Coastal wind retrieval from the CFOSAT scatterometer

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Outline

1. Motivation

2. Methodologies

3. Results

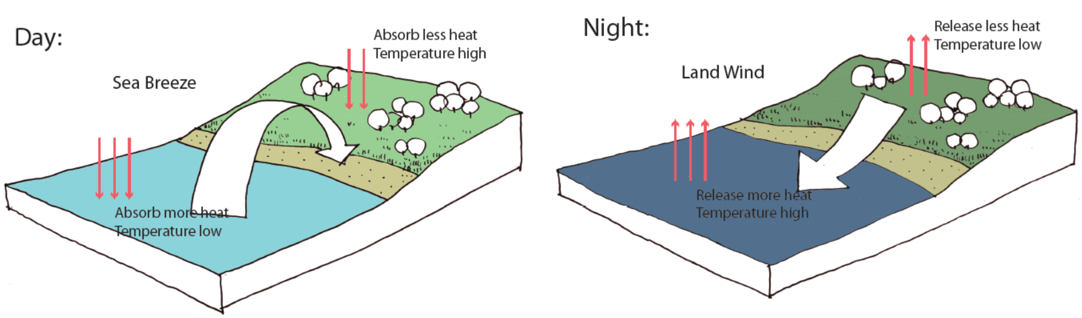
4. Conclusions

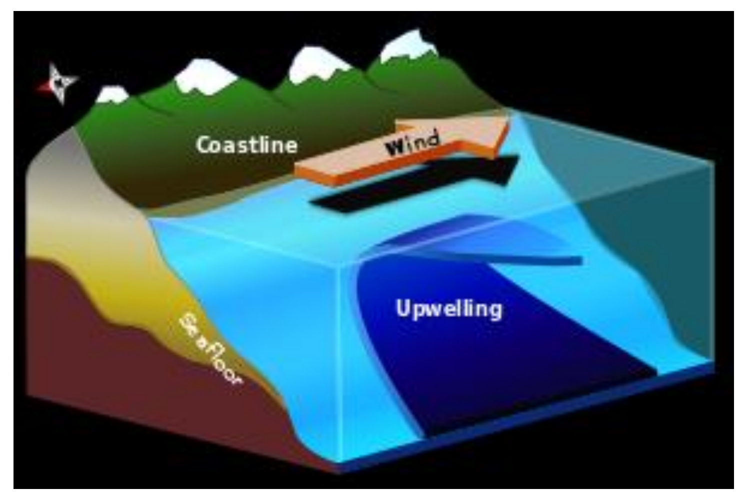
1. Motivation

Remote sensing of coast winds are relevant to：

- Offshore meteorology;
- Coastal ocean dynamics;
- offshore engineering environment;
- Regional NWP/Ocean modeling;
- …

Diurnal Wind Change in Coastal Area



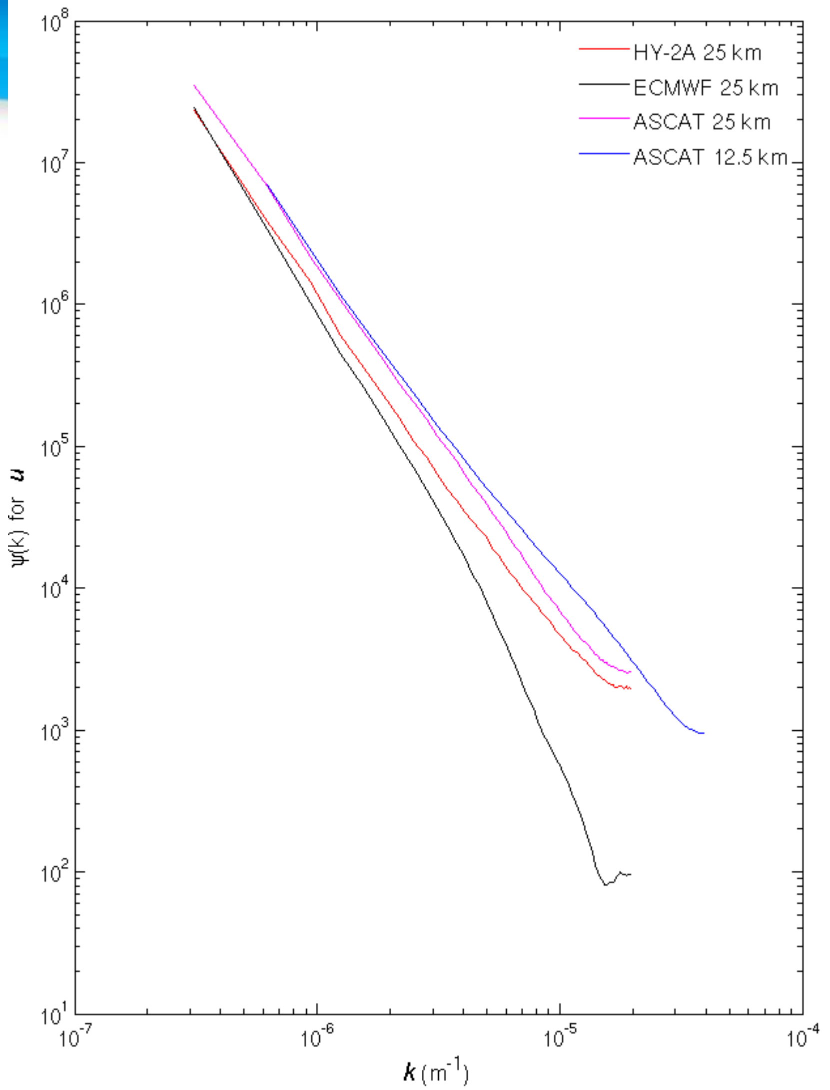


1. Motivation

Offshore wind data:

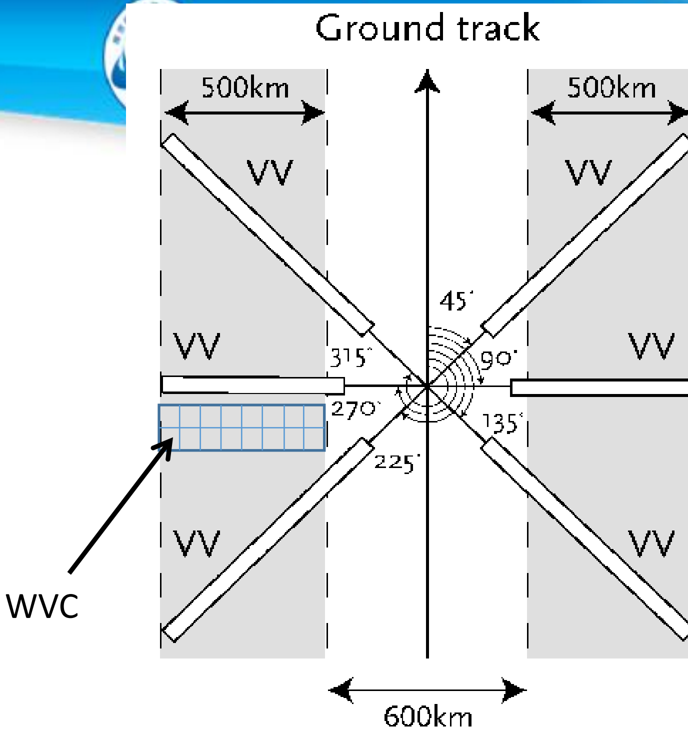
- Buoy; X-band radars; HF radar;
- SAR;
- Scatterometer;

