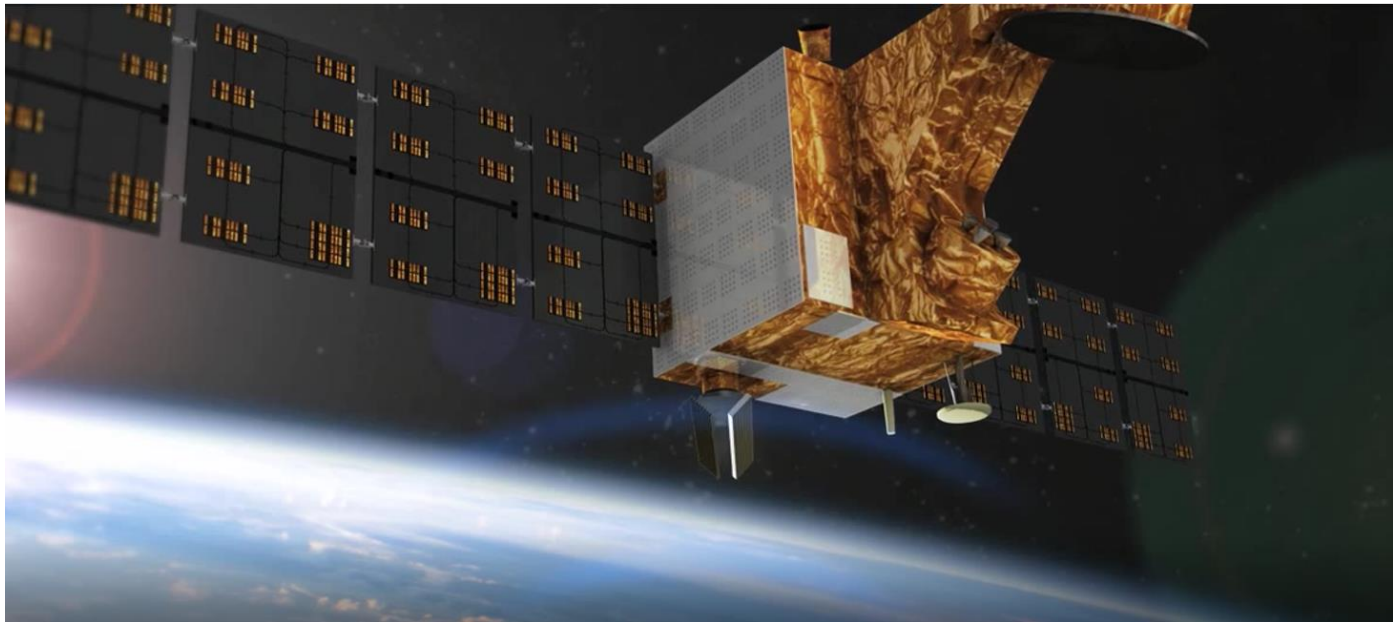




# Assessment of the CFOSAT scatterometer backscatter and wind quality



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Marcos Portabella (ICM)  
Shuyan Lang, Jianqiang Liu (NSOAS)

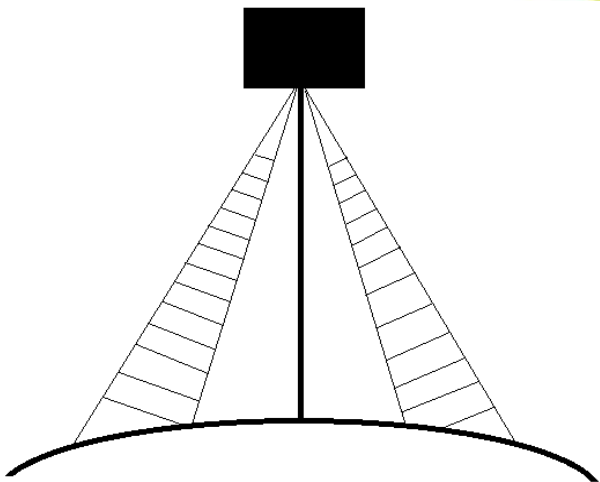
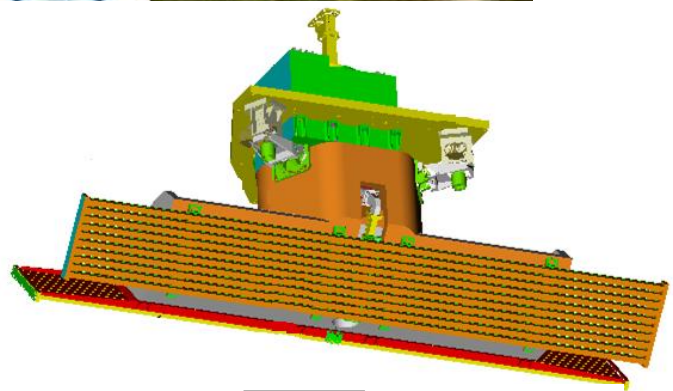


# Outline

- 1. Introduction
  - CFOSAT SCAT overview
- 2. Simulation
  - L1B simulator
  - L2 simulator
- 3. Expected performances
  - Backscatter
  - Wind
- 4. Conclusions and outlook



# I. Introduction

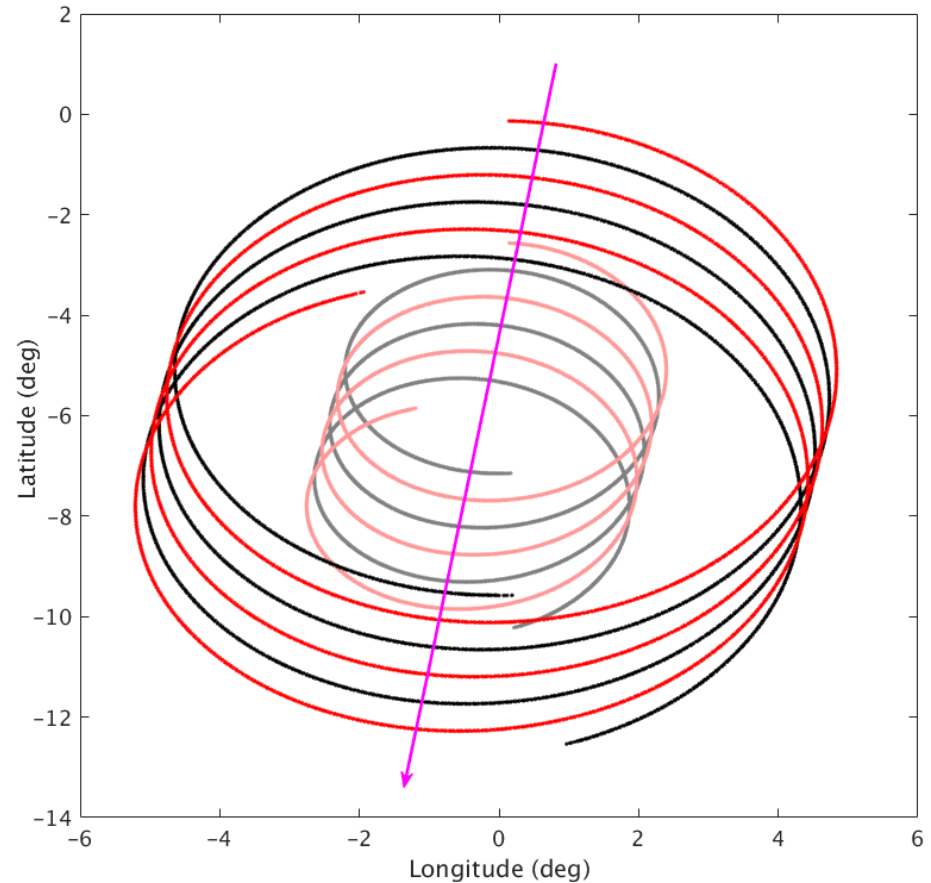
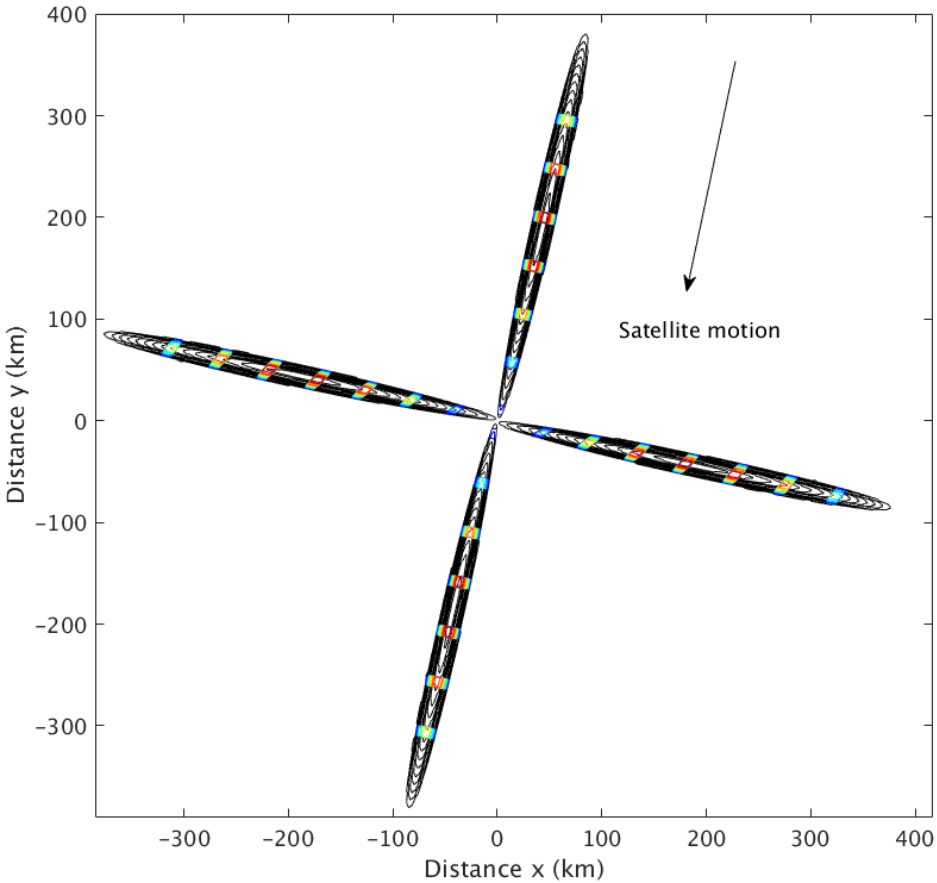


Three-dimensional model view of the antenna architecture of the CFOSAT SCAT (upper panel); schematic illustration of the beams' configuration (lower panel).

