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Temporal variation of PM_{10}, $PM_{2.5}$ and gaseous pollutants (NOx, SO_2) particles suspended in the atmosphere of an urban sit in Bou-Ismail.

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ABSTRACT/RESUME

Abstract: *In this work, we studied the daily variations of concentration of PM_{10}, $PM_{2.5}$ and gaseous pollutants at Bou-Ismail industrial area. An Airpointer carried out the different measurements during the month of February. This study revealed that PM_{10} and $PM_{2.5}$ concentrations ranged from 1.65 µg/m³ to 38.66 µg/m³ and from 0.75µg/m³ to 12.77 µg/m³ respectively. The highest concentrations were recorded on 23 February with 38.66 µg/m³ in PM_{10} and 12.77 µg/m³ in $PM_{2.5}$. This concentration is certainly related to the high road traffic density. It is important to note that PM_{10} and $PM_{2.5}$ concentrations did not exceed the WHO limit (50 µg/m3) and the Algerian regulation (80 µg/m³). Variations in the mean hourly concentrations of NO and NO_2 show stability during the midnight period until 7:00 AM with low concentrations. On the other hand, we notice during the day (from 8:00 AM until 6:00 PM) high concentrations of NO and NO_2. Variations in the mean hourly concentrations of SO_2 show two important peaks during the morning (0.27-0.32 ppb) and the evening peak hours (0.1-0.11 ppb).*

I. Introduction

Residents of densely populated cities are directly exposed to higher concentrations of different pollutants. Particulate matter (PM_{10} and $PM_{2.5}$) with aerodynamic diameters of less than 10 and 2.5 µm, respectively, are generally associated with causes of morbidity and mortality in human species[1- 8]. Many studies including the Mediterranean region have found that short-term and long-term exposures to $PM_{2.5}$ are also associated with an increased risk of mortality such as respiratory disease, lung cancer, asthma and heart disease [9-10] and their effects depend on the particle size and composition. Sources of particles differ; while the coarse particles PM_{10} (particles of 2.5 µm ≤ aerodynamic Diameter ≤ 10 µm) come from primary sources like dust and traffic-induced dust resuspension, fine particles ($PM_{2.5}$) are mainly the result of secondary sources, including the reaction of gases in the atmosphere [11]. In the implicated pollutants, these classes of particles are among the most studied in literature. Their effects depend on their size, nature and composition, which vary according to their origin. Their size is expressed with relation to their average aerodynamic diameter. Suspended

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particulate matter in the urban atmosphere is a heterogeneous chemical and physical entity. A pollutant is a body of anthropogenic or non-anthropogenic origin, solid, liquid or gaseous, contained in the atmosphere but not part of the normal composition of the air or present in abnormal amounts. According to a criterion of toxicity, source specificity and pollution generated, the main pollutants measured by the air quality monitoring bodies are nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), suspended particulate matter (SPM), volatile organic compounds (VOCs) and ozone (O_3). It should be recalled here that the toxicity of atmospheric particles is essentially related to the fraction of particles smaller than 10 µm [12].

The few occasional measurements of the levels of pollution carried out in the city of Algiers by the air quality monitoring network showed that the particles of automobile origin seem to predominate. Road traffic is particularly important in Algiers. The motorization rate is 200 vehicles per 1000 inhabitants, with an average age of 9 years for small vehicles and 14 years for large vehicles. In our study, we used the Airpointer (recordum Messtechnik GmbH, made in Austria) to determine the concentrations of various air pollutants (SO_2, NO_X and PM).

One month of monitoring campaigns were conducted out during the month of February 2016 in Bou-Ismail (36 ° 38'33'' N, 2 ° 41'24'' E), Algeria.

II. Materials and methods

II.1. Site of sampling

Atmospheric sampling was performed from February 2016. The sampling site is located in Bou-Ismail at the Center for Scientific and Technical Research in Physico-Chemical Analysis (CRAPC) (36 ° 38'33'' N, 2 ° 41'24'' E). The sampling site is situated 3 km east of Bou-Ismail city (c.a. 70,000 inhabitants) in the eastern part of the region of Tipaza, which is located 45 km in the west direction of Algiers (figure 1).

This site is considered an urban site with a highly dense population. Bou-Ismail is chosen since it is the largest industrial city of the Wilaya of Tipaza. Indeed, this city welcomes in its dynamic an industrial zone, located to the south-east of Tipaza, several operators in different economic fields, besides, it contains one of the regional leaders specialized in the transformation of paper, Tonic.

Figure 1. *Map indicating the location of the sampling site referenced in the text.*

II.2. Sampling

Ambient concentrations of NO, NO_2, SO_2 and PM_{10}, $PM_{2.5}$ were measured using samplers (airpointer, recordum Messtechnik GmbH) over the course of 24 hours during the month of February 2016.

The Airpointer is an air quality measurement system based on a modular construction method that allows many customization options to the customer. This equipment can simply be installed and connected at any time, on different sites such as: industrial sites, traffic, confined spaces, construction sites, airports, allowing measurements in motion.

