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Episodic analysis of particulate matter concentrations in the City of Johannesburg

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INTRODUCTION

Air pollution and the related health problems facing South Africa today are a unique blend of those faced by both developing and developed countries. Poor air quality is a concern in many parts of the country, potentially contributing to negative human health impacts. South African air quality legislation makes government responsible for managing and controlling ambient air pollution concentrations. In order to assist in this process, eight compounds, namely (particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), benzene (C_6H_6), lead (Pb), and nitrogen dioxide (NO_2) have been identified as priority pollutants for air quality management, and ambient air quality standards have been gazetted for these pollutants.

From these pollutants, PM is a large component of air pollution in South Africa and is known to have varied impacts on human health that include respiratory, lung disease and premature death. National ambient air quality standards for PM_{10} over 24-hour and annual average period, have been set (**Table 1**), and the attainment of these standards is critical to reducing associated health risks.

Table 1: South African ambient air quality standards (DEA, 2009)

Pollutant	Averaging Period	Limit Value ($\mu g/m^3$)	Compliance date
Particulate Matter (PM_{10})	24-hour	120	31 December 2014
	24-hour	75	1 January 2015
	Annual	50	31 December 2014
	Annual	40	January 2015

In order to effectively manage PM levels in the country, the sources and concentrations of this pollutant needs to be properly characterised. By developing an improved understanding of the nature of PM in the country, we may be better equipped to effectively manage air pollution into the future, and thus be better positioned to adapt to the impacts of climate change on air quality.

PM IN THE CITY OF JOHANNESBURG

The City of Johannesburg (CoJ) measured PM mass concentrations exceed national ambient air quality standards at times. This city is the largest urban area in South Africa, and contains a large population of people whose health might be impacted by poor air quality. The city is home to a number of industries, and its motor vehicles contribute to PM_{10} emissions. In order to effectively manage PM in the CoJ and mitigate the resultant human impacts, it is critical to understand the current trends and the main drivers of PM_{10} levels.

The CoJ operates an air quality monitoring network that consists of eight monitoring stations located in the major centres of the city. These are equipped with analysers that are used to continuously monitor PM_{10} levels. PM_{10} data for the period (2004–2012) were obtained for use in this study via the South African Air Quality Information System (SAAQIS) in order to identify PM_{10} air pollution episodes in the city. The data received from the SAAQIS had to be cleaned in order to ensure acceptable data quality. As such, only those datasets that had > 70% coverage were used for analysis in this study. These data were input in the software programme, IGOR pro, and used to calculate the daily, monthly and yearly averages for the creation of time series, in order to identify trends and air pollution episodes.

