



Validation of Scatterometer and Radiometer High Winds Using Oil Platform Anemometers

Andrew Manaster, Lucrezia Ricciardulli, and Thomas Meissner
Remote Sensing Systems, Santa Rosa, CA, USA



Motivation

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- Buoys are considered the calibration target for wind retrievals 0-15 m/s
 - Satellite winds are consistent with buoys for $w < 15\text{m/s}$, within a 1 m/s uncertainty
 - There has been a long-standing debate about the validity of buoy winds above 15 m/s
 - RSS satellite winds are 10 – 15 % higher than buoys (globally). Other groups match satellite winds to the buoys for winds up to 25 m/s.
 - Therefore, verifying the validity of winds in the range 15-30 m/s is extremely important, and it can help reconciling a major source of inconsistency between different data products.
 - For validation at even higher winds speeds (above 30 m/s, hurricane-force) we use SMAP and SFMR from hurricane hunters aircraft.

Methodology: Buoys or Platform winds?

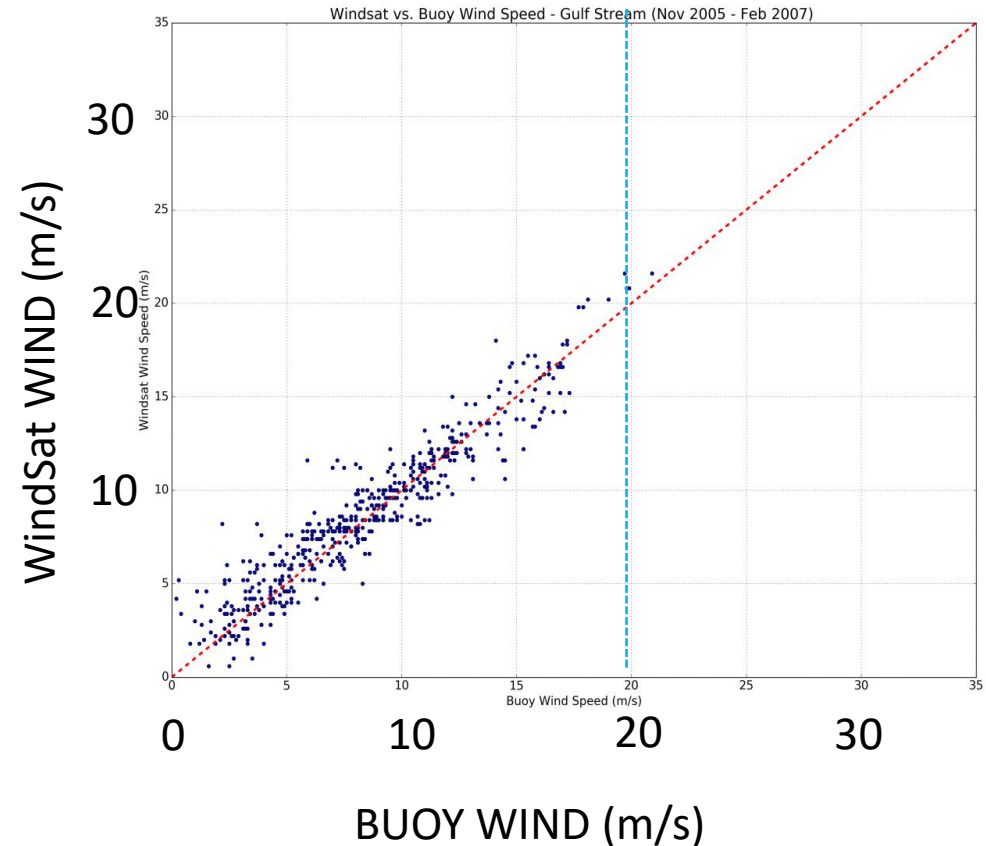
MOORED BUOYS: It was initially suggested to use several buoys maintained by the University of New Hampshire to test buoy validity for high winds between 20-30 m/s.

→ We found very few measurements > 20 m/s for these buoys

PLATFORMS: For this study, we use wind measurements from anemometers mounted on oil platforms in the North Sea.

Similar study was performed by Pineau-Guillou et al. 2018 but they had limited flexibility on quality control of the platform data (source of data was ECMWF buoy database).

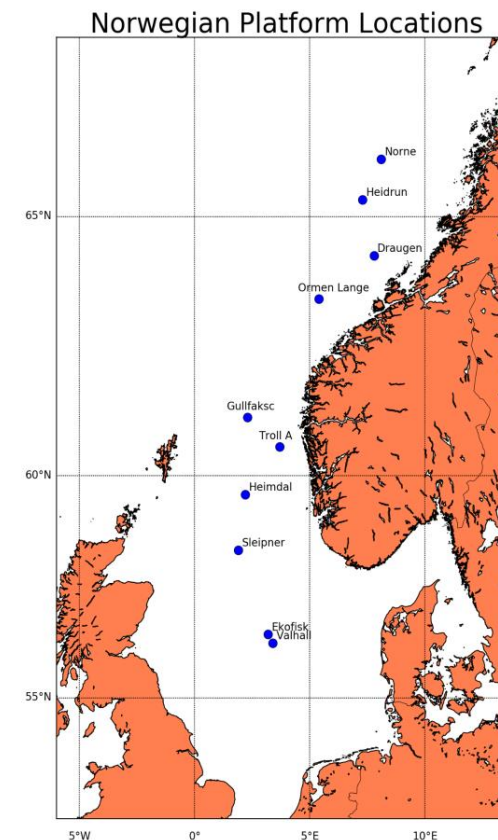
→ We tested the reliability of the platforms by performing extensive quality control.