The Airpointer offers a choice of analytical modules, using approved reference methods for monitoring air pollutants (SO_2, NO_X and PM) classified as relevant by the European Union, the World Health Organization, the US EPA and the most responsible organizations all over the world.

The thermo electron used for pollutant analyzers in samplers that operate for an average of 1 min and measure target pollutant as follows: SO_2 by ultraviolet fluorescence (detectable lower limit less than 1.0 ppb); NO and NO_2 by chemilumin escence (detectable lower limit less than 2.0 ppb) and the particulate matter less than 2.5 and 10 µm by nephelometry (detectable lower limit less than 1 µg/m^3) detection limits are provided by the manufacturer.

III. Results and discussion

III.1. Temporal variation of PM_{10} and $PM_{2.5}$ particles suspended in the atmosphere. Concentrations of particulate matter varied on the following time scales: daily (daily), weekly (weekday). These changes were directly correlated with the variability of emissions and changes in geophysical and climatic parameters.

a. Daily concentrations of PM_{10} and $PM_{2.5}$

The daily variation of the PM_{10} and $PM_{2.5}$ concentrations obtained in Bou-Ismail for the month of February is shown in Figure 2. Worth to

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note that the PM_{10} and $PM_{2.5}$ concentrations ranged from 1.65 µg/m^3 to 38.7 µg/m^3 and from 0.75 µg/m^3 to 12.8 µg/m^3 respectively. In addition, it is worth noting that the two days (22 and 23 February) were characterized by a high concentration (30.5 µg/m^3 and 38.7 µg/m^3 in PM10 and 8.9 µg/m^3 and 12.8 µg/m3 in $PM_{2.5}$. This high concentration is related to the origin of the air masses impacting our station from Spain, originating from Portugal that crosses the Mediterranean Sea as shown in Figure 3.

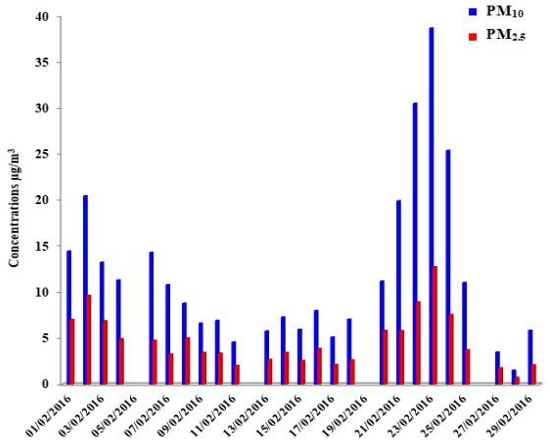

Figure 2. *Daily variation in concentrations of PM10 and PM2.5 measured at Bou-Ismail.*

The world health organization (WHO) estimates that the average daily PM_{10} should not exceed 50 µg/m^3 and 25 µg/m^3 for $PM_{2.5}$. This value was incorporated into the Algerian regulations (Decree N°. 06-02 of 7 January 2006) as a reference value.

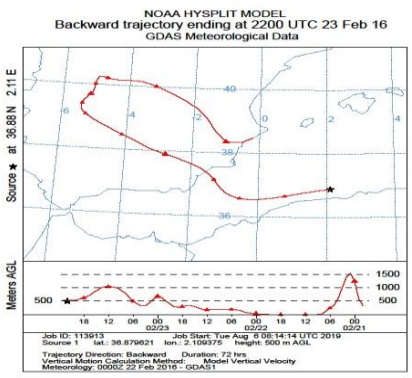

Figure 3. *The retro-trajectory of air masses traced by hysplit Maximum 210 m 72 H).*

b. Weekly Concentrations of PM_{10} and $PM_{2.5}$

Weekly variations of PM_{10} and $PM_{2.5}$ for February 2016 are shown in Figure 4. It is observed that PM_{10} and $PM_{2.5}$ concentrations ranged from 6.9 µg/m^3 to 11.9 µg/m^3 and from 3.4 µg/m^3 to 4.7 µg/m^3, respectively. In addition, the days of the week show the highest concentrations (up to 11.9 µg/m^3 in PM10 and up to 4.7 µg/m^3 in $PM_{2.5}$). The lowest concentrations were recorded during weekend (down to 6.9 µg/m^3 in PM_{10} and 3.4 µg/m^3 in $PM_{2.5}$). These results can be explained by the variation in the density of traffic that significantly affects the concentrations of PM_{10}, but also by changes in weather conditions [13].

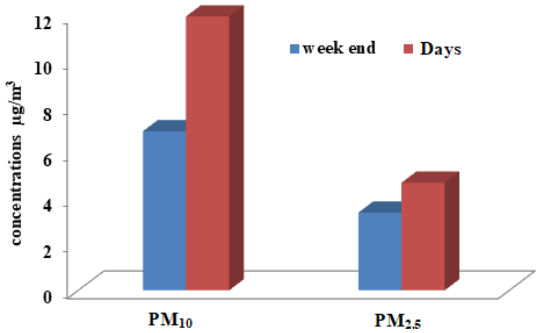

Figure 4. *Weekly variation of the contents of the measured PM_{10} and $PM_{2.5}$ in Bou-Ismail.*

Comparison of atmospheric levels of PM_{10} related to Algerian standards (AS/ OJ RAPD-2006), U.S. (U.S. EPA, 1997), European (OJ EC-1999) and WHO (WHO 2005) are given in table 1. These comparisons show that the daily PM_{10} levels do not exceed the WHO, US-EPA, European and Algerian standards compared to WHO's strict guidelines.

