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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Climatology of atmospheric PM_{10} concentration in the Po Valley" *by* A. Bigi and G. Ghermandi

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Thanks to referee #1 for the contribution in improving the study and for the appreciative comments.

As both referees pointed out (see general comment #6 by referee 2), in the original manuscript we omitted a discussion on the possible influence of the meteorology on PM10 trends.

Two types of influence can be exerted by meteorology: one due to occasional events (e.g. a winter milder than the last 10 or 20 years average) and one due to long term trends in meteorological variable (e.g. climate change).

The former influence, by occasional meteorological events, can be assumed to be negligible in all the trends we investigated: in GLS analysis most of meteorology has been removed thanks to STL decomposition and filtering of seasonal component. Also in annual quantiles is assumed to be extremely low the influence of meteorology, because quantiles are more robust to outlying (e.g. occasional) observations. Eventually a larger influence of meteorology might have occurred for seasonal trends, although the use of frequency of concentration ranges, of non-parametric Sen's slope (i.e. robust to outliers) and of bootstrap, have minimized the possible bias due to anomalous weather conditions.

In order to test the possible influence on PM10 trends by a long term trend in meteorological variables, we reviewed existing analyses of trends in meteorological variables in Northern Italy.

Nanni et al. (2007) showed an increase ranging between 10-30% per century of the amount of precipitation associated to intense precipitation (period 1880 – 2002) and an increase ranging between 5-30% per century of frequency of intense precipitation. Kelin Tank et al. (2002) showed a decrease in number of winter wet days between 3% and 9% per decade, a non significant change in total winter precipitation amount, and an increase (6 – 9% per decade) of precipitation per winter wet day (period 1946 – 1999). Toreti et al. (2009) with a robust and reliable statistical analysis, showed a decrease of -1.47 mm/year in winter precipitation in Northern Italy (period 1961 – 2006).

Trends for average, minimum and maximum atmospheric temperature in the Po valley ranged between 0.9 and 1.1 °K/century (period 1865 – 2003) according to Brunetti et al. (2006). Simolo et al. (2010) found a significant increase in maximum atmospheric temperature in Northern Italy ranging between $\sim$0.4 – $\sim$0.1 °K per decade depending upon season, and similar trends for minimum temperature.

Planetary boundary layer (PBL) height is known to have a large influence on air quality

in the Po valley, however the direct measurements available have a coarse temporal and spatial resolution (measurements at 00UTC and 12UTC per day at two sites in the valley), and no studies of trend of PBL height in the valley has been found by the authors.

The trends observed in these studies for precipitation and temperature range around few per mil per year and few hundredth of °K per year respectively. Reasonably assuming these trends valid also over the analysed period (1998 – 2011), we can consider their influence on PM10 concentration negligible compared to the effects due to meteorological variability, which instead has been partly removed by the STL deseasonlization procedure, by using quantiles and non-parametric Sen's slope.

An estimate of the difference between meteorologically-adjusted and non adjusted trends in annual averages (i.e. less robust than annual quantiles) can be gained from the extensive and deep analysis by Barmpadimos et al (2011). Barmpadimos and coauthors (2011) investigated both the influence of meteorology on PM10 variability in Switzerland and on PM10 long term trend at 13 sites, and estimated trends both for measured PM10 and for meteorologically-adjusted. The difference found by Barmpadimos et al. (2011) is extremely narrow at all sites besides Sion (figure 6, lowest panel), with the meteorologically-adjusted trend resulting largely more precise, but centred always within the 95% confidence band of the non meteorologically-adjusted trend.

A discussion of the influence of meteorology on PM10 trends, summarizing above considerations, will be included in the revised manuscript.

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