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Correlation Between Temperature Inversions and PM Concentrations: A Seasonal and Diurnal Perspective in Turin, Italy

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Extended Abstract
A temperature inversion is a thin layer of the atmosphere where the normal decrease of temperature with height switches to increase of temperature with height. A low-level inversion acts as a hat which keeps normal convective overturning of the atmosphere from penetrating through the inversion. As a result, the pollutants are trapped in the atmospheric region which is nearest to the Earth's surface [1]. The increase in pollutant concentrations leads to degradation of air quality in the troposphere, which seriously affects the human health [2]. In general, temperature inversion is typical of winter nights, greatly influencing local air pollution conditions in the lower layers of the atmosphere, which are those affected by human life. Studies [2] analysing the frequency of temperature inversions confirmed that the number of inversion days was higher from November to March than in other months. The analysis of over six years of PM data shows a clear seasonal pattern, with the highest concentrations occurring cyclically in winter. The highest concentrations are generally characterized by haze pollution due to atmospheric conditions favourable to accumulation in the lower layer of the atmosphere [3]. Furthermore, in these months, the PM2.5/PM10 ratio is generally higher [4], reflecting the difference in sources between summer and winter conditions [5]. This is driven by increased pollution sources, such as heating and traffic, and the higher frequency of thermal inversion events during this season. The contribution of heating sources influences particulate concentrations with increases during the evening and night periods. These results align with other studies that conducted a comprehensive analysis of the daily cycle of pollutants in urban areas [4]. According to [6], the peak concentrations were observed in the morning for the combination of heavy traffic and the breakdown of surface temperature inversions, which typically occurs around 7:00 AM in summer and 9:00 AM in winter. This study aims to investigate the possible correlation between thermal inversion episodes and increased PM concentrations on a daily basis; in which a more or less marked cyclical variation is observed depending on the time of day and season. For the particulate fractions, there was a significant hourly variation during the day. Due to the predisposing atmospheric conditions and a higher contribution of sources (such as domestic heating and biomass combustion), the winter months show higher concentration values of the PM fractions (PM1, PM2.5 and PM10). In addition, the middle hours of the day and evenings were affected by higher concentrations. The daily variation in concentrations was more pronounced in winter and autumn than in summer and spring. The variation was more pronounced for PM10 than for PM2.5 or PM1; in particular, PM2.5 and PM1 values were essentially stable during the night and their morning increase was small compared to that of PM10 [4]. Conditions with light winds, temperature inversion and low mixed layer heights contribute to the buildup of PM10 and PM2.5 as well as gas-to-particle processing [1]. This study could help to understand how to better manage emissions into the environment during the winter months, supporting policies aimed at reducing emissions. It is therefore important to know about thermal inversion phenomena and how they affect particulate concentrations in order to safeguard citizens' health. Temperature profiles are measured with an MTP5 meteorological temperature profiler, while PM concentrations are monitored using a Palas Fidas 200S optical particulate meter. Both instruments are located at the Polytechnic University of Turin in the metropolitan area of Turin, Italy.

Keywords: Thermal Inversion, Particulate Matter (PM), Air Quality, Seasonal Variation, Atmospheric Pollution, Urban Area

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