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Automatic correction scheme for the temperature dependent overlap function of CHM15k ceilometers

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Imperfections in a lidar's overlap function lead to artefacts in the background, range and overlap corrected lidar signals. These artefacts can erroneously be interpreted as aerosol gradient or, in extreme cases, as cloud base leading to false cloud detection. A correct specification of the overlap function is hence crucial to use automatic elastic lidars (ceilometers) for the detection of the planetary boundary layer or low clouds.
In this study an algorithm is presented to correct such artefacts. It is based on the assumption of a homogeneous boundary layer and a correct specification of the overlap function down to a minimum range, which must be situated within the boundary layer. The strength of the algorithm lies in a sophisticated quality check scheme which allows to reliably identify favorable atmospheric conditions. The algorithm has been applied to 2 years of data from a CHM15k ceilometer from Lufft. Backscatter signals corrected for background, range and overlap have been compared using the overlap function provided by the manufacturer and the one corrected with the presented algorithm. Differences between corrected and uncorrected signals reach up to 45% in the first 300m above ground. The amplitude of the correction turned out to be temperature dependent being larger for higher temperatures. A linear model of the correction as a function of the instrument's internal temperature has been derived from the experimental data. Case studies and a statistical analysis of the strongest gradient derived from corrected signals reveal that the temperature model is capable to correct overlap artefacts with high quality, in particular such due to diurnal variations. The presented correction method has the potential to significantly improve the detection of the boundary layer with gradient based methods because it removes false candidates and hence simplifies the attribution of the detected gradients to the planetary boundary layer. A particularly high benefit can be expected for the detection of shallow stable layers typical for nighttime situations.
The algorithm is completely automatic and does not require any intervention by a human expert beside the definition of an adequate instrument specific configuration and is therefore suited for the use in large ceilometer networks.
This work will be submitted in a corresponding paper in AMT.