Oil Platform Wind Data

- Data acquired from the Norwegian Met Office
- 10 platforms that encompass various time periods from 1999-2016
- Many sites had multiple anemometers at varying heights.
- Winds given at 10 minute, 20 minute, or hourly intervals at the height of the anemometer → we averaged to hourly
- Original data was provided as winds at the anemometer height and as converted to 10m winds.
- No anemometer height in files.





Data Preparation

- Hourly averaged anemometer wind speeds were collocated with satellite measurements within +/- 1 hour and in the absence of rain
- Since the **satellite wind speeds** are measured at a **height of 10m** and the collocated **platform winds** were measured at the **height of the anemometer** (which varied from platform to platform and could vary from anemometer to anemometer on a given platform), we needed to [reduce platform winds to their 10m equivalent.](#)
- In order to do this we needed anemometer heights, which were not explicitly given in data files.
- We retrieved by “reverse engineering”, using the profile equation given by the Norwegian Met Office.

Testing different profiles for 10m winds

1) **POWER LAW PROFILE** $wind_{10m} = wind_{anem} \left(\frac{10.0}{hgt} \right)^\alpha$ (variable a)

a) **a = 0.06** (neutral stability case, based on the findings in a paper by Furevik and Haakenstad 2012, validated with radiosondes)

b) **a = 0.13** (based on an empirically determined formula used by the Norwegian Met Office).

2) **LOG PROFILE** $wind_{10m} = wind_{anem} \left(\frac{\ln(\frac{10.0}{Z_0})}{\ln(\frac{hgt}{Z_0})} \right)$ (as for buoys; $Z_0 = \text{constant}$)

We started by comparing to WindSat first, since it has the longest time series available for collocation with platforms.



Quality Control of Platform Data

Collocations of these 10m winds with WindSat allow us to perform several scrupulous quality checks:

- 1) Check consistency with satellite data using different types of vertical profile to adjust platform winds to 10m height
- 2) Reject data with low correlation or significant bias compared to WindSat etc...
- 3) Check whether a suspected wind speed bias/degraded performance existed at specific wind direction due to flow deformation by the wind towers (suggested by Mark Bourassa)
- 4) Check temporal stability of each individual tower by comparing the timeseries of platform winds to colocated satellite measurement

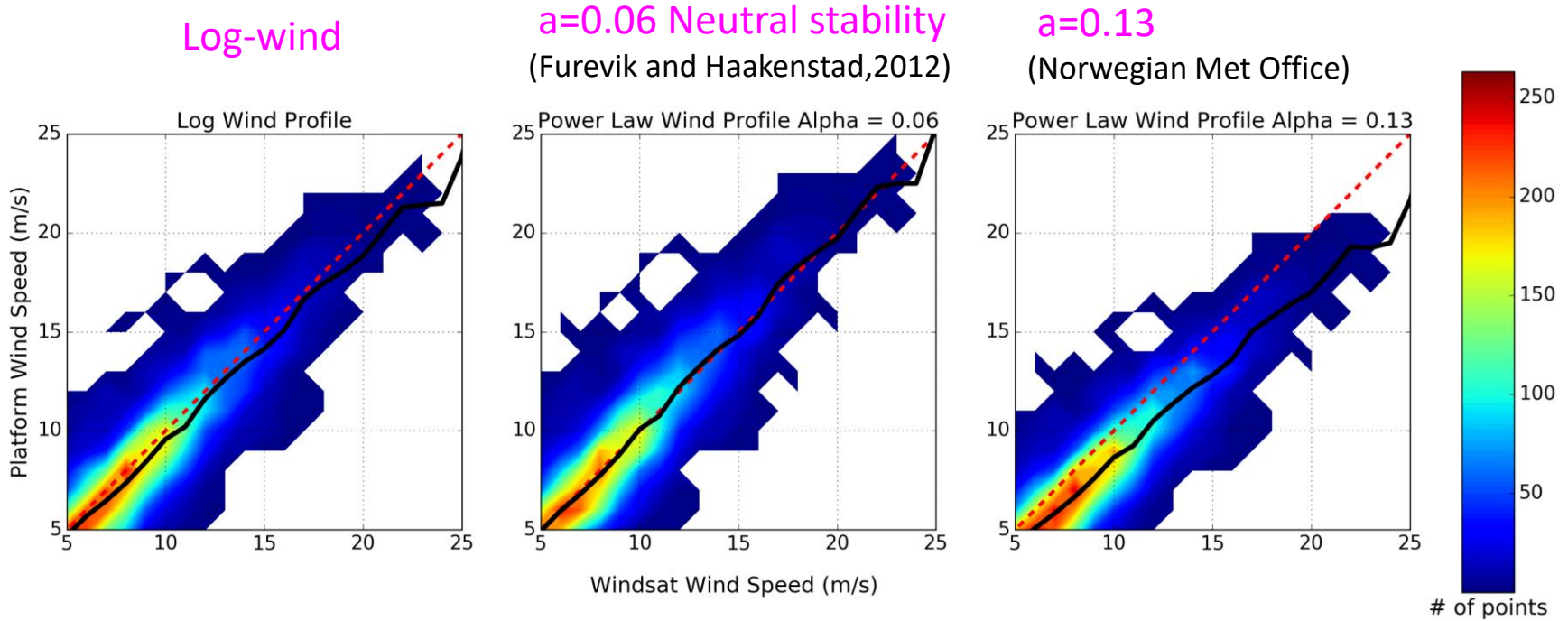


Impact of using Log wind vs Power law profiles

Example of anemometer that DID pass Quality Control

10m Wind Speed vs. Windsat Wind Speed
draugen WIA, 2003-2016, Sensor Hgt = 78.00m

