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GF-3 SAR OCEAN WIND RETRIEVAL AND PRELIMINARY ASSESSMENT

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Outline

1.Motivation

2.Dataset

3.GF-3 wind retrieval methodology

4.Results and discussions

5.Conclusions and perspectives

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1. Motivation

- On August 10, 2016, carrying the first Chinese C-band multi-polarization SAR, Gaofen-3 (GF-3) satellite was successfully launched.
- Following several months of on-orbit commissioning phase, GF-3 SAR images have been in operation since January, 2017.

1. Motivation

- As one of the primary users, the State Oceanic Administration (SOA) is conducting GF-3 SAR ocean wind retrieval and plans to officially release the near real time SAR wind products soon.
- The aim of this work is to present the first results of GF-3 SAR derived winds and preliminary assessment using the buoy measurements.

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2. Dataset

GF-3 SAR data

Imaging mode [1]	Polarization	Resolution (m)	Swath(Km)	Num of SAR scenes used
SS	VV+VH or HH+HV	25	130	26
QPSI	VV+HH+VH+HV	8	30	3
QPSII	VV+HH+VH+HV	25	40	5
FSI	HH+HV	5	50	2
NSC	VV+VH	50	300	1

[1] SS, QPSI, QPSII, FSI and NSC stand for Standard Strip, Quad-Polarization Strip I, Quad-Polarization Strip II, Fine Strip I and Narrow ScanSAR imaging mode of GF-3.

2. Dataset

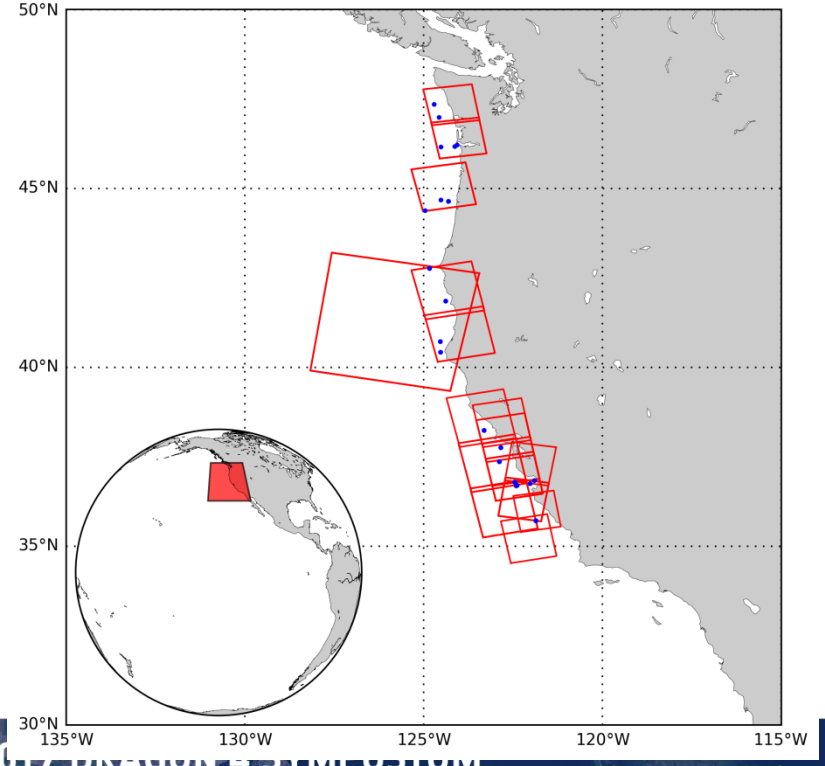
NDBC buoy data

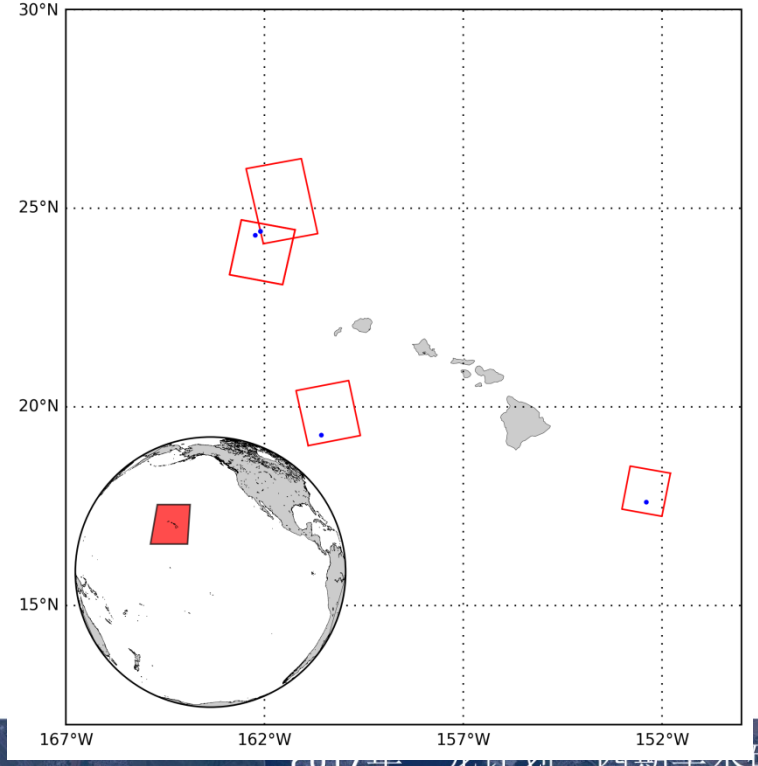
- buoy wind speeds had to be converted to the winds at 10 m for comparison

$$U(z) = \frac{u_*}{\kappa} ln\left(\frac{z}{z_0}\right)$$

- time interval between of SAR and buoy :less the 30 min
- buoy located inside the GF-3 SAR scene

