Long term trend and weekly cycles of PM_{10} in the Po valley

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In order to assess changes and variability in daily PM_{10} concentration in the Po valley, 35 pluri-annual time-series have been analysed. Data have been collected at 35 different sampling sites within the Po valley, including both traffic and background sites, either urban, suburban or rural. The dataset comprise pollution data up to January 2012 acquired within the Regional Environmental Agency monitoring networks; all data are referred to actual sampling condition, as required by 2008/50/EC.

Series with at least 10 years of data have been tested for long term trends in the deseasonalised monthly means, in annual quantiles and in binned monthly concentration. In the former test data have been deseasonlised by STL (Cleveland *et al*, 1990) technique and temporal trend has been estimated *via* GLS model on the STL trend component. Trend significance has been estimated by model-based resampling. Trend for the 25th, 50th and 95th annual quantiles has been estimated by Theil-Sen method; significance of annual quantiles trend has been tested by non-parametric resampling. In order to assess a seasonal long term trend, PM_{10} daily concentration for each month have been binned by 15μg/m³ increments and the frequency of each bin in each month over the sampling period has been computed. The trend in these frequencies for each month have been estimated by Theil-Sen method and significance has been tested by non parametric bootstrap, similarly to annual quantiles.

Weekly pattern at each site have been estimated, in order to assess pollution condition and anthropogenic sources influence at each station. Weekly cycle has been investigated through the study of PM_{10} anomalies. Being the data highly non normal, the analysis of deviations used a Kruskal-Wallis test. The significance of the weekly cycle has been double checked by group deviations in 6- and 8-days-week, and performing a Kruskal-Wallis test for these series of anomalies. Also the weekend effect magnitude for each site has been computed, i.e. the difference between the mean PM_{10} anomaly of Saturday through Monday and the mean PM_{10} anomaly between Wednesday through Friday.

A cluster analysis has been applied in order to highlight stations sharing similar pollution conditions over the reference period. Clusters have been built by hierarchical method, computing the dissimilarity matrix by Euclidean distance and using Ward's method to aggregate the data.

Finally, at the sites where both $PM_{2.5}$ and PM_{10} are sampled, a comparison of the weekly patterns for the two pollutants has been performed.

Results

Here are some of the main findings of the study:

- most sites exhibited significant decreasing trends in monthly, annual and seasonal data
- decreasing trends can be high (up to ~4.5% / year)
- many decreasing trends are higher over the period 2002 - 2011 compared to 1998 - 2011
- most of the decrease is due to lower autumn-winter high concentrations
- a significant weekly cycle is present in almost all of the sites; consistent results are shown by the analysis of weekly cycle magnitude
- clustering is driven mostly by the geographical position than by site classification

Finally the study shows how multiple and proper analysis methods are necessary in order to assess the significance of a pattern on atmospheric pollutant data.

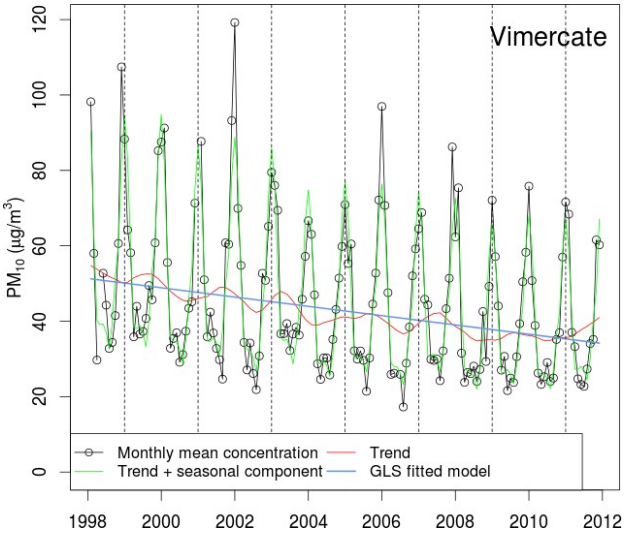

Figure 1. Deseasonalisation of monthly mean PM_{10} at Vimercate, along with GLS trend

Cleveland, R. B., Cleveland, W. S., McRae, J., and Terpenning, I. (1990) *J. Off. Stat.* **6**, 3–33