Parameters	Values
Transmitted power	$\geq 120$ W
Bandwidth	0.5 MHz
Pulse duration	1.35 ms
Pulse repetition rate (PRF)	75 Hz (VV) 75 Hz (HH)
Antenna peak gain	32.0 dB (VV) 31.8 dB (HH)
One-way 3 dB beam width	Range: $14.5^\circ$ ; Azimuth: $1.2^\circ$ (VV) Range: $15.0^\circ$ ; Azimuth: $1.1^\circ$ (HH)
Antenna spinning rate	Default: 3.4 revolutions per minute (rpm) High spinning rate: 3.74 rpm Low spinning rate: 3.06 rpm
Power consumption	$< 200$ W
Instrument mass	$< 70$ kg
Swath	1000 km



# I. Introduction

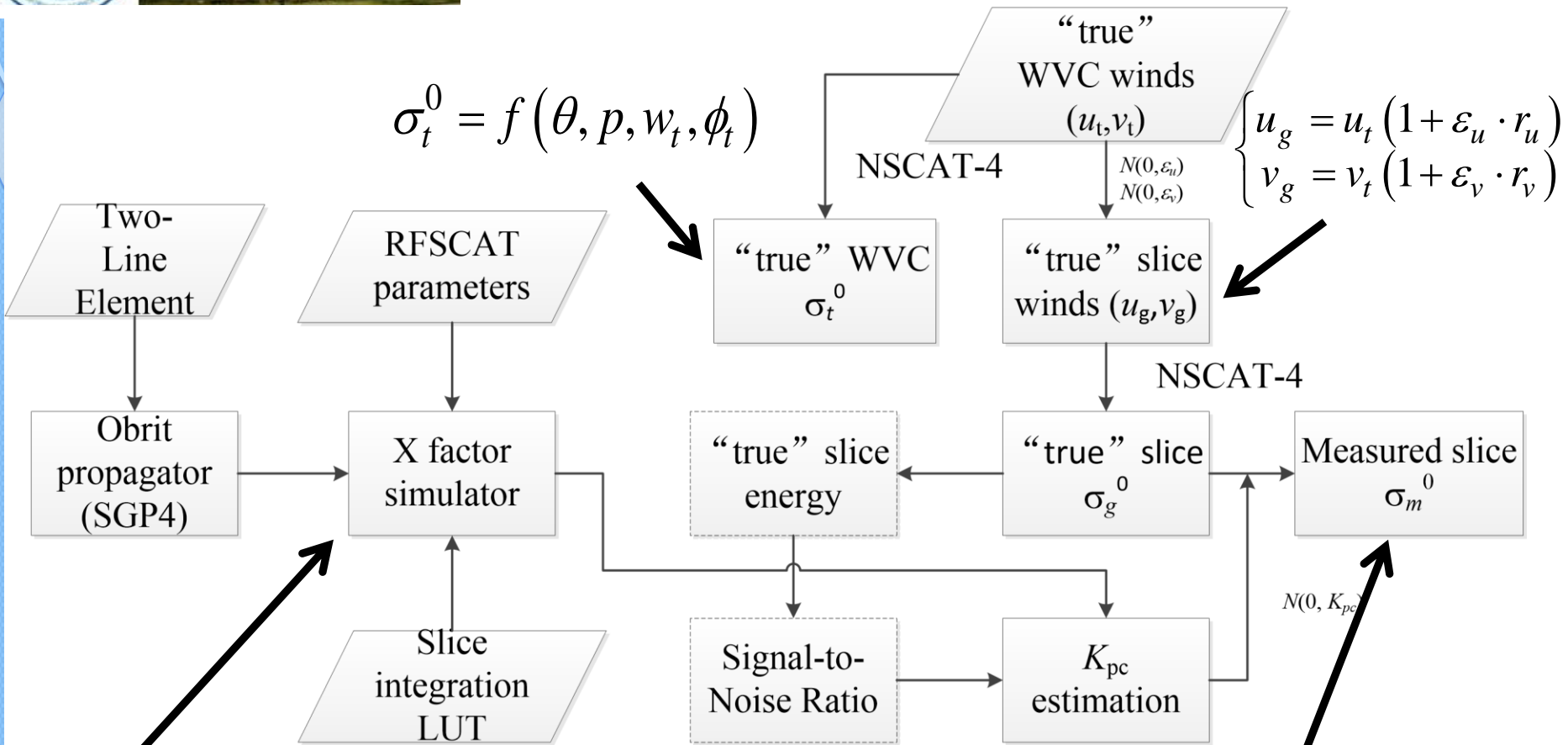


SCAT footprint and range-gated slices

Schematic of the illumination geometry formed by two beams



# 2. Simulation



$$X_i = \frac{P_t G_p^2 G_r \lambda^2}{(4\pi)^3 L} \sum_{j \in F} \frac{\Delta A_j g_j^2}{r_j^4} \sum_{k=k_s}^{k_e} \left\{ \frac{\sin \left[ \pi N_j \left( f_{b,j} T - \frac{k}{N} \right) \right]}{\sin \left[ \pi \left( f_{b,j} T - \frac{k}{N} \right) \right]} \right\}^2$$

$$\sigma_m^0 = \sigma_g^0 \left( 1 + K_{pc} \cdot r \right)$$

$$K_{pc}^2 = A + \frac{B}{\text{SNR}} + \frac{C}{\text{SNR}^2}$$



## Input :

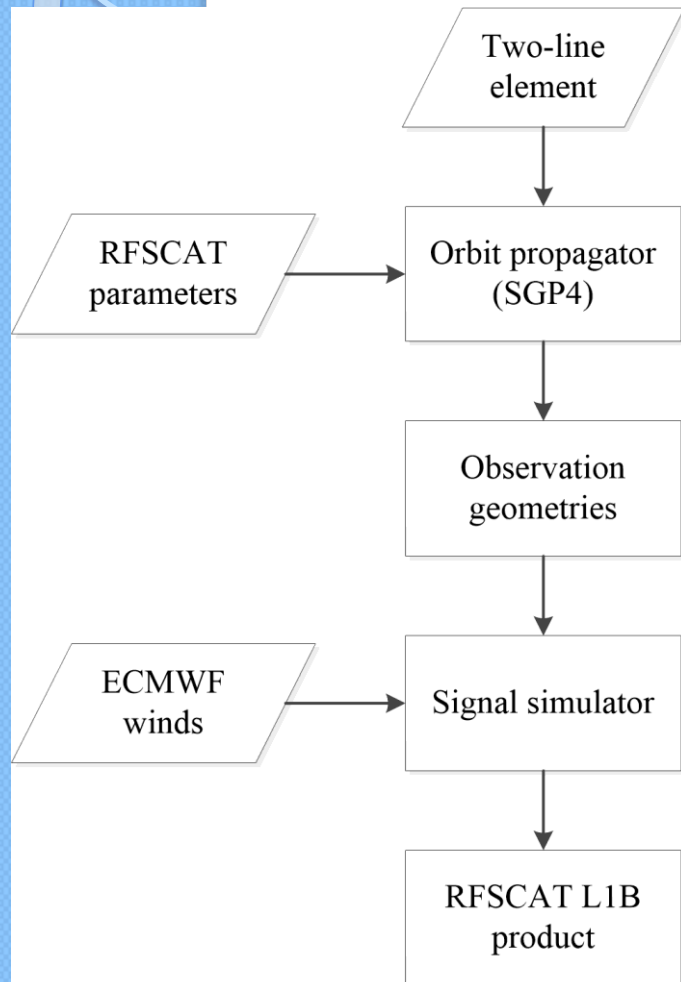
- Two-Line Element (TLE) set of satellite orbit
- CFOSAT SCAT instrumental parameters
- 3-hourly ECMWF forecasts as 'true' winds (spatially and temporally interpolated into SCAT slices' position)

