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Analysing trends in tropospheric levels of ozone

A new study has analysed trends in ozone levels in the European troposphere from 1996 to 2005. It indicated that average levels have been increasing despite reductions in pollutants that influence ozone formation. However, it also identified year-by-year variations, caused by climate and weather events, and suggested they could be masking the impact of emission reductions on long-term ozone trends.

Ozone in the lower part of the earth's atmosphere (troposphere) is recognised as a threat to human health and vegetation, and acts as a greenhouse gas. A major source of ozone is the chemical reactions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the troposphere. To combat this, national and European legislation have reduced the emissions of these substances over the past 20 years. To investigate the impact of reducing these emissions, it is important to establish trends in ozone levels over time.

The study analysed ozone data from 158 European rural observation sites, mainly situated in central Europe, from the EU GEOmon project[1] from 1996 to 2005. Annual and seasonal trends were determined as well as general geographic variations.

Overall, the average level of ozone across all the European sites increased each year by 0.16 parts per billion by volume (ppbv). However, within this overall trend there were geographical variations. Increases in annual ozone levels were observed at 54% of stations. Only 11% of stations experienced decreasing annual levels of ozone and these were mainly in eastern and south-west corners of Europe.

Very high average levels of ozone were recorded in several Austrian sites and the largest increase over time was observed in the Po Valley, Italy. This is a region with large anthropogenic emissions and very static weather conditions, meaning that accumulating ozone is unlikely to shift.

The research investigated the possible impact of influential events on the ozone levels, such as the 2003 north-western European heat wave. High temperatures are known to increase levels of tropospheric ozone and, when data from this year were removed from the calculations, fewer sites exhibited increases in annual ozone levels.
The researchers suggested that these extreme events could potentially mask the effect of emission reductions when considering trends over decades. Indeed the study found that there was a near uniform decrease in levels of NO_x and VOC emissions in Europe, suggesting they are not reflected in the observed ozone trends. To take these 'freak years' into account a longer time-series would be required, which may show a stronger relationship between emissions and ozone levels.

Finally, the research compared the observed levels of ozone with those simulated by the CHIMERE[2] model. The model predicted a smaller increasing annual trend in the European average level of ozone than the study's results at 0.05 ppbv per year. It appears that the method of collecting data from numerous stations is a robust way to explore regional trends. However, there was a lack of data from sites in France, Spain and the Mediterranean area, which may bias the ozone trends towards those in Central/Northern Europe and longer time series may be needed to account for individual years where there are particularly high levels of ozone caused by climate and weather events.

1. GEOmon (Global Earth Observation and MONitoring) was supported by the European Commission under the Sixth Framework Programme. See: www.geomon.eu

2. See: www.lmd.polytechnique.fr/chimere/

Source: Wilson, R.C., Fleming, Z.L., Monks, P.S. *et al.* (2011) Have primary emission reduction measures reduced ozone across Europe? An analysis of European rural background ozone trends 1996-2005. *Atmospheric Chemistry and Physics Discussions.* 11:18433-18485. This study is free to view at: www.atmos-chem-phys-discuss.net/11/18433/2011/acpd-11-18433-2011.html

Contact: p.s.monks@le.ac.uk

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