

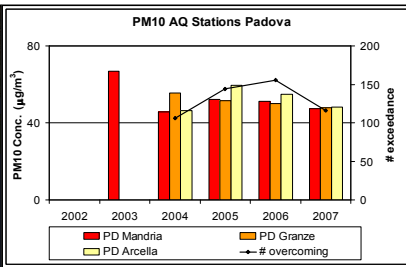
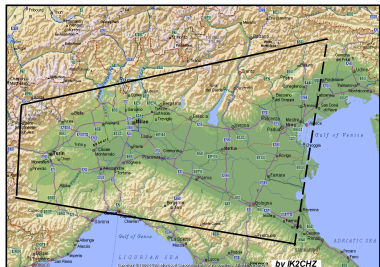
Characterization of PM10 accumulation periods in the Po valley by means of Boundary Layer profilers

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PO Valley : Hot spot in Europe...



The region of the Po Valley has a particularly unfortunate topographical conformation (right) which favors low wind and strong inversion situations, conditions which can lead to extremely high PM concentrations, especially during the cold season. Also PBL structure is strongly conditioned from this meteorological and orographic situation. This causes very frequent exceedance of the thresholds of PM10 concentrations set by the Council Directive 1999/30/EC (50 µg/m³ for single daily averages, 40 µg/m³ for yearly average), left. and monitored by regional network of Air Quality station (AQ) right panel.

SODAR and Radiometer: Reliable tools for monitoring the PBL!

In response to the frequent air quality emergencies in the North-Eastern Italian region Veneto, the DRST - Centro Meteorologico di Teolo (CMT) of the Regional Agency for Protection and Prevention of the Environment of the region Veneto (ARPA Veneto) has installed by 2005 a network of passive radiometers and SODAR for air quality monitoring purposes. The network, co-funded by the European Union, Italy and the region of Veneto, is composed by:

- 3 MTP5-HE Radiometer Kipp&Zonen (R)
range 1km - resolution: [L] 50 m - [T] 5 min
- 4 SODAR PCS-2000 Metek (S)
range about 0,5 Km - resolution: [L] 20 m - [T] 15 min
- 1 HATPRO Radiometer RPG (R*)
range 10 km - resolution: [L] progressive - [T] 5 min

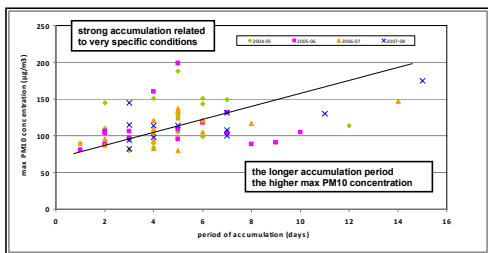
In the three years of operations the MTP5-HE were found to be solid and reliable instruments with up to more than 90% of effective working time. SODARs are penalized by the light wind climatology of the Po Valley, while the more complex HATPRO system needed more attention in terms of update software and hardware.



Inventory of episodic PM10 conditions for the city of Padua

An inventory of episodic conditions for the city of Padua (AQ station collocated with MTP5-HE) for the last four cold seasons (Sep-Apr) was compiled. An episode is defined either when PM10 concentration exceeds 80 µg/m³ or the monthly average at least two days in a row. The relation between peak concentration and episode duration is shown in the figure below.

Winter	# Acute Episod.	Average Max Conc. (µg/m³)	Average Period (days)
2004-05	20	118±29	5±2
2005-06	18	110±29	6±3
2006-07	17	108±21	5±3
2007-08	12	117±25	6±4