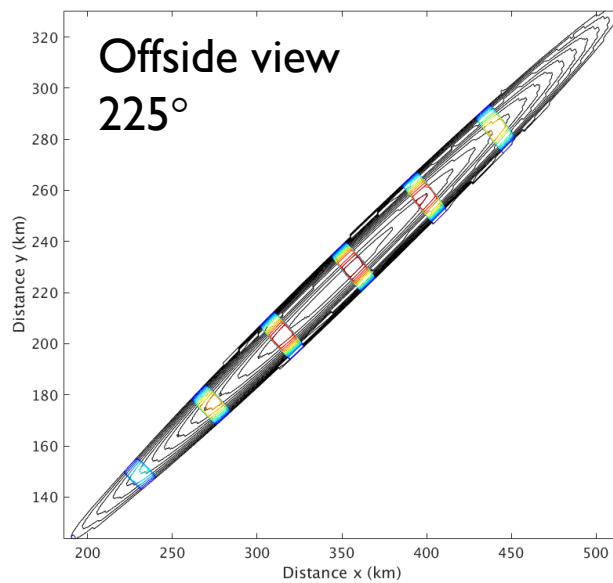
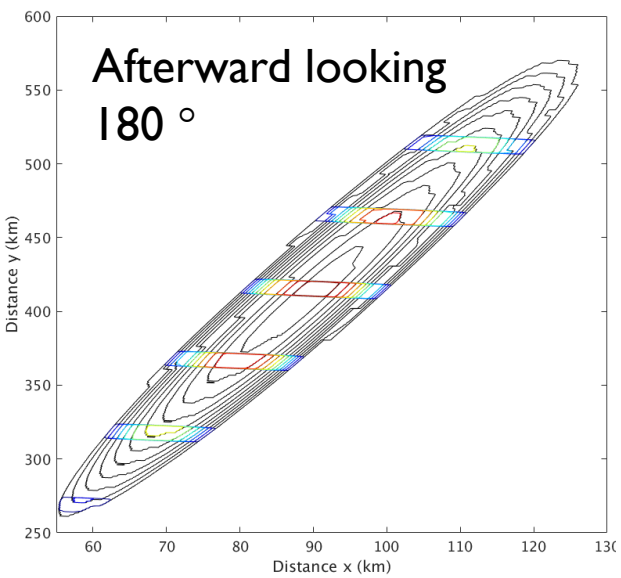
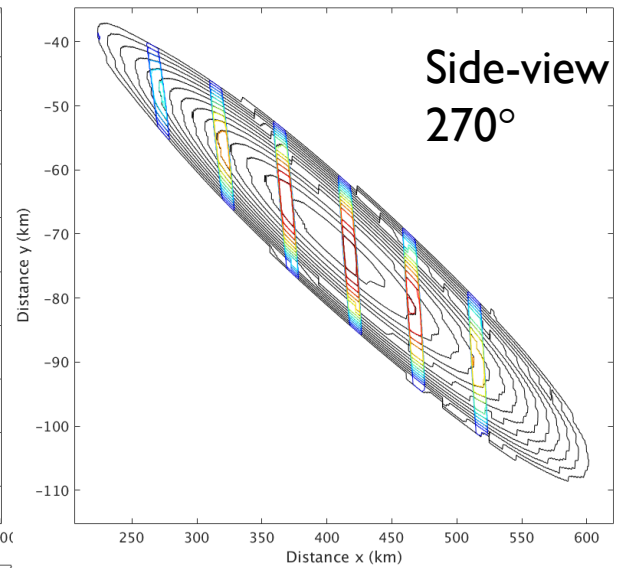
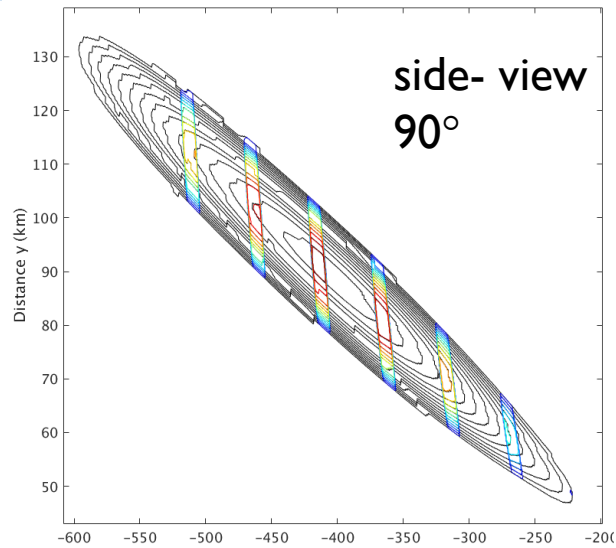
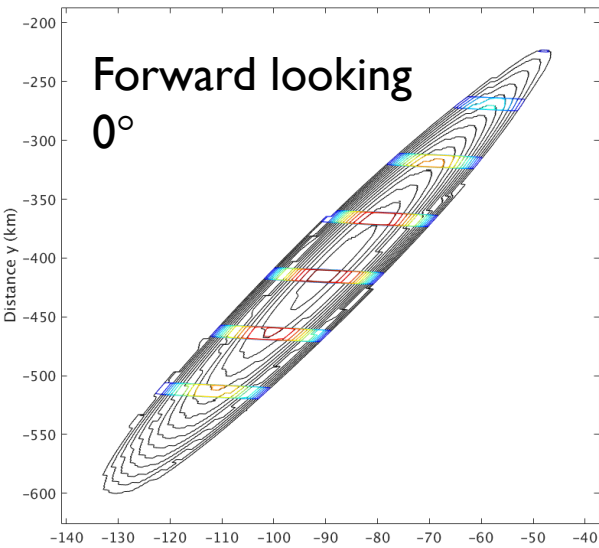
## Output : LIB product in NetCDF format

- Slices' geometries
- Backscatters ( $\sigma^0$  ; GMF: NSCAT-4)
- Signal-to-Noise Ratio (SNR)、 slice  $\sigma^0$  precision (Kp) ;
- Orbit parameters
- $\sigma^0$  flags

## Optional outputs :

- Power
- X factor
- Spatial response function (SRF) for research <sup>6</sup>





## Illustrations of SRFs for VV beam

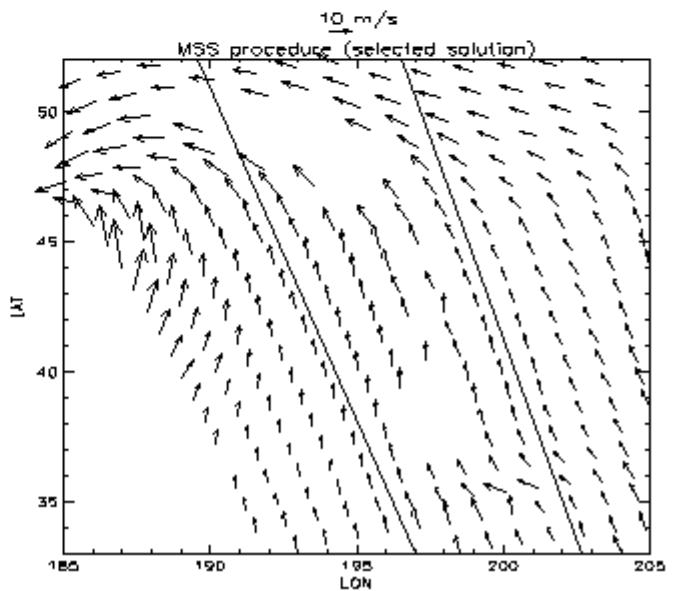
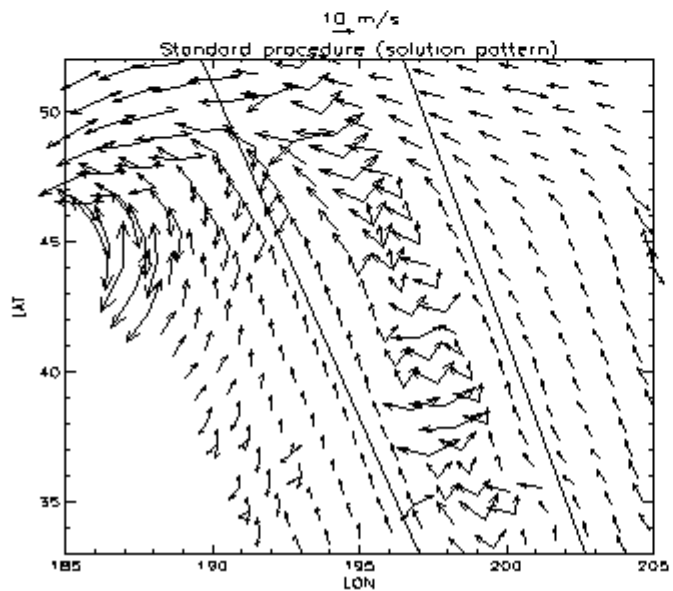
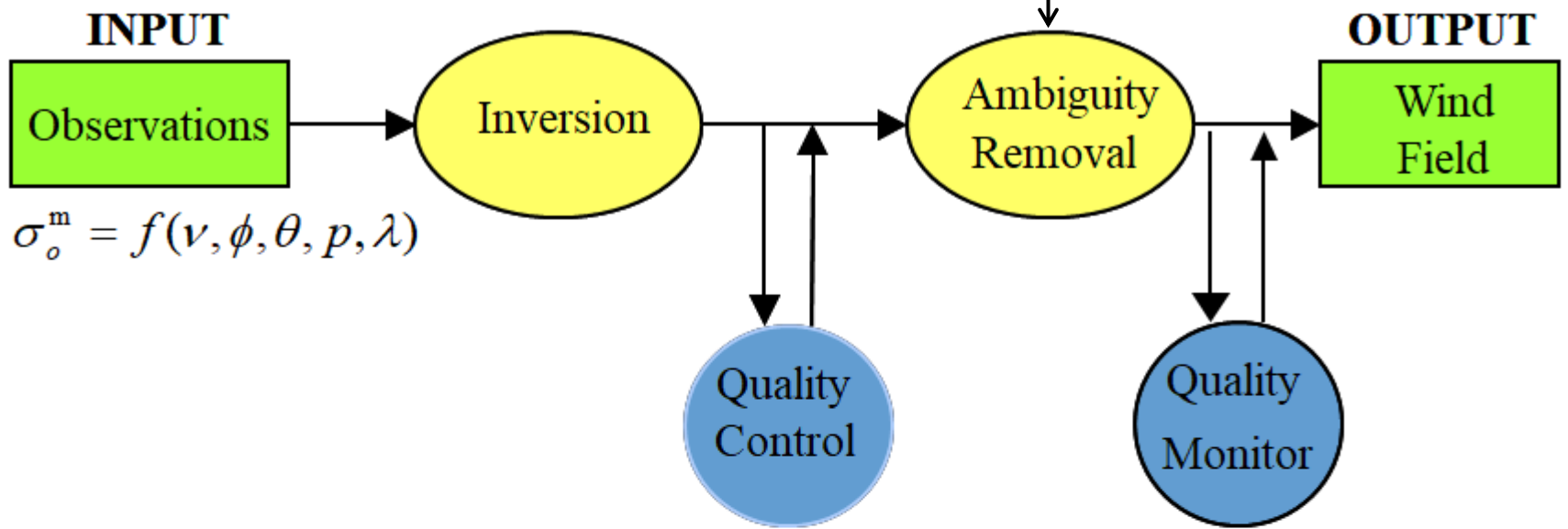
- Descending pass
- Contour lines of 1 dB bin
- Black curves – footprint
- Color curves – slices (one in fine is shown)



