MODELLING THE IMPACT OF GLOBAL CHANGES ON SUMMER EUROPEAN SURFACE O₃ LEVELS AT THE 2050 HORIZON

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Introduction
The evolution of climate due to change in green house gas emissions and pointed by the IPCC community is liable to induce important impact on air quality. Evolution of green house gas emissions and air pollutants due to policy as well as modifications of meteorological parameters linked to climate change are likely to affect pollution levels, as well as the increase of global background O₃ levels (Jacob et al., 1999).

This work aims to evaluate the impact of global changes on summer (JJA) O₃ surface levels through a regional model study with CTM CHIMERE accounting for change in anthropogenic emissions of precursors from future scenarios, global background pollutant levels through appropriate boundary conditions from INCA model forced by LMDZ, and change meteorological conditions reflecting AR5 scenario. For consistency, all these forcings are built on the same scenario: the RCP 6.5 (Representative Concentration Pathways, Riahi et al., 2007) developed in IPCC-AR5 framework for climate projections.

Methodology
Two long term simulations with CHIMERE model are conducted, reproducing present (1996-2005, 9 years) and future (2045-2055, 11 years) conditions in emissions, climate, and boundary conditions. The simulated periods correspond to summer, running from July 1st to August 31st each year, and were each spun up with 5 days of run.

Results
Figure 2, left column shows simulated surface O₃ averaged over summer (June to August) for the (top) present-day simulation period (1996-2005), (middle) future simulation period (2045-2055). The pannel (bottom) shows the spatial distribution of ozone surface evolution between the future and present simulations, ranging between -7 ppbv and 4 ppbv.

The simulations produce a contrasted distribution with a general decrease of mean O₃ levels in central Europe and the north of France, a slight increase of 1 to 2 ppbv in South Western Europe, east and north to Black Sea, in the east of Spain, and the stronger values are depicted in UK and Nethedlands. The two latter hotspots agree well in location and range with a previous model study by Szopa et al. (2006) in which were accounted both global and European changes in anthropogenic O₃ precursor emissions (according to the Maximum Feasible Reduction scenario, however).

Figure 2 also shows the daily minimum (central column) and maximum values (right column) of surface ozone in ppbv, averaged over the present simulation (top) and future simulation (middle) periods. The spatial distribution of daily minimum and maximum change in ppbv between future and present range between -8 and 22 ppbv for daily min and -14 and 7 ppbv for daily max.

An increase of daily minimum levels in urbanised regions is observed, peaking in England and Netherlands with a change in the range of 20 ppbv. This increase of daily minima in surface ozone levels is possibly linked to NOₓ titration, for urbanised regions are more likely to be saturated in NOₓ.

The results show a decrease of daily maximum averages up to ~14 ppbv in a wide area from Parisian basin to Scandinavia, and in the south of Spain. An increase in daily maximums up to 7ppbv is depicted north-west to Spain, in the southern half of France and the south of Mediterranean, in a wide area from Greece to the continental east of Europe and in the west part of the domain, including UK and Ireland.

The climate change is suspected to be responsible of the O₃ decrease in the southern part of Europe (extra-simulations to affirm it are however required).

Perspectives
This first set of simulations gives results that are consistent with some results included in a previous model study from Szopa et al. (2006) in which only the change in emissions and boundary conditions had been accounted for the future simulation. They give us confidence in this new modelling platform to simulate robustly the pollution changes under climatic and emission change scenarios.

In order to discriminate the specific impact of climate change and reduction in anthropogenic emission of precursors on the European pollution levels, it is necessary to lead new simulations. Namely, future simulations with a present climate, and new future simulations with emissions modified so as to fit to RCP 6.0, RCP4.5, RCP2.6.

References

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