



Jacob L. Høyer¹, Emy Alerskans¹, Chelle L. Gentemann², Pia Nielsen-Englyst¹, Leif Toudal Pedersen³ and Tom Block⁴

¹ Danish Meteorological Institute (DMI), Denmark

² Earth and Space Research, USA

³ DTU-Space, Technical University of Denmark, Denmark

⁴ Brockmann Consult, Germany

1. Introduction

Sea surface temperature (SST) is an essential climate variable that is critical for assessing the climate system and its changes. A global SST Climate Data Record (CDR) for the period 2002-2011 is constructed within the European Space Agency Climate Change Initiative (ESA-CCI) SST project using a two-step multiple linear regression model with passive microwave (PMW) data from AMSR-E.

The PMW SSTs are validated against drifting buoy measurements covering the whole CDR period. The PMW SSTs have been analyzed for dependencies with respect to wind speed and latitude, amongst others. In addition, a new RFI/QC filter based on the PMW SST retrievals has been developed. Uncertainty estimates for all PMW SST retrievals are available and have been validated to be accurate.

2. Data

ESA-CCI Multi-sensor Matchup Dataset (MMD6C):

- AMSR-E L2A brightness temperatures from RSS (NSIDC) version 7.
- *In situ* SST from drifting buoys, Argo floats, GTMBA, radiometer, ships, XBT, CTD, bottle and animal.
- Auxiliary data – ERA-Interim NWP data.

Total number of drifter matchups: 41,855,176.

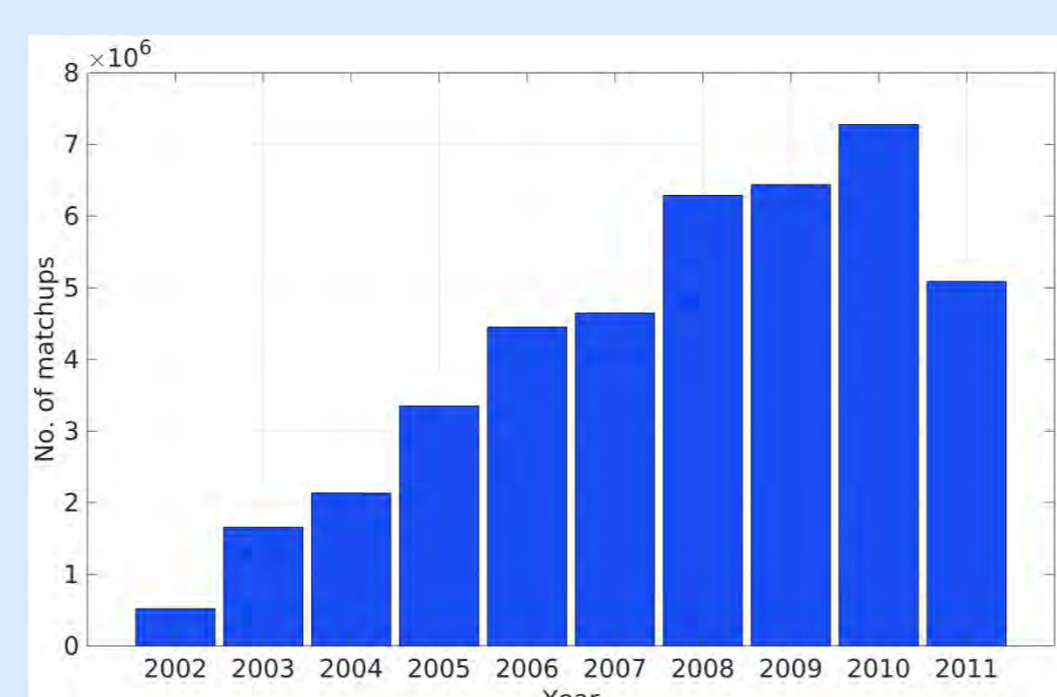


Figure 1. Number of matchups per year.

