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Summer atmospheric composition over the Mediterranean basin: investigation on transport processes and pollutant export to the free troposphere by observations at the WMO/GAW Mt. Cimone global station (Italy, 2165 m a.s.l.)

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In this work, we analysed reactive gases (O_3, CO, NO_x) and aerosol properties (eqBC, [U+F073]s and particle number concentration) collected at the WMO/GAW Mt. Cimone station (2165 m a.s.l., Italy) during the summer of 2012 in the framework of PEGASOS project. The major aim of this experiment is providing a characterization of the variability of summer atmospheric composition over the central Mediterranean basin, which is considered as a global "hot-spot" for atmospheric pollution and climate change.
The atmospheric tracers have been analysed as a function of (i) meteorological parameters, (ii) synoptic-scale circulation and (iii) anthropogenic emission source proximity as estimated by O_3/NO_x ratio variability. In particular, we identified three O_3/NO_x regimes which tagged the distance of anthropogenic sources: near outflow (23% of hourly data), far-outflow (38% of data) and background (39% of data). The highest levels of anthropogenic pollutants (e.g. O_3, CO, eqBC, accumulation particles) were concomitant with fresh emissions from northern Italy under near-outflow conditions: once injected to the free troposphere, these air-masses, rich in pollutants and climate-forcers (i.e. O_3, eqBC) and soil dust, can be spread over a large region, thus significantly affecting regional climate. Moreover, based on the anthropogenic source proximity, atmospheric tracer variability and synoptic-scale atmospheric circulation, we categorized and characterised four types of atmospheric regimes associated with (1) air-mass transport from the free troposphere, (2) transport of fresh emitted pollutants from the PBL, (3) transport at regional/continental scale of aged anthropogenic (4) transport of air-mass rich in mineral dust from northern Africa (i.e. coming from more than 1000 km).
Lastly, by analysing the probability density functions (PDFs) of trace gases and aerosol properties, "fingerprints" of the mentioned atmospheric regimes were pointed out. Such information is useful for the implementation of early-warning services, for the timely detection of event occurrence as well as for the definition of observation-based diagnostic for model verifications.