Evaluation of the HY-2A Scatterometer wind quality

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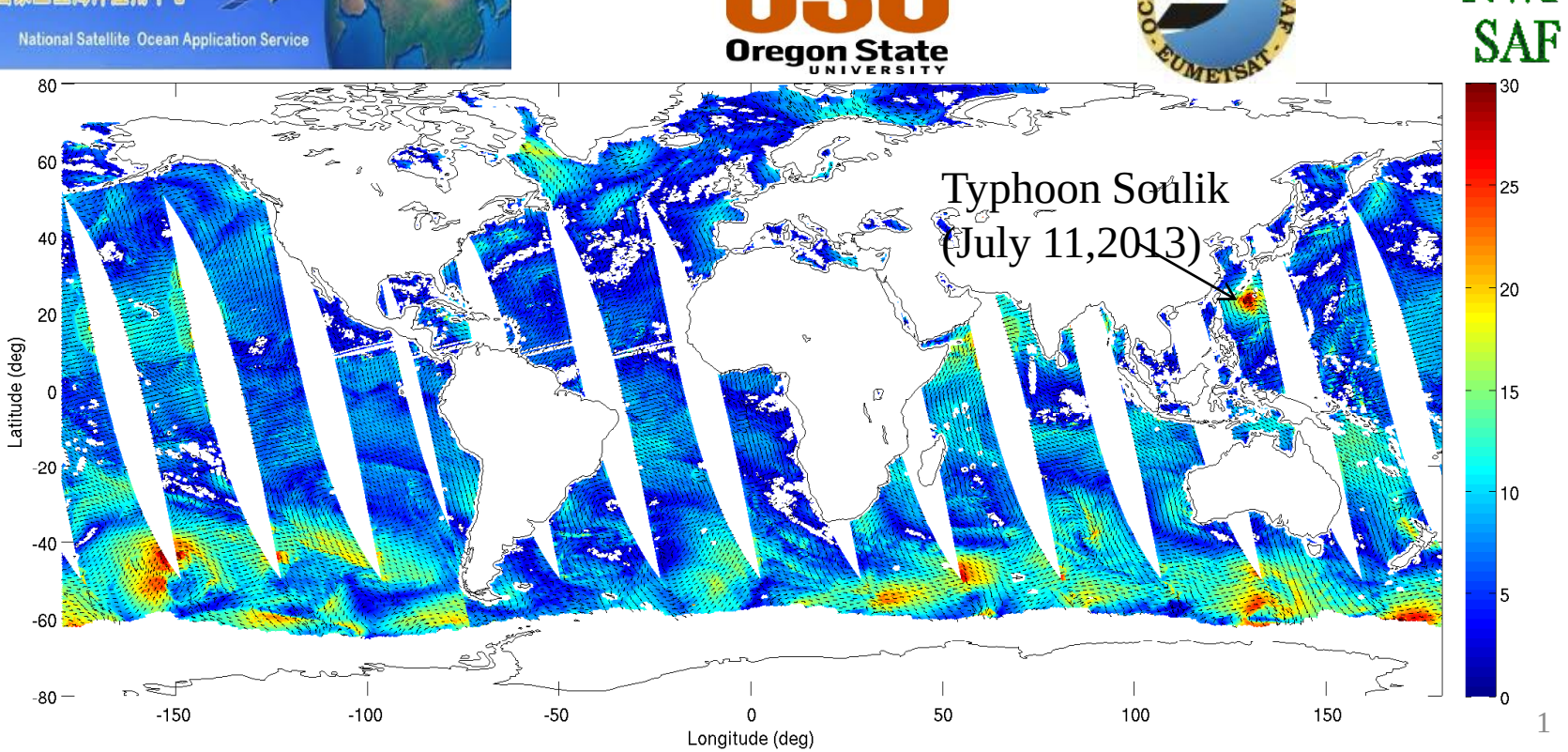
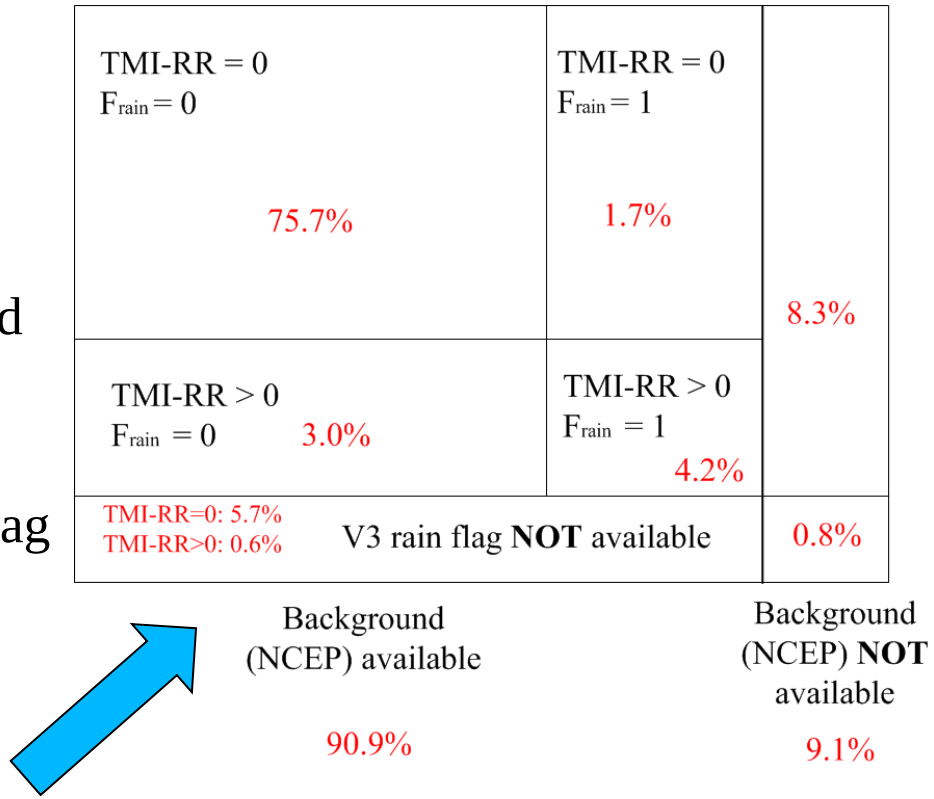


Data sets

1. The current HY-2A Scatterometer L2B data (25-km grid resolution) released by National Satellite Ocean Application Service (NSOAS, China)

