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Impact of particles on photolysis rates and air quality

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Photolysis rates in the atmosphere are greatly affected by the presence of clouds and aerosols. In regional Chemistry Transport Model (CTM) used for air quality modeling, the impact of particles on photolysis rates are generally not taken into account. In this study we coupled a regional CTM (Polair-3D from the Polyphemus platform) to a radiative transfer model (Fast-JX). The impact of particles on photolysis rates and on gas and aerosol concentrations is evaluated in July 2001 over Europe.
Taking into account particles when computing photolysis rates reduce photochemistry at the ground over all Europe (mean reduction of around 20% of all photolysis rates). This leads to a reduction of ground O3 concentrations by a few percent but O3 peaks are much more reduced, especially locally, close to precursors (NOx) emission sites. It was found that simulated O3 exceedances of the information threshold value (hourly O3 concentration > 180 µg.m-3) and to the alert threshold (hourly O3 concentration > 240 µg.m-3) are reduced by about 60 % and 50 % respectively when including aerosol feedbacks on photolysis rates.
Concentrations of oxidant species such as OH are also greatly affected through all the troposphere, leading to changes in concentrations of VOC, but also of secondary aerosols especially at the ground. For example, monthly ground isoprene concentrations are reduced by 8 % over Europe and by about 80% on some large regions of Spain and secondary aerosols by about 10 % over Europe.
Aerosol having the strongest impact is dust due to its strong loading over south Europe. Carbonaceous aerosols can have strong local impact due to their absorbing properties but are not abundant this year over Europe.
This study shows the importance of taking into account the particles effect on photolysis for both gas and aerosol ground concentrations.