Trends in European trace gases in the GEOMON project

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Introduction

The GEOmon project's mission is to build an integrated pan-European atmospheric observing system of greenhouse gases, reactive gases, aerosols, and stratospheric ozone. This particular research is based around the Reactive Gases, Pollutants and Climate work package of the project.

Starting with a selection of 30 European long term measurement stations from a variety of regional, national and European air quality networks (e.g. EMEP, GAW, AACENT), the objectives are to harmonise and directly compare the O_3, NO_2 and CO data. Investigations into instrumental calibration standards and data quality have been carried out in order to make comparisons between the sites as accurate as possible for a long time-scale trend analysis.

The chosen sites are shown on the map in Figure 1. Some sites do not have all data sets of interest available at present and some have only recently started continuous measurements, but many have over ten years of continuous measurements that are ample for long term trend analysis. The aim is to prove the importance of long term measurements at key representative sites and to classify some sites as "super-sites", whose long term trends are indicative of trends across Europe and around the world. By choosing many sites that are likely to receive the same air masses a matter of hours or days later, it could be noted if the geography and location of the site is indeed reflected in the background trace gas trends.

With the large number of mountainous sites and also coastal sites, it is hoped that this would help to better understand the dynamics of the Alps and other elevated areas in influencing long term trends and the links between the free troposphere and the boundary layer.

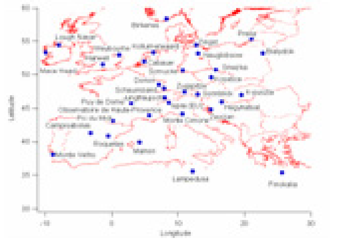

Figure 1. Preliminary GEOMON trace gas comparison sites

Ozone seasonal cycles and long term trends

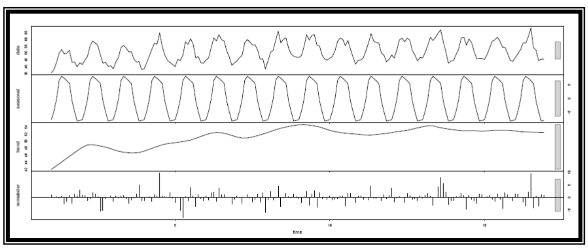

Figure 2. Jungfraujoch ozone data since 1993 (top panel), average seasonal cycle and long term trend (3rd panel) calculated with the use of anomalies (final panel) from the average seasonal cycle

Long term trend analysis for individual stations (e.g. Jungfraujoch in figure 2) were calculated for ozone and the average seasonal cycles of each station were compared.

A marked difference between average ozone levels, between the month of the highest values and the difference between the highest and lowest annual ozone levels were found.

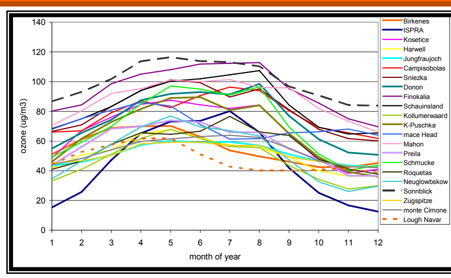

Figure 3. Average seasonal cycles for GEOMON sites

Peak and background ozone trends

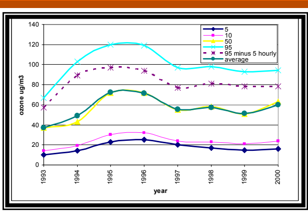

Figure 4. Roquetas (Spain) ozone trends by percentiles

The long term hourly averaged data was analysed in order to calculate percentiles. The 95th percentile represents the peak ozone events, whilst the 5th percentile could be used to describe background ozone. As can be noted in Figure 4, for the Roquetas station in Spain, the background and peak ozone trends are different and the peak values show greater variation over the measurement period. This has often been found to be the case in European air quality studies. In many cases the background ozone levels are actually still increasing, whereas the peak values are seen to be gradually decreasing. This trend varies across the GEOMON sites, as shown in Figure 5. Here we see the amount of variation across the measurement period (not the same length of time for each site) by the size of the circle and the colour represents whether there is an increase or decrease in this trend.

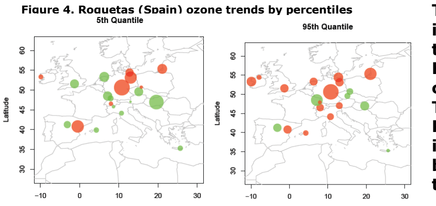

Figure 5. 5th and 95th percentile trends in corresponding measurement Periods. Green represents an increase in ozone and red, a decrease

The background ozone levels in Figure 5 have been seen to be increasing over the last few years (green circles), especially in the polluted areas of the Ruhr valley and Benelux and southern England, whereas the peak ozone levels are decreasing (red circles).

The Eastern European countries (Czech Republic, Hungary, Poland) with the exception of Lithuania have experienced increases in both their baseline and peak ozone levels. The biggest reductions in ozone were seen in Germany, where both the background and peak levels decreased.

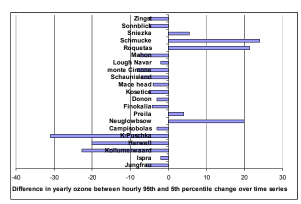

Figure 6. Increase over measurement Period of difference between 95th and 5th percentiles

NO_2 – O_3 trends in high and low NO_x environments

Two sites with very different NO_x regimes; Ispra with high NO_x and K-Pusczka with low NO_x NO_2 cycles are compared in Figure 7. Figure 8 shows the correlation between the O_3 and NO_2 seasonal cycles. The NO_2 seasonal cycles are more homogeneous in the high NO_x regime (note scale of NO_2 different in 2 graphs) and the ozone levels are affected by inhomogeneities in the NO_2 at these low NO_2 levels.

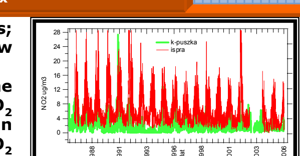

Figure 7. Ispra, Italy and K-Pusczka, Hungary NO_2 levels

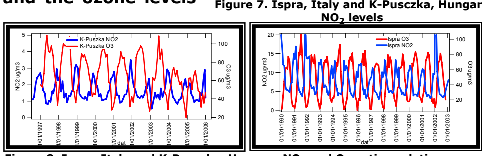

Figure 8. Ispra, Italy and K-Pusczka, Hungary NO_2 and O_3 anticorrelations

Future work

- A closer look at the ozone, CO and NO_2 trends at all sites will show whether the trends are related to their geographical location or vicinity to major pollution centres
- De-seasonalising the ozone and NO_2 trends and filtering the local pollution events will show whether climatic changes are actually affecting the trace gas levels
- A harmonised dataset for the trace gases at these sites will be made available for transboundary studies
- The GEOMON project continues until 2010, by which time, the analysis of these sites and a rigorous comparison of ground based with satellite measurements will leave a legacy for future air quality measurements, in terms of the analysis but also the representativesness of Europe's station network

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