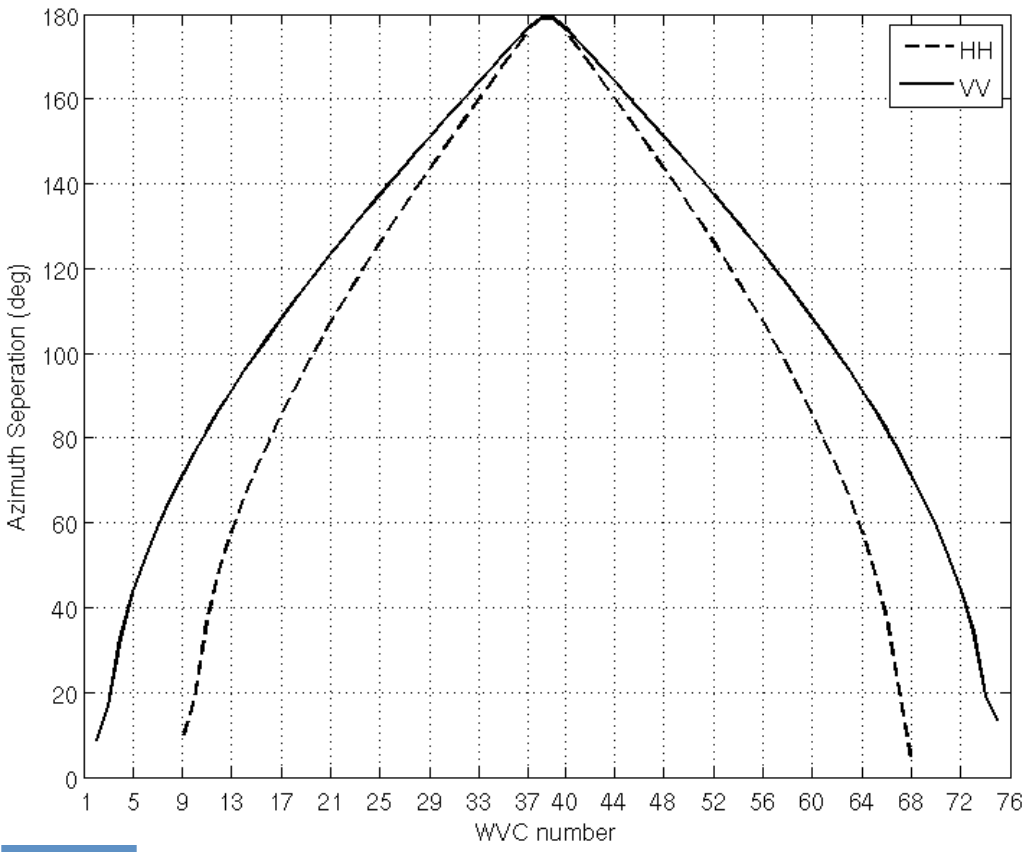
- v1 (Jan. 2012) : No quality flags.
- v2 (Feb. 2014).
  - No quality flags.
  - Improved AR, Land-Sea mask, grid
- v3 (May 2014).
  - The same with v2 but with Rain Flag



2. Data collocations (Jan.-Apr. 2012)

- ECMWF wind
- TRMM/TMI rain data ($N_{TMI\_RR=0}$ = 2.9 million, $N_{TMI\_RR>0}$= 0.22 million)
- Tropical moored buoys (N_{buoy}=11 k)

Data sets

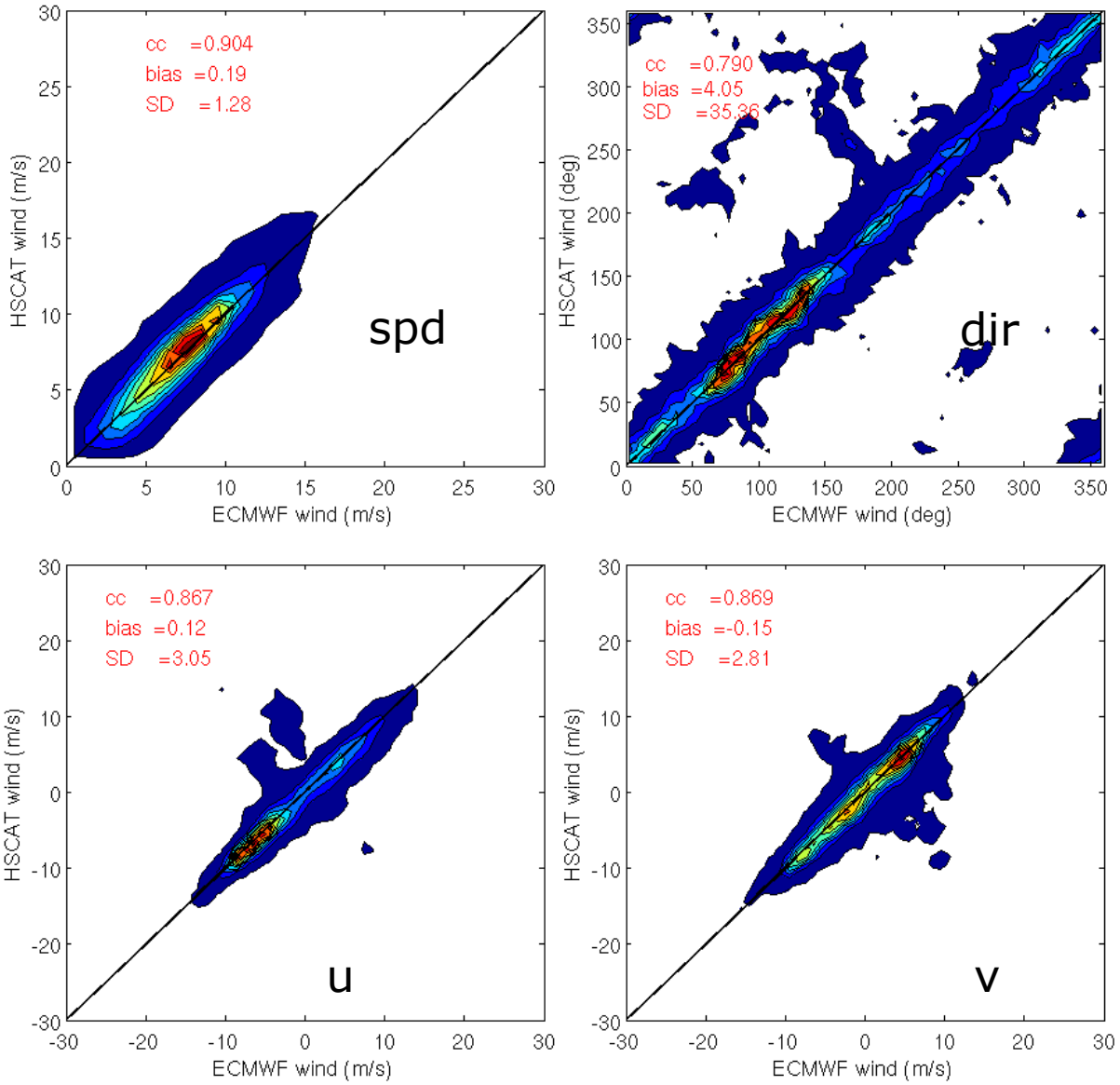


Mean azimuth seperation between fore and aft views by wvc number

- Category 0: wvc 1/76, no data;
- Category 1: wvc 2-9, and 68-75; (outer swath regions)
- Category 2: wvc 10-28, and 49-67 (sweet regions);
- Category 3: wvc 29-48 (nadir swath region)

