Environment Canada Environnement Canada

New Bridge for the St. Lawrence

Air Quality Assessment in the New Bridge for the St. Lawrence Corridor

Preliminary Report

Environment Canada

for

Infrastructure Canada

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INTRODUCTION

On October 5, 2011, the Government of Canada announced that the Champlain Bridge would be replaced with a new one. The Champlain Bridge is one of the busiest bridges in Canada and is a key corridor for the regional economy and for Canada as a whole. The corridor project for the new bridge over the St. Lawrence includes not only the new bridge for the St. Lawrence but also a new bridge for Nuns' Island, as well as the reconstruction and expansion of the federal section of Highway 15.

As part of the environmental assessment for this project, Infrastructure Canada has agreed to put in place an air quality monitoring program. It was within this context that Environment Canada installed a mobile sampling station in June 2014 near the old Champlain Bridge toll station, on Nuns' Island, in order to take air quality readings before the project's planned start in 2015.

This report is a preliminary analysis of the data gathered at the sampling station on Nuns' Island, operated by Environment Canada, as well as from three other air quality measuring stations belonging to Quebec's Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC) and the City of Montréal.

SAMPLING SITES

Environment Canada's mobile air quality research unit (MAQRU) was set up on June 13, 2014 some thirty metres east of the old toll station on Nuns' Island, between the traffic lanes going in opposite directions (figures 1 and 2), and is therefore located at the heart of the corridor for the new bridge over the St. Lawrence. This station is taking continuous readings of ambient nitrogen oxide concentrations (NO, NO_2, NO_x), ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2) and particulate matter ($PM_{2.5}$, PM_{tot}). Volatile organic compounds (VOCs) are also being sampled in accordance with the schedule set by the National Air Pollution Surveillance Network (NAPS).

In order to provide a contextual picture and to compare air quality in the immediate sector of the Champlain Bridge with other areas further away, the ambient concentrations of certain contaminants measured at other sampling stations located on Montréal Island (Verdun) and the South Shore (Longueuil and Brossard) (see Table 1 and Figure 3) are also presented in this preliminary report.

Figure 1 – The MAQRU on Nuns' Island

Figure 2 – Location (red rectangle) of the MAQRU on Nuns' Island

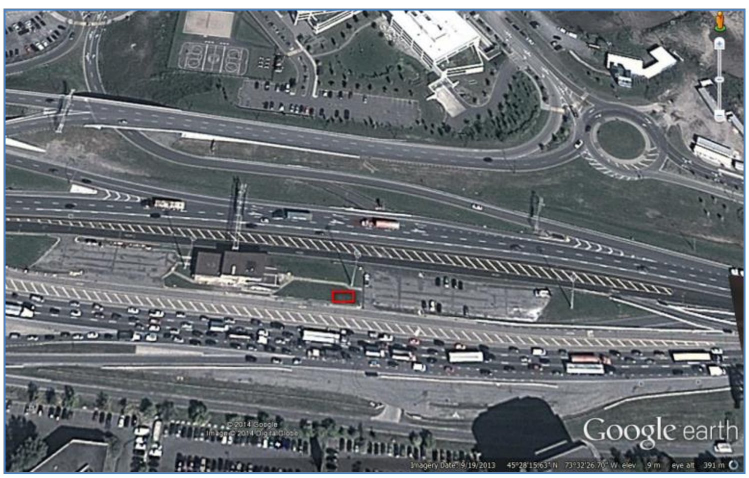


Table 1 – Air Quality Measuring Stations Presented in the Preliminary Analysis

Station Name	Location	Latitude	Longitude	Altitude
MAQRU	Montréal (Nuns' Island)	45.4702°	-73.5399°	20 metres
BOURASSA	Longueuil	45.5221°	-73.4881°	32 metres
PARC OCÉANIE	Brossard	45.4430°	-73.4686°	15 metres
VERDUN	Montréal (Verdun)	45.4717°	-73.5722°	21 metres

Figure 3 – Location of the air quality measuring stations presented in the preliminary analysis

The Bourassa and Parc Océanie stations are both located in residential areas, at distances of approximately 6 km and 2.5 km respectively from the Champlain Bridge, and are operated by the Direction du suivi de l'état de l'environnement at the Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques. These two stations take continuous and hourly readings of the ambient concentrations of ozone (O_3), nitrogen oxides (NO, NO_2, NO_x) and fine particulate matter ($PM_{2.5}$).

The Verdun station is also in a residential area, although Highway 15 arcs its way approximately 300 metres north and east of it. It is operated by the City of Montréal's Réseau de surveillance de la qualité de l'air. This station is equipped with analyzers that make it possible to take continuous and hourly readings of the concentrations of ozone (O_3) and nitrogen oxides (NO, NO_2).

INSTRUMENTATION AND DATA USED

The MAQRU is equipped with the instruments listed below in Table 2. The devices used to measure the ambient concentrations of pollutants respect the operating standards set out in the NAPS guidelines. The station is also equipped with a CR23x data logger (Campbell Scientific) and a wireless modem so it can transmit pollutant readings in real time to a database operated by Environment Canada.

Table 2 – Summary of the instrumentation and operational parameters used by the MAQRU (Nuns' Island, Montréal)

Pollutant	Instrument	Method	Flow	Scale	Interval (sampling)	Detection Limit	Calibration
NO	Thermo 42i-TL	Chemiluminescence	0.5 l/min	0-1000 ppbv	5 sec	0.4 ppbv	Thermo 146i
NO_2	Thermo 42i-TL	Chemiluminescence	0.5 l/min	0-1000 ppbv	5 sec	0.4 ppbv	Thermo 146i
NO_x	Thermo 42i-TL	Chemiluminescence	0.5 l/min	0-1000 ppbv	5 sec	0.4 ppbv	Thermo 146i
O_3	Thermo 49i	Photometry	1.5 l/min	0-500 ppbv	5 sec	1.0 ppbv	Thermo 49CPS
CO	Thermo 48i	IR absorption	1.0 l/min	0-5 ppmv	5 sec	<20 ppbv	Thermo 146i
SO_2	Thermo 43iTL	Pulsed fluorescence	0.5 l/min	0-200 ppbv	5 sec	0.5 ppbv	Thermo 146i
$PM_{2.5}$	BAM 1020	Beta radiation attenuation	16.67 l/min	0-500 ug /m^3	50 min	± 2.0 µg/m^3 <80 µg/m^3 (1 hr.) ± 5 µg/m^3 >80 µg/m3 (24 hr)	Foils for Beta Chinook Cal flow
PM_{tot}	BAM 1020	Beta radiation attenuation	16.67 l/min	0-500 ug /m^3	47 min	± 2.0 µg/m^3 <80 µg/m^3 (1 hr.) ± 5 µg/m^3 >80 µg/m^3 (24 hr)	Foils for Beta Chinook Cal flow
Weather	Vaisala HMP 45C RM Young	Temperature, relative humidity, wind speed and direction	-	-	5 sec	-	-

The MAQRU data presented in this report (NO, NO_2, O_3, CO, SO_2, $PM_{2.5}$ and PM_{tot}) have all been validated and cover the period of June 17 to August 31, 2014, with the exception of the SO_2 concentrations, which are only available up to July 28 due to an analyzer breakdown. For similar reasons, the PM_{Tot} data for July 23 to 27, 2014 is not available.

The VOCs (volatile organic compounds) were sampled using the NAPS schedule, i.e. a 24-hour period every six days. The analyses on the samples taken by the MAQRU between June 16 and July 22, 2014 were conducted at Environment Canada’s River Road Laboratory in Ottawa.

Air temperature and humidity as well as wind direction and speed were also measured starting July 3, 2014.

The data from the Bourassa and Parc Océanie stations (NO, NO_2, O_3, $PM_{2.5}$), which are part of the NAPS network, were gathered and pre-validated by the

Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques for the period of June 15 to August 31, 2014.

Data from the Verdun station (NO, NO_2, O_3), which is also part of the NAPS network, was gathered and validated by the City of Montréal for the same period. However, data from June 25 and July 10 is missing due to violent thunderstorms that affected the analyzers.

REFERENCE VALUES

For the various atmospheric contaminants, reference values (standards, criteria, guideline values, guidelines) can be used to analyze the concentrations measured in the ambient air. In this preliminary report, conventional exposure indicators are calculated and compared to reference values that are presented in Table 3. These reference values, normally used in the management of air contaminants, are from the Government of Quebec's *Clean Air Regulation* and the Montréal Urban Community's Bylaw 2001-10.

Table 3 – Reference values for certain ambient air contaminants

Indicator		Reference Values	
Pollutant	**Period**	**CAR[1]**	**CMM[2]**
Nitrogen monoxide (NO)	1 hour	-	1000 ppb
Nitrogen dioxide (NO_2)	1 hour	220 ppb	213 ppb
	24 hours	110 ppb	106 ppb
Ozone (O_3)	1 hour	82 ppb	82 ppb
	8 hours	65 ppb	38 ppb
	24 hours		25 ppb
Carbon monoxide (CO)	1 hour	30 ppm	30 ppm
	8 hours	11 ppm	13 ppm
Sulfur dioxide (SO_2)	1 hour		500 ppb
	24 hours	110 ppb	100 ppb
Fine particulate matter ($PM_{2.5}$)	24 hours	30 ug/m^3	-
Total particulate matter (PM_{Tot})	24 hours	120 ug/m^3	150 ug/m^3

[1] CAR: *Clean Air Regulation,* Ministère du Développement durable, de l'Environnement et des Parcs, Government of Quebec
[2] MUC: Montréal Urban Community's *Bylaw 2001-10*

RESULTS

This section is subdivided by contaminant. For each, with the exception of volatile organic compounds, a brief description of the pollutant in question is accompanied by a tabular statistical summary and box and whiskers plot (see explanations further down), making it possible to represent the breakdown of the hourly ambient concentrations measured over the period covered. A second type of chart makes it possible to represent the average hourly values of the pollutant concentrations based on the time and day of the week.

