Preliminary inter-comparison of hurricane hunter and buoy wind observations under high wind conditions, using collocations with ASCAT

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Photo: courtesy of P. Chang

Outline

1. C-band High and Extreme-force Speeds (CHEFS) project
2. ASCAT and buoy wind comparison
3. Hurricane hunter wind data analysis
4. ASCAT and Stepped Frequency Microwave Radiometer (SFMR) preliminary wind comparison

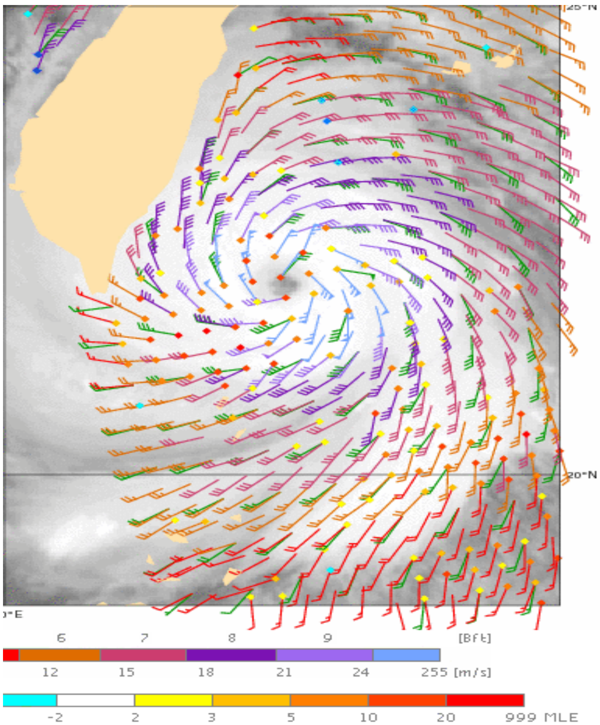
C-band High and Extreme-force Speeds (CHEFS) project

VH GMF: The understanding of the future C-band VH information contribution to high and extreme wind retrievals from C-band scatterometer missions;

Spatial scaling of extremes: The definition of spatial scaling issues and related consequences for product sample resolutions and validation approaches;

Understanding of extremes: To further understanding of satellite remote sensing of high and extreme wind conditions over the ocean

To consolidate an extreme wind reference



Data collection

- Period: **2007-2018**
- Moored buoy GTS U10N (NDBC, TAO/TRITON, PIRATA, RAMA, etc.)
- NOAA P-3 flight campaigns (summer & winter)
  - Stepped Frequency Microwave Radiometer (SFMR)
  - Dropsonde
- Best Track data
- ASCAT-A reprocessed U10N
- ERA5 & ECMWF OPS U10N

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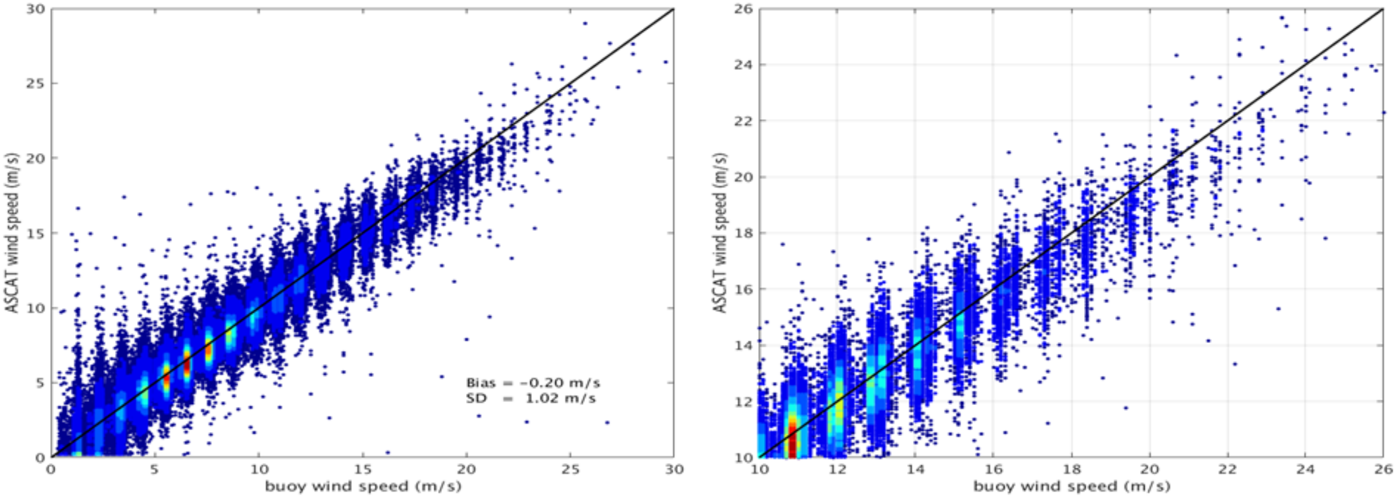
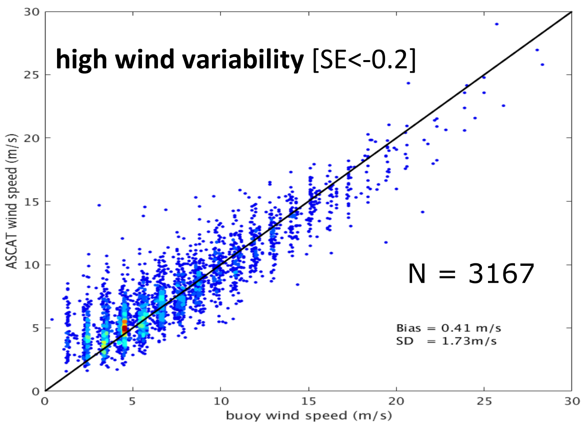
ASCAT/Buoy comparison