- ☐ D.G. Long (BYU) Seawinds on QuikSCAT;
- ☐ A. Fore (JPL): QuikSCAT
- ☐ A. Stoffelen (KNMI): ASCAT
    - 12.5-km operational;
    - 5-6 km experimental;
- ☐ G. Grieco (ICM & KNMI) : QuikSCAT;
- ☐ W. Lin (NUIST): CFOSAT;



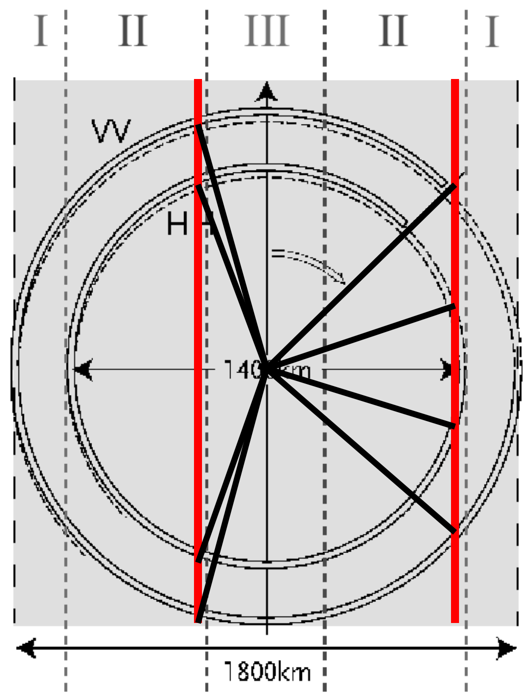
fixed fan beams

- C-band (5 cm)
- VV-pol
- Resolution: 25-50 km (10x35km)
- Fixed geometry
- ASCAT-A/B/C

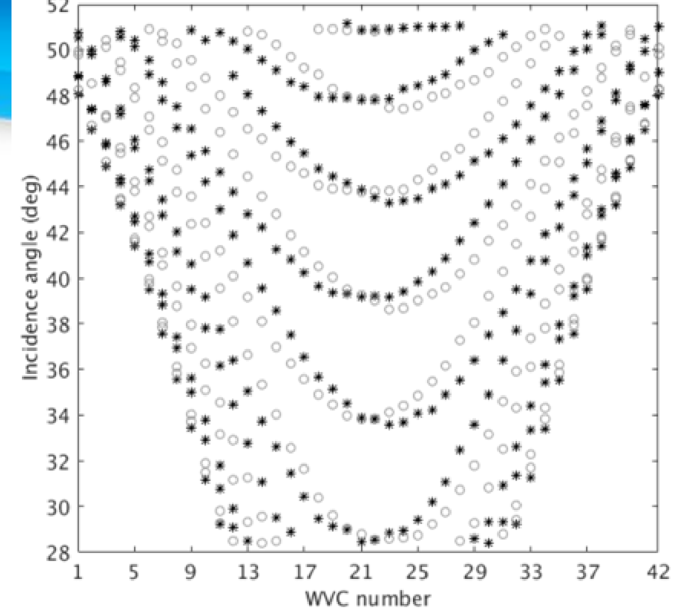


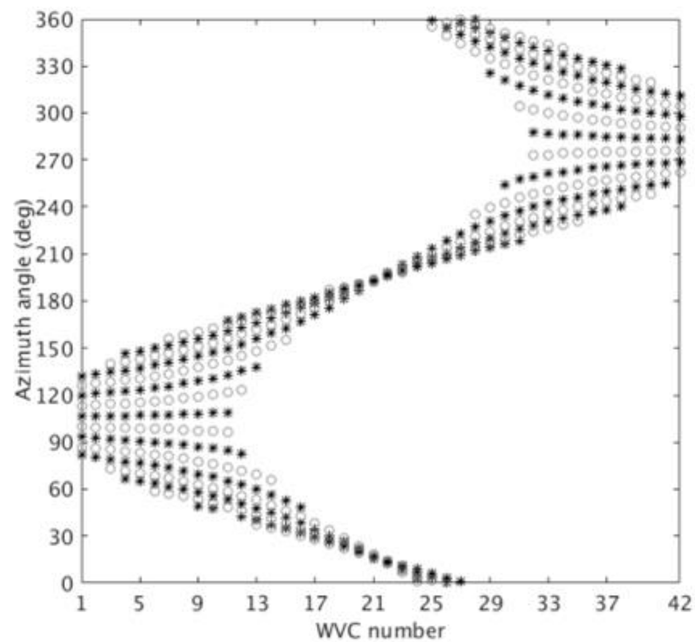
Rotating pencil beam

- Ku-band
- Dual polarization
- Resolution: 25 km (7x30km)
- Varying geometry
- SeaWinds-1/2, OSCAT, HY-2A/B/C



