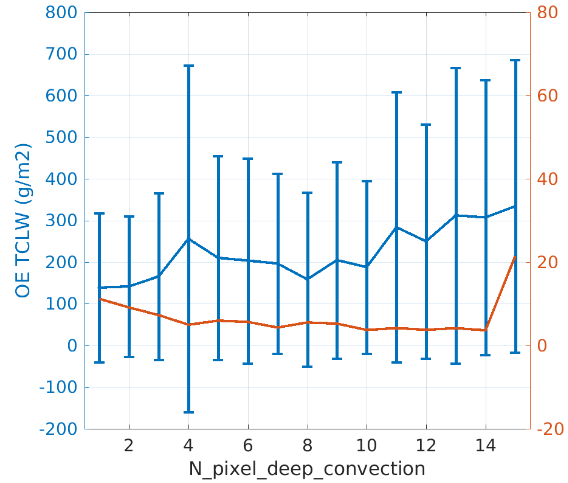


Total ice water content (TIWC; g/m^2)

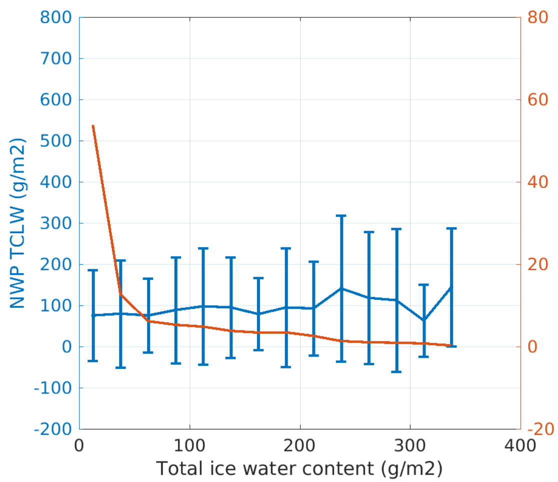
Total cloud liquid water content

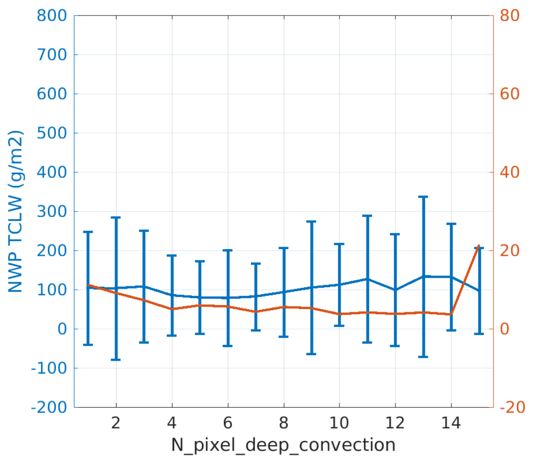
OE TCLW





NWP TCLW





Conclusion

- PMW SST OE retrievals developed:

  Updating state vector important

  Performance and uncertainty estimates very good

- Atmospheric impact on SST retrieval:

  Generally very stable performance

  Impact from deep convective clouds

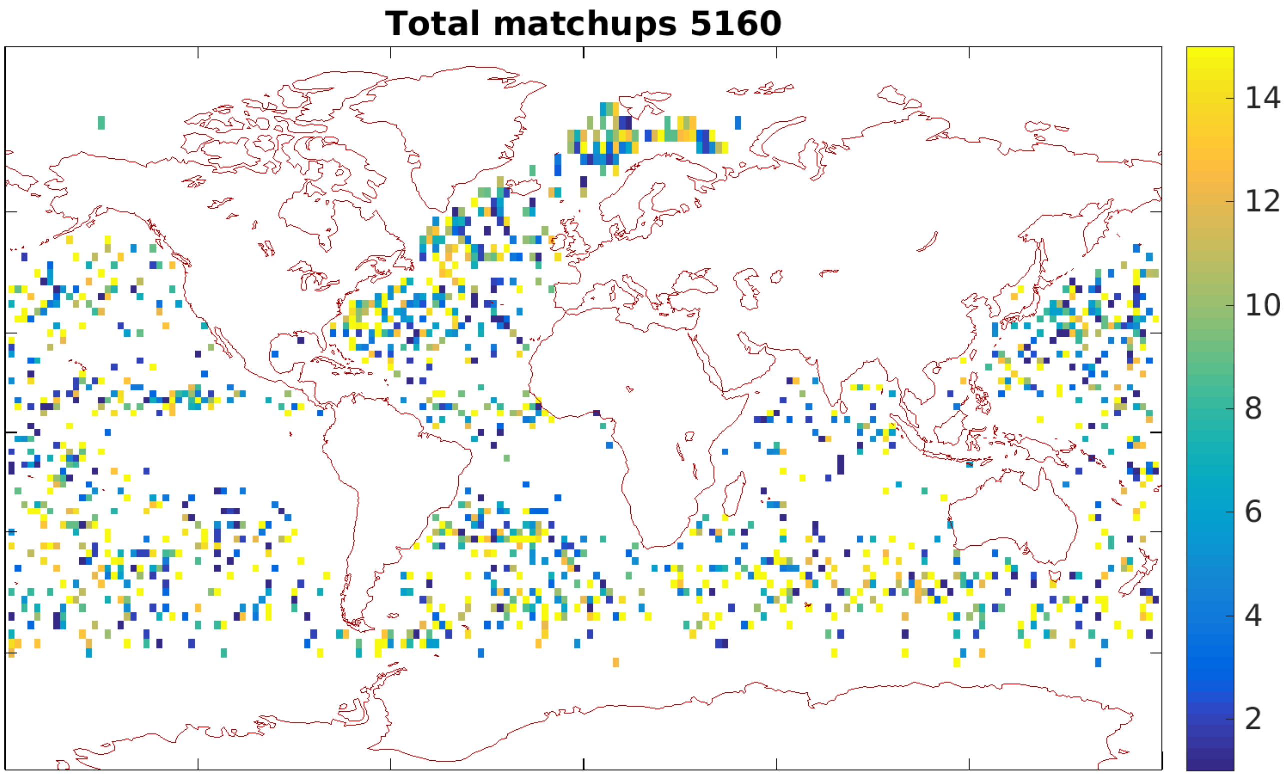
  OE can Identify and remove these effect

