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Monitoring of troposphere ozone in the peri- urban area of Oujda city in the east of Morocco

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Abstract
In The border city of Oujda (Moroccan-Algerian border /east of Morocco), and in order to monitor the tropospheric ozone (O_3) levels, two sampling campaign of stratospheric ozone have been carried between 04/2013 and 01/ 2014 out on an hourly base with the use of an automatic ozone analyzer device using the UV absorption technology. This article provides O_3 results to incorporate into reports and research studies. The monitoring of O_3 levels in the ambient air of Oujda during warm and the cold seasons respectively is needed, justified, discussed and interpret the O_3 measurements. During the warm season 60.07% of the recorded values are below the Moroccan limits and 41.1% are below world health organization limits, in the second sampling campaign (in cold season) 92% of the recorded values are below the Moroccan limits and 84.6% are below world health organization limits. This article provides background information on O_3 formation, sources, and a comprehensive review of probable O_3 impacts and also describes the monitoring of O_3.

Keywords: air pollution, Troposphere ozone, Volatile organic compounds, ozone precursors, Peri-Urban areas, urban areas.

Introduction
Ozone is a natural compound of the atmosphere that is always present at low concentration in lower atmosphere (at the surface). The natural presence is due to the exchange between troposphere and stratospheric layers [1], but anthropogenic sources of ozone that cause the increase of stratospheric ozone levels, is due to human activities. It's formed by photochemical reactions in the presence of precursors such as NOx (NO + NO_2) and volatile organic compounds (VOCs) [2], [3], and it's considered as an air pollutant (second pollutant) because when it's present at elevated levels it lead to respiratory effects in humans [4,5], and it's toxic for plants and many other life forms [6-8].
These effects must be validated; evaluation studies are used to examinant the severity of the problem and to investigate problem causes [4,9]. But in the stratosphere (between 20-30km altitudes) ozone protect all living organisms from harmful solar ultraviolet radiation, it's known as the good ozone.
The aim of this work was then monitoring the levels of surface ozone over a period covering both cold and warm season and show ambient concentration of O_3.
The monitoring of O_3 levels in the ambient air of Oujda during warm and the cold seasons is described in this paper.

2. Experimental
2.1. Climatic characterization
The city of Oujda has a Mediterranean climate. Rainfall can reach up to 300 mm (per year). It seldom snows in winter. Weather in Oujda is cold in winter hot and dry in summer.
Average annual temperatures vary between 15 ° C and 20 ° C. Highest ones can exceed 40 ° C, while the absolute minimum temperatures sometimes lowered below 0 °C. However, temperatures are still mild on the

Mediterranean coast.

2.2. Sampling of O3

The sampling campaign were conducted between April 2013 and January 2014, in the north zone of Oujda city covering the cold and warm seasons, locations chosen for the automatic analyzer located at GPS coordinates 34° 41′ 12″ N; 1° 54′ 41″ W (Fig. 1).

The studied zone is characterized by medium population and medium traffic density with vehicles using low fuel quality. The region also contains an industrial area but without considerable industrial activity. The sampling site were located in a peri-urban zone in the LCSMA laboratory local (Faculty of Science / Mohamed I university of Oujda) were it installed the automatic analyzer. The Sampling campaign of $O_3$was carried out by O_3 41M sample processing (Fig. 2). Total ozone measurements are made by comparing a frequency of the ultraviolet spectrum strongly absorbed by O_3 with that is not. The consistency of measurements with this method provides daily global coverage and profile of O_3 in the atmosphere.

