On the Quality of HY-2A Scatterometer Winds

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National Satellite Ocean Application Service

Outline

1. HY-2A scatterometer (HSCAT) Level 2 processed at ICM-CSIC (Spain) with KNMI's Pencil-beam Wind Processor (PenWP)
2. Ku-band QC approach based on ASCAT QC (MLE and SE)
3. TMI collocated rain data used to tune the HSCAT QC
4. Validation with ECMWF, buoy, ASCAT and RSCAT winds
5. Conclusions

L2 processing

The HSCAT Level 2A backscatter data from NSOAS have been processed using the EUMETSAT Numerical Weather Prediction (NWP) Satellite Application Facility (SAF) Pencil-beam scatterometer Wind Processor (PenWP):

- Numerical ocean calibration (NOC)
- Multiple solution scheme (MSS)
- Inversion residual (MLE-) based quality control
- Two-dimensional variational (2D-VAR) ambiguity removal (AR) scheme.

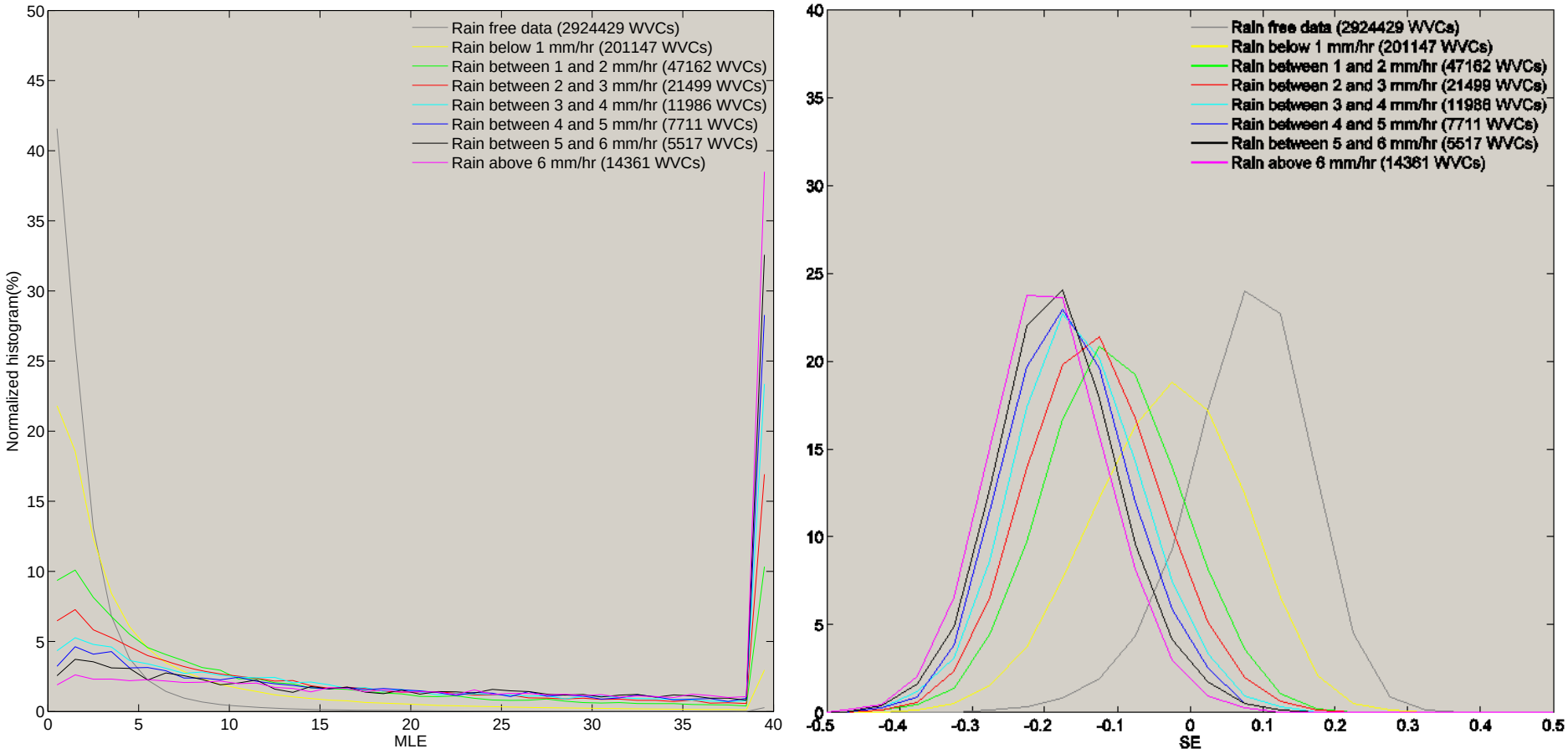
In addition, ICM develops

- Singularity analysis based quality control

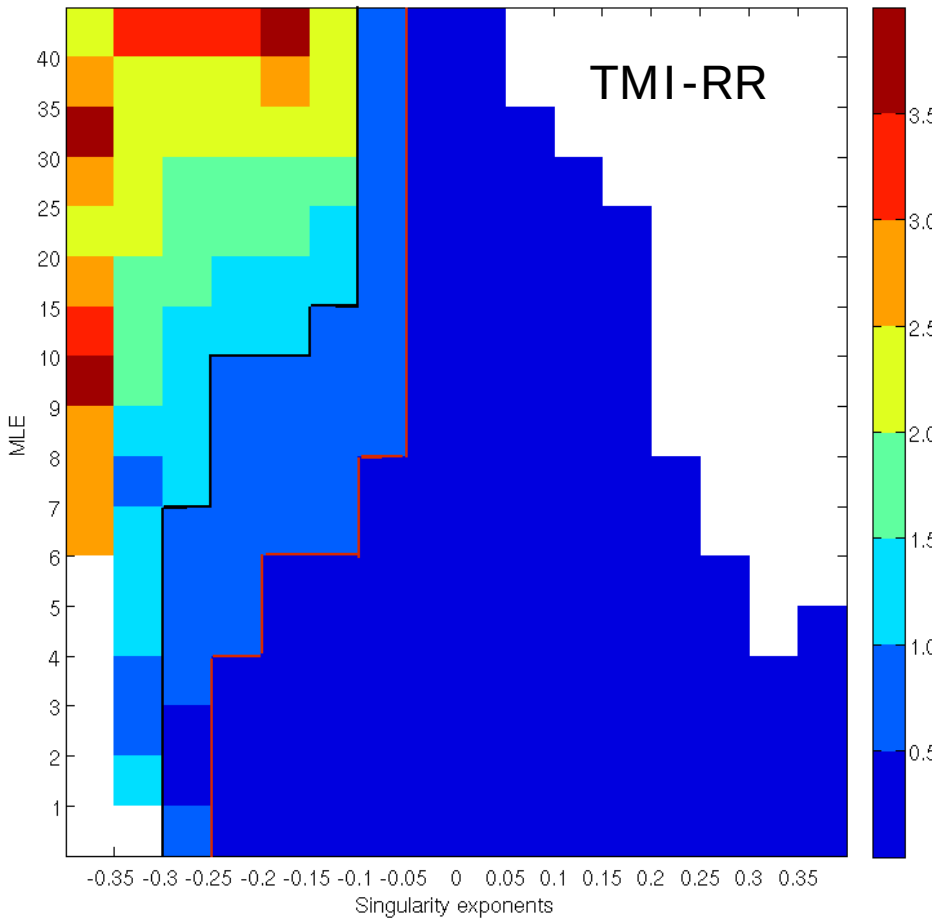
Datasets

- The HSCAT Level 2A backscatter data from NSOAS (July 2012- June 2014 + April 27-May 6, 2015); HSCAT L1B backscatter data (July 2014-April 2015), coming soon
- Collocated ECMWF (for the same period)
- Collocated TMI rain rate (July - December 2012)
  - < 30 min; < 25 km (only high latitudes, i.e. |Lat| < 40°)
- Collocated buoy winds (July 2012-June 2013)
  - < 5 min; <25 km (low & mid latitudes)
- Collocated ASCAT winds (July – August 2012)
  - < 25 min; < 25 km (only high latitudes, i.e. |Lat| > 60°)
- Collocated RSCAT (April 27 – May 5, 2015)
  - < 5 min; <25 km (low & mid latitudes)
- Other ancillary data used, e.g., MSG rain data

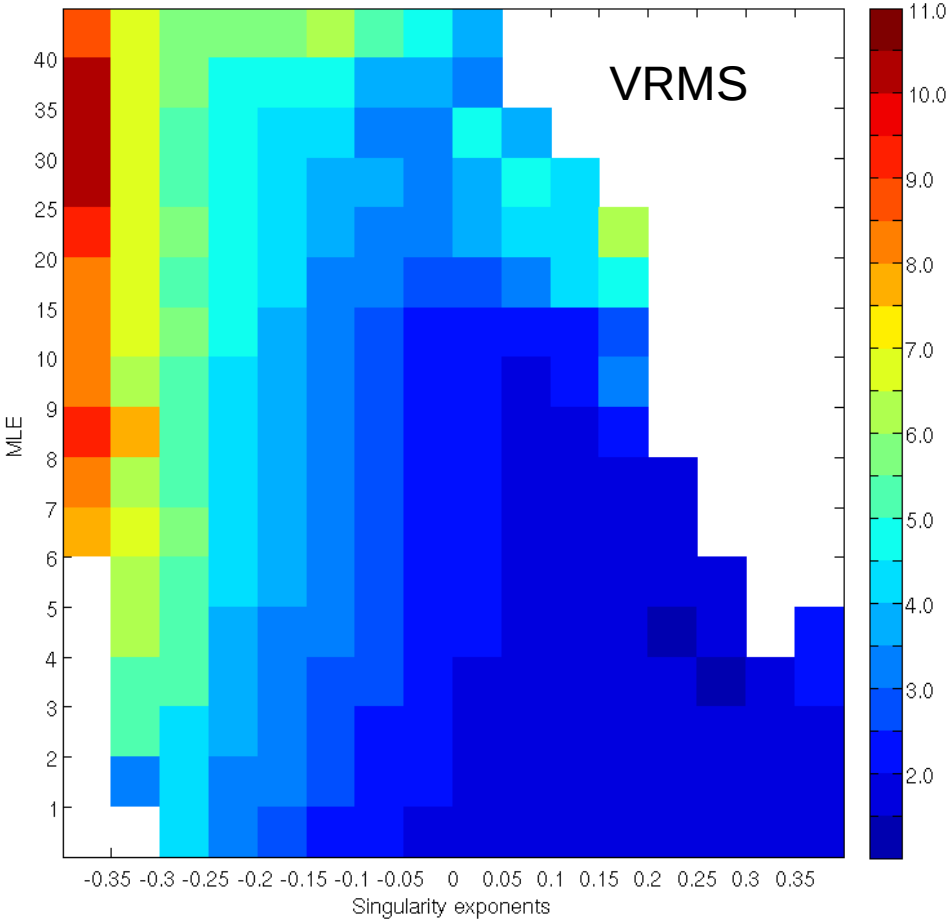
Quality indicators and quality control



Histogram of HSCAT MLE (Left) and singularity exponent SE (Right) at different TMI rain conditions



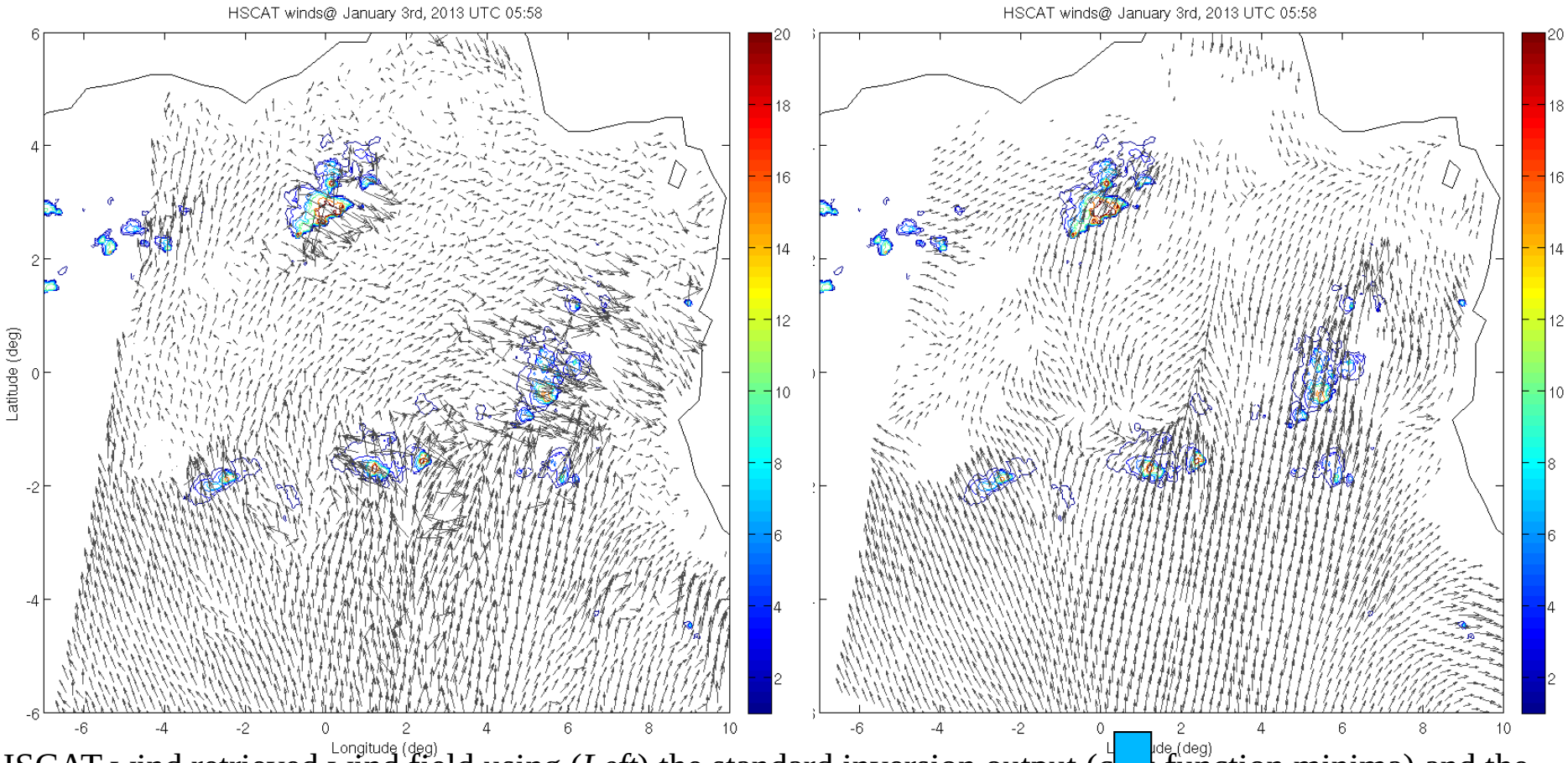
Mean TMI rain rate as a function of SE and MLE



VMRS difference between HSCAT and ECMWF as a function of SE and MLE

- Threshold definition: p(RR|SE) > 40% & p(RR|MLE) > 40%
- This method is applied for the different across-track WVCs and wind speed regimes

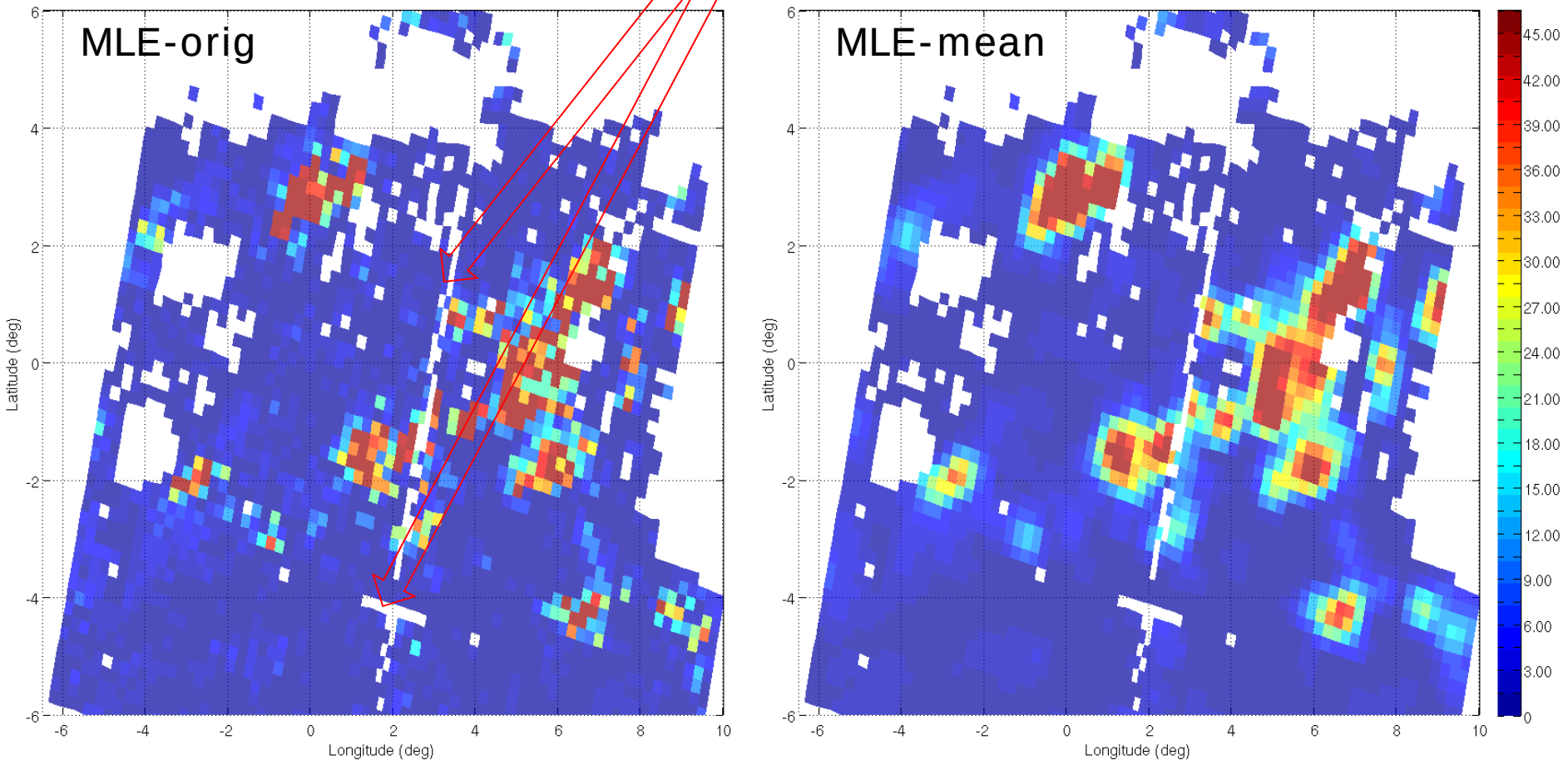
A typical case



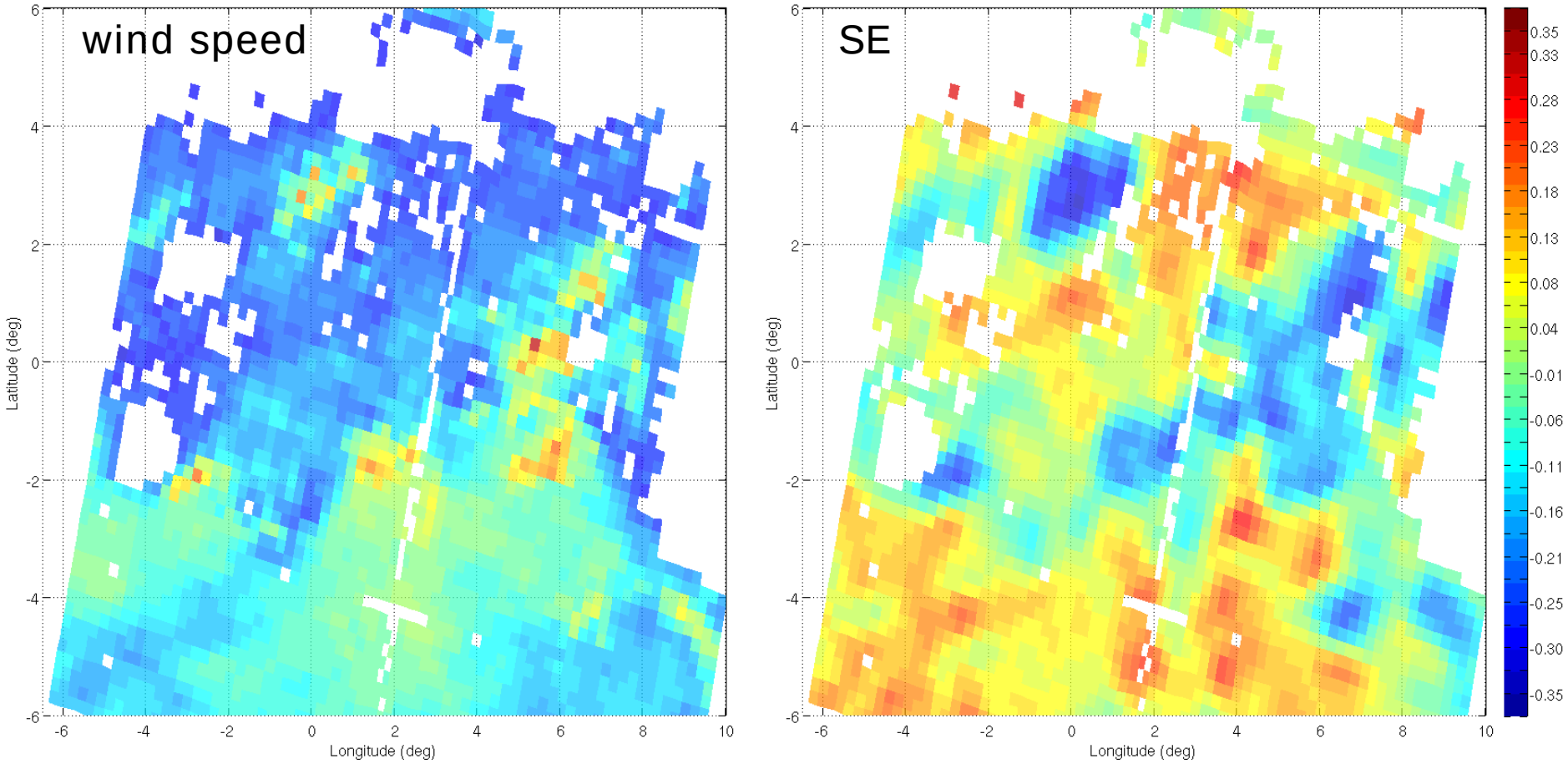
HSCAT wind retrieved wind field using (*Left*) the standard inversion output (c[illegible] function minima) and the median filter AR; Poor performance particularly at low winds (*Right*) the mult[illegible]e solution scheme and 2D-VAR AR. The acquisition date is January 3rd 2013 at about 6:00 UTC. The co[illegible]ur lines show the MSG rain rate (see the legend)

