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Atmospheric aerosol and ozone quasi-vertical profiles in the Po Valley during summertime: insights from stationary and mobile measurements from the ACTRIS-2 campaign

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The atmospheric aerosol columnar distributions are key parameters in evaluating the impact of anthropogenic emissions on climate and in improving model ability to describe aerosol-radiation and aerosol-cloud interactions. Aerosol vertical profiles are still poorly characterized in many areas and, with the purpose of appraising them, background measurements are required from low/high altitude stations and mobile/airborne measurements.
Ambient measurements of short-lived climate forcers (aerosol and ozone) were investigated in the Po Valley, a well-known air pollution hot spot, during the summer of 2017 under the framework of the "ACTRIS-2 - Mt. Cimone and Po valley" intensive field campaign. Low troposphere stationary measurements were performed at the "urban-background" in Bologna and at the high altitude remote site of the Monte Cimone GAW station (MTC, 2165 m a.s.l.), at about 80 km South-East from Bologna, on the Apennines. "Quasi-vertical profiles" between the abovementioned measuring sites were probed using a mobile pollutants measurement laboratory (MOSQUITA) equipped with several aerosol and gas analyzers. The roundtrips to MTC started in the morning and ended in the late afternoon, in order to assess the importance of the daily evolution of the polluted boundary layer (PBL).
The measurements included: Black carbon mass concentration and size distribution were measured via a Single Particle Soot Photometer (SP2 - DMT). Multi Angle Absorption Photometers (MAAP - Thermofisher) were deployed in the two stationary sites, in the mobile lab and in airborne measurements flaying over the city of Bologna and reaching MTC site. Aerosol Ångström Exponent (AAE, 370-950 nm) was derived from an Aethalometer (AE33 – Aerosol d.o.o) measurements. The total number of particles was monitored by a CPC. Aerosol chemical compositions was measured by Aerodyne Aerosol Mass Sepctrometers (HR-ToF-AMS and ACSM) and organic aerosol OA sources were identify by Positive Matrix Factorization (PMF) analysis of OA mass spectra. O_3, CO_2, temperature and relative humidity via monitors.
Our results highlighted the importance of the anthropogenic emissions, especially from traffic, in polluting the lower troposphere in terms of BC mass concentration and absorption coefficients showing urban-background values up to 10 and 6 times higher than what is measured at MTC, respectively. Their concentrations decrease with altitude and the vertical profile obtained during the trip-back in the afternoon shows higher values as it is influenced by the increase of the height of the PBL due to convective mixing. Similarly, in the morning OA profile shows concentration below 1000 m a.s.l. about twice as high as concentration at MTC, while in the afternoon OA concentrations are higher in the urban area and decrease at higher altitude. The O_3 vertical profiles shows different atmospheric structures: the most frequent showing an increase up to about 500 m and remaining at an almost constant values up to MTC; O_3 concentrations increased in the afternoon, due to the PBL influence, and decreased in proximity of traffic emissions, due to titration by NO.