## 2. Simulation

“True” WVC winds

Wind variability of 1.5 m/s



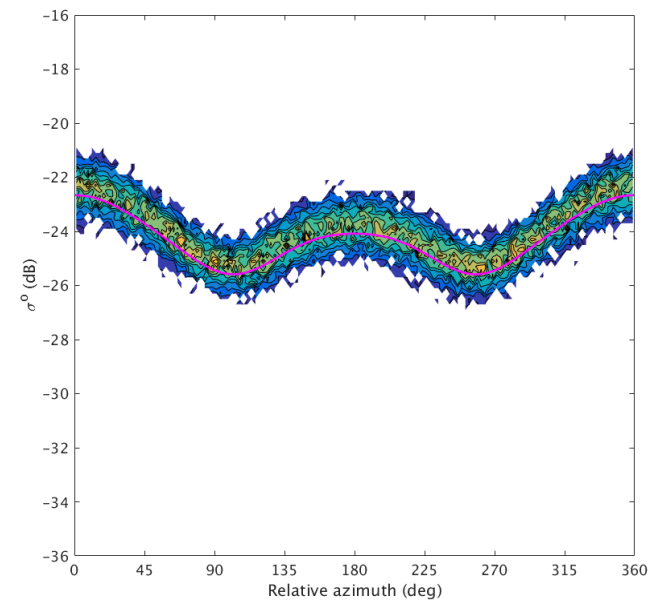
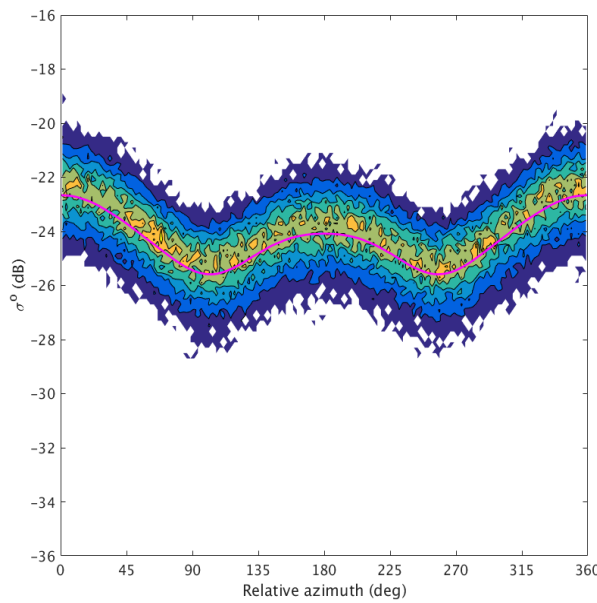
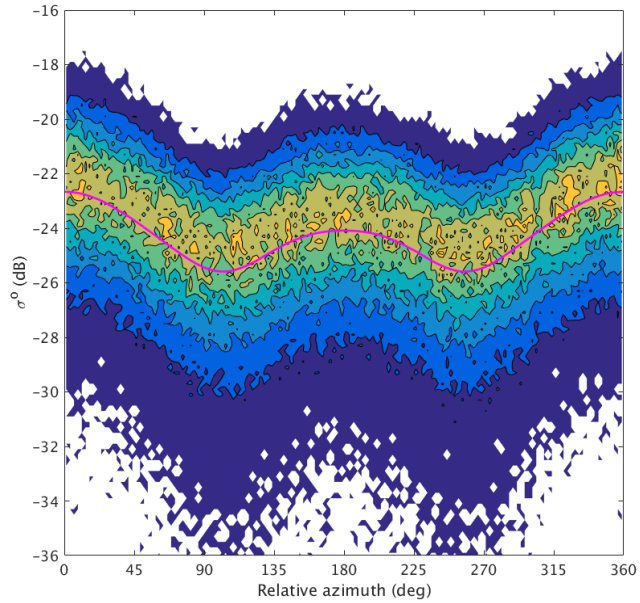


### 3. Expected performance

Slice

WVC 12.5 km

WVC 25 km



Two-dimensional histogram of the simulated  $\sigma^0$  (VV beam) versus the relative azimuth angle  $\phi_g$  for  $\theta = 40^\circ$  and  $w_t = 4$  m/s, and for slice  $\sigma^0$  (a); WVC-mean  $\sigma^0$  with grid resolution of 12.5 km (b); and WVC-mean  $\sigma^0$  with grid resolution of 25 km (c)

