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Spatiotemporal trends of surface ozone concentrations and metrics in France

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Ozone pollution appears as a major air quality issue in Europe. A few issues about O_3, such as a better understanding of surface trends and a better assessment of O_3 impacts, are still challenging. The objectives of this work were to i) quantify the spatiotemporal trends in ground-levels O_3 concentrations, associated with potential impacts on human health and vegetation, and to ii) assess the impact of the changing precursor emission on the time trends. For the first time, a long-term spatiotemporal analysis of annual trends were performed in 61 rural, 92 suburban and 179 urban background stations in metropolitan France over the time-period 1999-2012. We focused on annual surface O_3 metrics (mean concentrations, hourly maxima, median and 98th percentile), O_3 human health metrics ($SOMO_35$, i.e. the annual Sum Of daily maximum 8-h Means Over 35 ppb and EU60, i.e. the number of exceedances of daily maximum 8-h values greater than 60 ppb) and O_3 vegetation impact metrics (AOT40, i.e. sum of the hourly exceedances above 40 ppb for daylight hours during the assumed growing season for sensitive crops and forests) at individual sites.

Long-term analysis of hourly surface O_3 data from 332 background air pollution monitoring sites in France showed that annual mean concentrations decreased by 0.12 ppb.year-1 at rural sites. Suburban stations increased annual averages (+ 0.10 ppb.year-1) and at urban sites, mean concentrations increased (+ 0.14 ppb.year-1) over time. In all station types, a significant reduction in peak concentrations, largely attributed to the reduction in NO_x and VOC emissions within the European Union which started in the early 1990s, was found at more than 70% of stations. We demonstrated that the O_3 control measures are effective at rural sites, while O_3 concentrations are still increasing in the cities. The human health and vegetation impact metrics showed a downward trend at the national level for all stations, with the slowest decrease at urban stations. The generation of realistic spatiotemporal O_3 maps is a valuable tool for risk assessment resulting from O_3 exposure. The spatial interpolation approach, concatenating local regression and kriging of residuals, is an effective way and a valuable tool to provide spatiotemporal mapping of O_3 metrics. This method was successfully applied, from 332 monitoring stations, over whole domain at 250 m of spatial resolution.