Lastly, for each pollutant, there is a comparison of the air quality indicators in relation to the reference values. For the various indicators based on periods of 8 and 24 hours, mobile averages of 8 hours or daily averages were calculated if at least 85% of the hourly data was available over the period. Subsequently, the hourly daily maximums and the mobile 8-hour averages maximum, as well as the daily averages, were extracted in order to find out the number of days where the reference levels were exceeded.

> ***Box and whiskers plot***: *This is a rectangular box where the two extremities are quartiles (the 25th and 75th percentiles). These extremities are extended by dashes ending in orthogonal segments (the whiskers). These segments extend from the minimum value to the maximum value and the median is represented by a dash in the box.*

Nitrogen Oxides (NO_x)

Nitrogen oxides include nitrogen monoxide (NO) and nitrogen dioxide (NO_2). They are created mainly in the combustion process which releases the nitrogen present in the fuel and in the combustion air. The nitrogen monoxide (NO) released during combustion oxidizes rapidly into NO_2 in the atmosphere. By dissolving in atmospheric water vapour, the NO_2 produces acids that interact with gases and particles present in the atmosphere to form particles known as nitrates or other compounds that can be hazardous to people and the environment.

Nitrogen Monoxide (NO)

Table 4 and figures 4, 5 and 6 reveal that the concentrations and extreme values of NO measured at the Champlain Bridge are considerably higher than those taken at the Longueuil and Brossard stations and, to a lesser extent, higher than those at the Verdun station, the one closest to the MAQRU and to the major road network for the bridge. According to Figure 5, NO concentrations are higher on weekdays compared to weekends and this is the case for all stations. A daily cycle is also quite apparent from Monday to Friday, particularly for the MAQRU, with maximums corresponding in all likelihood to peaks in road traffic.

Table 4 – Statistical summary of the hourly readings of ambient NO concentrations (in ppb) from June 15 to August 31, 2014

NO	MAQRU	Parc Océanie	Bourassa	Verdun
Data availability	92.4%	97.2%	99.8%	79.5%
Minimum	0	0	0	0
Maximum	97.5	37.2	41.1	64.8
Average	9.4	0.7	1.1	2.4
Median	6.6	0.2	0.4	0.9
Standard deviation	9.1	2.1	2.3	4.6

Figure 4 – Breakdown of hourly readings of ambient NO concentrations from June 15 to August 31, 2014

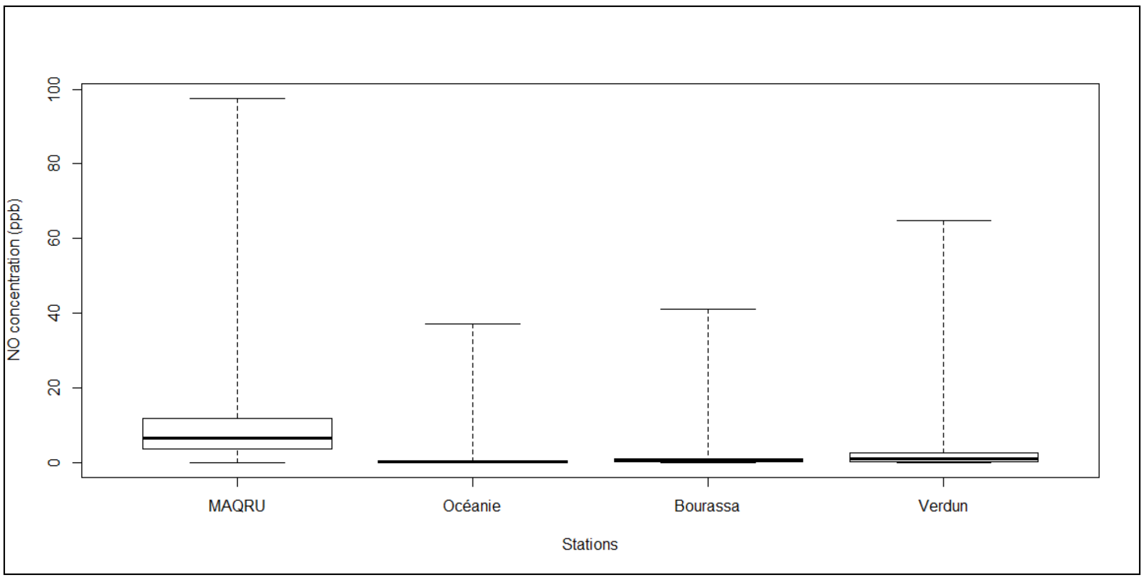


Figure 5 – Diurnal and weekly trends based on hourly readings of ambient NO concentrations from June 15 to August 31, 2014

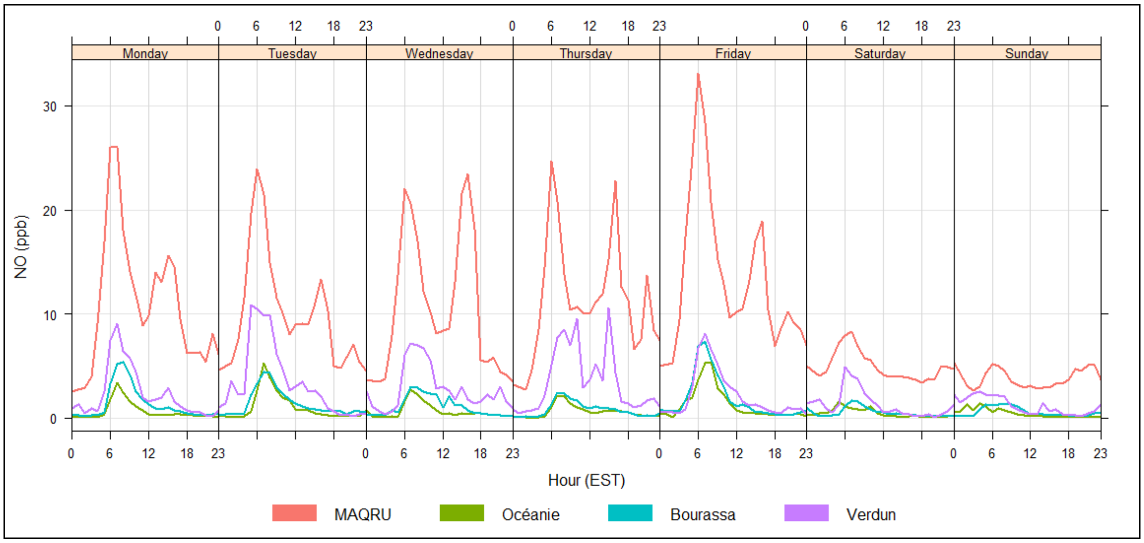
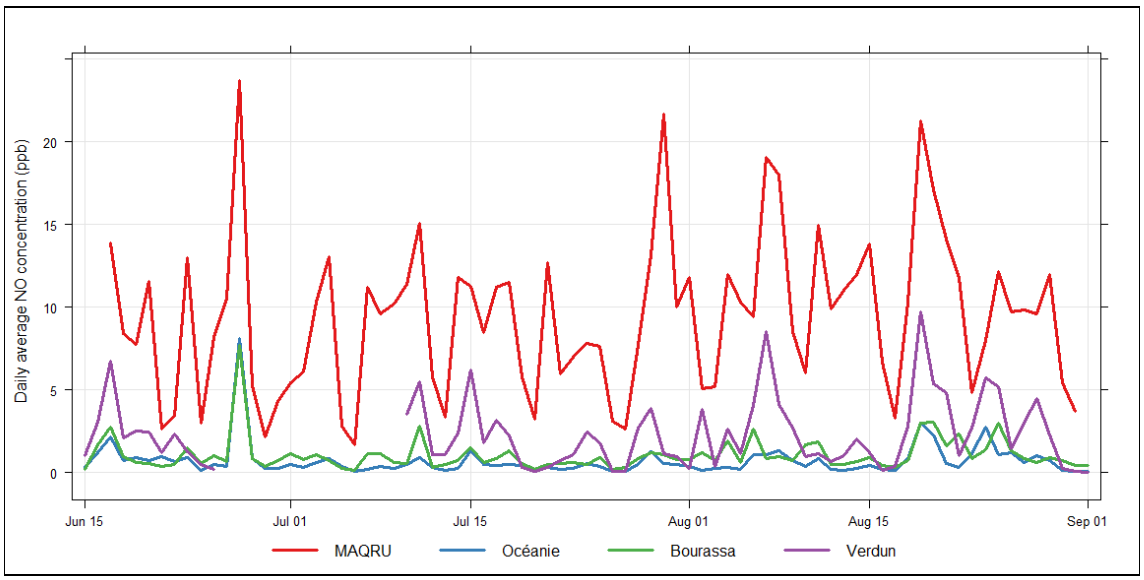


Figure 6 – Evolution in average daily NO concentrations from June 15 to August 31, 2014



Based on Table 4, it is important to note that, for the period of June 15 to August 31, 2014, there were no days when the hourly NO concentrations reached the MUC reference level of 1,000 ppb. The highest level, recorded at the MAQRU, was 97.5 ppb, well below the reference level.