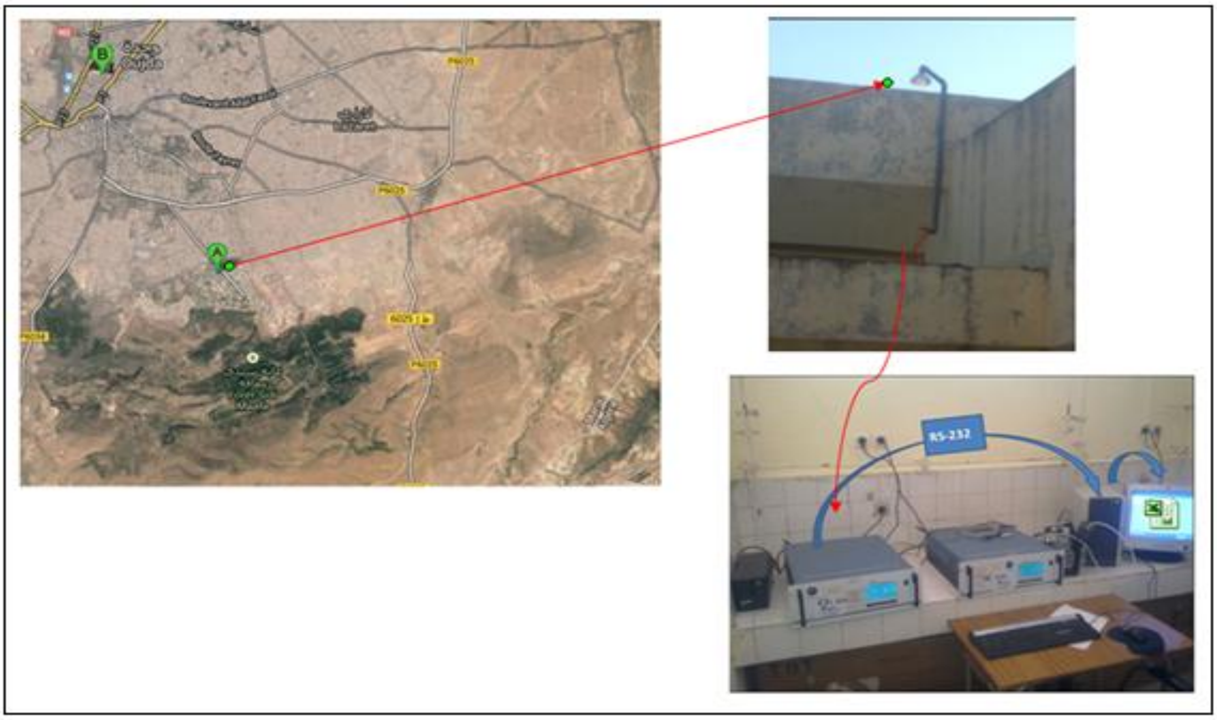

Figure 1: Visualization of the sampling locations ??? (Google maps)

Figure 2: automatic analyzer of O3 (O341M)

- Programmable measures range from 0.1 to 10 ppm with a detectable minimum of 1 ppb 50 seconds response time;
- Automatic control of parameters affecting metrology and testing work (UV, flow, temperature, pressure, energy);
- Expression of the measurement values in ppm or mg/m^3;

- Storage medium with programmable period (capacity: 5700 average);
- Remote signaling function "measure" and "alarm".

2.3. Analytical procedure for O3

The O_3 41M (SA, environment ®) is a continuous ozone analyzer (specific to low levels), and can be used to measure profiles of ozone in the atmosphere. It's operating on the principle of absorption of UV radiation (253.7 nm). The input sample is performed by a Teflon tube (6 mm outer diameter) connected to the rear of the apparatus. The levy is provided by an internal pump. The measure is given by an alphanumeric display located on the front panel.

Measurement cycle (about 10 seconds):

-1- Passage of gas through the selective filter O3,ventilation measurement chamber (4s);
-2-Measurement of 0 made by UV measurement (period defined by "UV Reference");
-3-Switching the solenoid valve;
-4-Gas flow directly into the measuring chamber, ventilation (4 seconds);
-5-Measurement performed by UV measurement (period defined by "UV Reference").

The total ozone was measured during 2013-2014, with O_3 41M SA environment) spectrometer. Figure 4 and figure 5 below illustrate the seasonal variation recorded at this location (Oujda sidi maafa). Low ozone event were shown for 2013, these data have been up dated within the Excel reporting format.