Satellite	Time period	Resolution	Product version	Table 1. Satellite sensor and data information.
AMSR-E	June 2002-October 2011	58 km (resampled)	L2A swath data product AMSR-E V12	

4. RFI/QC filter

Retrieve SST using two additional algorithms:

- -10GHz: no 10 GHz channels.
- -18GHz: no 18 GHz channels.

3 σ -filter is used on SST retrieved with the -10GHz and -18GHz algorithms minus SST retrieved with the baseline algorithm to mask RFI and for quality control of the retrievals:

$$\begin{aligned} |(SST_{r-10} - SST_{r_{baseline}}) - \mu_{-10}| &> 3\sigma_{-10} \\ |(SST_{r-18} - SST_{r_{baseline}}) - \mu_{-18}| &> 3\sigma_{-18} \end{aligned}$$

where

σ_{-10} is the std of $SST_{r-10} - SST_{r_{baseline}}$

μ_{-10} is the mean of $SST_{r-10} - SST_{r_{baseline}}$ and correspondingly for -18GHz algorithm.

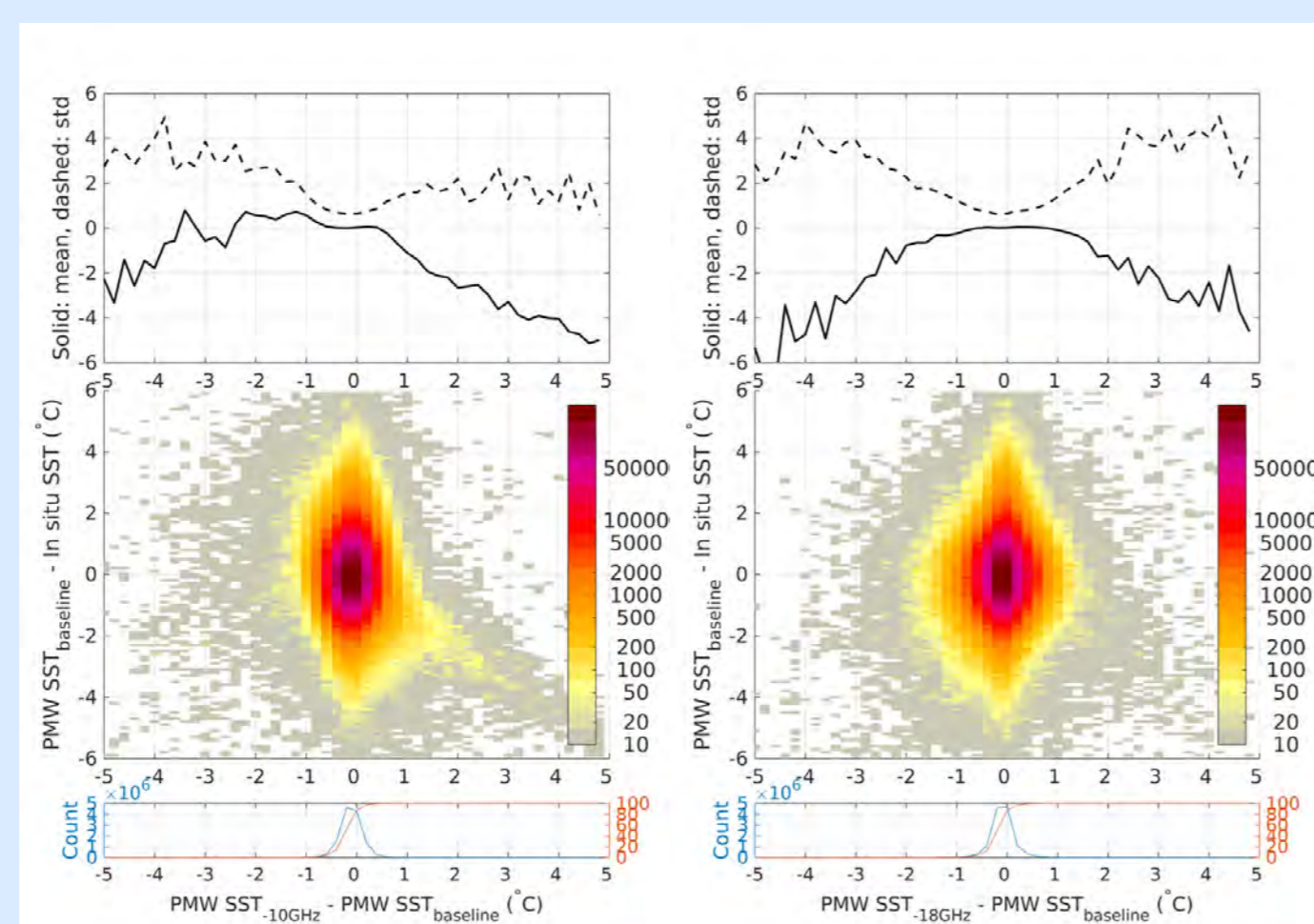


Figure 2. Baseline PMW SST minus *in situ* SST as a function of (left) $PMW SST_{-10GHz} - PMW SST_{baseline}$; and (right) $PMW SST_{-18GHz} - PMW SST_{baseline}$. Top panel shows the mean and standard deviation of the difference, mid panel shows distribution of matchups and bottom panel shows number of matchups per bin.

