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Absolutely calibrated Raman lidar as a reference in atmospheric humidity profiling

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The operational humidity profiling in meteorology is carried out mostly by balloon-borne radio sondes. Capacitive or less often chilled mirror sensors are used as sensors. Both types of sensors are prone to systematic errors that require careful corrections. Recently, some national meteorological services (MeteoSwiss, DWD) have introduced Raman lidars for operational humidity profiling.
Raman lidars exploit the proportionality between the intensity of scattered by Raman process laser radiation and the number density of scattering molecules. Water vapor-air mixing ratio is deduced from the ratio of the measured intensities of Raman scattering from water vapor and nitrogen molecules. The coefficient of proportionality denoted as calibration constant depends on instrument parameters and spectroscopic parameters of the scattering molecule and is primary factor defining lidar measurement accuracy. Derivation of the calibration constant using above mentioned parameters, known as “absolute” calibration, is possible but leads to high uncertainty. Therefore Raman lidars are calibrated against reference instrument- radio sonde or microwave radiometer. The accuracy of such calibration is thus defined by the accuracy of the reference instrument.
A new, first principle calibration method, based on the use of gravimetrically produced water vapor/air mixture will be presented. The method allows deriving of the calibration constant with uncertainty lower than 0.1%, traceable to the primary standards of mass and length. The calibrated in such way lidar has the potential to become a reference in radio-sonde, microwave radiometer and GPS water vapor measurements.