Detailed investigation of the role of buoy wind errors in buoy-scatterometer disagreement

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Introduction

Direct observations of near-surface winds are crucial for the calibration and validation of estimated winds by satellite-based platforms like scatterometers. For more than 17 years, the Woods Hole Oceanographic Institution operates several moored buoys in the Atlantic and Pacific Ocean (namely STRATUS, NTAS, WHOTS, and SPURS). These buoys are well equipped with redundant meteorological observation systems that sample all wind-relevant parameters in 1-min resolution. This unique dataset is used to investigate the buoy performance and assess measurement errors. Comparison of inter-sensor differences with results from a computational fluid dynamics (CFD) simulation suggests flow distortion is an important source of error.

STRATUS buoy vs. scatterometer

Equivalent neutral winds
- Liu-Katsaros-Businger (LKB; *Liu et al., 1979*) and
- COARE (*Fairall et al., 1996*) in current version COARE3.5 (*Edson et al., 2013*)
- The two parameterizations reveal different equivalent neutral wind speeds

Buoy-satellite colocation
- Satellite can be colocated to 1-min-buoy observation

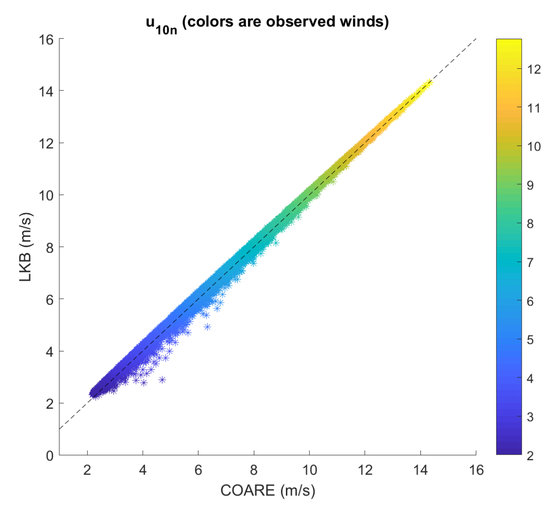

Fig. 1 Equivalent neutral wind speeds estimated from wind observations via two different parameterizations. Shown are hourly estimates from the STRATUS buoy.

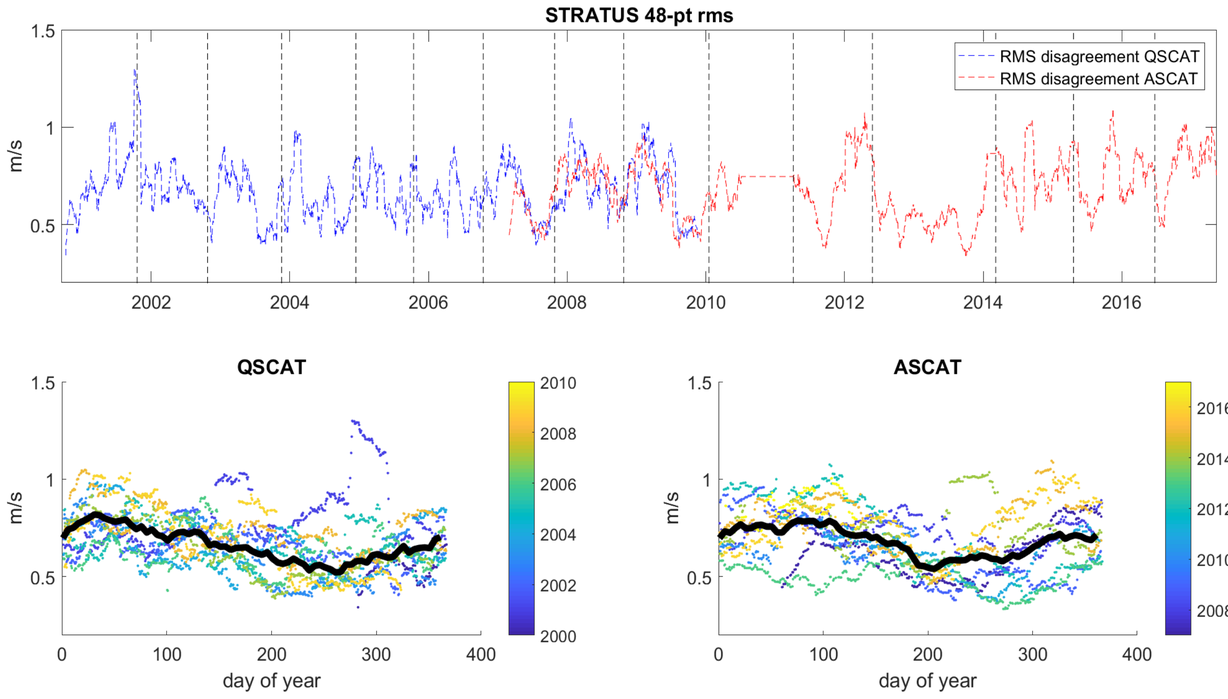

Fig. 2 (Top) Time series of 48-pt RMS between scatterometer (QuikSCAT and ASCAT) and hourly averaged buoy observations. (Bottom left) RMS of every year and mean for QuikSCAT colocations. (Bottom right) RMS of every year and mean for ASCAT colocations. Shown are equivalent neutral winds estimated with LKB.