2. Dataset – collocations





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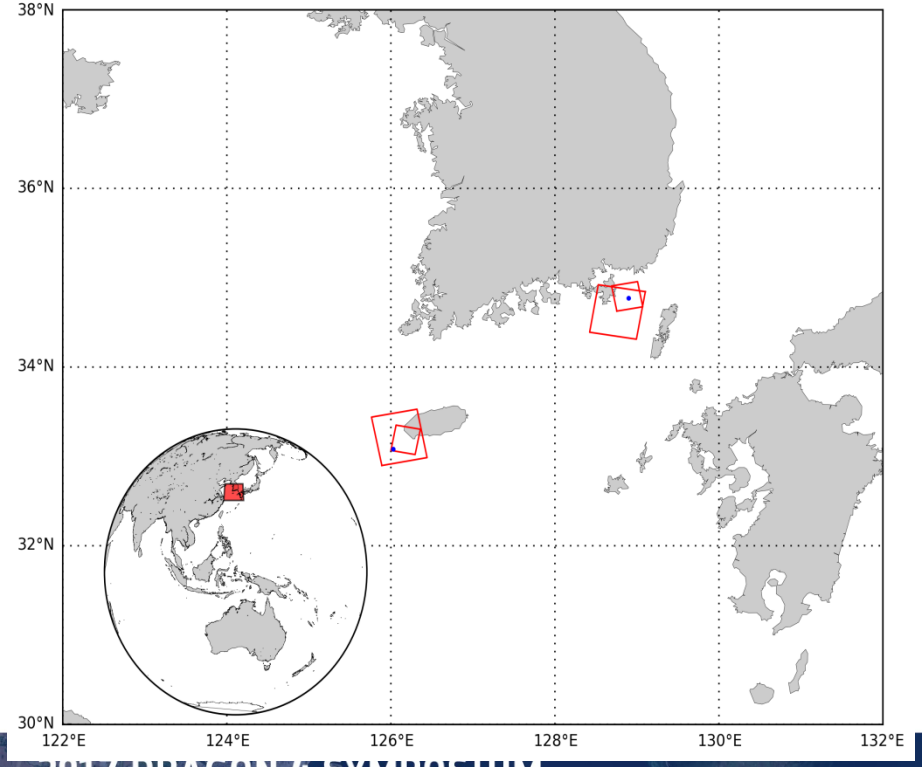

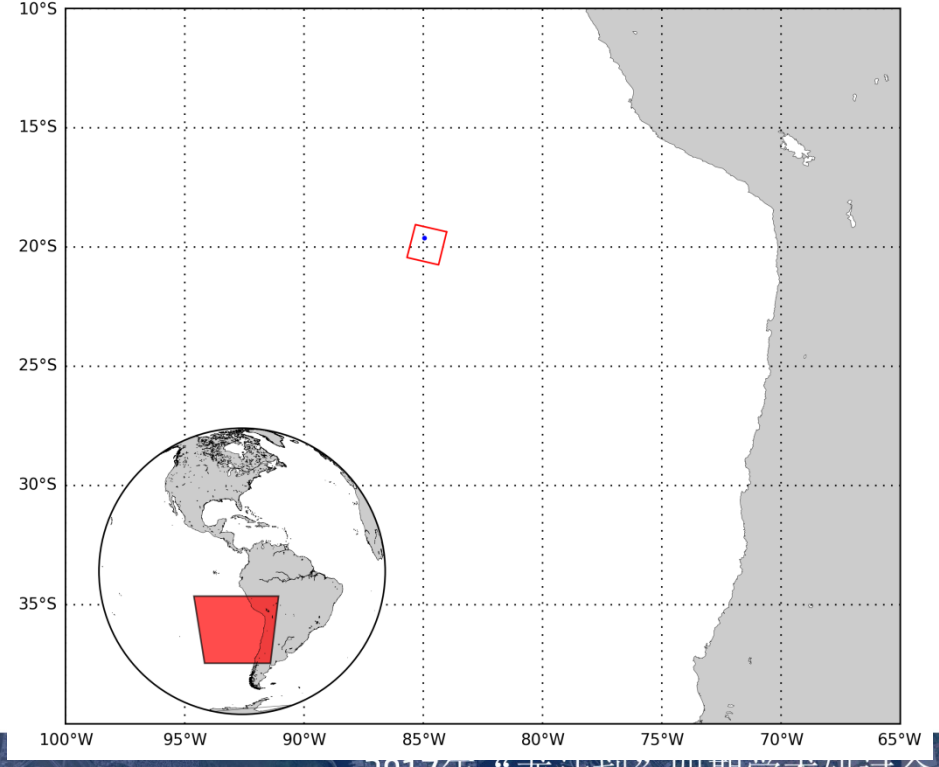

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3. GF-3 wind retrieval methodology

- To invert to the wind vector,the cost function $J(u,v)$ defined as follows is minimized.

$$J(u,v)=\left(\frac{\sigma^0{}_{obs}-\sigma^0{}_{GMF}(u,v)}{\Delta\sigma^0}\right)^2+\left(\frac{u_{model}-u}{\Delta u}\right)^2+\left(\frac{v_{model}-v}{\Delta v}\right)^2$$

- In order to make the inversion scheme more efficient, the minimization is performed with the help of the pre-computed look-up tables (LUT) from GMF models.

3. GF-3 wind retrieval methodology

GMFs:

- VV polarization:
  - ✓ CMOD-IFR2 adopted by Sentinel-1A/B
  - ✓ CMOD5.N used by MetOp-ASCAT
  - ✓ C-SARMOD (Mouche & Chapron, 2015)

- HH polarization:

  VV GMF + PR model Mouche et al. used by Sentinel-1A/B
  Zhang et al.

