

# Lidar learning from repeat verifications

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## INTRODUCTION

Industry confidence in ground-based lidars continues to grow, and are being utilized more by developers, owners, and consultants. But how does the key wind speed measurement hold over time?

This study compares lidar verification results for six lidars units, each tested at two different times. How does the speed comparison between met mast and lidar compare between each verification?

### Test setup:

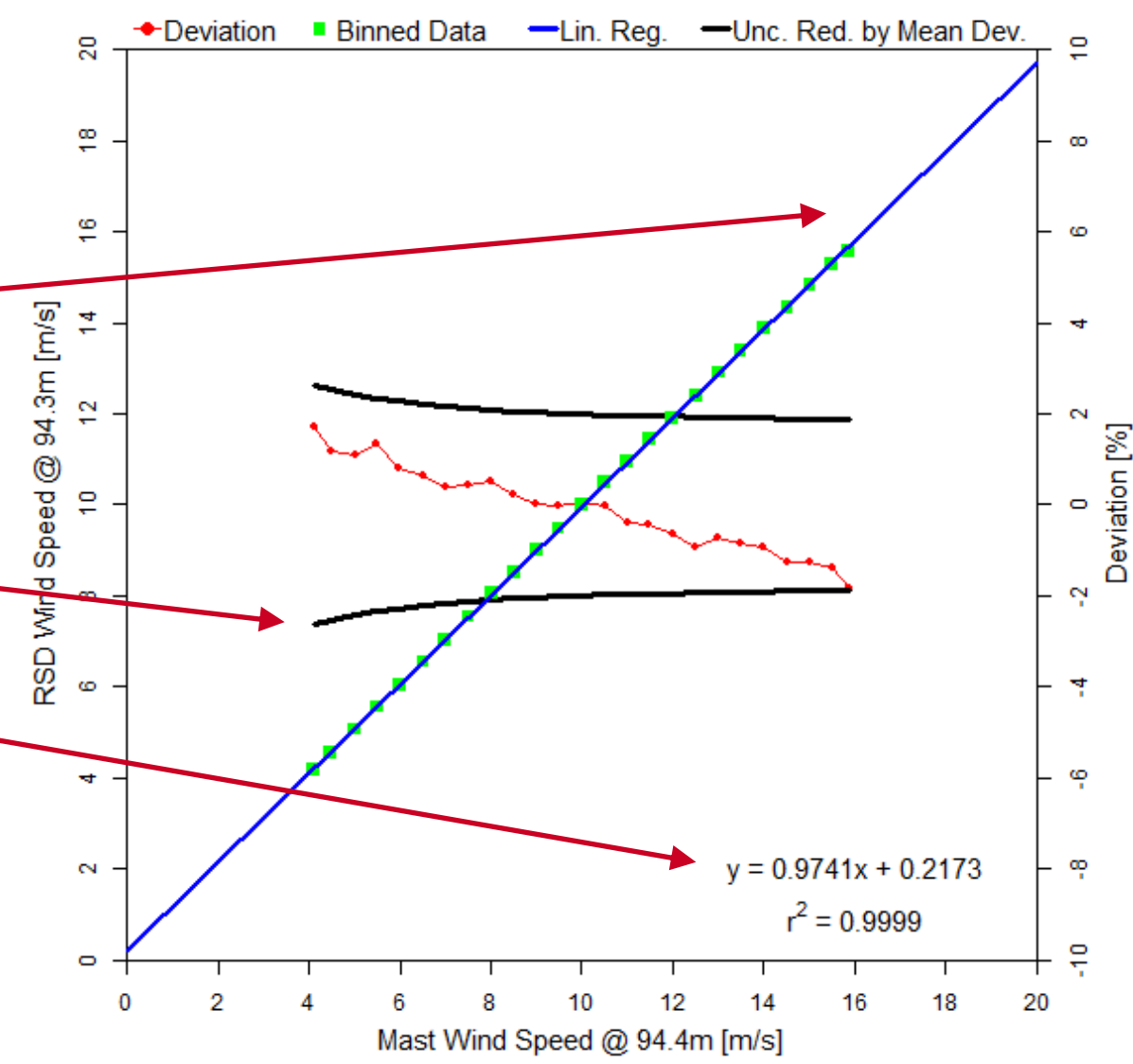
- 6 lidar units (two common models) at two test sites
- Re-verification occurred after 13 to 46 months
- Compare wind speed best-fit equation from first and second verification at same height at each height
- Compare fit deviation to verification uncertainty and to 0.1 m/s