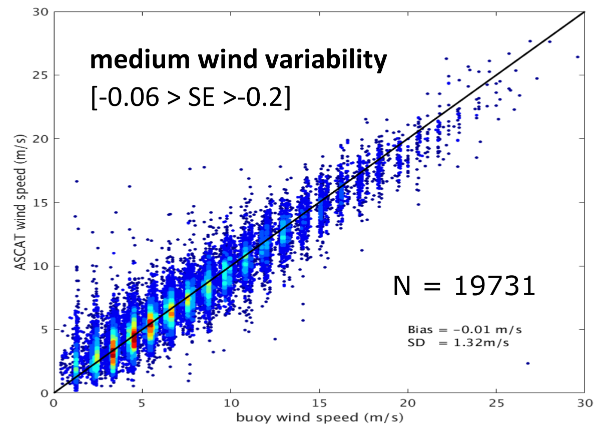


12.5 km ASCAT QC-accepted wind speed versus buoy wind speed

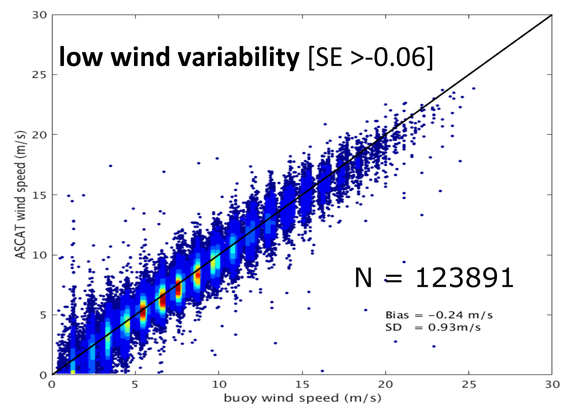
ASCAT 12.5-km winds slightly low w.r.t. buoy winds above 15 m/s (regardless of anemometer height) – Similar results for 25 km ASCAT winds

ASCAT/Buoy comparison - different wind variability conditions





- ASCAT 12.5-km winds slightly low w.r.t. buoy winds
- Standard deviation increases as the wind variability condition increases



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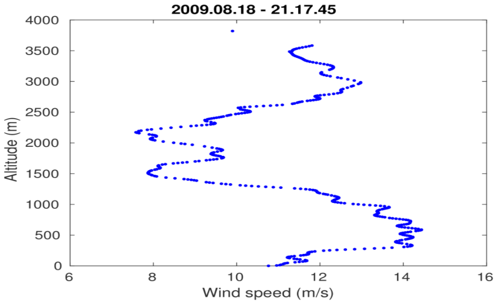
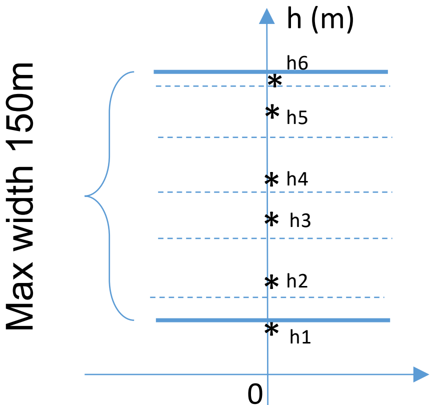
Dropsonde WL150 Algorithm



- WL150 wind is a altitude **weigthed average of the lowest 150m** wind measurements available between 10m and 350m



$$h_1 \geq 10\ m$$
$$h_6 \leq 350\ m$$

$$u_{L150} = \frac{\sum_{i=1}^{n} u_i w_i}{h_n - h_1}$$

$$v_{L150} = \frac{\sum_{i=1}^{n} v_i w_i}{h_n - h_1}$$

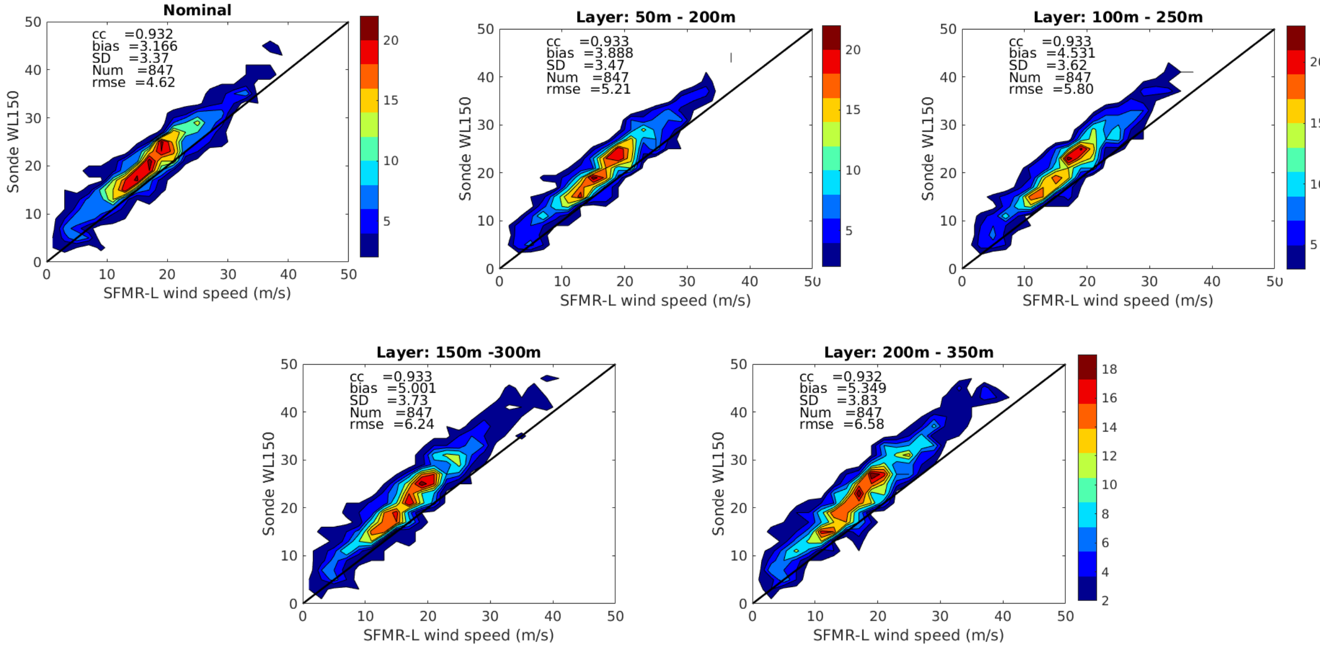
$$\boldsymbol{WL150} = \sqrt{u_{L150}{}^2 + v_{L150}{}^2}$$

$$u_{10} = \mathbf{0,85} u_{L150} + 0{,}89$$

$$v_{10} = \mathbf{0,85} v_{L150} + 0{,}89$$

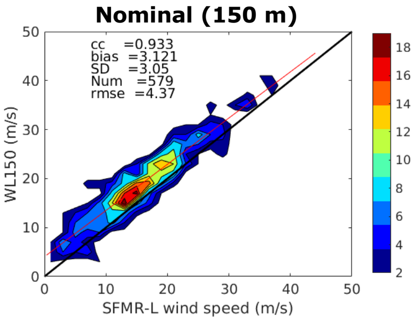
$$\boldsymbol{U10\_WL150} = \sqrt{u_{10}{}^2 + v_{10}{}^2}$$

