# A comparison of QuikSCAT winds to in situ observations in the Western Boundary Current regions

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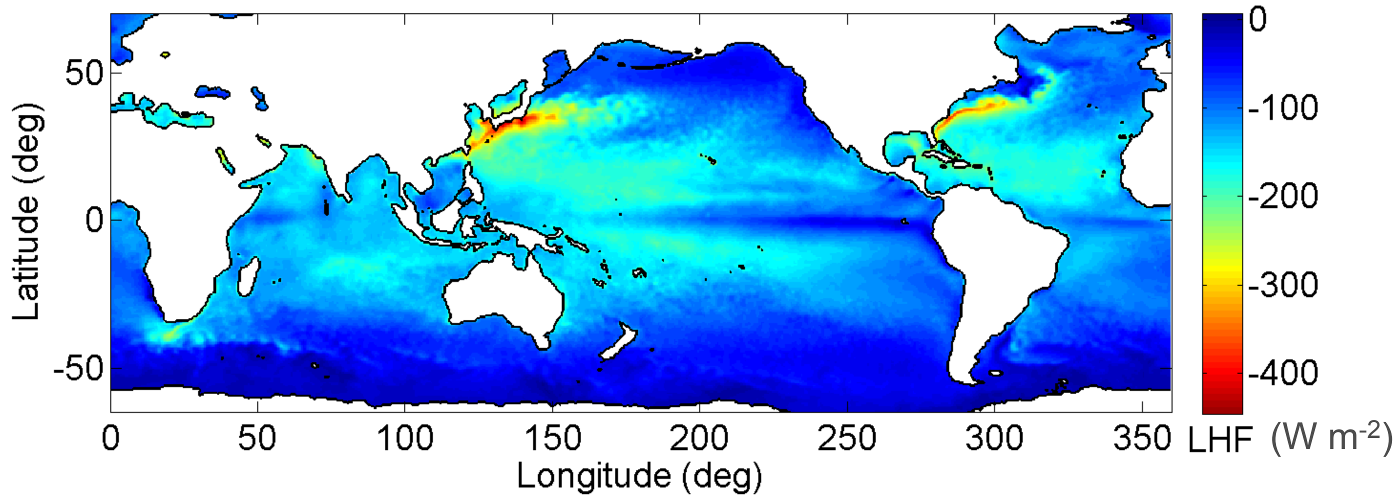
IOVWST, Barcelona 2010

# Why be concerned with Western Boundary Current regions?




Wintertime (DJF) 2005-2006 average latent heat flux calculated from QuikSCAT, AMSR, and ECMWF

Western boundary currents (WBC) are regions of enhanced air-sea interaction and surface heat fluxes.

- formation of mode water
- storm energetics
- global ocean circulation
- coupling throughout the troposphere.

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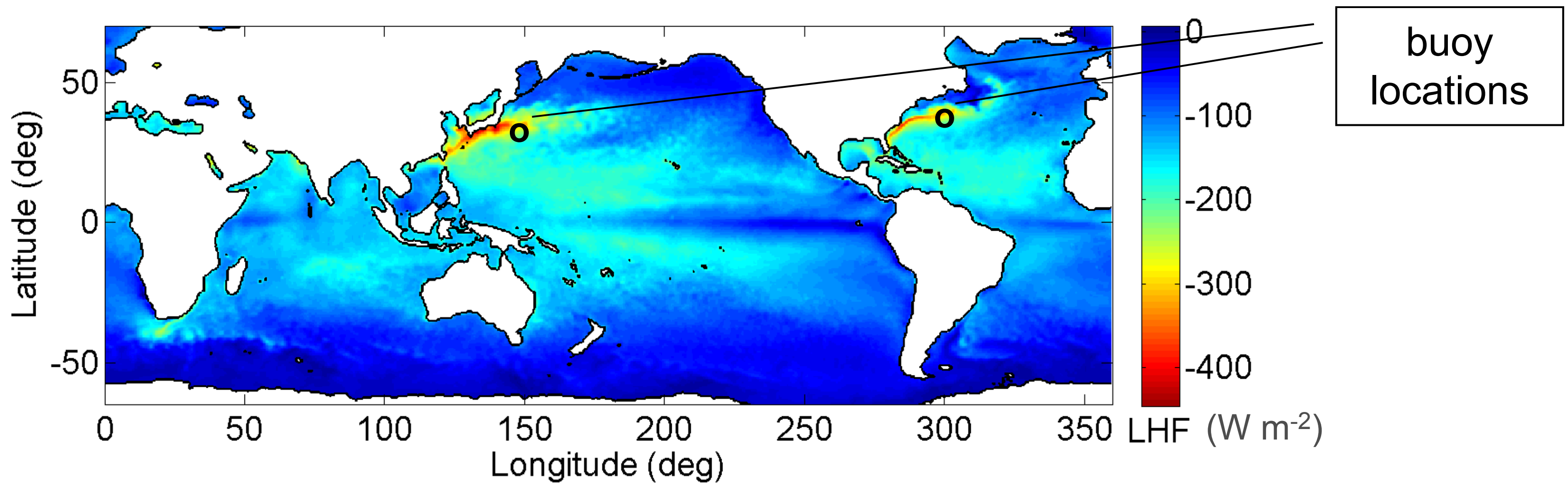


Two moored buoys provide in situ observations at the surface .

Specifically motivating:

* An in-situ validation of QuikSCAT winds in challenging environmental conditions

* The effect of surface currents, waves, and stability on wind speed and wind stress measurements

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# The buoy data

**The 2007 KEO buoy**


NOAA/PMEL,
M. Cronin

Hourly observations of:

* wind vector (10 min. average)
* air, sea temperature
* surface current (15m and 10m depth)
* rain rate
* relative humidity

**CLIMODE buoy**

J. Edson, R. Weller,
S. Bigorre

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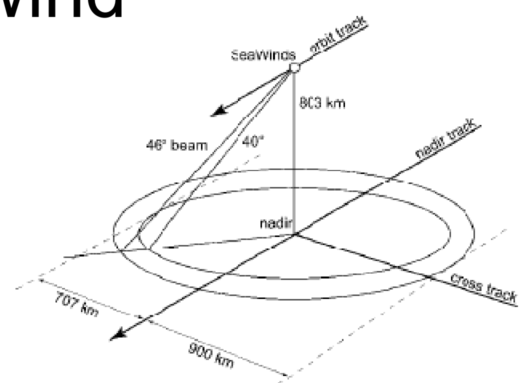
# QuikSCAT remote wind

* JPL Po.daac level 2B wind retrieval (12.5 km)
* The QSCAT-1/F13 geophysical model function
* Rain flags: IMUDH (Huddleston and Stiles 2000).
  NOF (Wentz, Mears, Smith 2000)
  QuikSCAT Radiometer (Ahmad et al. 2005).




