Evaluation of three lidar scanning strategies for turbulence measurements

Several errors occur when a traditional Doppler beam swinging (DBS) or velocity-azimuth display (VAD) strategy is used to measure turbulence with a lidar. To mitigate some of these errors, a scanning strategy was recently developed which employs six beam positions to independently estimate the $u$, $v$, and $w$ velocity variances and covariances. In order to assess the ability of these different scanning techniques to measure turbulence, a Halo scanning lidar, WindCube v2 pulsed lidar, and ZephIR continuous wave lidar were deployed at field sites in Oklahoma and Colorado with collocated sonic anemometers. Results indicate that the six-beam strategy mitigates some of the errors caused by VAD and DBS scans, but the strategy is strongly affected by errors in the variance measured at the different beam positions. The ZephIR and WindCube lidars overestimated horizontal variance values by over 60% under unstable conditions as a result of variance contamination, where additional variance components contaminate the true value of the variance. A correction method was developed for the WindCube lidar that uses variance calculated from the vertical beam position to reduce variance contamination in the $u$ and $v$ variance components. The correction method reduced WindCube variance estimates by over 20% at both the Oklahoma and Colorado sites under unstable conditions, when variance contamination is largest. This correction method can be easily applied to other lidars that contain a vertical beam position and is a promising method for accurately estimating turbulence with commercially available lidars.

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