Incidence angles





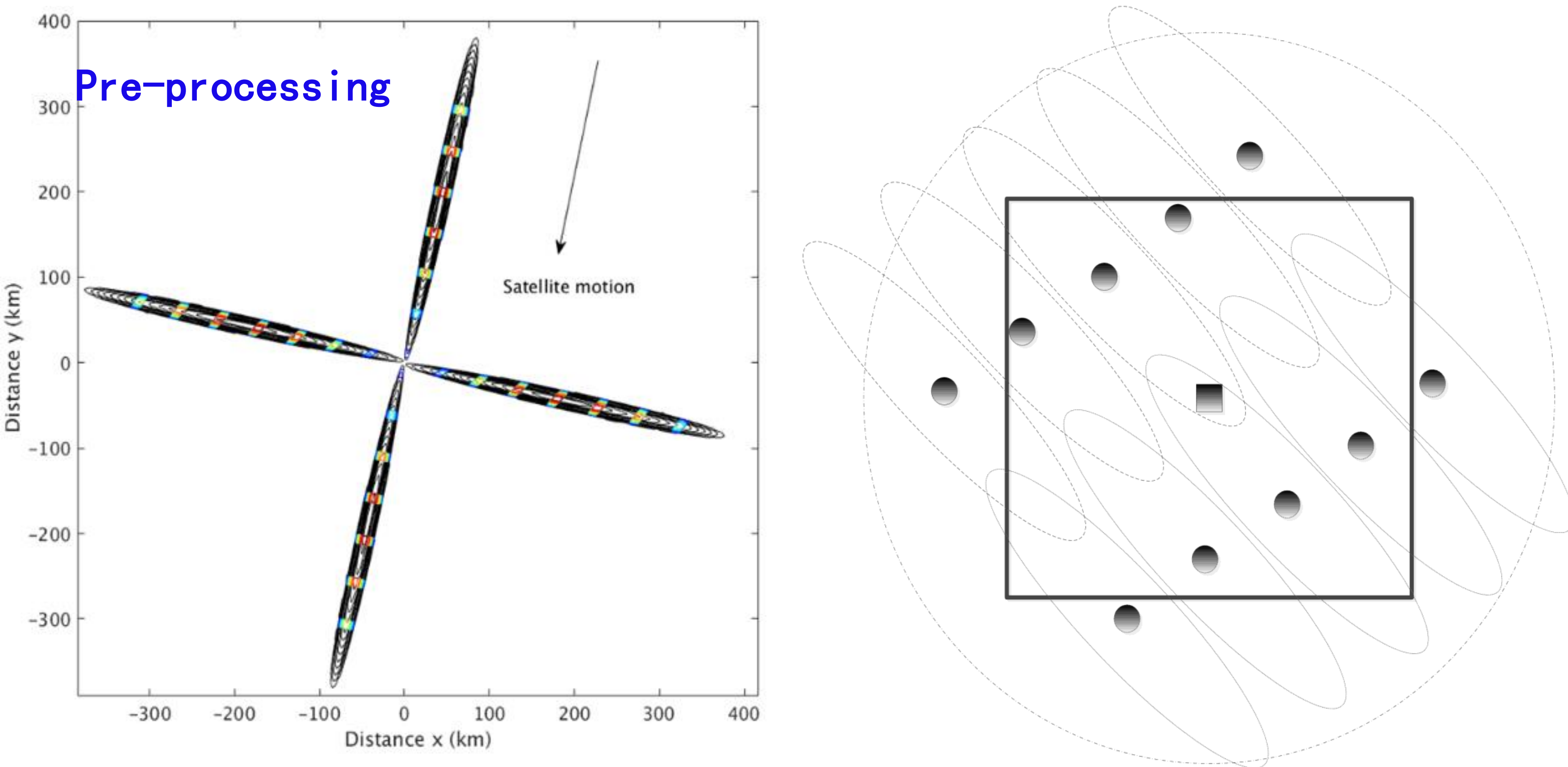
Azimuth angles

Rotating fan beams

- Ku-band
- Dual polarization
- Resolution: 25 km
- (10 x 12~15 km)
- Varying geometry
- CFOSAT

2. Methods

Pre-processing

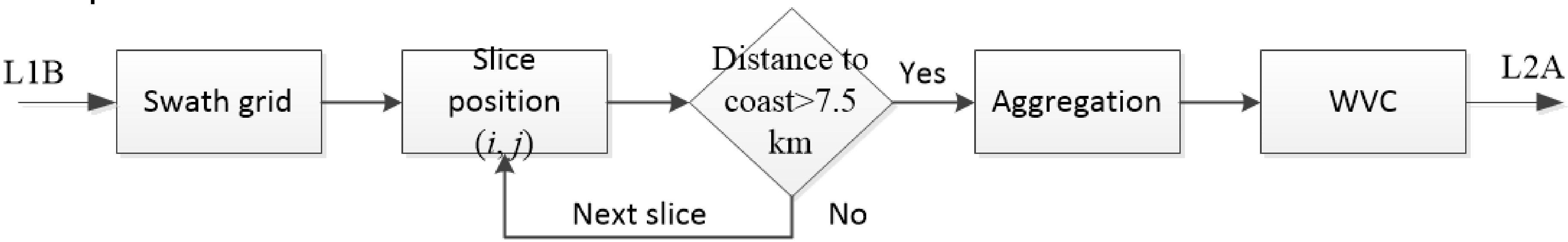


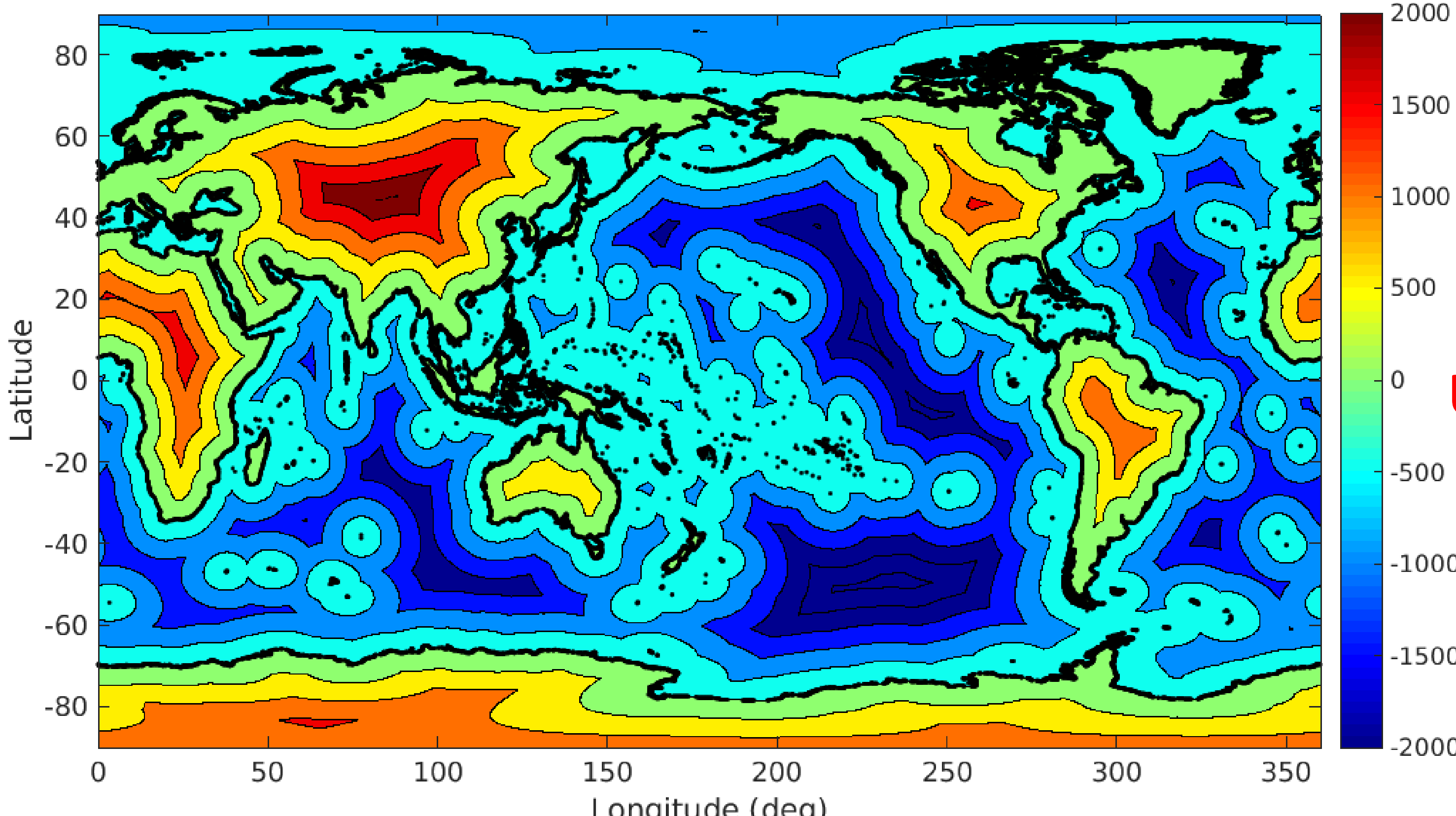
(a) The footprint (black contours) and raw slices (color contours) of CSCAT at four different azimuth angles; (b) illustration of slice aggregation.

