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Future atmospheric circulation changes driving higher urban PM2.5 concentrations in Europe

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Air quality management is strongly driven by legislative aspects related to the exceedance of air quality limit values. Here, we use the Norwegian Climate Centre's Earth System Model and a novel downscaling method to assess the impact of a future scenario of maximum feasible aerosol emission abatement and increasing greenhouse gases (RCP4.5) on urban PM2.5 concentrations in Europe. Our results show a more positive North Atlantic Oscillation mean state in the future, combined with a large eastward shift of both North Atlantic sea-level pressure centres of action. This is likely primarily driven by the aerosol abatement, and is associated with more frequent mid-latitude blocking and a northward shift of the jet stream. These changes favour higher than expected anthropogenic urban PM2.5 concentrations in Southern Europe, while they have the opposite effect on the northern half of the continent. In the future scenario, despite the strong air pollution emission reductions, PM concentrations in substantial parts of Southern Europe are found to exceed the World Health Organisation Air Quality Guideline daily limit of 25 $\mu g/m^3$ on 25 to over 50 days per year, and annual guidelines of 10 $\mu g/m^3$ on more than 80% of the 30 years analysed in our study. We conclude that alterations in atmospheric circulation in the future, induced by stringent maximum feasible air pollution mitigation as well as GHG emissions, will negatively influence the effectiveness of these emission abatements over large parts of Europe. This has important implications for future air quality policies.