Platform wind



WindSat wind



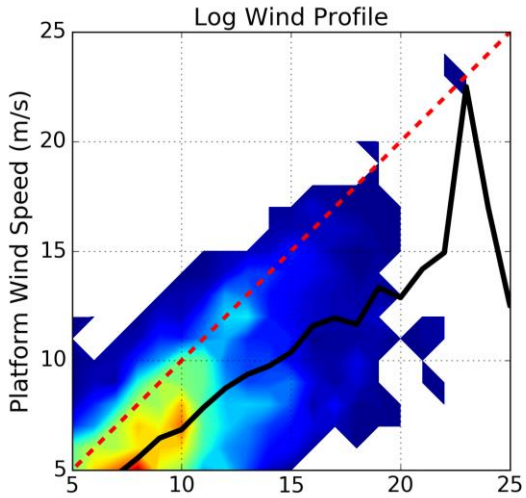
Impact of using Log wind vs Power law profiles

Example of anemometer that DID NOT pass Quality Control

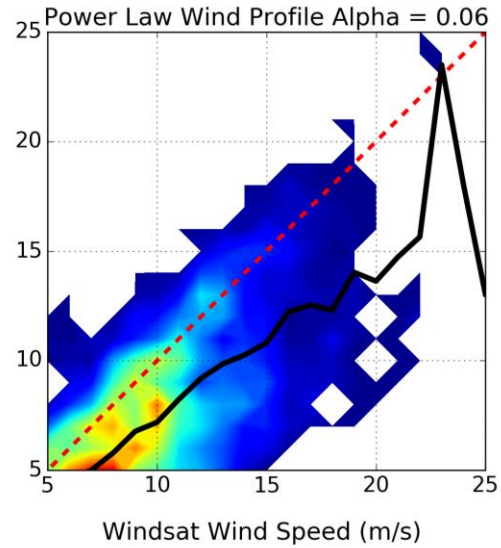
10m Wind Speed vs. Windsat Wind Speed
heidrun, WIA, 2003-2009, Sensor Hgt = 87.00m

Platform wind

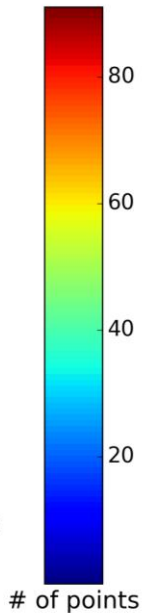
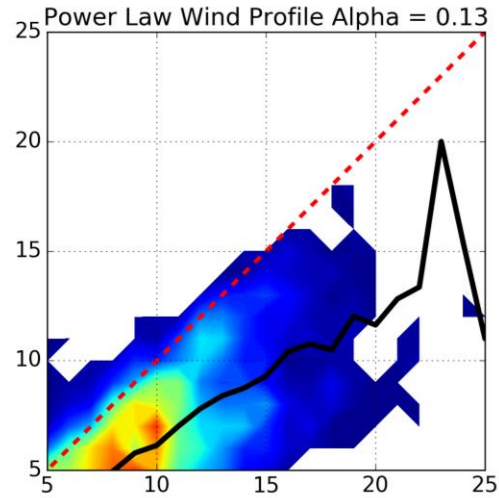
Log-wind



a=0.06 Neutral stability
(Furevik and Haakenstad,2012)



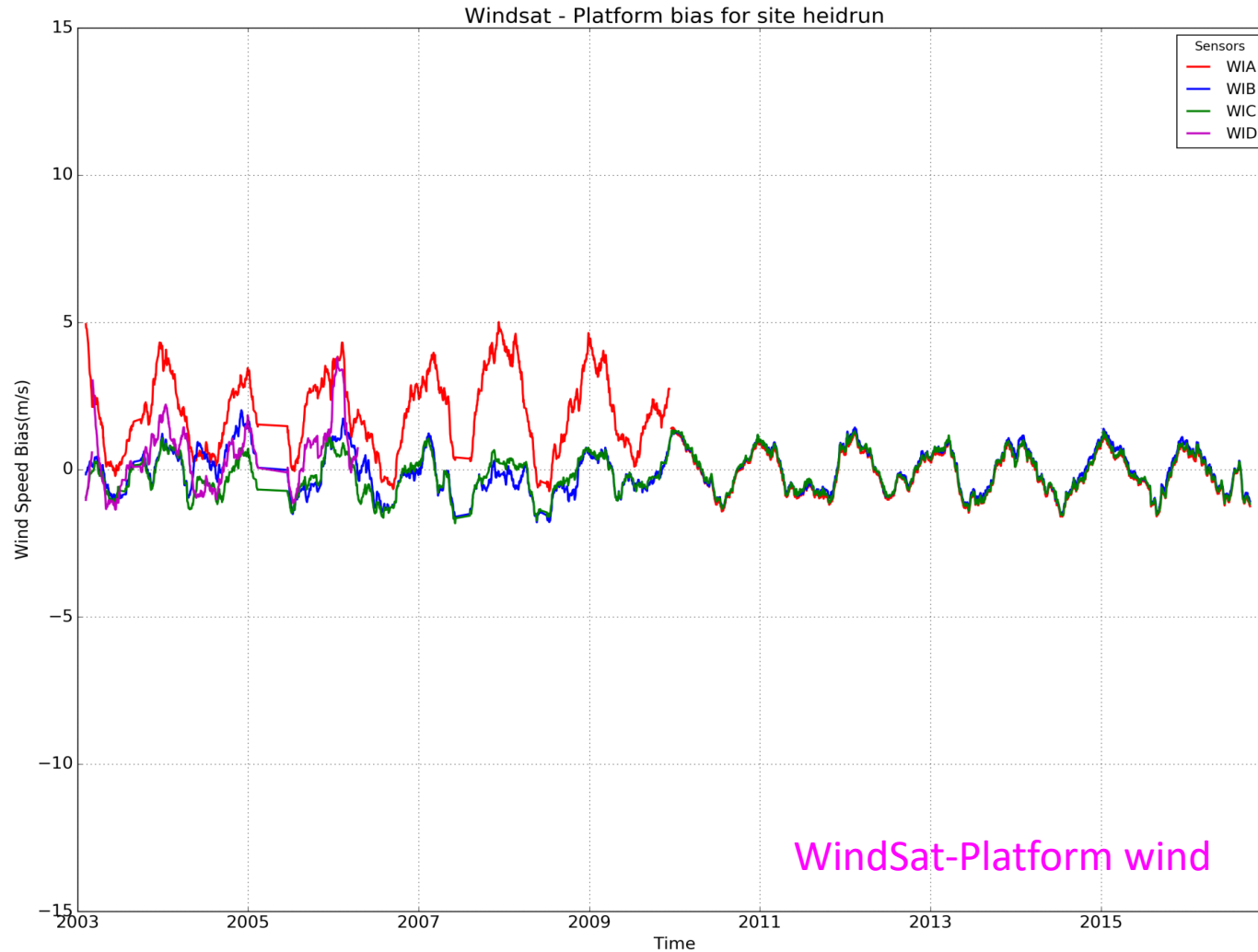
a=0.13
(Norwegian Met Office)



