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Contribution of atmospheric processes affecting the dynamics of air pollution in South-Western Europe during a typical summertime photochemical episode

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Abstract. The southern Mediterranean region frequently experiences critical levels of photochemical pollutants during summertime. In order to account for the contribution of different atmospheric processes during this type of episodes, the WRF-ARW/HERMES/CMAQ modelling system was applied with high resolution (1 km^2, 33 sigma vertical layers, 1 h) to assess the different dynamics in a coastal environment and an inland-continental zone: the North-Eastern and Central Iberian Peninsula (NEIP and CIP, respectively). The former is characterized by a very complex terrain, while the latter behaves as a flat area, which clearly affects the pattern of local flows. A representative type of photochemical pollution episode (occurring over 78% of summer days) which occurred during 17–18 June, 2004 is selected as the study period. The CMAQ Integrated Process Rate provides the hourly contributions of atmospheric processes to net O_3, NO_x and NMVOCs concentrations. The O_3 photochemical formation occurs mainly in downwind areas from the main NO_x emission sources during midday. At surface level it accounts for 50 to 75 μg m^{-3} h^{-1}. The urban areas and main roads, as main sources of NO_x emissions, act as O_3 sinks, quenching up to −200 μg m^{-3} per hour during the traffic circulation peaks. The O_3 concentration gradient generated, larger during daytime, increases the contribution of diffusion processes to ground-level O_3 (up to 200 μg m^{-3} h^{-1} fluxes, mainly from upper vertical layers). The maximum positive contributions of gas-phase chemistry to O_3 occur in the coastal domain at high levels (around 500 to 1500 m a.g.l.), while in the continental domain they take place in the whole atmospheric column under the PBL. The transport of ozone precursors by advective flows determines the location of the maximum O_3 surface concentrations. The O_3 chemical formation involves the oxidation of less NMVOCs in the NEIP than in the CIP domains, due to differences in chemical sensitivity between these areas. The dry deposition is an important sink in the lowest layer of the model, together with vertical diffusion flows. Finally, the contributions from cloud processes, wet deposition and heterogeneous chemistry are negligible during the whole episode, characterized by a high solar radiation and neither precipitation nor cloudiness. This process analysis provides new quantitative information about the origin of the peaks of O_3 and its precursors, aiding the design of abatement strategies in South-Western Europe.

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