Nitrogen Dioxide (NO_2)

Based on Table 5 and figures 7, 8 and 9, the same comments as above for NO can be made for NO_2 in terms of relative concentrations recorded at the MAQRU compared to the surrounding stations and in terms of the daily and weekly variations in concentrations.

Similarly, the table and charts presented here reveal that there were no days when the NO_2 concentrations at the MAQRU reached or even came close to the hourly or daily reference values of the MUC or CAR, the highest reading being approximately 40 ppb and 28 ppb respectively. Lastly, the four stations recorded a maximum at the same time on June 27, 2014.

Table 5 – Statistical summary of the hourly readings of ambient NO_2 concentrations (in ppb) from June 15 to August 31, 2014

NO_2	MAQRU	Parc Océanie	Bourassa	Verdun
Data availability	92.3%	97.2%	99.8%	79.5%
Minimum	0.8	0.4	0.9	0
Maximum	41.7	31	39.6	34.6
Average	11.5	4.4	5.9	7.7
Median	10.4	3.3	4.3	5.9
Standard deviation	5.4	3.4	4.7	5.5

Figure 7 – Breakdown of the hourly readings of ambient NO_2 concentrations from June 15 to August 31, 2014

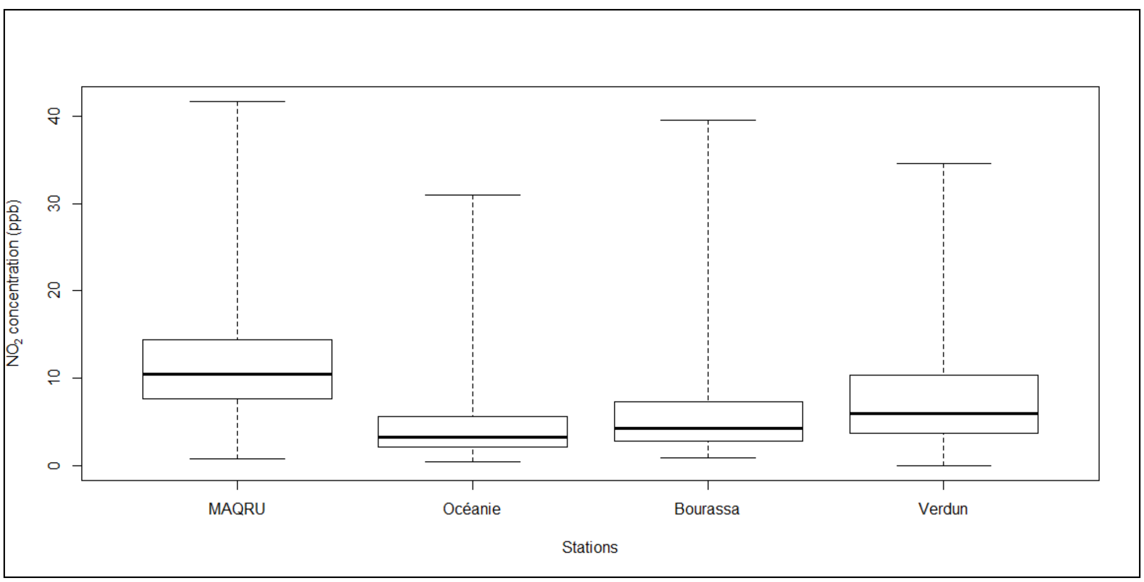


Figure 8 – Diurnal and weekly trends based on hourly readings of ambient NO_2 concentrations from June 15 to August 31, 2014

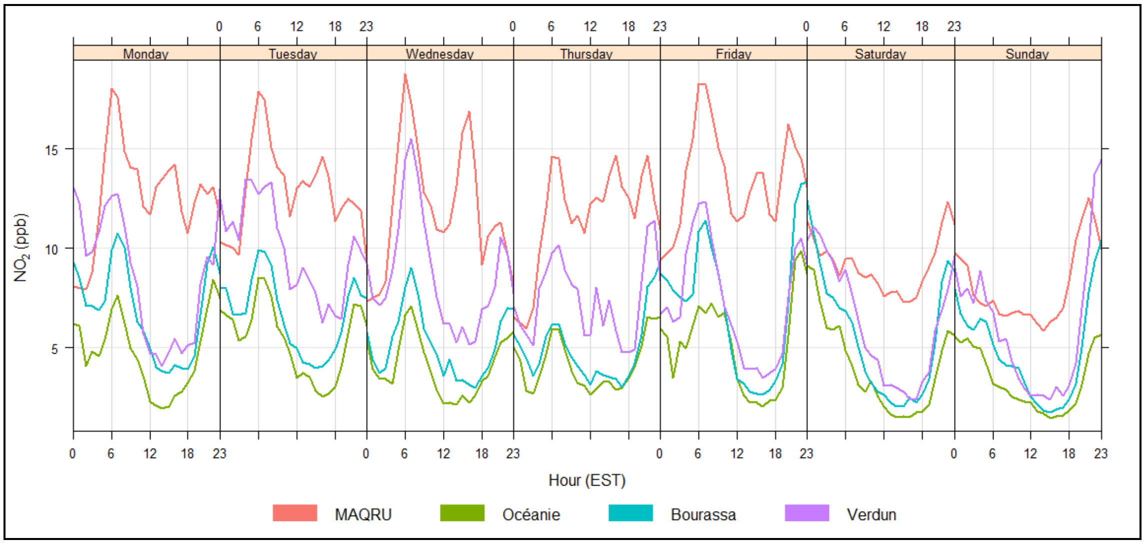
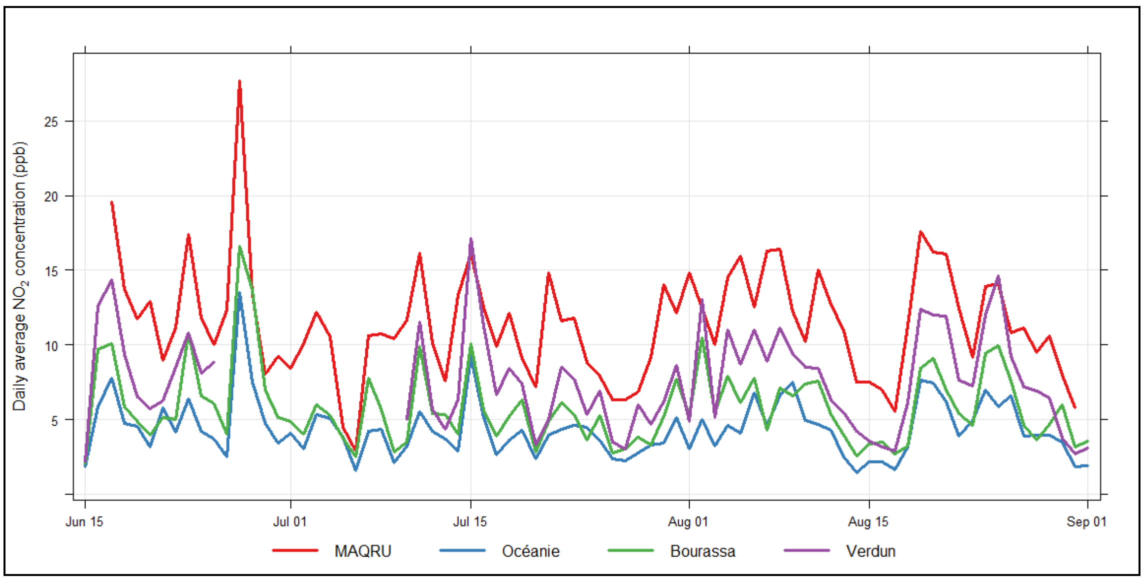


Figure 9 – Evolution in average daily NO_2 concentrations from June 15 to August 31, 2014



Tropospheric Ozone (O_3)

Tropospheric ozone is a colourless and extremely irritating gas that forms in the layer adjacent to the Earth's surface. It is called a "secondary" pollutant because it is created when two primary pollutants react to solar radiation. The two primary pollutants are nitrogen oxides (NO_x) and volatile organic compounds (VOCs). NO_x and VOCs are the product of natural sources or human activity. Approximately 95% of NO_x stemming from human activity are attributable to the burning of coal, gasoline and oil from motor vehicles, homes, industry and power plants. VOCs from human activity come mainly from gasoline combustion and marketing, upstream oil and gas production, residential wood heating and the evaporation of liquid fuels and solvents.

