Review of: Kaas and Emeis, The five main influencing factors on lidar errors in complex terrain.

General

I applaud the perusal of insight and simplicity clearly demonstrated by this paper. Particularly the idea to split the error source into two parts, curvature and speed-up, is well seen and well demonstrated. Similarly I like the structuring with models of increasing complexity and the opportunity this gives to draw insight and identify limitations.

I am a little disappointed however in the low amount of insight that is drawn and lack some deeper reflections on the implications of the findings. My main suggestion is therefore to add a 'Discussion' section (not necessarily with this name and (please) separate from the Conclusions) where the authors reflect on (suggestions):

- That the errors (on hill tops?) are always negative. Is this a general result, why and can we expect lidar measurements in positions where it wouldn't be true?
- The reasons for the trends that are seen (this is already tackled to some degree in the text). For example (one only that caught my eye), why does increasing stability give larger errors where increasing roughness (and forest) gives smaller errors?
- How do the parameterizations combine? (e.g. if you have strongly stable flow and tall trees, are the predicted errors even lower?)
- (Why) Should we believe these results? To what extent is there experimental corroboration?
- Would other 'hi-fi' models give similar results?
- It's a bit alarming to see how much the errors change with the parameterizations? What does all this say about the uncertainty of the corrections?

The elegance of the paper would be heightened by a corresponding lift in the quality of the writing. Not that this is bad but some of the explanations are more difficult to follow than necessary. Perhaps use more examples (measurement situations) in explaining the trends shown in the different plots. Make the text shorter where you can.

Specific comments:

Abstract
First para:
Wind lidars (or Doppler lidars) don't have much to do with "light detection and ranging" – they don't detect or range!! It's just a name so please don't labour this. Is it the 'measurement principle' (what is this?) that is the problem – or the assumptions inherent in the processing of the raw data?

L15: suggest remove e.g.

L20: suggest remove *manifold* (I had to look it up and it's my mother tongue..)

Last sentence:
'When planning a measurement campaign, an accurate estimation of the prospective (predicted?) lidar error should be carried out in advance ***to decrease measurement uncertainties*** *and* ***maximize the value****.':*
Knowing what the error isn't enough of course – you need to make the correction in order to reduce the uncertainty. What are you maximizing the value of?

1 Introduction
L32: *Due to their principle of measurement*,.. – Please be more specific here
L32: profiles = profilers

L45: *equivalent* – change to identical?
L59: *there is no significant increase in the* magnitude of the *errors* (add magnitude of the)

L77: delete between

A general comment here is that most, if not all, of the literature fails to recognize that traditional instrumentation (i.e. cups) in complex terrain have a fairly high uncertainty.

L134: Do you expect (or not) that stability directly affects the lidar accuracy? (I think this is most unlikely). Understand your explanation that stability indirectly affects the error through changed profile, turbulence(?) and flow patterns. Are there other flow parameters that might be relevant- e.g. Froude number?

L139: *Courtney et al.* ***were*** *(not* ***are****) proposing…* They probably got wiser from the subsequent experiments…;)

2 Methods

L184: The uncertainty of all experimental data should be estimated before comparing to models – cups as well as lidars. How should this uncertainty be used?

L191: Again, what about the 'mast' measurement uncertainty?

L222: win -> wind

L249: I think you are using 'exemplary' wrongly throughout the paper. Please check its definition. I would write '*are shown as examples within this study*'.

L268: Are these results only valid for a top-placed lidar? What about the more general case of a lidar on the side of a hill (where the error is usually lower anyway)?

L272: and error -> an error

L283: add *horizontal* after *reconstructed*

L293 (eq 3) – please state here what u_in and u_out are (you do this later in L310). Are there assumptions (symmetry?, linear change in speed?) in this simplification? I wasn't completely clear about this.

L302 (eq 6) – why, contrary to expectations, does the opening angle still appear here?

L315 mostly -> usually

L315: why does this comment appear here and not in the results section?

L343: Several comments regarding the -2% threshold for cup-anemometers and the comparison with this. Firstly is 2% realistic (the reference is in German, but it is easy enough to find typical values for cup operational uncertainties (class B in complex terrain) and add in mounting and calibration uncertainties. I would suspect higher values than 2% (was this using class A?). And is this standard uncertainty (k=1)?

But this would be the total uncertainty for the cup. Wouldn't it be fairer to compare with the total uncertainty of the lidar and not just the uncertainty due to the non-homogeneous flow?

The -10% seems very arbitrarily chosen. Do we expect an uncertainty of 10% if the error is 10%?

L351: All of this section takes some digestion. Try and make the text more straightforward, E.G (L351) *For the least complex hill, ….* I would suggest something like *For the least complex hill (H/L=0.1), the lidar error is below 2% until a non-dimensional height (z/L) of 0.16 is reached. The error reaches a maximum of 3% at z/L=0.5 and falls below 2% again above z/L= 1.5.* Maybe even set this in context, e.g. with a hill L=1000m and H=100m.

3.4 Influence of surface roughness

L427: *reference* – which reference?

L436: The -2% dashed line is missing in Figure 7 (Right)