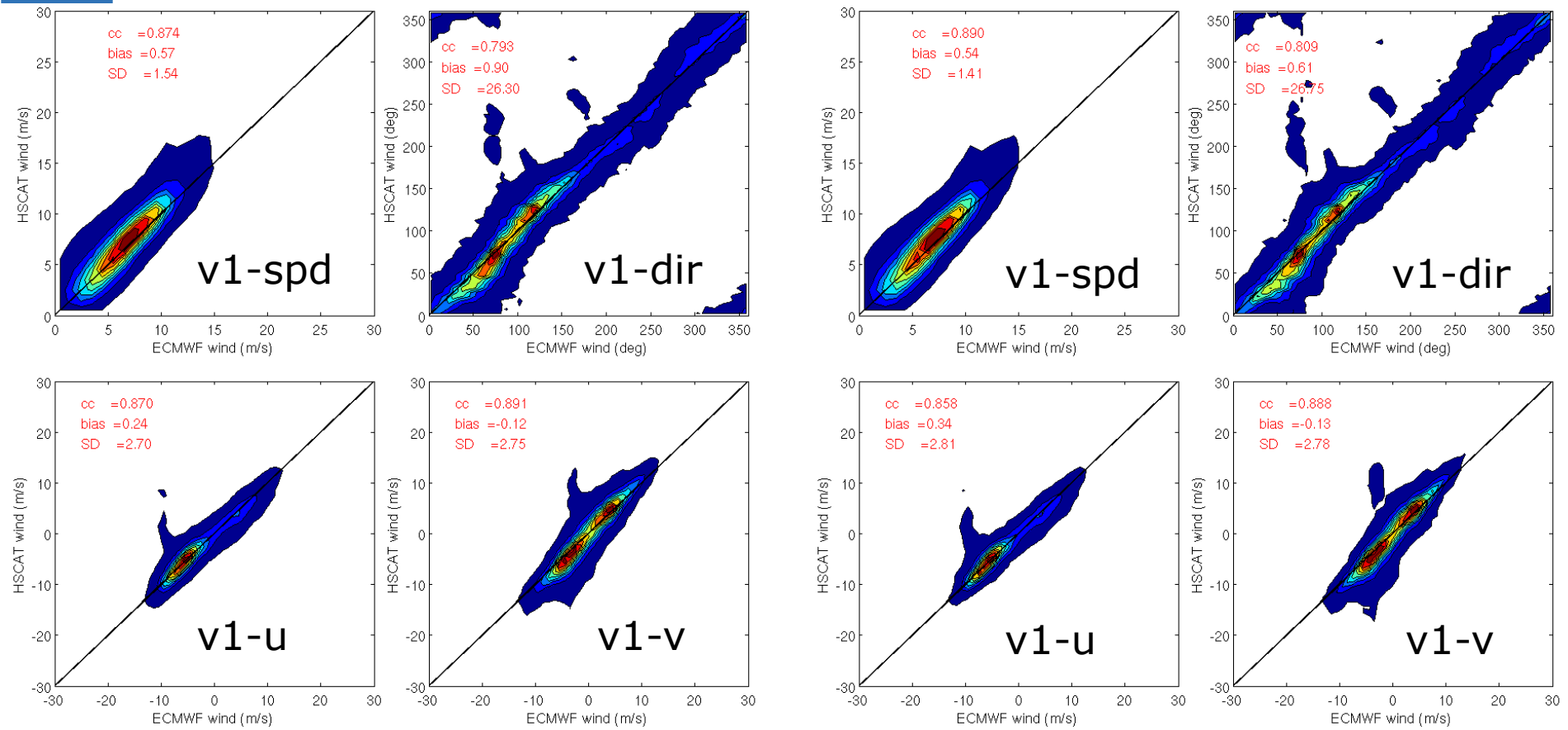
Quality evaluation

- Ignore wind retrievals without NCEP winds;
- By comparing to ECMWF: only consider the data with collocated TMI-RR=0 mm/h (v1 and v2), or rain flag unset (v3 ‘rain-free’)
- By comparing to Buoy: only consider the data with normalized inversion residual below 4 (i.e., MLE<4, v1 and v2), or rain flag unset (v3 ’rain-free’)



Two-dimension histograms of HSCAT wind components against ECMWF winds (TMI-RR=0 mm/h). Wind retrievals when **NCEP** background winds **not available**. v2(v3), sweet swath