Table 6 – Statistical summary of hourly readings of ambient O_3 concentrations (in ppb) from June 15 to August 31, 2014

O_3	MAQRU	Parc Océanie	Bourassa	Verdun
Data Availability	93.2%	99.5%	99.7%	80.3%
Minimum	0	0.1	0.9	1.2
Maximum	53.9	62.5	59.7	55.7
Average	23	26.2	25.5	23.3
Median	22.2	25.7	24.8	22.6
Standard deviation	11.1	12.5	12.6	11.8

Figure 10 – Breakdown in hourly readings of ambient O_3 concentrations from June 15 to August 31, 2014

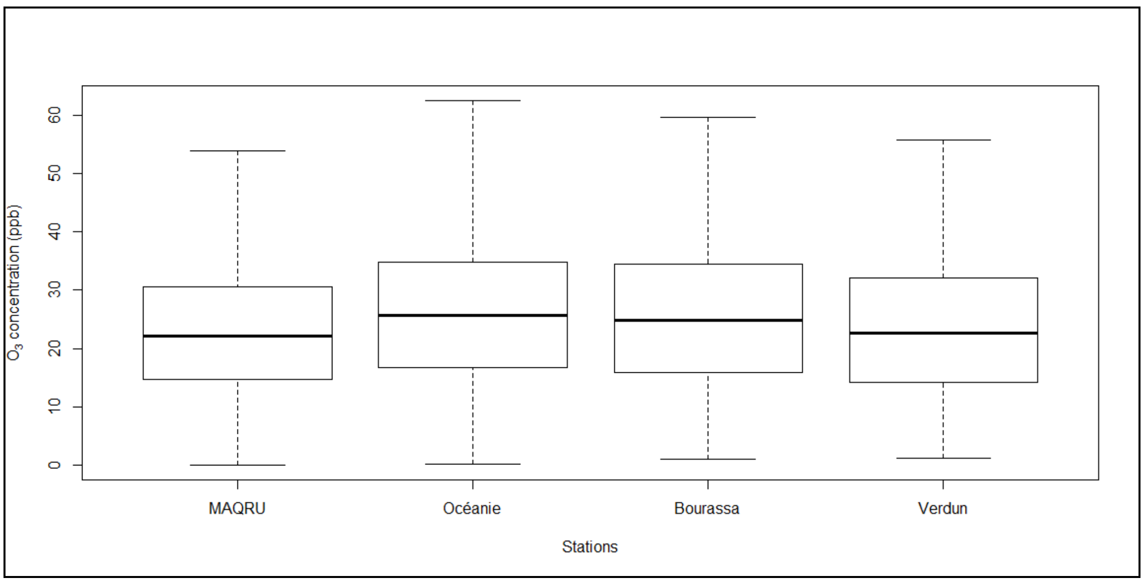


Table 6 and figures 10 and 11 reveal that ozone concentrations are similar from one station to another, ozone being more regional than local in nature. The ozone's diurnal cycle, with maximum production in the afternoon and minimums during the night, is also well represented at all stations. The fact that concentrations measured at the MAQRU are systematically slightly lower than the others is due to ozone titration by the NO from road traffic.

Figure 11 – Diurnal and weekly trends based on hourly readings of ambient O_3 concentrations from June 15 to August 31, 2014

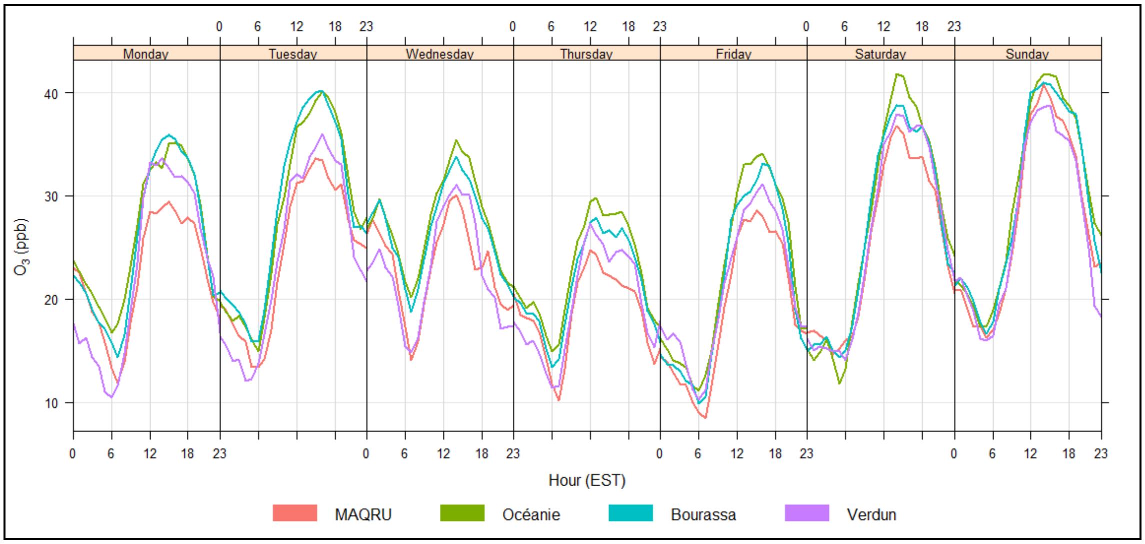
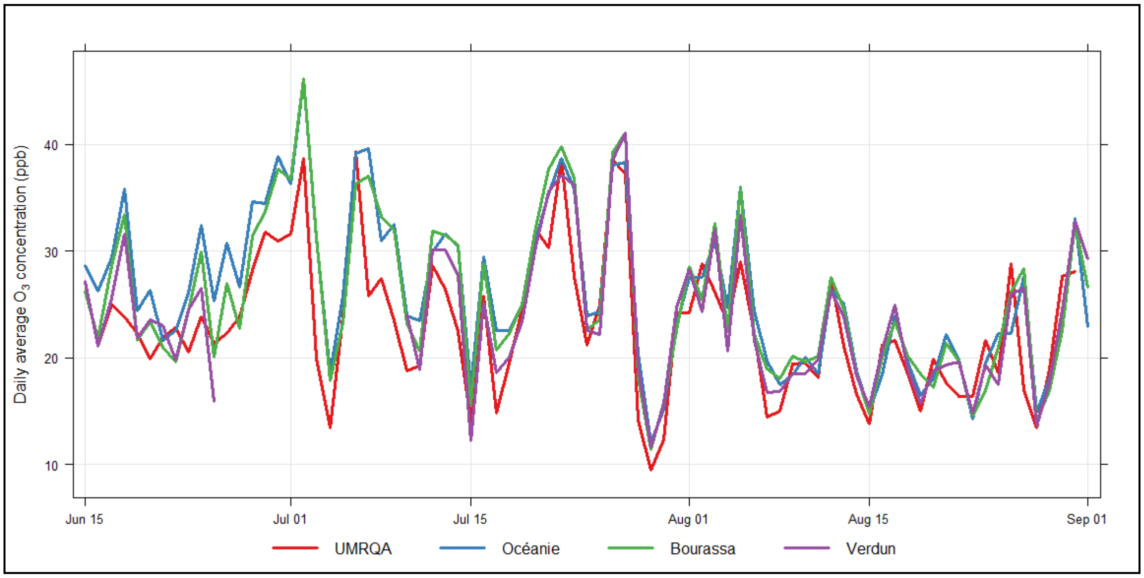


Figure 12 – Evolution in average daily O_3 concentrations from June 15 to August 31, 2014



As Table 6 shows, there were no days, during the period of June 15 to August 31, 2014, when the hourly concentrations of O_3 reached the MUC or CAR reference values of 82 ppb. The highest hourly values were in the area of 50-60 ppb.

However, the MUC reference values in terms of indicators calculated over 8 hours (38 ppb) and 24 hours (25 ppb) were exceeded several times. The CAR reference value of 65 ppb over 8 hours was never reached.

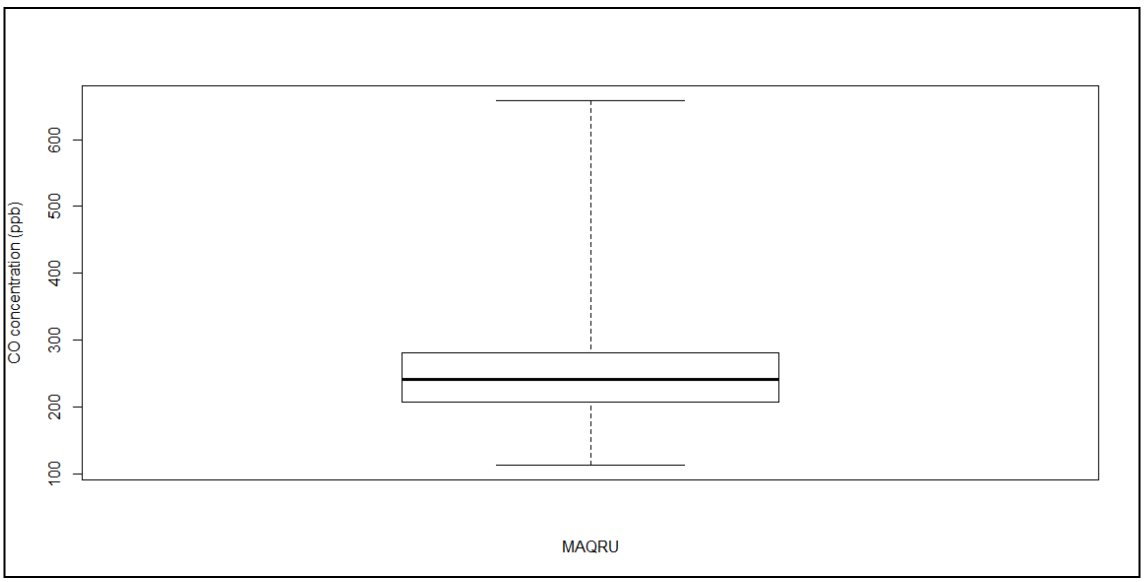
Carbon Monoxide (CO)

Carbon monoxide (CO) is a colourless, odourless, tasteless and toxic gas. Created from the incomplete combustion of hydrocarbon-based fuels, it is released directly through the exhaust pipes of vehicles. The forestry industry, residential wood heating and forest fires are other less significant although non-negligible sources.