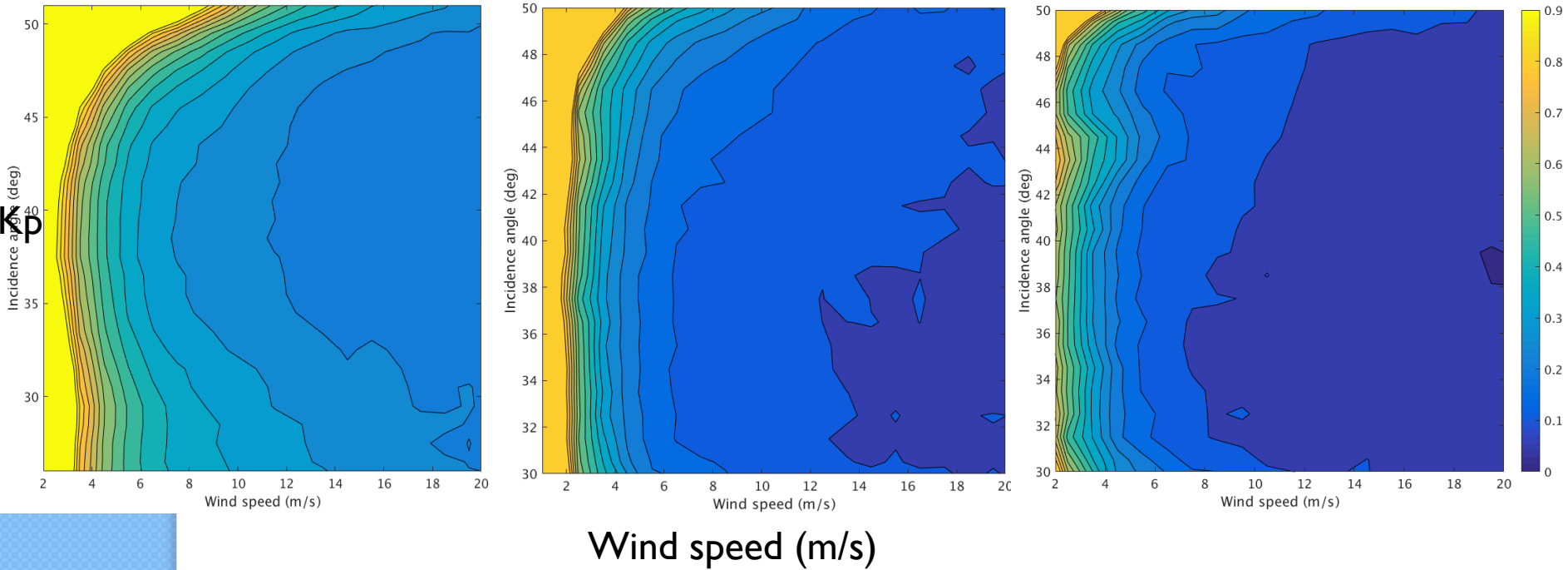


### 3. Expected performance $K_p = \frac{\sqrt{\text{Var}[\sigma^o]}}{\mathcal{E}[\sigma^o]}$

Slice

WVC 12.5 km

WVC 25 km

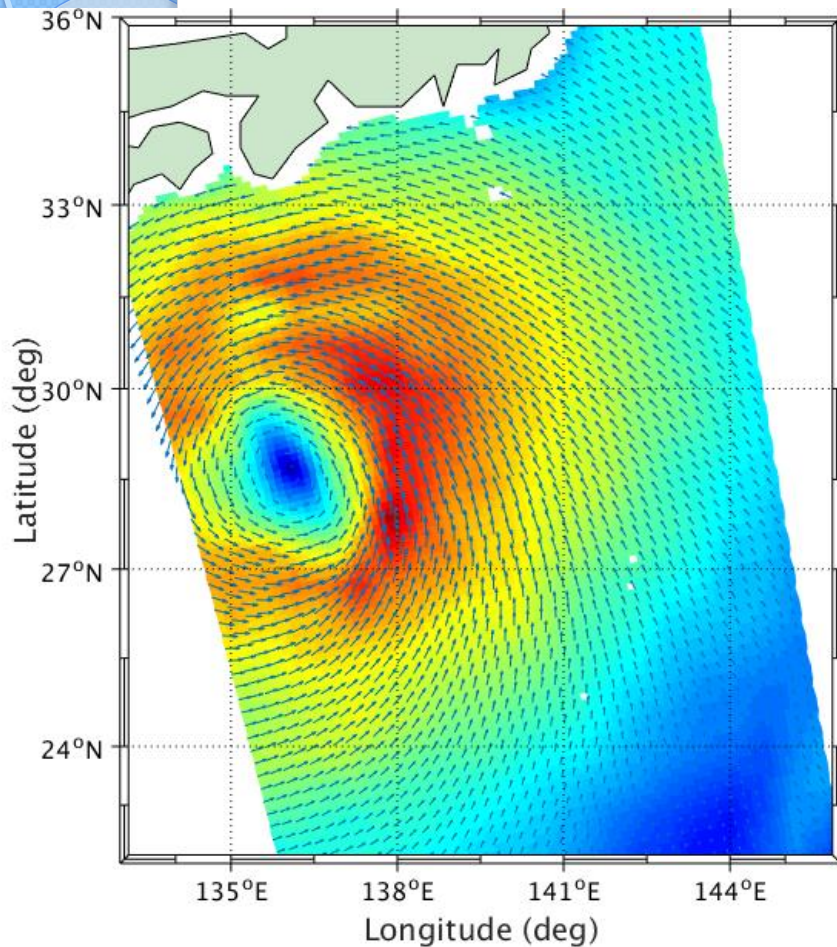


Wind speed (m/s)

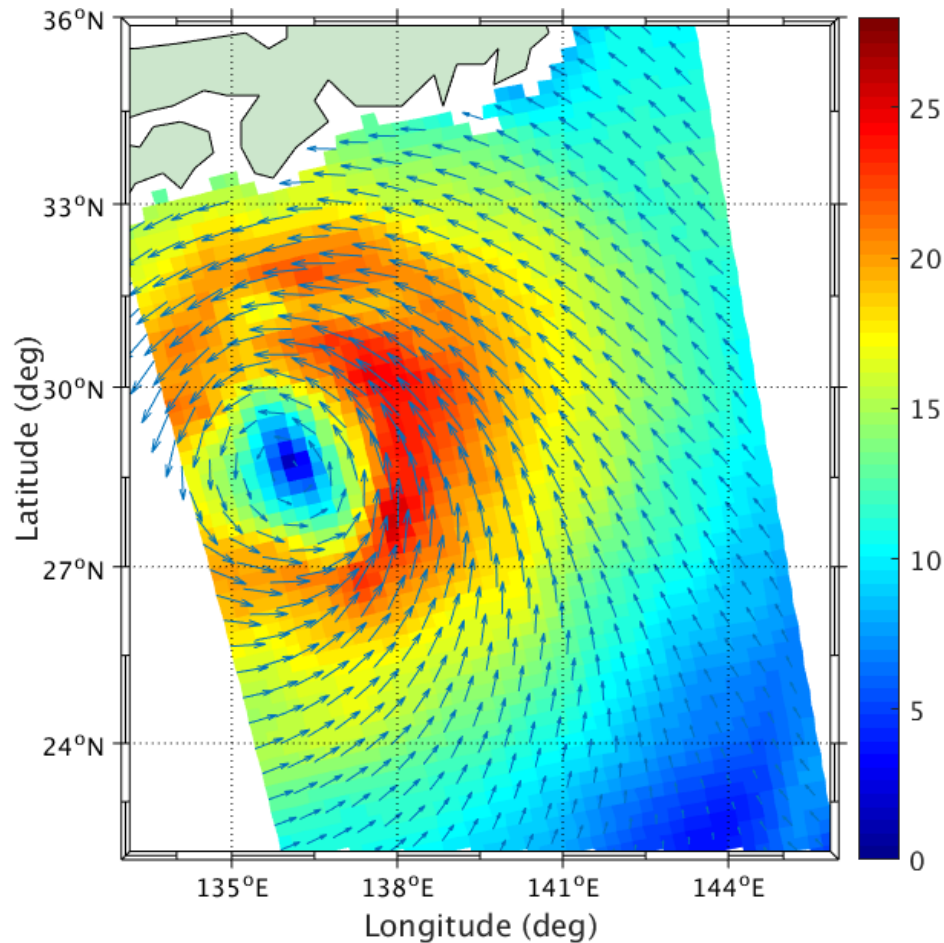
Contour plots of the normalized measurement error ( $K_p$ , VV beam) as a function of wind speed (x-axis) and incidence angle (y-axis), and for a slice  $K_p$  (a); WVC-mean  $K_p$  with grid resolution of 12.5 km (b); and WVC-mean  $K_p$  with grid resolution of 25 km (c). Note that a contour spacing of 0.05 is used.