2. Methods

Objective: keep as many useful slices as possible

Preprocess flow





GSHHG
Used as LUT

2. Methods

Wind inversion

Bayesian approach

$$p\left(\sigma_s^0 \middle| \sigma_m^0\right) = p\left(\sigma_m^0 \middle| \sigma_s^0\right) \cdot p\left(\sigma_s^0\right)$$

Maximlikelihood estimator

↓

Quality control

$$\langle \delta \rangle^2 = f\left(\mathrm{MLE}, \mathrm{SE}\right)$$

QC based on inversion residual

↓

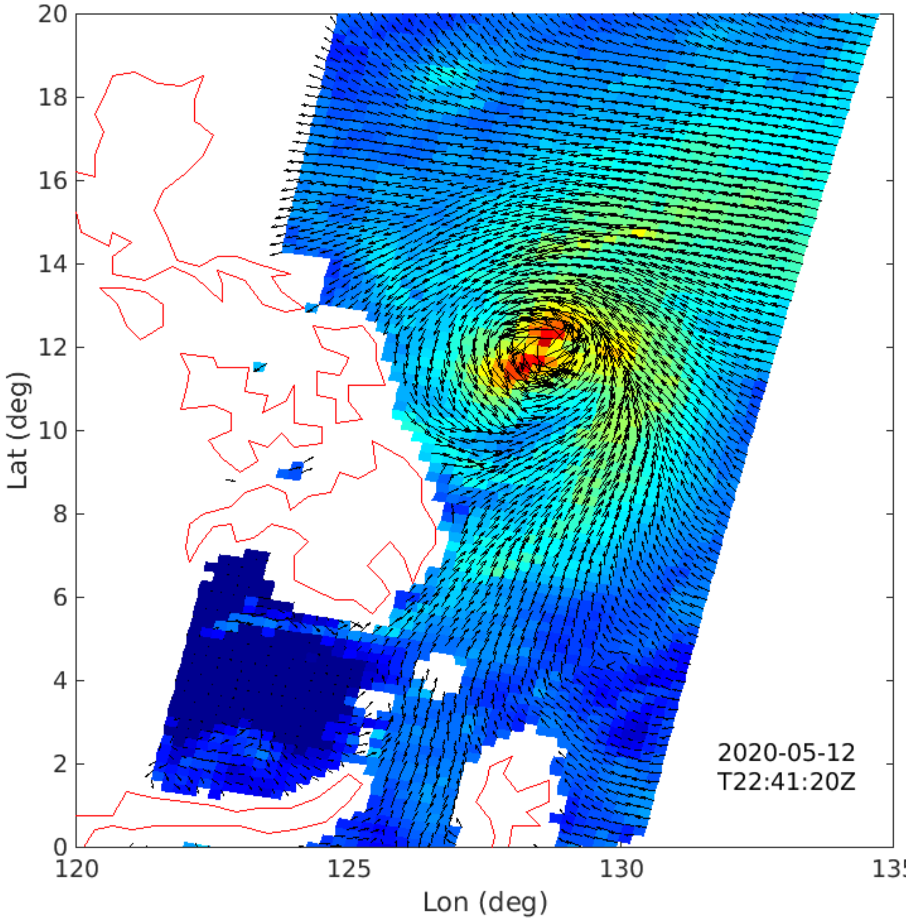
Ambiguity removal (2DVAR)

$$J\left(\mathbf{x}_o^k, \mathbf{x}, \mathbf{x}_b\right) = J_o\left(\mathbf{x}_o^k, \mathbf{x}\right) + J_b\left(\mathbf{x}\right)$$

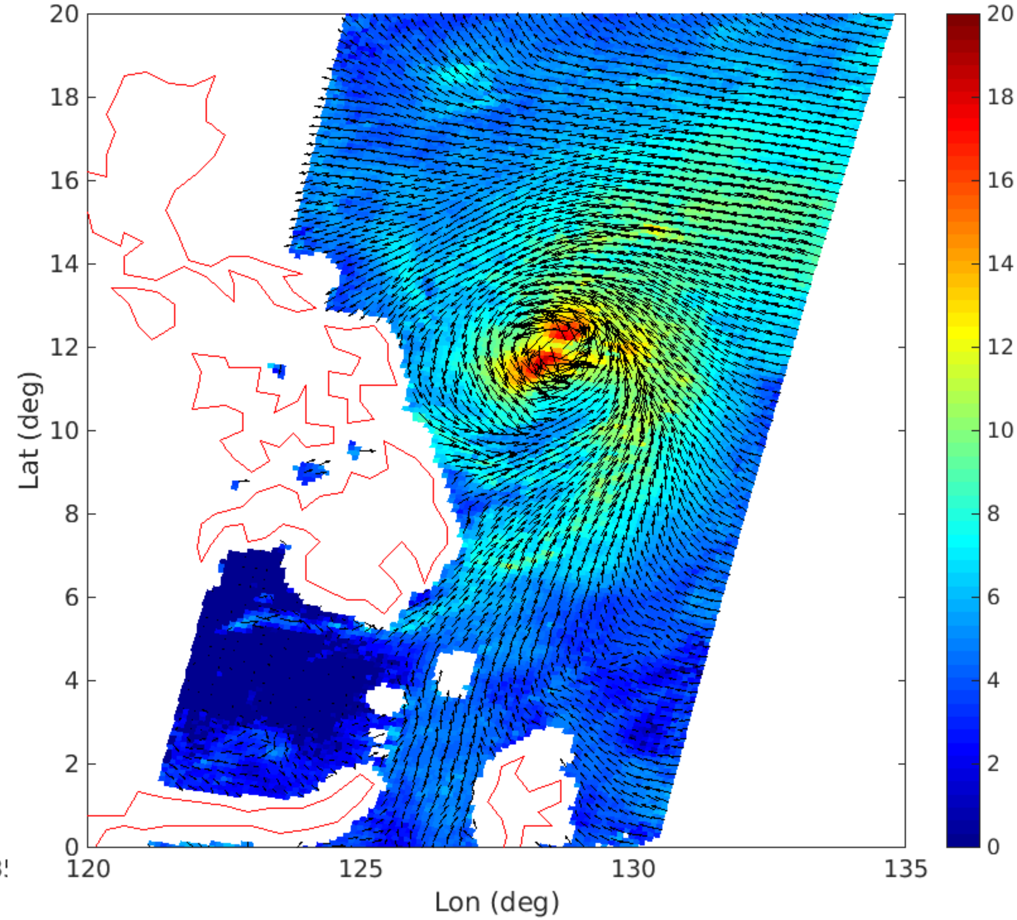
Ambiguity removal

3. Results

Typhoon Vongfong



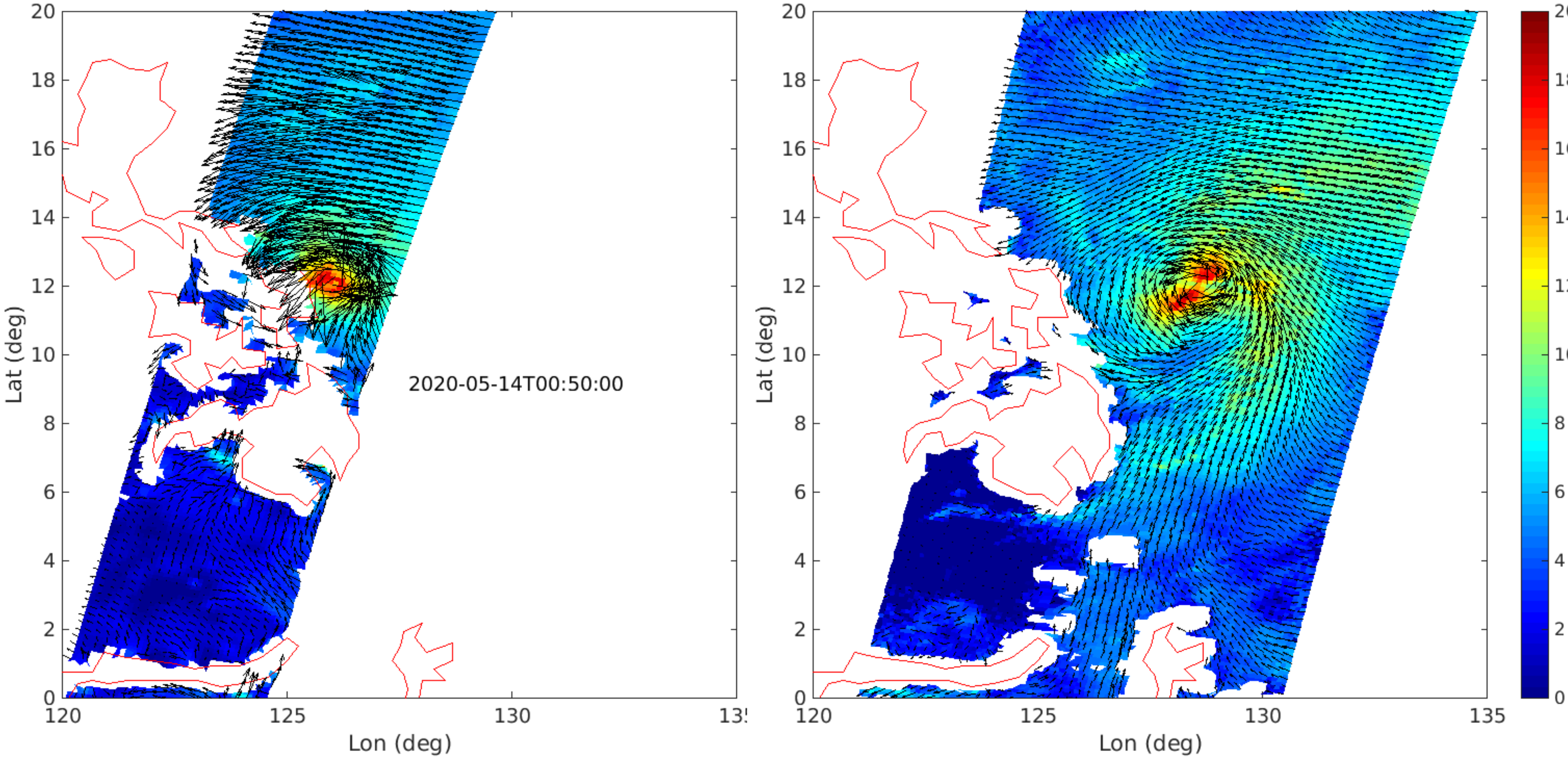
CFOSAT 25 km (expr)