Table 7 – Statistical summary of hourly readings of ambient CO concentrations (in ppb) from June 15 to August 31, 2014

CO	MAQRU
Data availability	92.8%
Minimum	113.3
Maximum	658.2
Average	251.5
Median	241.8
Standard deviation	65.4

Figure 13 – Distribution of hourly readings of ambient CO concentrations from June 15 to August 31, 2014



Although nothing specific can be drawn at this preliminary stage from Table 7 and Figure 13, Figure 14 shows a variation in CO concentrations that seems to correspond to the intensity of road traffic; a maximum concentration in the morning, another in the afternoon and a last one in the evening have been observed.

Figure 14 – Diurnal and weekly trends based on hourly readings of ambient CO concentrations from June 15 to August 31, 2014

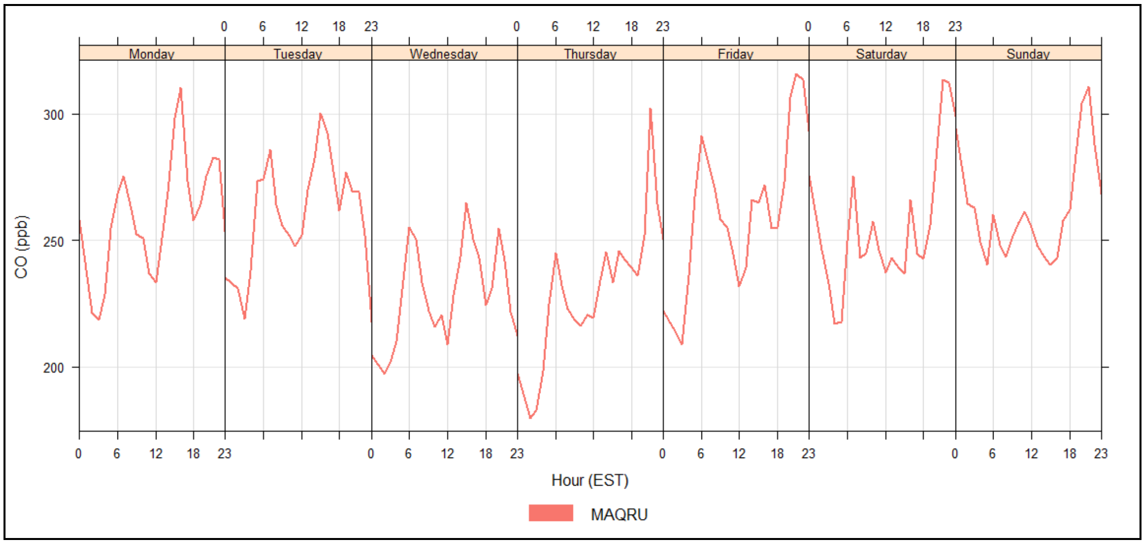
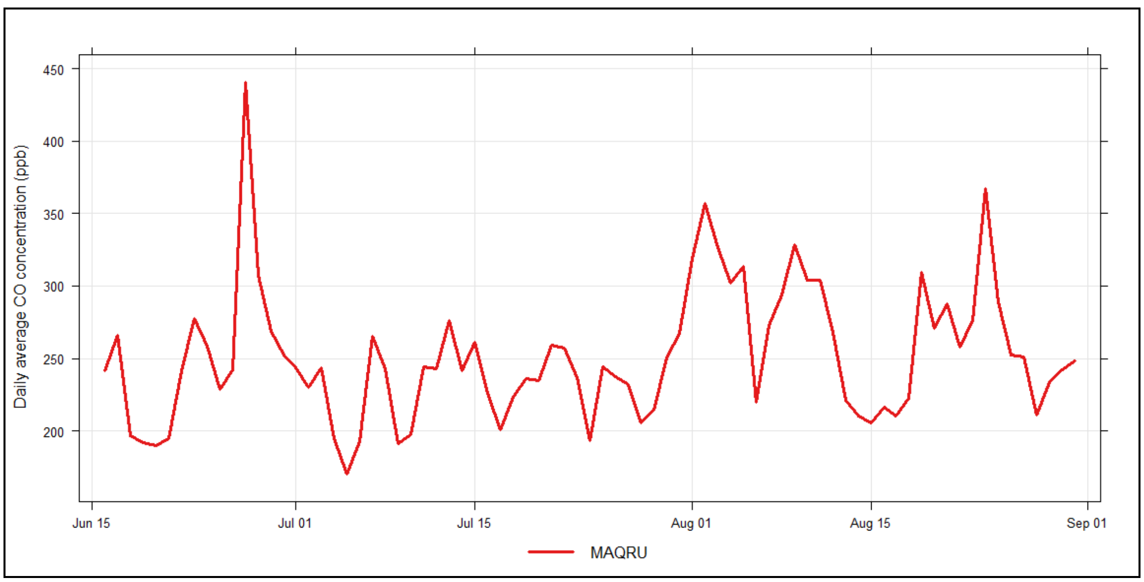


Figure 15 – Evolution in average daily CO concentrations from June 15 to August 31, 2014



According to Table 7 and again covering the period of June 15 to August 31, 2014, there were no days when the hourly concentrations of CO reached or even came close to the MUC or CAR reference value of 30 ppm. The maximum value recorded was 658 ppb (or 0.66 ppm). The scenario is therefore the same for average concentrations over 8 hours compared to the MUC and CAR reference values, which are 13 and 11 ppm respectively.

Sulphur Dioxide (SO_2)

Sulfur dioxide belongs to the family of sulfur dioxide gases (SO_x). It is created during the combustion and refining processes from the sulphur contained in raw materials such as coal, oil and minerals containing metals. When it dissolves in atmospheric water vapour, SO_2 produces acids and interacts with particles and gases present in the air to form particles known as sulfates and other compounds that can be toxic to people and the environment.

Table 8 – Statistical summary of the hourly readings of ambient SO_2 concentrations (in ppb) from June 15 to August 31, 2014

SO2	MAQRU
Data availability	51.3%
Minimum	0
Maximum	15.7
Average	0.8
Median	0.4
Standard deviation	1.3

As can be seen in Table 8 and figures 16, 17 and 18, the values of the SO_2 concentrations recorded at the MAQRU are very low in relation to established reference values.

Figure 16 – Breakdown of hourly readings of ambient SO_2 concentrations from June 15 to August 31, 2014

Figure 17 – Diurnal and weekly trends based on hourly readings of ambient SO_2 concentrations from June 15 to August 31, 2014

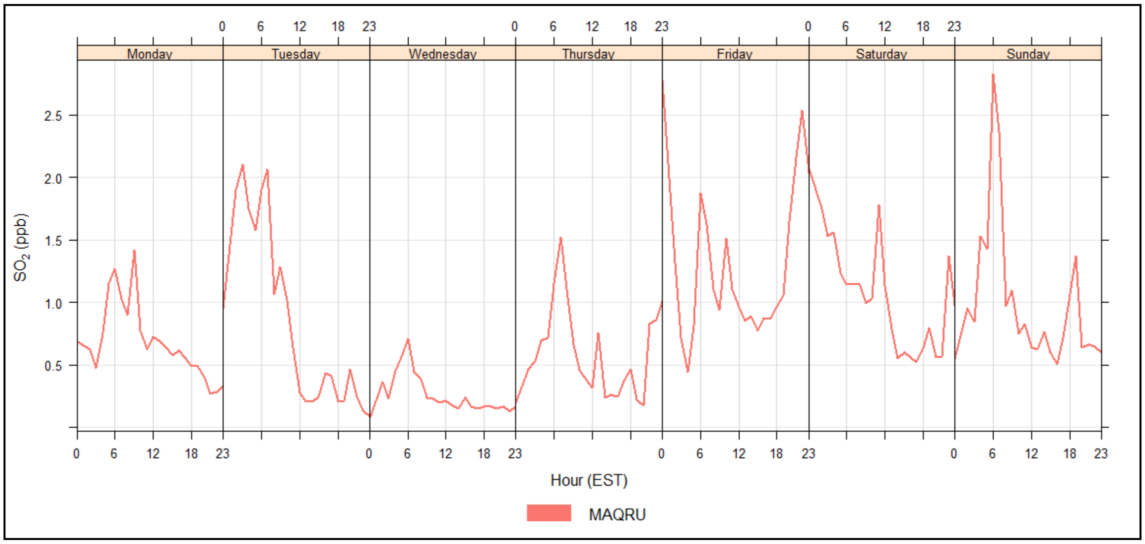
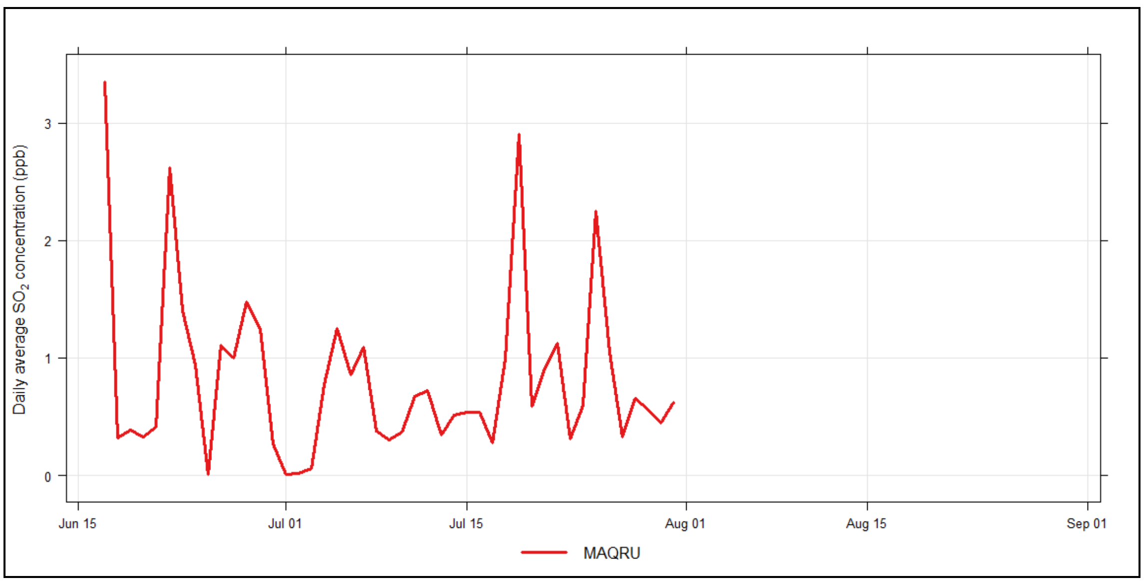


Figure 18 – Evolution in average daily concentrations of SO_2 from June 15 to August 31, 2014



For the period of June 15 to August 1, 2014, there were no days when the average daily concentrations of SO_2 reached the MUC reference value of 110 ppb or the CAR's reference value of 100 ppb. The MUC reference value of 500 ppb for an hourly concentration was never reached and the maximum recorded was barely 16 ppb.