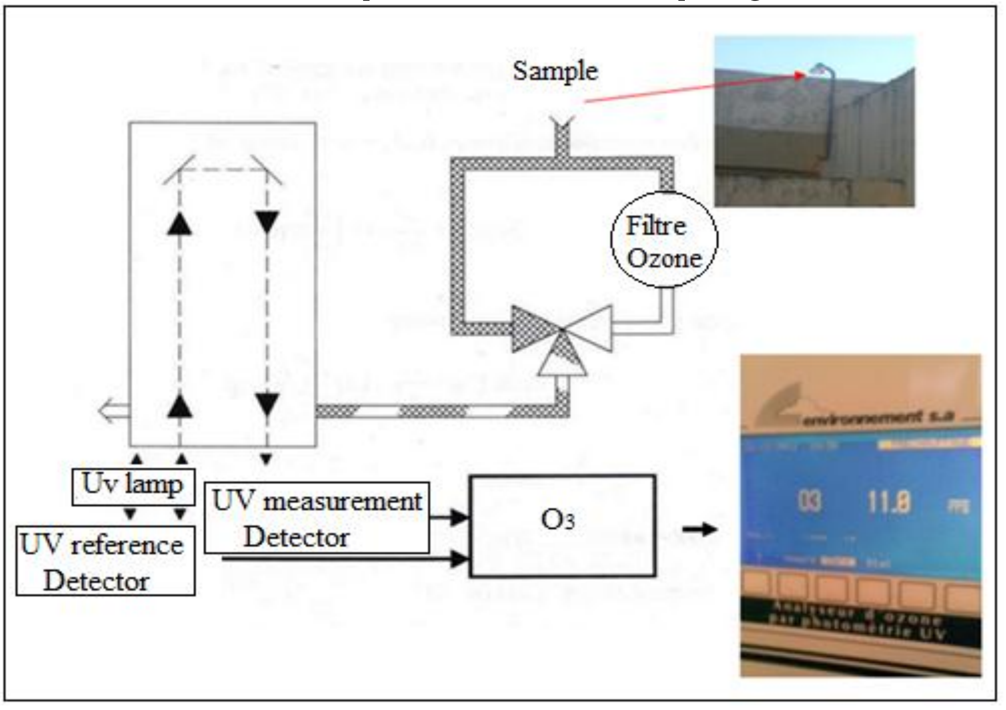

Figure 3: Diagram of the general principle.

3. Results and discussion

The duration of the sampling is divided into two periods:
- The first period between 04/2013 and 09/2013 (126 days) during the warm season (Fig. 4);
- The second period between 09/2013 and 01/2014 (143 days) in the cold season (Fig. 5);

According to Moroccan legislation two Limit value are defined:
- Limit value for the preservation of health: 110 µg/m3 average over a range of 8h;
- Limit value for preservation of vegetation: 65 µg/m3 daily average not to be exceeded more than 3 consecutive days;

World health organization Air quality guidelines define the limit value 100 µg/m^3.

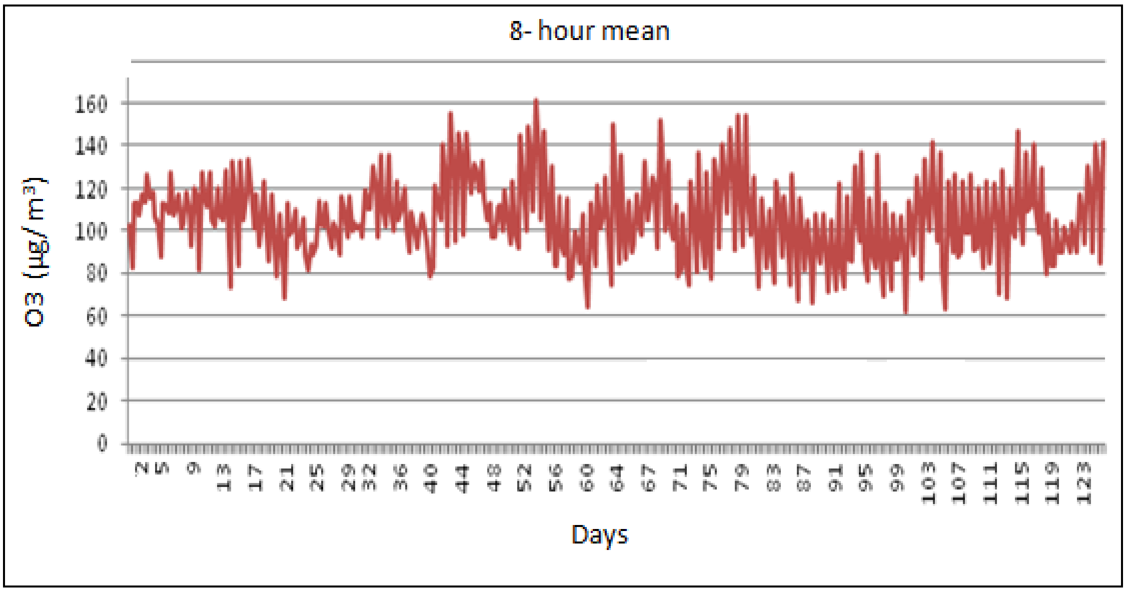

Figure 4: Ozone measurements during warm season

60.07% of the recorded values are below the Moroccan limits and 41.1% of the values are below the limits of world health organization. The Explanation of these high values is due to the elevated Insulations and high levels of VOCs. we suspected the practical rooms for levels of VOCs when organic solvent are widely used, but this theory has been excluded as the device continued to record the same value, even during periods of vacation. These values may be due to the forest zone (natural source VOCs) [10], [5], [11] which is close to the sampling points, this forest is composed by Eucalyptus and Pine trees.

