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Atmospheric Measurement Techniques Discussions

Interactive comment on "Vertical profiles of the 3D wind velocity retrieved from multiple wind LiDARs performing triple range-height-indicator scans" *by* M. Debnath et al.

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General comments The paper describes using scanning lidars to perform 'virtual mast' measurements (scanning along a vertical line) and makes comparisons with co-located physical met mast measurements. Virtual met mast measurements are already, and will increasingly become, useful additions to many field campaigns so the subject is certainly scientifically relevant. The burning scientific questions are; how accurately can we measure means speeds, turbulence and extremes and what are the main limitations? In my opinion, whilst demonstrating one particular technique for virtual met mast measurements, this paper does not contribute very significantly to the relevant scientific issues.

Firstly, the trajectory chosen here is a so-called co-planar RHI (2 scanning lidars facing each other and measuring in a vertical plane) plus a third out of plane scanning lidar. This requires a very specific geometry (two lidars placed on a line intersecting the 'mast' position, here equi-distant from the 'mast') that is easy enough on a test field but very rarely practical in real life measurements where the choice of lidar positions is usually much more restricted. Why was this special case chosen rather than a more typical non co-planar configuration? What are the advantages (above recovering the vertical speed from only 2 lidars) and what are the limitations? Such issues should be covered in the paper.

Secondly, the measurements presented are 2 hours out of a campaign lasting nearly 3 months. Only 6 (six!) discrete values are presented in the error analysis (Figure 9). This can not be a good basis for concluding anything about the accuracy of a measurement technique. Even if these results are considered to show good accuracy, how do we know if these are representative? How will the accuracy vary with wind speed, wind direction, turbulence intensity, wind shear, temperature, other things we haven't thought about. . .. . ..? I do not believe that a 2 hour 'snap-shot' is a good scientific basis for concluding anything (good or bad) about measurement accuracy.

Specific comments Purpose of the paper – Please state clearly in the Introduction what is the purpose of the paper – i.e. what is the scientific question you are addressing. I am really not clear whether it is to look at vertical profiles (as the paper title suggests but are 2 hours of wind profiles very interesting?) or to conduct an error analysis (does this make sense with so few samples?). Line 68 'Accuracy . . . is then assessed' – What does 'accuracy' really mean here; difference to the reference sensors (how accurate are these?) or uncertainty? Line 99 ' sonic anemometers were calibrated..' – What does this mean and how was it done? I don't think this should be left to a reference (not available yet anyway) since here we are establishing the accuracy of our central reference instrument. How does 'maximum offset error' relate to uncertainty? Why is instrument resolution given as a calibration result? Line 112 'mean difference of -0.03

m/s' ..' Is this an aggregate of all 3 profiling lidars at all heights? The Rˆ2 is rather low for a direct lidar/mast comparison. Line 120 – 'Accuracy of the radial velocity .. is always smaller than 0.5 m/s' – again what is meant by 'accuracy'? Is this maximum difference? Line 121 – 'angular resolution . . . is smaller than 0.01 deg' – yes, but what about the accuracy? This can be a major source of measurement error but is not really addressed. What about range accuracy (also very relevant for an inclined beam)? Was this checked? Line 124 – 'range gates were selected to ensure a good quality of the velocity signals..' – Please explain what you mean here. Shouldn't you choose the range gates closest to the reference points? Line 130 – 'the vertical distance is always less than 10m' – What magnitude of wind speed error could this introduce? Line 147 – Why was the synchronisation relatively poor? How much difference would better synchronisation have made? Why not make some staring measurements at just one height to give some idea of the extra error introduced by the scanning? Line 196 – 'frequency chirp' – do you mean the AOM frequency shift? Figure 3 – The plot shows wind speeds at low heights (50 and 100m) is significantly higher that at 300m. Is this correct (in which case this should be commented on in the text) or are the signatures mixed up? Line 210 – What is meant by' average peak velocity'? Line 212 – Is the stability at 5m very interesting when the heights seem so de-coupled? Why not use one of the reference heights? Is a time average very useful? Line 226 – 'The estimated difference is the result of the accuracy. . ..' Why is the difference 'estimated'? How can you know that is (really) is the result of the items you list? Maybe re-phrase to 'Possible factors contributing to the observed differences are . . .'. Line 231 – It would be relevant here to also report the differences between the various references. Line 247 – 'lower agreement .. due to the poor quality of the velocity signals of the sonic anemometers.' – This is a very bold statement. How do you know this is true, why is it, and why are you wasting your (and our) time comparing the lidars to something you don't believe is working properly? Line 258 – what other explanations (for the differences) could there be? Figure 6 – The authors claim that the vertical components are well correlated with the sonics and lidars. In my experience, lidars will usually correlate well (and better

than this) to mast instrumentation. It would be interesting to see the lidar profilers correlation with the sonics. Is this better than the 3xRHI? If so, what is the point of the 3xRHI? Generally why have so many references (lidars and sonics) been chosen? Does this help the reader (I think not)? Line 290 – As asked before, why so short a period out of such a long campaign? And why these 2 hours in particular? This is important but should be explained clearly early in the paper.

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