  HH GMF: C-SARMOD

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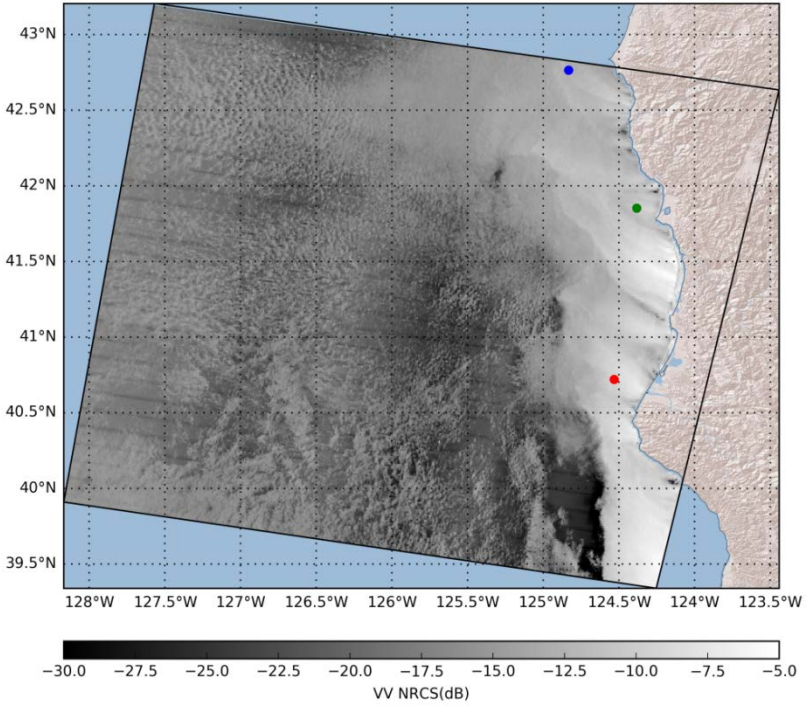
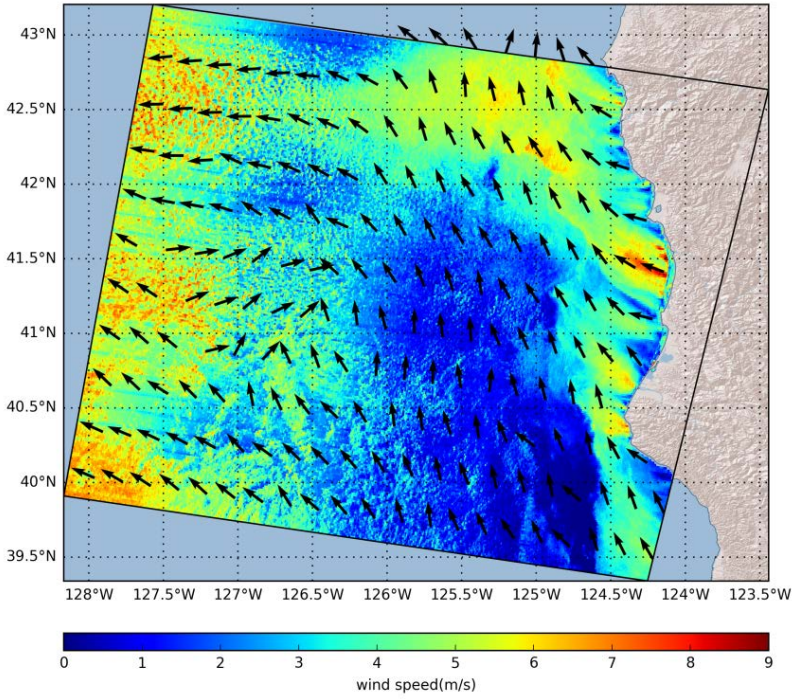
4. Results and discussions -- case of katabatic wind





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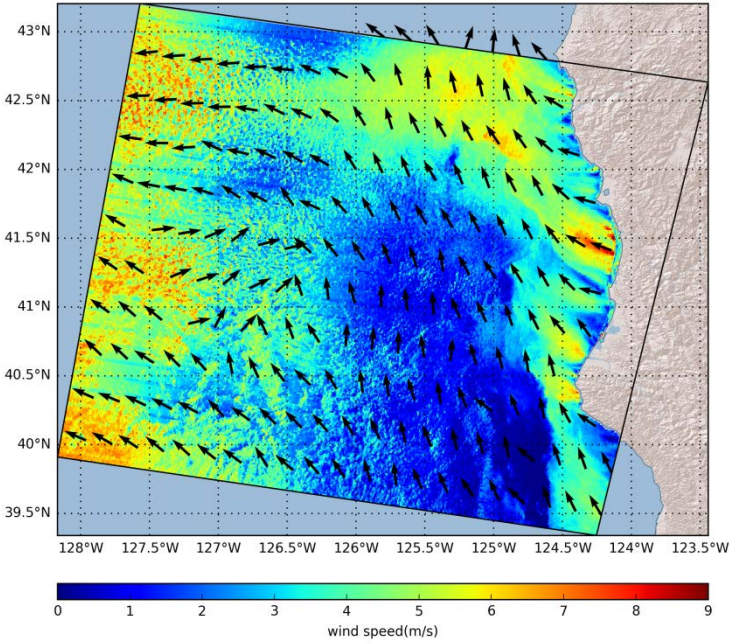
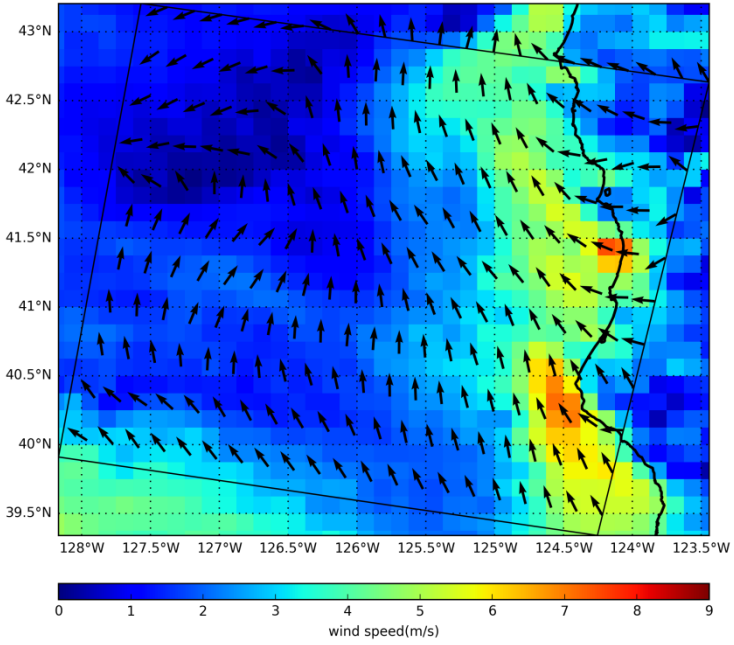
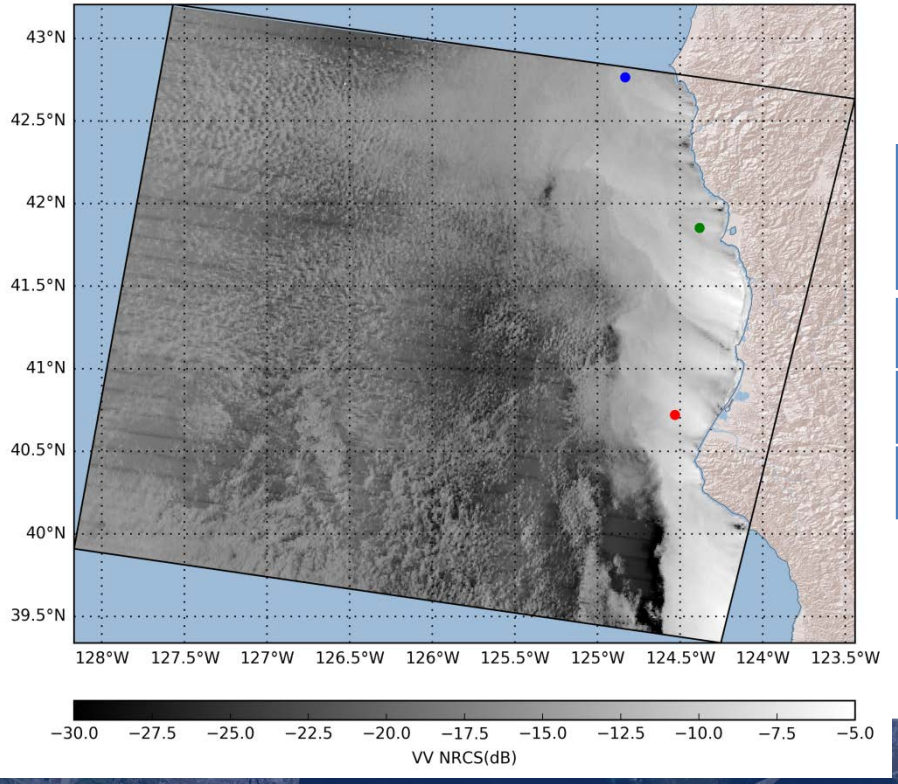