MLE plots below

Frequent missing values at nadir ??? Check L1B data soon

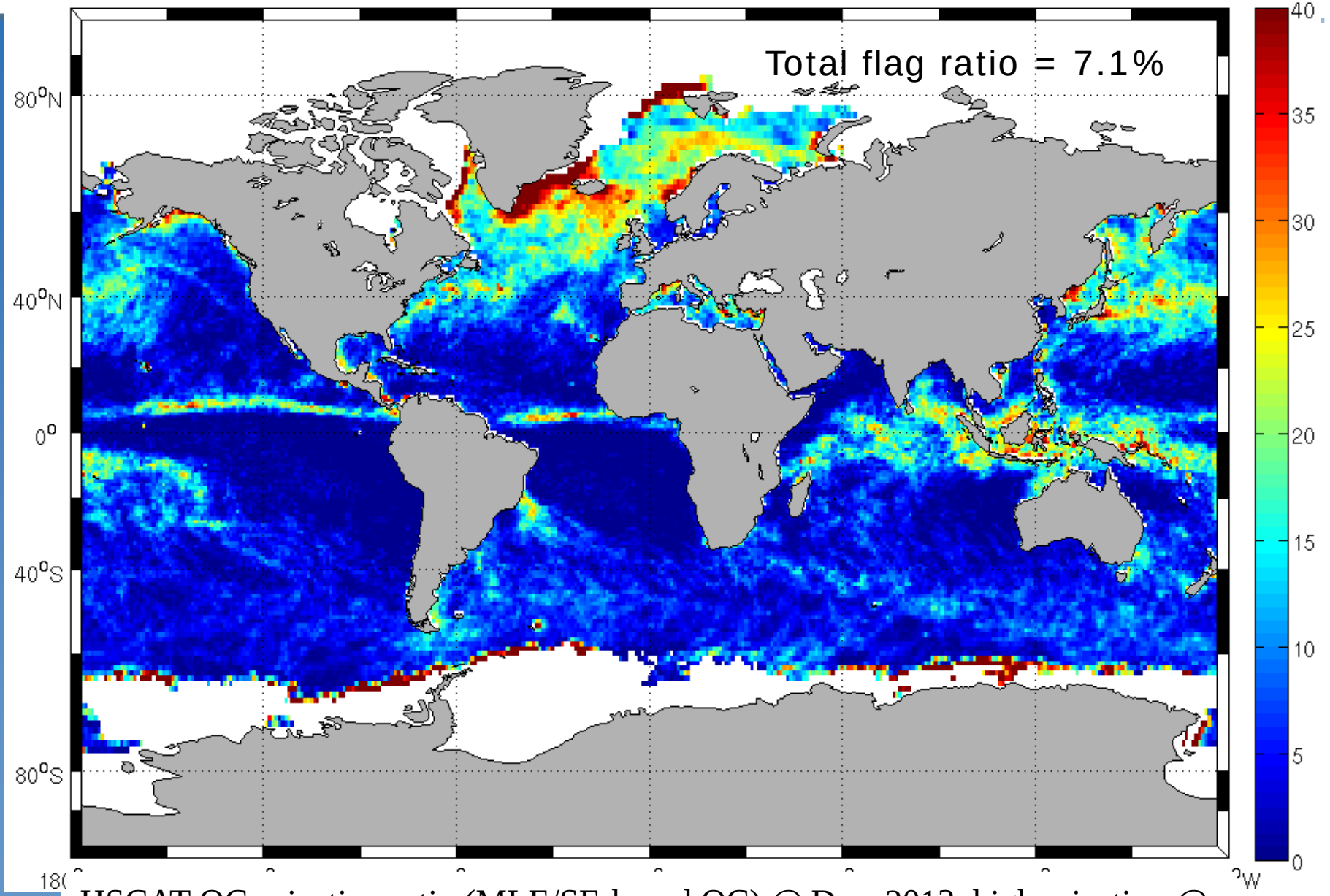


(*Left*) The MLE distribution of the above case, wind retrieval using PenWP; (*Right*) The mean MLE distribution (weighted averaged from the centered 3x3 box) associated with the left panel.



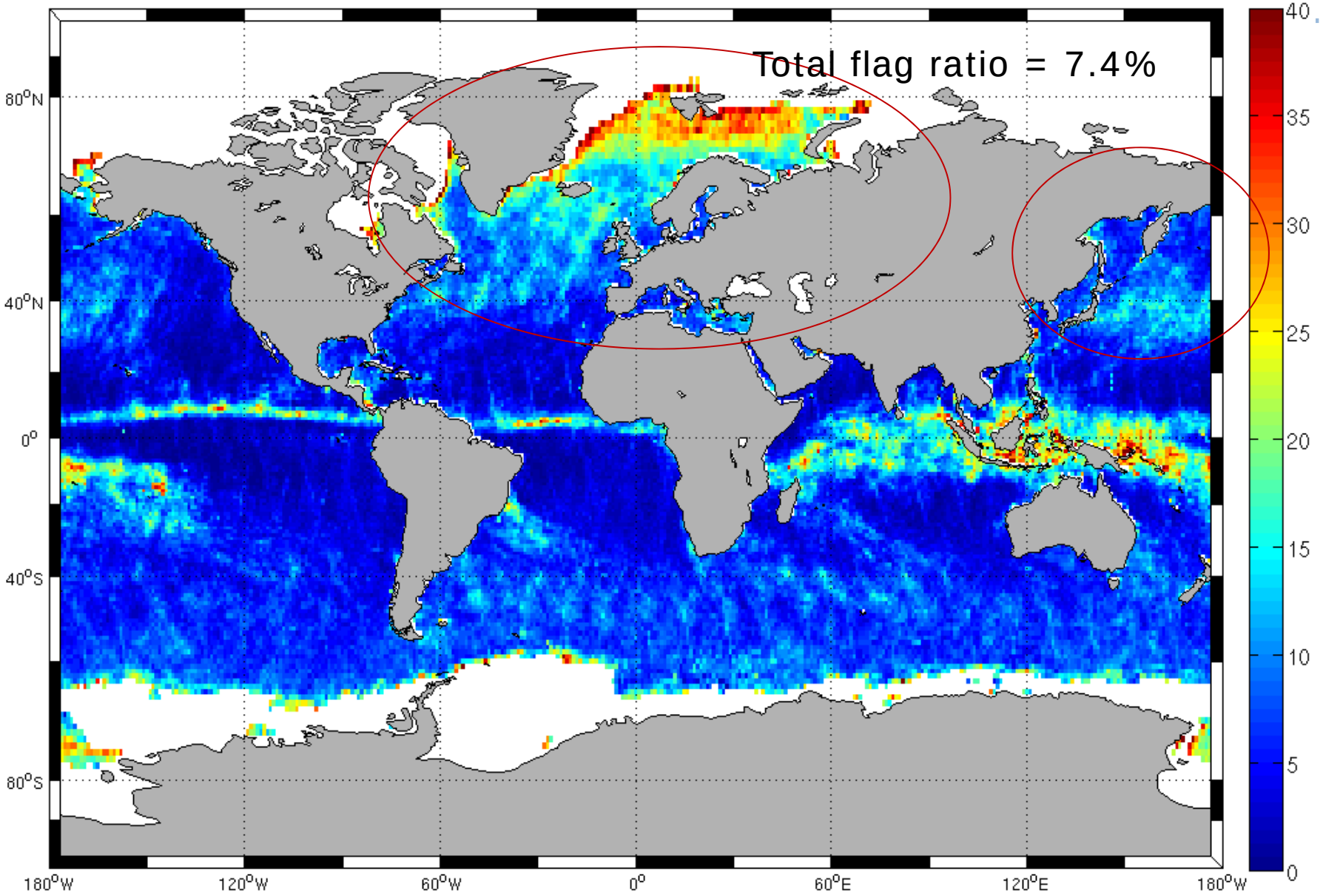
(*Left*) The wind speed distribution, wind retrieval using PenWP; (*Right*) The singularity map (SE values) of this case

HSCAT QC rejections



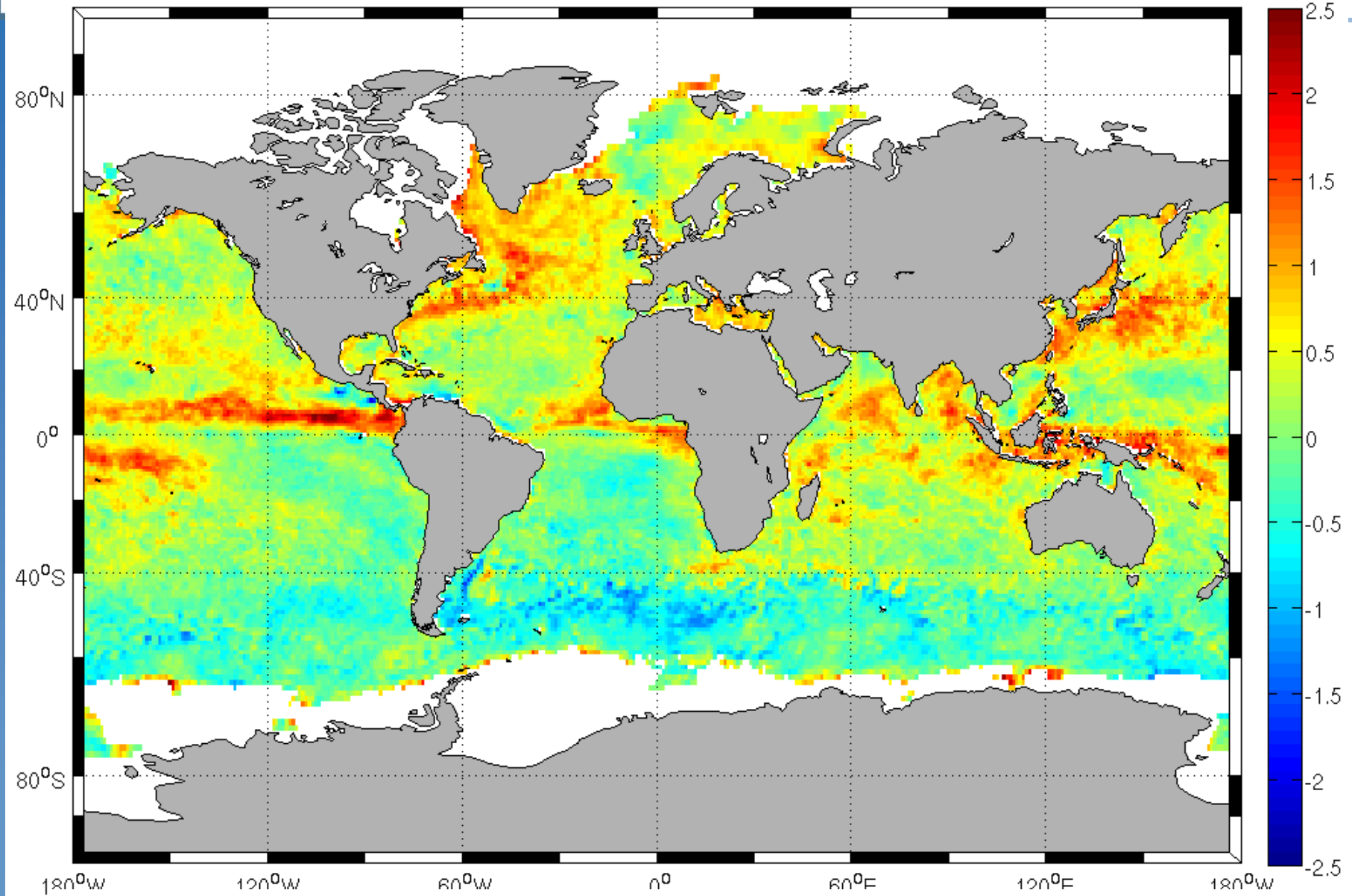
HSCAT QC-rejection ratio (MLE/SE-based QC) @ Dec. 2013, high rejection @ coastal areas and North Atlantic ocean

OSCAT QC rejections



OSCAT QC-rejection ratio (PenWP QC) @ Dec. 2013

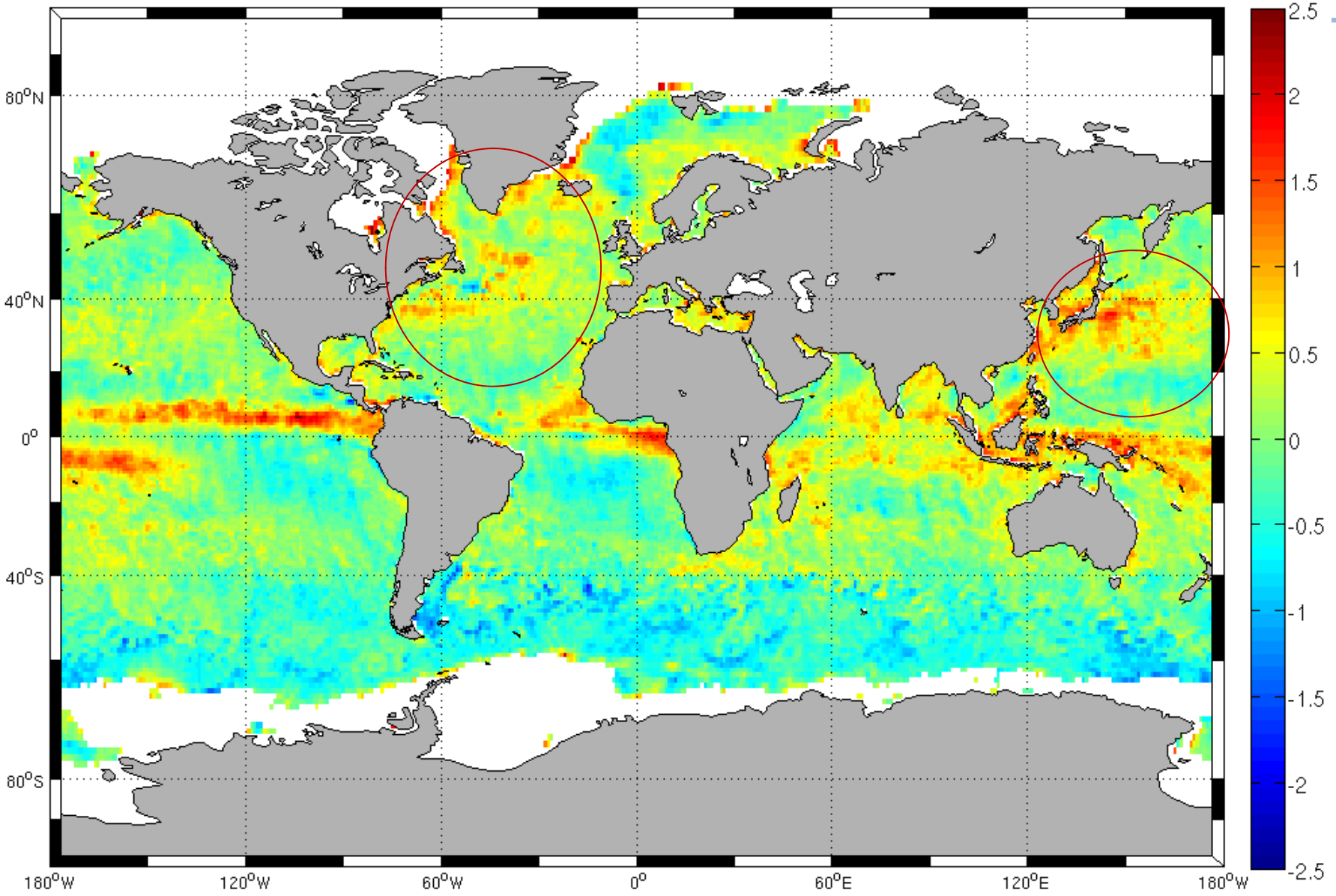
HSCAT minus ECMWF wind speeds



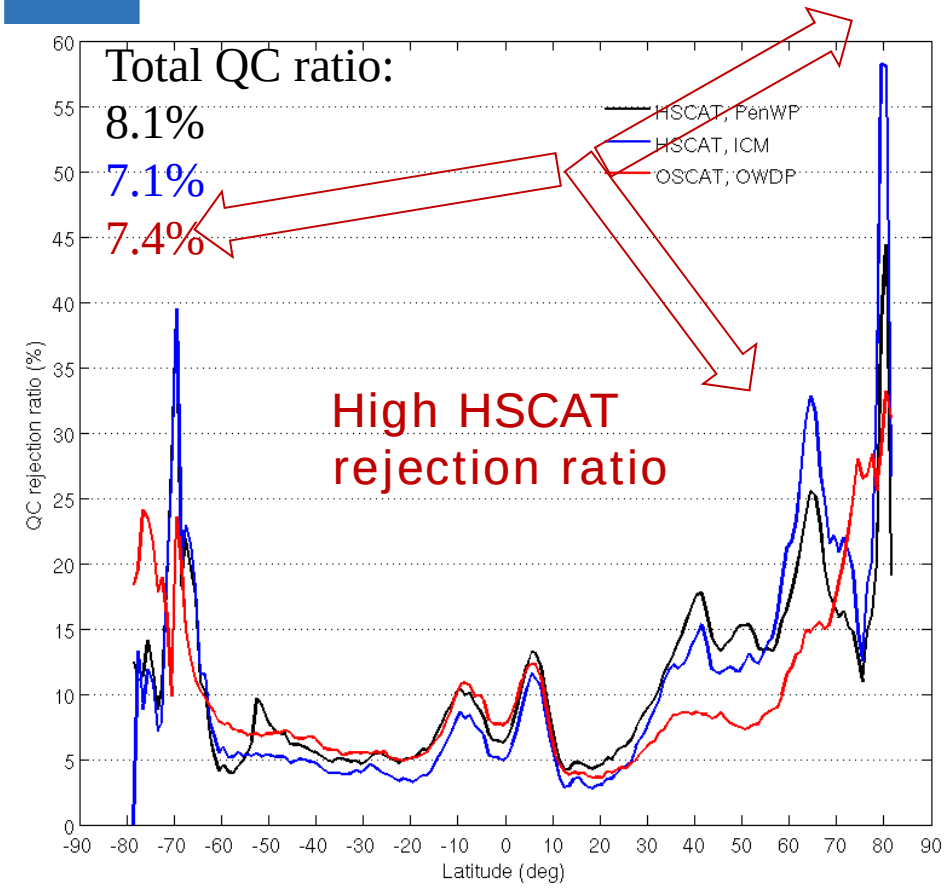
HSCAT wind speed bias w.r.t. ECMWF @ Dec. 2013, only QC-accepted data are studied