CFOSAT 12.5 km (expr-like)

3. Results

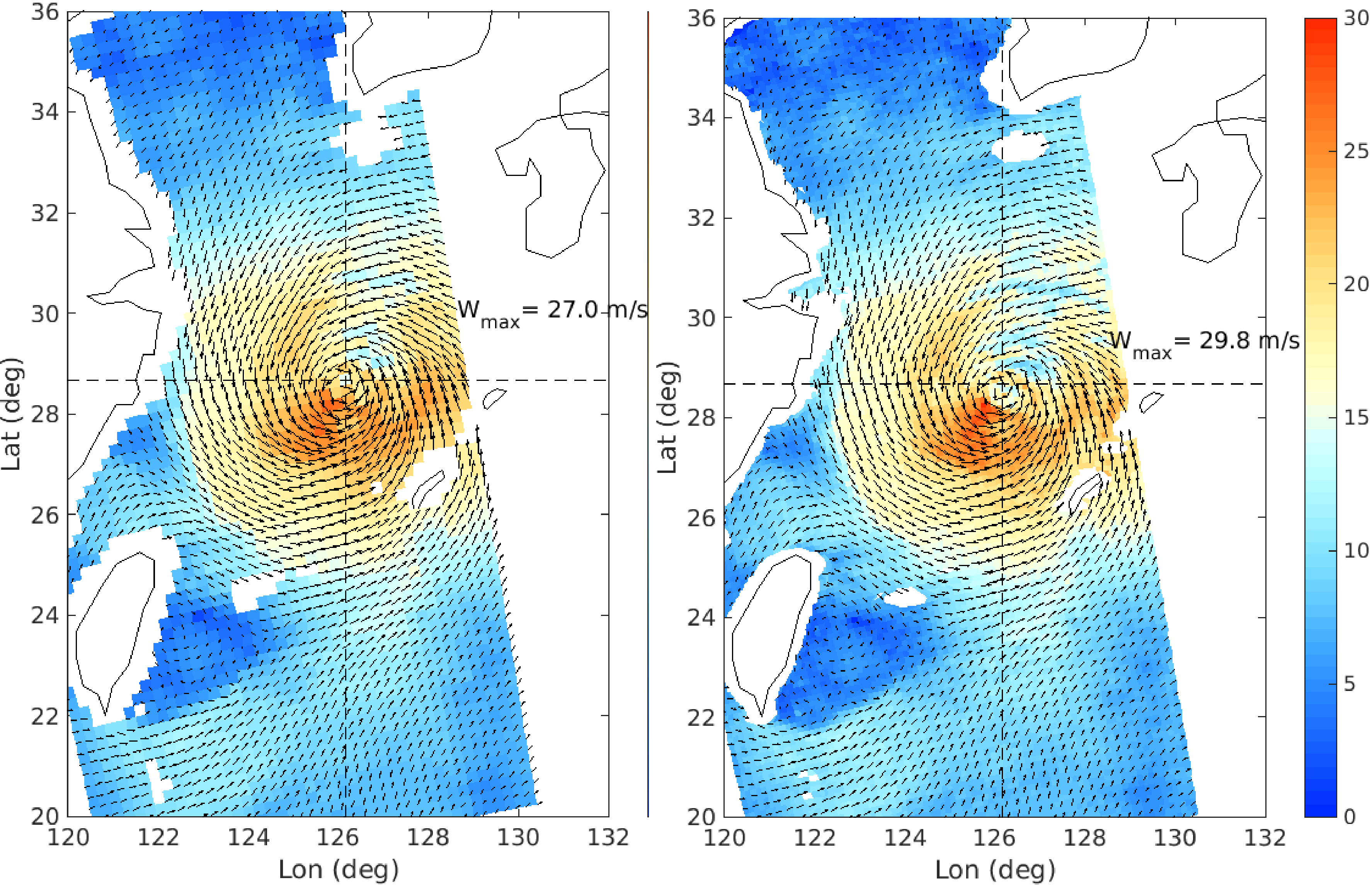
Typhoon Vongfong



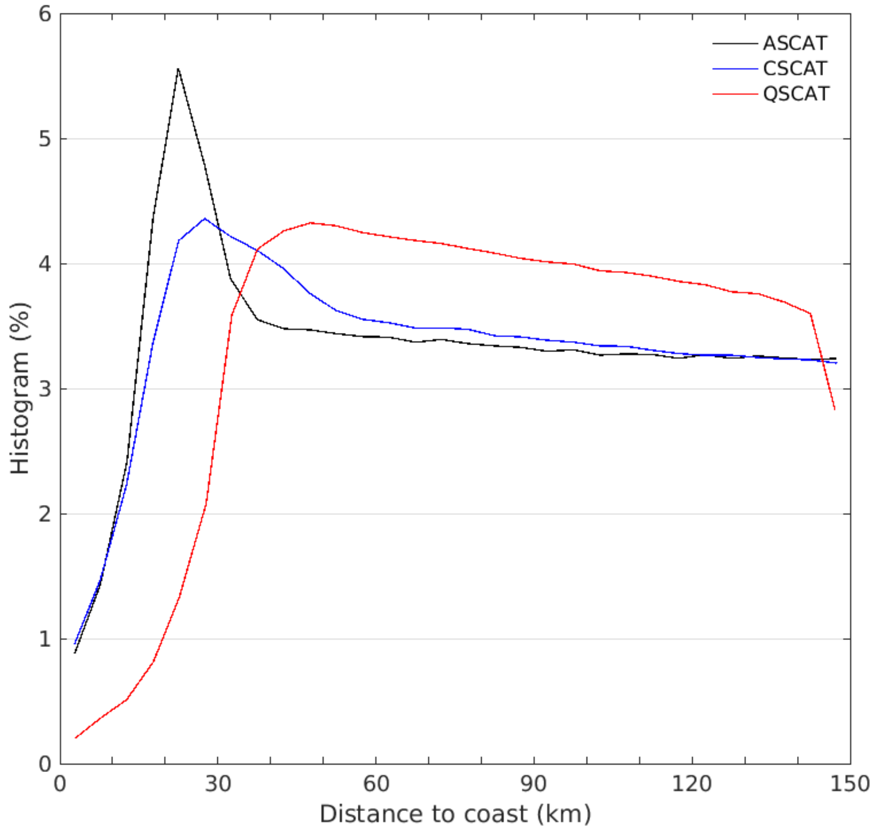
ASCAT 12.5km (coa product) CFOSAT 12.5 km (coa)