GF-3 wind @ 1 km



ECMWF wind @ 12.5 km

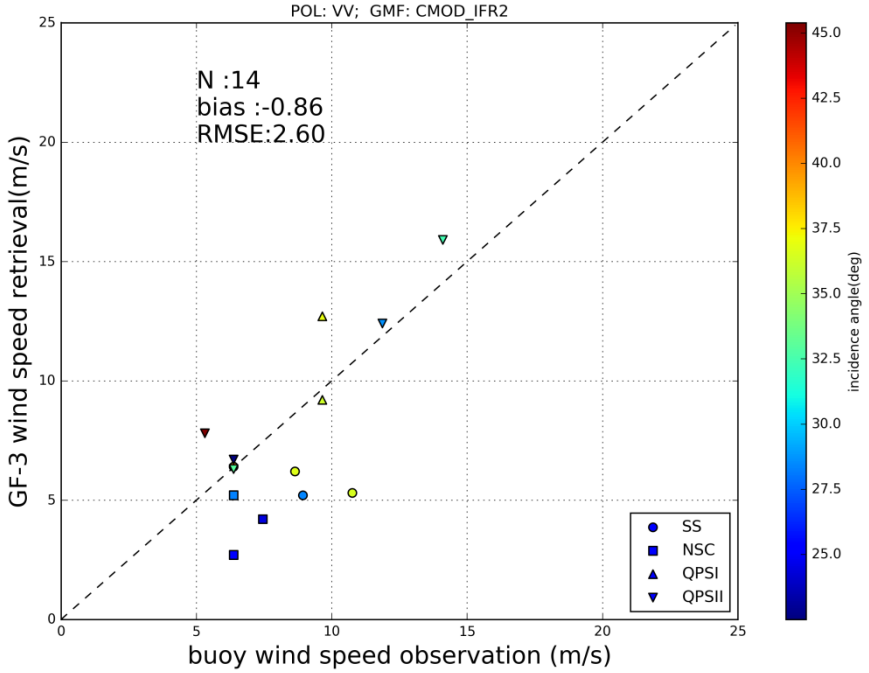
4. Results and discussions -- case of katabatic wind

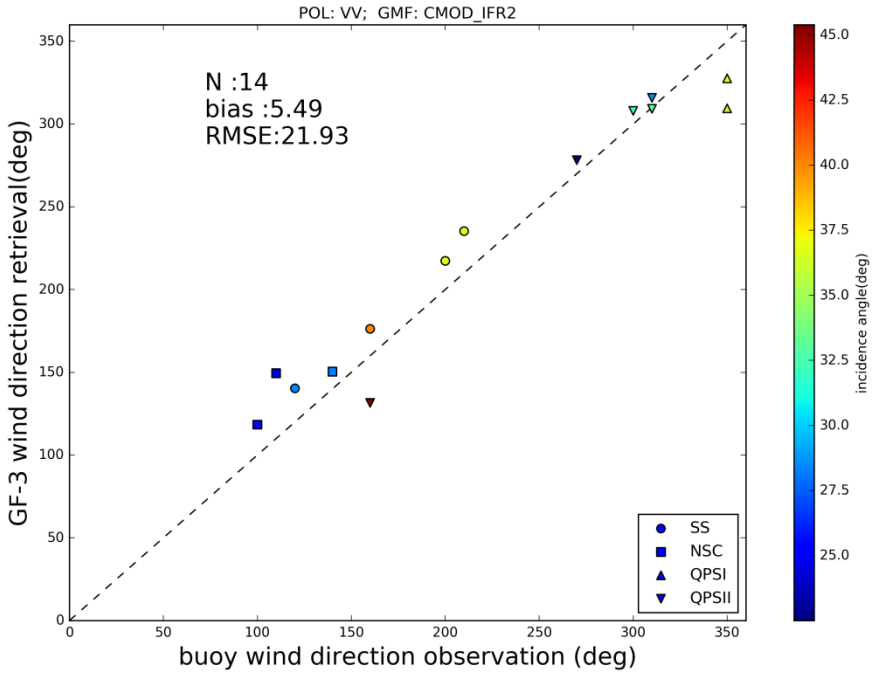


Comparison with 3 NDBC buoys

Buoy id	Buoy U10 (m/s)	GF-3 U10 (m/s)	Buoy wind direction(°)	GF-3 wind direction (°)
46015	6.16	6.1	143	150.4
46027	6.16	4.2	104	112.2
46022	7.2	5.2	114	145.5