Quality evaluation: Comparing with ECMWF

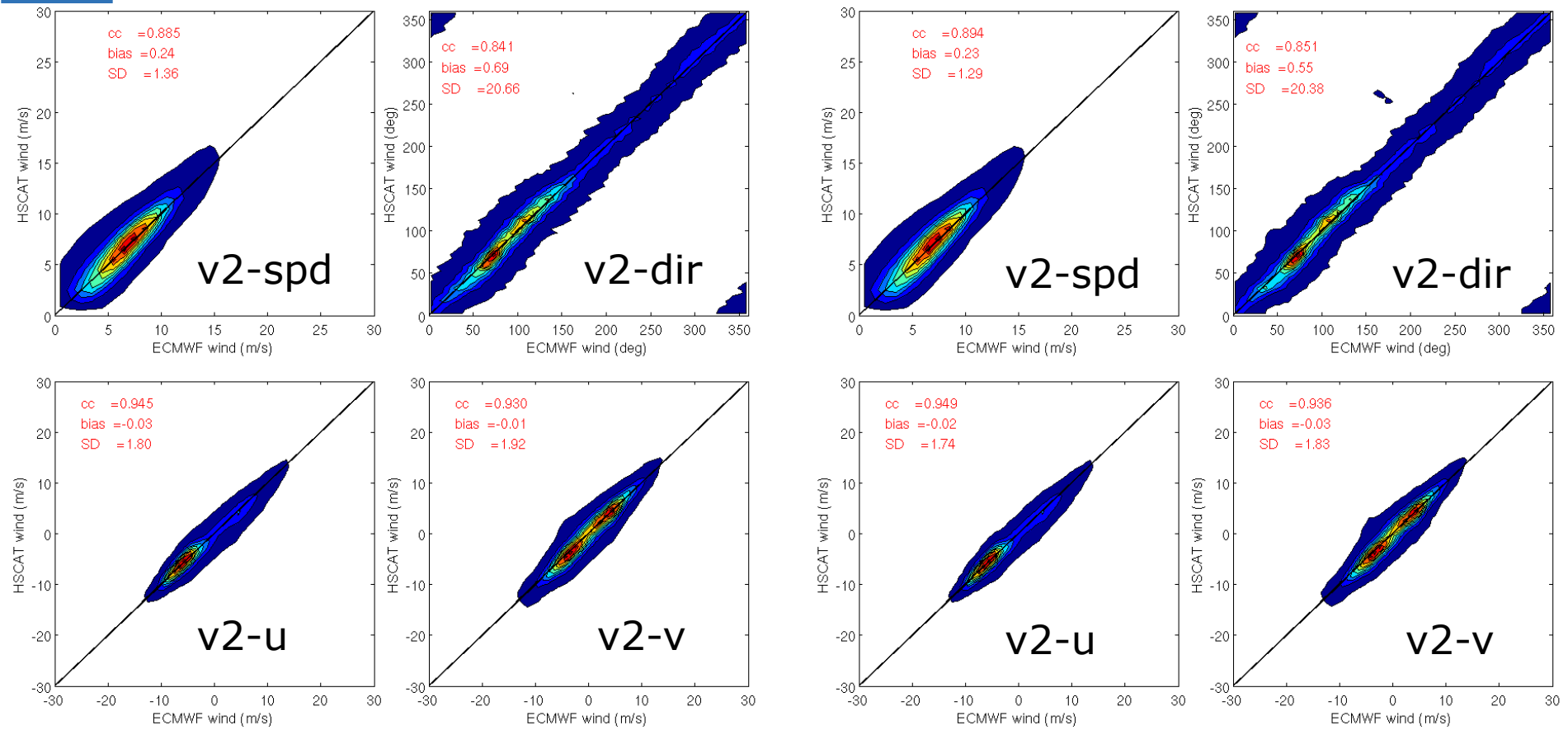


(a) full swath (b) sweet swath

Fig. 1 Two-dimension histograms of HSCAT wind components against ECMWF winds (TMI-RR=0 mm/h). Wind retrievals when **NCEP** background winds **available**.

- Ambiguity removal errors; Speed bias at high winds; poor linearity of v-component;

Quality evaluation: Comparing with ECMWF

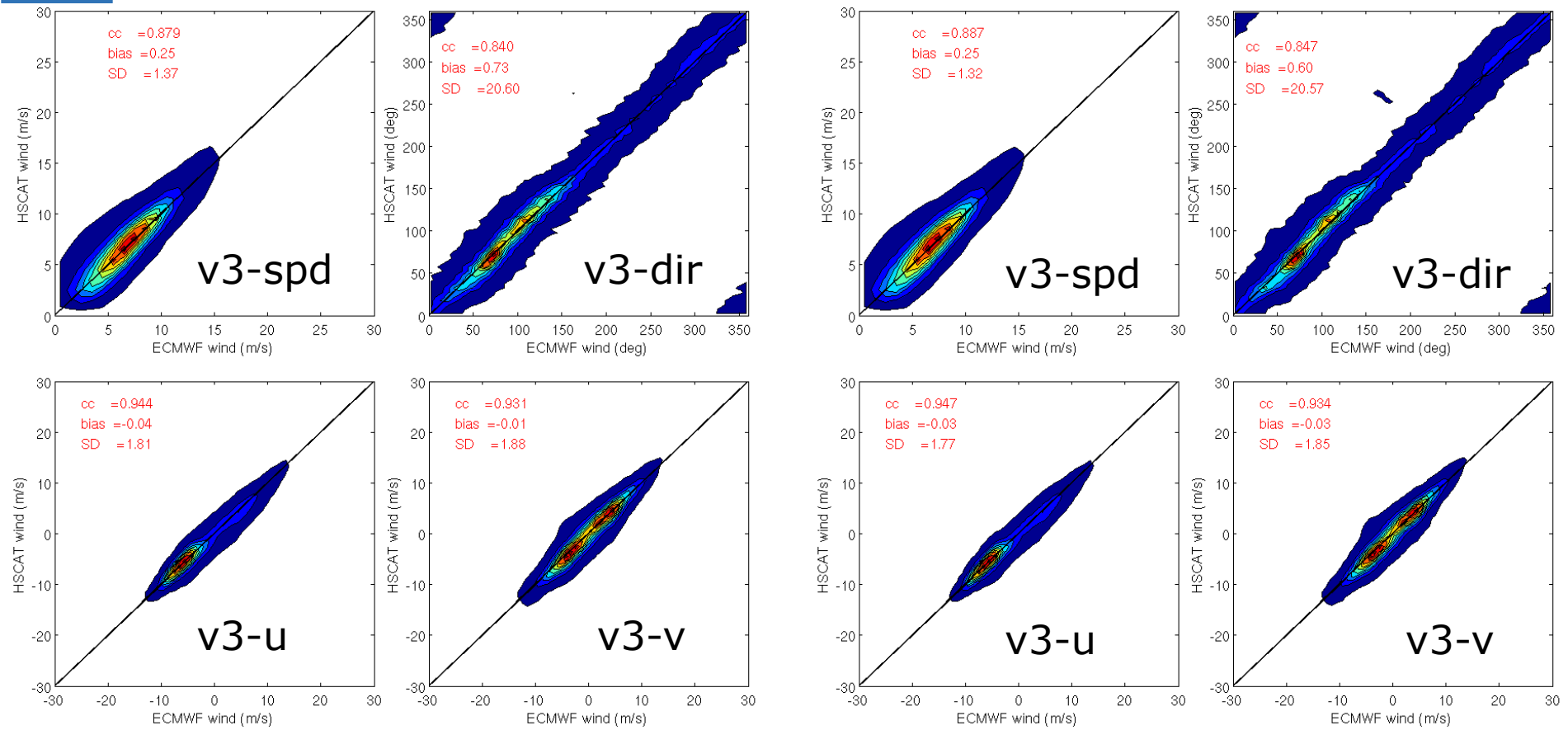


(a) full swath (b) sweet swath

Fig. 2 Two-dimension histograms of HSCAT wind components against ECMWF winds (TMI-RR=0 mm/h). Wind retrievals when **NCEP** background winds **available**.

- Less ambiguity removal errors; Less speed bias; no low winds (<1 m/s)

