



Methane source identification using Non-Methane Hydrocarbon (NMHC) source apportionment in the Eastern Mediterranean and Middle East region

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Methane (CH₄) is a potent greenhouse gas but its sources remain poorly quantified in the Eastern Mediterranean and Middle East (EMME) region where major oil and gas production takes place. Light alkanes, such as ethane (C₂H₆), are co-emitted with CH₄ by oil and gas activities and are promising tracers for quantifying the methane emissions from this sector. Cyprus is an ideal location for studying the composition of regional air masses and for characterizing different emission source signatures at a regional scale. A Picarro G2401 greenhouse gas analyzer and two field-based Gas Chromatography Flame Ionization Detectors (GC-FID) for Non-Methane Hydrocarbons (NMHC) measurements were deployed during two campaigns, one in “urban” (Nicosia) and one in “regional background” (Cape Greko) environment respectively. The campaign at the regional background site consisted in continuous methane and NMHCs (C₂-C₁₂) observations using a mobile laboratory that was deployed at the south-eastern edge of the island between December 2021 and February 2022. This location was chosen to capture airmasses of remote south and eastern origin, uninfluenced by local sources. We use these observations to 1) evaluate the significance of long-range transported versus local sources in Cyprus, 2) identify and document regional anthropogenic methane sources, and 3) assess the accuracy of the EDGAR sectoral emission inventory over EMME. Positive Matrix Factorization (PMF) analysis of the NMHC dataset resulted in the identification of four distinct sources namely tropospheric background, urban, heavy oil combustion, and transported from Middle East. The latest occurred during three distinct episodes and on average, had the highest NMHC concentrations. Generally, the different urban and regional signatures/sources displayed good and variable correlations between CH₄ and C₂ to C₆-NMHCs. By investigating the PMF results together with CH₄ concentrations and an atmospheric dispersion model (FLEXPART), we provide a comprehensive characterization of the pollution sources at regional scale over the Eastern Mediterranean region.