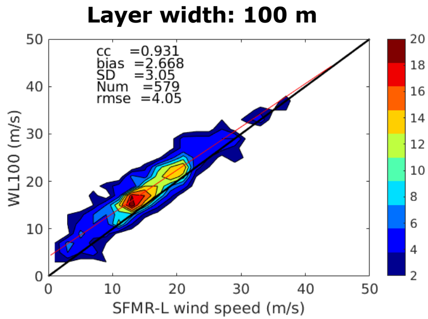
WL150 Algorithm: Minimum heights effects

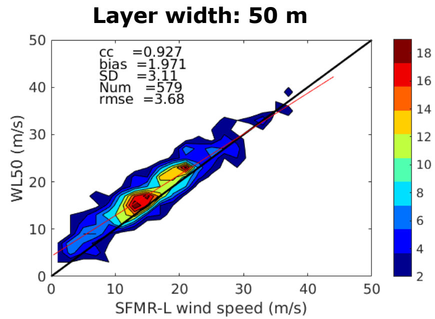


- Increasing mean bias from 3.17 m/s (nominal altitudes) to 5.35 m/s (highest altitudes).
- Slightly increase of the standard deviation and scaling with height.

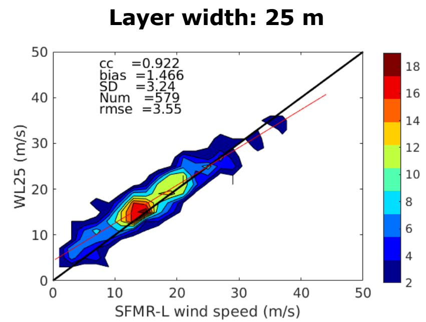
WL150 Algorithm: Layer width effects



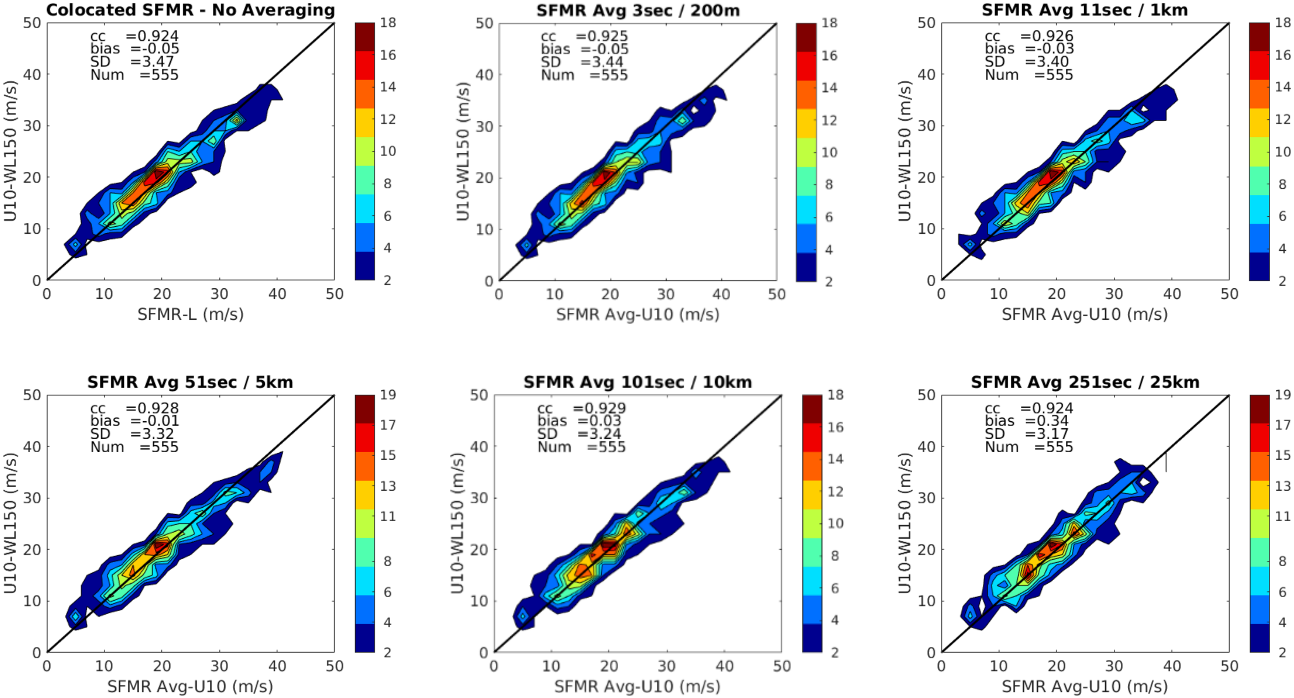




- The layer width has an impact on WL wind computation;
- The sonde WL wind/SFMR mean bias and RMSE decrease when using smaller layers;
- The 0.85 correction used to convert the sonde WL150 into U10 should be revised when having layer smaller than 150 m.



Sonde U10_WL150 w.r.t. SFMR averaging



Slightly decrease of the standard deviation

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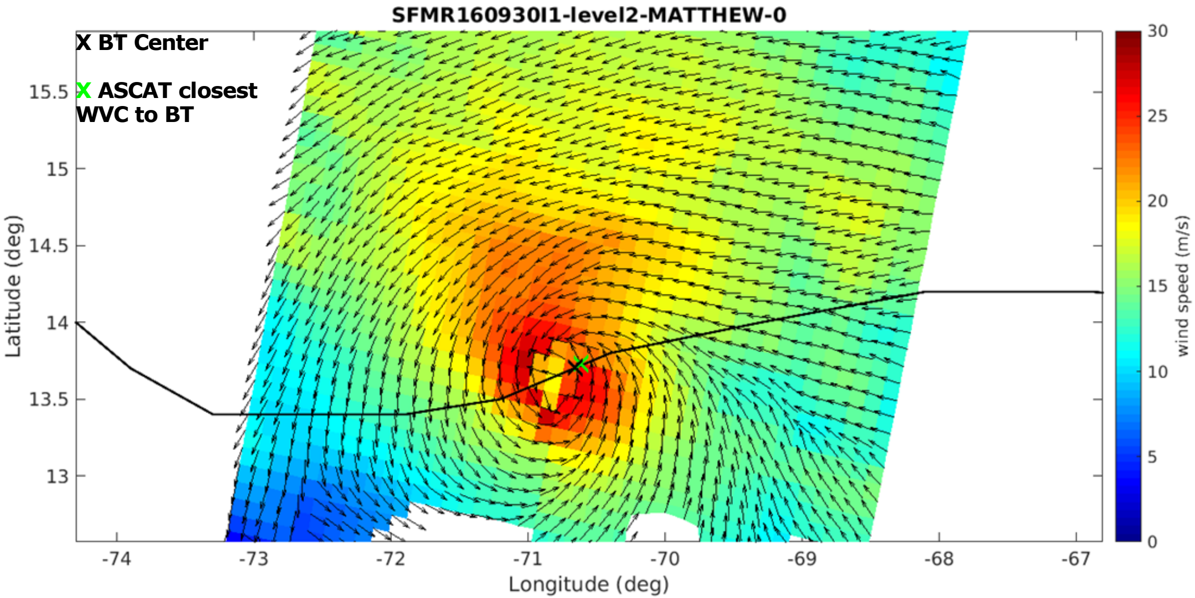
SFMR/ASCAT Comparison: Storm center identification