From Chelton Freilich (2005)

# Preparing the data

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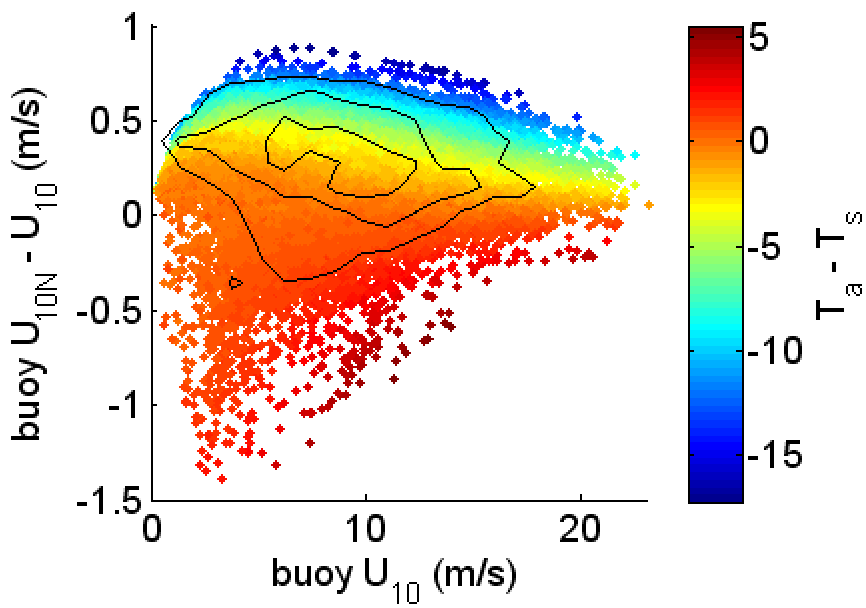


mean $U_{10N} - U_{10}$: 0.22 m/s

st. dev. = 0.24 m/s

**Color**: observed air-sea temperature difference (mostly unstable)

**Contours**: data density

Hereforth, all “buoy” measurements are anemometer winds, adjusted to 10 meter height, neutral stability.

# Preparing the data

- adjust buoy wind data to $U_{10N}$, using COARE 3.0
- co-locate in situ measurements with QuikSCAT measurements: within 30 minutes and 12.5 km
  - **each buoy observation corresponds to 2-5 QuikSCAT observations**

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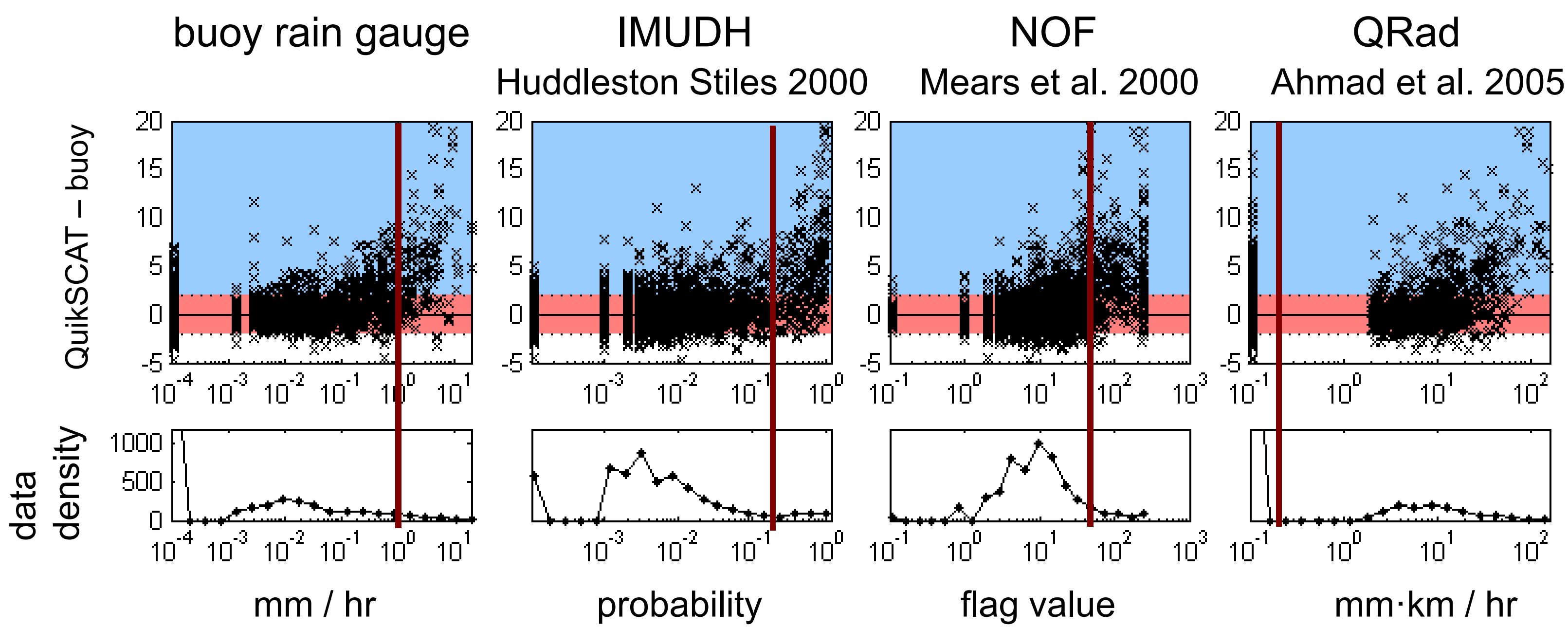
  - **each buoy observation corresponds to 2-5 QuikSCAT observations**
- remove outer swath measurements, low wind speed (U<1 m/s) observations
- identify rain-contaminated data . . .