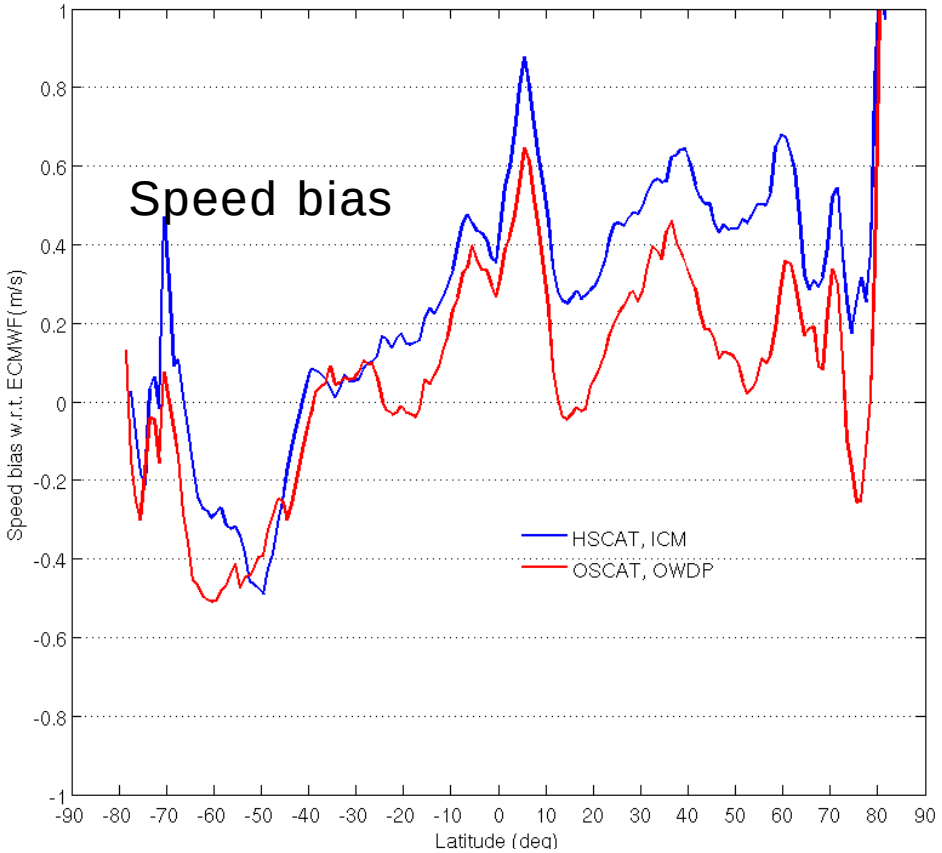
SMOS BARCELONA EXPERT CENTRE

OSCAT minus ECMWF wind speeds



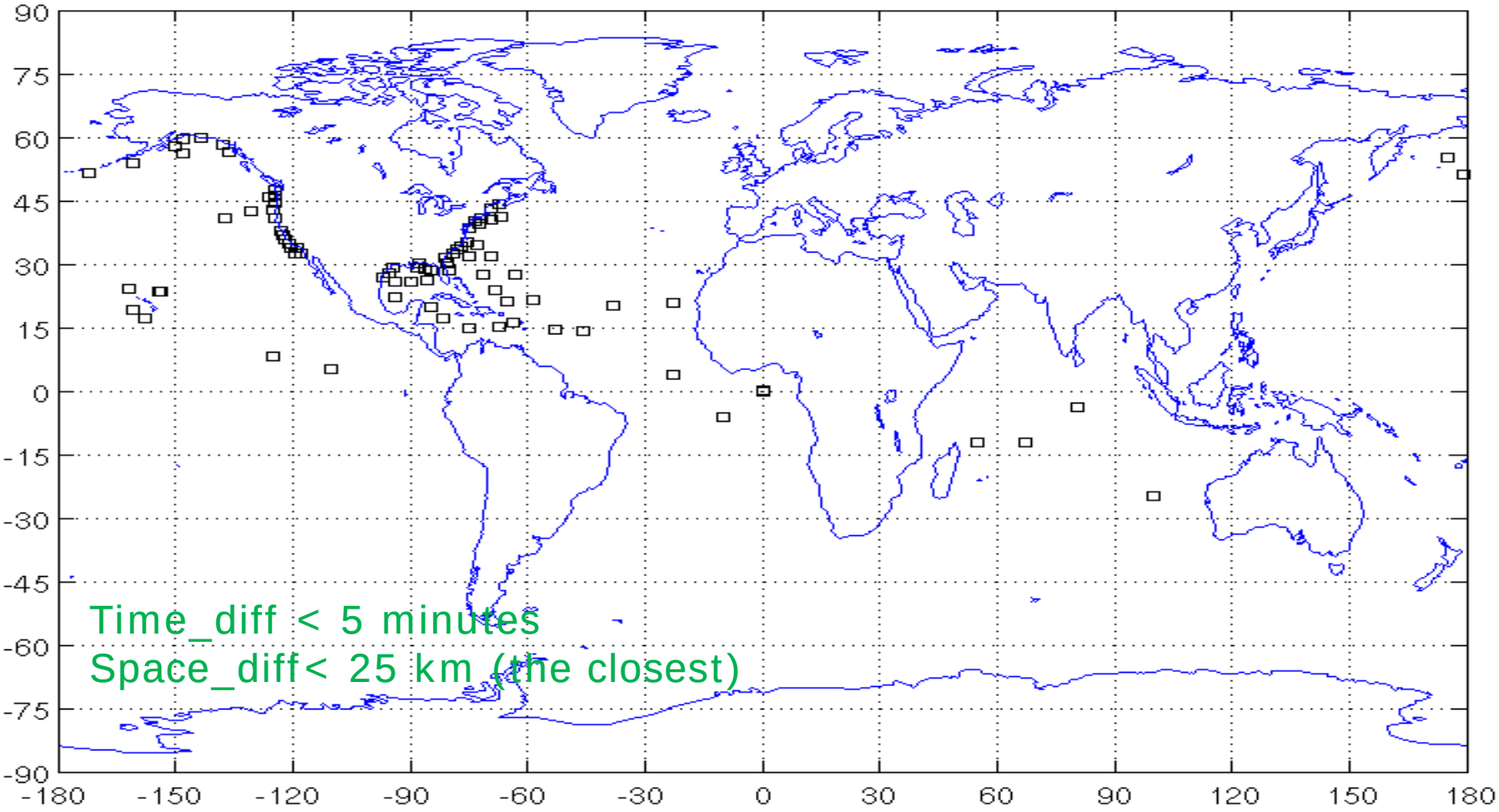
OSCAT wind speed bias w.r.t. ECMWF @ Dec. 2013, only QC-accepted data are studied





(Left) HSCAT QC rejection ratio as a function of Latitude; (Right) HSCAT wind speed bias w.r.t. ECMWF as a function of latitude, only QC-accepted data are studied

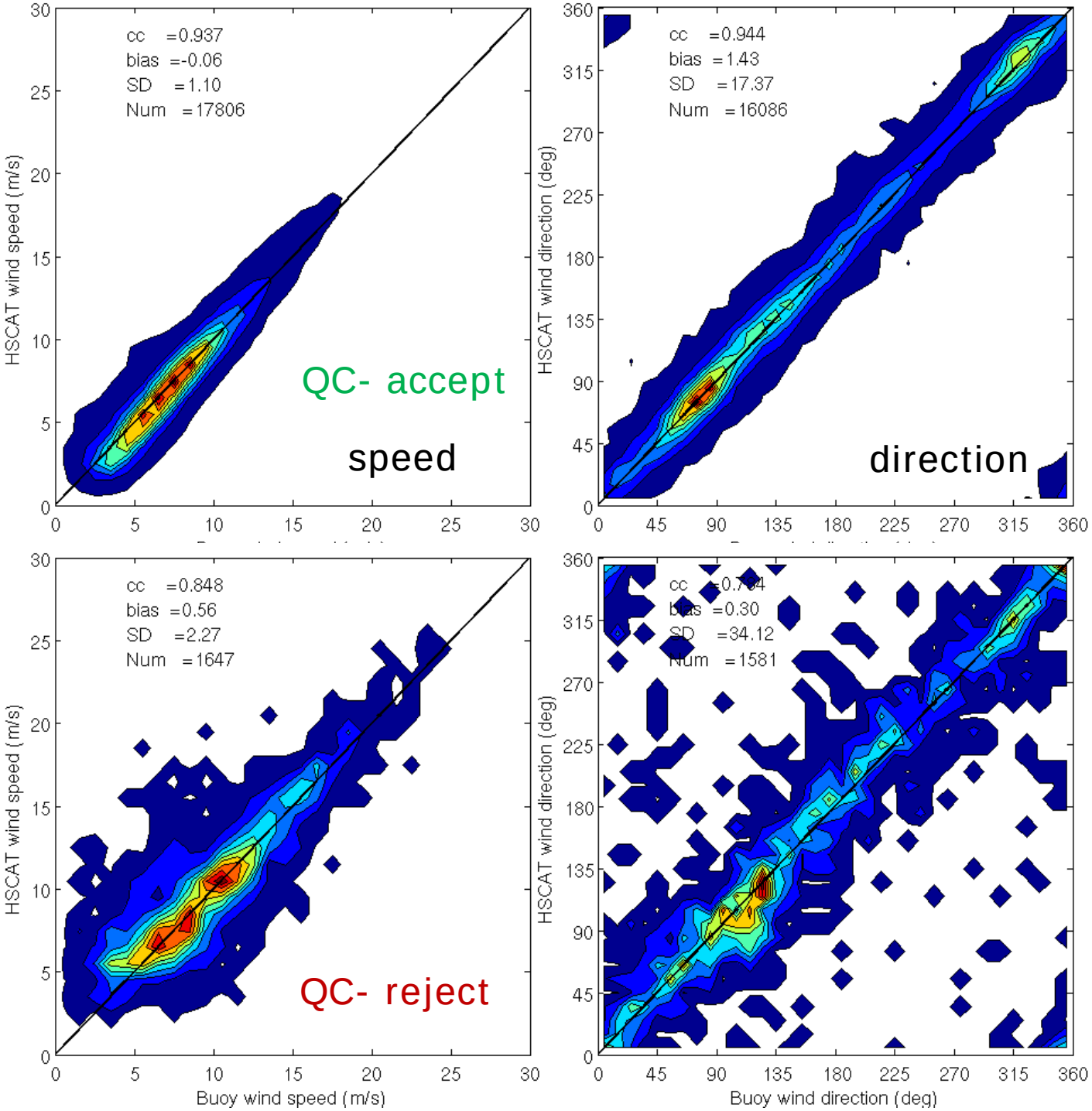
HSCAT versus buoy winds



N_total = 19,453; Rejection = 8.5% (high rejection due to the buoy location above Lat=40°); Accept = 91.5%

HSCAT vs buoy point measurements

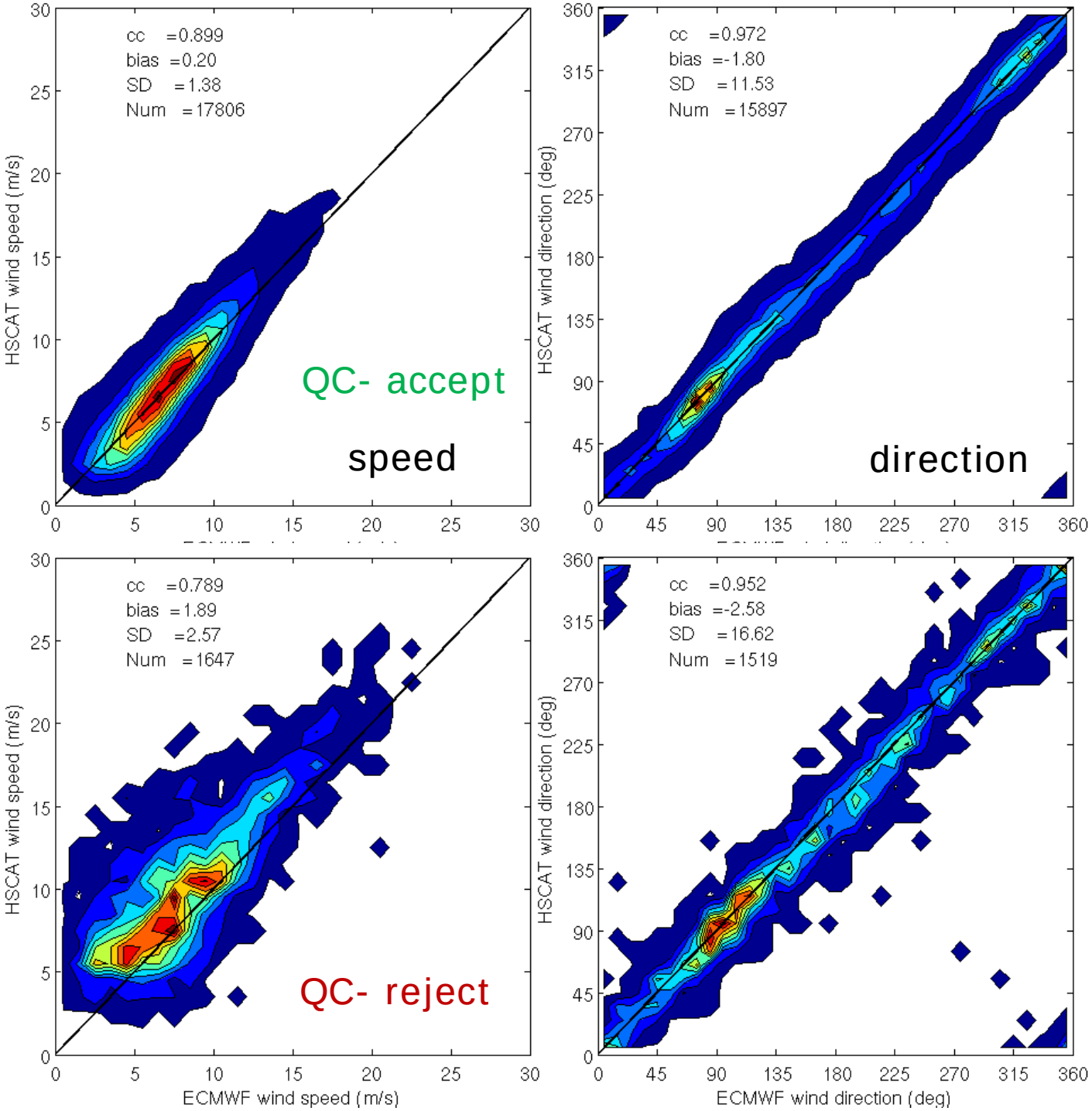
	spd_bias	spd_SD	Dir_bias	Dir_SD	u_SD	v_SD
Reject	0.56	2.27	0.3	34.1	3.61	4.13
Accept	-0.06	1.10	1.4	17.4	1.58	1.61



HSCAT wind versus 10-min buoy wind

Wind direction stats only for (mean) winds > 3 m/s

- Calibration issues
- Too many QCed WVCs along the diagonal; further QC tuning is needed!



HSCAT wind versus ECMWF wind

Wind direction stats only for (mean) winds > 3 m/s

- Calibration issues
- QCed WVCS: larger discrepancies w.r.t. ECMWF than w.r.t. buoy (expected)

TC analysis, QC-rejected. r^2=0.65

	buoy		HSCAT		ECMWF	
	u	v	u	v	u	v
scaling fact	1.0	1.0	0.89	0.92	1.05	1.10
bias factor	0.0	0.0	0.25	0.01	0.65	0.12
SD error (NWP scale)	2.6	2.8	1.7	1.5	1.5	1.6
SD error (SCAT scale)	2.4	2.7	1.5	1.3	1.7	1.8

TC analysis, QC-accepted. r^2=0.16

	buoy		HSCAT		ECMWF	
	u	v	u	v	u	v
scaling fact	1.0	1.0	0.99	0.97	1.01	1.04
bias factor	0.0	0.0	0.06	-0.07	0.17	0.02
SD error (NWP scale)	1.29	1.31	0.79	0.72	1.04	1.05
SD error (SCAT scale)	1.23	1.25	0.69	0.60	1.11	1.13

HSCAT versus ASCAT winds

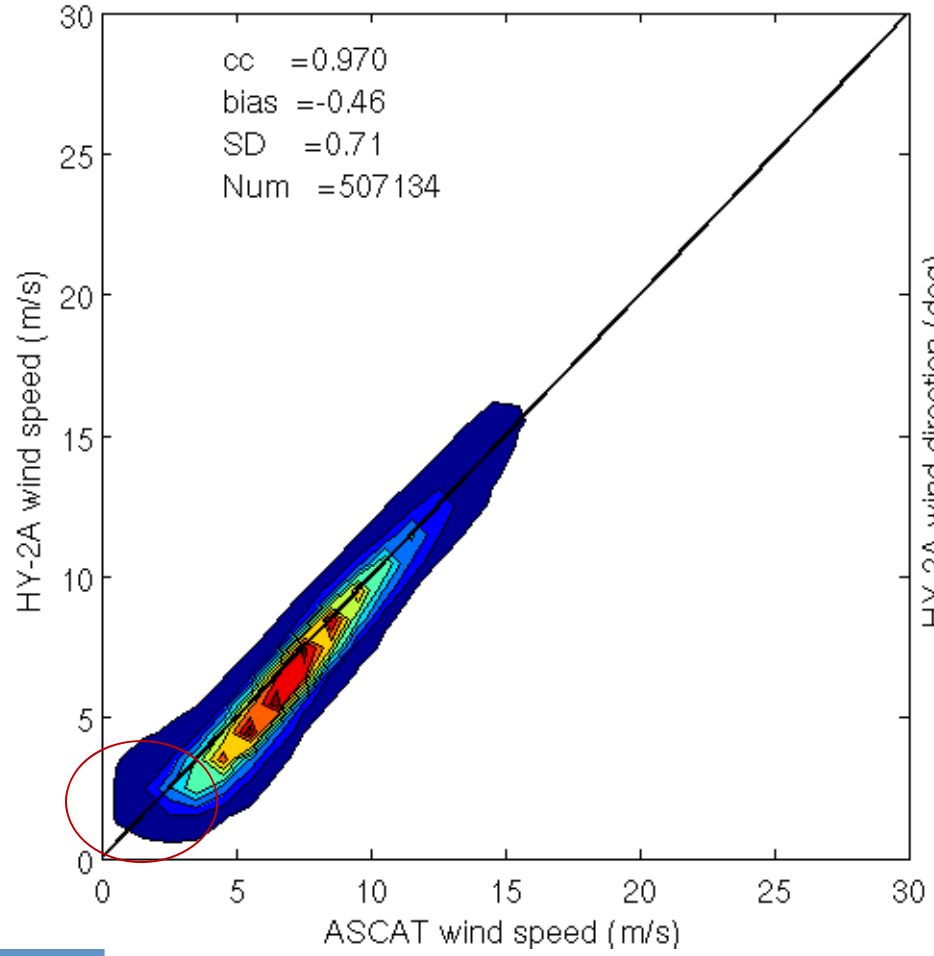
All of the HSCAT-ASCAT collocations are over high latitude (|Lat|>60°) (HY-2A descending local time: 6 a.m., MetOp descending local time 9:30 a.m.)