The 24-hourly averages (**Figure 2a**) over the entire study period show that most stations recorded exceedances of the ambient air quality standard for PM_{10} shown in **Table 1**. In particular stations located in Orange Farm, Diepsloot, Alexandra, Ivory Park, Buccleuh and Jabavu had the largest number of exceedances, whereas stations in Newtown and Delta Park had the least. It was further found that in 2009 (**Figure 2b**), the ambient air quality standard in Jabavu was exceeded over 10 days during a winter season in July. This is a good example of an 'air pollution episode'. In addition, this station exceeded the ambient air quality standard for PM_{10} 18 times in the year 2009.
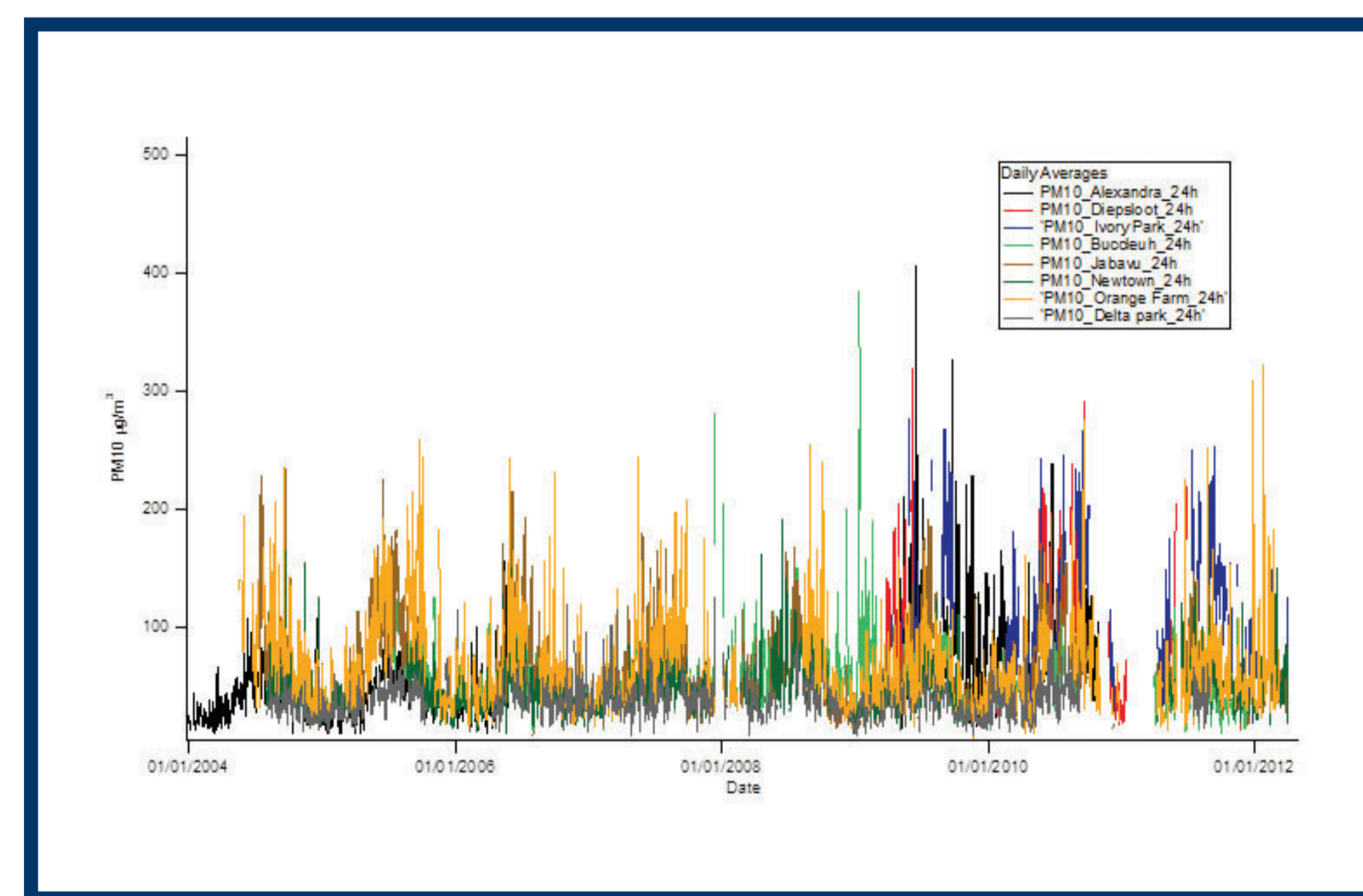