Quality evaluation: Comparing with ECMWF

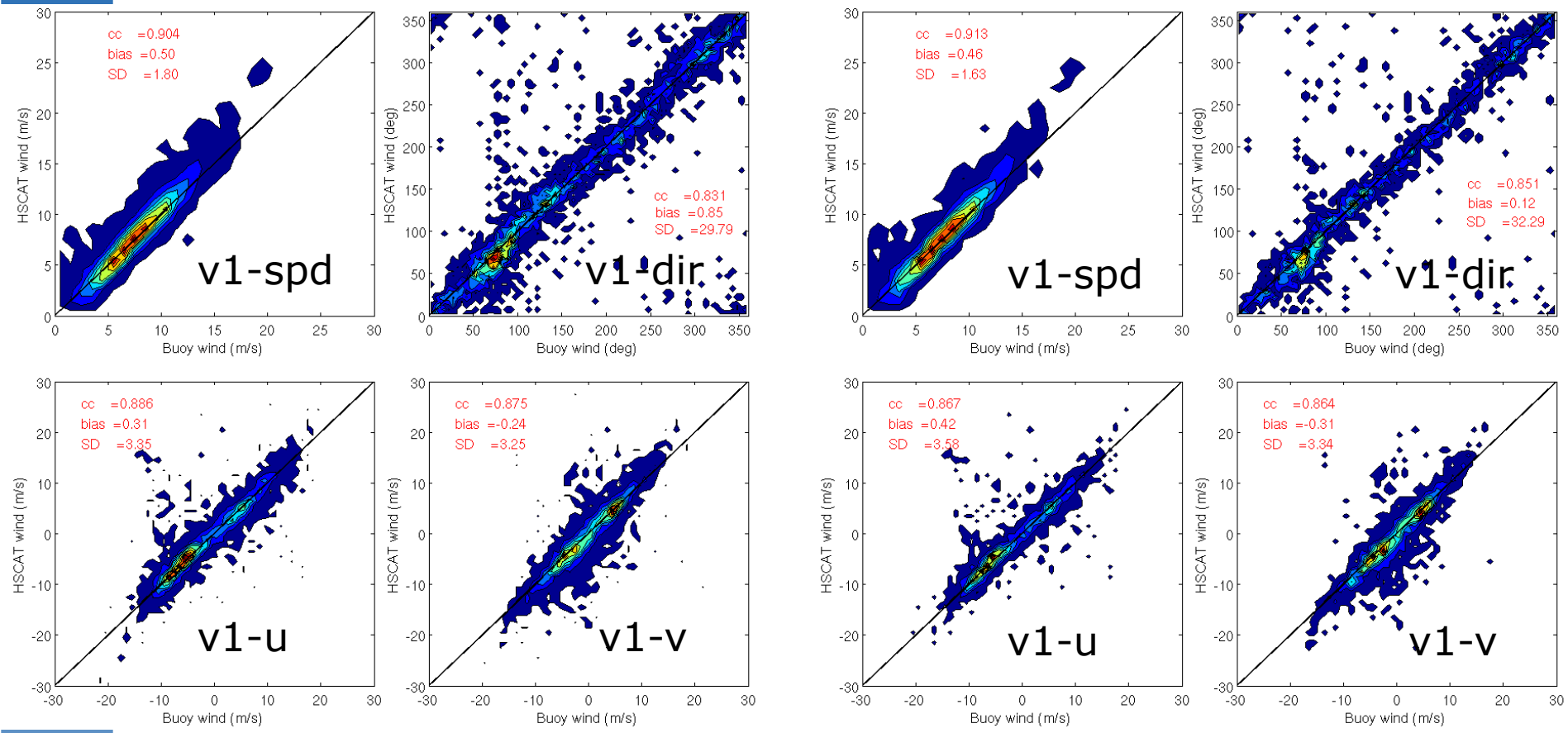


(a) full swath (b) sweet swath

Fig. 3 Two-dimension histograms of HSCAT wind components against ECMWF winds (**v3 QC accepted WVCs**). Wind retrievals when **NCEP** background winds **available**.

- Less ambiguity removal errors; Less speed bias; no low winds (<1 m/s)

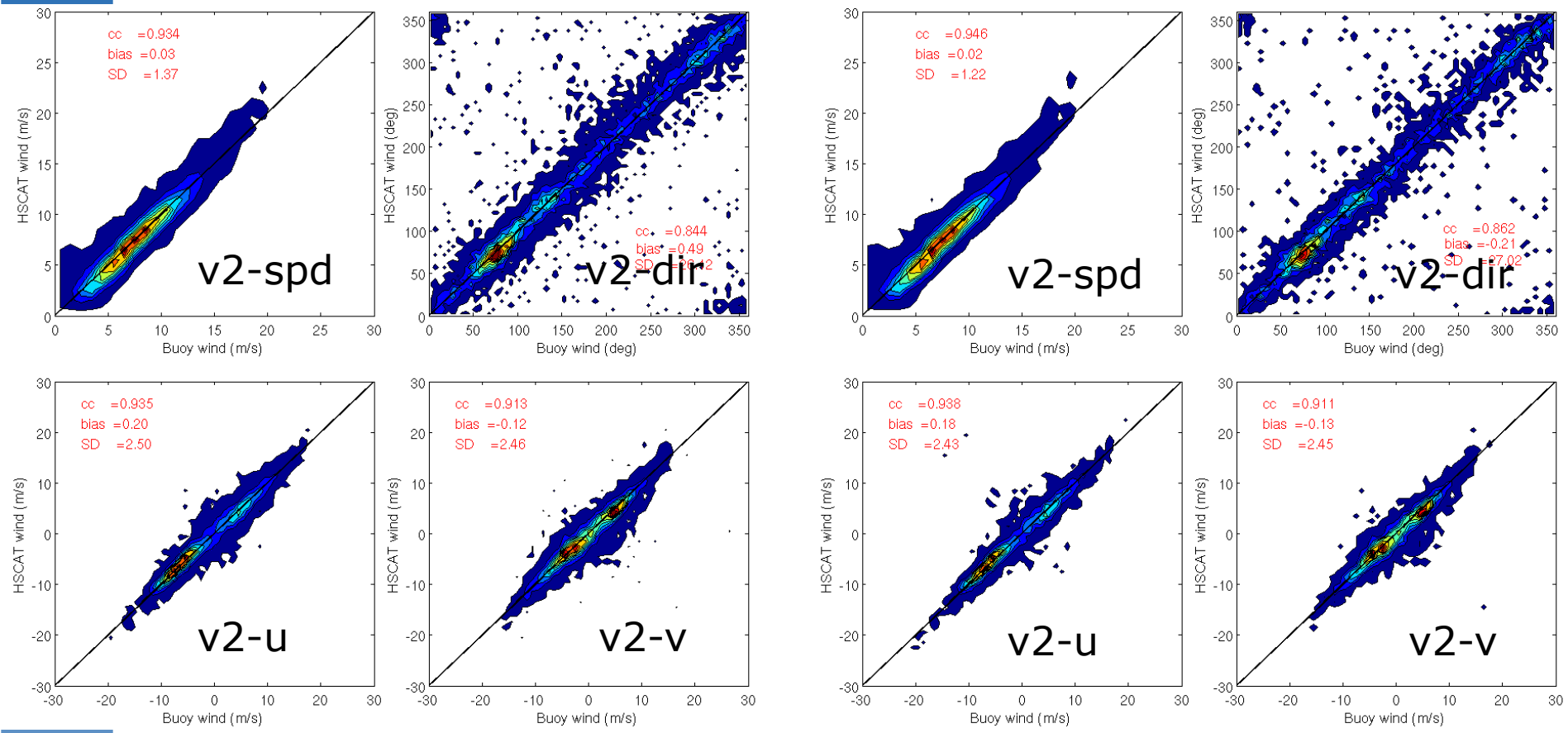
Quality evaluation: Comparing with Buoy



(a) full swath (b) sweet swath

Fig. 4 Two-dimension histograms of HSCAT wind components against Buoy winds (MLE<4). Wind retrievals when **NCEP** background winds **available**.