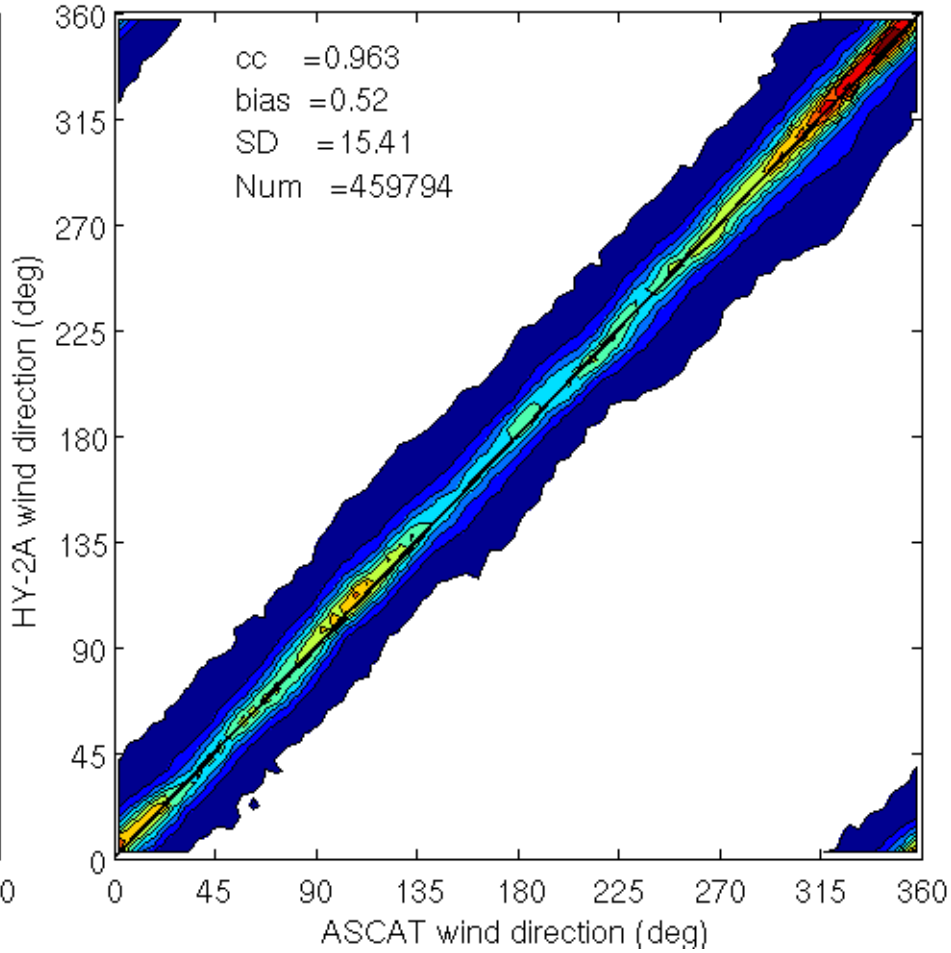
Total number of RSCAT-HSCAT collocations=549,468 (Sea ice exclued)

	HSCAT-accept	HSCAT- reject
ASCAT-accept	92.30% (C1)	7.46% (C2)
ASCAT-reject	0.16% (C3)	0.08% (C4)

Time_diff < 30 minutes
Space_diff< 25 km (the closest)

