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Atmospheric Measurement Techniques Discussions

Interactive comment on "A six-beam method to measure turbulence statistics using ground-based wind lidars" *by* A. Sathe et al.

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This is an interesting sequel to the conference paper by Sathe and Mann (2012) and adds the important information that not all beams can be at the same elevation angle. This may have been obvious to some but I didn't realise it until I tried to invert the M matrix! It also provides details of an extensive field comparison between a 6 beam lidar and cup anemometers on an 89m mast at the Riso test centre. Despite the wind energy community enthusiasm for cup anemometers this raises the question of why there were no comparisons with sonic anemometer determinations of the complete stress tensor. Maybe that is in progress but clearly measurements and comparisons of all 6 stress tensor components would be desirable.There are sonic anemometer data

available near the site which were used for Obukhov length determinations. Admittedly these were from an 80m level sonic on a mast that was about 1000m away but some rough comparisons might have been appropriate. I presume that they may have been made but not reported.

There is a clear demonstration of the limitations of turbulence measurements using VAD techniques which compute instantaneous single point velocities from non coincident sample volumes.

One slightly unsatisfactory aspect of the paper is Section 2.2. After struggling through the matrix algebra of Section 2.1 we suddenly get the results in Table 1 with rather a minimal explanation and only a partial indication of how the results were achieved. It certainly seems reasonable that with five beams at the same zenith angle and one with a zero zenith angle then uniform azimuthal spacing is optimal, but it is not obvious that the 5 and 1 arrangement is better than a 3 and 3 division between 2 polar angles or some other arrangement. The 45° zenith angle also seems reasonable but this was imposed as a limit and it would be interesting to know how different this is from a larger angle or the 15° or 30° used in some commercial lidar profilers.

The large data set (401 thirty minute blocks) is impressive and the results very interesting. Mean winds show excellent agreement (<Ulidar > = 0.999 <Ucup> with r2 > 0.999) in comparison with the cup and vane measurements but the variances show more scatter and less agreement. Turbulence levels with the 6 beam variance calculations are higher than those obtained with the VAD method, as one would expect, but for unstable and neutral stratification they have lower variance than values from the cup anemometer and vane method (ratios 0.85 - 0.9). More discussion of this aspect would be useful, including spectra of the radial velocities and some discussion of the reliability of variances computed with the cup and vane approach.

As a final point it might be worth noting that there are 5-beam commercial units available with two zenith angles (0° and 30°) and if one were to rotate the coordinate frame

into the mean wind direction and assume, for example, that <v'w'> = 0 then it is possible to compute the remaining stress tensor components from the 5 beam variances.

Reference Sathe, A. and Mann, J., 2012, Turbulence measurements using six lidar beams. Extended Abstracts of Presentations from the 16th International Symposium for the Advancement of Boundary-Layer Remote Sensing. Steering Committee of the 16th International Symposium for the Advancement of Boundary-Layer Remote Sensing, 2012. p. 302-305.

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