## IEC 61400-12-1 ANNEX L VERIFICATION

- Lidar next to IEC 61400-12-1 compliant met for 4-12 weeks
- Output is best-fit linear equation between binned cup anemometer speed at met mast and binned lidar horizontal wind speed (similar to cup anemometer verification)
- Verification uncertainty calculated by bin
- Uncertainty is reduced if verification equation is used to correct wind speed

### Typical verification result:

- Lidar to cup speed fit
- Verification uncertainty (%)
- Verification equation

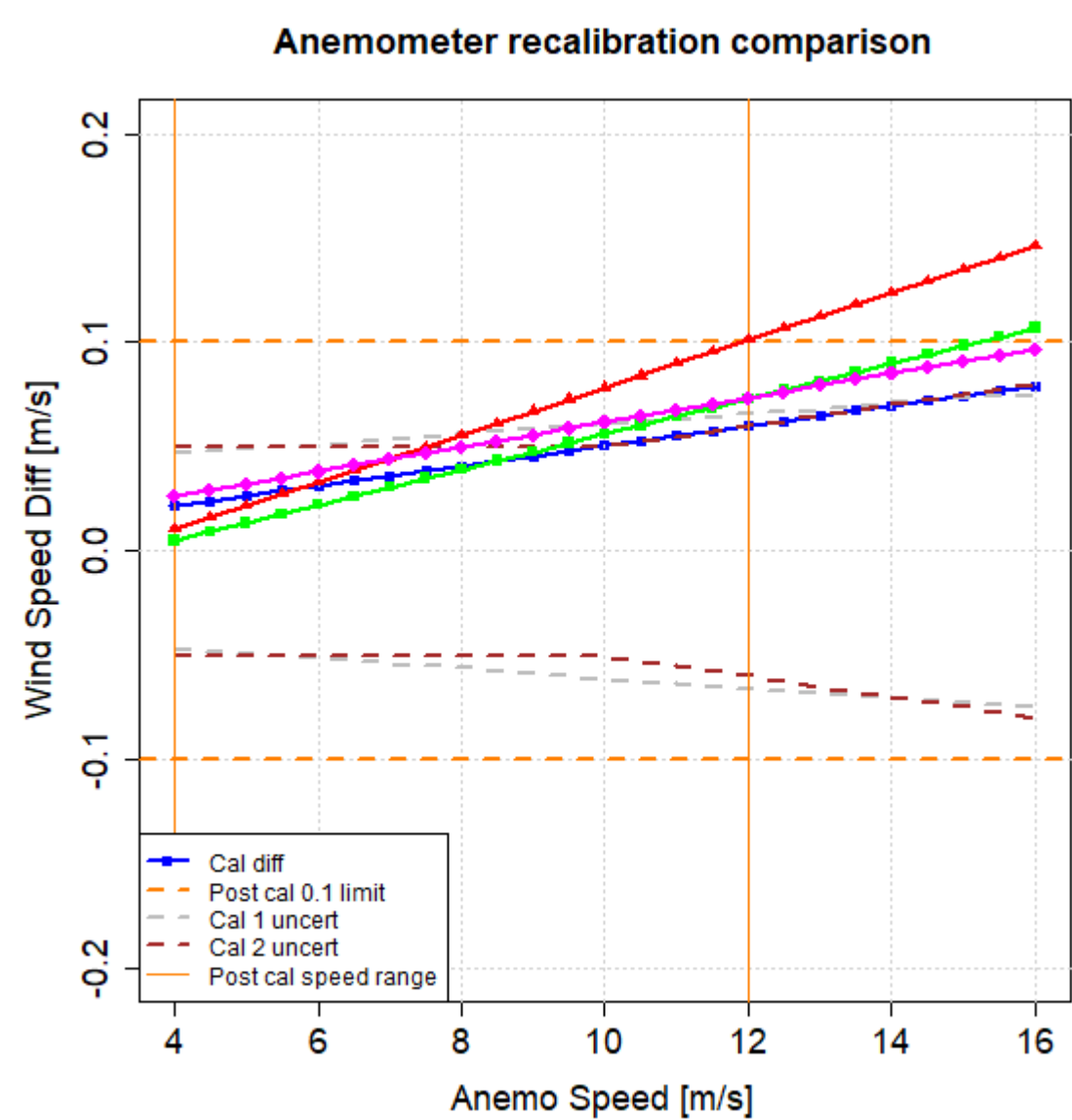


## ASIDE: ANEMOMETER CALIBRATION

What wind speed differences can be expected during re-calibration for cup anemometers?

