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The Vertical Structure, Sources, and Evolution of Aerosols in the Mediterranean Region

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The VESSAER campaign (VErtical Structure and Sources of AERosols in the Mediterranean Region) was designed to characterize the different sources of aerosol in the Mediterranean Basin and assess the regional impact of aerosol on cloud microphysical and radiative properties. VESSAER was conducted on an ultra-light aircraft in summer 2012. Research activities included ground-based observations in the central and northern regions of Corsica, as well as aerosol lidar and sunphotometer measurements near the eastern coast. The main scientific goals were to investigate local versus long-range sources of aerosol and cloud condensation nuclei (CCN) and their vertical stratification in the lower troposphere, study evolution and ageing due to atmospheric processes, and determine aerosol direct radiative impacts over a larger spatial scale.

The background aerosol concentrations (D > 0.01 um) within the boundary layer in Corsica were nearly 2000 cm^{-3} and increased to ca. 10^4 cm^{-3} during pollution events when back-trajectories originated from coastal areas in France and Italy and the Po Valley. Nearly all of these particles were CCN-active at 0.38% supersaturation, indicating a relatively hygroscopic aerosol. Vertical profiles of aerosol hygroscopicity revealed that ageing (with respect to CCN-activity) of European emissions occurred exclusively in the boundary layer. Within two days, the European emissions had become hygroscopic, probably a result of cloud processing. In contrast, aerosol hygroscopicity did not change as a function of transport time in elevated aerosol layers, suggesting that photochemical ageing of less hygroscopic material is relatively slow compared to ageing processes in the boundary layer.

The vertical profiles clearly showed the long-range transport of dust from the Saharan Desert and pollution from the European continent, which were the two major sources of aerosol during the campaign. Two of the research flights coincided with CALIPSO overpasses, when Saharan Dust layers were transported within the lower 5 km of the atmosphere. Concentrations of large particles (D > 0.3 um) increased throughout the troposphere during dust events, corresponding to an increase in aerosol optical depth up to 0.7 (at 440 nm). Dust cases were clearly identified by a high fraction of non-spherical particles and coarse-mode volume fraction. The mean extinction coefficient of the dust layers were up to 0.1 km^{-1}. The single-scatter albedo (in the UV) for each of the dust events was 0.90 (July 1) and 0.95 (July 9); the different values indicate a change in the type of dust due to different origins or transport. Results of satellite overpasses, ground-based remote sensing, airborne in-situ observations and regional-scale models have been combined to assess the radiative impact of dust over the Mediterranean Basin.

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