3. Results

Typhoon Maysak (Sept. 1, 2020)



3. Results

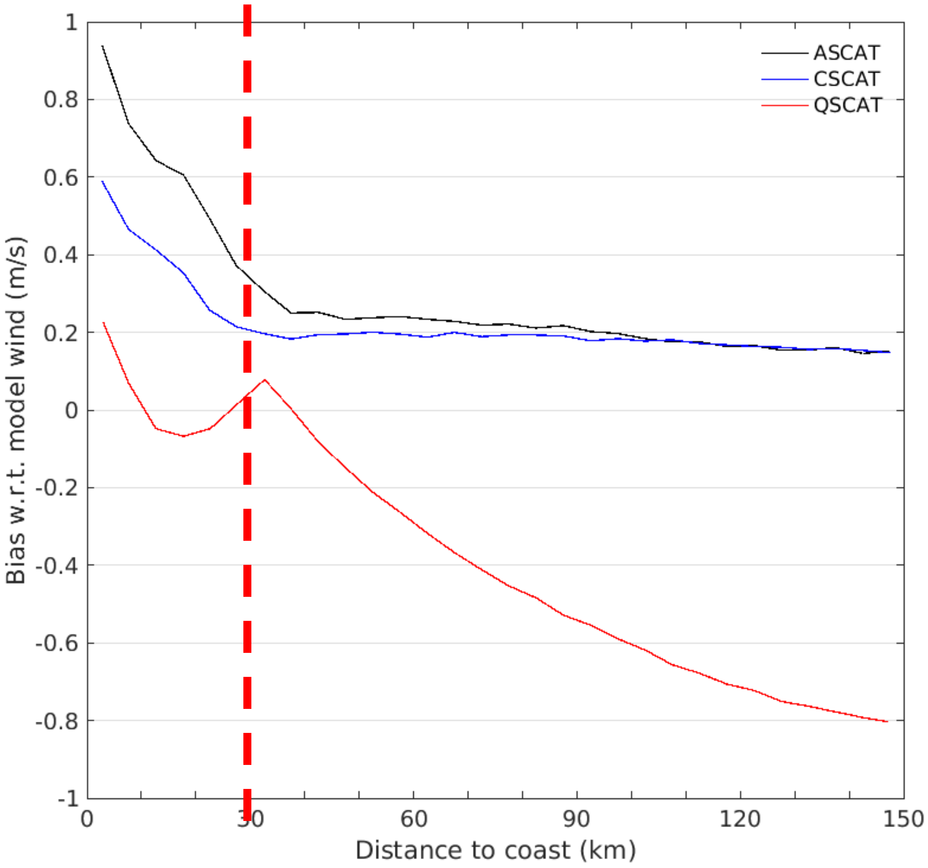


Histogram of the effective wind measurements near shore

Evaluation (12.5 km products) – wind retrievals 150 km to the coast

- CSCAT;
- ASCAT;
- QuikSCAT;