Comparison of 4 cup anemometers recalibrated at a different wind tunnel after 2.5 years.

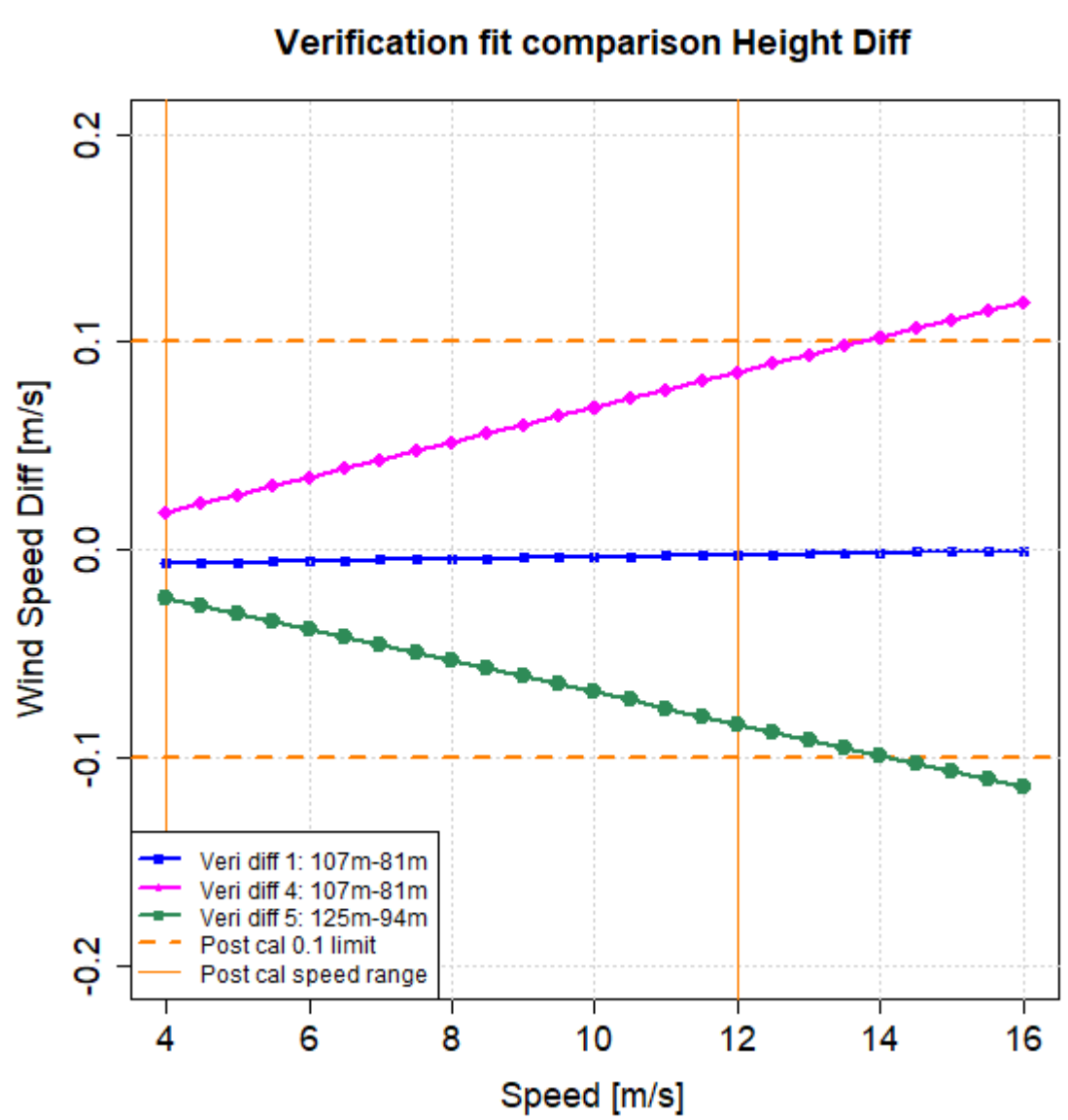
Results within  $\pm 0.1$  m/s between 4 m/s and 12 m/s pass IEC post calibration requirement.