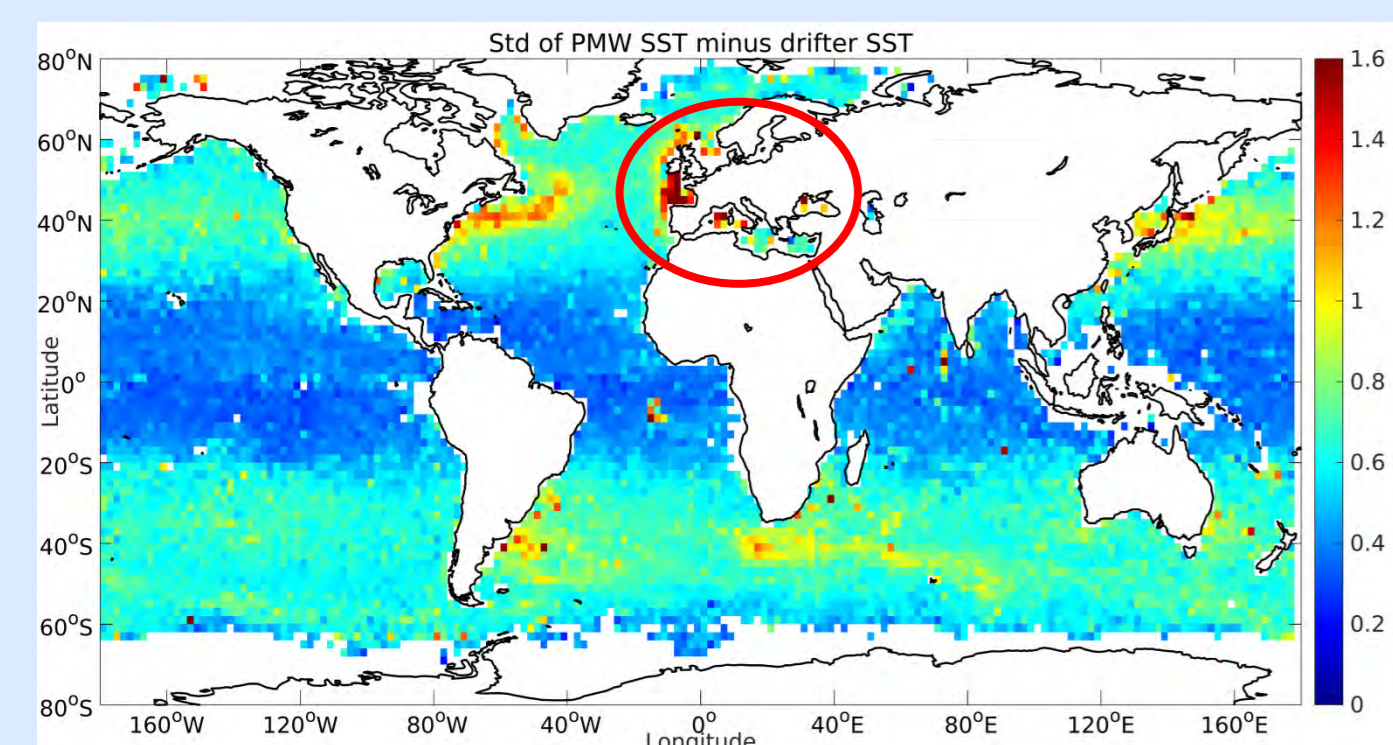


Figure 3. Geographical distribution of gridded standard deviation of baseline PMW SST minus *in situ* SST without application of the RFI/QC filter.