# How effective are the rain flags?

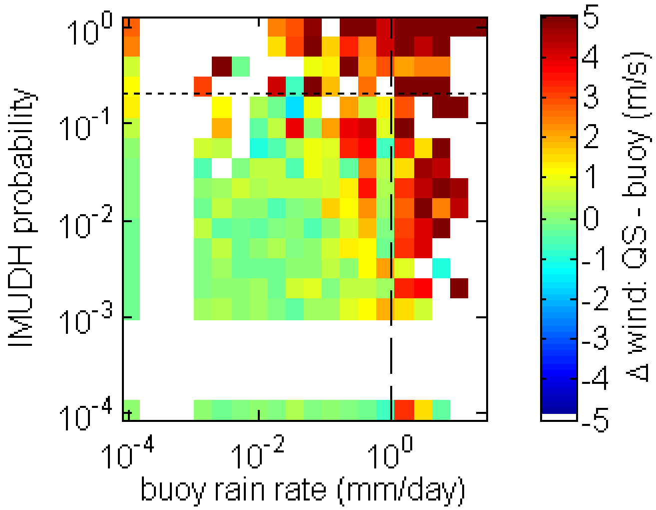
The wind discrepancy ΔU (QuikSCAT minus buoy) as a function of rain or rain flag index.
Both KEO and CLIMODE data are shown, with inner swath and wind speed above 1 m/s.



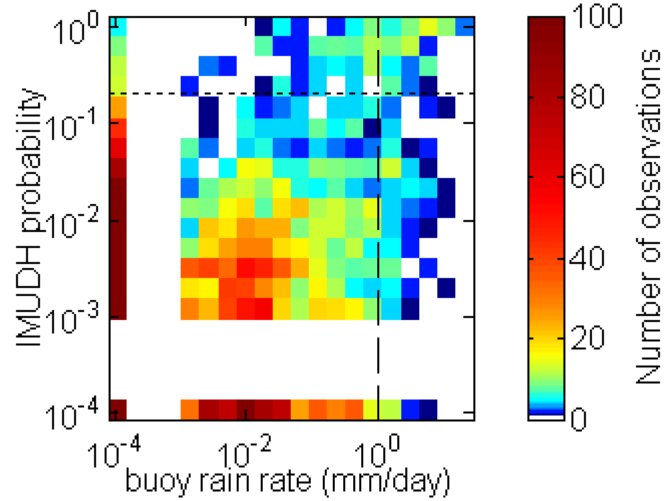

| | rain gauge: rain > 1.0 mm/hr | IMUDH probability > 0.2 | NOF U<10 and flag>50 or flag=250 | QRad rain > 0.2 mm km / hr | |
|---|---|---|---|---|---|
| observations removed with ΔU > 2 m/s : | 17.9% | 28.2% | 13.1% | 43.9% | desired removal |
| observations removed with (\|ΔU\|< 2 m/s): | 1.0% | 1.8% | 1.9% | 17.8% | FALSE POSITIVES |
| total points flagged | 3.2% | 5.3% | 3.3% | 21.2% | net |

# Something interesting is happening when satellite flags disagree with buoy rain rate

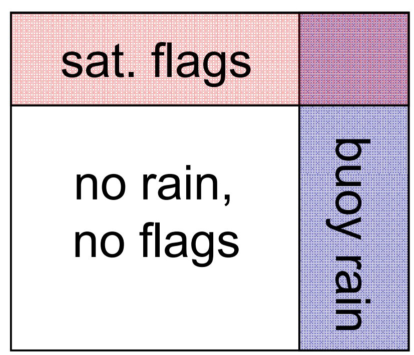
Wind discrepancy:
QuikSCAT minus buoy




Data density




Venn diagram:

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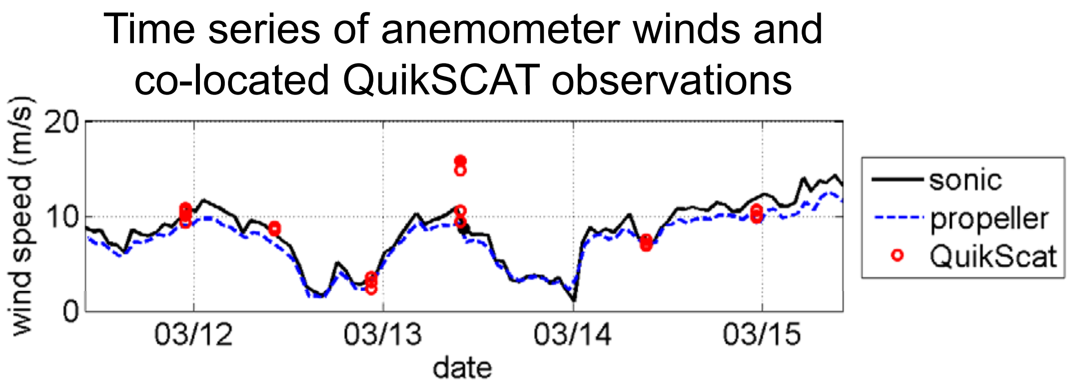
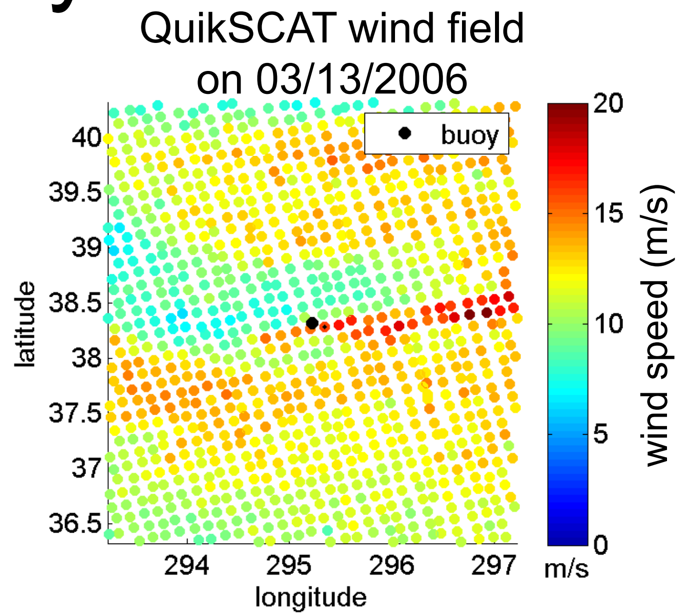
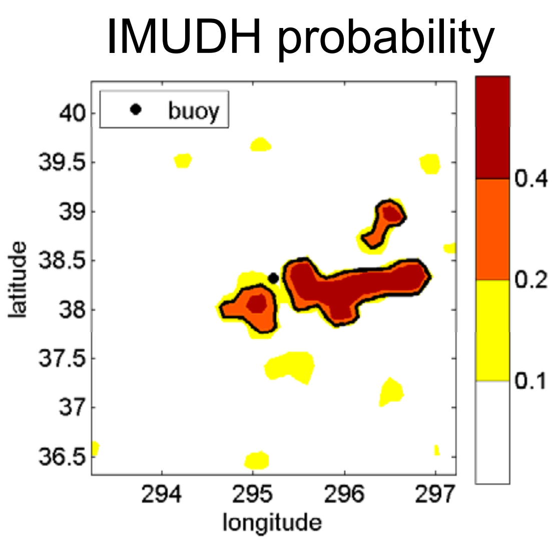
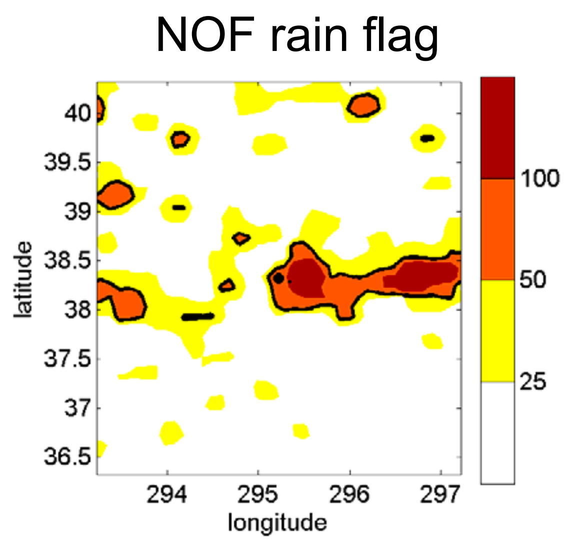
# Case example: rain flag disagreement due to spatial variability of rain