Particulate Matter ($PM_{2.5}$ and PM_{Tot})

Particles are airborne fragments. Depending on the compounds and processes resulting in their formation, they are categorized as either primary particles or secondary particles. The first are released at the source of the emissions in the form of particles caused for example by combustion in motor vehicles or by wear on breaks and tires. The passage of vehicles can also make dust on road surfaces airborne again. The second type is the result of a series of chemical reactions involving various precursor gases such as sulfur dioxides, nitrogen oxides and ammonia, which react with one another to form sulfate, nitrate and ammonium particles.

In large part, particle size determines the scope of the damage these particles can cause to human health and the environment.

- Total particulate matter (PM_{Tot}): atmospheric particles with a maximum diameter of approximately 100 micrometres;
- Fine particulate matter ($PM_{2.5}$): atmospheric particles with a diameter of less than 2.5 micrometres.

Fine Particulate Matter ($PM_{2.5}$)

Table 9 – Statistical summary of the hourly concentration readings of $PM_{2.5}$ (ug/m^3) from June 15 to August 31, 2014

$PM_{2.5}$	MAQRU	Parc Océanie	Bourassa
Data availability	96.8%	99.3%	99.6%
Minimum	1.4	0	0
Maximum	136.6	38	41
Average	15.3	8.7	10.2
Median	14.2	8	9
Standard deviation	8.3	5.4	5.9

Table 9 and figures 19, 20 and 21 show that the concentrations of $PM_{2.5}$ measured at the Champlain Bridge are higher than those at the Longueuil and Brossard stations, with concentration maximums that are also much higher. According to Figure 20, there does not seem to be any clear trend in the weekly evolution of hourly concentrations. A more detailed analysis would make it possible to find out more about the role played by weather conditions on these results, which extend only over a short period of the year.

Figure 19 – Breakdown of the hourly readings in ambient concentrations of $PM_{2.5}$ from June 15 to August 31, 2014

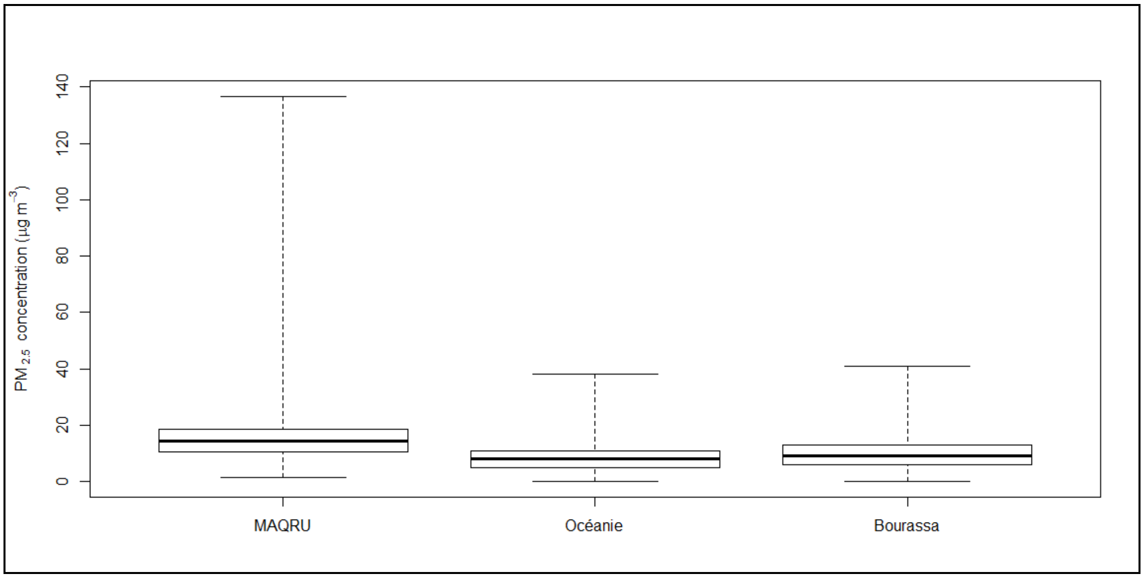
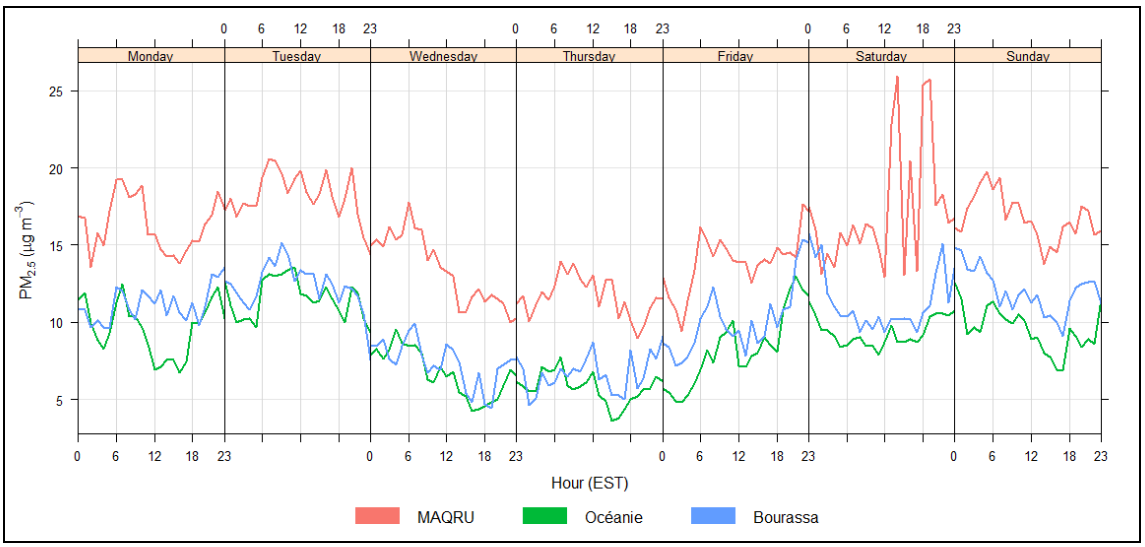
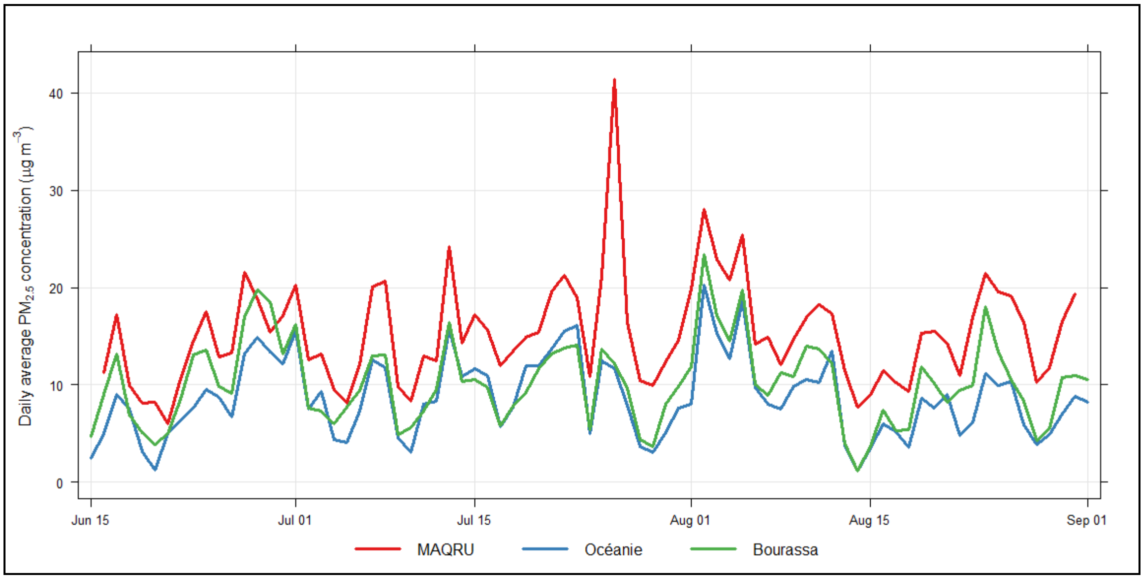


Figure 20 – Diurnal and weekly trends based on hourly readings of ambient concentrations of $PM_{2.5}$ from June 15 to August 31, 2014



For the period of June 15 to August 31, 2014, there was only a single day, Saturday, July 26, 2014, when the daily average concentrations reached the CAR reference value of 30 ug/m^3. It should be noted that all concentrations higher than 40 ug/m^3 were recorded on that day. This only occurred at the MAQRU, due to a local phenomenon in all likelihood, whereas the hourly concentrations of fine particulates exceeded the bar of 100 ug/m^3 in the afternoon and evening.