- 48-point root-mean-square difference (RMS) of STRATUS buoy observations with QuikSCAT (ASCAT) estimates reveals a RMS of the order of 0.69 (0.71) m/s with COARE and 0.66 (0.68) m/s with LKB
- A seasonal cycle is also present, regardless which scatterometer estimate and which parameterization is used

Flow Distortion

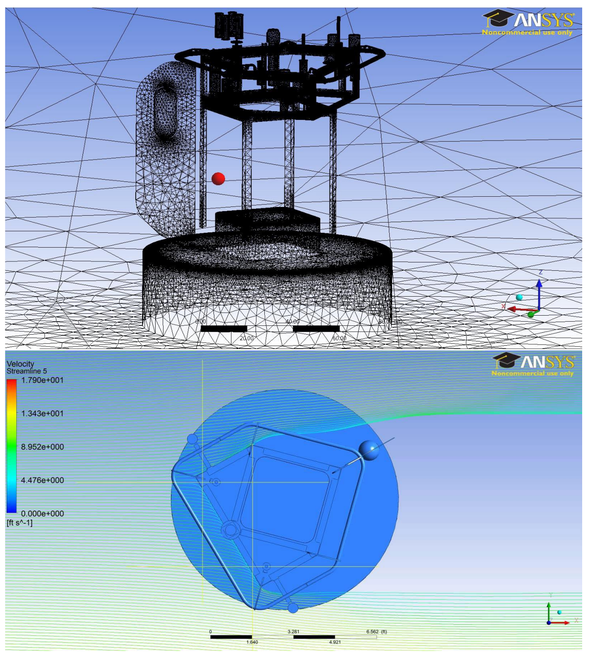

Fig. 3 (Upper panel) Model mesh of a WHOI buoy. (Lower panel) Stream lines around the buoy (top view). The yellow crosses are the wind sensor positions.

CFD study shows
- flow distortion on port and starboard side of the buoy
- accelerated on the far side by up to 3.5% and decelerated on the near side by -1%.

Flow distortion from buoys
- relative error up to 5% in wind speed
- Linear dependence of relative error within 50 degrees from either side

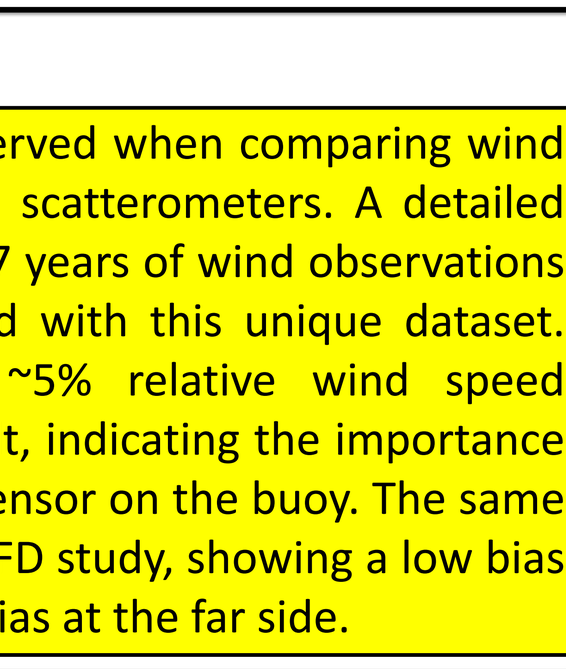

Fig. 4 Relative wind speed difference (starboard wind speed minus port wind speed divided by port wind speed) in relation to wind inflow angle. Negative directions mean inflow from port, positive directions mean inflow from starboard. Shown are hourly averages and 10°-bin averages.

Conclusion

A RMS of 0.5-0.7 m/s is observed when comparing wind speeds at WHOI buoys with scatterometers. A detailed investigation of more than 17 years of wind observations at the buoys was performed with this unique dataset. Flow distortion errors of ~5% relative wind speed difference are the main result, indicating the importance of the position of the wind sensor on the buoy. The same results are obtained with a CFD study, showing a low bias on the near side and a high bias at the far side.