Interpolation of Best track position to ASCAT pass time (BT points every 6h)

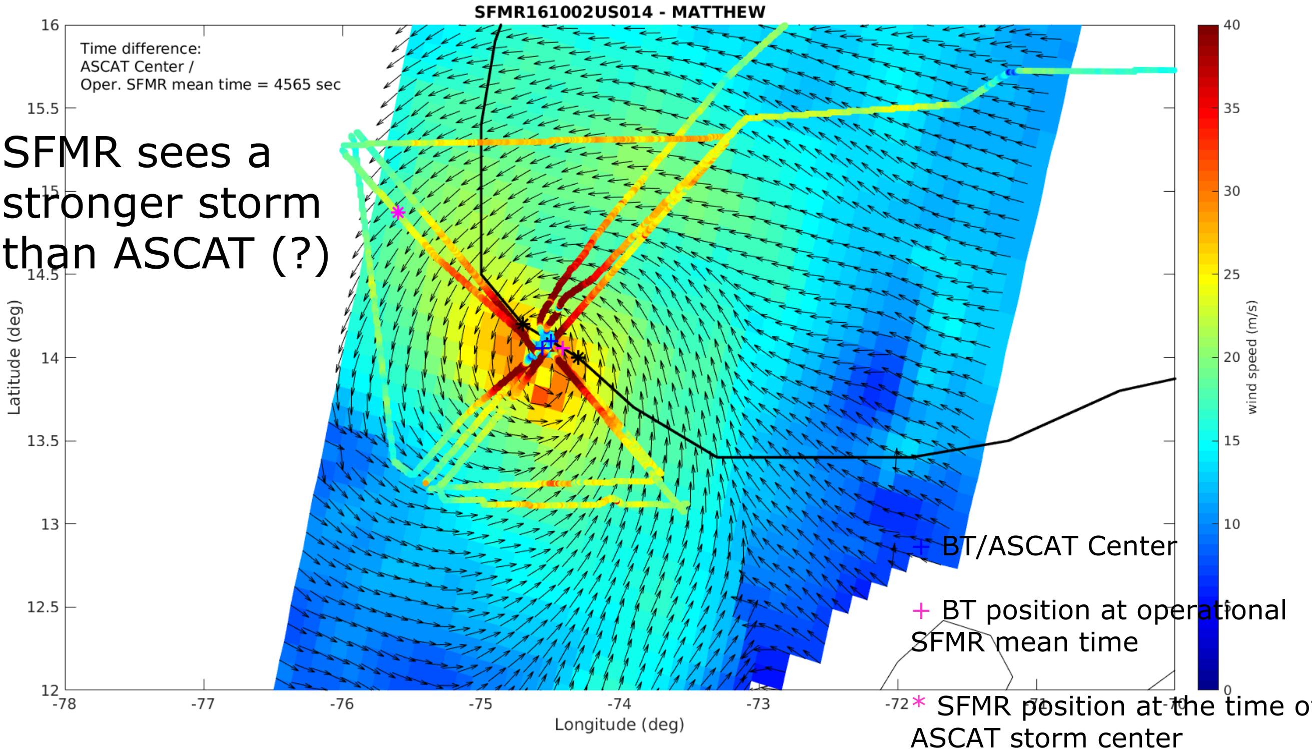
Is Best track accurate enough for ASCAT storm center estimation?



Test case: MATTHEW 2016

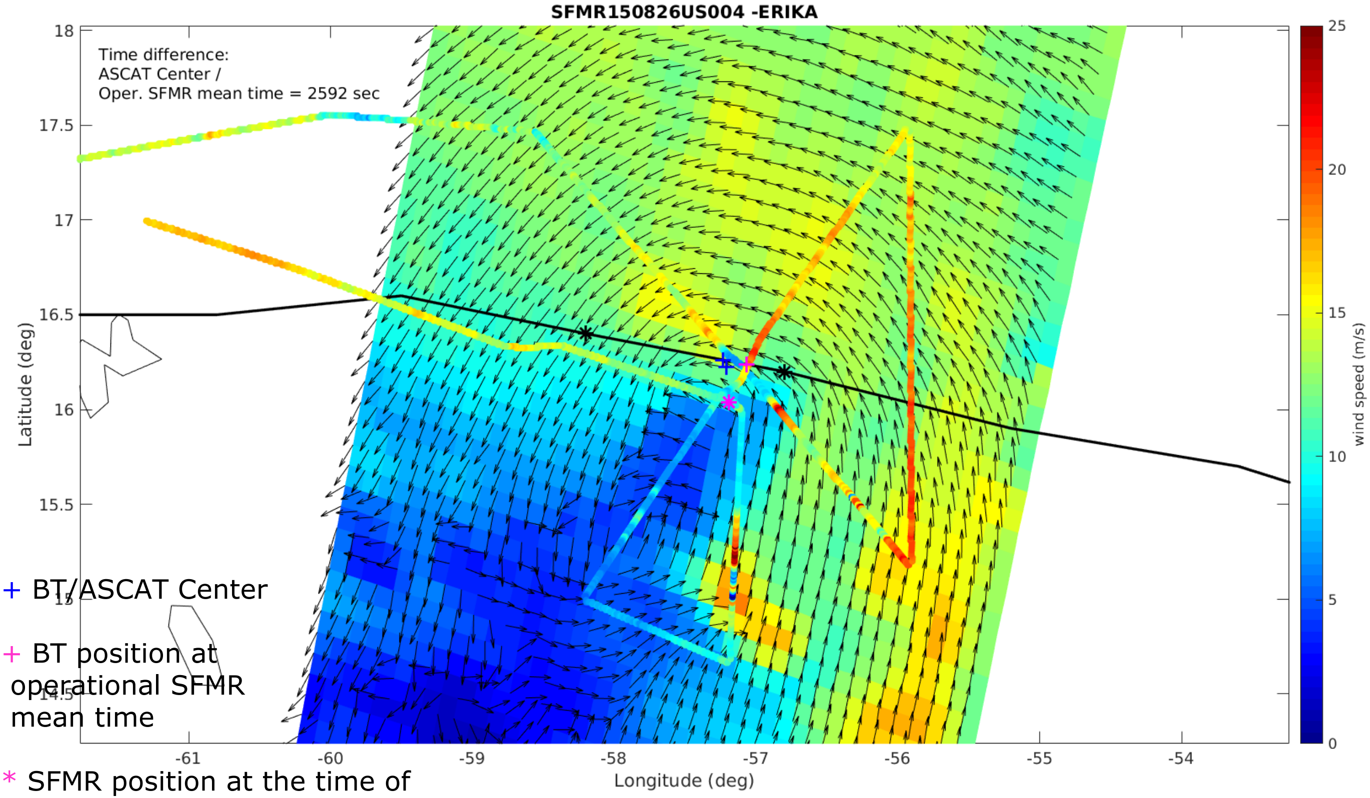
Storm-motion relative conversion: The BT vector around the time of the SFMR eye-wall observations (15% of maximum wind observations) is used.