3. Results

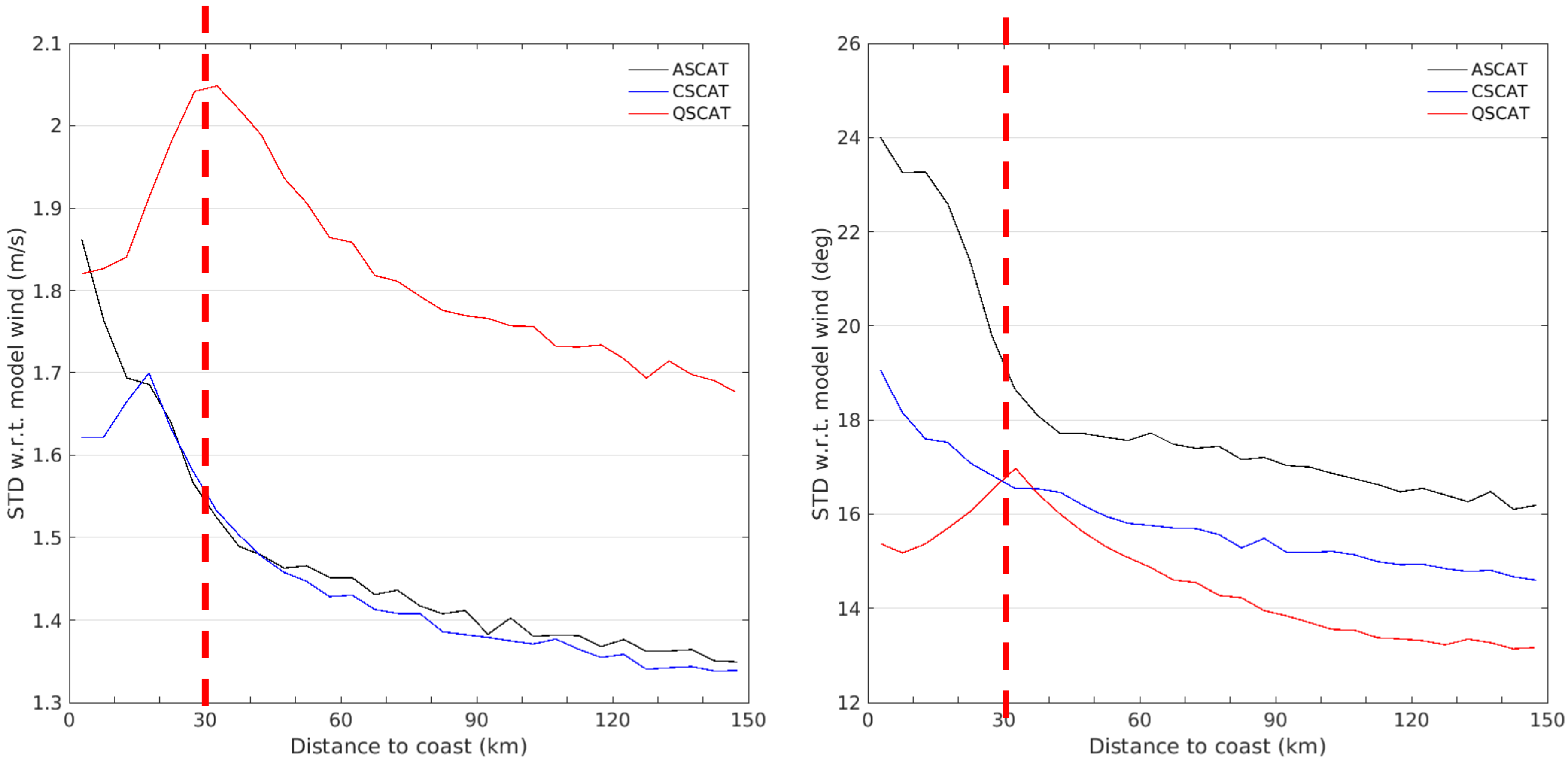


Wind speed bias as function of the distance to coast

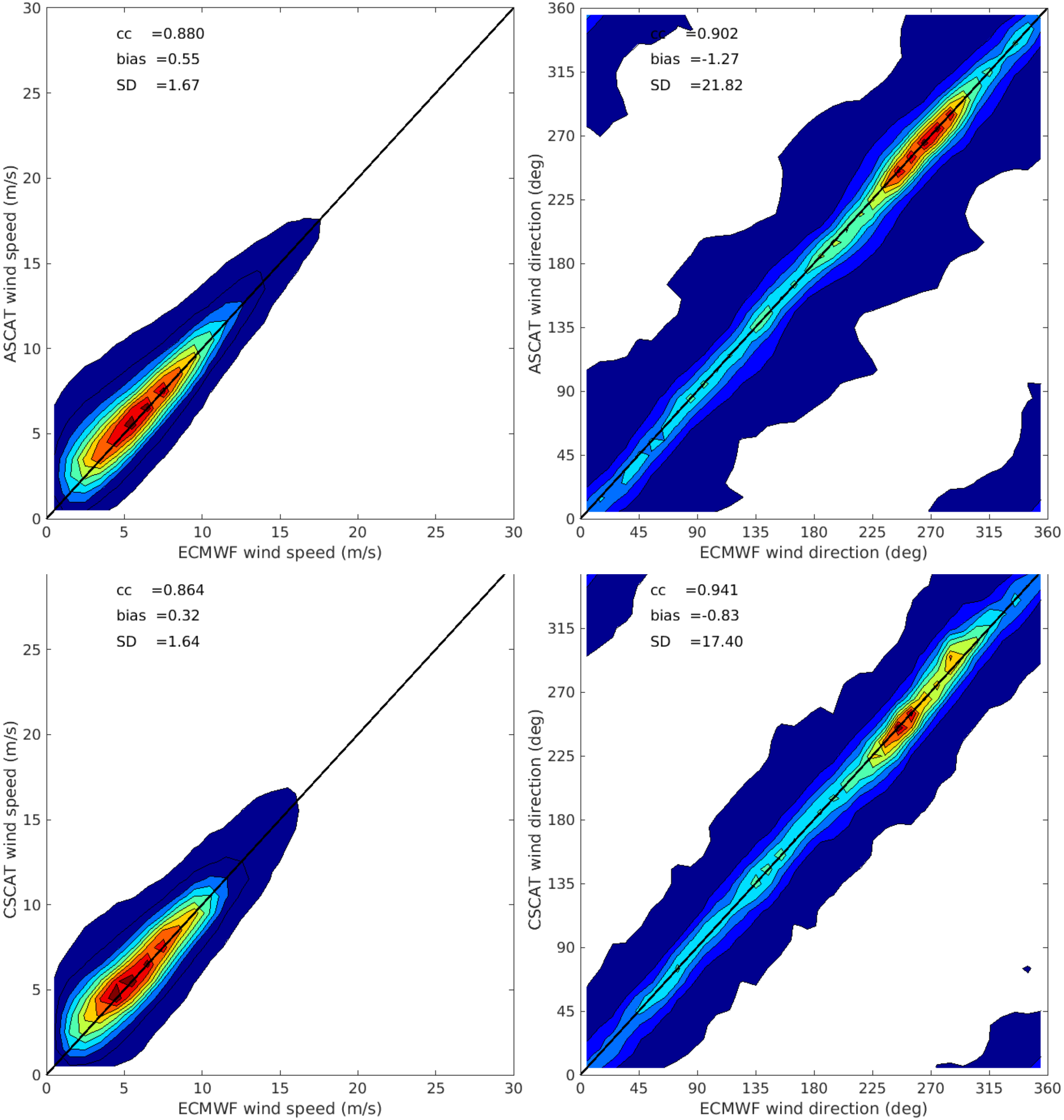
Evaluation (12.5 km products) – wind retrievals 150 km to the coast

- CSCAT;
- ASCAT;
- QuikSCAT;

3. Results

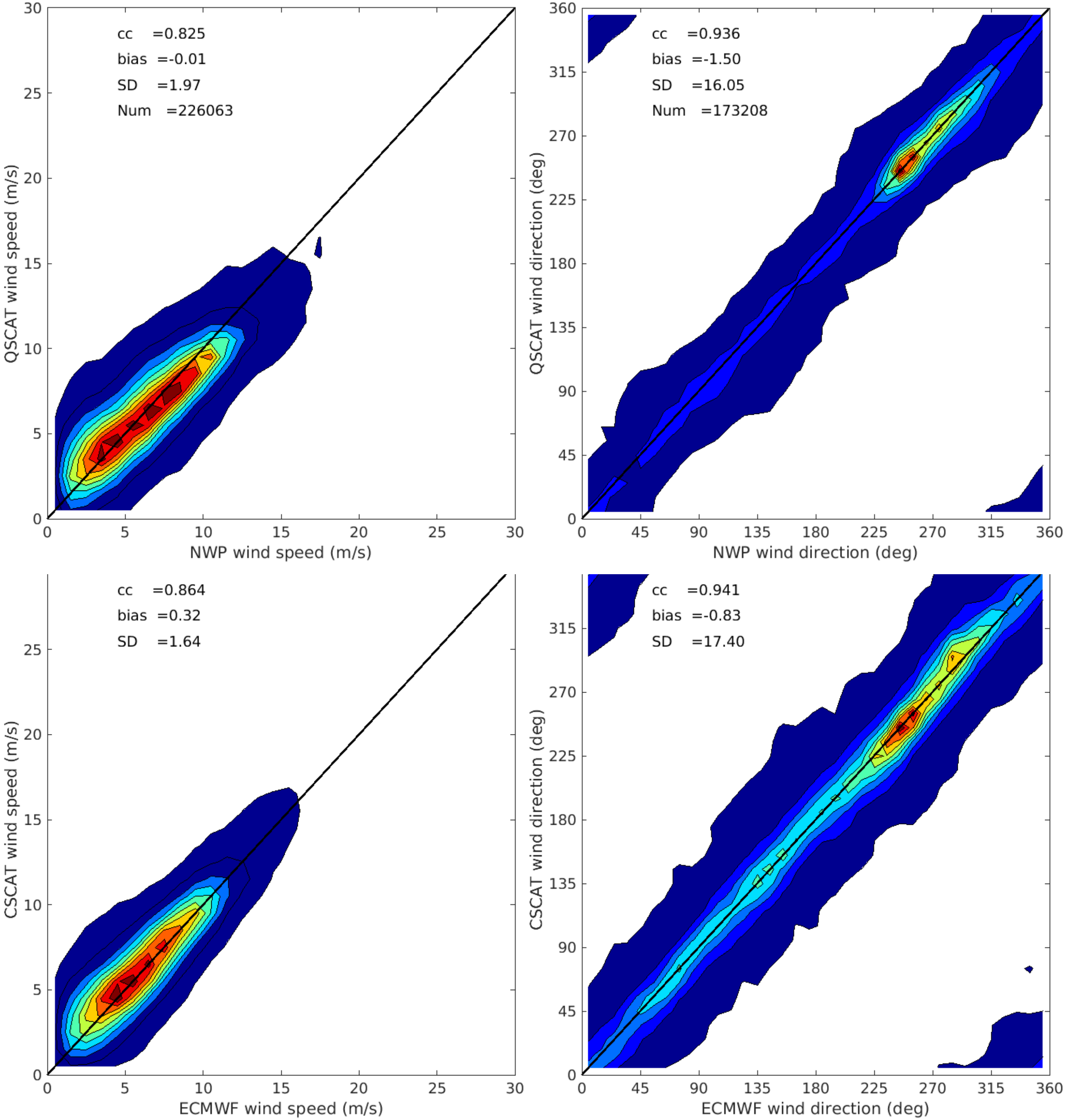


SD values of wind speed (left) and direction (w.r.t. NWP background winds) as a function of the distance to coast


cc =0.880
bias =0.55
SD =1.67
ASCAT wind speed (m/s)
ECMWF wind speed (m/s)
cc =0.902
bias =-1.27
SD =21.82
ASCAT wind direction (deg)
ECMWF wind direction (deg)
cc =0.864
bias =0.32
SD =1.64
CSCAT wind speed (m/s)
ECMWF wind speed (m/s)
cc =0.941
bias =-0.83
SD =17.40
CSCAT wind direction (deg)
ECMWF wind direction (deg)