4. Results and discussions – VV polarization





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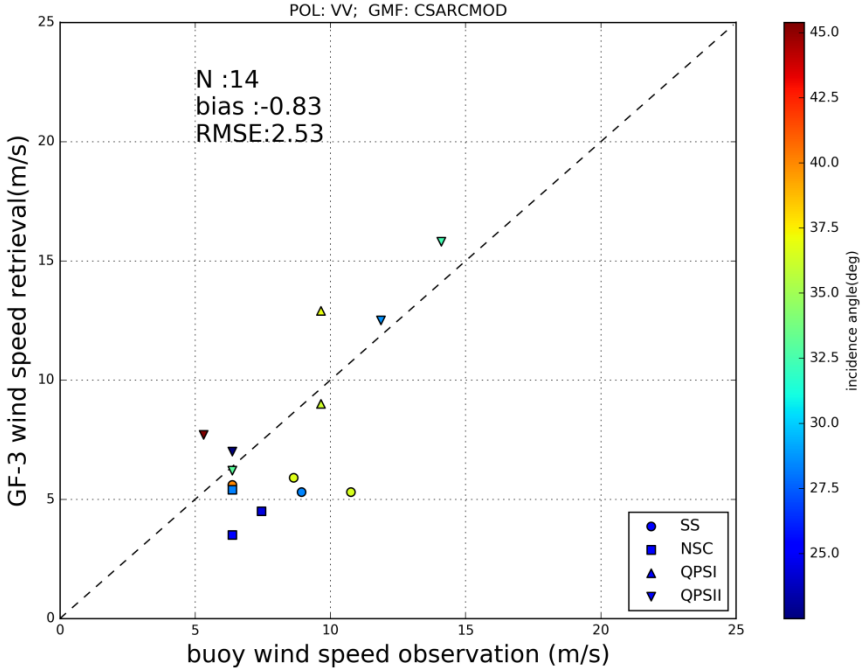