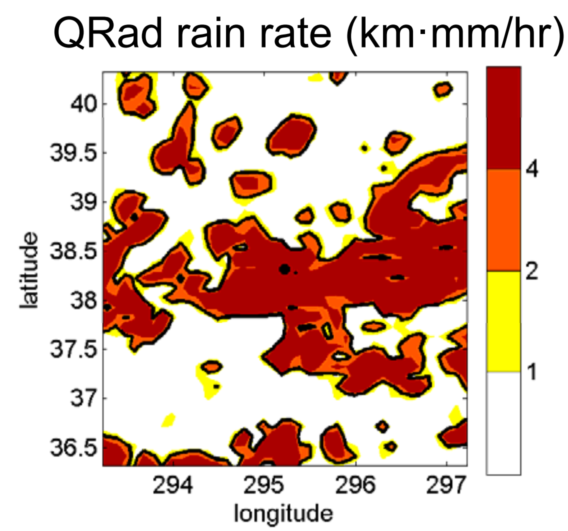


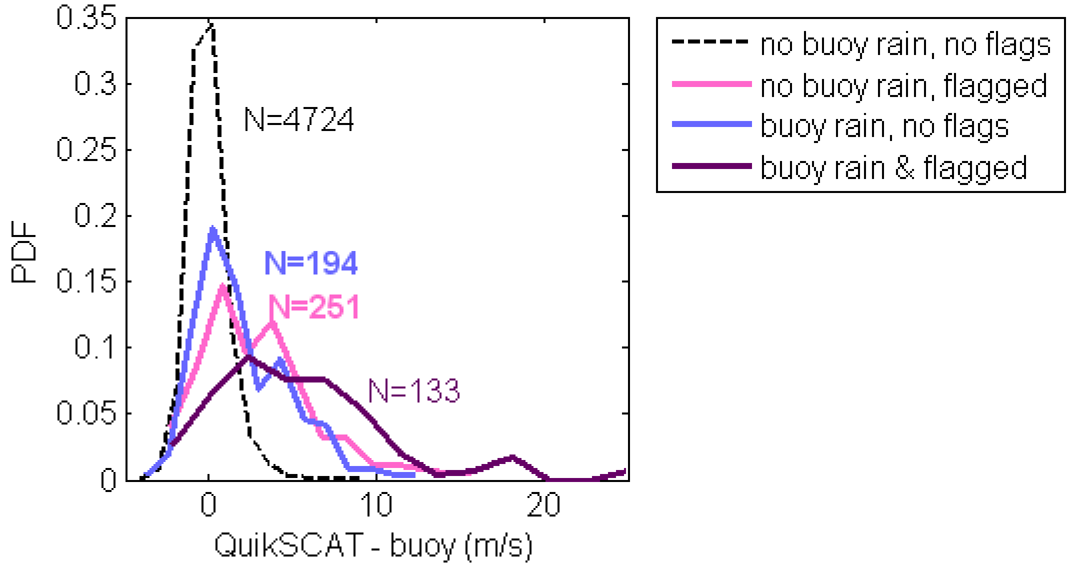

***The buoy recorded no rain at this time***

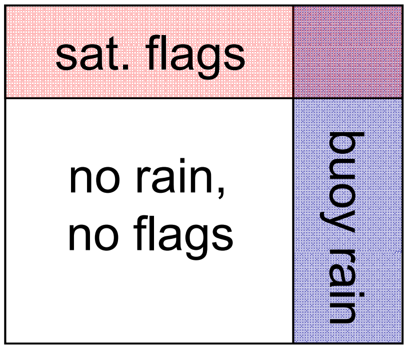


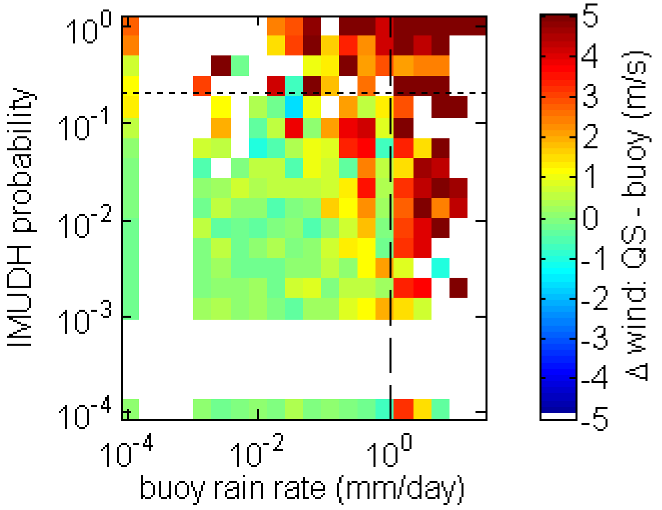



# Disagreement between rain gauge and rain flags results in larger wind speed differences.



# Final choice of rain flagging

| **rain gauge**: rain > 1.0 mm/hr<br>**IMUDH**: probability > 0.2<br>**NOF**: U<10 and flag>50, or flag=250 | |
|---|---|
| 40.5% | desired removal |
| 3.9% | FALSE POSITIVES |
| 8.6% | net |