WindSat wind



QC Check: Stability of timeseries for individual anemometers on each tower





WindSat-Platform Bias, 0-30 m/s, All platforms

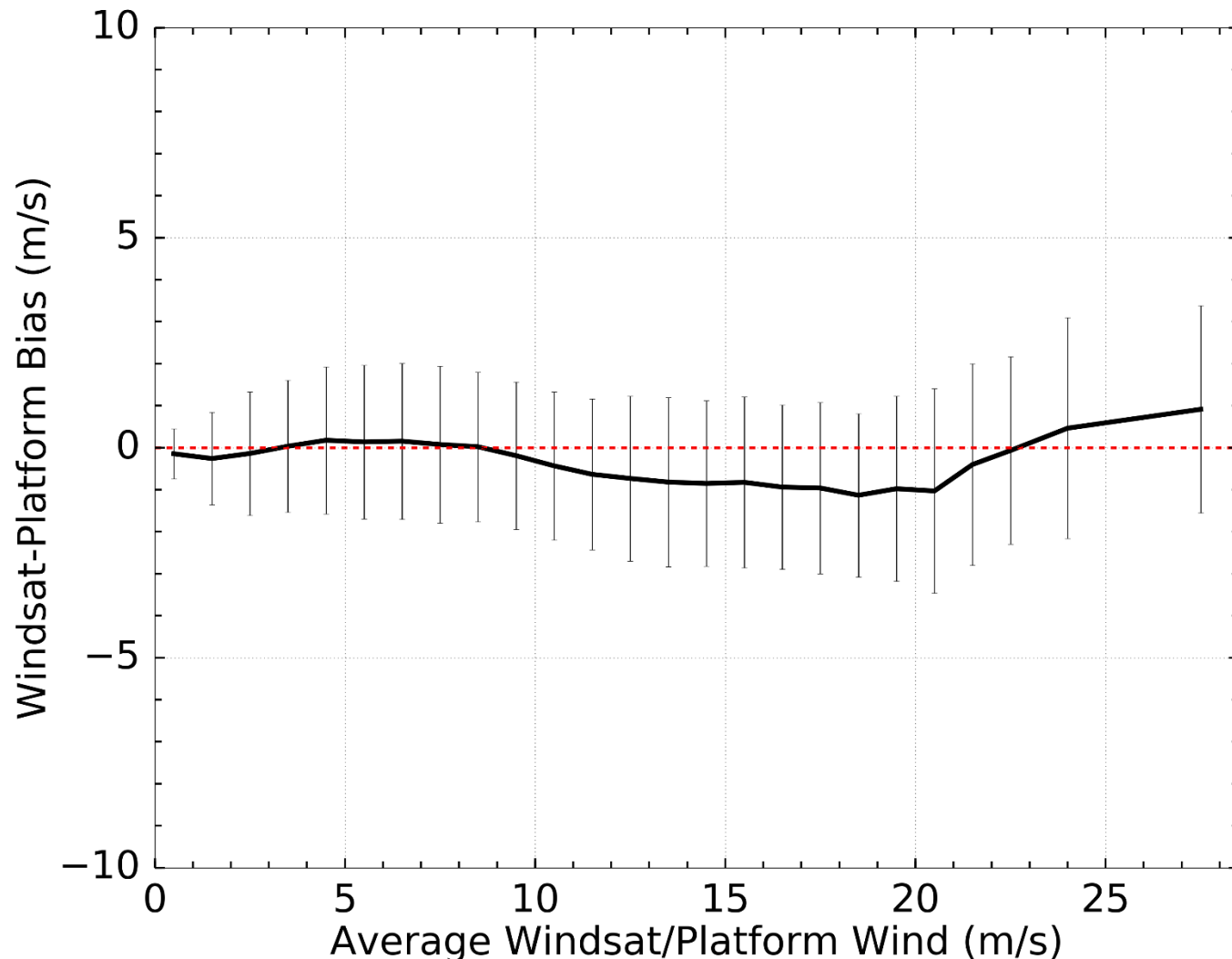
POWER LAW

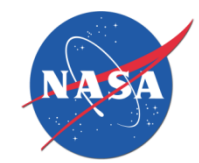
$a=0.06$

→ close to neutral stability: Choice based on validation with radiosondes(Furevik and Haakenstad 2012, and personal communication with Bridgette Furevik)