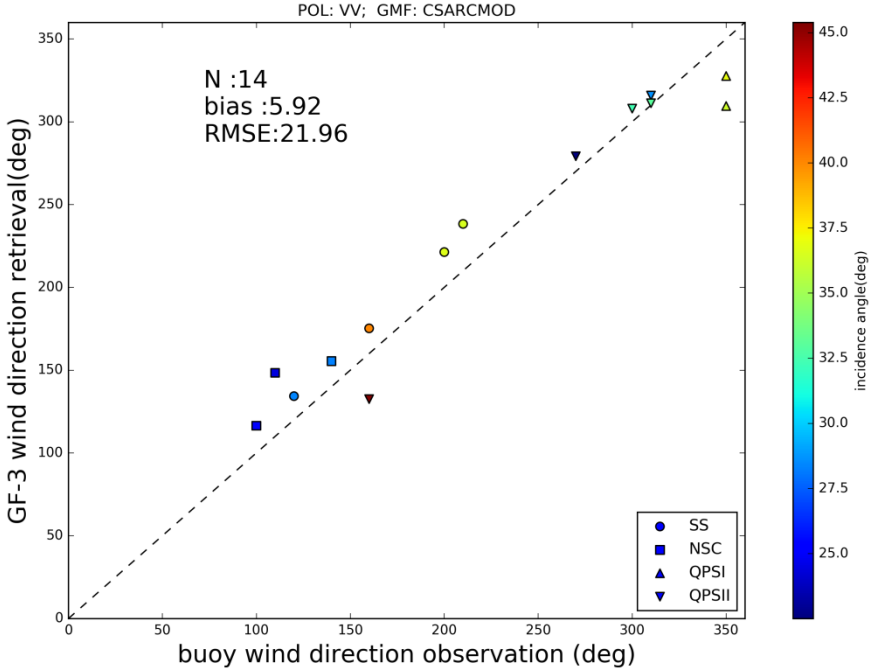

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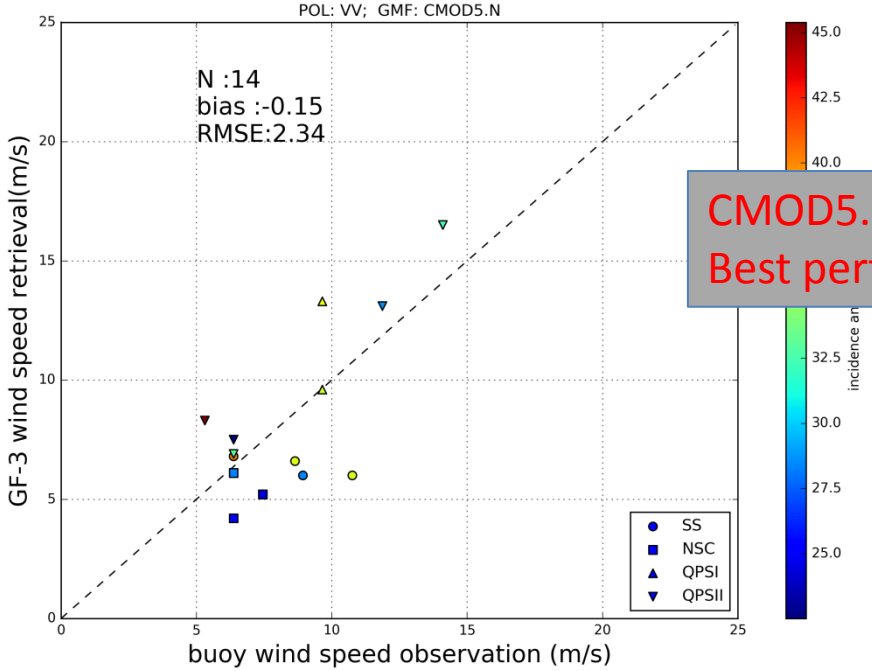
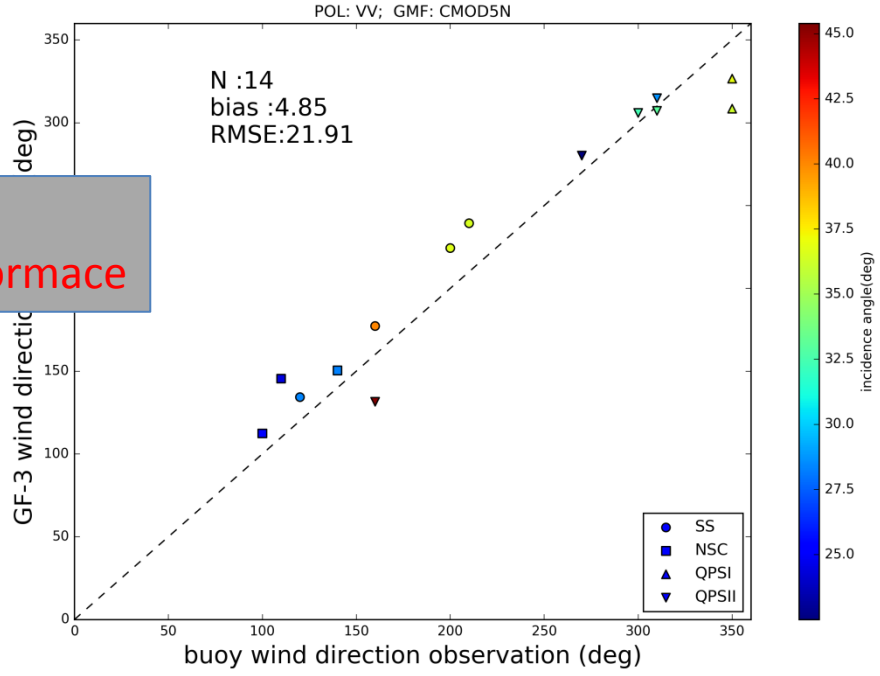
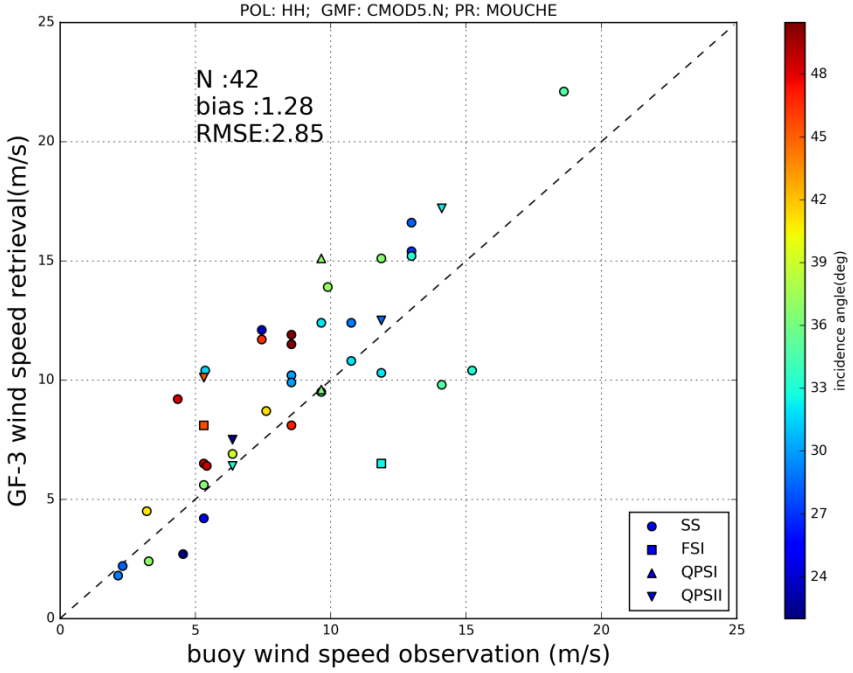
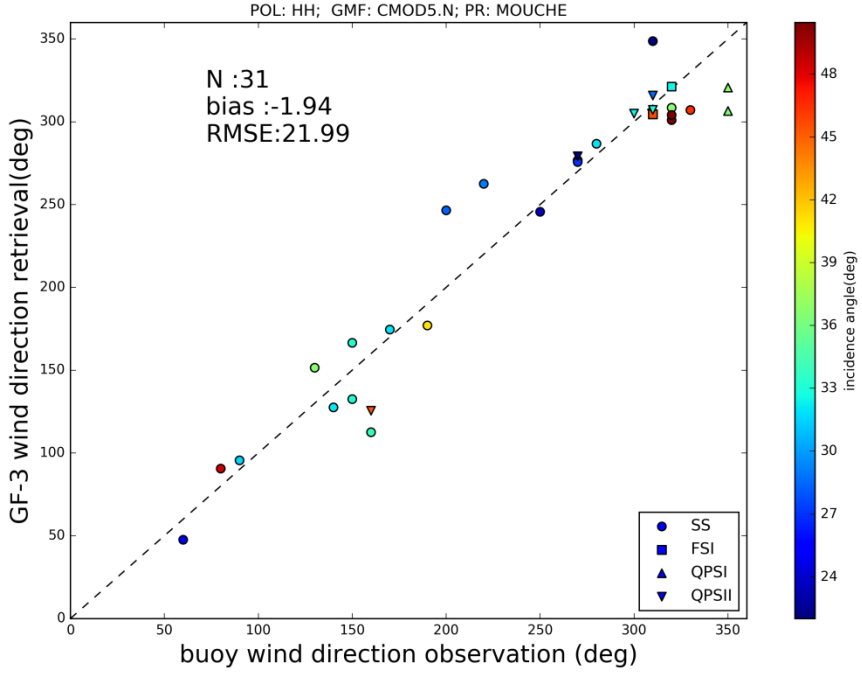