Fraction of data removed, considering only data in the inner swath, with U > 1 m/s

| | rain gauge:<br>rain > 1.0 mm/hr | IMUDH<br>probability > 0.2 | NOF<br>U<10 and flag>50<br>or flag=250 | QRad<br>rain > 0.2 mm km / hr | |
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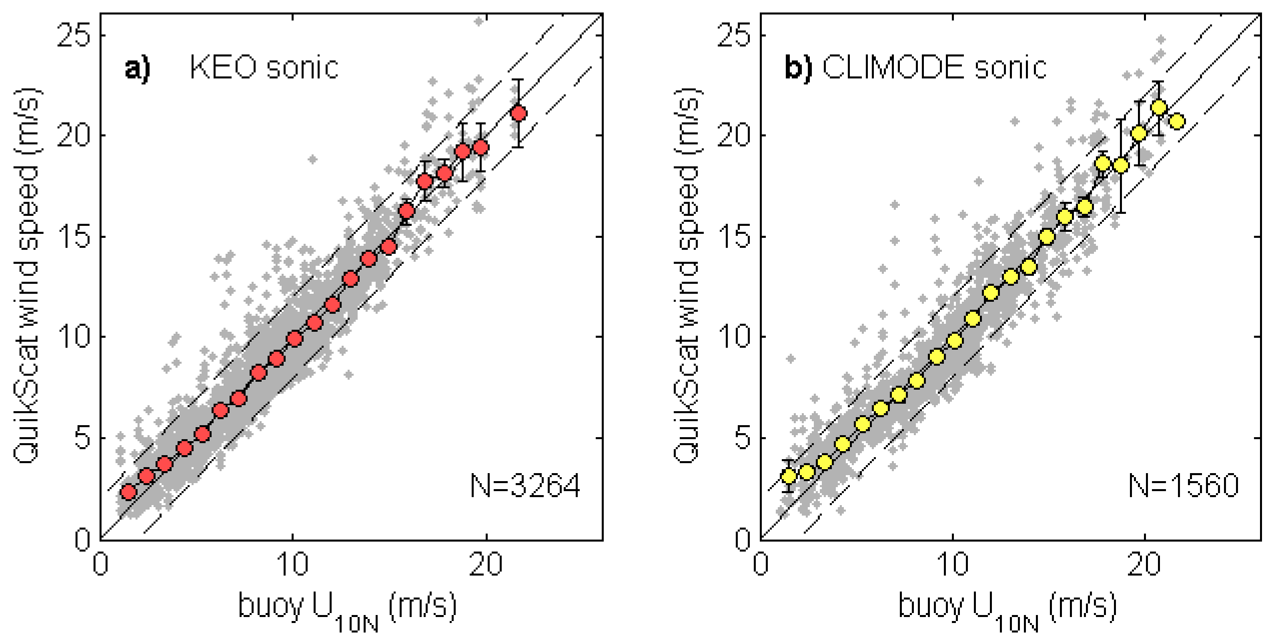
# Anemometer wind speeds show excellent agreement with QuikSCAT




| | bias (QuikSCAT – anemometer) | standard deviation |
|---|---|---|
| KEO | -0.05 m/s | 1.13 m/s |
| CLIMODE | 0.05 m/s | 1.43 m/s |

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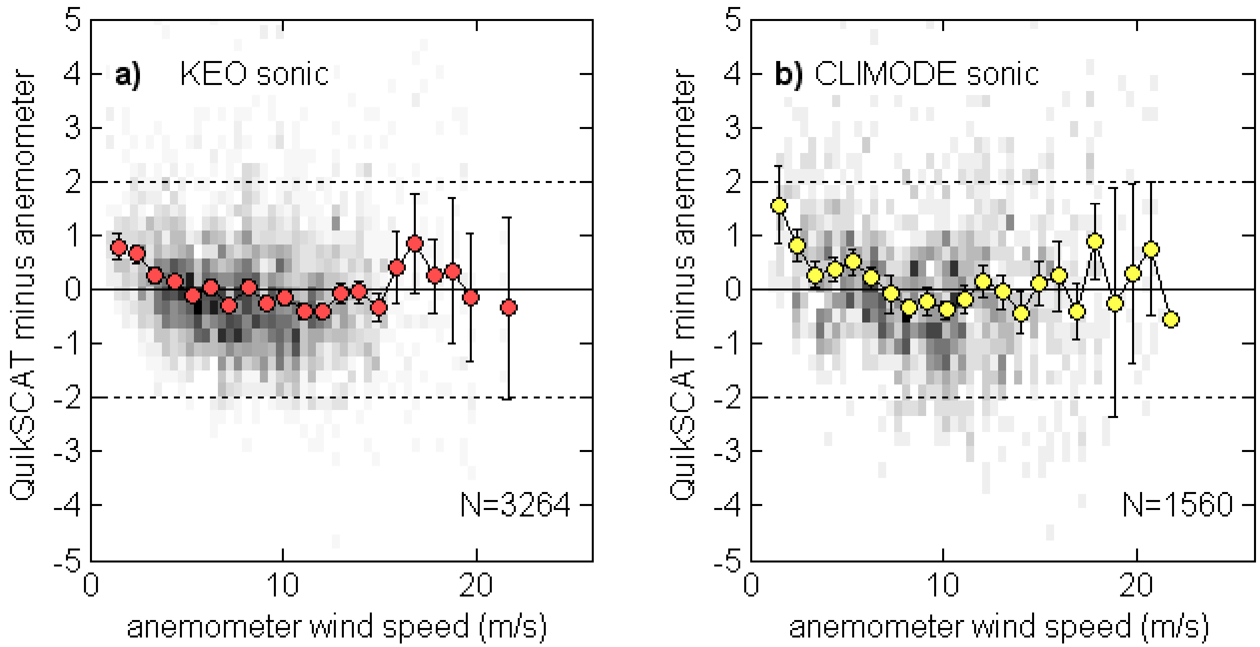