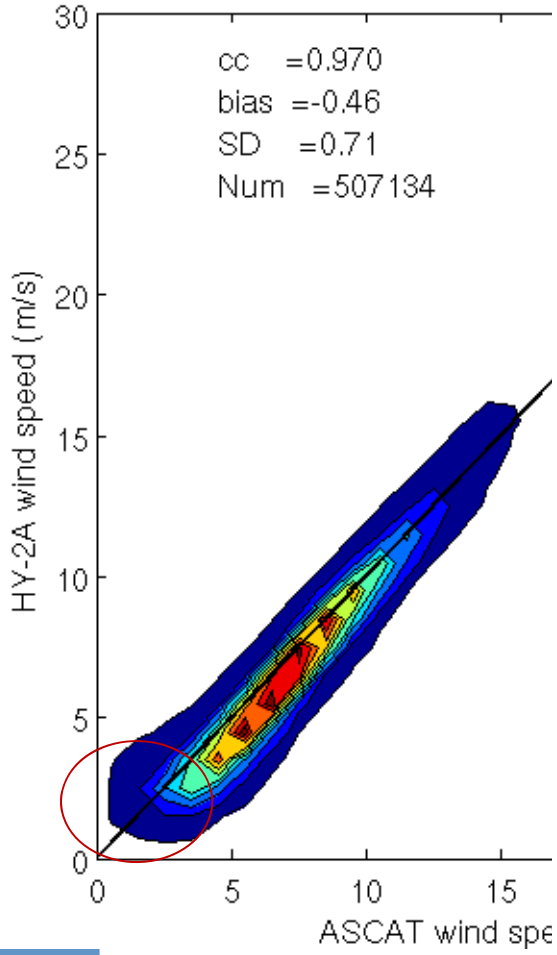
HSCAT versus ASCAT winds

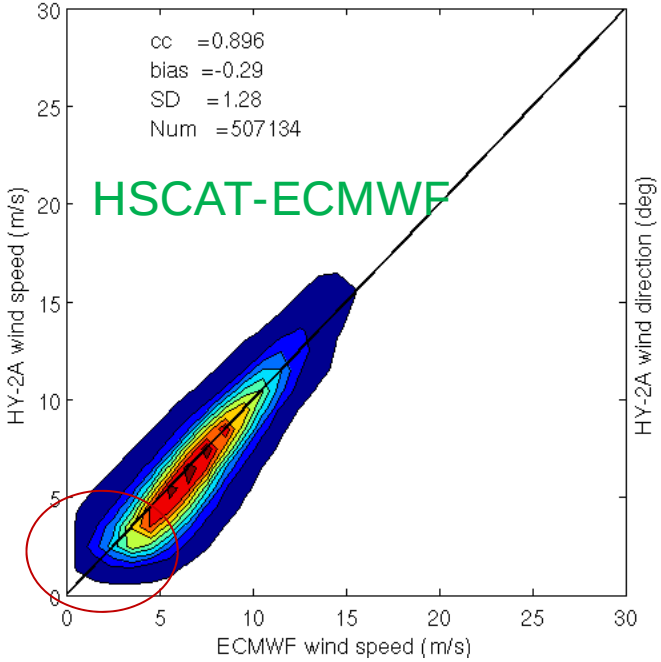


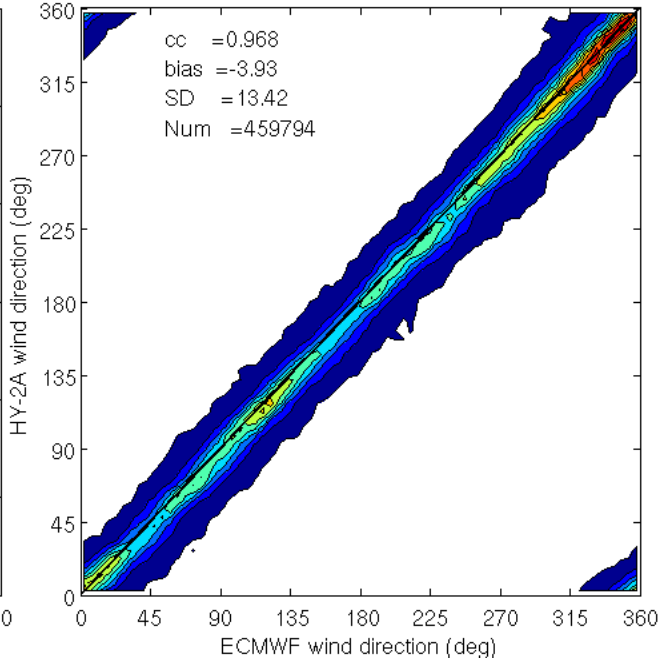


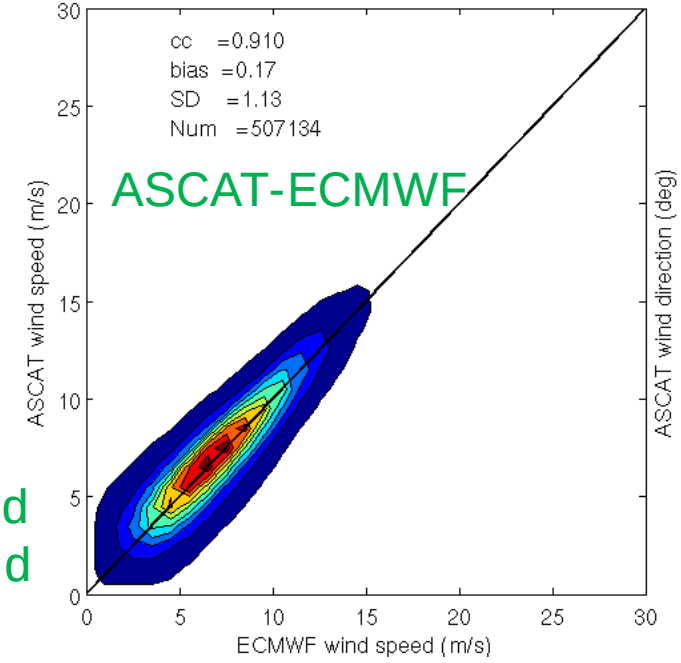
C1: ASCAT-accepted
HSCAT-accepted

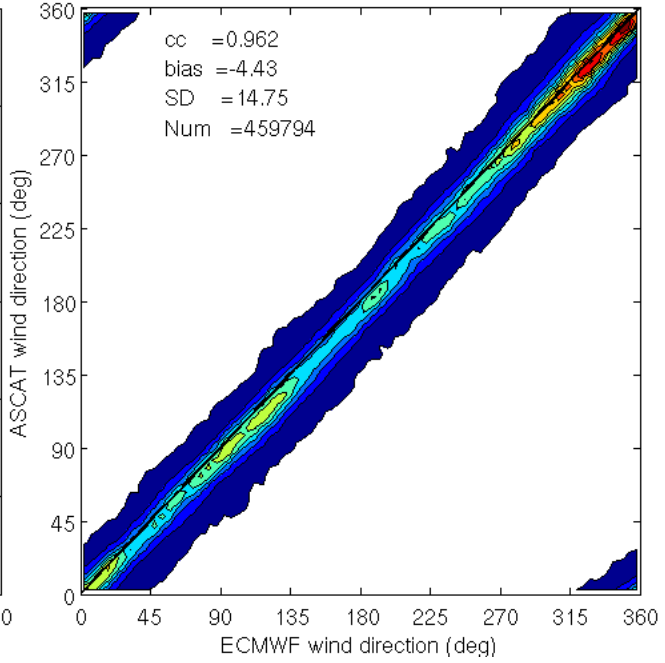
HSCAT versus ASCAT winds





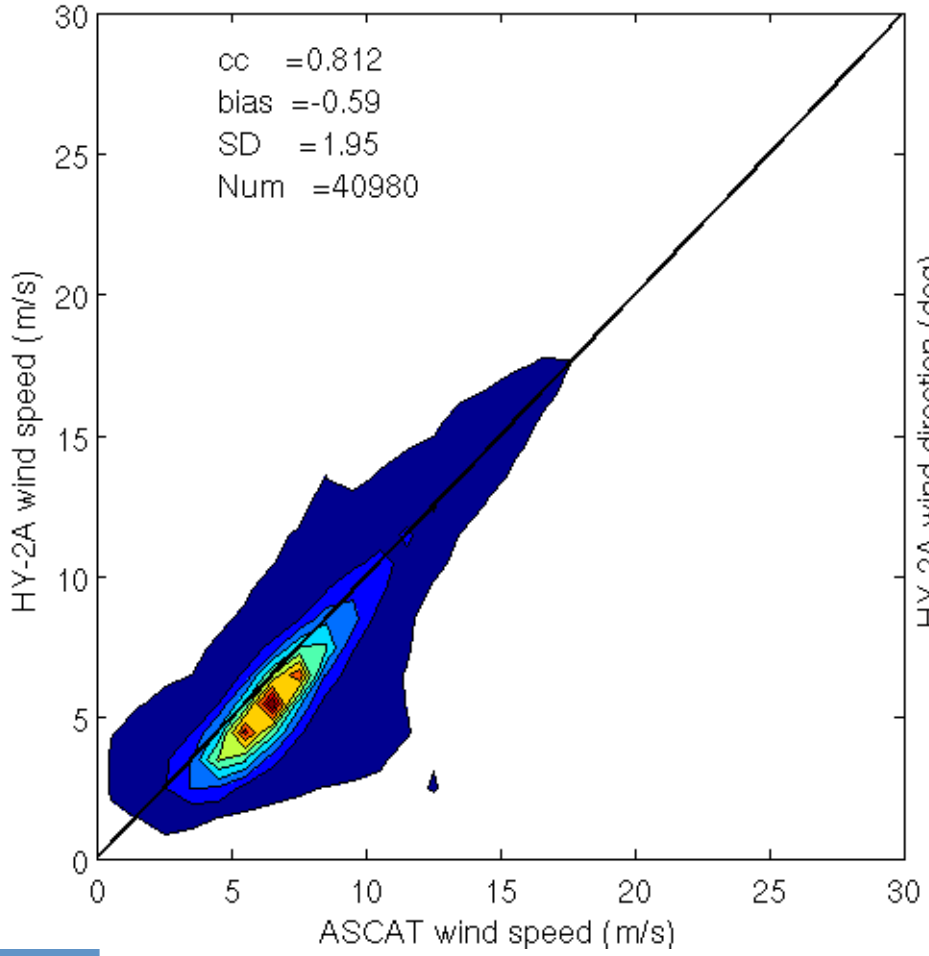


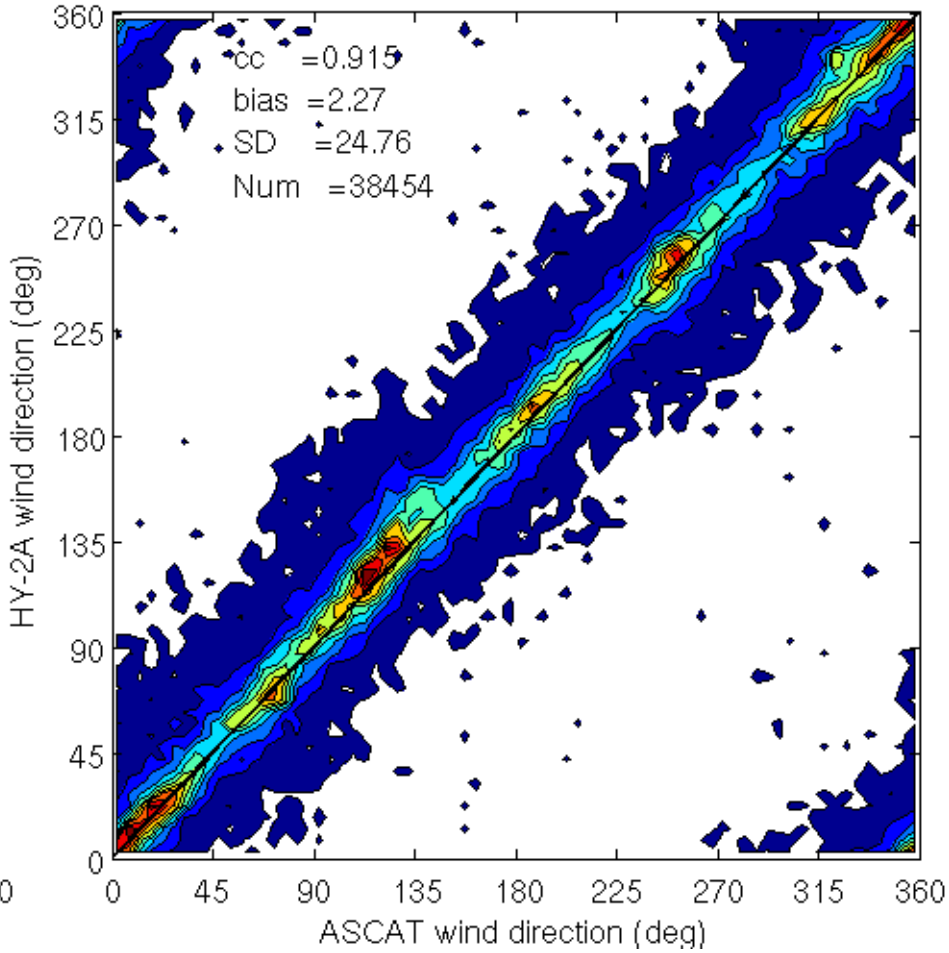




C1: ASCAT-accepted
HSCAT-accepted

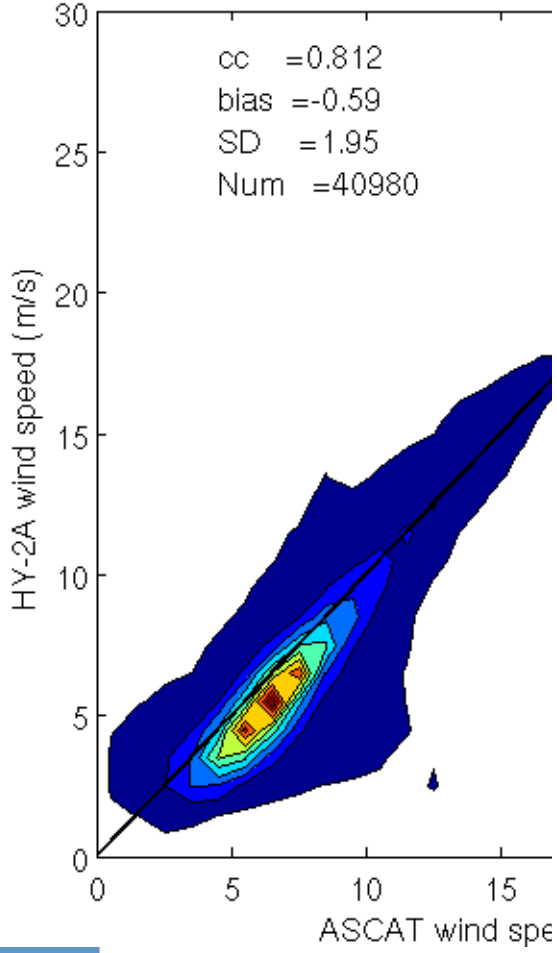
HSCAT versus ASCAT winds

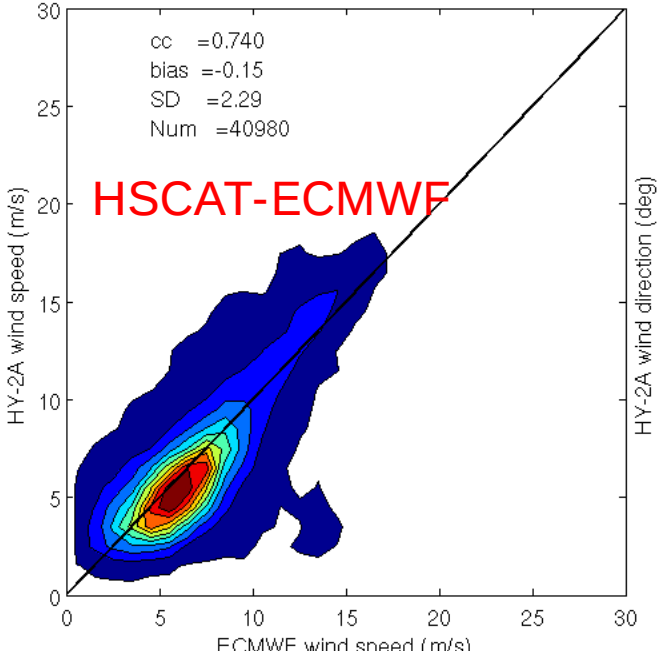


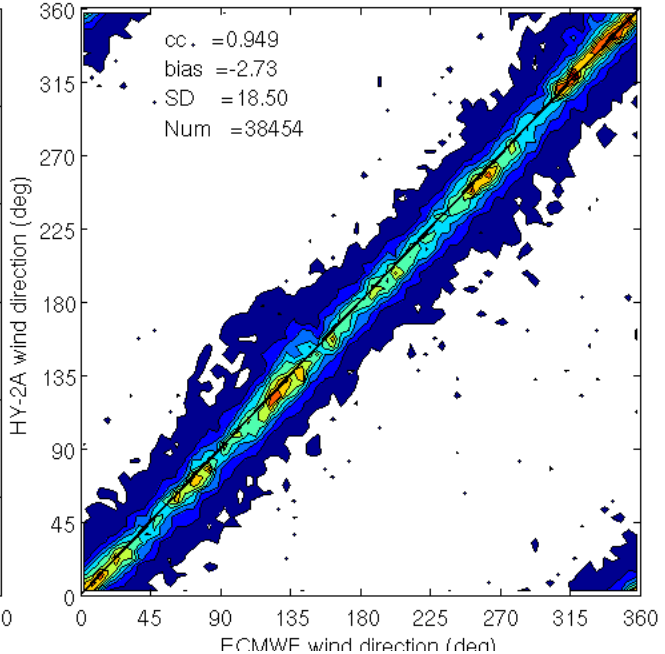


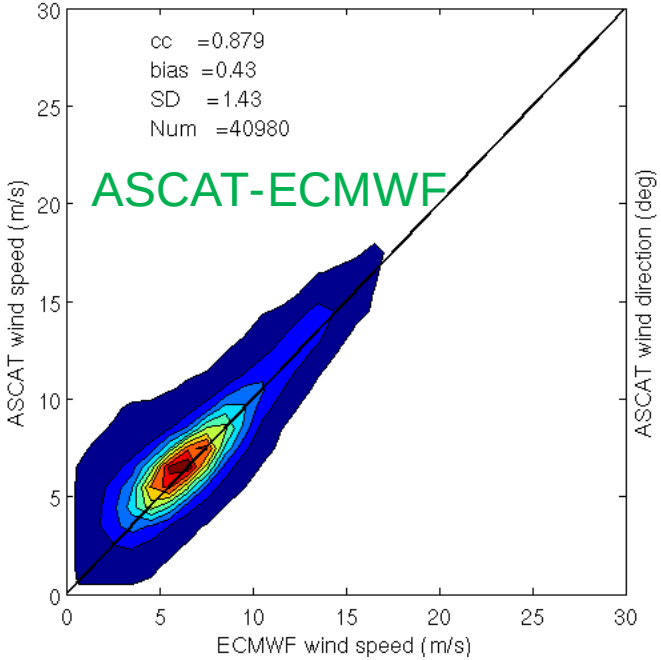
C2: ASCAT-accepted
HSCAT-rejected

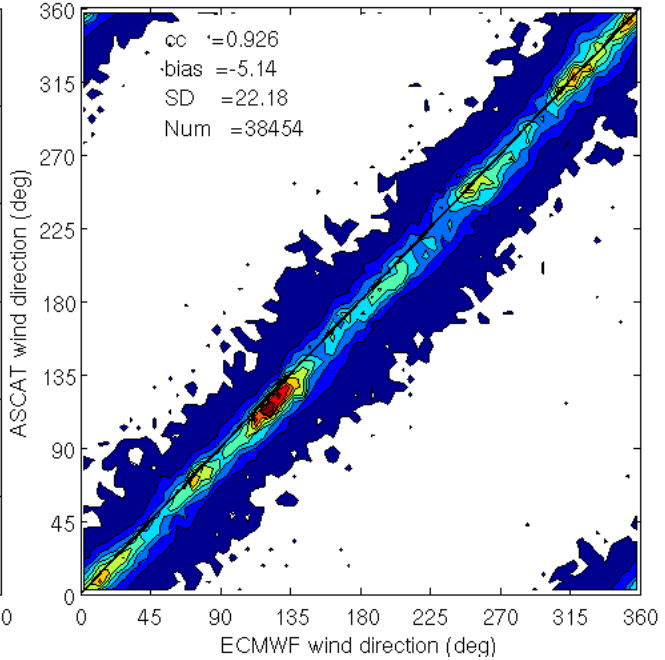
HSCAT versus ASCAT winds







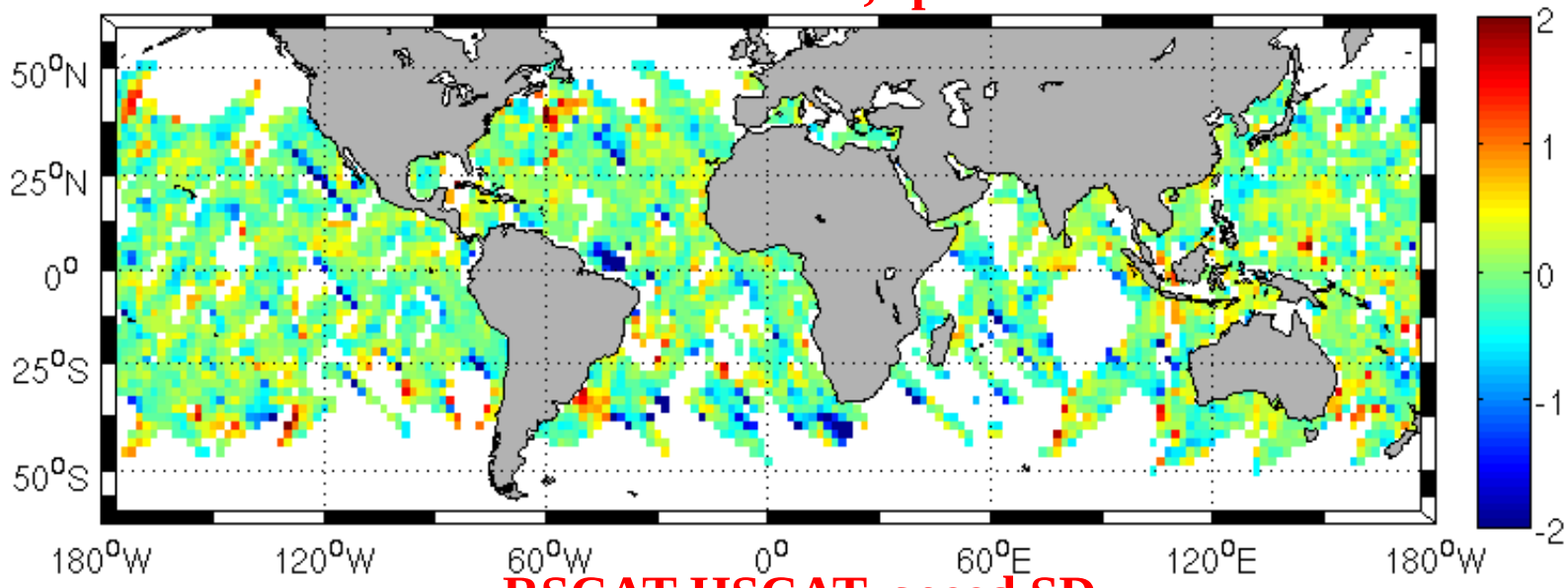




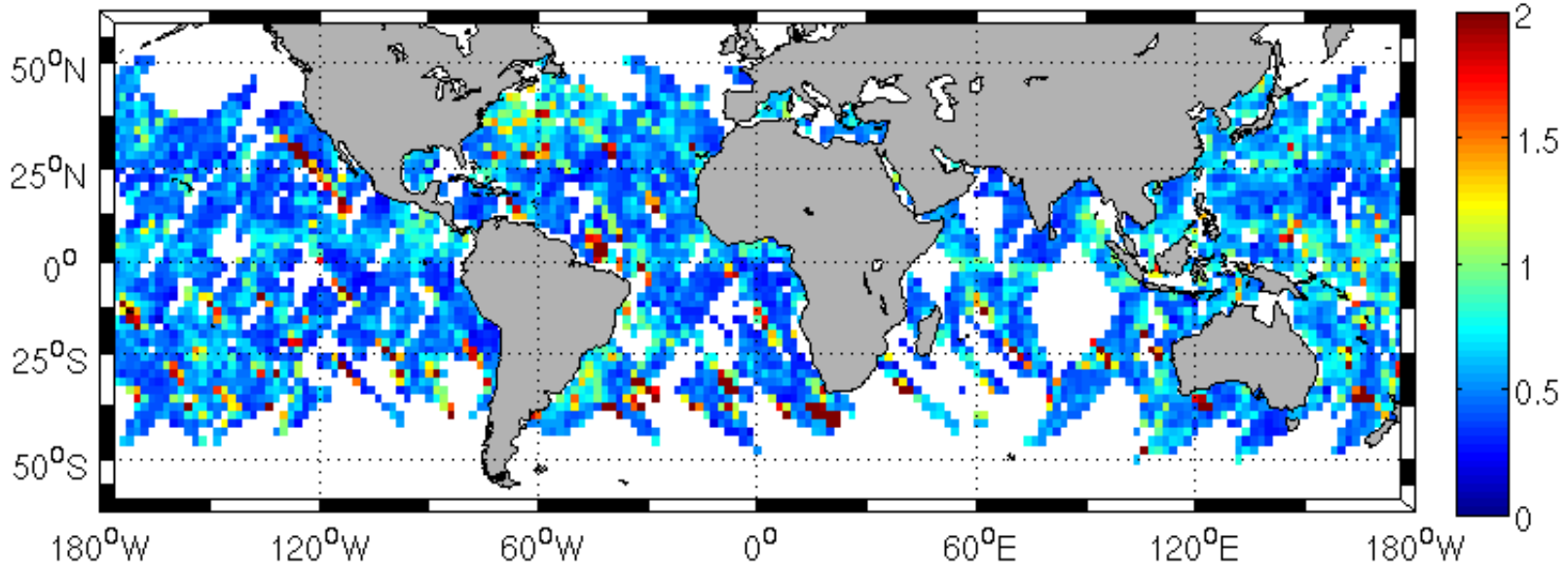
C2: ASCAT-accepte
HSCAT-rejecte

HSCAT versus RapidSCAT winds

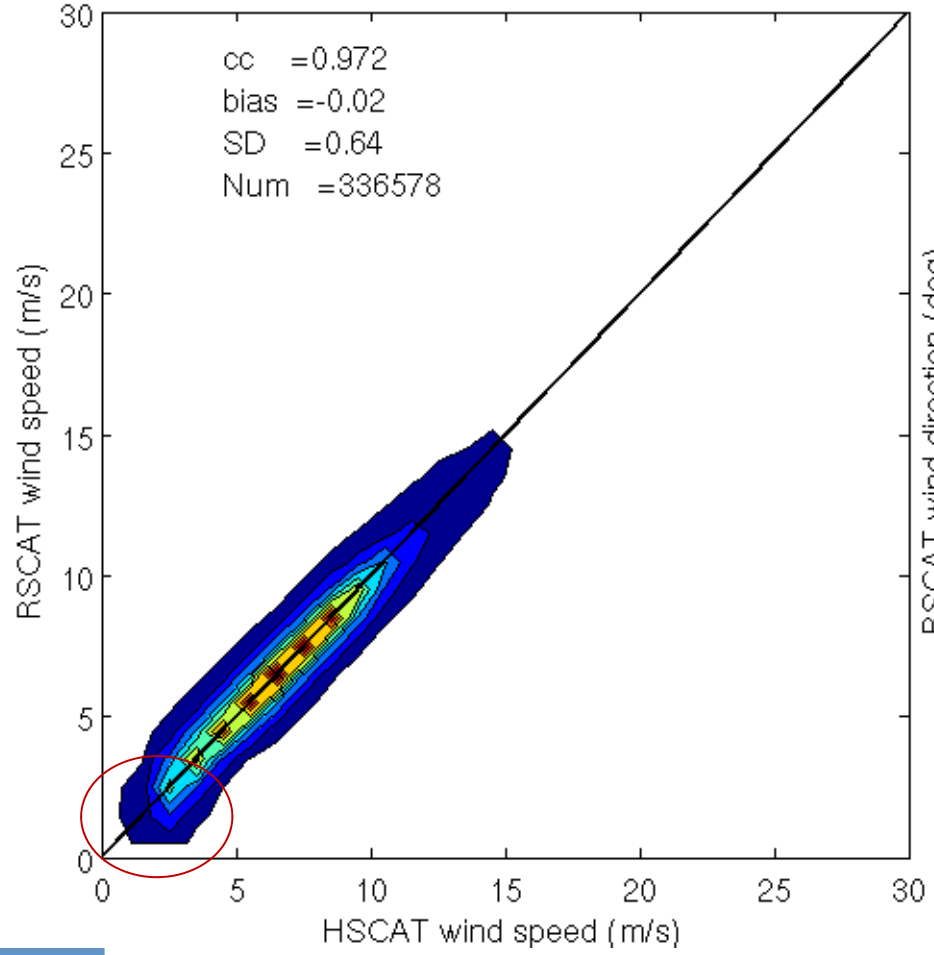
RSCAT-HSCAT, speed bias

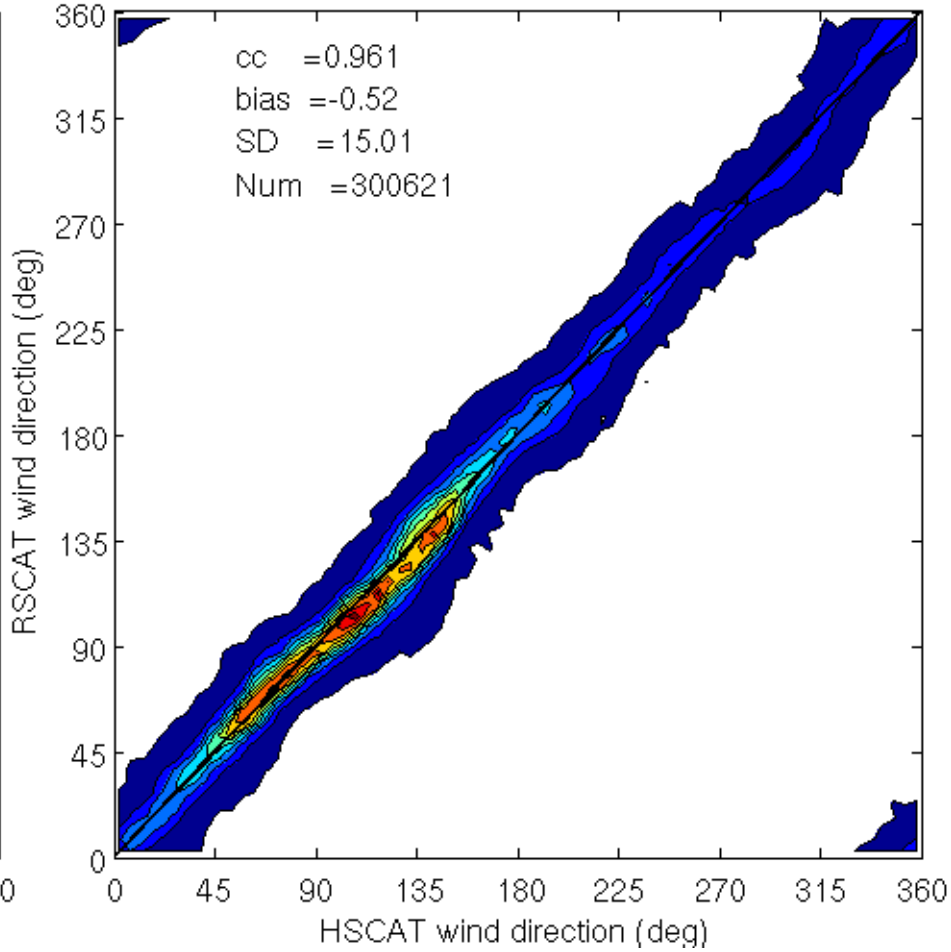


RSCAT-HSCAT, speed SD

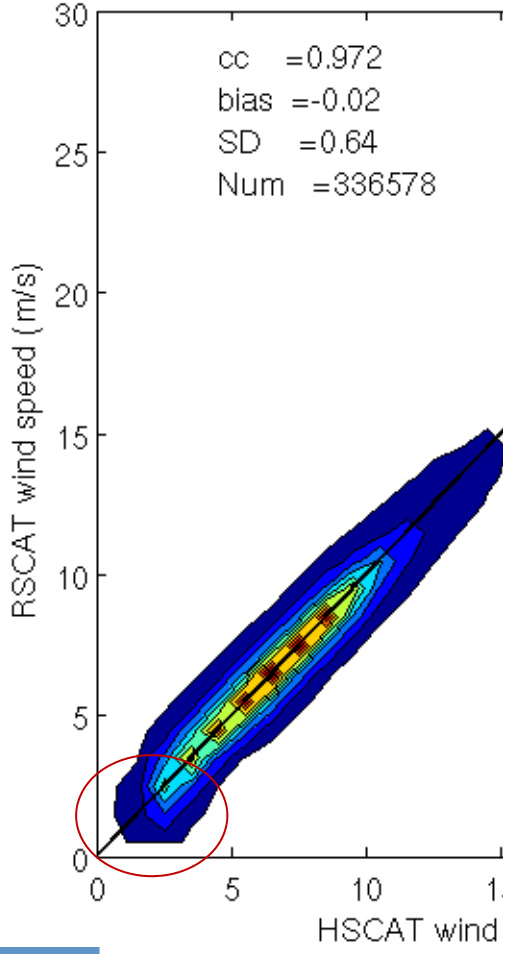


HSCAT versus RapidSCAT winds

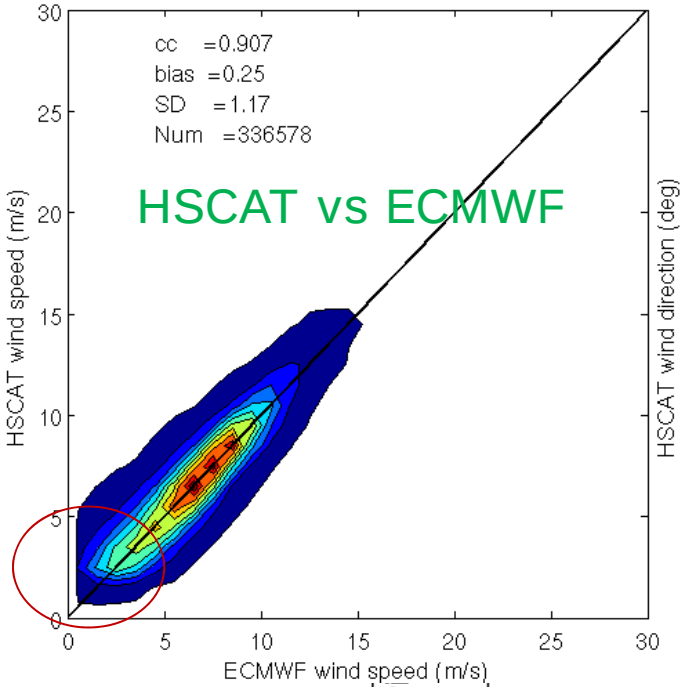


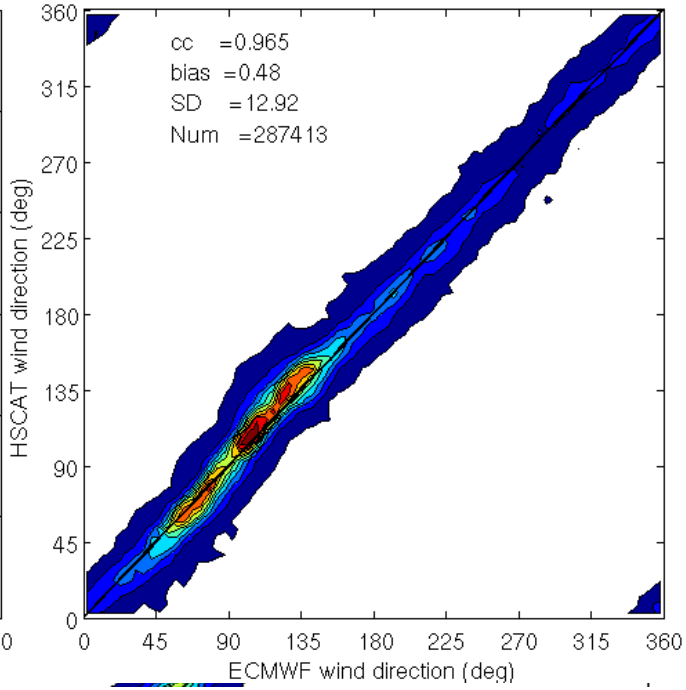


C1: RapidSCAT QC accepted, HSCAT QC accepted

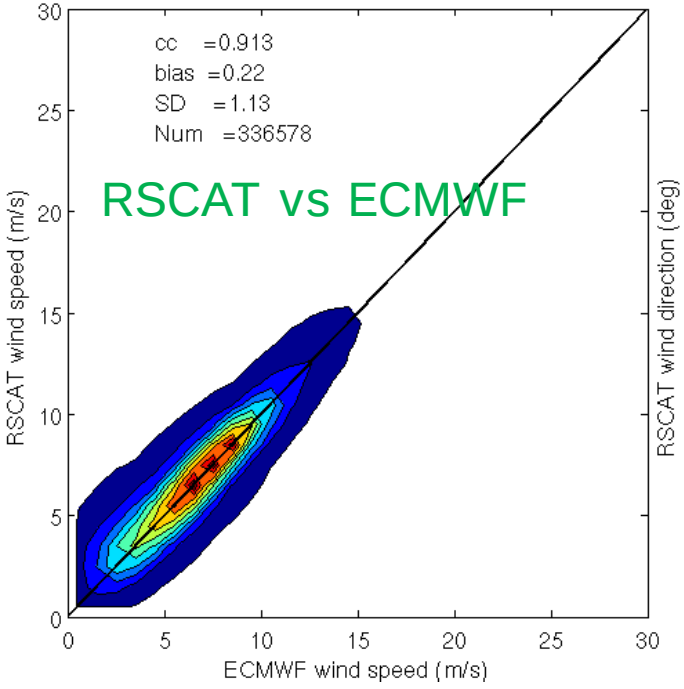


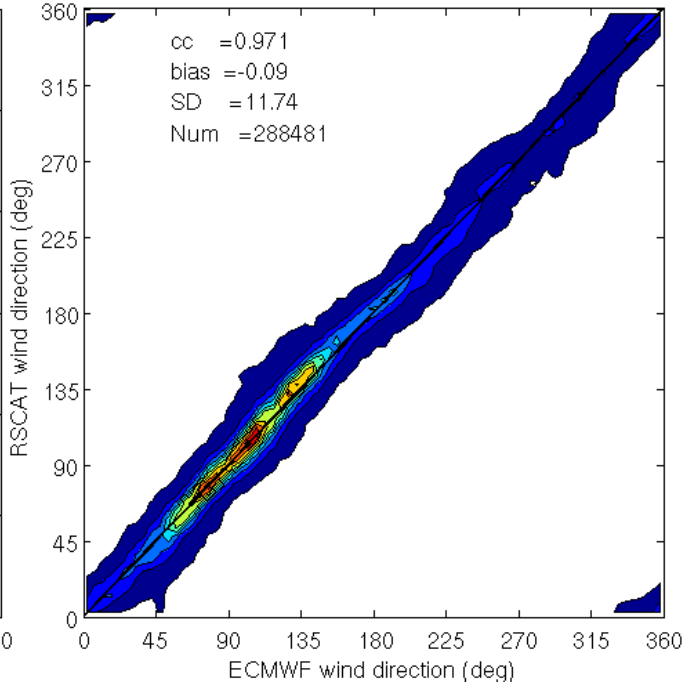
HSCAT vs ECMWF





RSCAT vs ECMWF



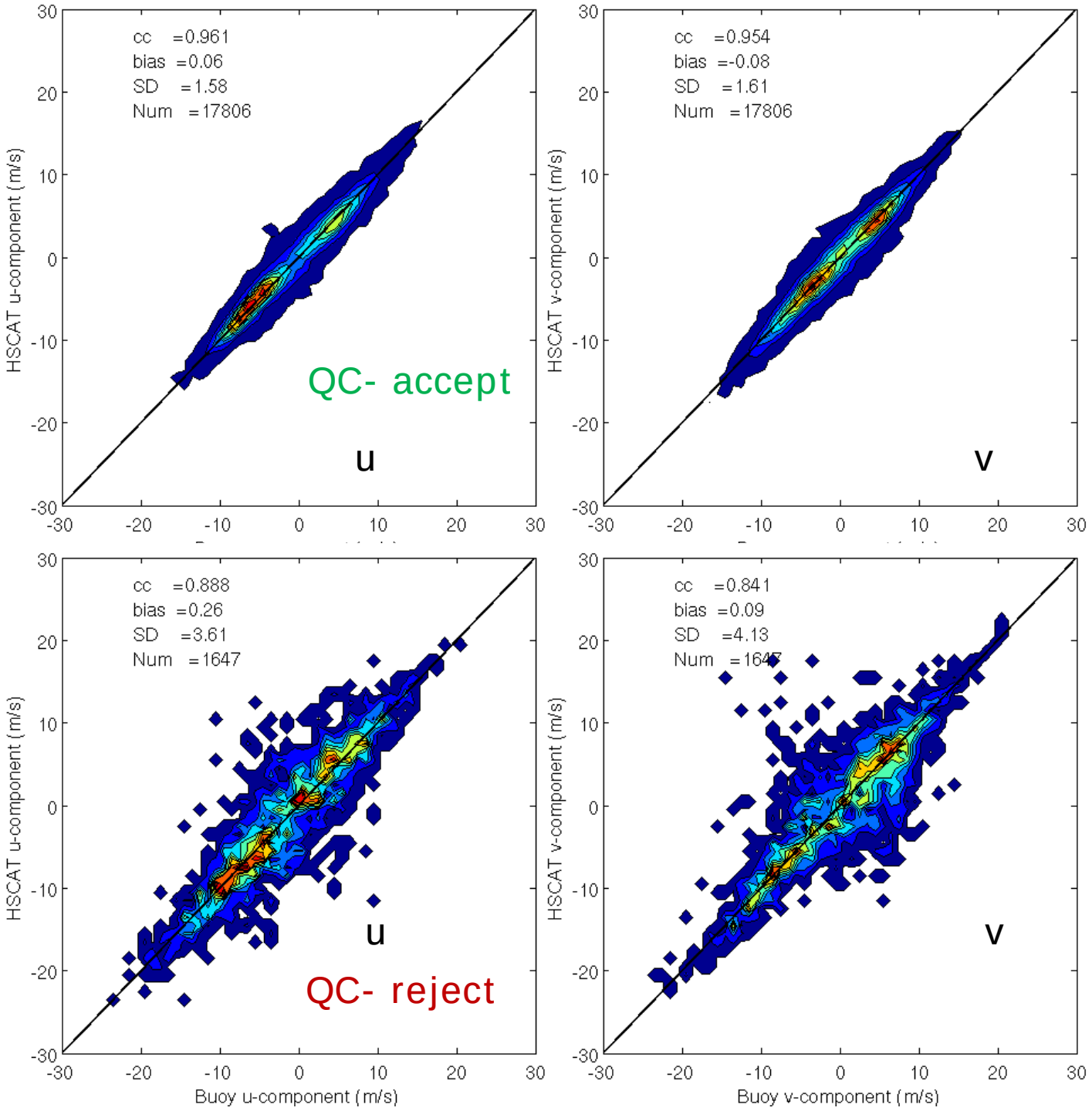


C1: RapidS

Conclusions

- HSCAT winds retrieved by PenWP are of very good quality
- Mean MLE and SE well correlate with rain & wind variability, and can be used for HSCAT QC.
- Remaining issues:
  - WVC irregular grid (nadir swath)
  - Lack of low winds
  - Sigma0/wind calibration, only at high lats?
  - High-latitude rejection ratio
  - QC improvement