→ QC: Platforms whose correlation coefficient with WindSat was < 0.75 not included

WINDSAT-PLATFORM BIAS, AVERAGE WIND DEPENDENCE -- POWER LAW, ALPHA = 0.06. From 2003 to 2016



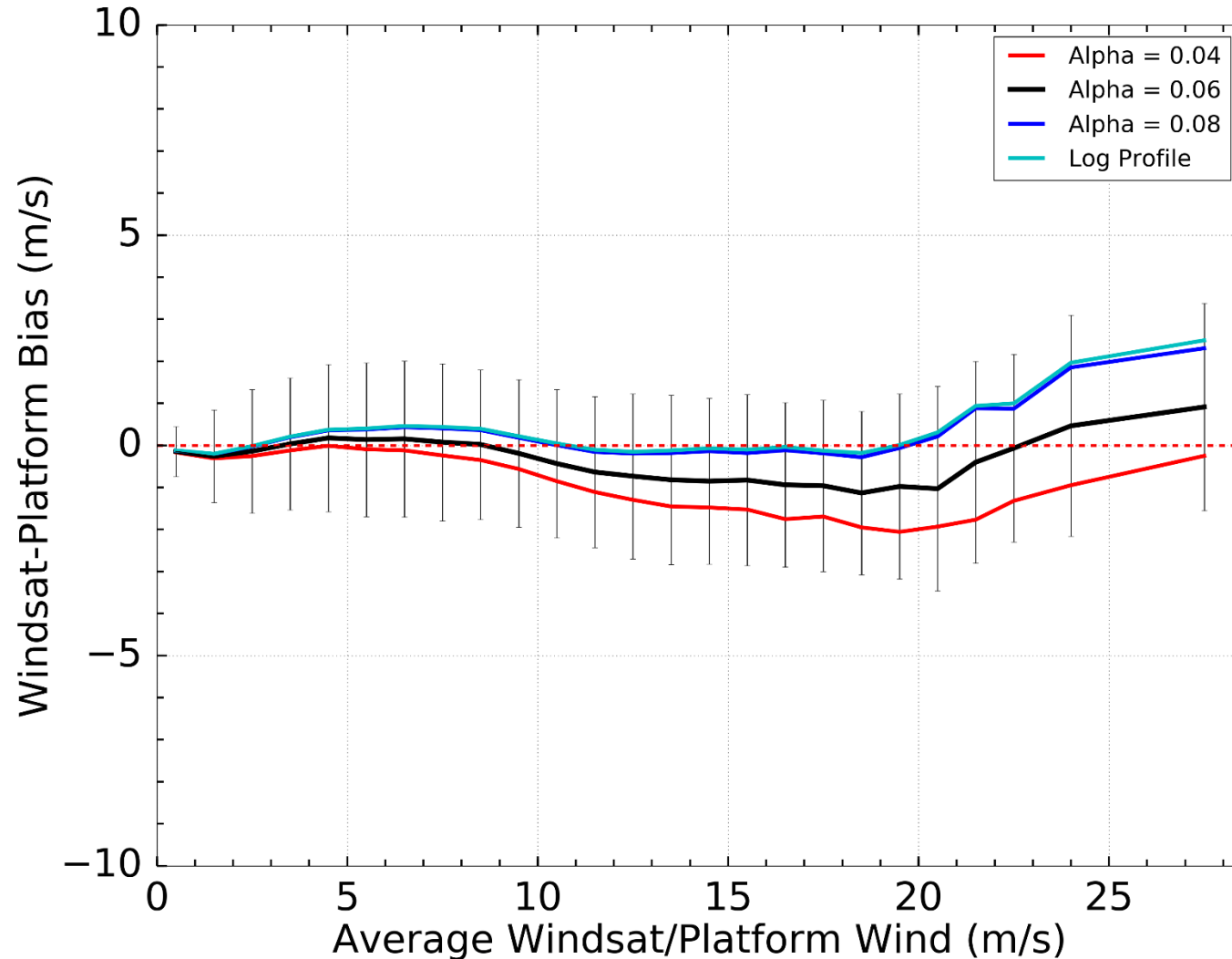


WindSat-Platform Bias, 0-30 m/s, All platforms

WINDSAT-PLATFORM BIAS, AVERAGE WIND DEPENDENCE -- POWER LAW, VARYING ALPHA. From 2003 to 2016

Comparison of Vertical profile choices

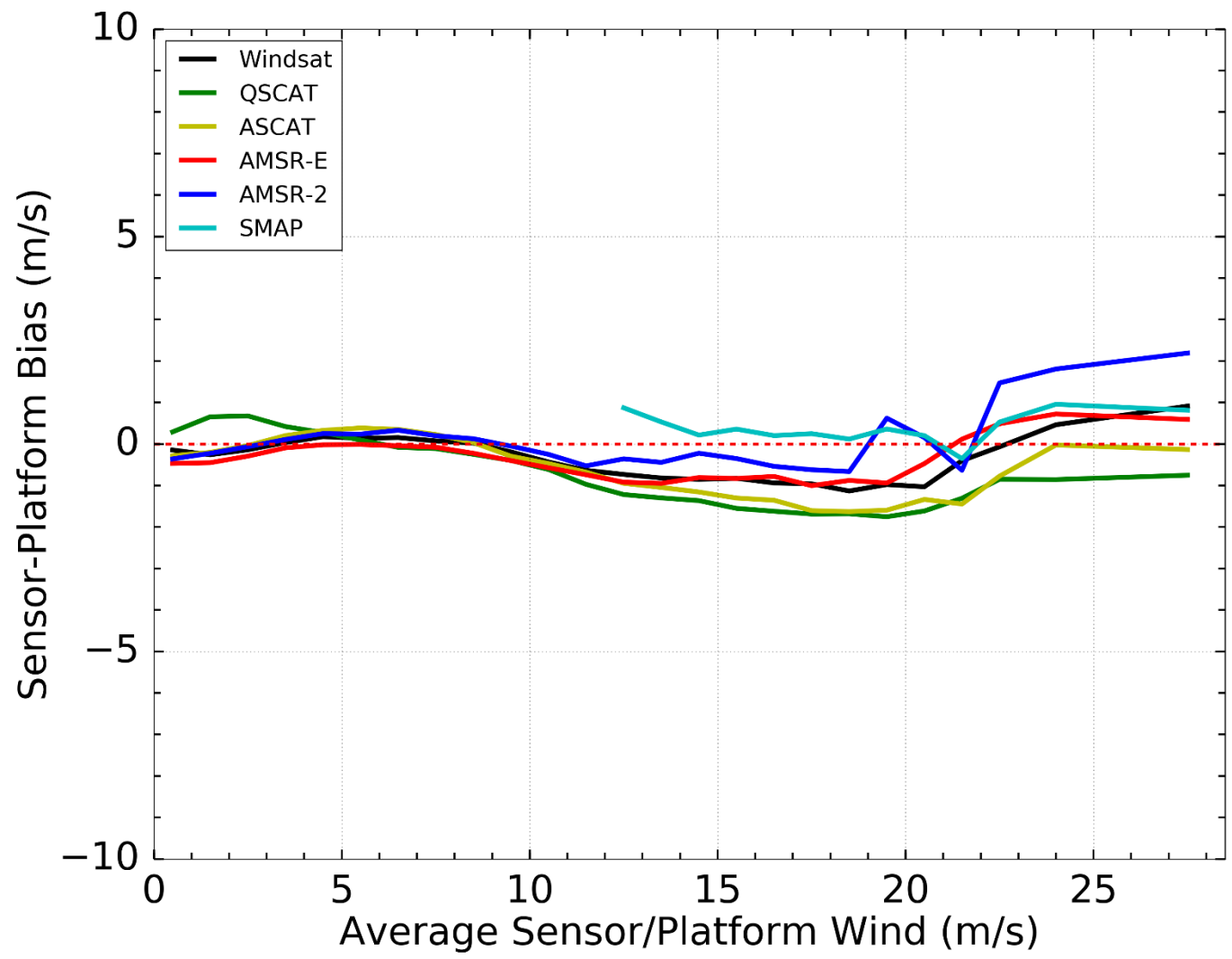