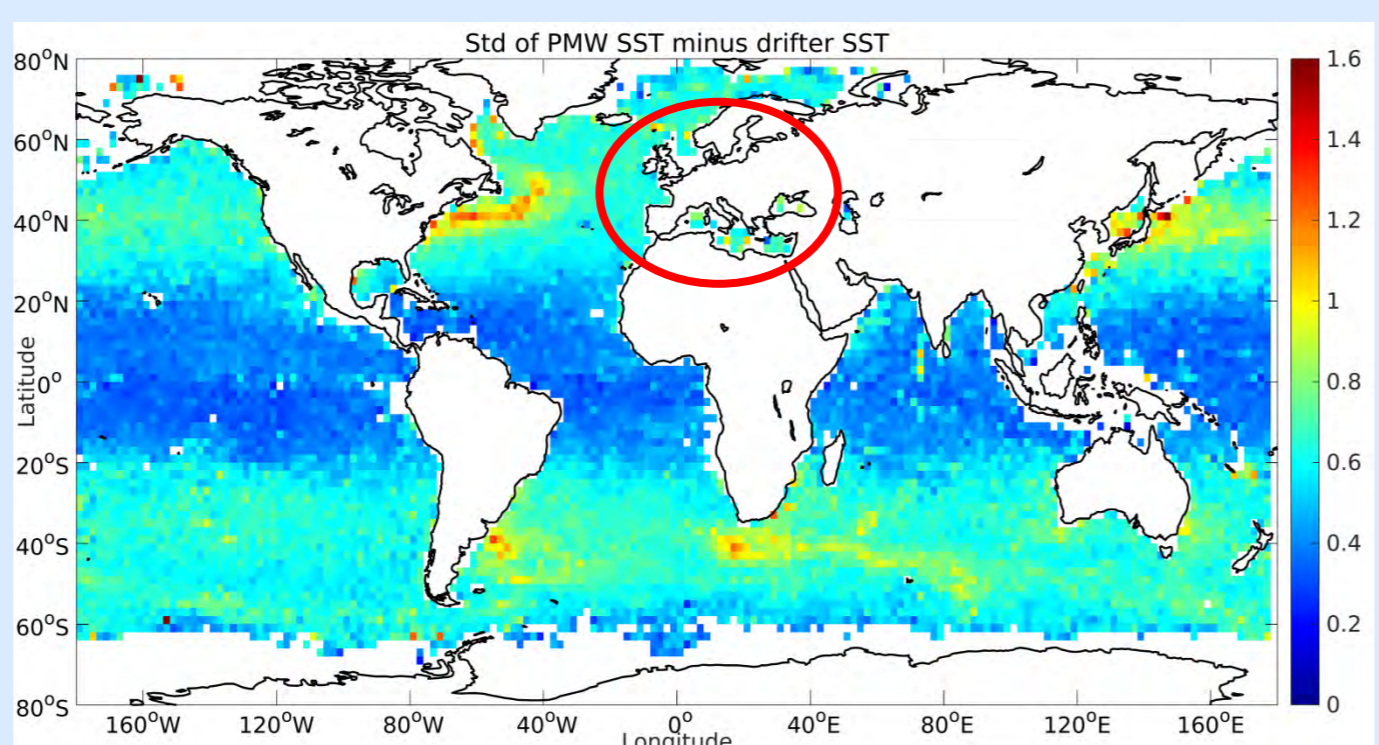


Figure 4. Geographical distribution of gridded standard deviation of baseline PMW SST minus *in situ* SST with application of the RFI/QC filter.

6. Conclusions

- New RFI/QC filter successfully masks out RFI.
- No significant temporal dependence; higher standard deviation for year 2002-2003 attributed to fewer matchups.
- No significant wind speed dependence; only slightly increased standard deviation for high wind speeds.
- Latitudinal dependence; lower standard deviation at low latitudes and higher standard deviation at higher latitudes.
- Good agreement between observed and retrieved uncertainties.
- Validation results for quality level 5 matchups: Mean of -0.011 K and standard deviation of 0.49 K.

3. PMW retrieval algorithm

The SST retrieval algorithm is a 2-step multiple linear regression model with localized retrieval algorithms:

$$SST_r = a_0 + \sum_{i=1}^{12} a_i t_i + b_i t_i^2 + c \theta_{EIA} + d WS + \sum_{j=1}^2 e_j \cos j \varphi_{REL} + f_j \sin j \varphi_{REL}$$

where

$$t_i = T_{Bi} - 150$$

for all channels except the 23.6 GHz channels.

$$t_i = -\ln(290 - T_{Bi})$$

for the two 23.6 GHz channels.

i denotes the summation over 12 AMSR-E channels; 6.9, 10.7, 18.7, 23.6, 36.5, 89.0 GHz.

1st step: Initial retrieval of SST using localized latitude and orbit-wise algorithms.

2nd step: Final retrieved SST using localized SST and wind speed algorithms.

The SST uncertainty retrieval algorithm is a multiple linear regression model:

$$\epsilon_{SST_r} = f(SST_r, WS, \theta_{SZA}, \phi_{AMSR-E}, \varphi_{REL})$$

5. PMW SST and SST uncertainty validation

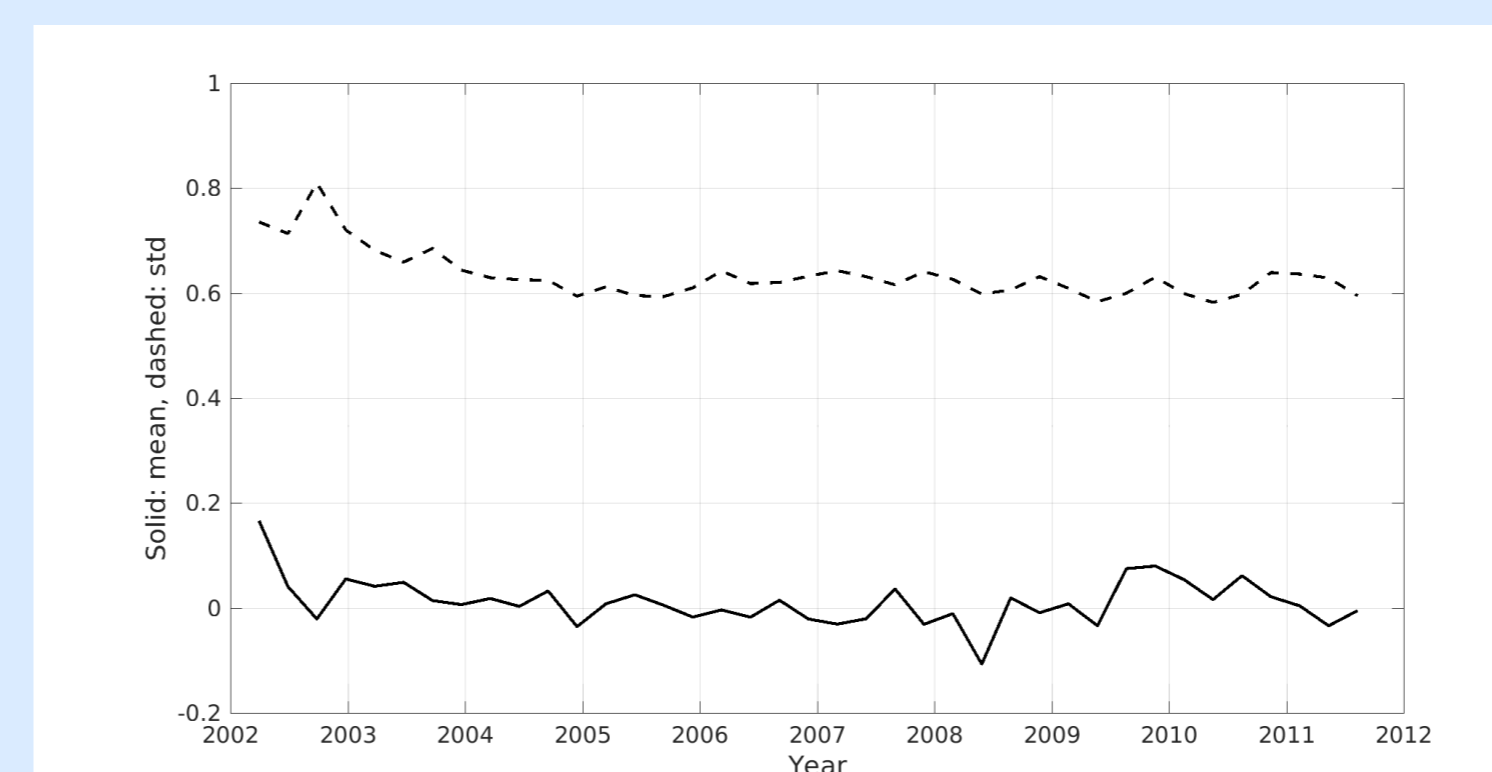


Figure 5. Mean (solid) and standard deviation (dashed) of PMW SST minus *in situ* SST as a function of time (season) for quality level 3-5 matchups.