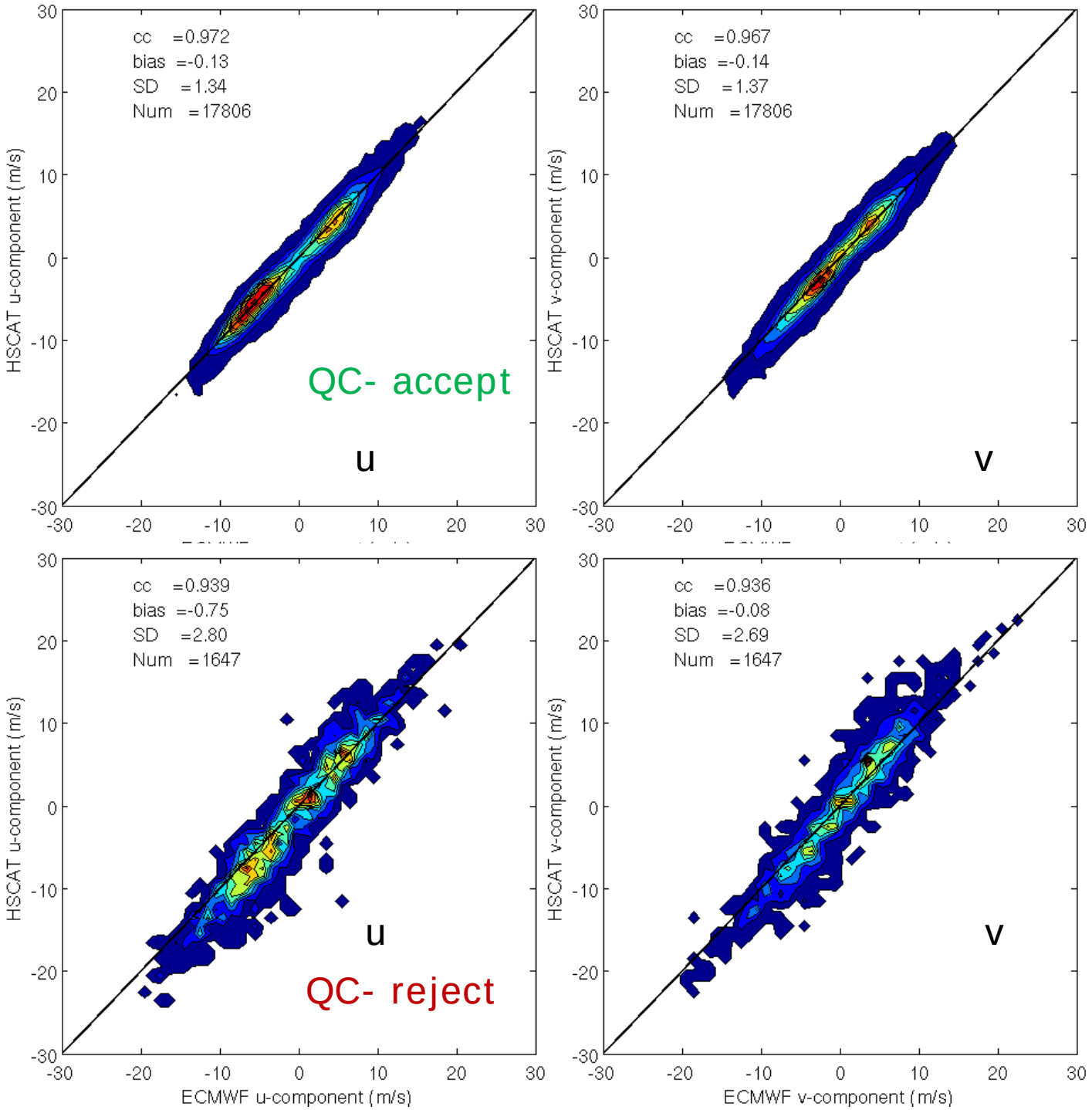
➢ **Many thanks to NSOAS for providing HY-2A sigma0 data!**



HSCAT wind versus 10-min buoy point measurements

For the statistics of wind direction, only the mean winds above 3m/s are considered

- Too many wind along the diagonal are rejected, the thresholds of those QC indicators should be tuned to improve HSCAT quality control.



HSCAT wind versus ECMWF wind

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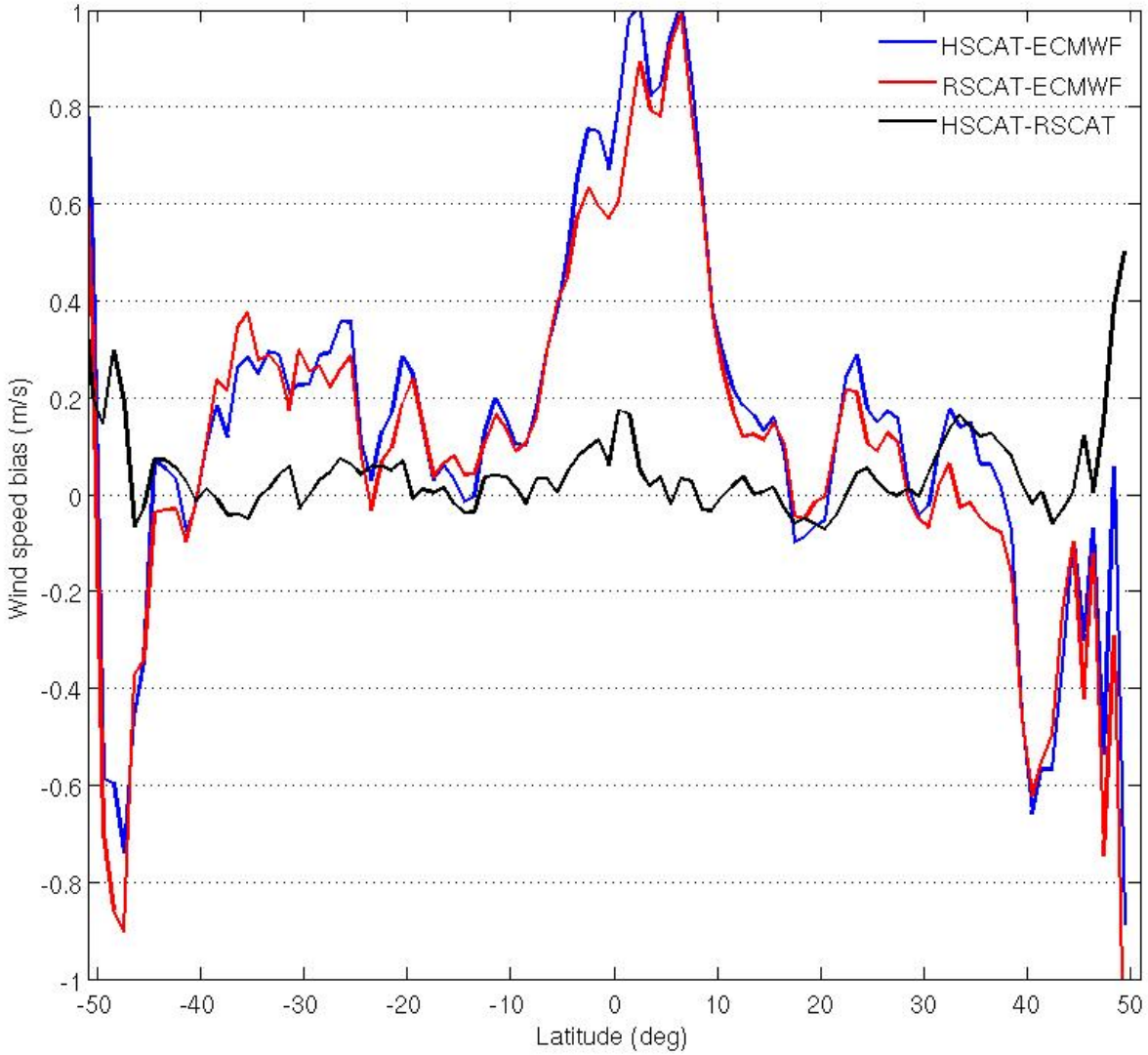
HSCAT versus RapidScat winds



HSCAT versus RapidScat winds

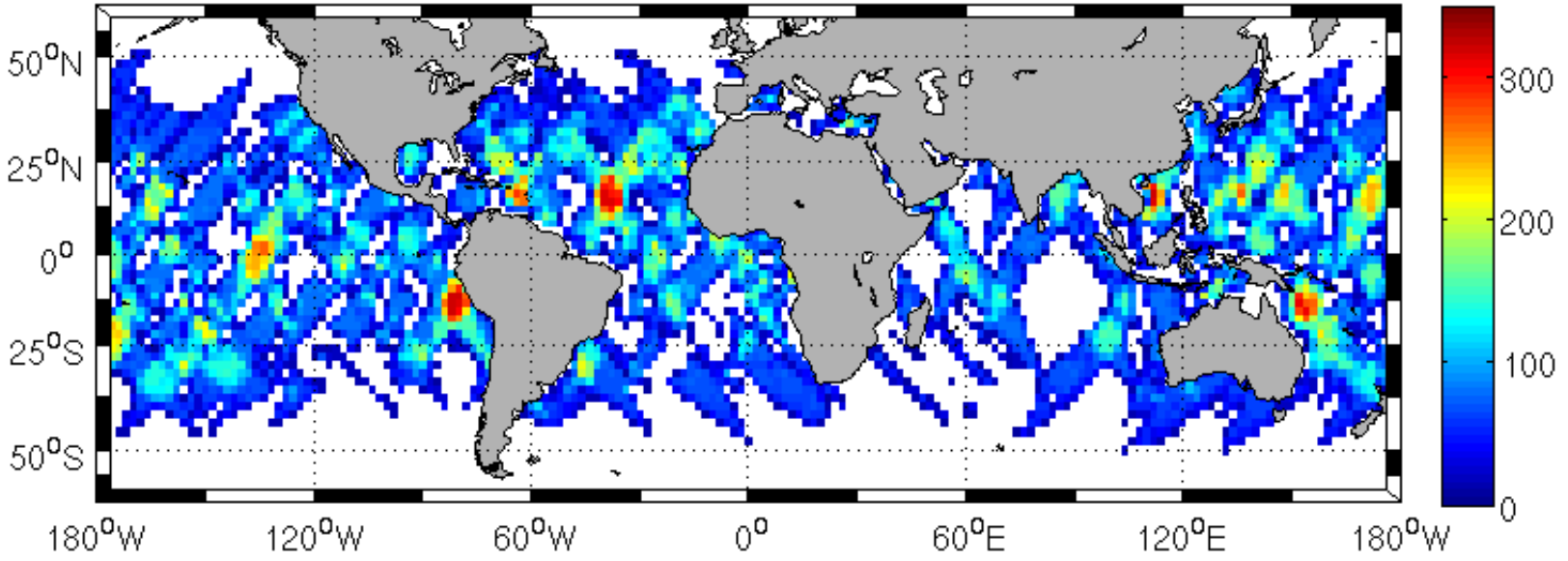
- Within the collocated RSCAT and HSCAT data, PenWP over quality-controlled HSCAT data (12%), comparing to RSCAT QC (8%). The HSCAT QC flag is re-developed to produce equivalent QC ratio with RSCAT.
- -0.6 dB NOC is applied to HSCAT

Time_diff < 5 minutes
Space_diff< 25 km (the closest)

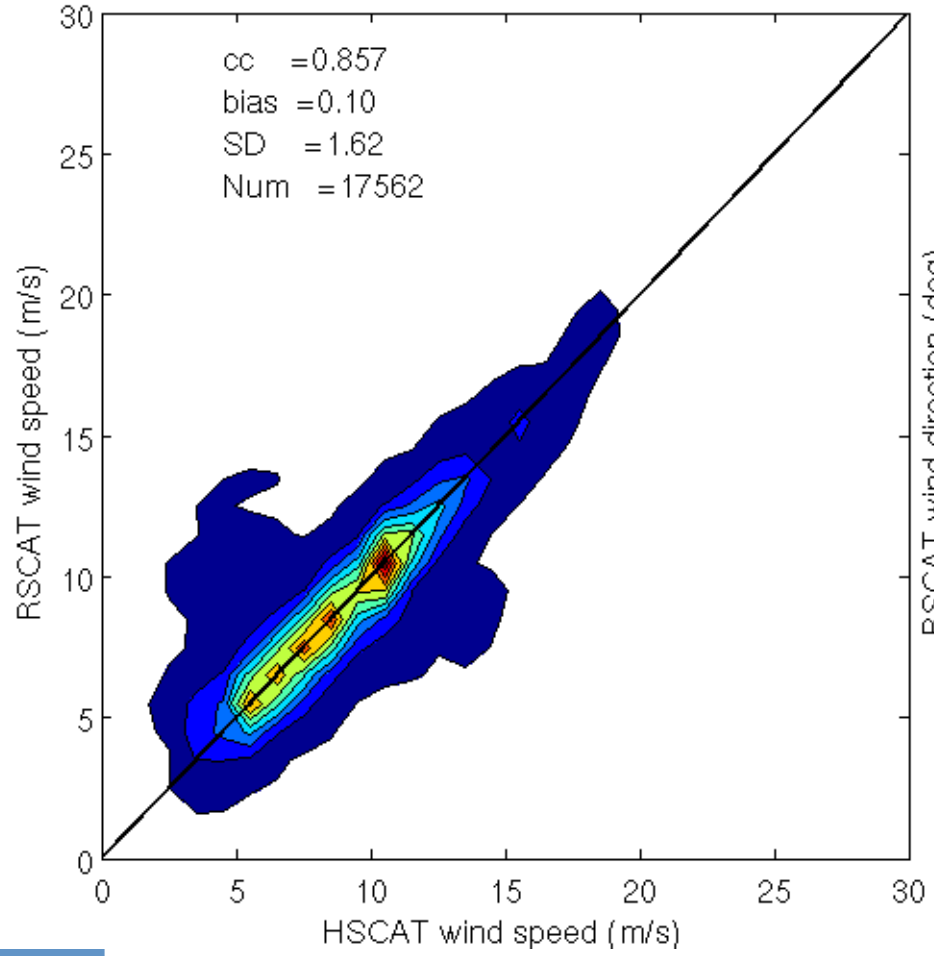
Total number of RSCAT-HSCAT collocations=386,153 (Sea ice exclued)

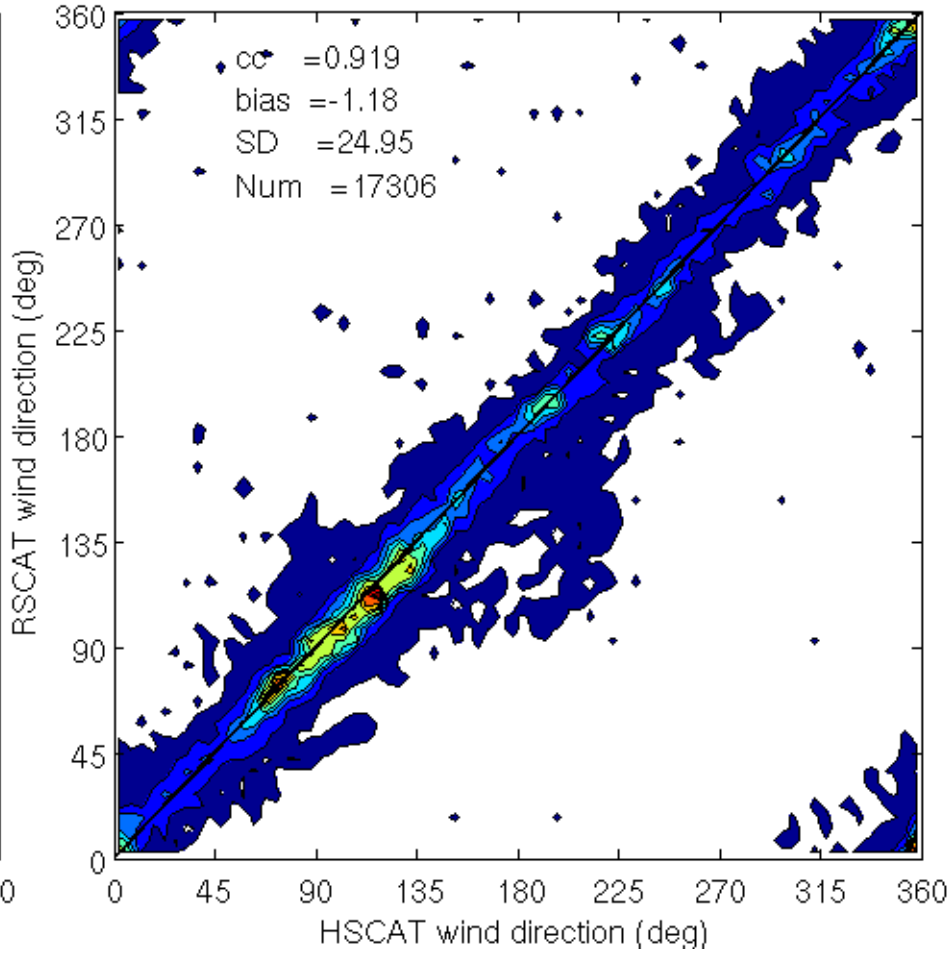
	HSCAT-accept	HSCAT- reject
RapidSCAT-accept	87.2% (C1)	4.5% (C2)
RapidSCAT-reject	4.7% (C3)	3.6% (C4)

Density plot of RSCAT-HSCAT collocations, 2°x2° (minimu *N*=10)

