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Atmospheric conditions associated with high and low summertime ozone levels in the boundary layer over some eastern Mediterranean airports

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Thanks to the vertical atmospheric measurements of the MOZAIC program, enhanced ozone mixing ratios in the lower troposphere over the Eastern Mediterranean have been found, frequently exceeding the 60 ppb, 8-h EU air quality standard, whereas ozone between 700 hPa and 400 hPa was only slightly (3–5 ppb, 5–10%) higher than over Central Europe. Also, the examination of the highest and lowest ozone levels in the lower troposphere (1.5-5 km) over some airports in the Eastern Mediterranean area showed the lower-tropospheric ozone variability over there is controlled mainly by the synoptic meteorological conditions, combined with local topographical and meteorological features. In particular, the highest ozone concentrations in the lower troposphere and subsequently in the boundary layer in the area are associated with large scale subsidence of ozone rich air masses from the upper troposphere under anticyclonic conditions while the lowest ozone concentrations are associated with low pressure conditions inducing uplifting of boundary layer air, poor in ozone and rich in relative humidity, to the lower troposphere.

In order to further evaluate the observed high rural ozone levels during summertime, vertical summer ozone profiles measured by MOZAIC in the period 1994–2008 over the Eastern Mediterranean basin (Cairo, Tel-Aviv, Heraklion, Rhodes, Antalya) are analyzed, focusing in the boundary layer (0-1.5 km). First, vertical profiles collected during extreme days with very high or very low tropospheric ozone mixing ratios are examined. Also, the average profiles of ozone, relative humidity, carbon monoxide, vertical temperature gradient and wind speed corresponding to the 7% highest and the 7% lowest ozone mixing ratios for the height layers of 0-500m, 500-1000m and 1000-1500m for Cairo and Tel-Aviv are examined along with the corresponding composite maps of geopotential heights at 850 hPa and 925 hPa. In addition, analyses of backward trajectories, using the FLEXPART model, in the lower troposphere over the examined airports are performed for the highest and lowest ozone days in combination with the calculation of the CAPE (CIN) criteria of instability (stability) for the selected vertical profiles.

In general, the maximum vertical ozone concentrations during days of highest ozone mixing ratios over all the examined Eastern Mediterranean airports are observed above the boundary layer at 2-3km altitude. Within the boundary layer, ozone is decreased on average in all airports, especially in Tel-Aviv and Cairo, which might be attributed mainly to the influence of nitrogen oxides originating from local urban pollution and atmospheric particles of mainly natural origin (e.g. desert dust) as well as dry deposition on the ground. The results of our analysis show that the influence of tropospheric ozone on both the boundary layer and surface ozone values, mainly through the process of atmospheric subsidence, is quite variable among the examined Eastern Mediterranean airports with the highest impact detected over the Aegean Sea airports of Heraklion and Rhodes.