Comments on the article "Methodology for deriving the telescope focus function and its uncertainty for a heterodyne pulsed Doppler lidar" by Pentikainen *et al.*

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General comments

The paper presents a practical method for characterizing the "telescope aperture function" of a pulse heterodyne lidar. As explained in the article, this function is required to correct the intensity of the signals recorded by the instrument (termed SNR as it is normalized to the level of white noise in the heterodyne lidar) from the variations of the instrument sensitivity with the range. This function is more complicated than with a direct-detection aerosol lidar as it is not given by the overlap between the laser beam and the telescope aperture, but has more to do with the efficiency of the heterodyne detection. However, an expression exists that predicts how it varies with the range as a function of two system parameters, namely the size of the telecope aperture D and the focal length f. The idea is to tune these two parameters until the corrected signal intensities match the attenuated backscatter measured by a nearby ceilometer. Of course, this method requires the presence of ceilometer nearby, but ceilometers are rather cheap instruments, and are deployed in great numbers in meteorological observation networks. The method opens the possibility to use a heterodyne wind lidar as an aerosol lidar and thus combine with a unique instrument the measurement of wind and aerosol backscatter profiles. This is of great interest for the characterization of pollution transport or the study of the atmospheric boundary layer.

There are several limtations to the method. One deals with the difference of the laser wavelength of a ceilometer (usually close to $0.9\mu m$) and a pulsed heterodyne lidar ($\lambda \approx 1.5\mu m$). The value of the attenuated backscatter are different at the two wavelengths, and the difference is dependant of the nature the aerosols. The methode would thus be in trouble if several layers of different aerosols are present in the laser beam. This limitation is clealry discussed in the text. There is, however, a second limitation. The heterodyne efficiency does not depend solely of the instrument paramaters, but also on the optical turbulence. This dependcy appears in equation (2) of the article with the ρ_0 parameter. It is assumed in article that $\rho_0 >> D$ so that its effect on $A_e(R)$ can be neglected.

This assumption is not justified. In practice, it can happen that the turbulence significantly degrades the heteridyne efficiency of the lidar. This is particularly the case when the beam is directed horizontally, a few meters above the ground, on a hot, sunny day. In the article, the vertical (or close to vertical) direction of the beam should alleviate the degradation as the optical turbulence drops very rapildy with the altitude, but it would be worth to have a short calculation of ρ_0 as a function of the range using a typical profile of C_n^2 and the formulation of Frehlich and Kavaya for ρ_0 (equation 165).

It is written in the abstract that the method proposed in the article is applicable to Halo Photonics heterodyne Doppler lidars. It is clear that it is tested on data from Halo Photonics lidars, but I do not see why it could not be applicable to heterodyne lidars from other manufacturers as long as they provide measurements of SNR. If that is true, it would be worth mentionning it in the abstract as it widens the applicability of the method.

Specific comments

1. In the paragraph that follows equation (1), the meaning of the η term is not explained.

2. Equation (5): the equation applies to relative uncertainties. This shall be made clear.

3. Line 28: why this $-22.2dB$ SNR threshold?

4. Table 4 on page 13: the meaning of b in $N(f^{-2}, b)$ and $N(f, b)$ is not explained in the legend.

Conclusion

This is an interesting paper that proposes a useful and practical way for the characterization of the variation of the receiving efficiency of a heterodyne lidar with the range. Minor modifications would improve its quality. It deserves publication.