This analysis provides a range of uncertainty due to the choice of vertical profile used to convert to 10m winds





MW Radiometers and Scatterometers -Platform Bias, 0-30 m/s,

SENSOR-PLATFORM BIAS, AVERAGE WIND DEPENDENCE -- POWER LAW ALPHA=0.06 From 1999 to 2016



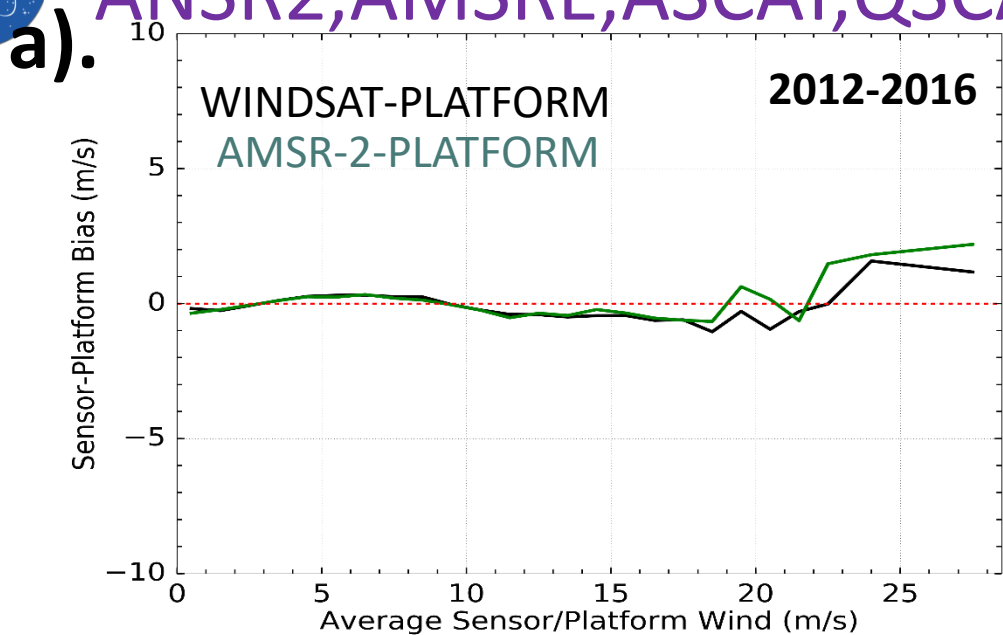
Note that each satellite Shown here covers different time periods

Nevertheless, they all remarkably agree with the wind towers within an uncertainty of less than 10%