Time difference ASCAT storm center / SFMR mean operational time: $\sim\mathbf{1.30\ h}$



Test case: ERIKA 2015

Time difference ASCAT storm center / SFMR mean operational time: ~**45 min**



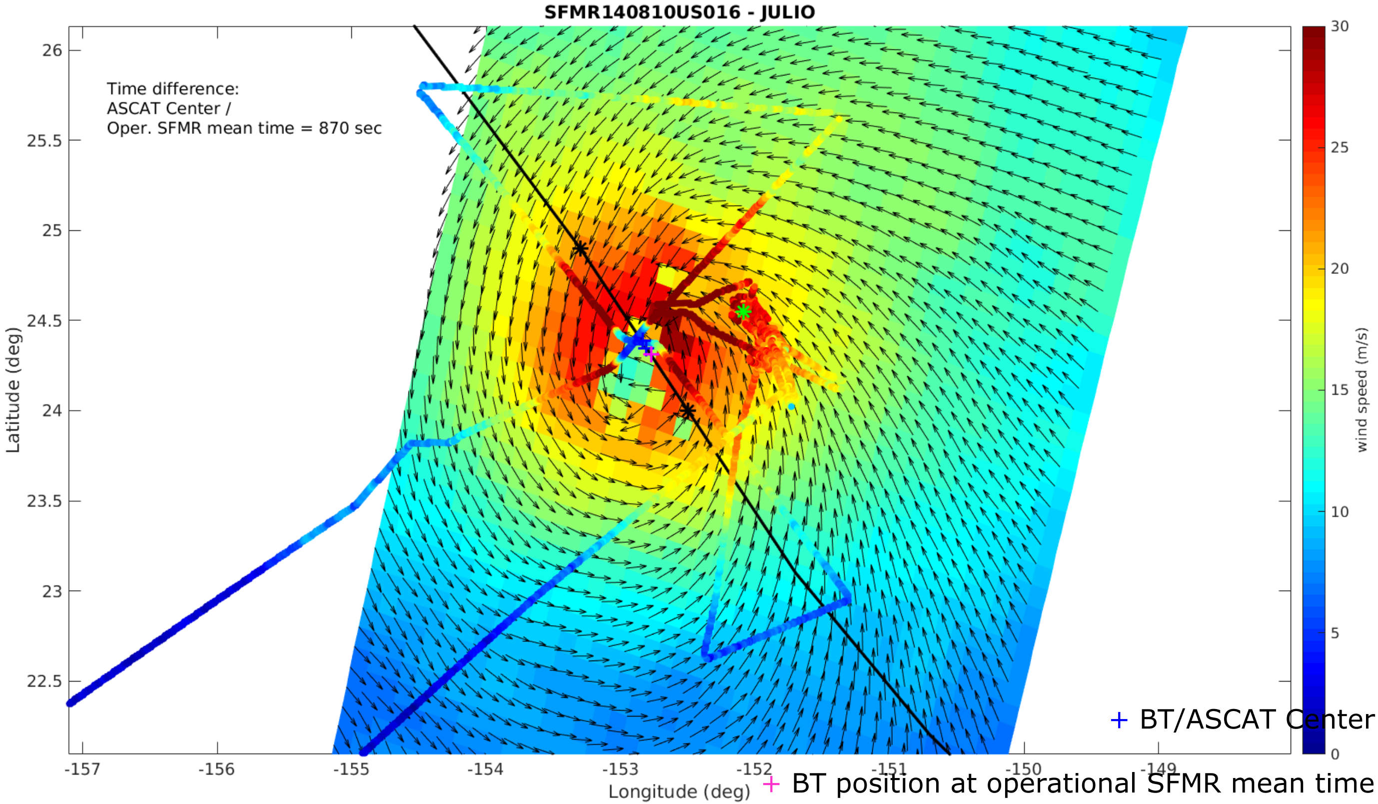
+ BT/ASCAT Center

+ BT position at operational SFMR mean time

* SFMR position at the time of ASCAT storm center

Test case: JULIO 2014

Time difference ASCAT storm center / SFMR mean operational time: ~**15 min**



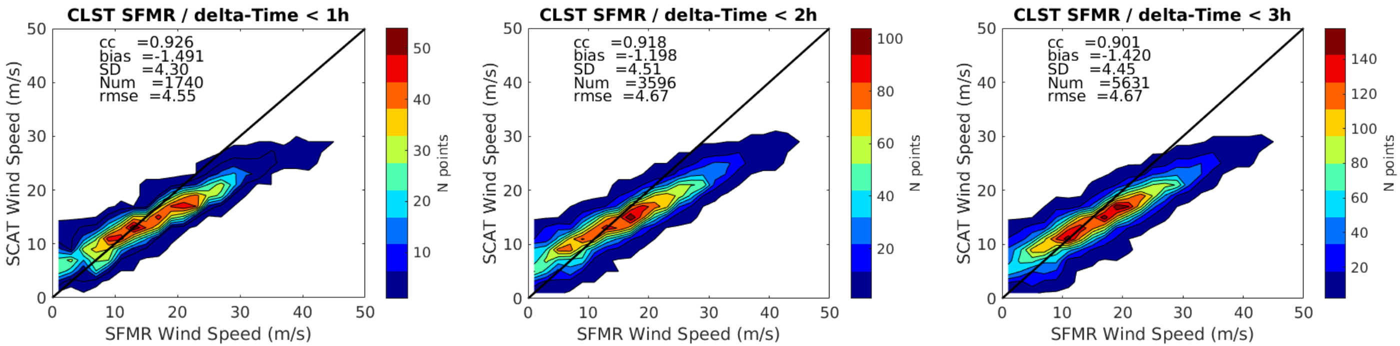
+ BT/ASCAT Center

+ BT position at operational SFMR mean time

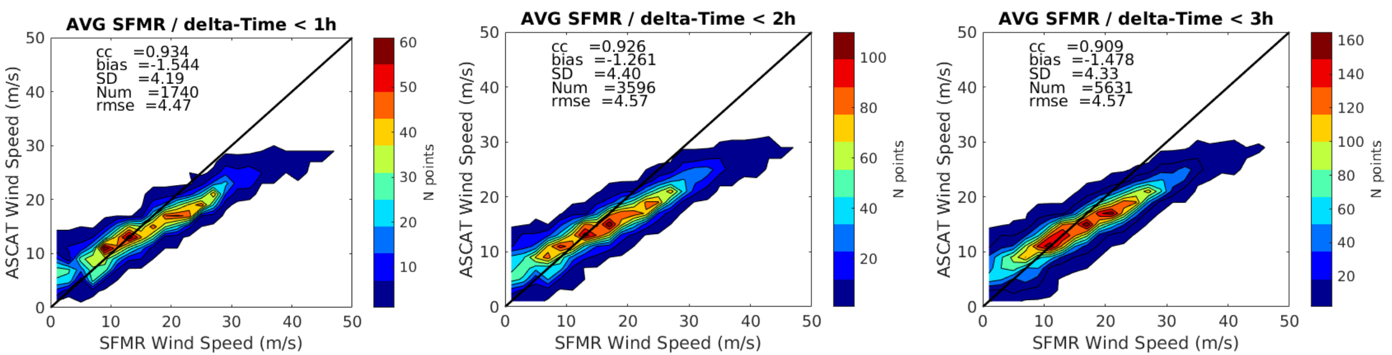
* SFMR position at the time of ASCAT storm center

SFMR/ASCAT Comparison: Preliminary Statistics

ASCAT compared to **closest SFMR** for different ΔT



ASCAT compared to **12.5km averaged SFMR** for different ΔT



Period: 2009-2016

Conclusions

- **ASCAT wind products in good agreement with collocated buoy winds up to 25 m/s; slight underestimation of ASCAT w.r.t. buoy for winds above 15 m/s;**
- Triple collocation analysis shows no significant degradation of buoy winds up to 25 m/s;
- SFMR & dropsonde comparisons at different spatial/temporal integrations show in general good agreement;
- Special attention is required at near eyewall collocations (most extreme winds & gradients);