ASCAT

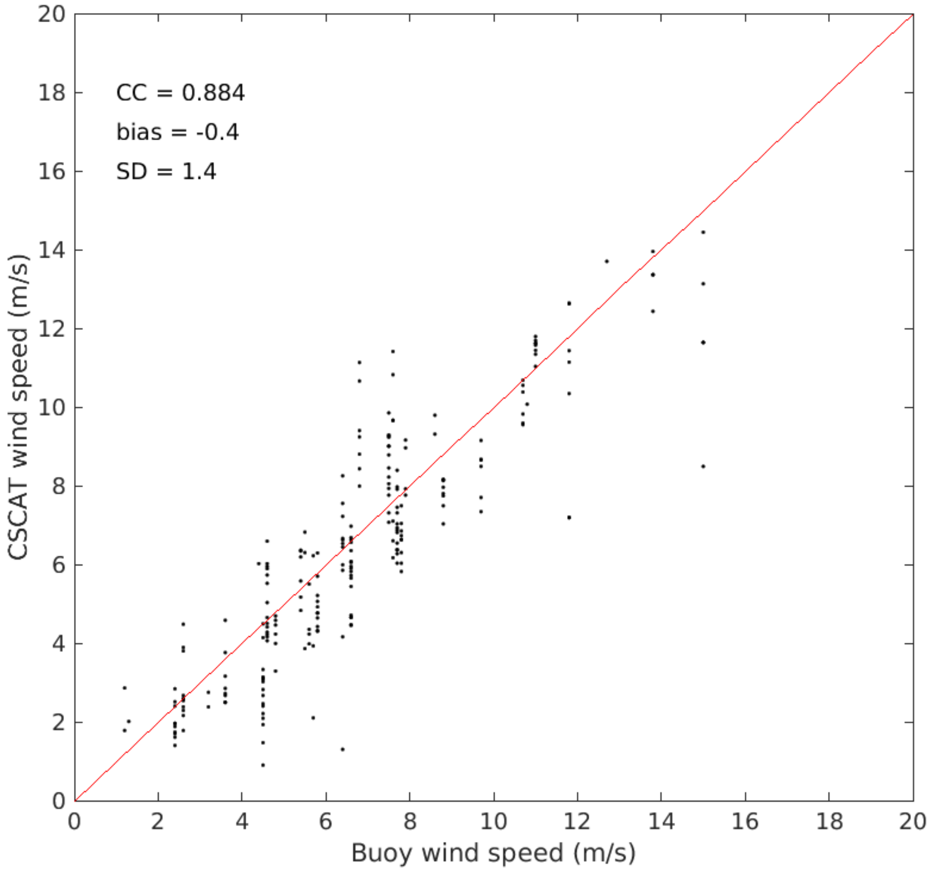
CSCAT

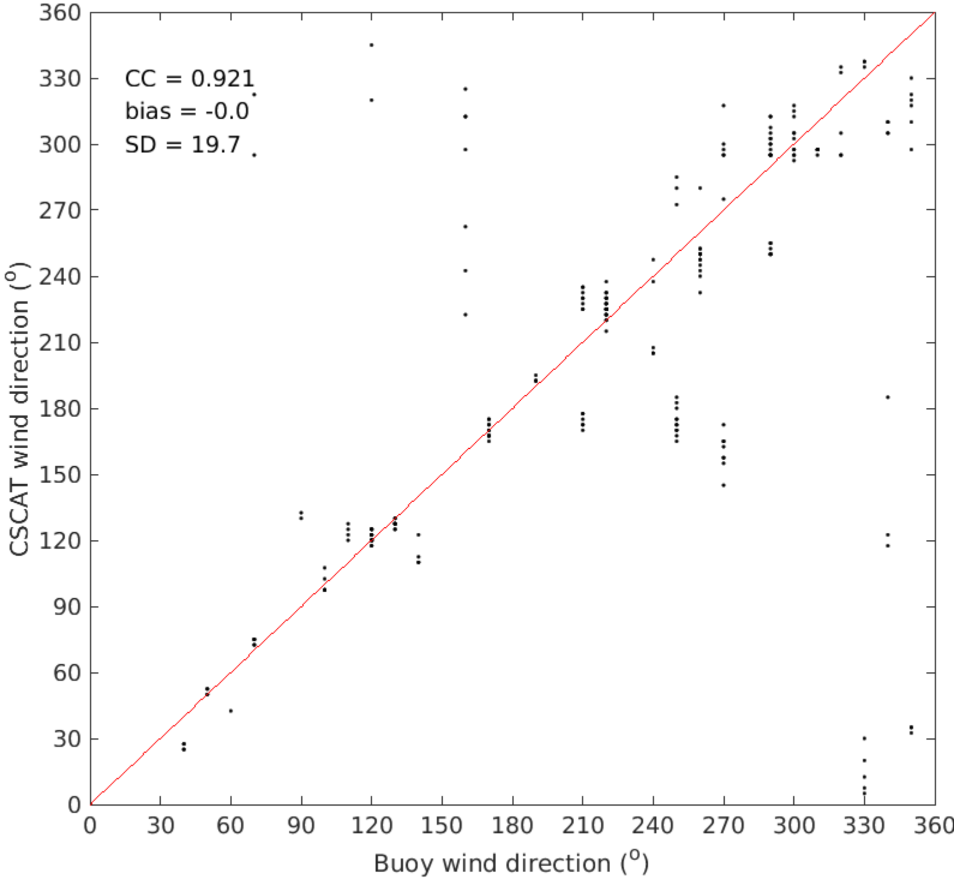

cc =0.825
bias =-0.01
SD =1.97
Num =226063
QSCAT wind speed (m/s)
NWP wind speed (m/s)
cc =0.936
bias =-1.50
SD =16.05
Num =173208
QSCAT wind direction (deg)
NWP wind direction (deg)
cc =0.864
bias =0.32
SD =1.64
CSCAT wind speed (m/s)
ECMWF wind speed (m/s)
cc =0.941
bias =-0.83
SD =17.40
CSCAT wind direction (deg)
ECMWF wind direction (deg)

QSCAT

CSCAT

3. Results





CSCAT offshore winds (<30 km) versus buoy measurements

4. Conclusions and outlooks

1) The coastal wind processing was simply adapted from the current CSCAT wind processor, by including a box-window procedure for the slice aggreation.

2) The CSCAT 12.5-km coastal winds are evaluated by comparing to the ASCAT/QuikSCAT coastal products, showing quite good wind quality

3) The offshore wind bias of CSCAT is lower than the other scatterometers, indicating a benefit from the high-resolution backscatter measurements

4. Conclusions and outlooks

- Improve the geolocation of the slices;
- Improve the nice correction in L1B
- Take land contamination effects into account

Merci

Thank you

谢谢