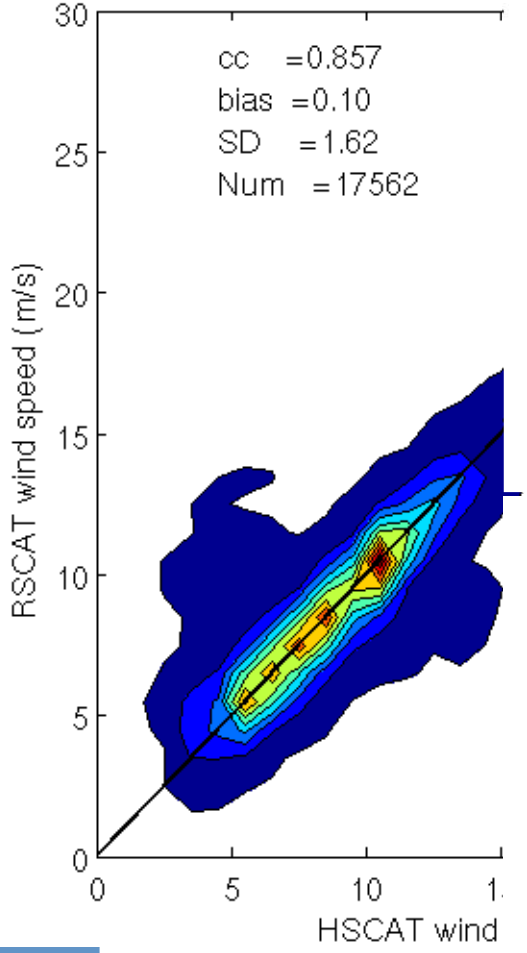


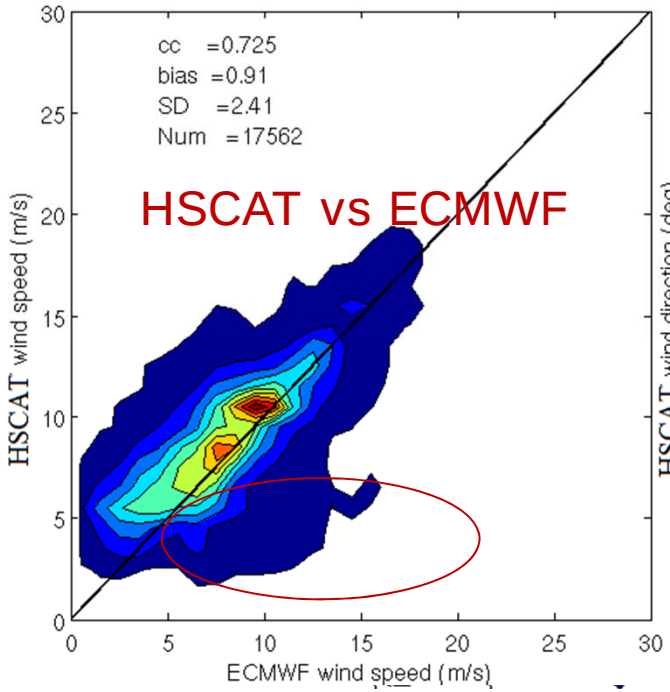
HSCAT versus RapidSCAT winds



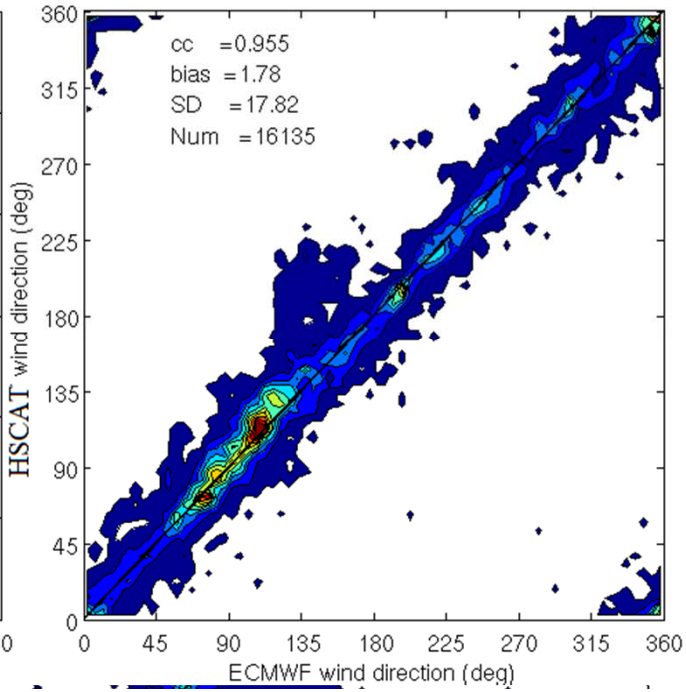


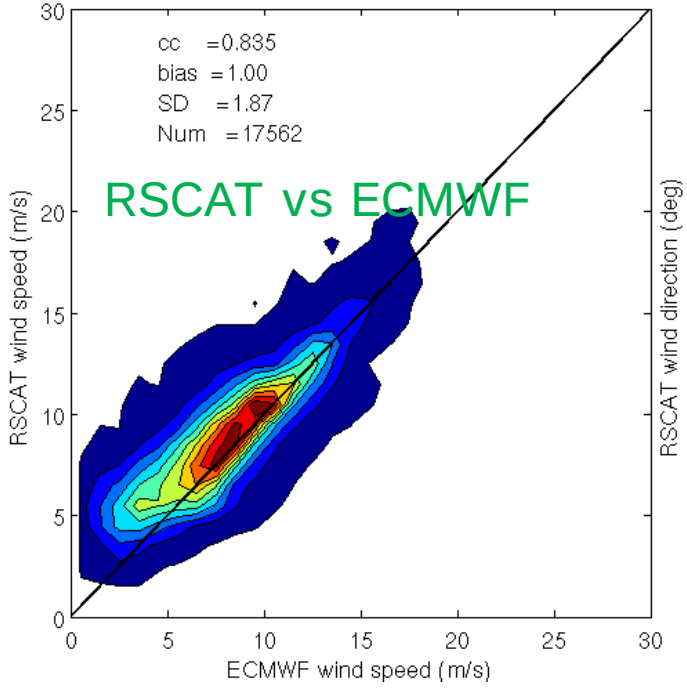
C2: RapidSCAT QC accepted, HSCAT QC Rejected



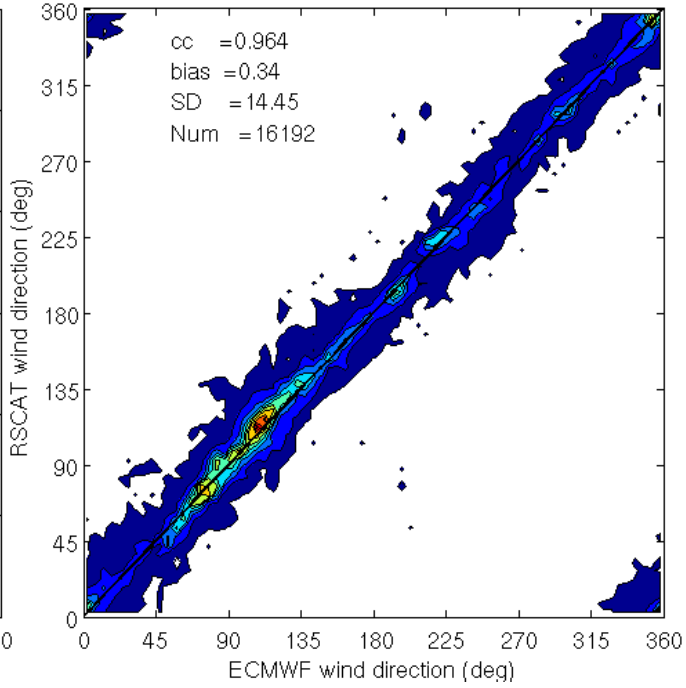


HSCAT vs ECMWF



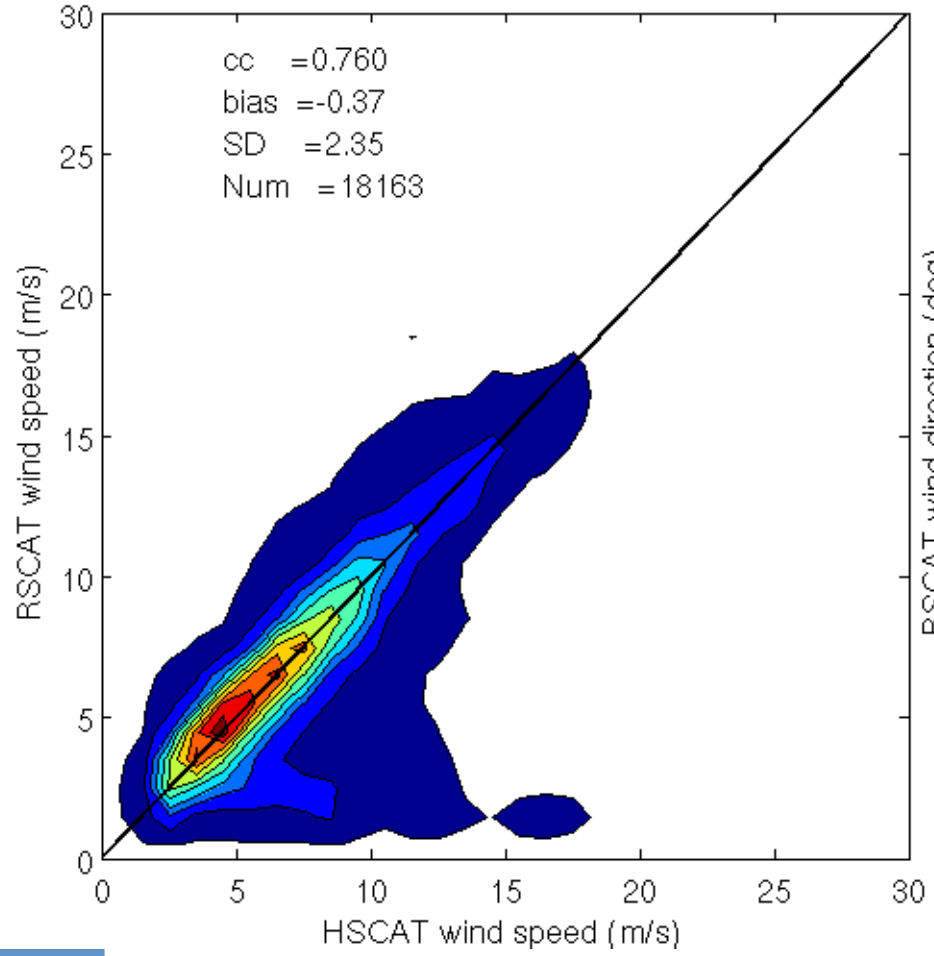


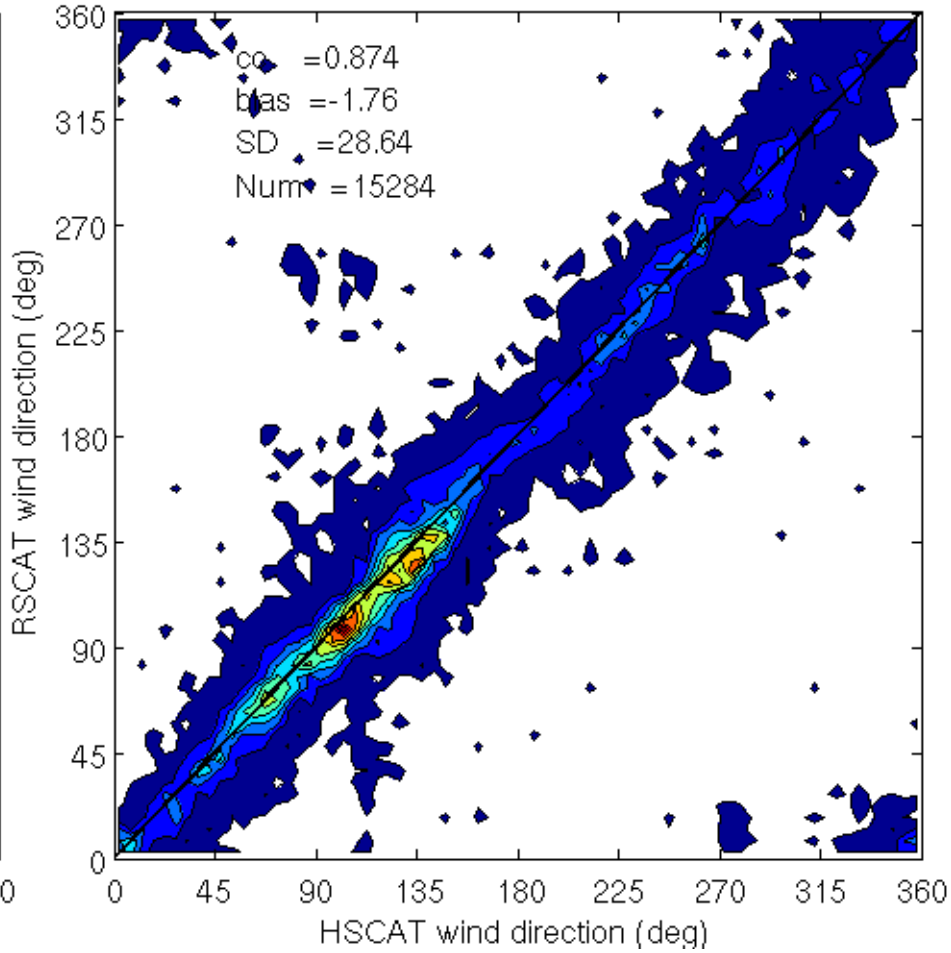
RSCAT vs ECMWF



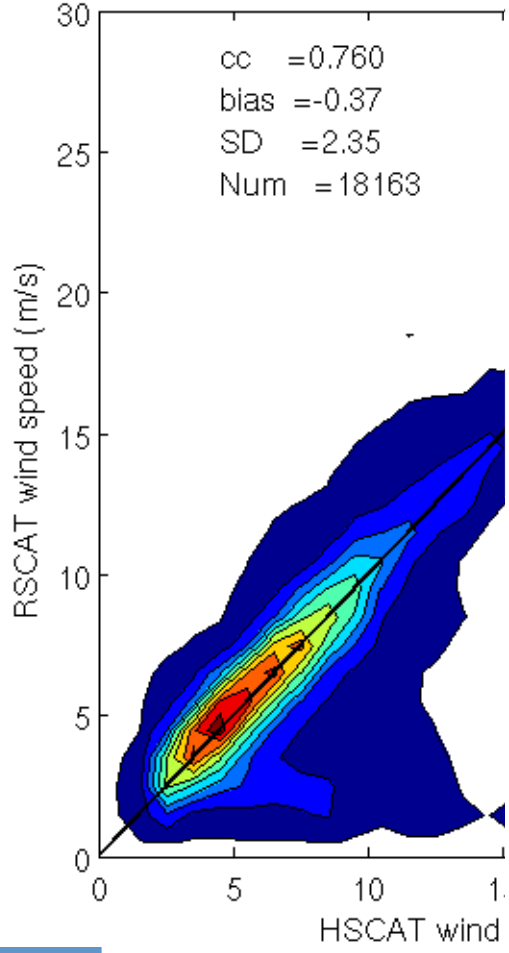
C2: RapidS

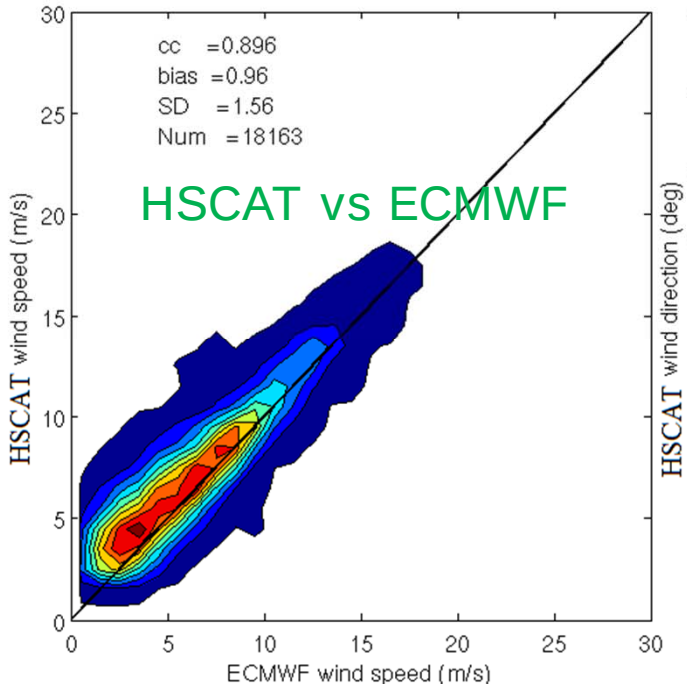
HSCAT versus RapidSCAT winds



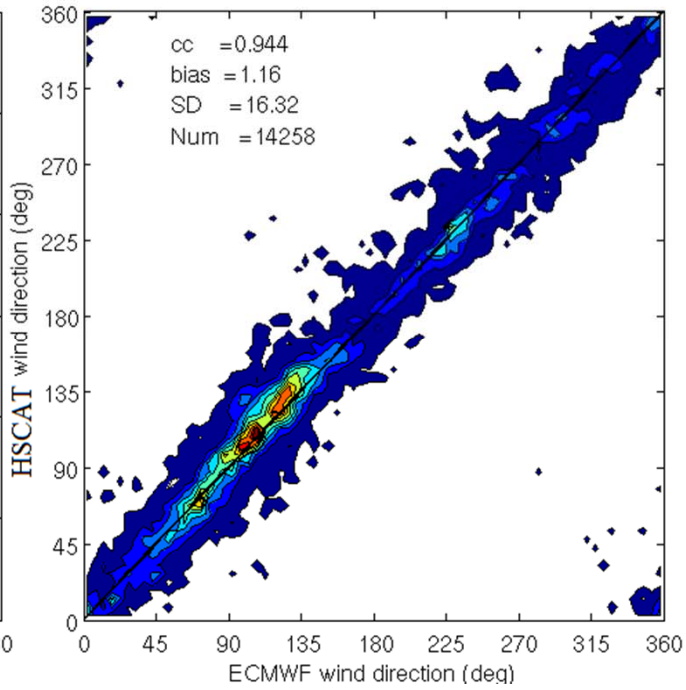


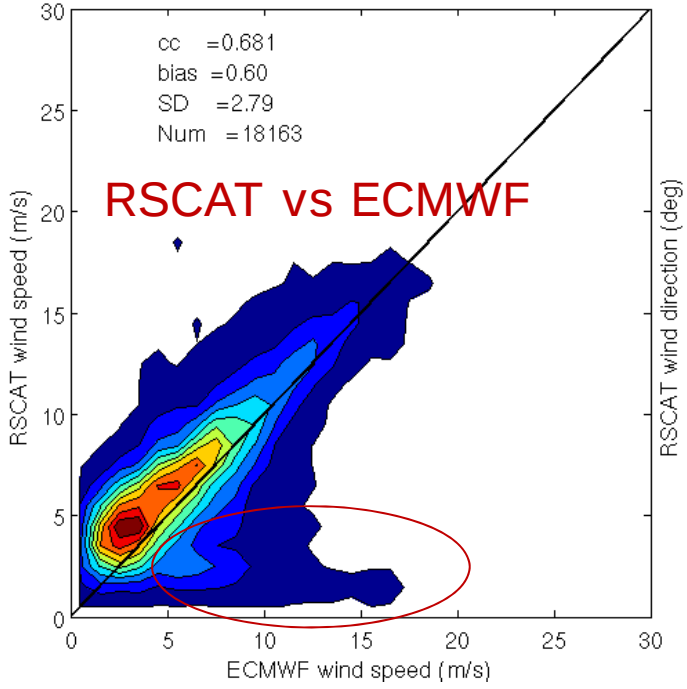
C3: RapidSCAT QC Rejected, HSCAT QC accepted