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Table 1. Air Quality Regulations.

PM_{10}	Limit values ($\mu g/m^3$)	Reference
WHO	50	WHO 2005
US-EPA	35	U.S. EPA, 1997
UE	50	OJ-EC-1999
AS	80	OJ - RADP, 2006

When compared with other cities, air quality values in the Bou-Ismail region were found not to exceed the maximum values stated in the various regulations associated with air quality targets. PM_{10} levels measured at Bou-Ismail are close to those observed in European cities such as Paris, Lyon and Marseille (22 to 40 µg / m^3), but lower than those observed in cities of some emerging countries known for their high pollution such as Beijing (135.9 $\mu g/m^3$) and Cairo (130 to 250 $\mu g/m^3$) [14].

III.2. The gaseous pollutants NO_2, NO and SO_2

The degradation of air quality and its impact on health and on the environment have become an overriding concern to the general public. The biggest agglomerations are the ones most affected by automobile pollution and those released from large industrial sites. . Among the air pollutants produced by these sites, we notice the presence of nitrogen oxides (NOx) including NO and NO_2 and sulfur dioxide (SO_2).

a. Hourly concentration of gaseous

The variation in the mean hourly concentrations of the month of NO, NO_2 and SO_2 observed during the sampling period are shown in Figure 5a, 5b, 5c. We observe that variations in mean hourly concentrations of NO and NO_2 show stability during the midnight period until 7:00 AM with low concentrations. On the other hand, we notice during the day (from 8:00 AM until 6:00 PM) high concentrations of NO and NO_2. This phenomenon can be attributed to the day-night differences in the chemical removal of NO and NO_2 via photo-oxidation reactions and the height of the mixing layer [15]. Also, nitrogen oxides are produced by the oxidation of air nitrogen during the process of combustion at high temperature (traffic, domestic heating, energy production, specific chemical production ...). This high concentration of NO and NO_2 found during the day are associated with the close proximity of the sampling site to the industrial zone of Bou-Ismail and the national main-road of Bou-Ismail-Blida (traffic flows and chemical production).

The variations in mean hourly concentrations of SO_2 show two important peaks during the morning (0.27, 0.32 ppb) and the evening peak hours (0.1, 0.11 ppb) (road traffic). SO2 comes mainly from the combustion of fuels and fuels containing sulfur (oil, diesel, coal, etc.) [15]. Sulfur impurities in fossil fuels are oxidized by oxygen in the air (O2) to sulfur dioxide (SO2). It is generally accepted that SO2 gas irritates the respiratory tract, the mucous membranes of the skin and eyes, which may cause asthma [16].

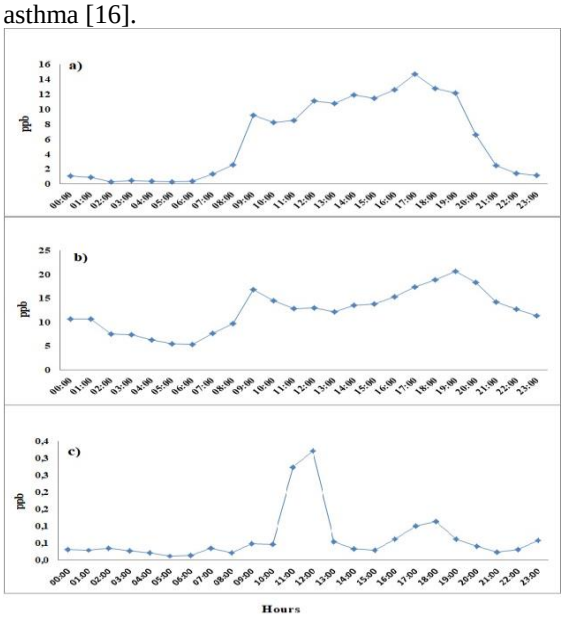

Figure 5. *Daily variations of mean values of NO, NO_2 and SO_2 concentrations (averaging time: 60 min).*

IV. Conclusion

In this work, we have been interested in the study of air quality at Bou-Ismail city. PM_{10} and $PM_{2.5}$ have concentrations ranging from 1.65 $\mu g/m^3$ to 38.66 $\mu g/m^3$ and from 0.75 $\mu g/m^3$ to 12.77 $\mu g/m^3$, respectively. The highest concentrations were recorded on 23 February with 38.66 $\mu g/m^3$ for PM_{10} and 12.77 $\mu g/m^3$ for $PM_{2.5}$. The average gaseous pollutants NO, NO_2 and SO_2 concentrations ranged from 0.31 to 14.74 ppb, 5.36 to 20.70 ppb and 0.01 to 0.32 ppb, respectively. Throughout the study period, the results obtained from Bou-Ismail air sampling unit were not found to exceed the national and international air quality guideline values, as it was required by different organizations.

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