CMOD5.N
Best performace



4. Results and discussions – HH polarization





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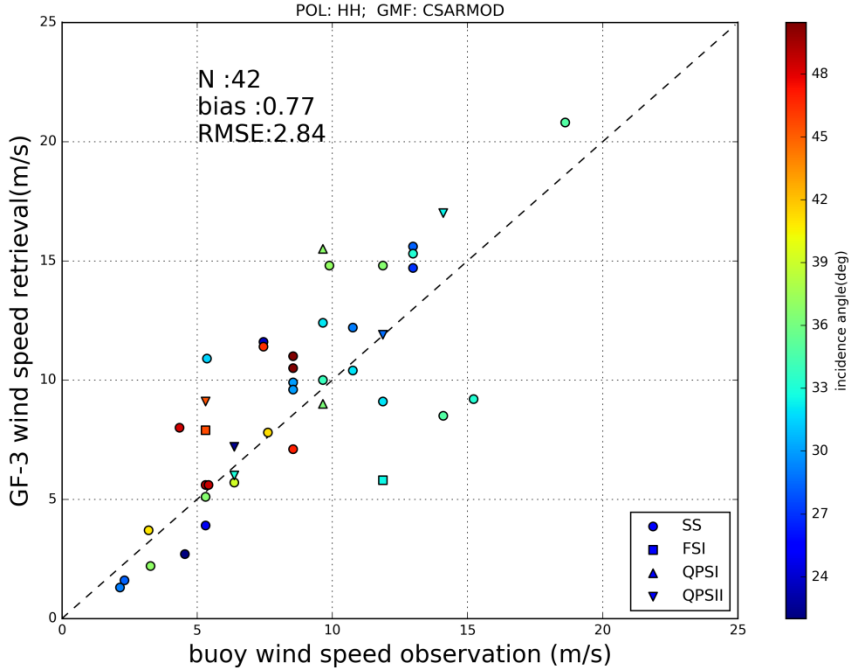

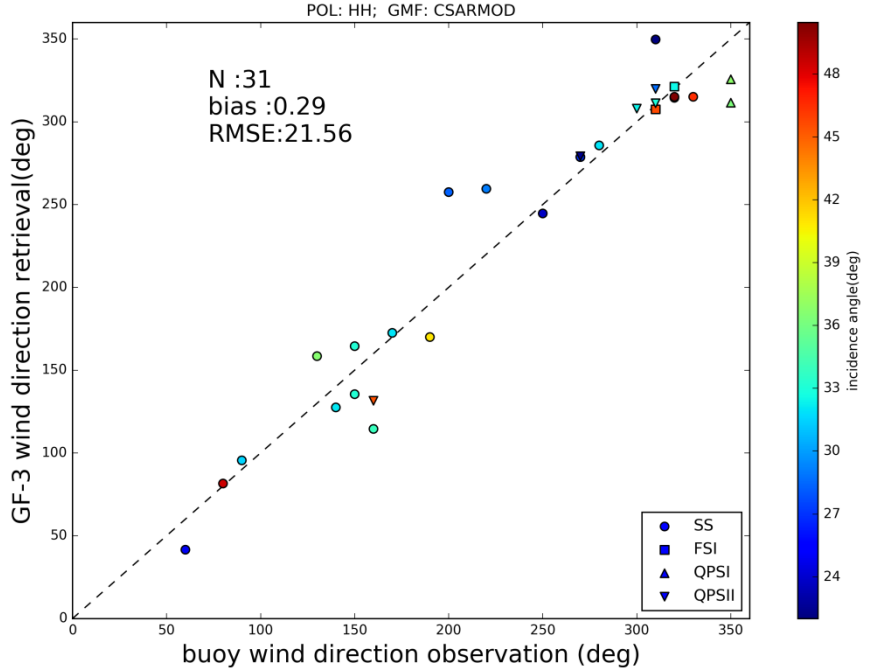

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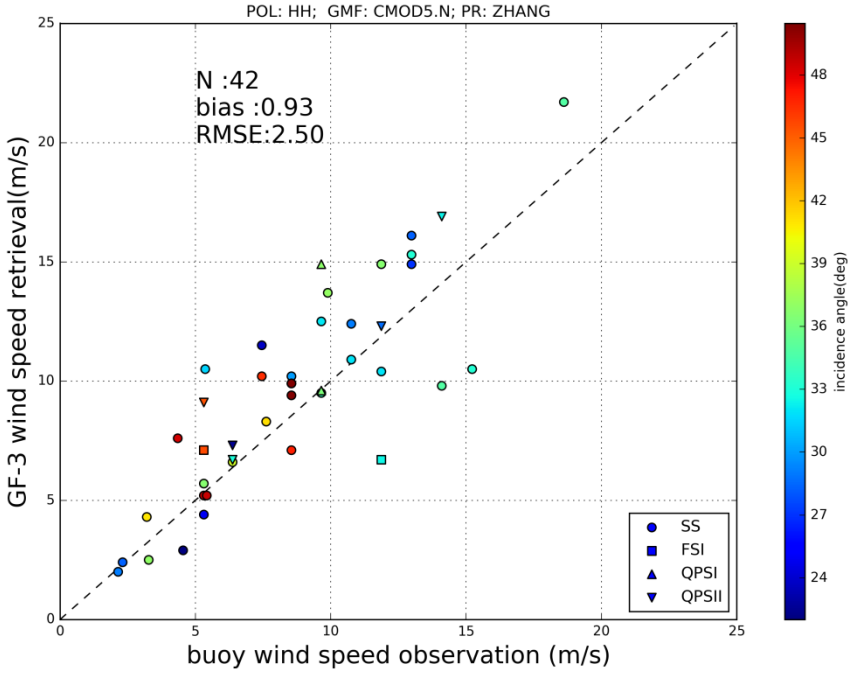

