Author response to the comments of Prof. Stefan Emeis on the manuscript "A review of turbulence measurements using ground-based wind lidars"

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September 30, 2013

We thank Prof. Emeis for reviewing our manuscript and his comments. We agree with most of his comments, except we think that it would be too harsh to conclude that 'a full measurement of atmospheric turbulence with one lidar will never be possible', and 'there is no way without the three lidar method'. In flat homogeneous terrains the assumption of horizontal homogeneity is not completely far from the truth. Especially for the mean wind speeds, lidars have been proven to measure quite accurately in comparison to the standard cup/sonic anemometers [Kindler et al., 2007, Peña et al., 2009, Sathe et al., 2011, Smith et al., 2006, Wagner et al., 2011]. Moreover, the committee draft of the IEC 61400-12-1 standards recommends using a single lidar for mean wind speed measurements. We believe that for such homogeneous sites turbulence measurements from a single lidar would also be possible if the correct processing algorithms are used. Hence, we would not like to explicitly negate the use of one lidar for turbulence measurements.

We agree with the reviewer's comments on emphasizing the need of using three lidars in complex terrains. To this extent we would like to modify the discussion on scanning configurations (page 6852, lines 1–5 of the discussion paper) as given below. We would also like to include Fig. 1 in the revised manuscript that demonstrates how three lidars can be potentially used to measure at a point.

Three measurement configurations have been used until now; staring, VAD, and RHI scanning (see section 3 for details of the scanning configurations). Ideally, using three staring lidars with their beams crossing at a point (similar to sonic anemometer) would provide more reliable measurements as compared to using a single lidar in a VAD or RHI scanning mode. Figure 1 illustrates this concept. The necessity of making assumptions of horizontal homogeneity is reduced significantly, and potentially it can provide measurements in complex terrain with increased reliability. The only challenge then is to tackle the probe volume averaging effect in the individual beam direction.

As regards the comments on innovative method, we would like to add to the discussion on improvements in lidar technology (page 6853) as follows:

Completely new principles could also drastically improve the turbulence measuring capabilities of lidars. One such suggestion is to exploit the translation of the speckle pattern in the image plane of the lidar telescope. In this way not only the line-of-sight velocity could be estimated, but also the two transverse velocity components. All components would be measured in the same volume reducing the problem of cross-contamination. The method has been tested successfully in the laboratory on translating hard targets [Iversen et al., 2011, Jakobsen et al., 2011], but it is much harder to get it to work with backscatter from atmospheric aerosols. Firstly, the return from the aerosols is much weaker and, secondly, the turbulence may reduce the correlation time of the speckle pattern, which could adversely affect the transverse velocity determination.

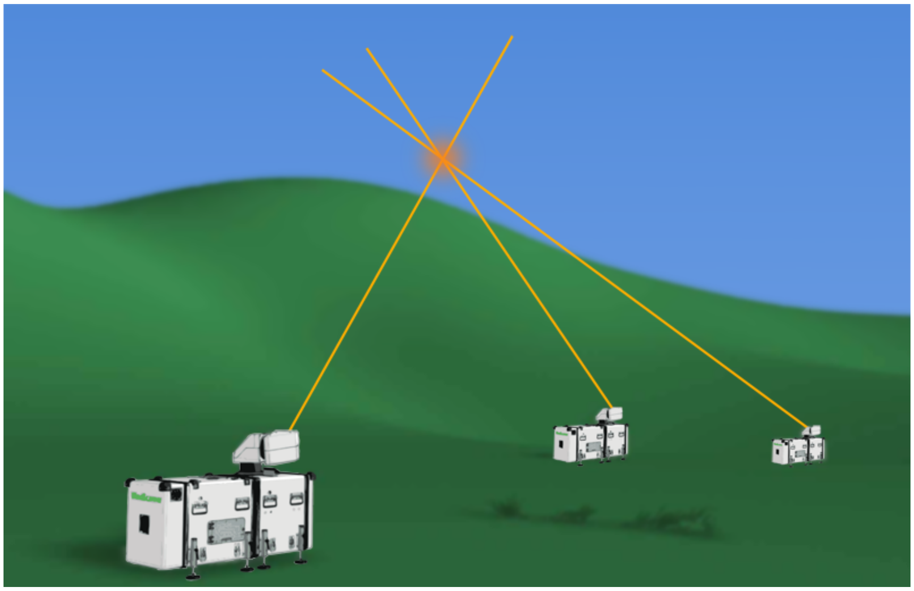

Figure 1: Three lidars intersecting at a point

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