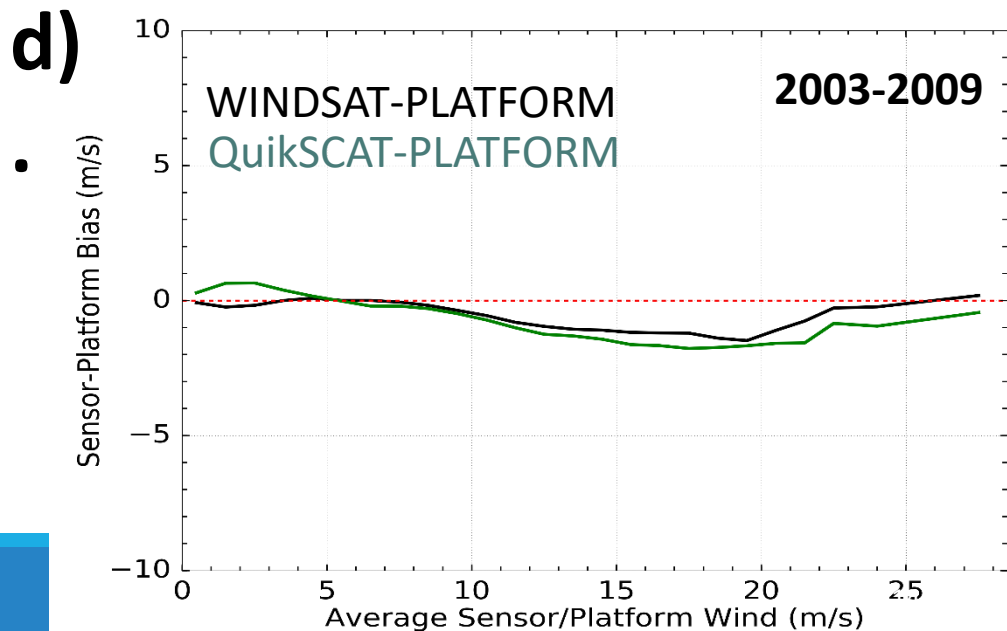
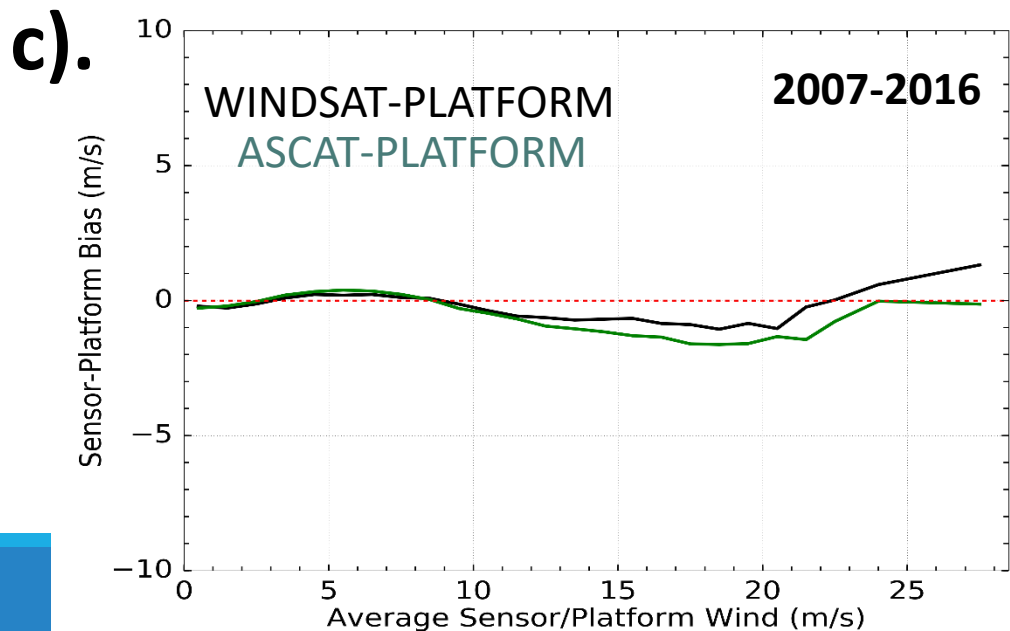
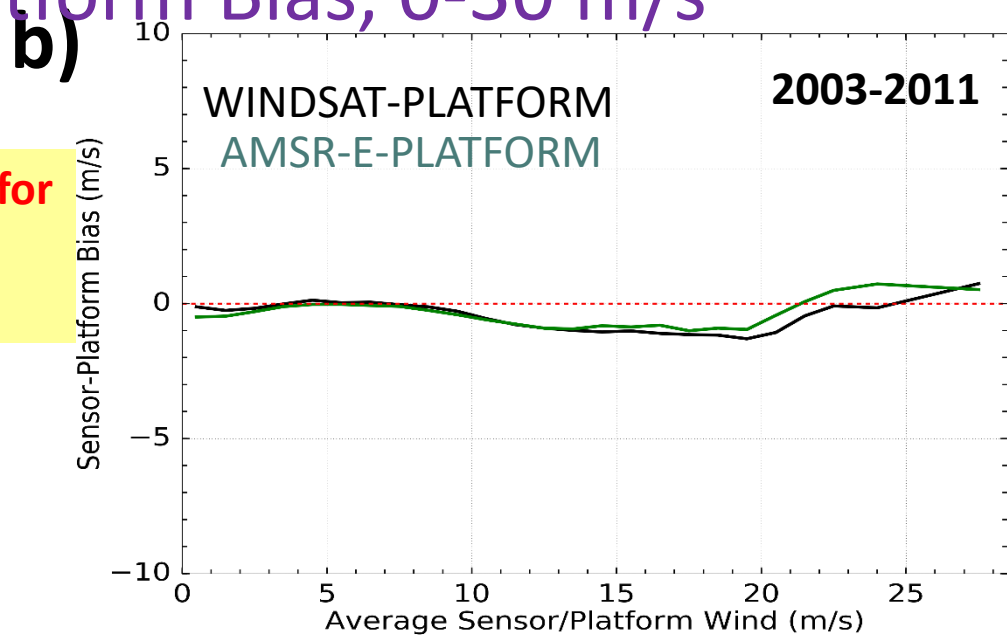
AMSR-2 seems a little higher than Other satellite data at high winds.