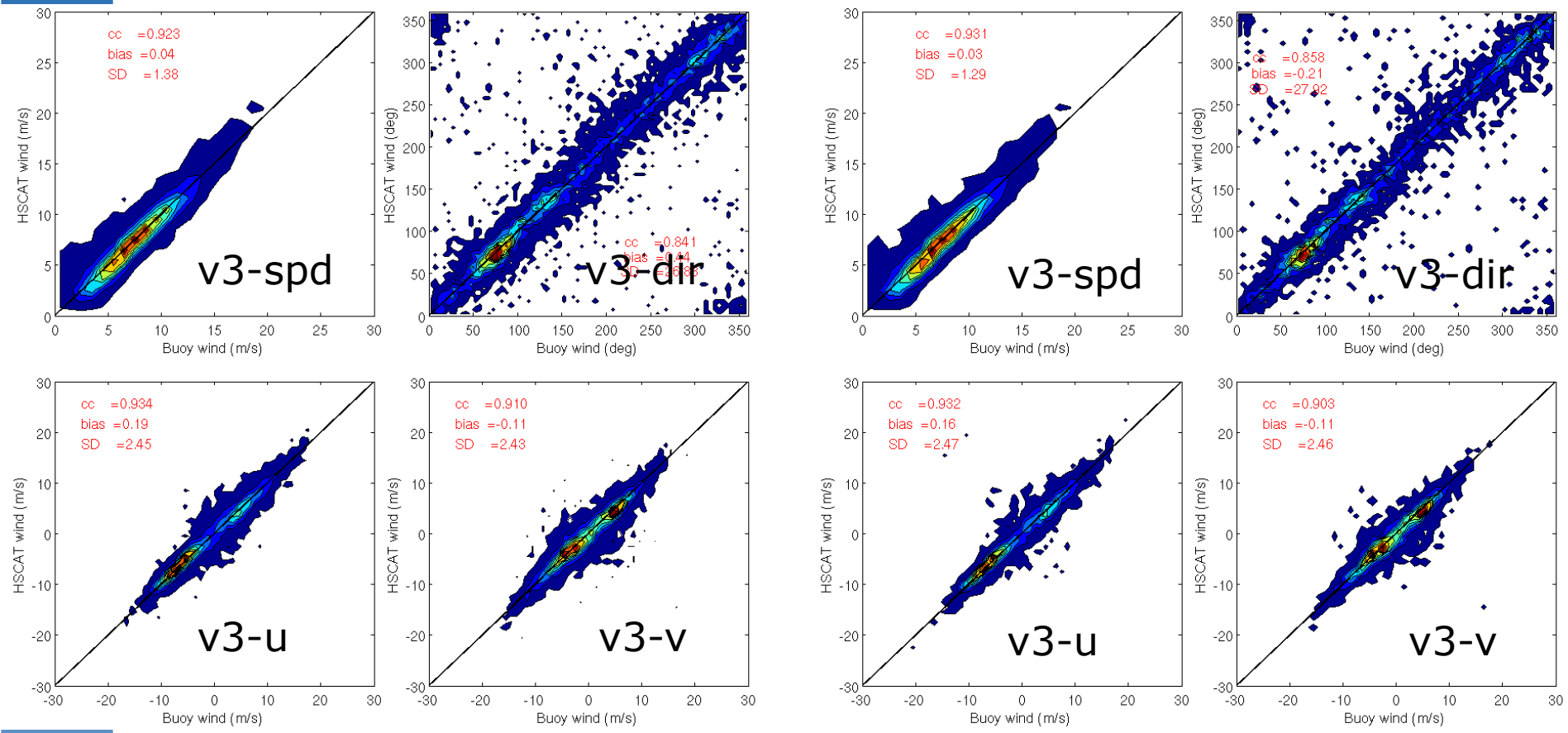
Quality evaluation: Comparing with Buoy



(a) full swath (b) sweet swath

Fig. 5 Two-dimension histograms of HSCAT wind components against Buoy winds (MLE<4). Wind retrievals when **NCEP** background winds **available**.

Quality evaluation: Comparing with Buoy



(a) full swath (b) sweet swath

Fig. 6 Two-dimension histograms of HSCAT wind components against Buoy winds (v3 QC accepted WVCs). Wind retrievals when **NCEP** background winds **available**.

Quality evaluation

In summary:

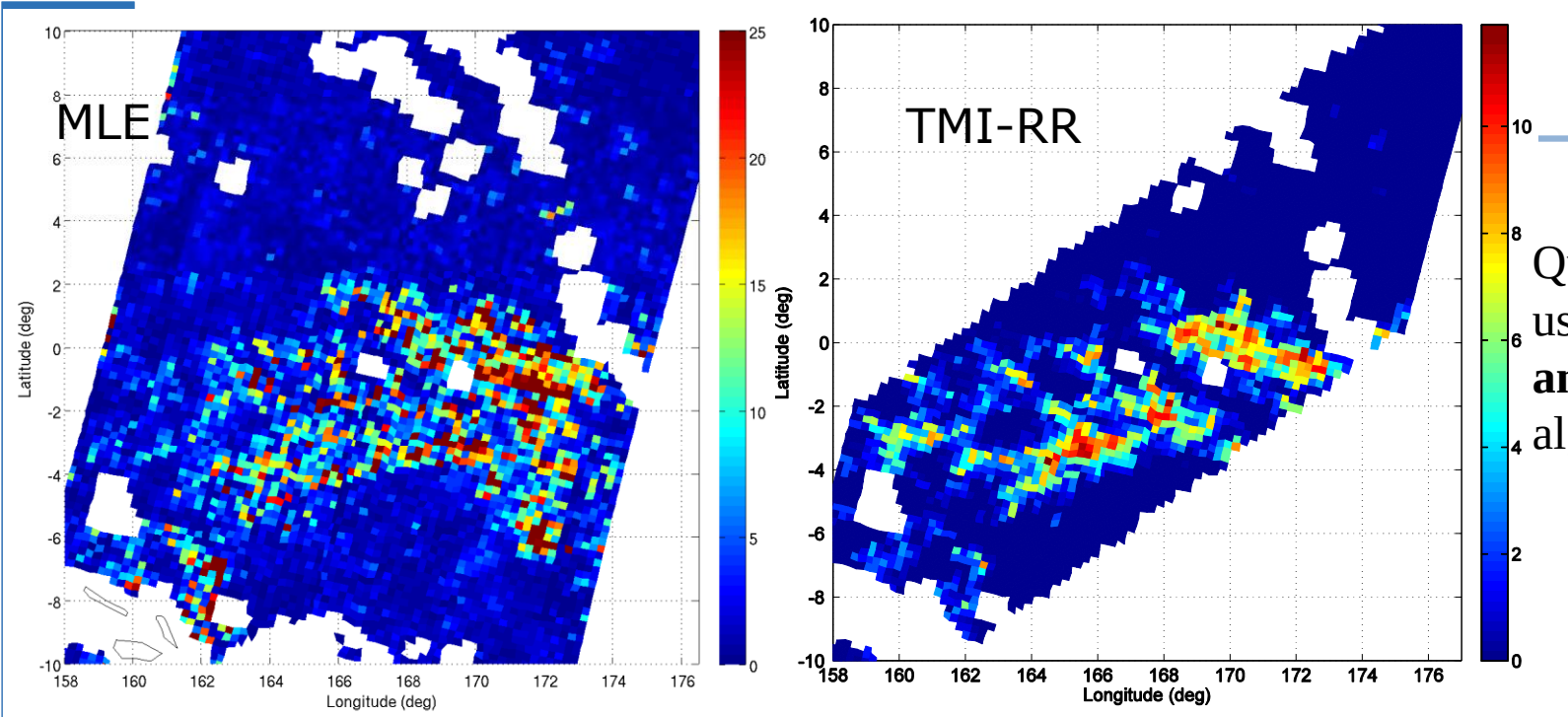
Winds acquired at the sweet swath regions of HSCAT are with better quality than those at the other swath regions.