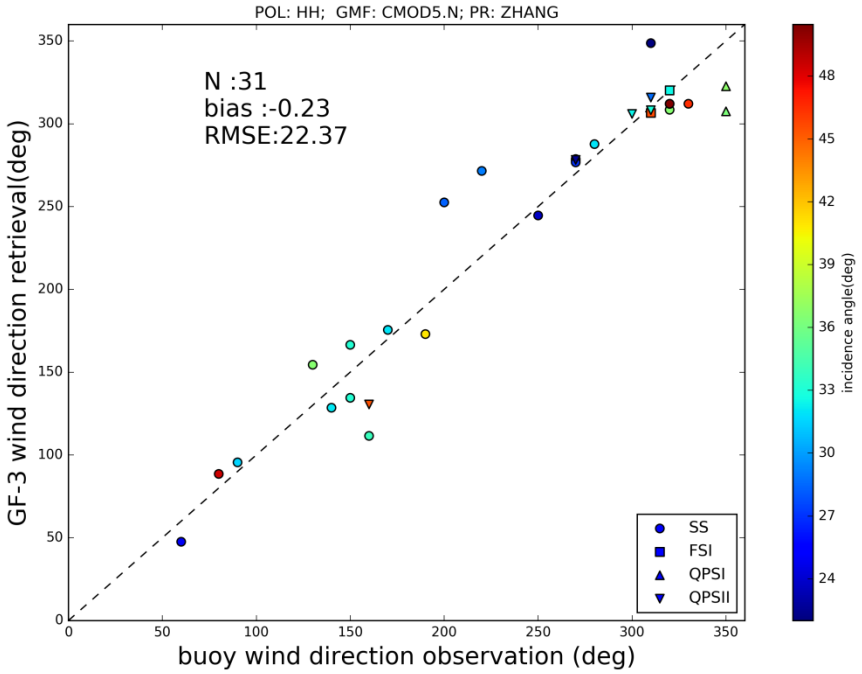

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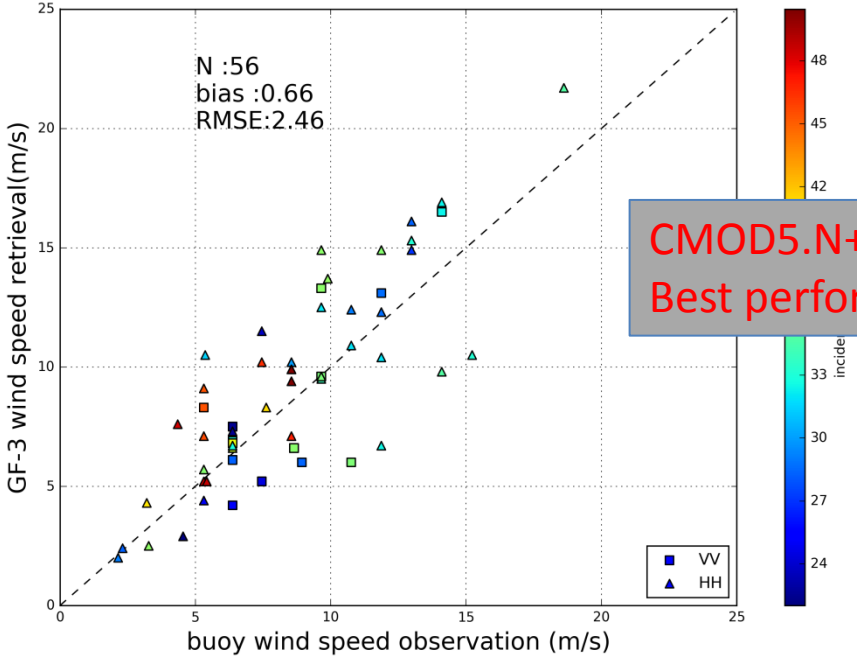
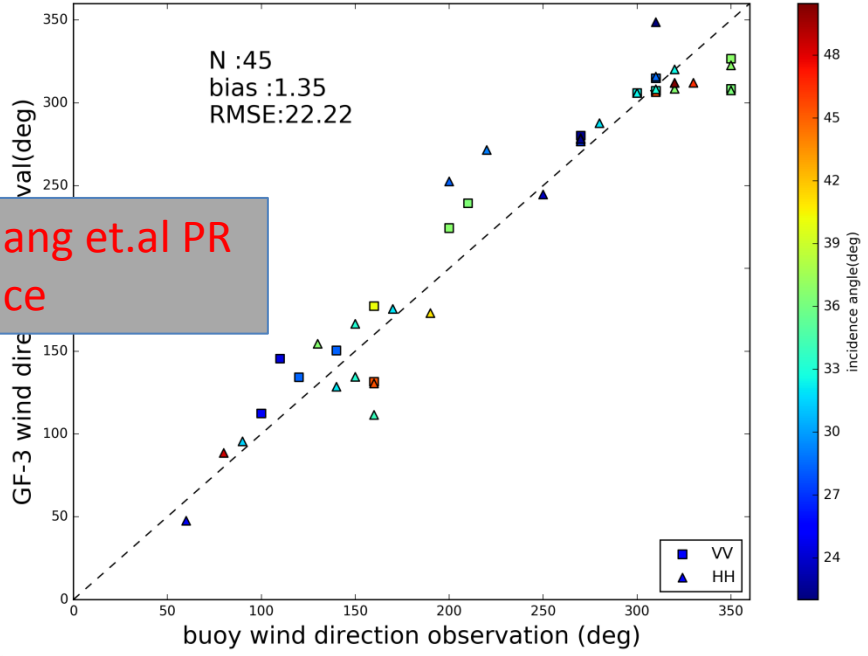


CMOD5.N+ Zhang et.al PR
Best performace



4. Results and discussions – general statistics

Polarization of GF-3 data	Wind speed			Wind direction			GMF used
	N	Bias (m/s)	RMSE (m/s)	N	Bias (°)	RMSE (°)	
All co-polarization	56	0.66	2.46	45	1.35	22.22	VV: CMOD5.n HH:CMOD5.n + PR model from Zhang et al [10]
VV	14	-0.15	2.34	14	4.85	21.91	
HH	42	0.93	2.50	31	-0.23	22.37	

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- proposed GF-3 SAR wind inversion methodology combines SAR observed NRCS at co-polarized channel with *a priori* wind information from ECMWF winds.
- Using this inversion scheme, coastal winds at 1 km resolution were estimated from the GF-3 SAR. One case of the coastal katabatic wind off U.S. west coast captured by GF-3 is presented.

5. Conclusions and perspectives

- Validation results against NDBC buoys indicate that GMF of CMOD5.N and PR of Zhang et al present the best performance for GF-3 wind inversion. Thus, these two models are chosen for production of GF-3 wind retrievals.
- Validation shows the RMSE of 2.46 m/s and 22.22° for wind speed and direction respectively.

5. Conclusions and perspectives

Future work:

- to collect more data (collocated with buoys,other sensors such as Windsat) to refine the GF-3 wind assessment.
- the possibility of estimating the wind direction directly from GF-3 SAR images will be investigated.