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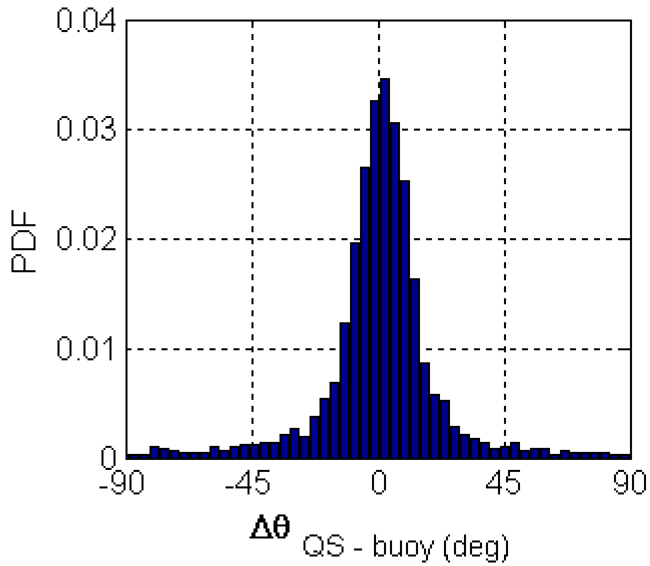
# QuikSCAT wind direction agrees with anemometer wind direction

Angle difference:
QuikSCAT to anemometer




| | Δθ: QuikSCAT to buoy |
|---|---|
| mean Δθ: | 1.2° |
| St. Dev: (for \|Δθ\| < 60°) | 16.0° |

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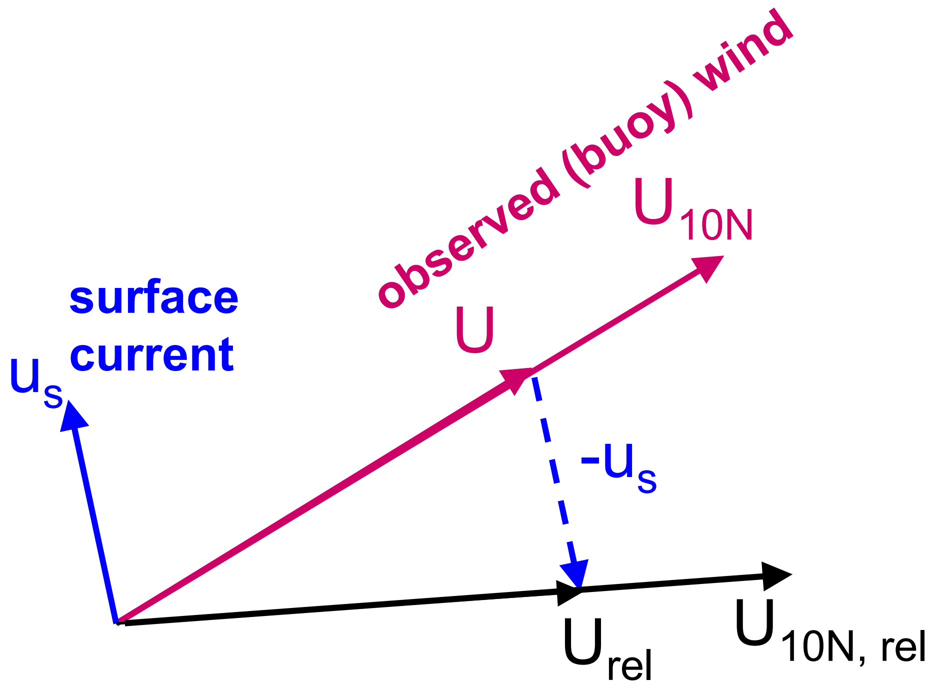
# Removal of surface current velocity from buoy wind vector




**buoy wind relative to current**

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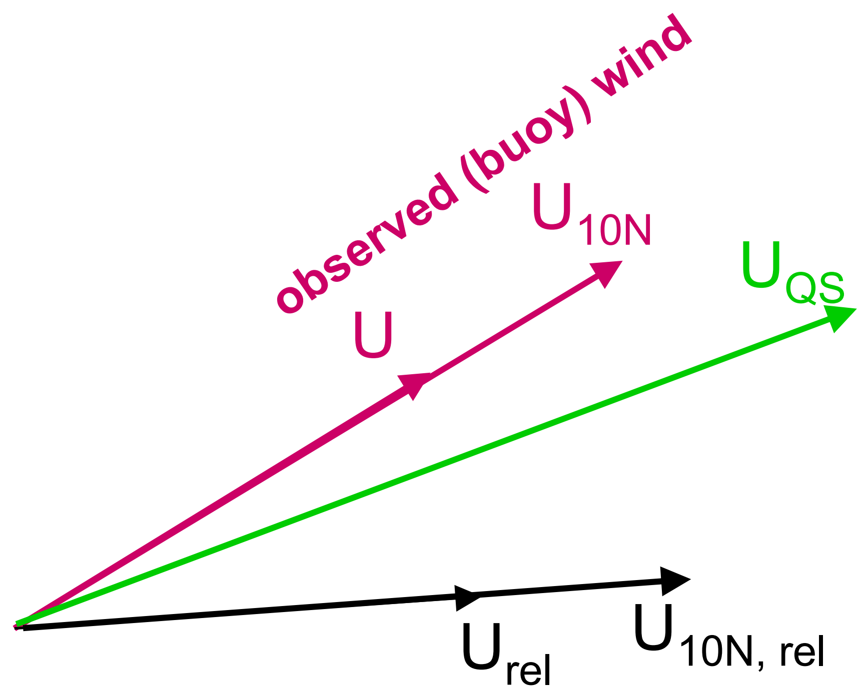