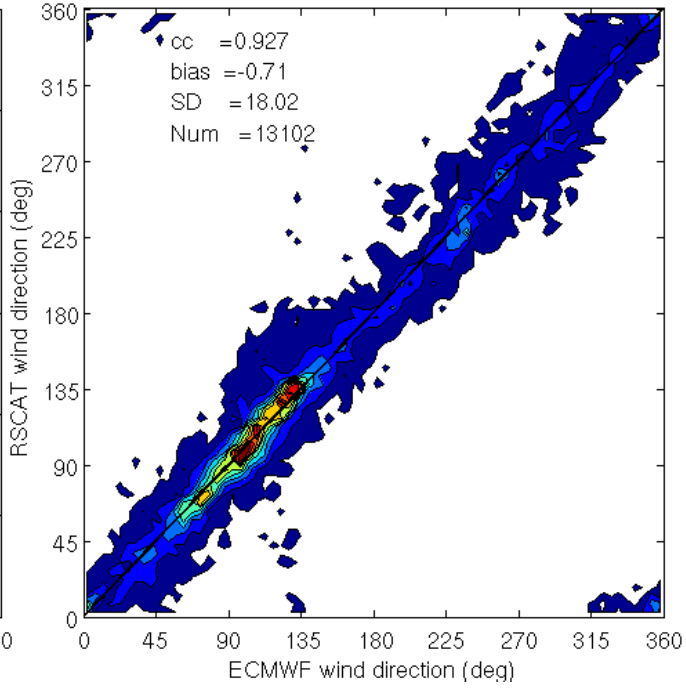


HSCAT vs ECMWF



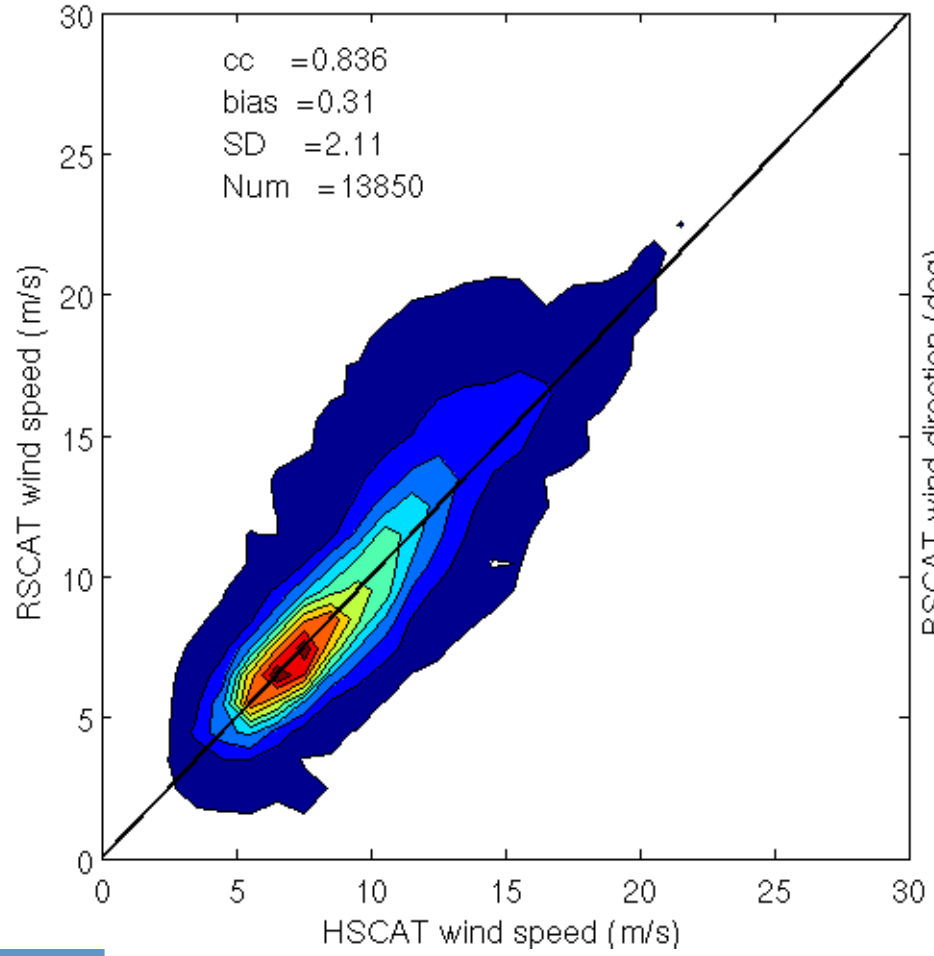


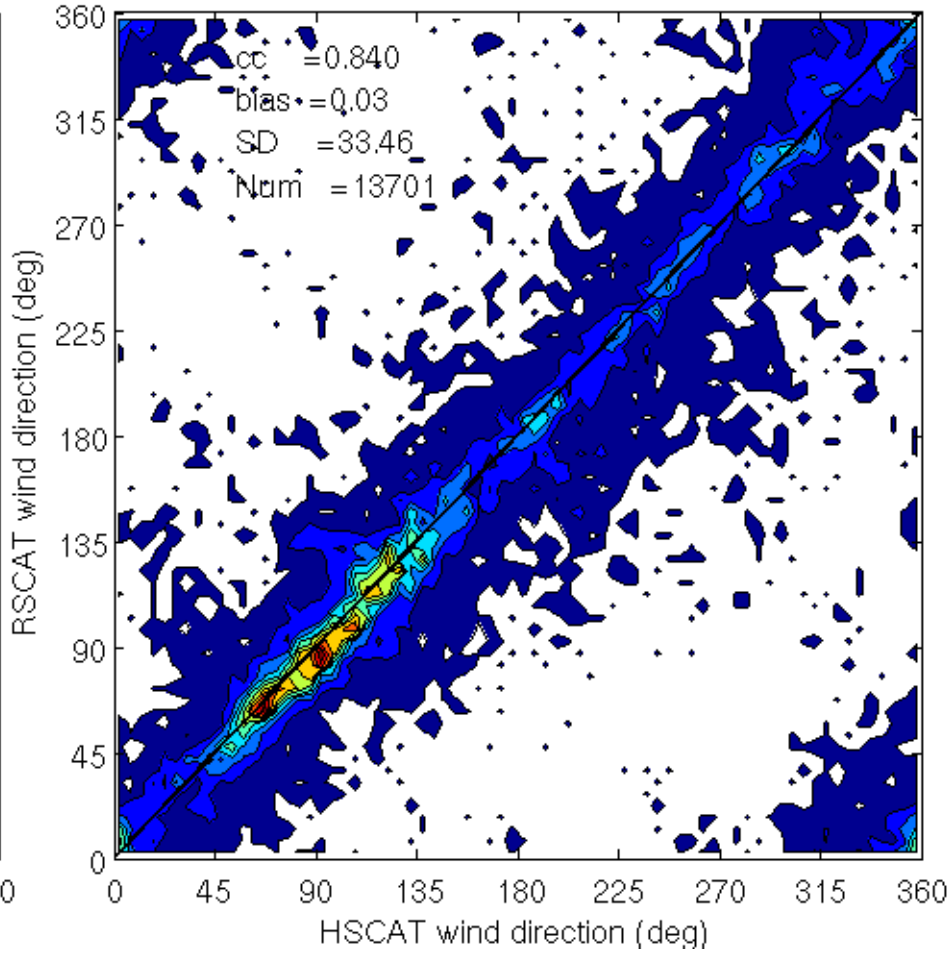
RSCAT vs ECMWF



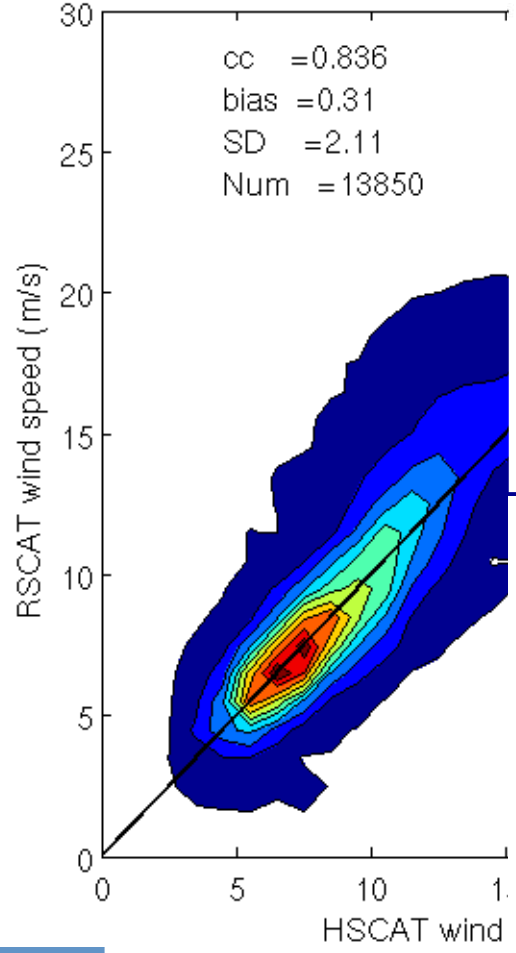
C3: RapidS

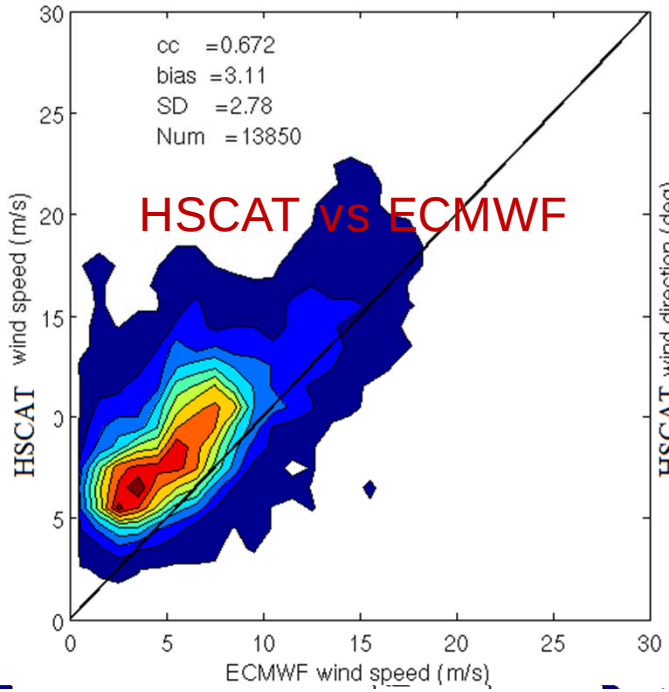
HSCAT versus RapidSCAT winds



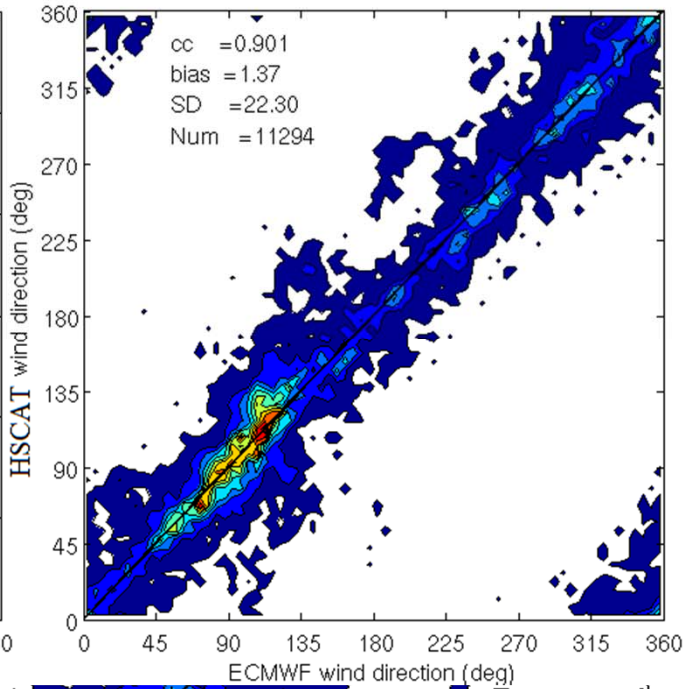


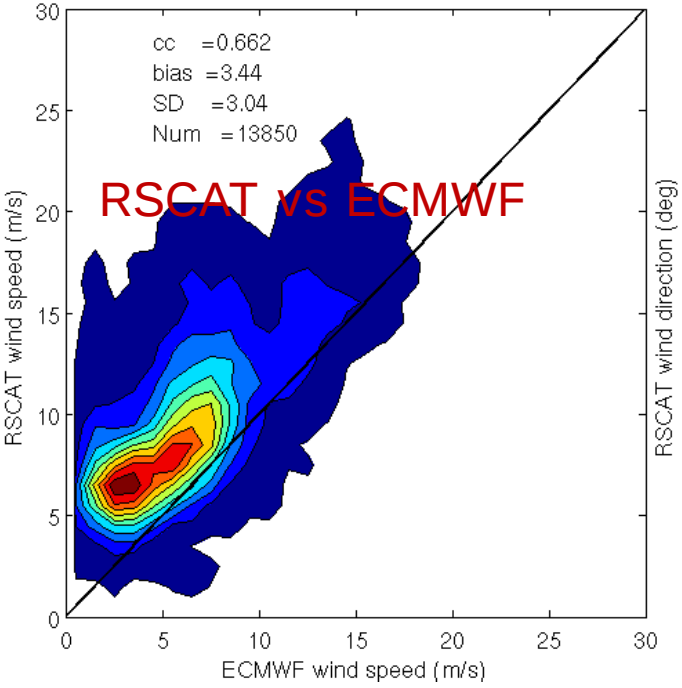
C4: RapidSCAT QC Rejected, HSCAT QC accepted



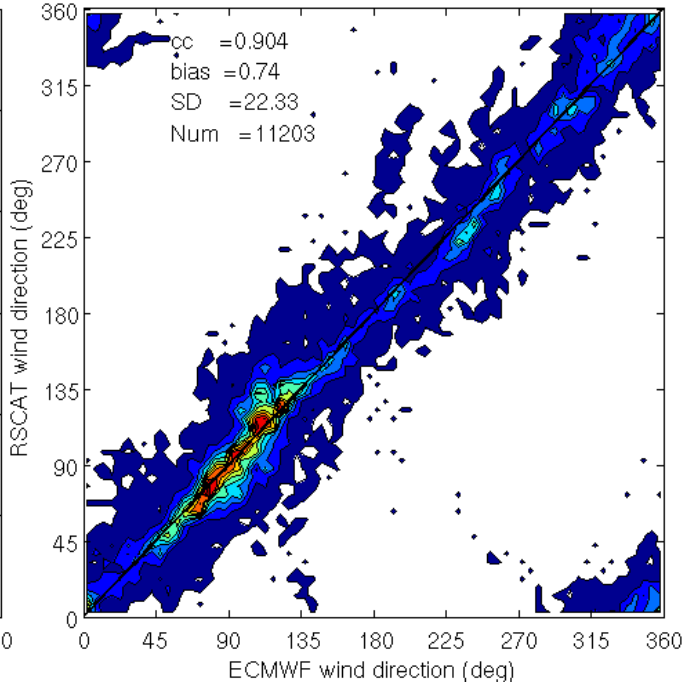


HSCAT vs ECMWF



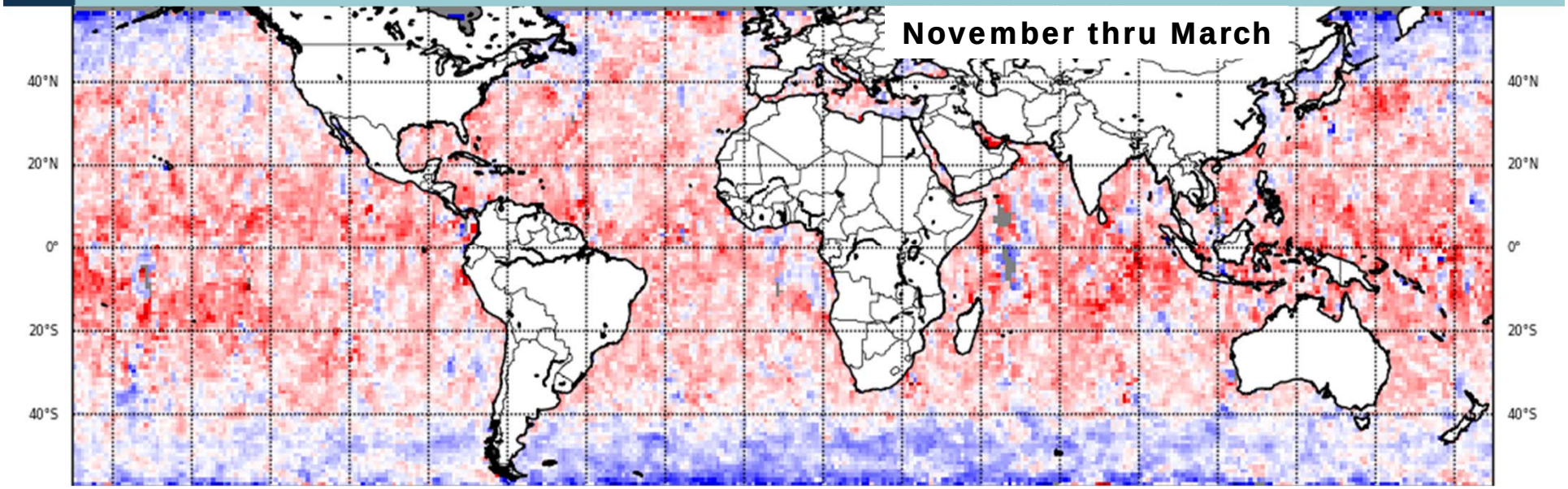


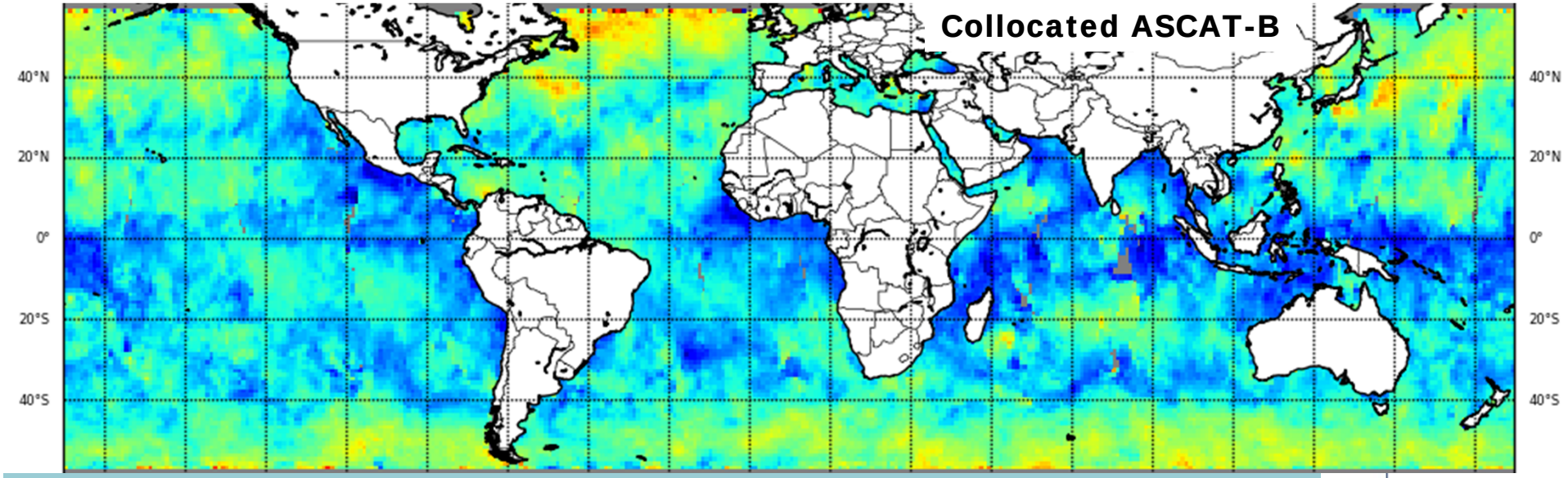
RSCAT vs ECMWF



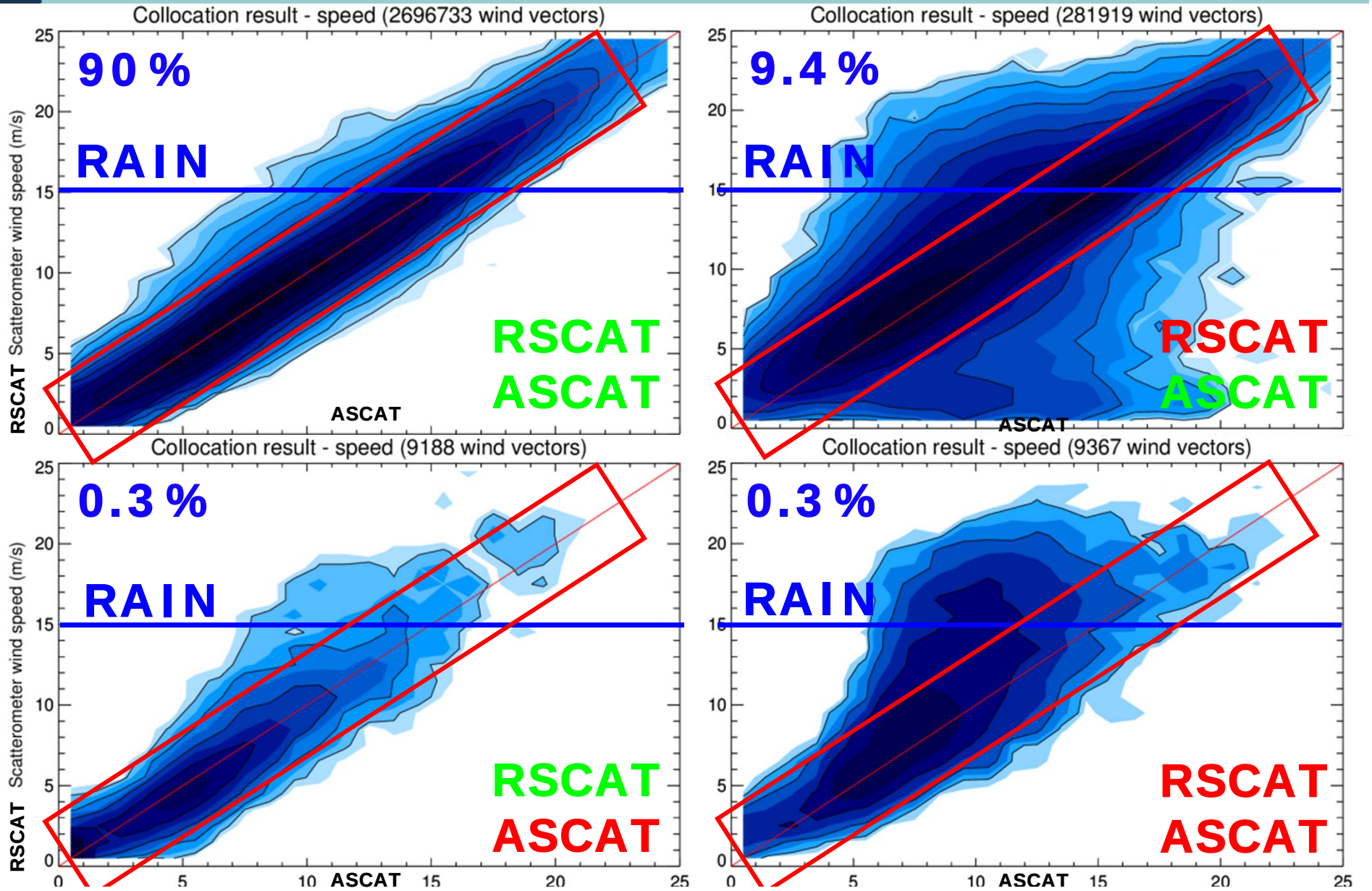
C4: RapidS

Rapidscat - ASCAT speeds





Speed and QC


Collocation result - speed (2696733 wind vectors)
90 %
RAIN
RSCAT
ASCAT
RSCAT Scatterometer wind speed (m/s)
ASCAT
Collocation result - speed (281919 wind vectors)
9.4 %
RAIN
RSCAT
ASCAT
ASCAT
Collocation result - speed (9188 wind vectors)
0.3 %
RAIN
RSCAT
ASCAT
RSCAT Scatterometer wind speed (m/s)
ASCAT
Collocation result - speed (9367 wind vectors)
0.3 %
RAIN
RSCAT
ASCAT
ASCAT