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What strategy is needed for attaining the EU air quality regulations under future climate change scenarios? A sensitivity analysis over Europe

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A wide number of studies show that several areas over Europe exceed some of the air quality thresholds established in the legislation. These exceedances will become more frequent under future climate change scenarios, since the policies aimed at improving air quality in the EU directives have not accounted for the variations in the climate. Climate change alone will influence the future concentrations of atmospheric pollutants through modifications of gas-phase chemistry, transport, removal, and natural emissions.

In this sense, chemistry transport models (CTMs) play a key role in assessing and understanding the emissions abatement plans through the use of sensitivity analysis strategies. These sensitivity analyses characterize the change in model output due to variations in model input parameters. Since the management strategies of air pollutant emission is one of the predominant factors for controlling urban air quality, this work assesses the impact of various emission reduction scenarios in air pollution levels over Europe under two climate change scenarios. The methodology includes the use of a climate version of the meteorological model MM5 coupled with the CHIMERE chemistry transport model. Experiments span the periods 1971-2000, as a reference, and 2071-2100, as two future enhanced greenhouse gas and aerosol scenarios (SRES A2 and B2). The atmospheric simulations have an horizontal resolution of 25 km and 23 vertical layers up to 100 hPa, and are driven by the global climate model ECHO-G . In order to represent the sensitivity of the chemistry and transport of aerosols, tropospheric ozone and other photochemical species, several hypothetical scenarios of emission control have been implemented to quantify the influence of diverse emission sources in the area, such as on-road traffic, port and industrial emissions, among others. The modeling strategy lies on a sensitivity analysis to determine the emission reduction and strategy needed in the target area in order to attain the standards and thresholds set in the European Directive 2008/50/EC.

Results depict that the system is able to characterize the exceedances occurring in Europe, mainly related to the maximum 8h moving average exceeding the target value of 120 μg/m3, mainly over southern Europe. Also, compliance of the PM10 daily limit values (50 μg/m3) is not achieved over wide areas in Europe. The sensitivity analysis indicates that large reductions of precursors emissions are needed in all the scenarios examined for attaining the thresholds set in the European Directive. In most cases this abatement strategy is hard to take into practice (e.g. unrealistic percentage of emission reductions in on-road traffic, industry or harbor activity); however, ozone and particulate matter air pollution improve considerably in most of the scenarios included.

Results also unveil the propagation of uncertainties from the meteorological projections into future air quality and claim for future studies aimed at deepening the knowledge about the parameterized processes, the definition of emissions and, last, reducing uncertainties.