## ASIDE: LIDAR VERIFICATION CORRECTION FACTORS BY HEIGHT

Compare wind speed best-fit equation from two heights separated by 25- 30m.

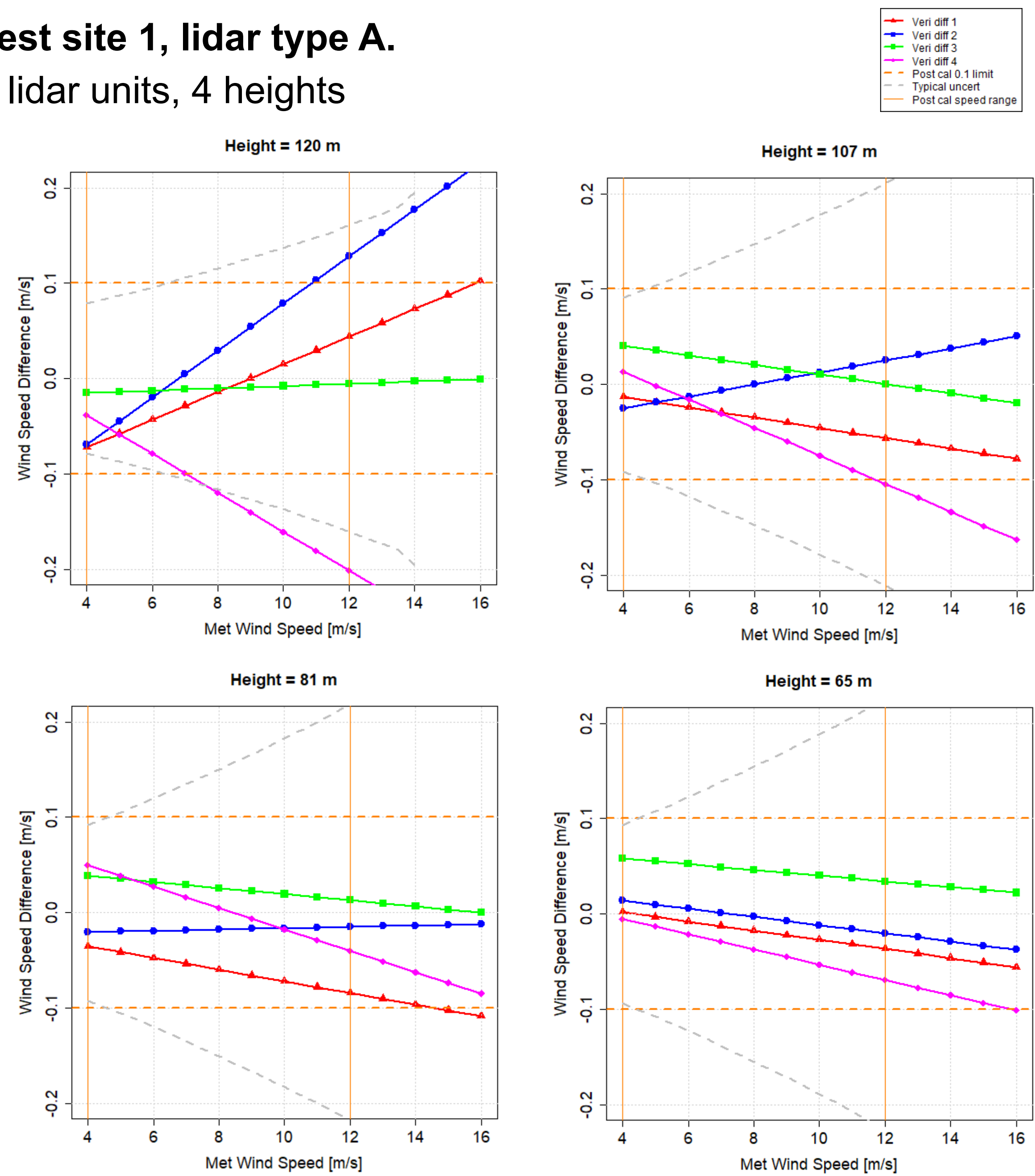
How confident can we be about using results from one height at another height if the verification is below the intended use height?