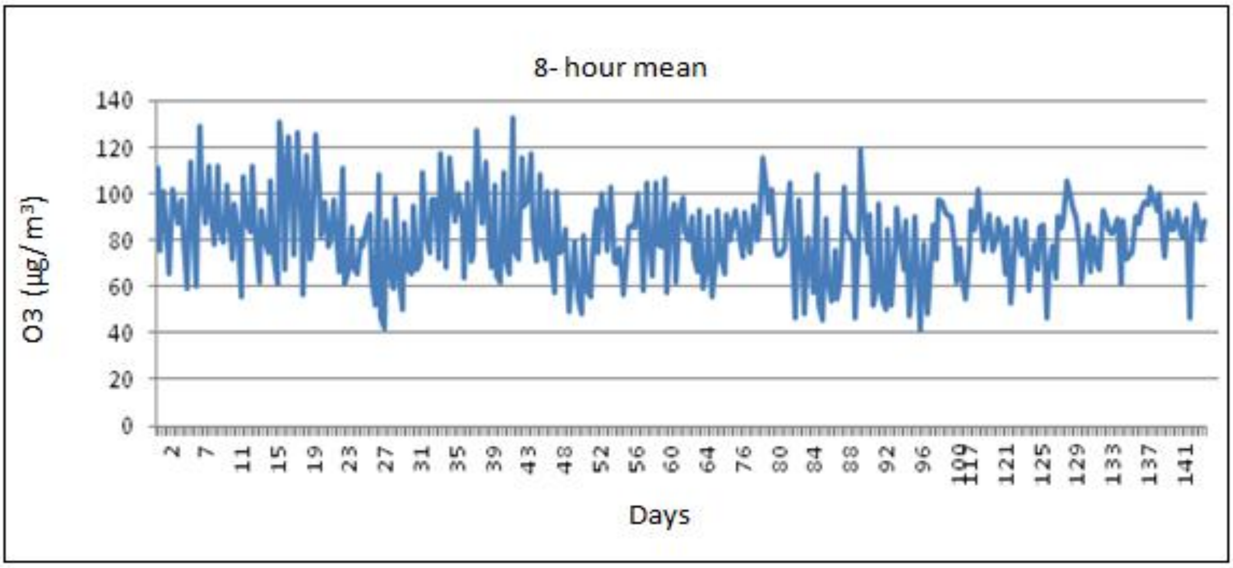

Figure 5: Ozone measurements during cold season

During the cold season (characterized by low levels of sunshine), 92% of the recorded values are below the Moroccan limits and 84.6 % of the values are below the limits of World health organization.
The relationship between the formation of ozone and sunlight is widely known, but to study the causal link between ozone and temperature a third sampling campaign was carried out between 01/2014 and 07/2014 (159 day), the relationship between temperature and troposphere ozone level is not clear (Fig. 6) but a statistical correlation test (IBM SPSS Statistics® software) shows a causal link, according to this test the correlation between daily mean of troposphere ozone and daily temperature mean is significant at the 0.01 level (Tab. 1) this mean that 99% of probability that this result is not due to Randomness.