**buoy wind relative to current**

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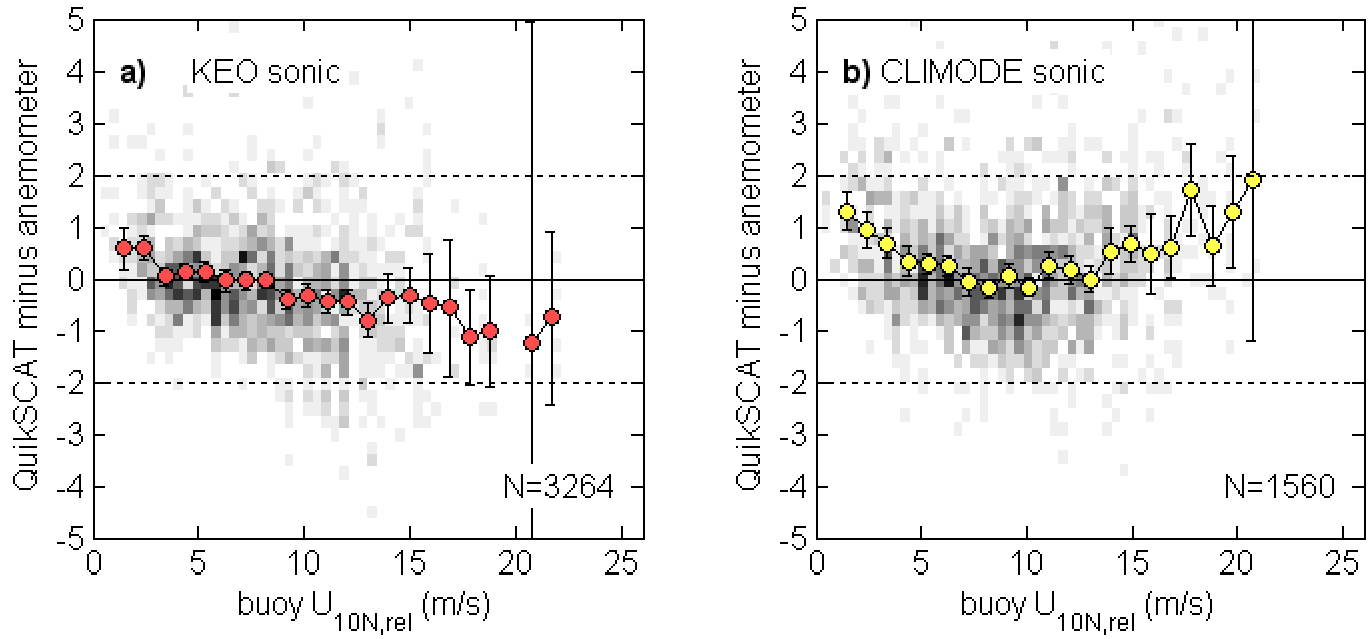
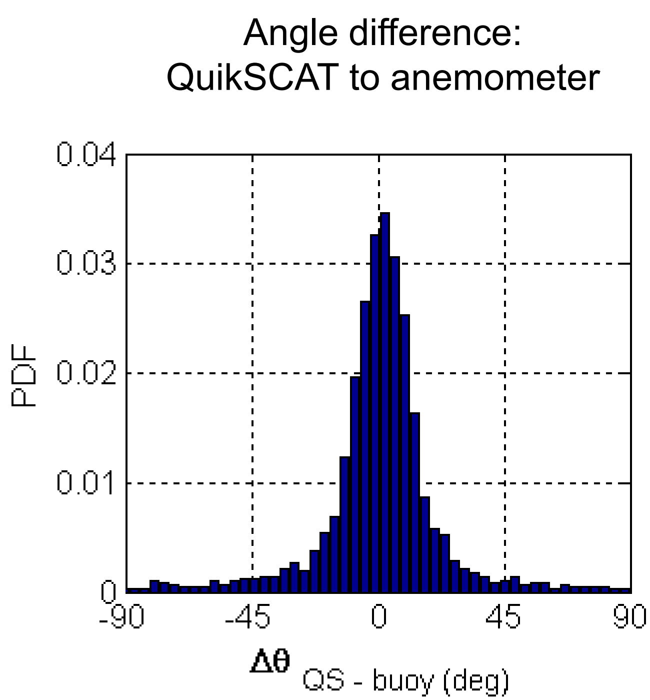
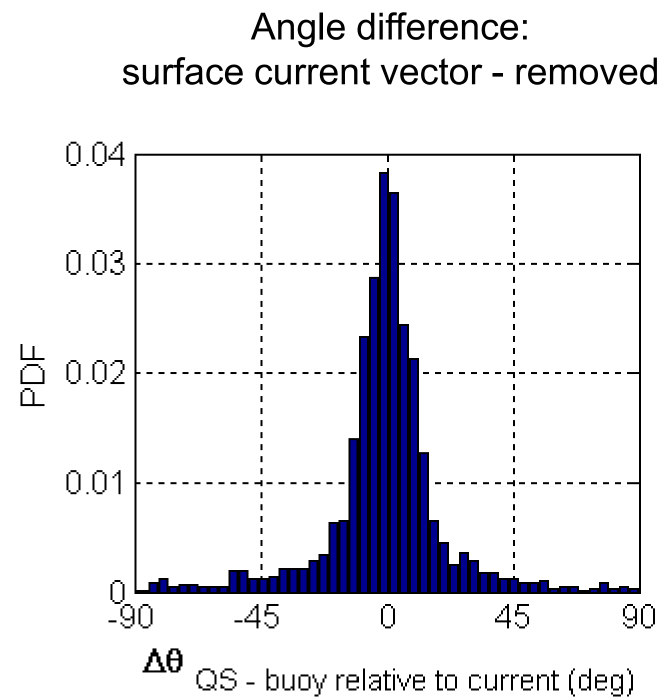
# Vector removal of surface current does not improve wind speed comparison




| | 10-meter, neutral buoy winds | | 10-meter, neutral buoy winds relative to current | |
|---|---|---|---|---|
| | bias (QS - buoy) | standard deviation | bias (QS - buoy) | standard deviation |
| KEO | -0.05 m/s | 1.13 m/s | -0.14 m/s | 1.12 m/s |
| CLIMODE | 0.05 m/s | 1.43 m/s | 0.27 m/s | 1.33 m/s |