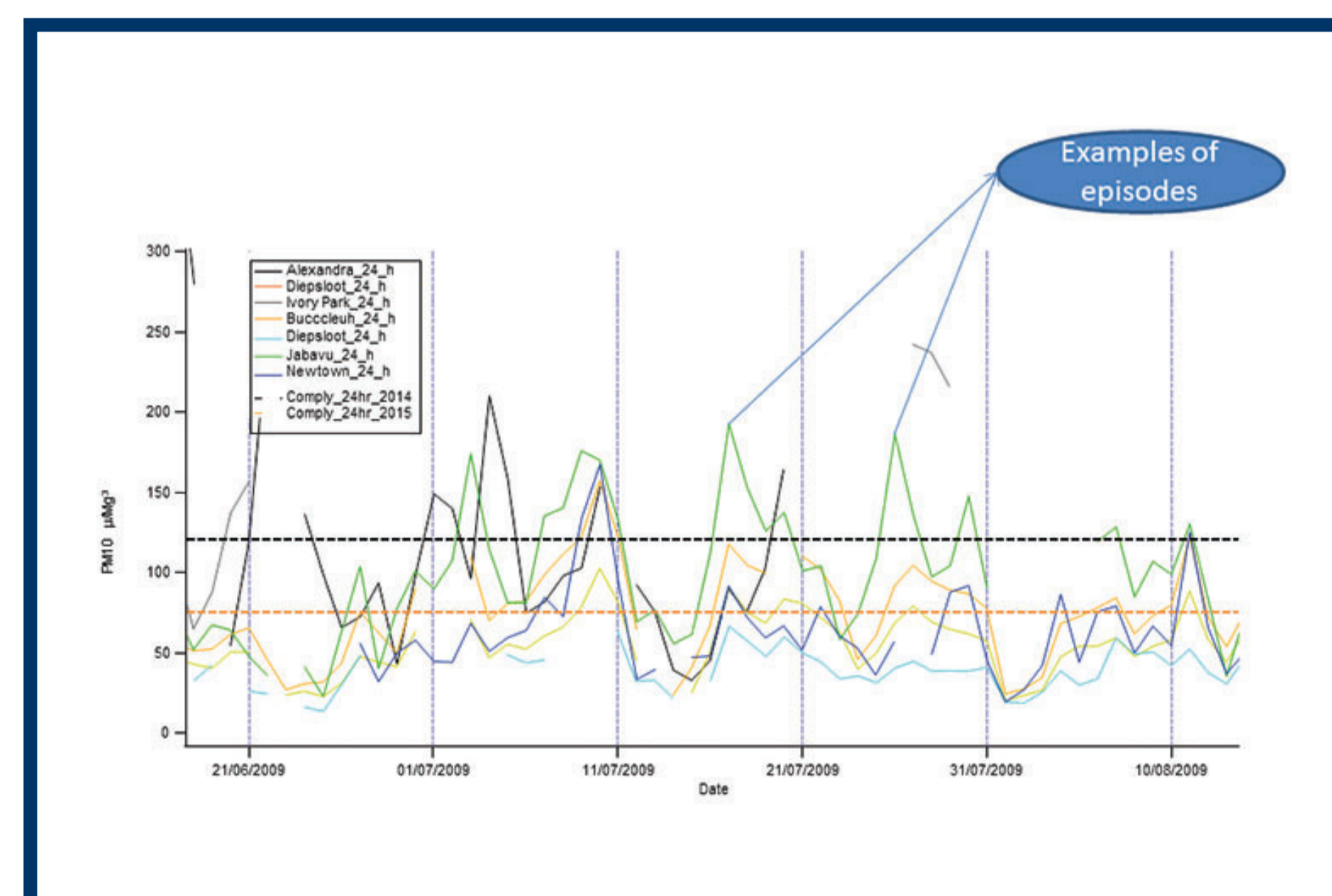Figure 2a): Time series of PM_{10} monitored (24-hour averages) for all the stations in Johannesburg

Figure 2b): Time series of PM_{10} monitored in July 2009 showing exceedances of ambient air quality standards

CONCLUSION

The analysis of PM_{10} data for the CoJ reveals a number of PM_{10} air pollution episodes, where the ambient air quality standards are exceeded over a number of consecutive days. Future research will focus on understanding the main drivers of these episodes, in order to better understand the relative influences of meteorological parameters, atmospheric chemical processes, topography and emissions.

REFERENCES

Department of Environmental Affairs, SANAQS, Government Notice No. 1210, Government Gazette No. 32816, 24 December 2009.

Particulate matter is a large component of air pollution in South Africa especially in urban areas and poor air quality is a concern in many parts of the country, potentially contributing to negative human health impacts.