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Statistical analysis of ceilometer overlap function

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Automatic LIDARs and ceilometers (ALCs) are gaining in popularity in the atmospheric boundary layer and aerosols studies due to their low-cost and automatic unattended operation. However, incomplete overlap between the emitted laser pulses and the receiver field of view in biaxial systems significantly deteriorates the ALC performance in the near range so the accurate knowledge of the overlapping function (OVL) is critical. Although theoretical determination of the overlap function is possible it requires reliable knowledge of all system parameters that are tough to be precisely determined in practice. Moreover, ALCs are exposed to the environmental factor as solar radiation and air temperature so the OVL can show temperature dependence due to the lack of temperature compensation in the external parts of the receiver optics. Therefore, individual experimental determination of the overlap function is not particularly useful in the real field measurements but the OVL should be routinely retrieved and the backscatter power should be continuously compensated for the inherent imperfection of the biaxial LIDAR systems. In this work, we utilize an experimental technique based on ceilometer measurements in optimal conditions (atmospheric boundary layer is well mixed and its height is in the complete overlap zone) in order to determine overlap function. Then temperature dependence of the OVL is statistically analyzed and modeled and the obtained regression model allows us to correct the ceilometer backscatter signal in non-optimal conditions when experimental determination of OVL is very difficult. The presented approach for correction of the raw ceilometer signal has the potential to improve the continuous monitoring and exploration of shallow atmospheric boundary and aerosol layers.