- Dropsonde WL150 – the layer width and mean altitude do matter. The 0.85 correction factor (to estimate the 10m winds) applies for the lowest 150m layer; alternative correction factors are required for other layers.
- Significant best track position errors
  - Alternatives: use of SFMR data to estimate the storm track; this will only work though when coincident (in time) SFMR-ASCAT overpasses; more accurate estimation of storm center using ASCAT data.
- **Substantial underestimation of ASCAT winds > 15 m/s w.r.t. SFMR;**
- **ASCAT & SFMR however very well correlate (0.93) for high winds**;
- **Discrepancy between buoy & SFMR high-wind scaling. Which one should we trust?**

Two new positions issued at the Barcelona Expert Centre (ICM-CSIC):

- Remote sensing

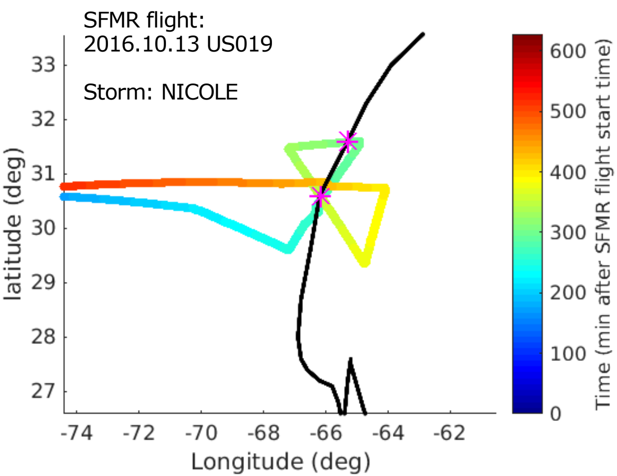
- Data assimilation into regional NWP

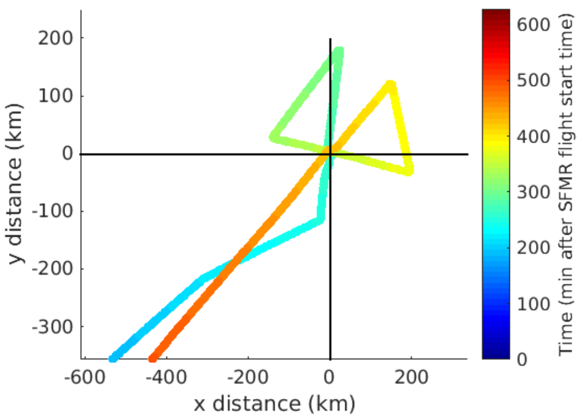
Contact point: Marcos Portabella (**portabella@icm.csic.es**)

SFMR/ASCAT Comparison: Storm motion relative conversion

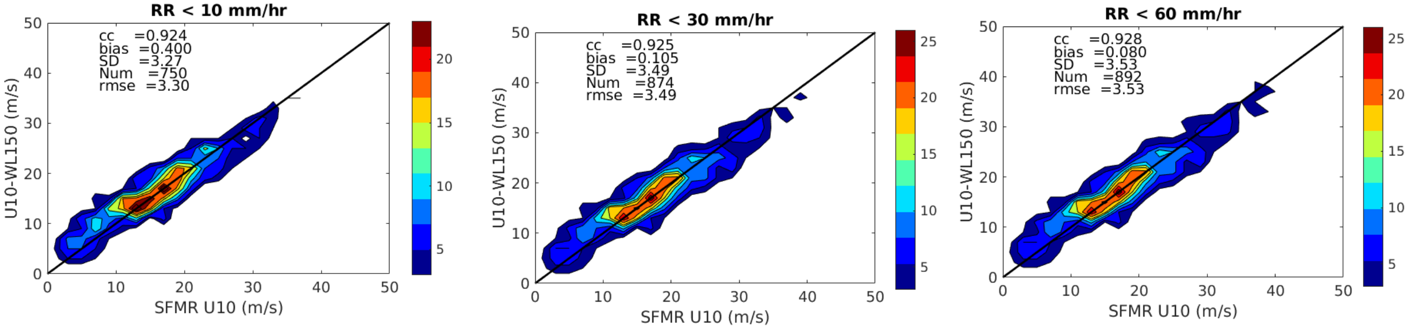
- Only **one best track vector** (*) is used for SFMR storm-relative conversion;

- The vector used is the one around the **time of the SFMR eye-wall observations** (15% of maximum wind observations – operational SFMR altitude).