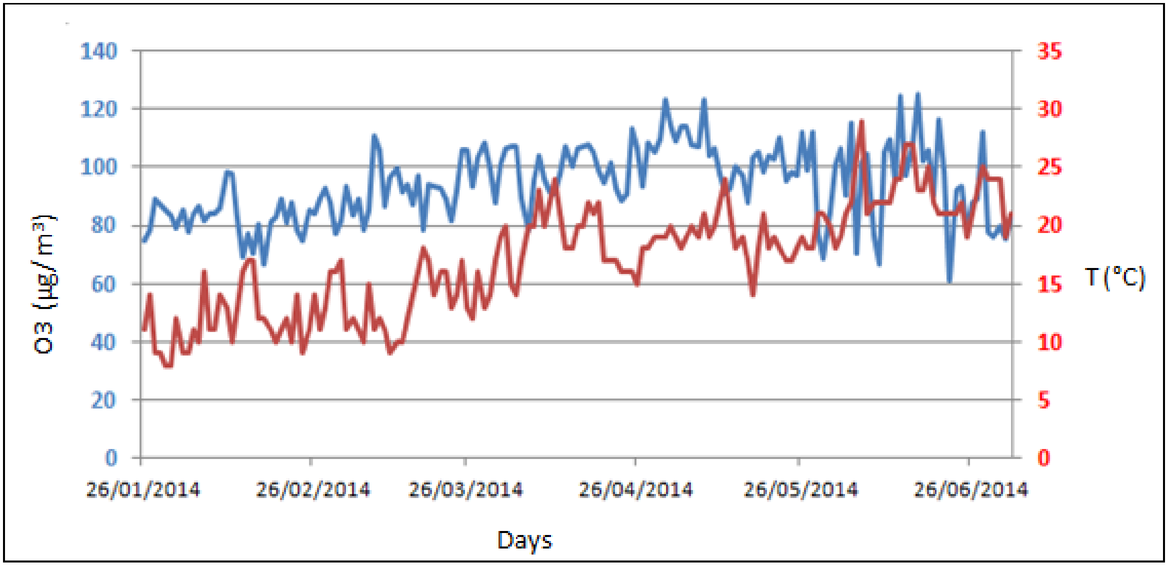

Figure 6: correlation between daily ozone and temperature

Table 1: Statistical correlation test (IBM SPSS Statistics® software)

Correlations			
		Ozone daily mean (µg/m^3)	Temperature daily mean (°C)
Ozone daily mean µg/m^3	Pearson Correlation	1	0.413**
	Sig. (2-tailed)		0.000
	N	96	96
Temperature daily mean °C	Pearson Correlation	0.413**	1
	Sig. (2-tailed)	0.000	
	N	96	96
** Correlation is significant at the 0.01 level (2- tailed).			

To make a comparative study between ozone in the peri-urban area and city center of Oujda, a second analyzer was installed in the downtown of Oujda (location B) Fig.1.
We can say that there is not much difference in measurement between the downtown and the peri- urban area.

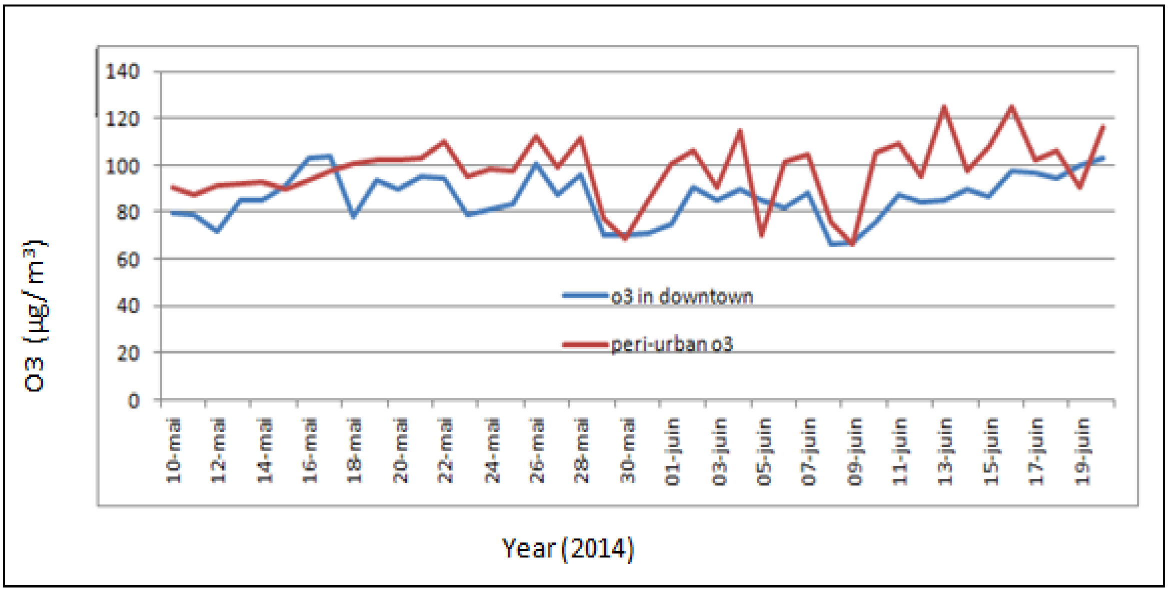

Figure 7: correlation between downtown and the peri-urban area

Conclusion

This study allowed us to monitor the levels of surface ozone over a period covering both cold and warm season and show ambient concentration of O_3.
Monitoring of this pollutant, as in the case this study, has been carried out modern technology what enables us to gain accuracy and of saving of time, but the expansive cost of this technology is the principal disadvantage, when the study concern a big area and because material considerations, passive samplers is a good solution.
High levels of troposphere ozone is due to his levels VOCs produced by the forest exist close of the monitoring zone.
Researchers have to use analytical technique statistical approaches to develop models that can discuss, interpret the O_3 measurements and predict health response to ozone.

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