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# Simulation of improved daytime capabilities to retrieve aerosol extinction coefficient using Rotational Raman lidars

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So far, most of the multi-wavelength Raman lidar observations of aerosols are performed at night, because Raman signals are weak compared to daylight background. Different techniques have been developed to improve Raman lidar daytime capabilities in the past years. Indeed, the retrieval of aerosol extinction during daytime is feasible through the detection of backscattered radiation due to the pure Rotational Raman Spectrum (PRRS) of molecular nitrogen or oxygen, much brighter than the vibration-rotation spectrum.
The existing techniques for the measure of PRRS are based on small-bandwidth emitter and receiver systems and on a small receiver field of view to suppress the daylight background. They have been successfully tested and implemented in a few systems which are already in operational use within EARLINET (European Aerosol research Lidar NETwork).
In this work, several different configurations used as receiver for a lidar system detecting the PRRS in daytime conditions are compared by means of numerical simulations. The configurations are mainly differentiated by the design of the spectral selection unit implemented in the receiver of each lidar system, based on a narrow-bandwidth filters, broad-band filters, grating spectrometers, and hybrid solutions. The research of configurations able to be more easily implemented on a large number of lidar systems within ACTRIS are explored.
To show the performances of the investigated lidar configurations, a blind test has been carried out to get the simulated performances in the retrieval of the aerosol extinction profile during night-time and daytime starting from a known scenario. The atmospheric scenario used as the reference profile is represented by one of the night-time measurements with MUSA (MUlti-wavelength system for Aerosol) lidar at CNR-IMAA Atmospheric Observatory – CIAO (15.72E, 40.60N , 760 m a.s.l., Potenza, Italy).
Though all the configuration considered in the blind test proved to be solid to suppression of solar background, the simulations shows that PRRS can be efficiently used to provide accurate aerosol extinction profiles only if the lidar receiver shows a suppression of the elastically backscattered radiation in the order of 10-5. This requirement is well satisfied only using receivers equipped with a double-grating spectrometer filtering the backscattered radiation in a sequential way, or using broad interference filters selected in order to be temperature independent and stable in the detection of the PRRS at different environmental temperatures and incident angles of the backscattered radiation.