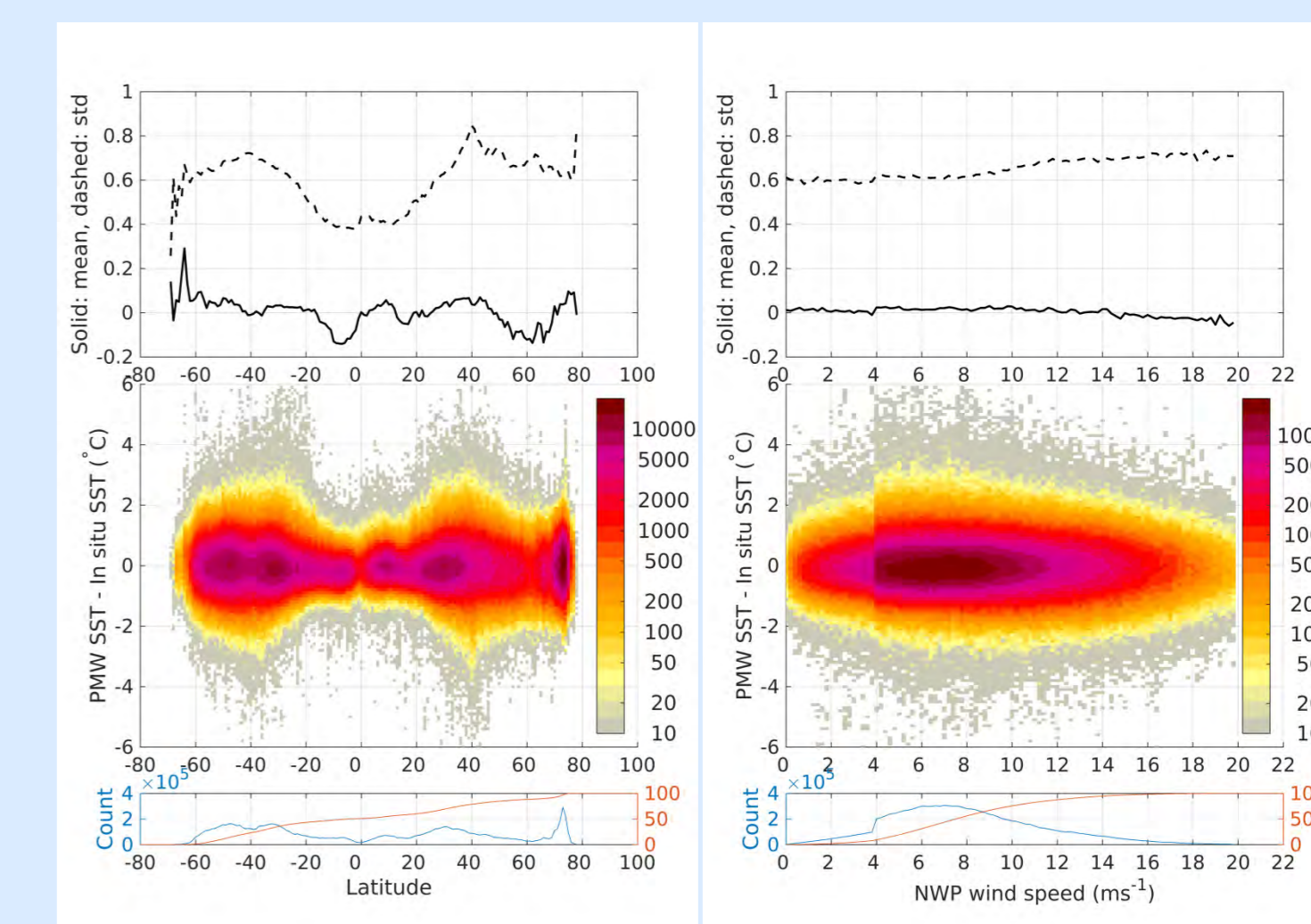


Figure 6. PMW SST minus *in situ* SST as a function of (left) latitude; and (right) NWP wind speed. Top panel shows the mean and standard deviation of the difference, mid panel shows distribution of matchups and bottom panel shows number of matchups per bin.

