

Fresh biomass burning aerosol observed in Potenza by multiwavelength Raman Lidar and sun-photometer

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The summer of 2021 was characterized by exceptionally dry and warm climate, which caused a high number of local fires. The biomass burning aerosols product by these fires modify the regional climate and the radiation budget. This scenario could get worse in the coming years, indeed the Mediterranean basin has become a wildfire hotspot.

On 14 August 2021, the Lidar Raman MUSA and the CIMEL 318 sun-photometer (operating at CIAO atmospheric observatory of CNR-IMAA in Potenza, Italy) observed an extremely fresh smoke plume. The forest fire started at 16:00 UTC and the biomass burning plume was transported over the CNR IMAA of Potenza. The Lidar measurements have been carried out from 22:27 to 02:16 UTC. The case study represents a unique measure, to our knowledge, due to the very short distance between the fire and the measuring station that is only 1 km. Indeed the particles didn't have aged smoke and they were not contaminated by other types of particles.

In the time interval from 22:27 to 23:19 UTC, Lidar measurements reveal a biomass burning layer below 2.7 km. The particle depolarization at 532 nm is 0.025 and Lidar ratios at 355 and 532 nm are respectively 40 and 38 sr. For all wavelengths, the mean value of Ångström exponent is 1.5. All these values are typical of small and spherical particles.

To obtain the microphysical properties of the particles, an inversion based on a regularization algorithm using on $3\beta + 2\alpha$ measurements have been used. The value of surface concentration is $410 \mu\text{m}^2 \text{cm}^{-3}$, the volume concentration is $21 \mu\text{m}^3 \text{cm}^{-3}$ and the number density is 2300cm^{-3} . The size distribution is bi-modal with a peak at $0.13 \mu\text{m}$ in the accumulation mode. The effective radius have a mean value low of $0.15 \mu\text{m}$. Single scattering albedo is approximately 0.96 at all wavelengths. Finally, the real part of the refractive index is 1.58 and the imaginary is 0.006, indicating a low absorption probably due to a negligible presence of black carbon. The aerosol optical depth (AOD) over the entire air column was obtained from the CIMEL 318 sun photometer. The columnar particle properties were retrieved from the sky radiances and the aerosol optical depth at different wavelengths. Even if the first available measurements are at 5:34 UTC, they confirm the analysis of MUSA data despite the lower concentration of the smoke plume at that time. Also the values of single scattering albedo (around 0.95 at 440 nm) are in agreement with those obtained from the microphysical inversion of Lidar data.