Figure 21 – Evolution in average daily concentrations of $PM_{2.5}$ from June 15 to August 31, 2014



Total Particulate Matter (PM_{Tot})

Table 10 and figures 23, 24 and 25 show that the concentrations of PM_{Tot} at the Champlain Bridge are higher during weekdays than on weekends. The maximum concentrations seen in the mornings seem also to appear in Figure 23 for weekdays.

An average daily concentration of 90 ug/m^3 for June 27, 2014 was the highest value recorded during the period of June 15 to August 31, 2014. However, this was well below the CAR and MUC reference values of 120 ug/m^3 and 150 ug/m^3 respectively. It is interesting to note that the peaks in nitrogen oxide concentrations (road traffic indicators) and carbon monoxide were also observed on June 27, 2014 (see figures 6, 9 and 15), which strongly suggests that airborne particles at the time were mostly composed of road dust.

Table 10 – Statistical summary of the hourly readings of ambient concentrations of PM_{Tot} (ug/m^3) from June 15 to August 31, 2014

PM_{Tot}	MAQRU
Data availability	91.1%
Minimum	4.3
Maximum	236.5
Average	42.7
Median	39.9
Standard deviation	21.6

Figure 22 – Breakdown of hourly readings of ambient concentrations of PM_{Tot} from June 15 to August 31, 2014

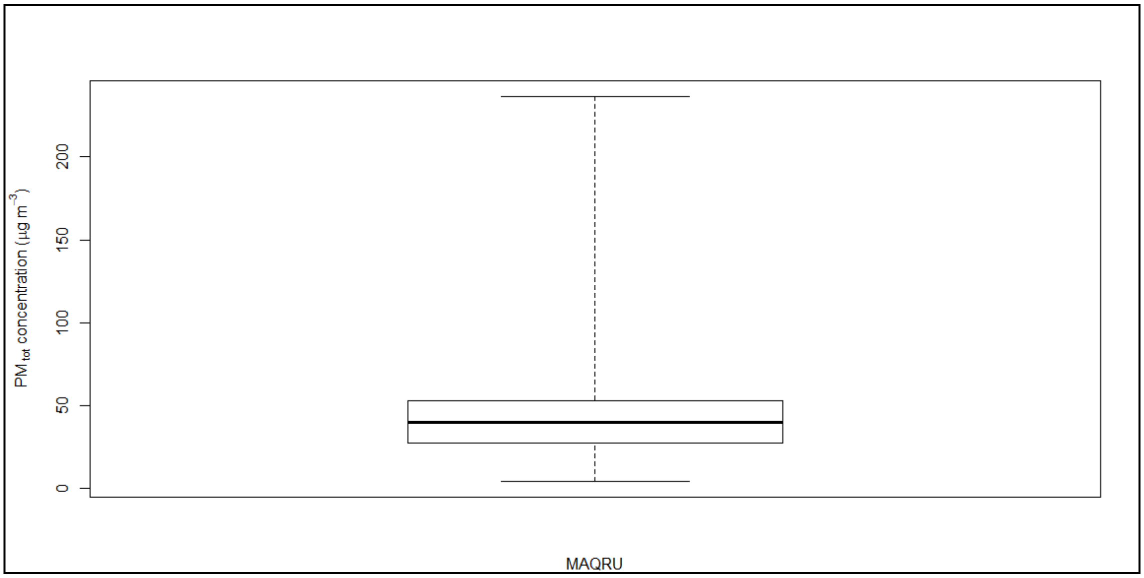


Figure 23 – Diurnal and weekly trends based on hourly readings of ambient concentrations of PM_{Tot} from June 15 to August 31, 2014

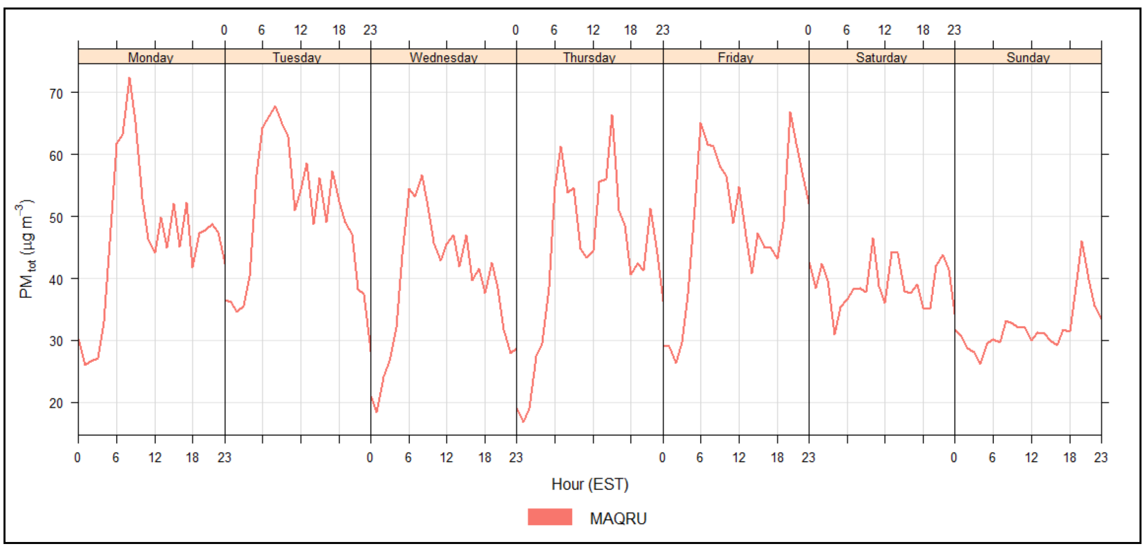
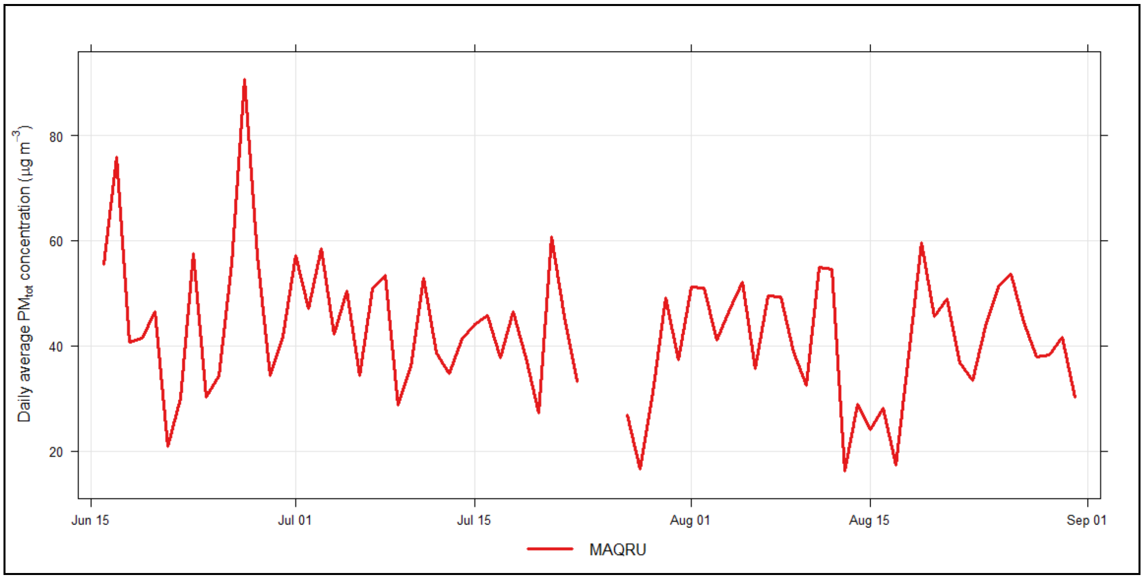


Figure 24 – Evolution in average daily concentrations of PM_{Tot} from June 15 to August 31, 2014



Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs) are gases and vapours that contain carbon, such as gasoline vapours and solvents (with the exception of carbon dioxide, carbon monoxide, methane and chlorofluorocarbons). Although several thousand organic compounds present in the natural and polluted troposphere correspond to the definition of VOC, most monitoring programs focus on the 50 to 150 most common hydrocarbons. The concentrations available from the various volatile organic compounds (VOCs) measured at the MAQRU are listed in Appendix A.

WEATHER DATA

The wind data recorded between July 1 and August 31, 2014 at the MAQRU, at the Pierre-Elliott-Trudeau Airport in Montréal (Dorval) and at the St-Hubert Airport are listed here in the form of a table of wind frequency by direction (Table 11) and wind roses (figures 25, 26 et 27). This comparison between stations where wind is measured provides a first glimpse into wind behaviour at the MAQRU station on Nuns' Island to find out which airport's wind regime it most closely matches.

