Unabated Climate Change Leads To Both Benefits And Trade-Offs In Regional And Urban Air Quality Over Western Europe

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Abstract

Climate change will impact air quality across multiple scales. At the hemispheric scale, it may alter intercontinental transport patterns and background air quality; at regional and urban scales, climate-driven changes in chemical production/loss and in climate-sensitive emissions and local mixing affect air quality. We employ a nested modelling approach to analyse how a large climate change signal, through these key processes, impacts regional and urban-scale air pollution in 2100 for western Europe, the UK and London. Climate change projections from the HadGEM2 Earth System Model provide boundary conditions to the nested WRF-EMEP4UK model, which in turn drive the street-scale ADMS-Urban model. We use the extreme Representative Concentration Pathway (RCP) 8.5, which produces annual-mean temperature increases of >5°C across Europe. Higher temperatures increase biogenic isoprene emissions twofold over Europe, which together with changes to the lifetime of nitrogen oxides (NO_x), impact regional and urban ozone (O_3) and fine particulate matter ($PM_{2.5}$) air quality. This future scenario predicts a strong regional contrast, whereby surface O_3 concentrations are higher for southern Europe (up to 20%) and lower for northern Europe (up to ~15%) than present-day, highlighting the influence of lower background O_3 concentrations that aid to reduce O_3 air quality over northern Europe. Annual-average $PM_{2.5}$ concentrations are elevated (10-30%) over most of Europe. The seasonality of urban air pollution is modified over the UK under climate change, such that the O_3 peak amplitude is reduced, suggesting less influence of transport that drives the spring ozone peak. In contrast, $PM_{2.5}$ concentrations exhibit a more pronounced wintertime peak. For both pollutants greater variability is simulated by the urban compared to the regional model. The diurnal cycles of urban O_3 and $PM_{2.5}$ become less variable is the future. We highlight implications for future emission controls to meet the 2021 WHO air quality guidelines.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, TOAR: Tropospheric Ozone Assessment Report