ANSR2, AMSRE, ASCAT, QSCAT vs Platform Bias, 0-30 m/s



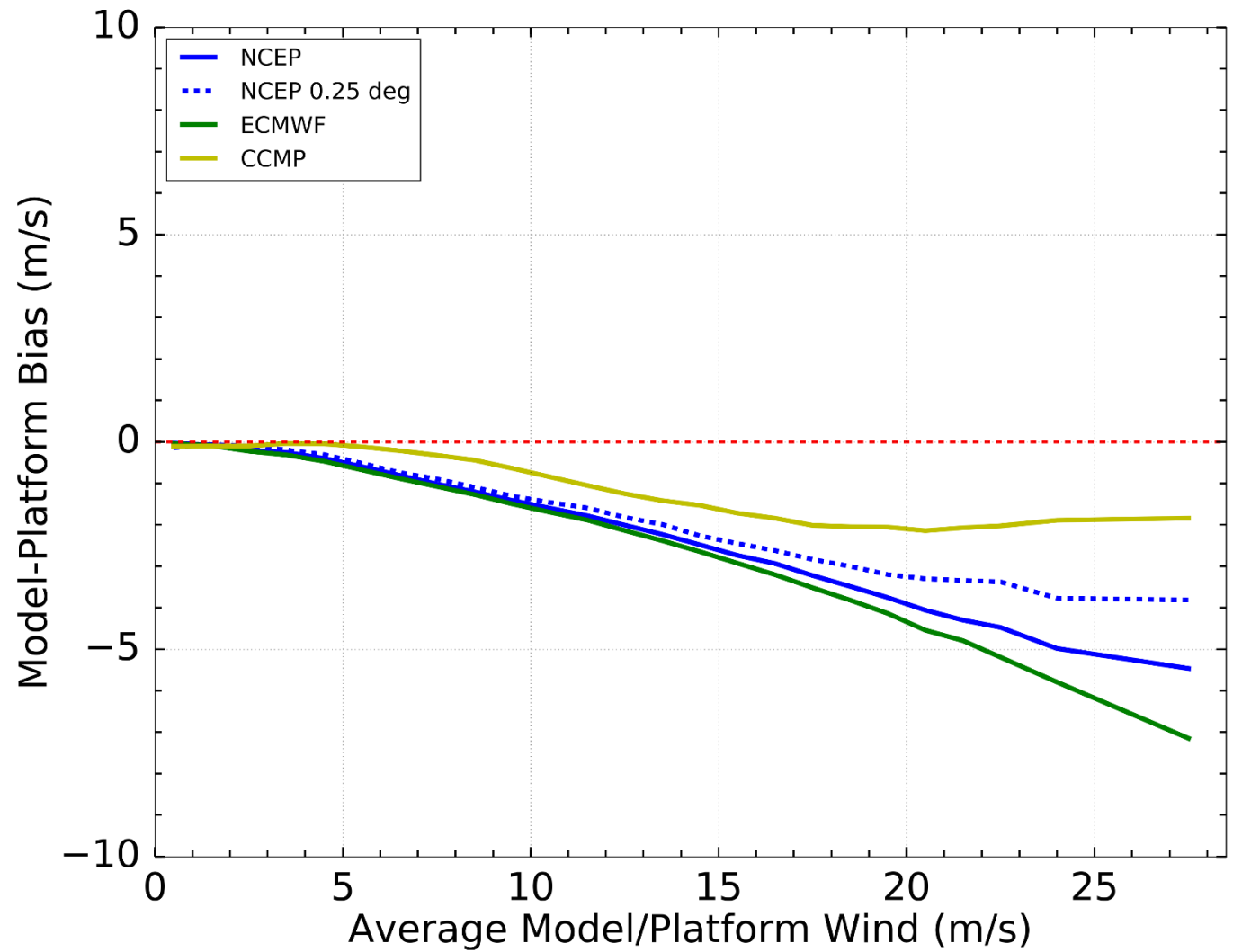
Comparison for coincident time periods





NWP Model and analysis winds -Platform Bias, 0-30 m/s,

MODEL-PLATFORM BIAS, AVERAGE WIND DEPENDENCE -- POWER LAW ALPHA=0.06 From 1999 to 2016





Conclusions

1. **Satellite high winds are consistent with wind tower measurements typically within 1 m/s (5%).** This is within the satellite wind uncertainty of about 10% (~2-3 m/s in the range 20-30 m/s).
2. **NWP Model high winds are consistently much lower than wind platform winds** at this locations: from 10 % lower (CCMP) up to 20-25% lower (ECMWF).
3. AMSR2 seems to be higher (1-2 m/s) than the other satellite winds.
4. QuikSCAT is a bit lower, but still within the 1 m/s uncertainty. Residual rain-contamination?

Summary: Satellite winds are consistent with wind towers, model winds are biased low for winds greater than 15 m/s .

This result is consistent with the paper by Pineau-Guillou et al. 2018. Our study added extra levels of quality control and understanding of platform data to make the conclusions more robust and valid for all satellite retrievals.