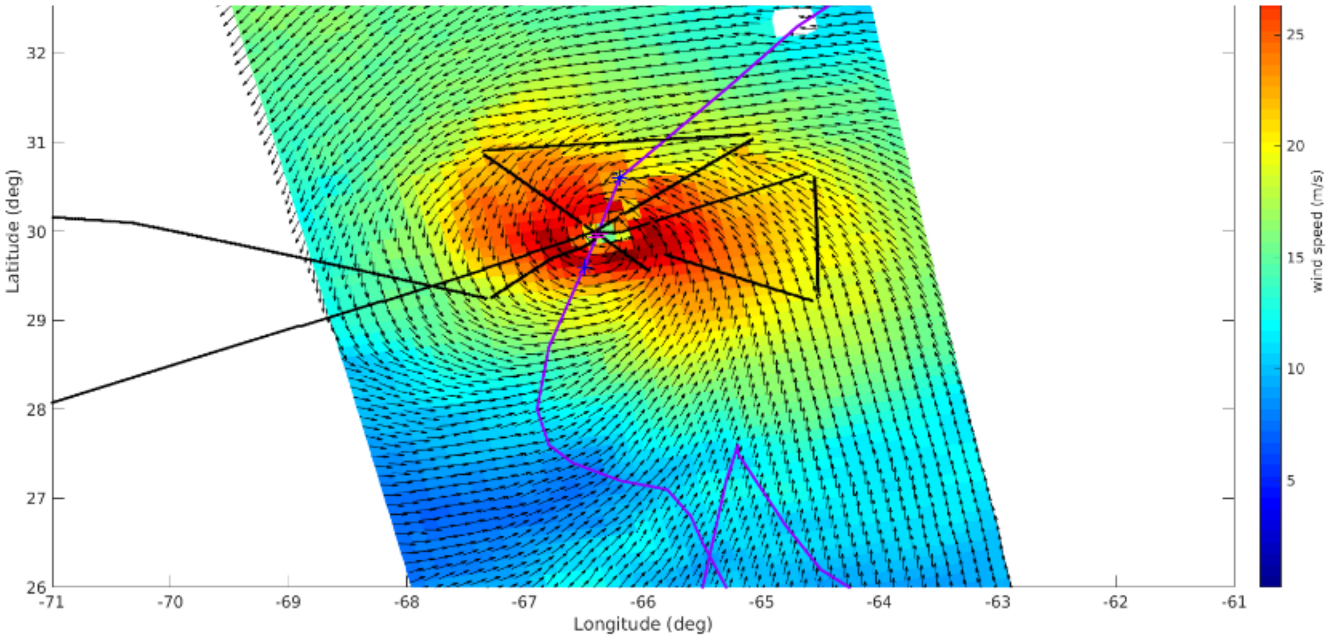
SFMR/Sonde statistics: Rain Effects



- Slight overestimation of SFMR w.r.t. dropsonde at high wind speeds, when high rain rate events occur

- A new reprocessed SFMR dataset will be analyzed (Sapp et al., 2019)

Artifacts when using different BT vector

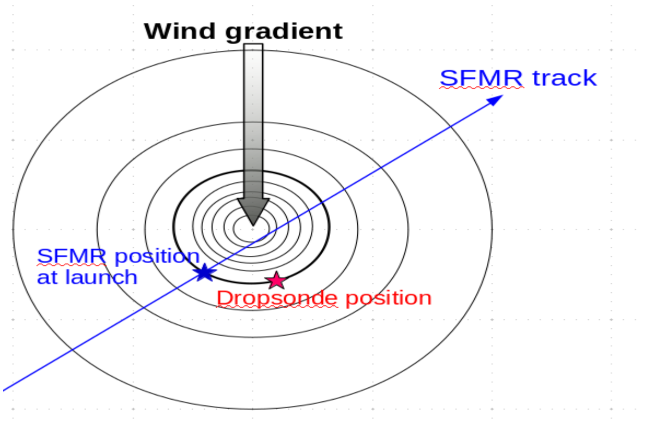


SFMR/Sonde collocation method (1/2)

Using the **dropsonde launch time:**
Associating to the dropsonde surface winds the SFMR value at the dropsonde launch time

The dropsonde **displacement** is generally with the **same radial distance** with respect to the center.

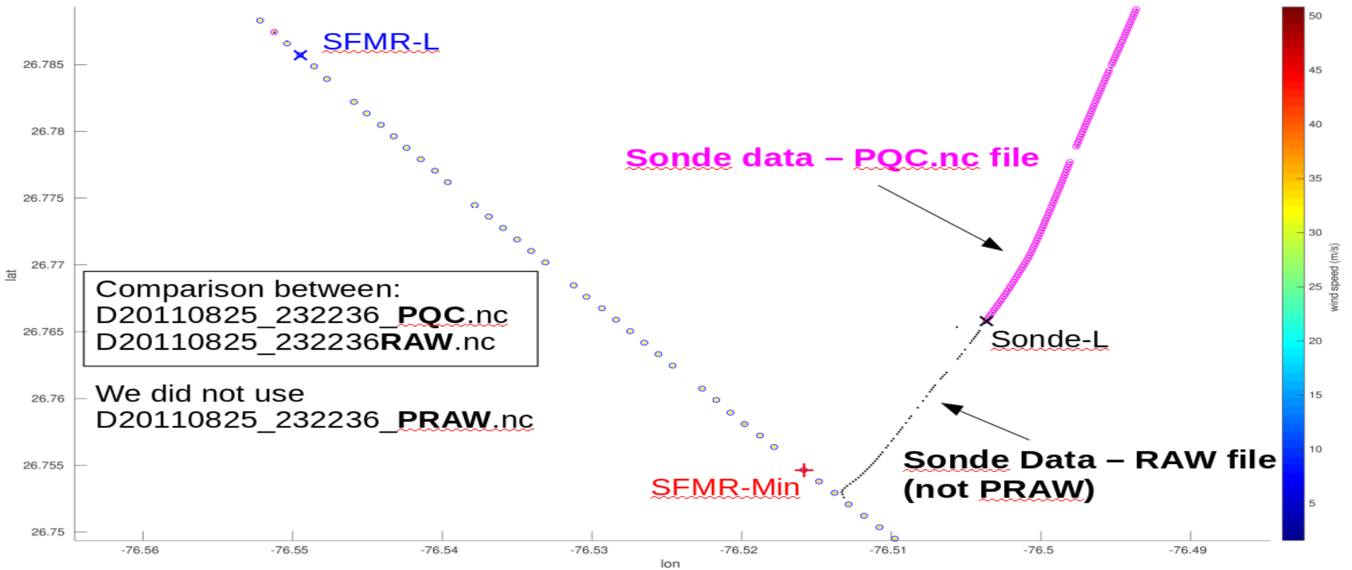
We assume that the dropsonde and the SFMR at the launch time are observing the same wind.



