

Short-term and long-term pollutant data: an integration for decision policy makers ¹

Misurazioni da rete fissa e rete mobile: una integrazione per decisioni di politica ambientale

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Riassunto: Oggi più che mai è interesse delle amministrazioni pubbliche conoscere il livello di concentrazione delle sostanze inquinanti presenti nell'aria data l'accertata relazione causale tra il loro livello e le malattie respiratorie e cardiovascolari. Per conoscere la concentrazione di inquinante in più punti dello spazio occorre impiegare stazioni di monitoraggio ambientale mobili (osservazioni di breve periodo) le cui informazioni fornite verranno integrate con quelle derivanti dalla rete di monitoraggio fissa (osservazioni di lungo periodo). Il presente lavoro intende mostrare che un adeguato uso delle stazioni mobili ed un buon metodo di imputazione permettono una riduzione del numero di stazioni fisse con conseguente riduzione dei costi di installazione e manutenzione degli strumenti utilizzati. Riferendoci alle concentrazioni bi-orarie di PM₁₀ a Palermo, per il triennio 2003-2005, si propone una procedura di stima dei valori non osservati dalla stazione di monitoraggio mobile (fittizia) tenuto conto della struttura spazio-temporale del livello di concentrazione di PM₁₀ (*Site-Dependent Effect method*, SDEM). La bontà del metodo proposto è valutata mediante il coefficiente di correlazione e l'indice di concordanza.

Keywords: short-term series, PM₁₀, missing values

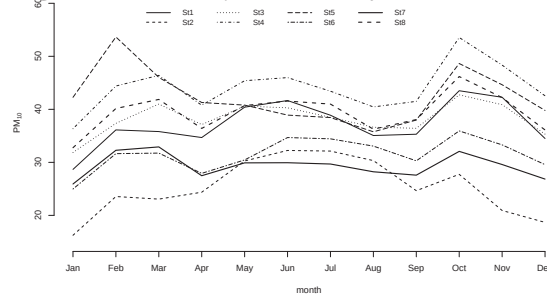
1. Introduction

Modeling atmospheric particulate matter with an aerodynamic diameter less than 10 $\mu\text{g}/\text{m}^3$ (PM₁₀) is an important problem in statistical methodology, above all to explain the PM₁₀ behavior in space and time, since PM₁₀ has been linked to many adverse effects on human and environmental health. It is therefore important to identify areas where the values exceed the limits for policy makers, set by the Commission of the European Union to 50 $\mu\text{g}/\text{m}^3$ for daily mean. For the increasing interest for air quality control in space and time, the information from fixed monitoring stations (*long-term measurements*) is integrated with information deriving from mobile stations data (*short-term measurements*). Mobile stations are useful to provide information on atmospheric environment on point locations where fixed monitoring sites are missing, where urban characteristics are very typical, and the importance of the canyon effect probably is enhanced, and to detect *hot spot* areas. But short-time measurements are incomplete so it is necessary integrate them with long-time measurements to know the real PM₁₀ level concentrations in the metropolitan area. In this paper we propose a procedure to derive PM₁₀ bi-hour mean levels to complete short

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Figure 1: Monthly mean in 8 fixed sites.



time measurements accounting for correlation and time variability between fixed monitoring stations showing that an adequate use of mobile monitoring stations and a good imputation method reduce the number of fixed stations, with a consequent retrenchment of expenses.

2. Data and methods

Data analyzed in this paper consider PM_{10} measured in 8 (1 is “background”, 7 are “traffic”) monitoring fixed stations in the urban area of Palermo, Sicily, since 2003 to 2005. In order to demonstrate that a rational use of mobile stations can reduce the number of fixed ones, we suppose that 1 fixed station (St3 in Fig.1) is a mobile one, for which we have data recorded all over 2003 and for only two months (January and June) in 2004 and 2005. So we have 7 *long-time* series, fixed sites, and 1 *short-time* series, mobile site. Accounting for correlations between monitoring fixed sites (spatial correlation) and for week effect, day effect and hour effect per site (time effects) and assuming their additivity we apply the *Site-Dependent Effect method* (SDEM) (Plaia and Bondì (2006)) in order to estimate missing values in St3.

$$\hat{x}_{swdh} = \bar{x}_{wdh} + \frac{1}{2} \left[\left(\bar{x}_{sw\cdot\cdot} - \sum_{s=1}^S \frac{\bar{x}_{sw\cdot\cdot}}{S} \right) + \left(\bar{x}_{s\cdot d\cdot} - \sum_{s=1}^S \frac{\bar{x}_{s\cdot d\cdot}}{S} \right) + \left(\bar{x}_{s\cdot\cdot h} - \sum_{s=1}^S \frac{\bar{x}_{s\cdot\cdot h}}{S} \right) \right] (1)$$

Results on completed series by application of (1) are compared to recorded long-time series using the coefficient of correlation (ρ) and the index of agreement (d) (Junninen *et al.* (2004)), resulting to be 0.89 and 0.93, respectively. The reconstructed time series for Station 3 allows to compute the daily-mean time series which shows to reproduce very well the real behavior of the observed series: this will allow to evaluate also the number of days per year the daily mean exceed $50 \mu g/m^3$, confirming the possibility to reduce the number of fixed stations if the network is integrated by mobile ones.

References

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