Instrumental correction of the uneven PMT aging effect on the calibration constant of a water vapor Raman lidar

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The water vapor profile derived from Raman lidar measurements is obtained from the ratio of water vapor to nitrogen Raman-shifted returns. The proportionality factor converting the signal ratio to water vapor/air mixing ratio is referred to as lidar calibration constant. The calibration constant is a function of the water vapor and nitrogen Raman cross sections and the efficiencies of the respective Raman channels including the photomultiplier tubes (PMT) efficiencies. Unequal, gradual changes in the water vapor and nitrogen channels PMT efficiencies due to aging effects lead to steady alteration of the calibration constant.

This effect has been observed during the seven- year continuous operation of the RAman Lidar for Meteorological Observations (RALMO)1. A more detailed research2, has shown that the calibration constant change is more pronounced during summer time, which is explained by the higher daylight exposure of the PMTs during this period. Periodical recalibration of the lidar with radiosonde measurements is used to correct the calibration constant. This approach, however, induces additional systematic errors due to the nature of the calibration procedure and because of sonde-to-sonde accuracy variations. The systematic errors could induce artefacts leading to an incorrect interpretation of certain data points in the framework of climatological studies.

To resolve this problem we developed a new, instrumental method for automated correction of the lidar calibration constant. By this method, the change in the water vapor and the nitrogen PMTs efficiencies are estimated from the PMTs responses measured when they are illuminated simultaneously by a single stabilized LED light source. A correction factor is deduced from the ratio of the signals of the two photomultipliers. The correction measurements are taken automatically once daily before midnight. The correction is applied when the correction factor exceeds a predefined threshold for several days.

The method principle, the instrumental setup and preliminary results will be presented.

References

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