Way forward

- Improve the Wentz-DMI forward model
- Further assess atmospheric influence on retrieval
- Inter-compare RTTOV and Wentz-DMI forward models
- Implement OE for AMSR-2

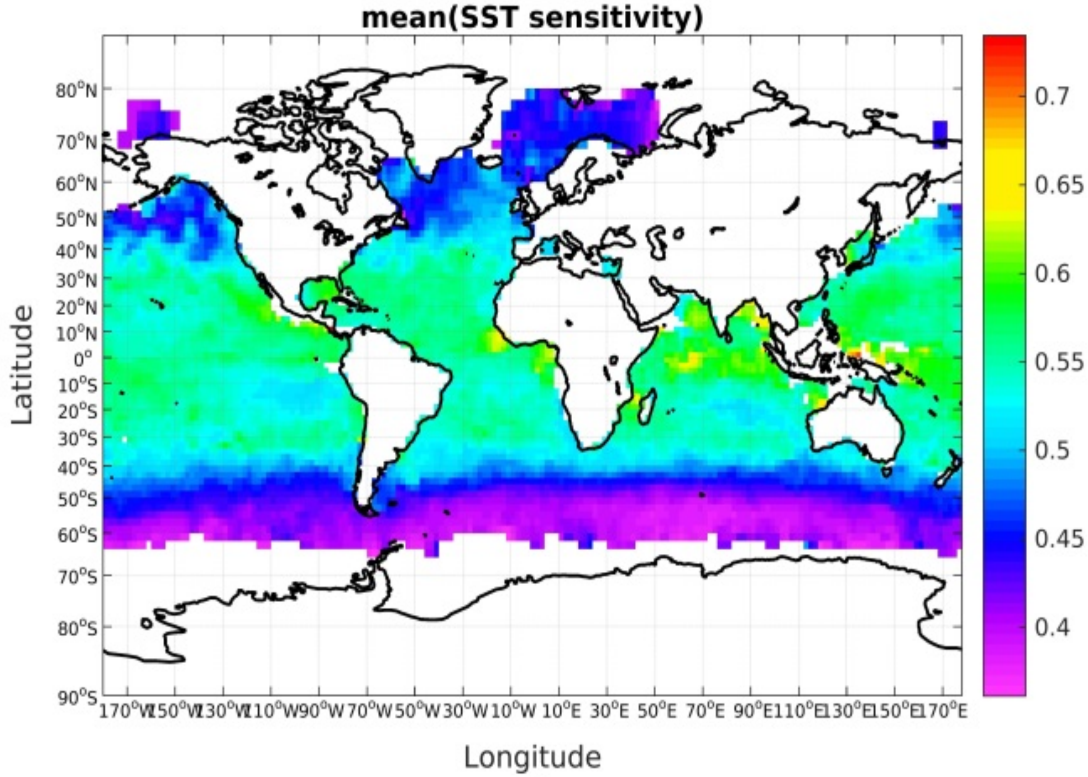
Thank you!

Distribution of deep convective clouds



Distribution of the number of pixels, ranging from 1 to 15, containing deep convective clouds averaged for 2x2 degree bins

Sensitivity



(a)

The SST sensitivity is lowest in high latitudes and increases towards the equatorial region, which is consistent with the fact that ∂TB/∂SST is smaller for cold waters (especially for X-band 10.65 GHz channels)