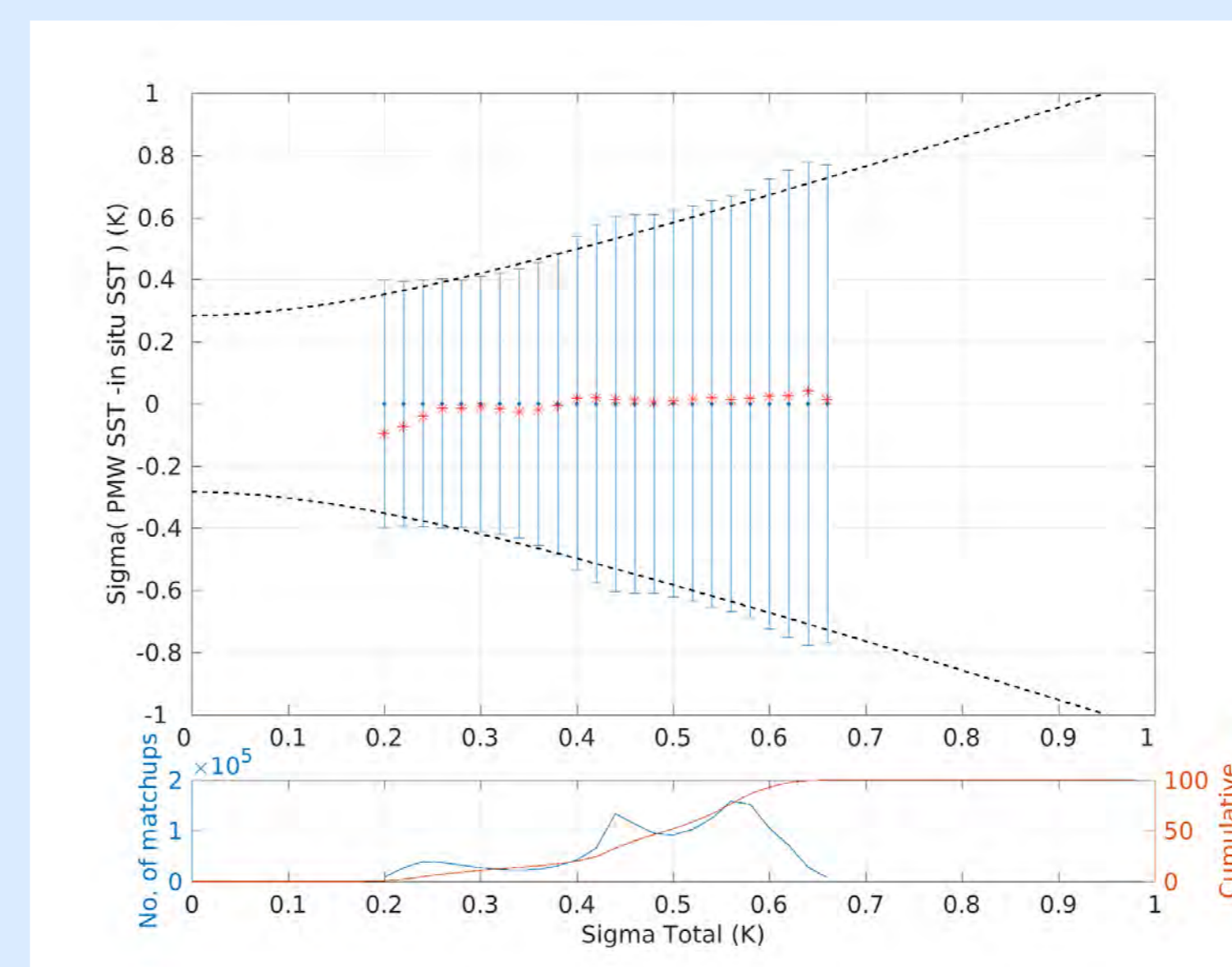


Figure 7. PMW SST uncertainty validation against *in situ* drifter SST. Dashed lines show the ideal uncertainty model accounting for uncertainties in drifter SST and the sampling error. Solid black lines show one standard deviation of the PMW minus *in situ* differences for each 0.02 K bin and the red symbols mark the mean bias. The bottom plot shows the number of matchups (blue) and the cumulative percentage of matchups per bin (red).

Filtering	Mean (K)	Std (K)	No. of matchups
Quality level 3	0.027	0.74	2,137,058
Quality level 4	0.015	0.64	9,094,449
Quality level 5	-0.011	0.49	4,449,041

Table 2. Performance of SST retrieval algorithm with mean and standard deviation of PMW SST minus *in situ* SST and number of matchups contributing to the statistics for quality level 3-5. The data have been filtered for RFI, using the RFI/QC masking described in section 4, rain contamination, sea ice contamination, land contamination and quality controls of the satellite and auxiliary data.

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Contact: Jacob L. Høyer (jlh@dmj.dk)