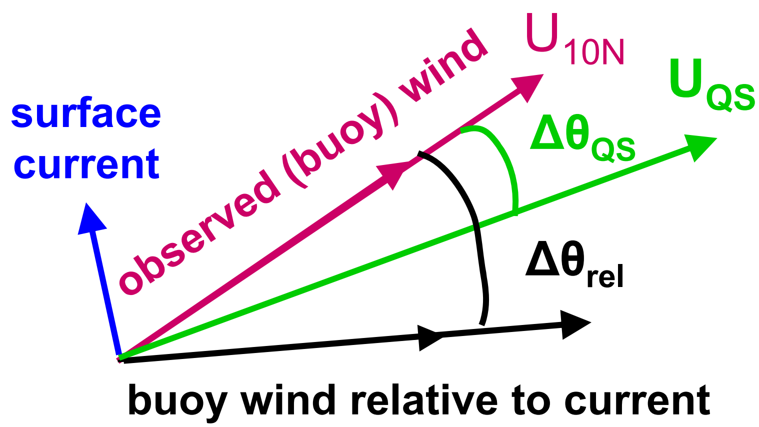
# Surface current velocity removal does not largely improve direction comparison




| | Δθ: QuikSCAT to buoy | Δθ: surface currents removed |
|---|---|---|
| mean Δθ: | 1.2° | -0.3° |
| St. Dev.: (for \|Δθ\| < 60°) | 16.0° | 16.4° |

# Is the surface current direction consistent with QuikSCAT direction?




Here, for example, the wind relative to the current is turned to the right.

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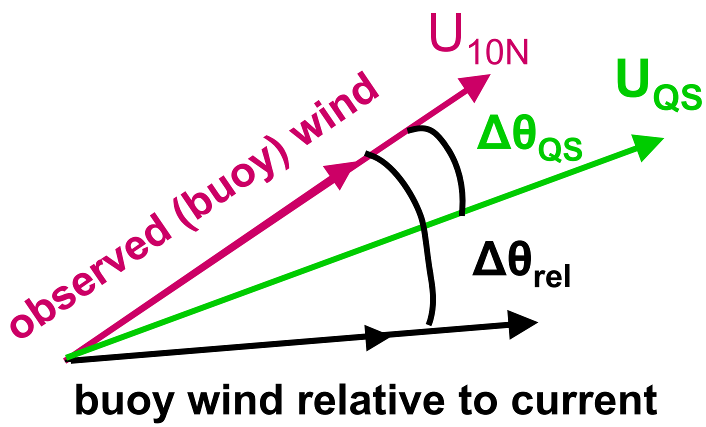
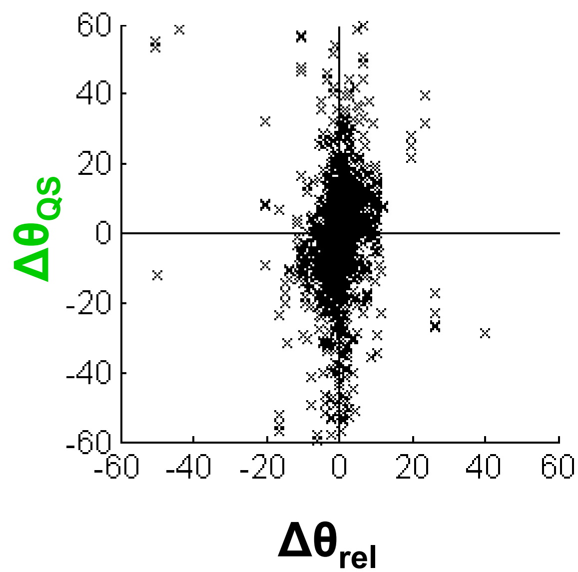
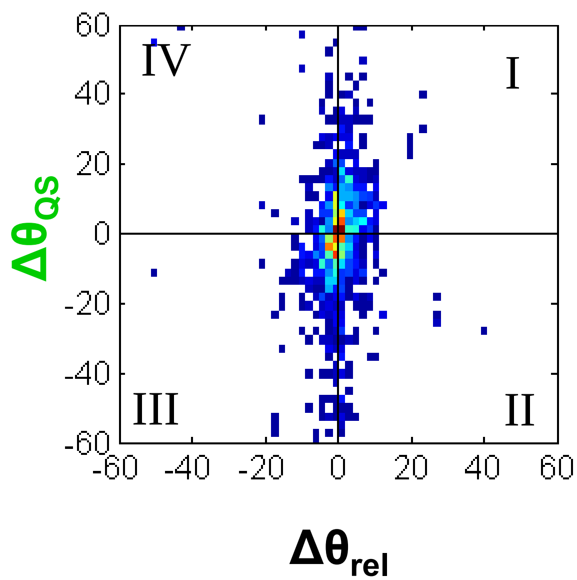
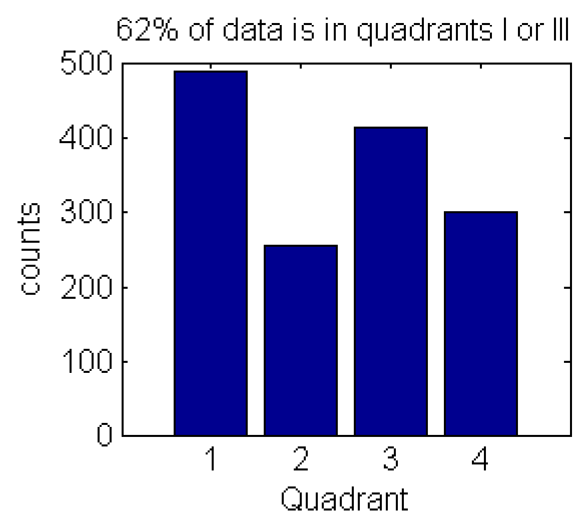
# The surface current direction is generally consistent with QuikSCAT direction




Although there is a lot of scatter, in 62% of the observations, the angle difference between QuikSCAT and anemometer winds has the same sign as the angle difference due to ocean currents.



# Conclusions

- Satellite rain flags are compared to buoy rain gauge data:
  - The IMUDH flag identifies the largest number of erroneous observations, while tagging the fewest "false positives."
  - The NOF does not remove as much "bad" data
  - The QRad appears to massively over-flag the data
- Disagreement between satellite rain flag and buoy rain rate is often due to spatial variability of the rain.
- QuikSCAT and buoy winds show excellent agreement for speed and direction.
- Vector removal of the surface current from the buoy wind does not significantly improve the agreement.
- In 62% of the observations, the angle difference between QuikSCAT and anemometer winds has the same sign as the angle difference due to ocean currents.