- In the presence of NCEP background winds:

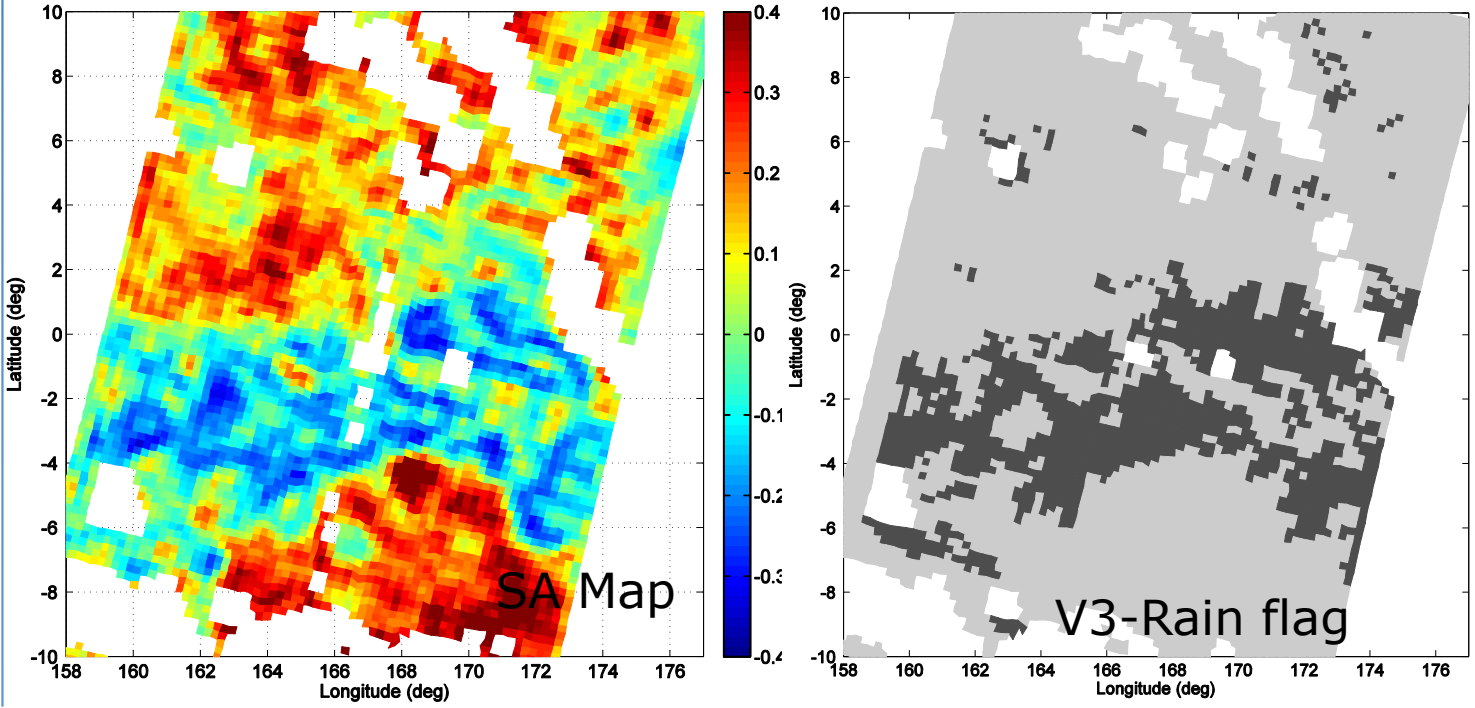
1. v1 data show an overall wind speed bias; substantial AR errors, even for the sweet regions;
2. v2 data have improved AR, less wind speed bias, especially at high wind conditions. Besides, there is no low wind data (<1 m/s).

- In the absence of NCEP background winds:

1. Both v1 and v2 data have substantial AR errors. Wind speed bias is still evident for the v1 data.

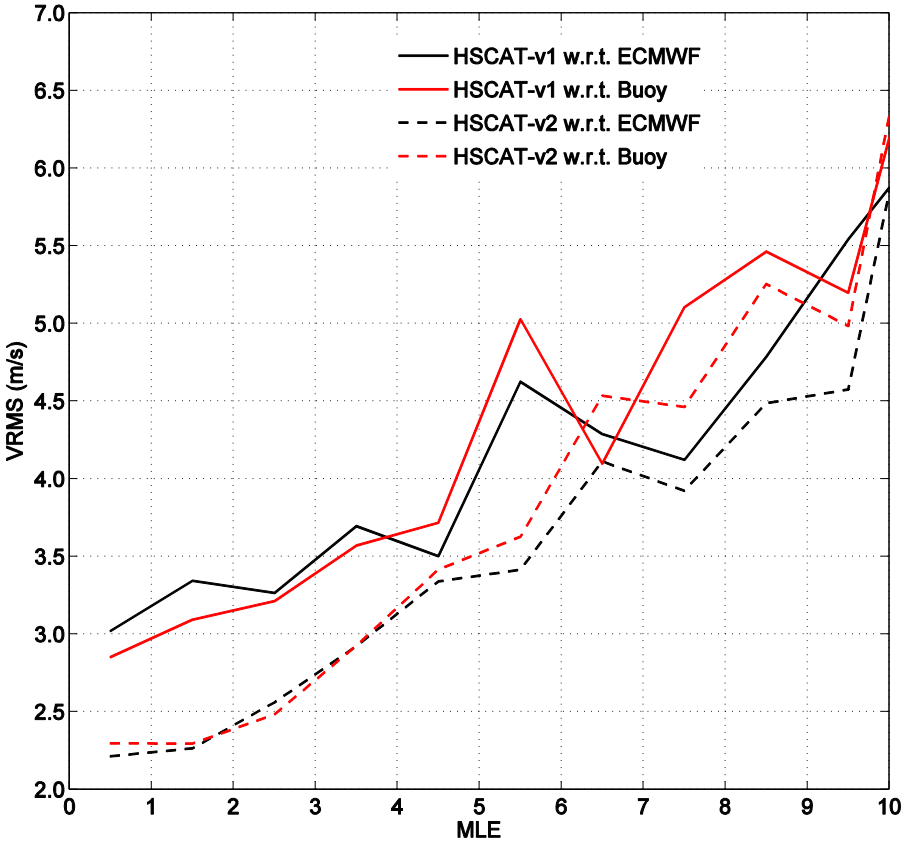


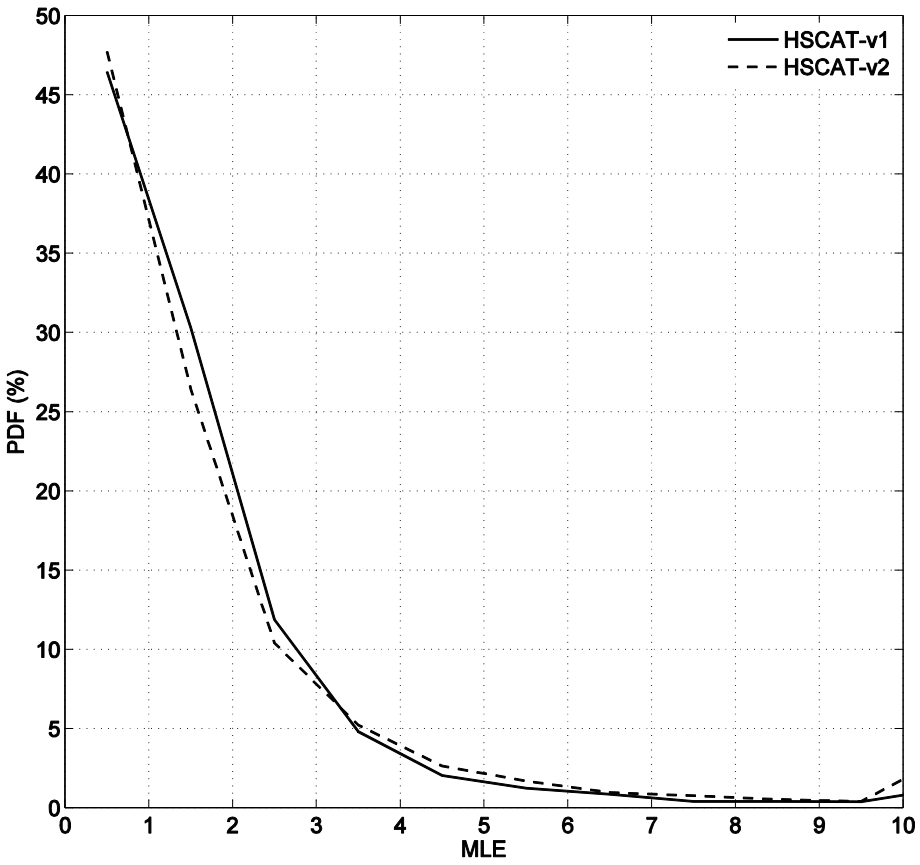
Quality evulation using **singularity analysis** (Lin et al, *GRSL*, 2014).



The SA map (lower left panel) shows good correlation with the rain flags distrubtion (lower right panel, v3 data).

Quality evaluation





(left) VRMS between HSCAT-v1 and ECMWF winds (black-solid line); VRMS between HSCAT-v1 and Buoy winds (red-solid line) winds; VRMS between HSCAT-v2 and ECMWF winds (black-dashed line) winds; VRMS between HSCAT-v2 and Buoy winds (red-dashed line) winds;
(right) The percentage of WVCs as a function of MLE

- MLE is indeed a quality sensitive parameter
- The VRMS values of HSCAT-v1 data are higher than those of v2 data
- *p*(MLE<4) is about 90%.

Triple collocation analysis

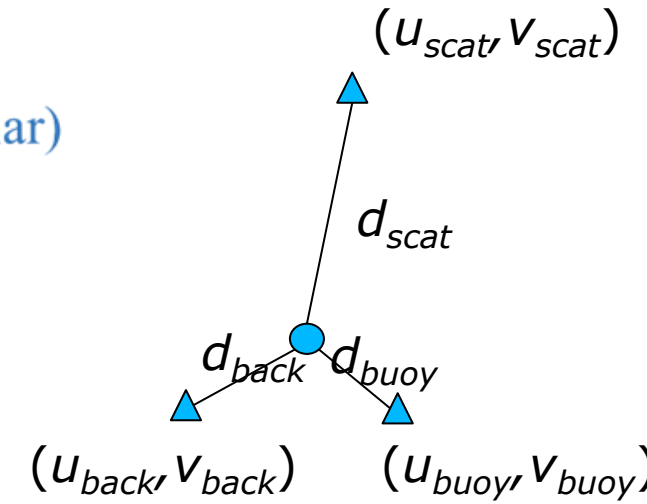
$$x_i = a_i t + b_i + \delta_i$$

a_i and b_i stand for resp. the trend and bias calibration coefficients and δ_i for a random measurement error in system *i (buoy, scat, or background)*.

- Sweet swath;
- v1/v2 MLE<4.0; v3 QC accepted WVCs

  (To make sure 'QC-accepted' ratio are the similar)
- Mitigation of ambiguity removal errors;

1. Allow each of the three wind vectors in a collocation triplet to have two ambiguities 180° apart, leading to 8 different combinations of which 4 are independent(the other 4 differ by an overall minus sign);
2. Calculate the center of gravity for each of the four ambiguous triplets;
3. Calculate the distance of each of the ambiguous triplet winds to the center of gravity and find the maximum distance;
4. Select the ambiguous triplet that has the smallest maximum distance to its center of gravity.



$$d^i_{max} = max\{d_{buoy}, d_{scat}, d_{back}\}$$

For one of the four sign combinations

Triple collocation analysis

Triple collocation error estimates with MARE and fixed representativeness errors on HSCAT resolution scale.

	$r^2(m^2/s^2)$		$\varepsilon_{buoy}(m/s)$		$\varepsilon_{scat}(m/s)$		$\varepsilon_{back}(m/s)$		*N*
	u	v	u	v	u	v	u	v	
v1	0.0	0.0	1.12	1.18	1.96	1.71	1.36	1.47	5201
	0.5	0.5	1.12	1.18	1.96	1.71	1.34	1.44	5201
	1.0	1.0	1.12	1.18	1.96	1.71	1.33	1.43	5201
v2	0.0	0.0	1.19	1.24	1.44	1.18	1.29	1.50	5133
	0.5	0.5	1.19	1.24	1.44	1.18	1.28	1.47	5132
	1.0	1.0	1.19	1.24	1.44	1.18	1.27	1.45	5132
v3	0.0	0.0	1.15	1.27	1.43	1.15	1.24	1.41	4370
	0.5	0.5	1.15	1.27	1.43	1.15	1.23	1.39	4370
	1.0	1.0	1.15	1.27	1.43	1.15	1.22	1.37	4370

v3 data selection: sweet swath, rain flag available and ‘rain-free’ data.

Conclusions

1. AR needs to be improved, using a more available background wind (e.g., ECMWF). 2D-VAR will be tested for HSCAT.
2. The v2/3 data show remarkable improvement with respect to v1 data
3. The v3 rain flags are effective. However, other QC flags should be also developed, particularly to complement the NSOAS rain flag. MLE and SE are good candidates of quality sensitive parameters, and will be tested for HSCAT QC soon.
4. Quality degradation from Jul. 2012. to Jun. 2013. (not shown)