# 3. Expected performance



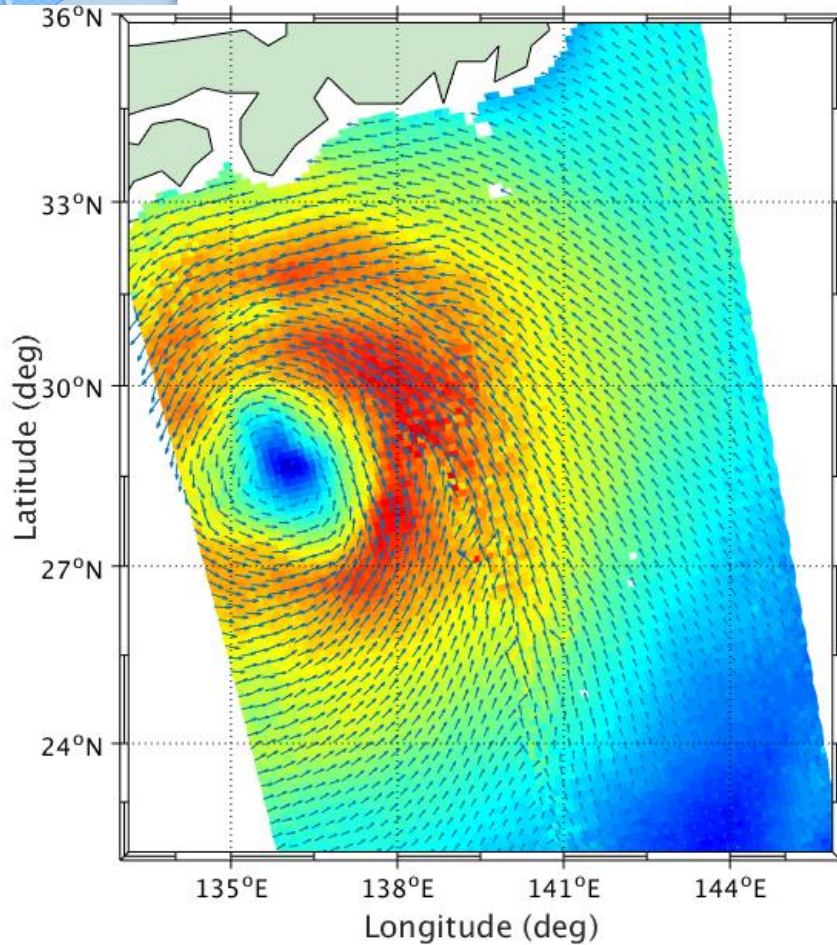
“true wind field” 12.5 km



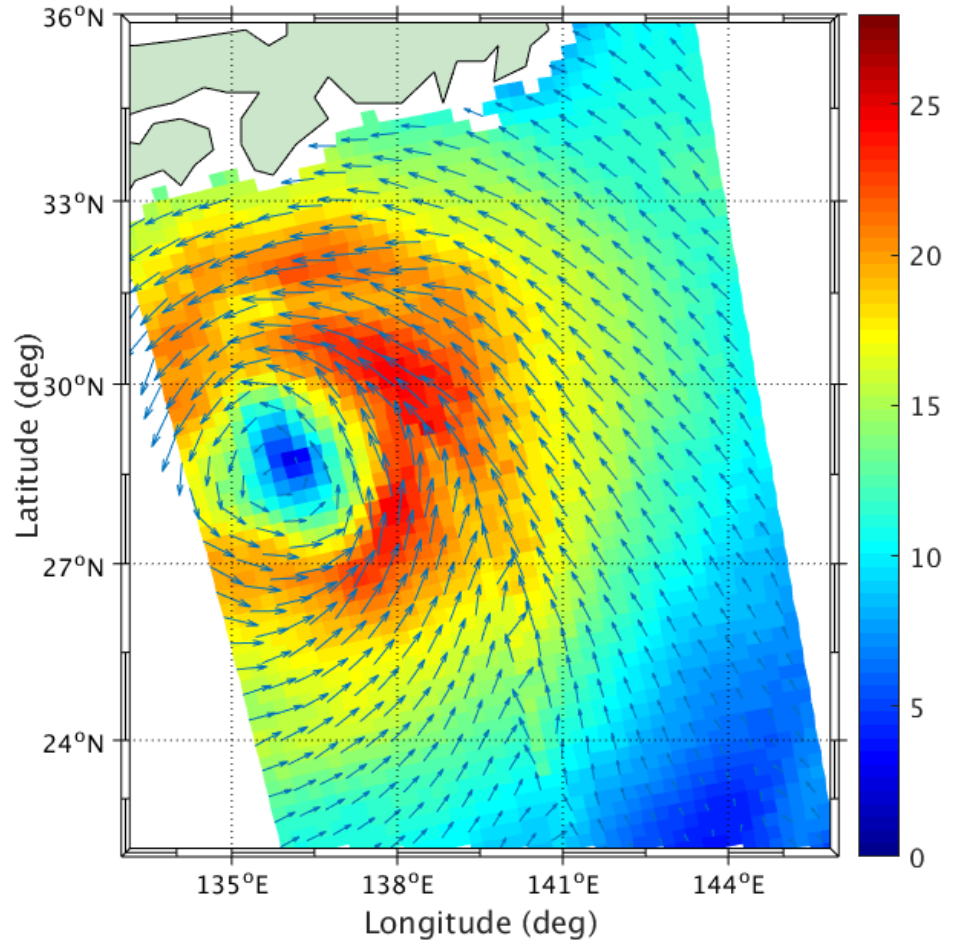
“true wind field” 25 km



# 3. Expected performance



Retrieved winds 12.5 km

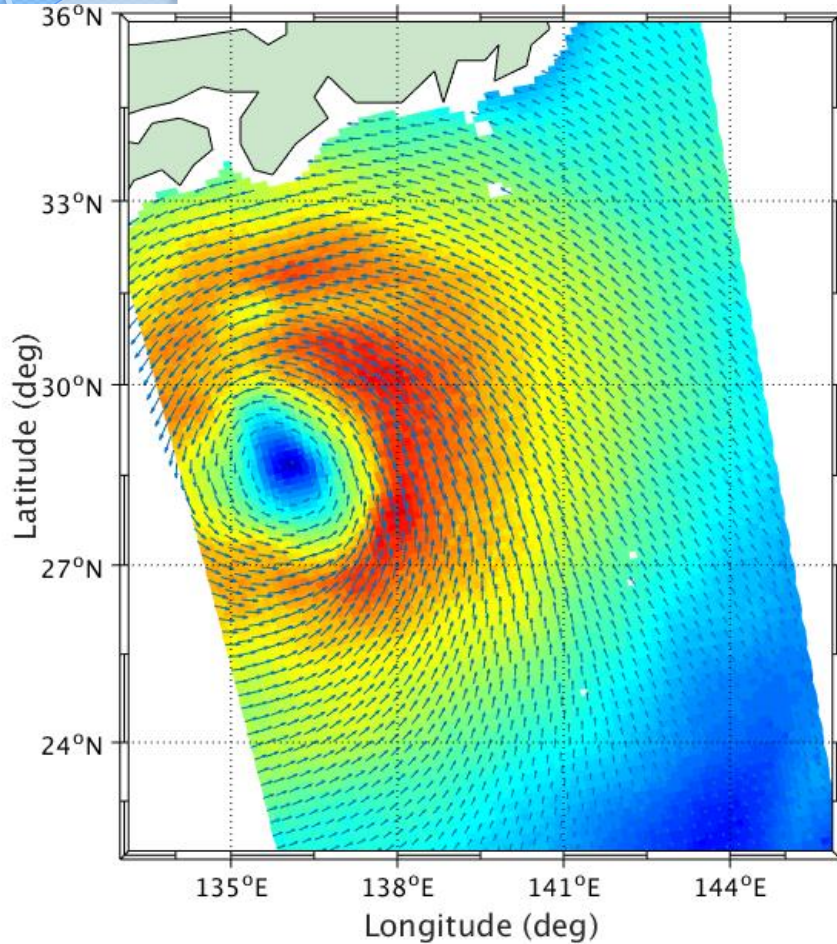


Retrieved winds 25 km

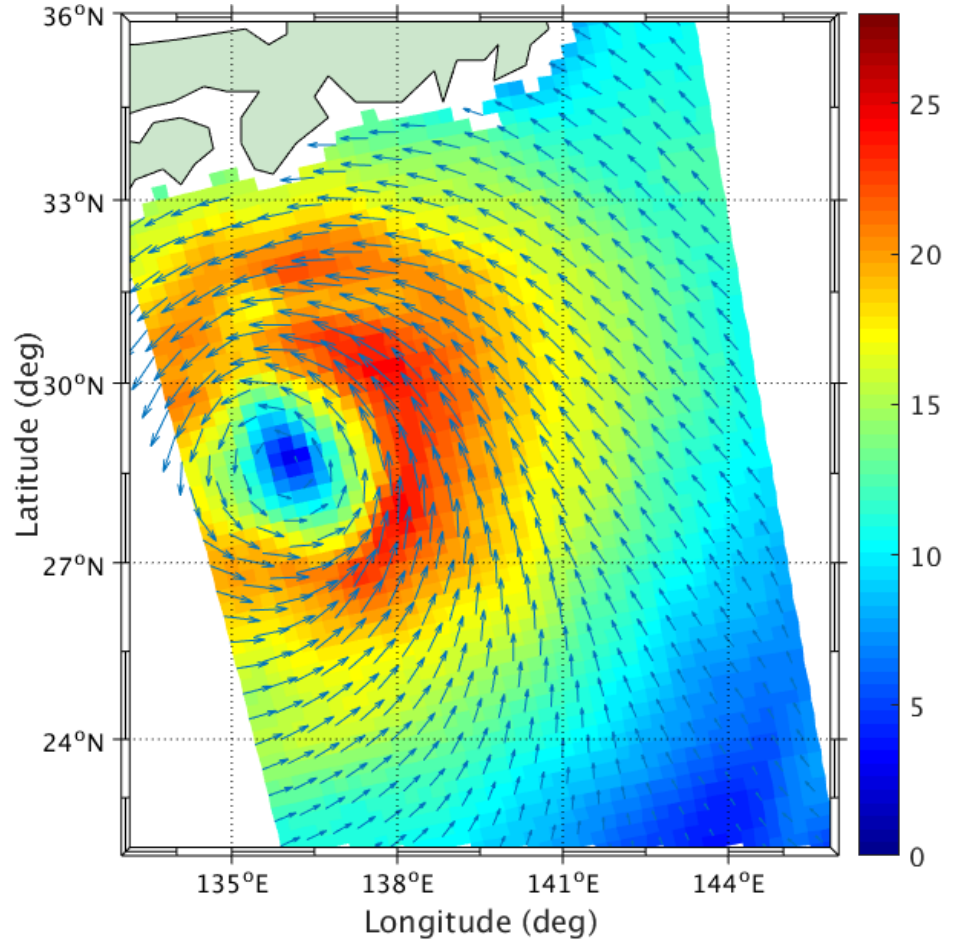
**Maximum solutions=4**



# 3. Expected performance



Retrieved winds 12.5 km

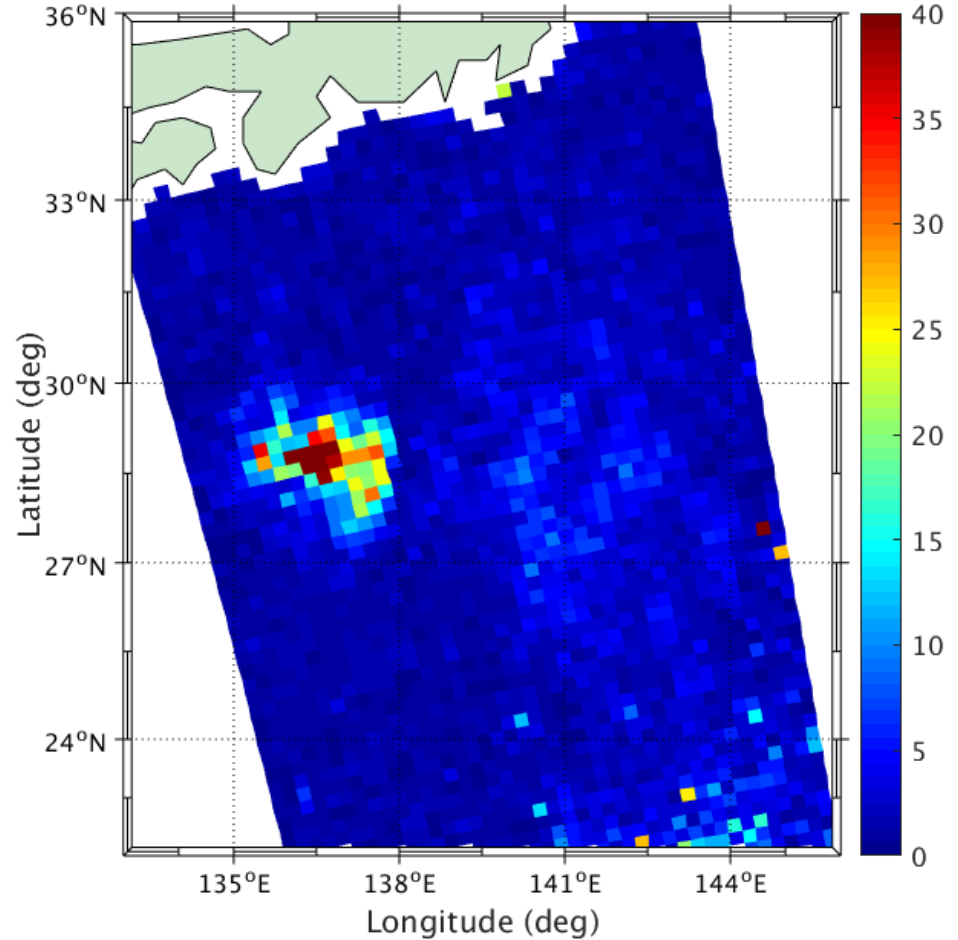
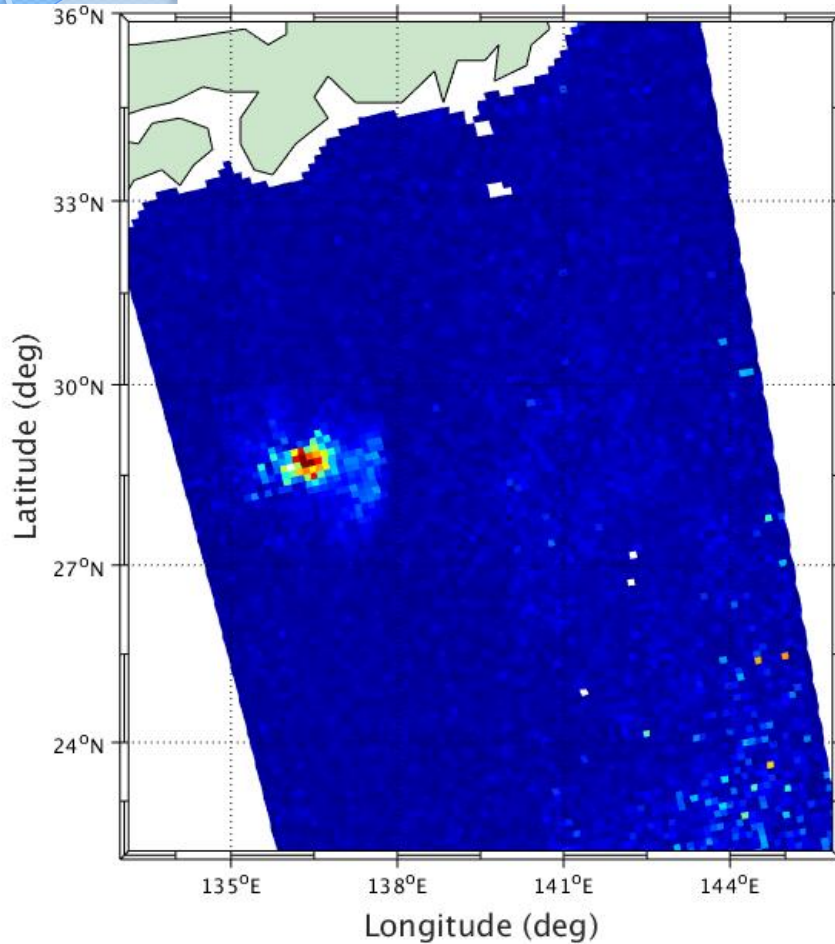


Retrieved winds 25 km

**Maximum solutions=144**



# 3. Expected performance



Inversion residual (MLE) @12.5 km