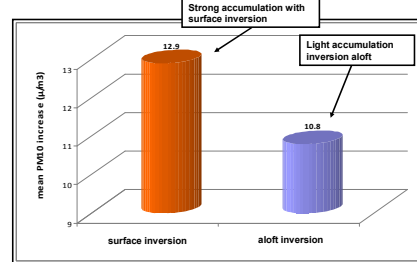
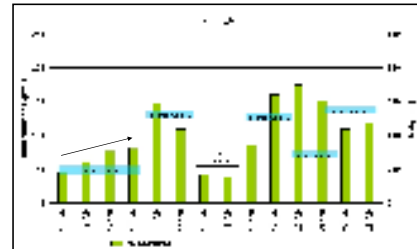
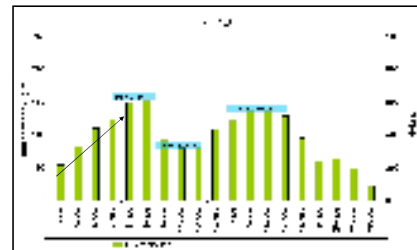
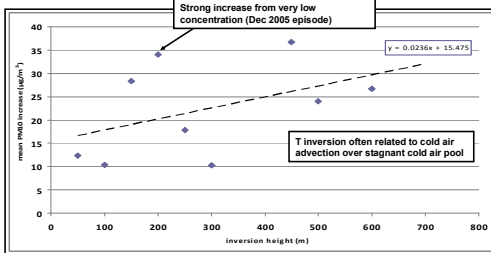


Height of temperature inversion: a sign for strong PM10 accumulation?

Typically episodic conditions are related to cold season anticyclonic synoptic conditions with absence of precipitation and significant winds. During such conditions PM10 accumulation seems to be stronger on days when the height of the temperature inversion is at around 500m than on days when it is below 200m (show in the figures at left).

A statistical analysis on the set of 67 episodes (shown in the figure below) identified in our data set appears to confirm this general rule, highlighting some exceptions (e.g. the Dec 2005 which started with a very strong accumulation from very low PM10 levels and had a temperature inversion at 200m). The temperature inversions at higher levels, visible in the daily average profiles, are frequently related to advection of warm air over a pool of cold air. These situations seem particularly fit for favouring important PM10 accumulation, more than temperature inversion originating from nocturnal radiation cooling of the surface.

Another indication of the usefulness of high-resolution temperature profiles is in differentiating inversion which reach the surface from those which do not. The former are related, on average, to larger PM10 increments (13 µg/m³) compared to the latter (10 µg/m³) see histogram.



Conclusions

In this study data from three air quality stations in the city of Padua were analyzed in relation to the meteorological conditions, particularly to the temperature profiles derived with the MTP5-HE radiometer. The main findings are:

- the cold season PBL structure of the Po Valley is especially apt for favouring the accumulation of PM10 (67 episodes in the last four cold seasons with average peak concentrations of about 120 µg/m³ and duration of 5-6 days);
- the radiometer and SODAR (not shown) are useful to quantify the PBL structure, especially temperature inversion and low level wind conditions;
- higher reaching surface based temperature inversions (top ~500 m) seem related to larger PM10 accumulations than lower reaching (<200 m);
- PM10 peak concentration are often related to the duration of episodes (the higher the longer); however, there are conditions which allow for significantly larger accumulations in shorter times and may be related to warm air advection of a stagnant cold air pool;
- temperature inversions reaching the ground seem to allow for larger PM10 accumulation inversions that do not reach the surface; temperature inversions which are detached from the surface 300m and more seem to have no particular effect on PM10 accumulation.

These findings point towards a more detailed use of the temperature profile information in the estimation of PM10 accumulation in the cold season. In particular, a network of temperature profilers have the potential to point to regional differences in PM10 trends.

Breaking News! February 2008 an Exceptional Acute Episode

During last winter, from 18th February to 3rd March 2008, an exceptionally acute episode was recorded in Veneto. Very stable conditions with warm air advection aloft, no precipitation, light winds and persistent temperature inversion cause an efficient stagnation and accumulation of PM10. During this event, record concentrations were measured the alpine valley Val Belluna (yellow arrow), separated from the Po Valley to the north by the pre-alpine chain. A curiosity: probably very light (and therefore non-turbulent) valley breezes (cf. wind roses) from the polluted Po Valley (red line) into the Val Belluna contributed to the very high concentrations recorded in a region with otherwise good air conditions (blue line).