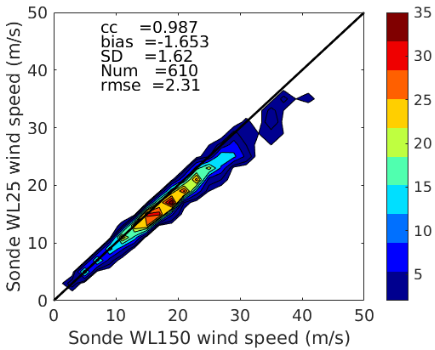
[Uhlhorn et al., 2007 and Klotz et al., 2014]

SFMR/Sonde collocation method (2/2)

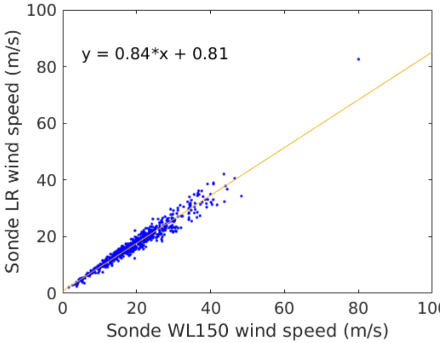
Using Sonde launch time saved in the raw data

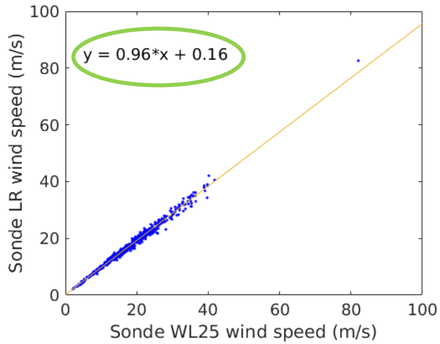


WL25 w.r.t. WL150: new correction factor

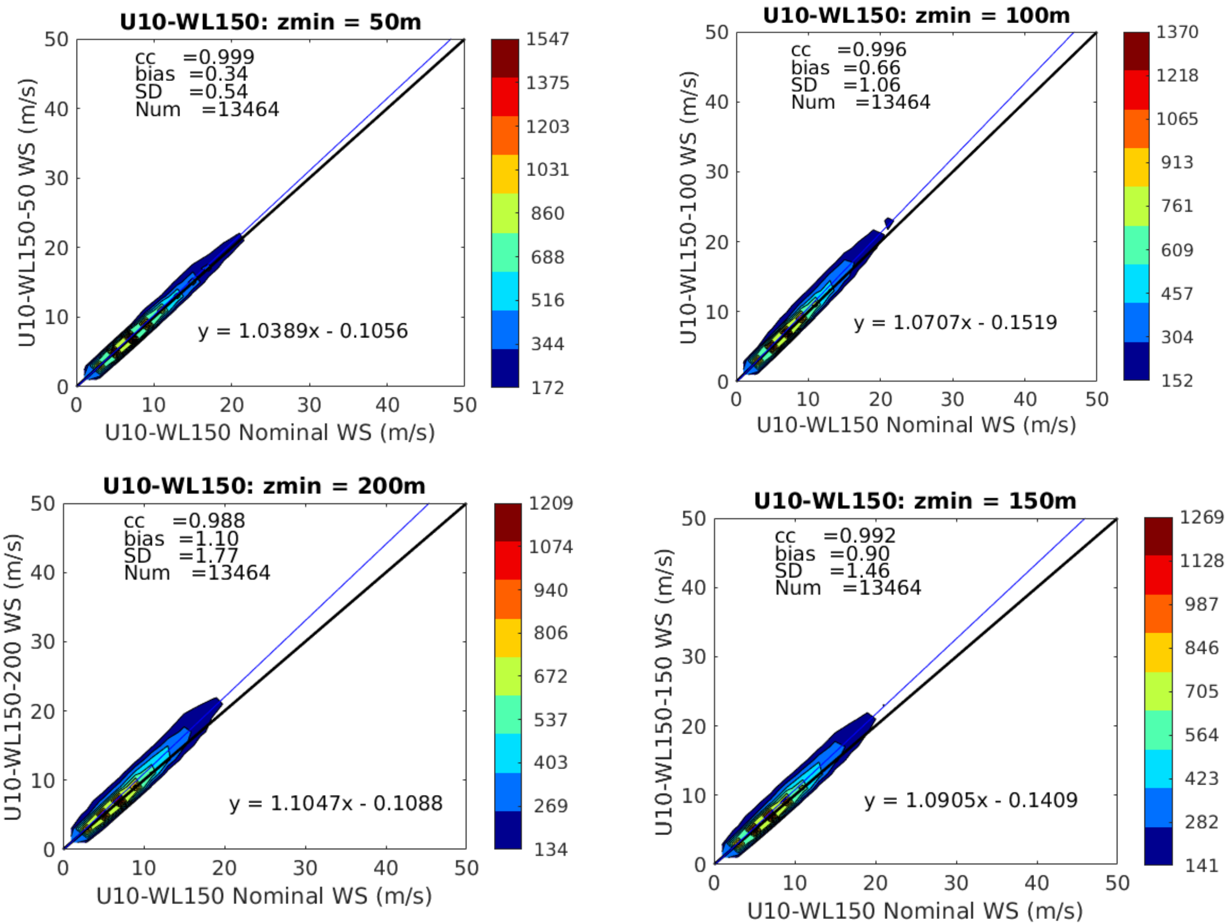


- WL25 gets lower winds w.r.t. WL150
- WL25 might be more noisy than WL150 as it is derived by measurements closer to the surface
- New correction needs to be applied to estimate U10 from WL25





Sonde U10_WL150: different minimun heights



A correction has been defined and applied