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Analysing the influence of climate change on future air quality (XXI century): from European to local scales

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The impacts of climate change on air quality may affect long-term air quality planning. However, the policies aimed at improving air quality have not accounted for the possible variations of climate. Furthermore, the coarse horizontal resolution of current global climate-chemistry simulations does not permit an estimation of the effects of climate change on tropospheric pollutants distributions at regional scales. Climate change alone influences future aerosol concentrations through modifications of gas-phase chemistry, transport, removal, and natural emissions.

The goal of this study is to determine how concentrations of aerosols respond to changes in climate over the Iberian Peninsula. The methodology includes the use of the regional modelling system MM5 (regional climate model version)-CHIMERE for three nested domains covering Europe, the southwestern Mediterranean and southeastern Spain with a horizontal resolution of 90, 30 km and 10 km, respectively, and a vertical resolution of 23 layers up to 100 mb.

In order to isolate the possible effects of climate change on the ground concentrations of aerosols in Europe, the assumption of unchanged anthropogenic emissions (derived from EMEP database) was implemented in the chemistry transport model. Two time slices driven by ECHO-G global circulation model covering from 1991-2010 and 2071-2100 under the SRES A2 scenarios have been compared.

The results indicate that climate change influences the concentrations of both gas-phase pollutants and aerosols through changes in temperature, precipitation, mixing height, transport, humidity, and oxidant levels. The trends of variation of ozone and aerosols are influenced by the higher temperatures modelled for the future climate, since it favours the formation of secondary gas-phase products. It also enhances sulphates and secondary organic aerosols (SOA) and contributes to the decomposition of ammonium nitrate, remaining in the gas phase. Further, the changes in precipitation have a strong effect in the frequency of the washout and therefore in the levels of aerosols; this effect is not so important for gas-phase compounds.

The concentrations of aerosols decrease with increasing precipitation as wet deposition provides the main aerosol sink. The changes in ventilation (wind speed, mixing height) have stronger effects on aerosols than on gaseous pollutants because of their lower background concentrations. Changes in humidity and cloudiness also affect the levels of pollutants.

Summarising, we should highlight that climate impacts air quality by increasing the mean concentrations of gaseous pollutants and aerosols in most regions at the Iberian Peninsula. This may be driven by an enhanced secondary production as a consequence of the temperature increase, the changes in precipitation patterns, the decrease of the mixing heights (especially during wintertime because of the change in circulation patterns) hampering the dilution of pollutants and the stagnant conditions found, which are substantially modified in the simulations for the period 2071-2100.