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Heterogeneity of accumulation and dispersion conditions for PM10 in the Po Valley

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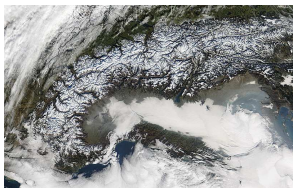
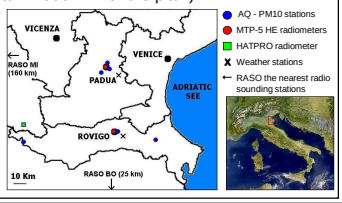
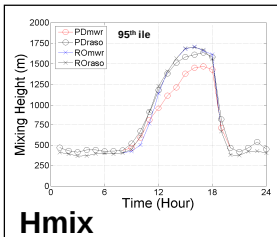
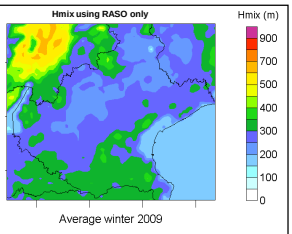
Introduction

On a European scale the Po Valley can be viewed as a hot spot in relation to air pollution issues, especially during the cold seasons, which feature frequent occurrences of low wind and high static stability conditions, often accompanied by marked temperature inversions.
It is generally acknowledged that the meteorological conditions are a very strong driver for air quality, where the dominant actors are near-surface winds and thermal static stability in the planetary boundary layer (PBL). ARPAV has installed in 2005 a PBL profiler network which consists of 4 passive microwave radiometers (MWRs) for retrieving temperature profiles and 4 SODARs for retrieving wind profiles.
In this study the quality of the temperature profiles gathered in the last 5 years is documented and in particular, consideration is given to the spatial variability of these factors, in order to assess the usefulness of deploying a network of profilers on an area of the scale of the region Veneto (ca. 12.000km^2 for the plain).



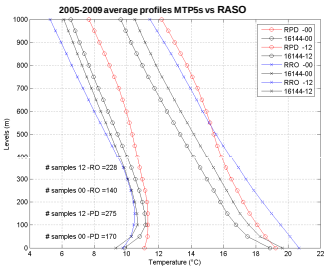


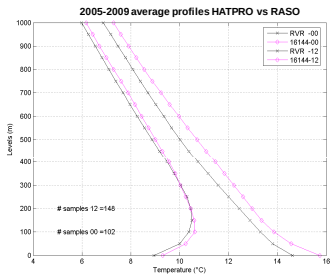




Hmix

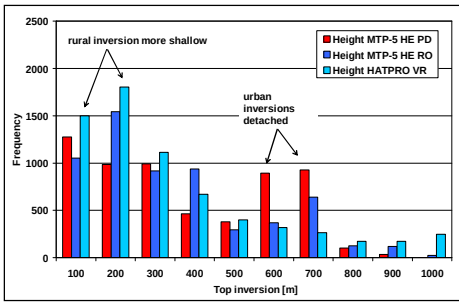
When the MWRs data are included, the mean Hmix for PD is 100m or almost 20% lower than the estimation with method based only on the RASO data. For the average 95th percentile value this difference increases to about 200-300m. For the RO site the impact of the local temperature profile results to be smaller. As far as regional-scale variability in the mixing height are concerned, the study highlights systematic differences, in that average Hmix is about 100m or 15% higher in RO than in PD. For the higher Hmix values this difference increases up to 400m or about 30%. Note, that these average profiles were obtained on the entire data set for all October-to-March months for the years 2005-2009, when both MWR in PD and RO data were available, including both stable and perturbed synoptic conditions. .

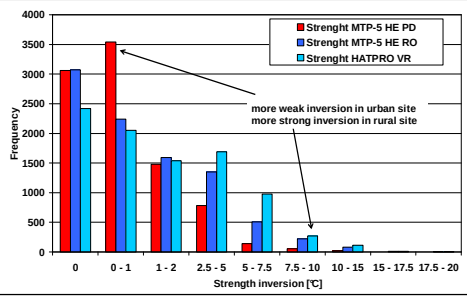




Quality MW Radiometers

For the comparison exercise the radio sounding stations of Milano Linate and Bologna S. Pietro Capofiume were used. As none of the MW radiometers was located near a radio sounding (RASO), observation times were identified for which the RASO of Milano and Bologna show temperature difference <2K in the lowermost kilometers. These are taken as conditions of "homogeneity" conditions, for which we can assume that the radiometers of Padua and Rovigo should be both reasonably close to the radio soundings.
Results show BIAS <1K in midnight 2-3 in noon, with similar difference year by year.

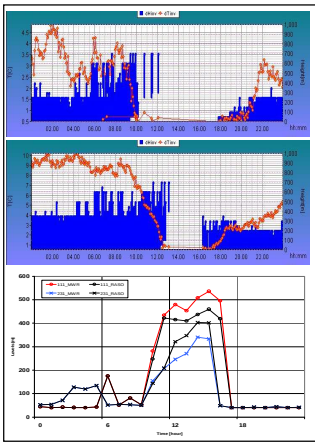




Inversion Inventory

5 year inventory, from 2005 to 2009, of temperature inversions as diagnosed by the three MWRs PD, RO, and HATPRO VR.

It is remarkable that the wintertime Po Valley is characterized by the presence of temperature inversions almost 70% of the time for PD and RO, in rural site VR it is even over 73%



A case study

Figure shows the temperature inversions of the site of PD and RO for 12th January 2009 along with the corresponding mixing height evolution for the day. It emerges very clearly that for RO the temperature inversion is much more persistent and the mixing height lower, both of which are consistent with the significantly higher PM10 concentration for this day. Indeed, the stagnant conditions which caused high concentrations the day before in PD, relaxed and caused a PM10 decrease (not show) while they intensified in RO, consistent with a marked increase in the air pollution.

Conclusion

In this study 5 years data from MWR shown that:

- Comparison with radio sounding in "homogeneous conditions" suggest that the **MWR-retrieved temperature profiles are useful and of consistent quality**, with a bias smaller than **1K at midnight** and up to **2-3K at noon**;
- The inventory of temperature inversions over the Po Valley portion of Veneto yields a **presence of inversions of up to 73%** of the time for the October-to-March periods, where this value is slightly smaller for urban locations; urban inversions tend to be weaker and more detached from the ground, while rural inversions can be much more intense and are more frequently shallow; regional differences occur in the order of 30% of the time;
- The MWR temperature profiles impact the mixing height (Hmix) estimates based on radio sounding profiles in that most of the time the **resulting Hmix is smaller** (up to 20% for the urban site); regional differences in the order of 15% emerge from the analysis when local profile are used
- Given the fact that PM10 concentrations are not only dependent on the mixing height and the presence of temperature inversion, this estimate has to be regarded as an upper limit. A meteorological pre-processor, like CALMET for example, would be an ideal framework to make best use of this local information.