Referee Report on

Analysis of the measurement uncertainty for a 3D wind-LiDAR

The article presents an error propagation analysis for the Cloud Turbulence Lidar (CTL). The analysis uses both synthetic and measured time series to assess the variability that could be expected in the measured time series due to the uncertainty in the 3 detectors reported longitudinal velocity. This error is treated as Gaussian and added to the longitudinal velocity which should be measured by each detector for the synthetic/experimental velocity. The 3 longitudinal velocities with added noise are then reconstructed to reproduce an approximation of the wind vector time series which would be measured, which is then compared to the original synthetic or experimental velocity.

The authors then use these approximated time series to test a filtering approach that can be used to post-process the added noise and reduce the random noise that has been artificially added in.

In general, the article is well written, and to the extent that the authors analysis is conducted, appears to be appropriate. However, there are several concerns that I regarding the applicability of this analysis to the general uncertainty output from the system. The biggest concern is simply that the uncertainty analysis only propagates a single error (specifically the detector error). As such, the study is very limited in its approach. Their own error propagation analysis provided in Section 3.6 indicates that the error is going to be amplified the precision of the support structure and resulting angle of the detectors to the plane of the lidar. The geometric dimensions of the array are assumed to be precisely known and constant. What is the sensitivity of the wind to uncertainty in the dimensions? Can this structure be assumed to be perfectly rigid during a measurement? Does the measuring distance, h, impact uncertainty? Surely temperature changes will result in some expansion/contraction of the support structure? Furthermore, uncertainty in the Euler angles used to transform the wind velocity from the lidar frame of reference to the inertial frame of reference can produce significant uncertainty in the resulting wind components. This effect is also not considered.

Therefore, as noted, this manuscript is somewhat limited to simply the propagation of the detector uncertainty to the measured wind in the lidar plane of reference, with an analysis of the filter/smoothing functions best suited to reduce this added noise. In this context, careful characterisation of the detector uncertainty would be important for the analysis. However, this characterisation is limited to just two sentences, which does not sufficiently justify the stated detector uncertainty of $\sigma^{det} = 0.04$ m s^{-1}. From what I can tell, the authors take the resolution of the sensor output of 0.1 m s^{-1} and assume a 99% confidence bound(?) of 3σ to get a standard deviation of the uncertainty of 0.04 m s^{-1} (assuming that they are rounding up?). However, this is just guesswork on my part. If this is the case, than the error propagation analysis is not even assessing the uncertainty of the individual lidar measurements, but is simply assessing the propagation of the resolution limitations of the individual lidar measurement.

I would therefore recommend that the authors, at the very least, provide more detail and care into the assessment and description of σ^{det}. The paper would also be much more strengthened by including additional error sources into their analysis, however this may require significant revisions of the manuscript.

Additional comments:

1. Figure 2 was a little confusing for me due to the perspective. Specifically it took me some time to understand that the plane of the lidar was parallel to the oncoming wind field. I think the confusion comes from the kite being angled to the mean wind, but the lidar appearing to be drawn on the kite. Once I had figured out the arrangement of the CTL on the MPCK, the text of section 2.2 made more sense, but perhaps the authors may wish to add more details/different views to Figure 2 so that others may not be equally confused.

2. Tables 1 and 2 have redundant information and could be combined. Note that whereas Table 2 refers to 10 Hz as the sampling rate, Table 1 refers to the same quantity as the time resolution. Technically, the time resolution is 0.1 s, not 10 Hz.

3. line 182: should be ‘lose’, not ‘loose’.

4. The synthetic time series input the noise as a white noise process, what justification is there that the detector uncertainty appears in the form of white noise. Note that the nature of the noise could impact the efficacy of the smoothing for noise removal/uncertainty reduction.