## RESULTS

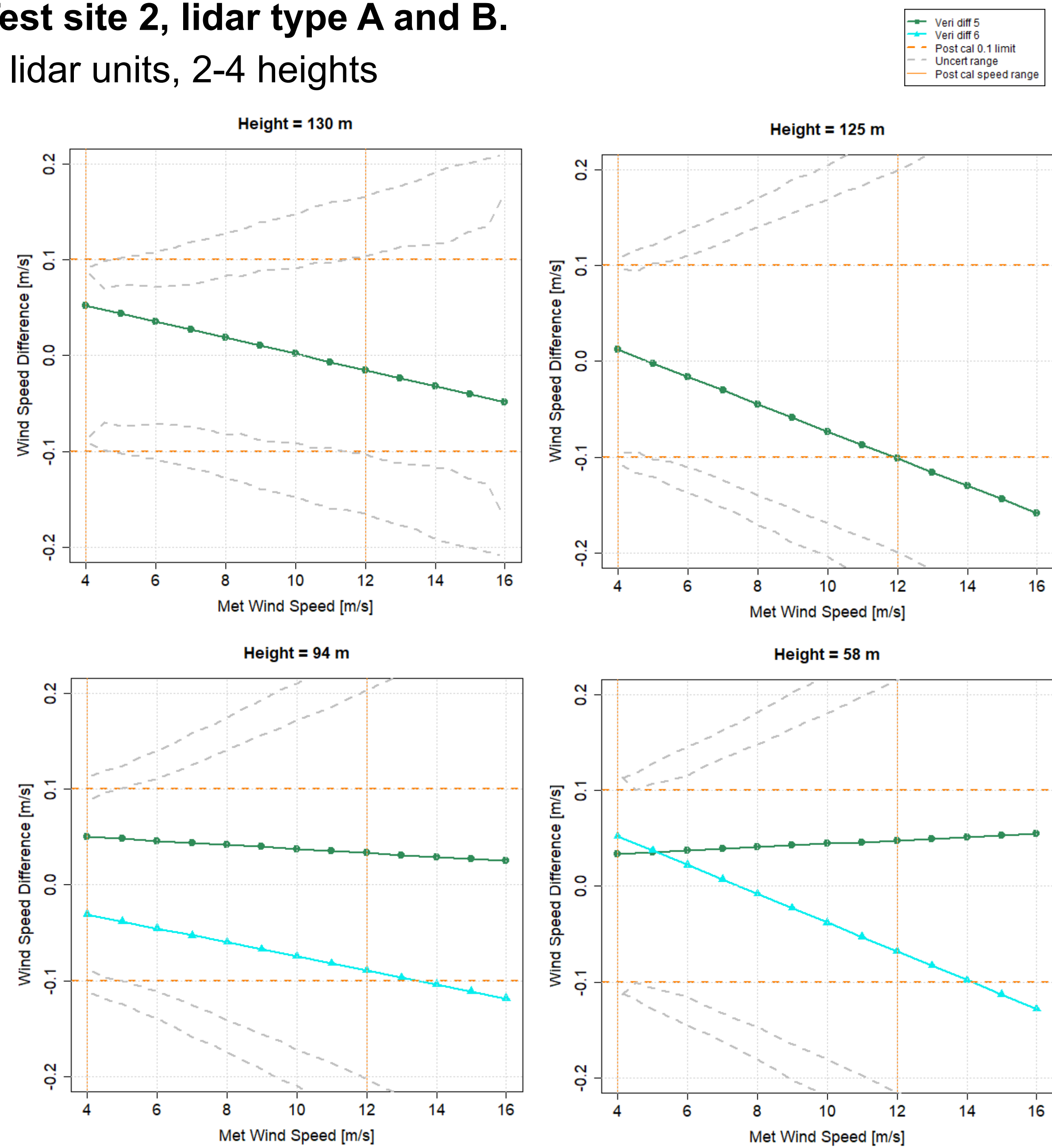
### Test site 1, lidar type A.

4 lidar units, 4 heights



### Test site 2, lidar type A and B.

2 lidar units, 2-4 heights



## FINAL COMMENTS

Lidar verifications occurred between 2017 and 2023, so some units have older software or hardware. The results can still provide useful information.

Except at height 120m at test site 1, all reverifications were within the test uncertainty and within the IEC post calibration limits for an anemometer.

What is your experience with repeat lidar verification or with seeing a change in lidar wind speed measurement?

How often to you verify your ground based lidar units?