Inversion residual (MLE) @25 km

**Maximum solutions=144**



### 3. Expected performance

Resolution	Geophysical noise (m/s)	SD values of wind			
		speed (m/s)	dir (°)	u (m/s)	v (m/s)
25 km	0.0	0.34	13.6	1.15	1.21
	0.5	0.35	13.6	1.14	1.22
	1.0	0.37	13.6	1.14	1.22
12.5km	0.0	0.43	15.1	1.23	1.33
	0.5	0.43	15.2	1.24	1.34
	1.0	0.45	15.3	1.25	1.34

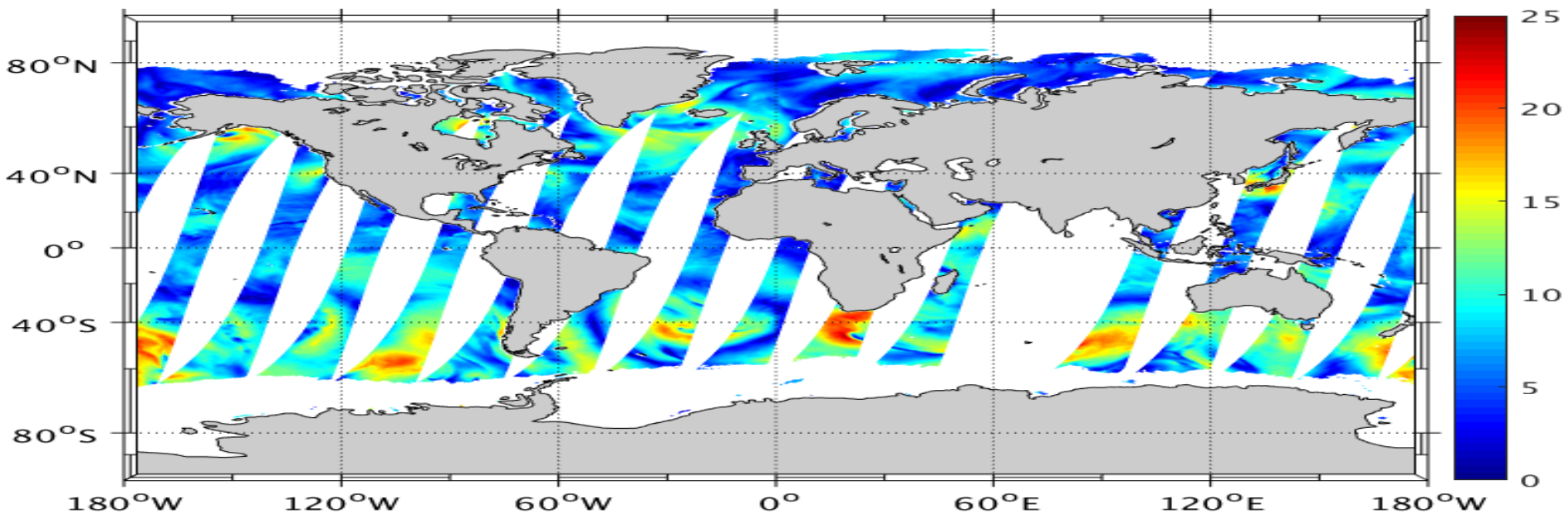
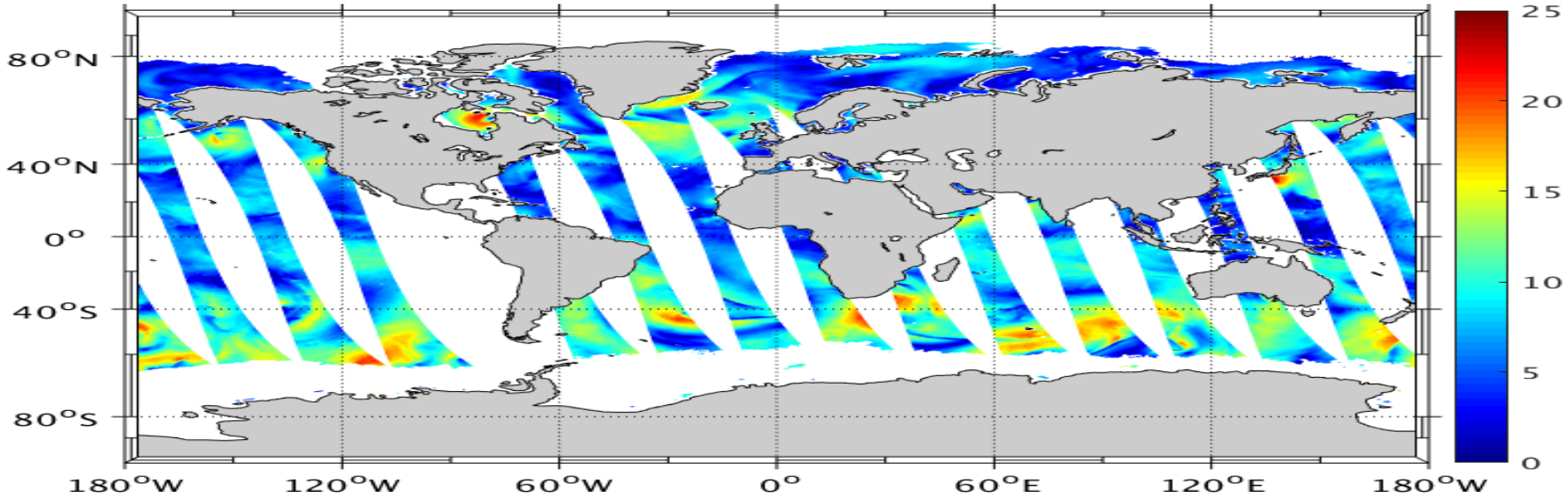
Expected SCAT wind quality at different grid resolutions and geophysical noise conditions. The SD values of the difference between retrieved winds and input (“true”) ECMWF winds are estimated.

