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Data set Description:
PI: G. L. Liberti
CoI: D. Dionisi
Instrument: RMR lidar
Site: Rome Tor Vergata
Measurement Quantities: Tropospheric Water Vapor

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Instrument Description:

The whole system is mounted in two 20-ft standard superimposed containers and can be moved to different locations for special measurement campaigns. The transmitter is based on an Nd:YAG laser with second (532 nm: green) and third (355 nm: UV) harmonic generators. The green beam is used for the elastic backscatter (aerosol and Rayleigh temperature profiles), whereas the UV beam is used to acquire Raman-backscattering signals from H2O and N2 molecules to retrieve the WVMR profile. Backscattered radiation is collected and analyzed at three wavelengths of interest: 532 nm for the elastic backscatter and 386.7 and 407.5 nm for Raman scattering of N2 and H2O molecules, respectively. The receiver is based on a multiple-telescope configuration, allowing the sensing of a wide-altitude atmospheric interval. For the Raman backscatter, two different collection channels are employed: one for the lower range (0.1-5-km altitude, using a 30-cm telescope and an optical fiber) and one for the upper range (2-13-km altitude, using an array of nine 50-cm aperture telescopes and an optical fiber bundle) called 'lower channels' and 'upper channels' respectively. It must be noted that the use of optical fibers in both the lower and upper channels minimizes the overlap function problems after the ratio of H2O and N2 channels is taken; thus, the WVMR profile should be reliable from the beginning of the beam-field of view (FOV) overlap. For elastic backscatter, an additional 15-cm telescope is used to sense the lower atmosphere (0.5-8 km), whereas the above-mentioned lower and upper channels are used for sensing the ranges of 6-40 and 25-80 km, respectively. A laser synchronous chopper system modulates the incoming radiation in the three channels for the upper layers to prevent photomultiplier blinding by the strong return from low altitudes. The acquisition vertical resolution is 75 m, and the signals are generally integrated over 60 s (600 laser pulses) before recording. The procedure reported here refers to nighttime operation. The lidar can also operate in daytime, limiting the Raman observations to the lower atmosphere with the 30-cm telescope receiver. Indeed, a slide allows changing the field diaphragm in the focal position of this telescope, reducing its FOV in daytime; the associated higher overlap altitude actually suggests not using the smaller diaphragm in nighttime. The high background signal due to the 25-fold larger collecting area and the larger FOV of the nine telescopes of the array make it impossible to use the largest receiver in daytime. The field diaphragm position along the three directions, X, Y, Z, in all 11 telescopes, as well as the azimuth-zenith orientation of the two laser beam-pointing mirrors are computer controlled through stepping motors; however, no automated operation has been attempted to date.

Data processing

To improve the signal to noise ratio, raw data is integrated in time during the whole lidar session. Signals are then corrected for background noise and Rayleigh extinction. Un-calibrated water vapor profiles are retrieved combining low and high Raman detection channels in the 3-6 km overlap range, determined by a statistical analysis of the profiles coming from both channels. A parametric automatic procedure is implemented to calibrate the combined profiles using as a reference the operational 0000 UTC soundings at the WMO station 16245 (Pratica di Mare) located about 25 km southwest of the lidar site. To further reduce statistical error, a vertical integration is applied following an height-dependent smoothing scheme. The water vapor profiles obtained at the end of this process are expressed in grams of water vapor per Kg of dry air.

<u>Error analysis</u>

The reported water vapor error in the NDACC data files take into account not only the statistical error but also the uncertainty associated to the calibration constant. This uncertainty, which has been estimated in Dionisi et al. (2010), is around 10%.

<u>Instrument history</u>

01/1998 to 06/1999: Beginning of the first test measurements in 1998 at Rome Tor Vergata

10/1999 to 01/2001: lidar system was deployed in Pallanza di Verbania for the Mesoscale Alpine Programme campaigns

02/2001 to 04/2002: lidar system was installed back at Rome Tor Vergata site for test measurements using only five of the nine 50-cm aperture telescopes of the Raman receiving upper channel

05/2002: beginning of routine measurements with RMR full receiving channel configuration.

06/2009 to 09/2009: System maintenance and replacement of the interference filters.

04/2011: Installation of 355 nm elastic middle range receiving channel.

06/2011 to 05/2016: Due to severe technical and financial problems, routine measurements were interrupted and only campaigns measurements were performed.

12/2012: Laser maintenance.

06/2016: re-start of routine measurements with Raman low channel configuration.

10/2017 to 01/2018: Laser maintenance.

08/2020-07/2022: Hardware issues with the low Raman WV channel

12/2022: New Laser source acquisition

04/2023: Beam expanders major maintenance and upgrade: now allowing the emission of the 1064 nm with the 532 nm.