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Bringing to light specific sources and dust transport as key parameters in the simulation of PM episodes in Mediterranean areas

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High levels of particulate pollution – overpassing the limits imposed by international regulations – are nowadays common among the cities of the European Mediterranean coast, due to the presence of large harbors or industries, dense urban areas, and frequent air mass recirculation phenomena. To propose efficient environmental policies relative to particulate matter (PM), we first need to better understand the generation of such pollution incidents and the role played by the different sources of PM. In this frame, there is much space for the improvement of Chemistry Transport Models (CTM), particularly in defining the different forcings (emissions, transport, resuspension etc.) of the simulation.

Here we approach the problem of particulate pollution in Mediterranean areas by performing simulations for the period of summer 2006 on a French coastal site. This study focuses on the comprehension of the parameters responsible for PM episodes, through the study of a well-defined episode of particulate pollution. It allowed us to identify weaknesses in the CTM inputs, to quantify their impact on a regional scale and to propose orientations for further improvements of the CTM results.

We performed simulations with the model CHIMERE (http://euler.lmd.polytechnique.fr/chimere) forced by MM5 (http://www.mmm.ucar.edu/mm5) meteorological fields, for a period of two consecutive months in the summer of 2006. Ground observations covering all the area

showed the existence of a PM episode which lasts for two weeks and is expressed with two intense peaks. Comparison of simulations and ground observations made clear that the model was able to reproduce the evolution of PM concentration but with two important biases: the underestimation of mean PM quantity (frequently met among CTMs) especially during episodes, and a poor hourly variability. Numerous hypotheses were made and tested. Our results clearly revealed two major points:

1) Using satellite observations for the optical depth and back trajectories, we identified the transfer of African dust as the origin of the elevation of background particulate pollution (lasting for 15 days). We showed that the use of model output describing the transfer of dust to the limits of the domain makes our model much more competitive in predicting and reproducing the daily variation of PM concentration. This improvement was clearly determined by integrating such modifications.

2) As responsible for the poor hourly variability of the modelled particulate pollution in urban areas, we identified a lack of anthropogenic sources in the model inventory. By connecting linearly the PM emissions by traffic with nitrogen oxide emissions (based on observed PM-NO correlations) we managed to quantify the order of magnitude of the missing source. We showed that this quantity is compatible with the estimations of particle resuspension from vehicles (estimated at 10 times the combustion emissions of the vehicles), not taken into account in many PM inventories. Simulations performed by integrating this missing aspect in the model led to a much better hourly variability.

Our hypotheses made clear the necessity for a better parameterization of particulate matter forcings in the CTMs. Taken under consideration, they allowed us to satisfactory reproduce the episodes we studied, and gave us orientations for the improvement of particulate pollution modeling in the Mediterranean area.