	$\epsilon$ [m/s] SCAT scale	$\epsilon$ [m/s] Model scale
ASCAT	$0.34 \pm 0.001$	$0.80 \pm 0.003$
ECMWF	$1.25 \pm 0.007$	$1.02 \pm 0.005$

**Triple collocation results of collocated buoy-ASCAT-ECMWF data**



# 3. Expected performance





## 4. Conclusions and outlooks

- SCAT 10-km slices  $K_p$  is generally high (above 20%); the WVC  $K_p$  however is generally fine (about 5%-20%), depending on the surface wind speed conditions.
- Geophysical noise (wind variability) impacts on the slice measurement, particularly for wind speeds below 5 m/s. However, geophysical noise does not substantially degrade the measurement precision of WVC  $\sigma_0$ s.
- Provided that the backscatter measurements are under rain-free condition and well calibrated, the expected wind quality is fully compliant with the mission requirements, i.e., a wind speed SD error  $< 2.0\text{m/s}$  and a wind direction SD error  $< 20^\circ$ , as proposed by NSOAS.
- The L2 processing with multi-solution scheme and 2DVAR is too sensitive to the background wind quality, suggesting that further L2 processing developments are required at the postlaunch stage.
- The innovative observation geometry of SCAT is not fully exploited. Inversion, quality control, ...
- Sea surface temperature effects on the Ku-band radar backscatter are not negligible. Improved GMF (large incidence range) with SST effect?

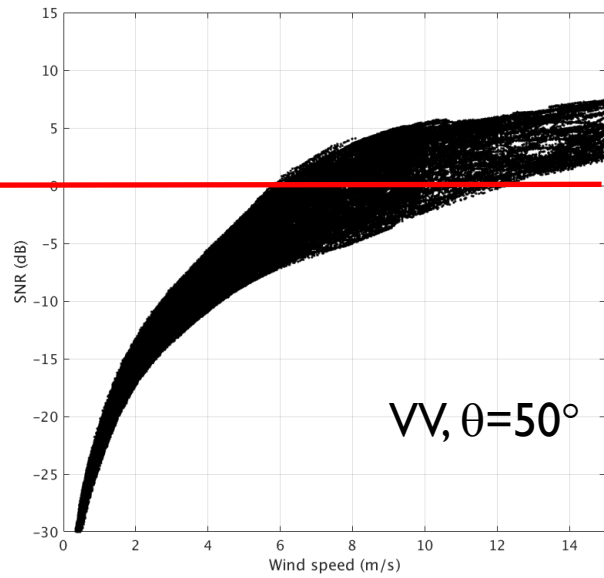
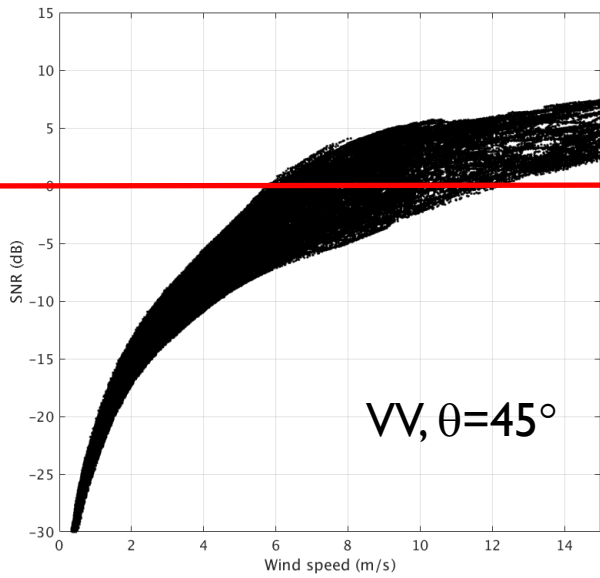
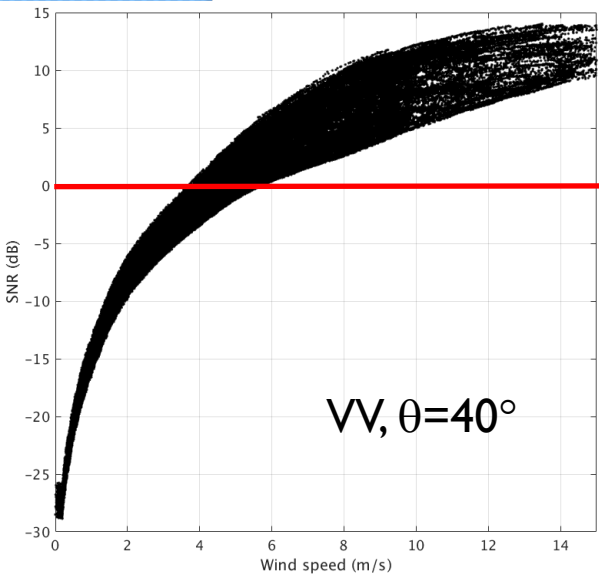
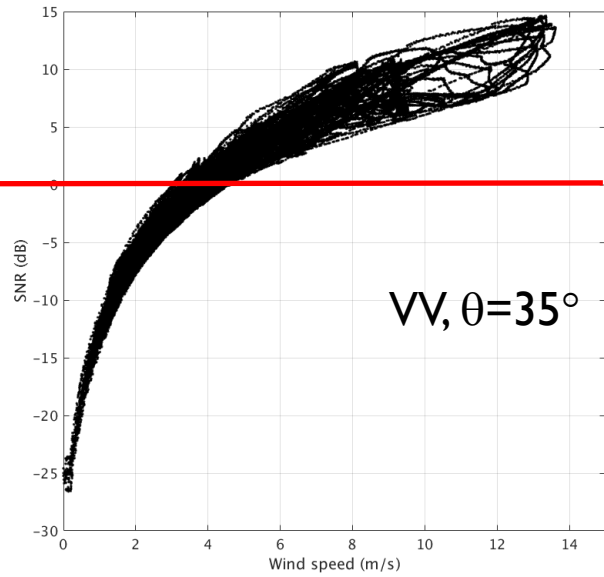
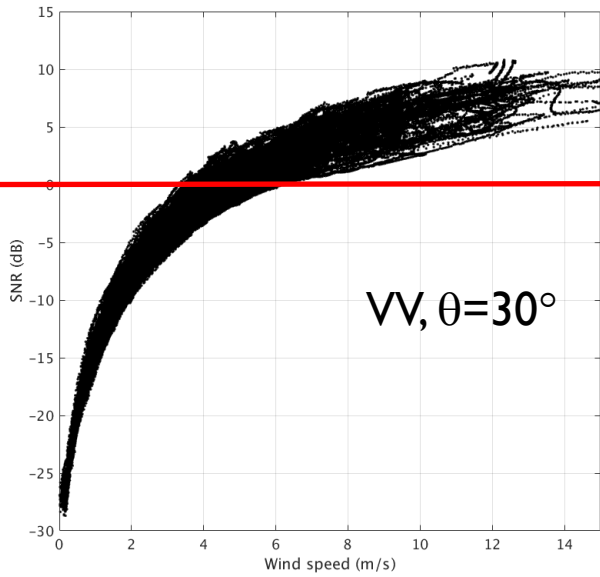
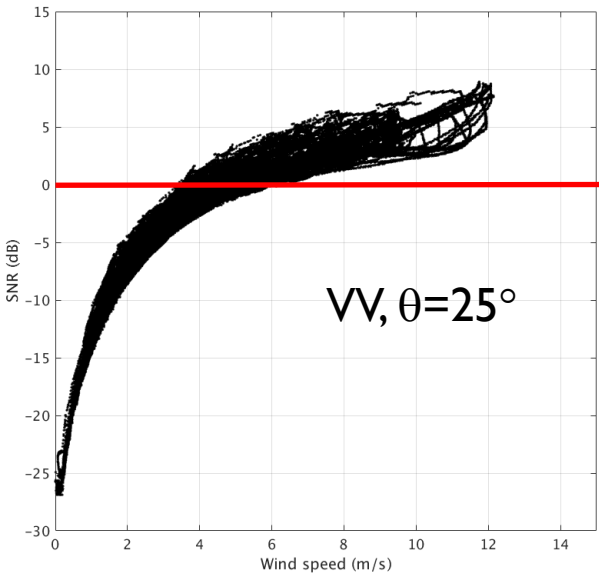


**Thank You**



# 2 Instrument characteristics

Slice  
SNR





# 2 Instrument characteristics

Slice  
SNR