Table 11 – Frequency of wind direction as a percentage for the period of July 1 to August 31, 2014 based on hourly winds

Direction	MAQRU	Dorval	St-Hubert
North	1	2	4
North-Northeast	4	3	3
Northeast	3	2	3
East-Northeast	3	1	2
East	3	3	1
East-Southeast	3	2	2
Southeast	7	7	4
South-Southeast	7	7	7
South	8	6	13
South-Southwest	12	11	9
Southwest	18	17	18
West-Southwest	17	17	14
West	5	8	5
West-Northwest	3	7	3
Northwest	3	5	5
North-Northwest	2	3	5
Calm wind	1	1	4

Generally speaking, wind direction seems to be similar from one location to the next. Southerly winds at the St-Hubert Airport seem to occur more frequently than at the Dorval Airport or at Nuns' Island (difference of approximately 5%). It should be noted that only wind readings from June and July 2014 were used here. A more complete analysis, after an entire year of running the MAQRU instruments, would make it possible to correlate with more certainty the wind conditions at Nuns' Island with one of the airports.

Figure 25 – Wind Rose for Dorval (July-August 2014)

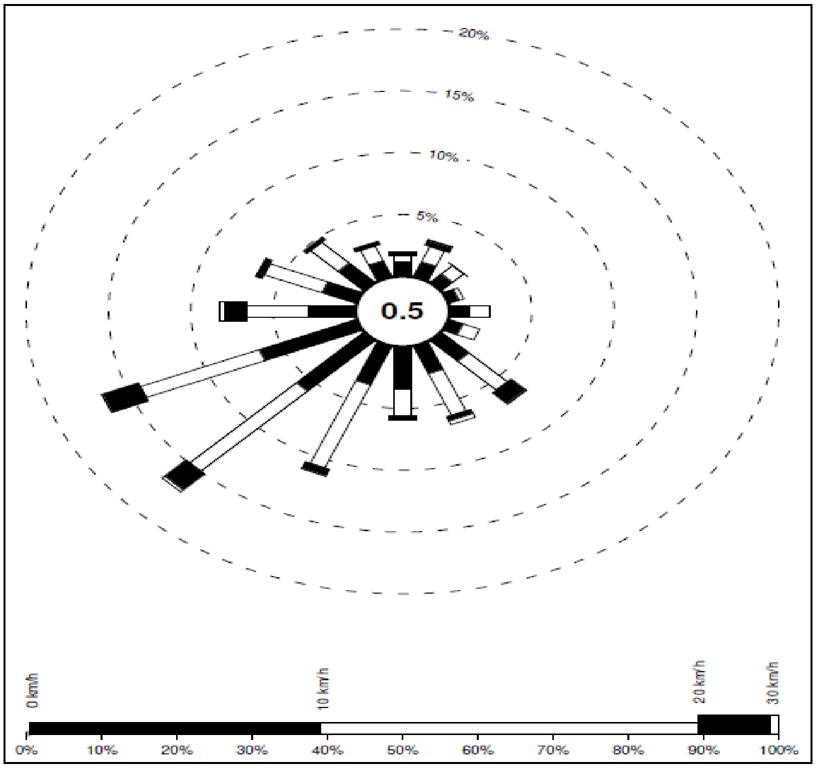


Figure 26 – Wind Rose for St-Hubert (July-August 2014)

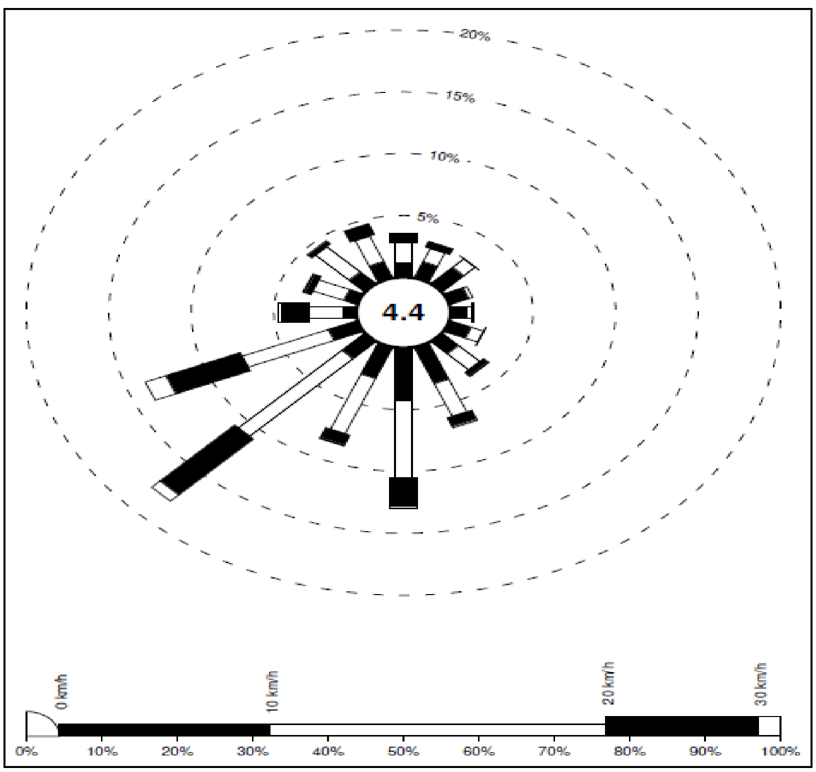
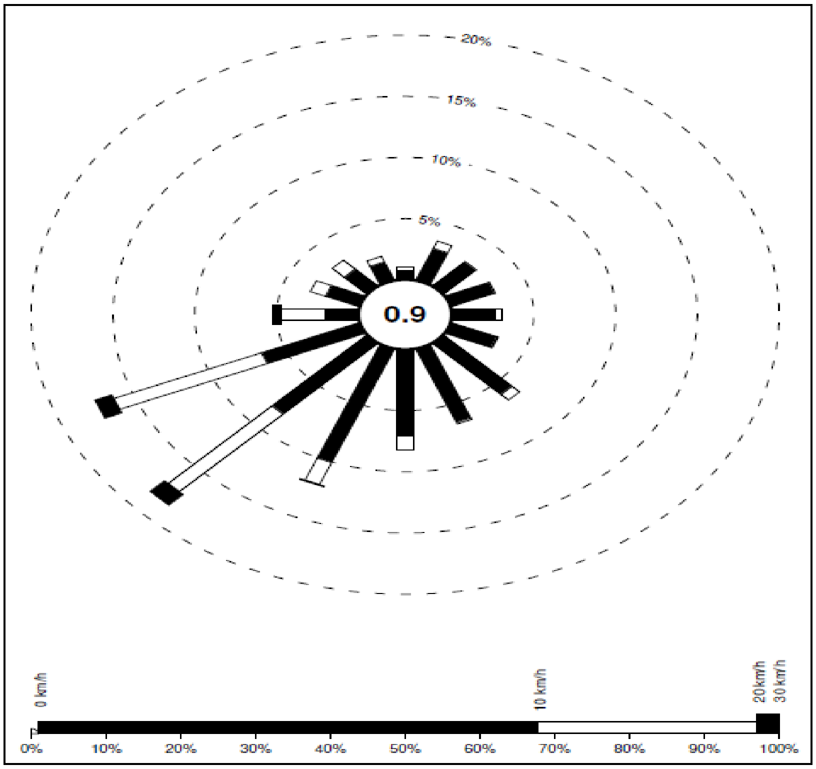


Figure 27 – Wind Rose for MAQRU (July-August 2014)



CONCLUSION

The concentrations of several atmospheric contaminants at Nuns' Island, at the heart of the Champlain Bridge corridor, have been measured at the MAQRU since mid-June 2014 as part of a monitoring program run by Infrastructure Canada.

The preliminary analysis of the MAQRU data, combined with readings taken at three other sampling stations on the South Shore and on Island of Montréal, has allowed us to conclude the following:

- The concentrations and maximums for several pollutants measured at MAQRU are higher than those recorded at the surrounding stations. The Verdun station is the one that comes nearest to what was measured at MAQRU, due to its location near Highway 15, which is an extension of Highway 10 from the Champlain Bridge.
- There seems to be a diurnal and weekly trend in the concentrations of certain pollutants over the period considered with a road traffic signature.
- The concentrations and the diurnal variation of ozone seem similar at the four stations, revealing a more regional nature of this pollutant rather than a local one.

- The concentrations of NO, NO_2, CO, SO_2, $PM_{2.5}$ and PM_{Tot} recorded at the MAQRU did not exceed the CAR and MUC reference values used in this preliminary report, with the exception of particle concentrations during one day that were probably connected with a one-off local event.
- The ozone concentrations recorded at the MAQRU did not exceed the 1-hour CAR and MUC reference values. However, the MUC 8-hour and 24-hour reference values were exceeded at that station.

Over the next few months, it will be possible to clarify with greater accuracy what has been observed to date at the MAQRU.

ACKNOWLEDGEMENTS

We want to thank Quebec's Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques and the City of Montréal for sharing the data on the atmospheric pollutant concentrations measured at their respective stations.

Appendix A

Concentrations of volatile organic compounds sampled at MAQRU, on Nuns' Island, between June 16 and July 22, 2014

Volatile Organic Compound	Concentration of Averages over 24 Hours (ug/m3)						
	Jun16	Jun 22	Jun 28	Jul 4	Jul 10	Jul 16	Jul 22
Ethylene	0.93	1.05	1.13	0.74	0.74	0.58	0.61
Acetylene	0.38	0.48	0.57	0.27	0.35	0.28	0.36
Ethane	2.06	2.30	1.98	1.57	1.29	1.71	3.06
Freon 134A	1.24	1.12	0.98	0.67	0.49	0.55	0.74
Propene	0.37	0.39	0.39	0.29	0.25	0.19	0.26
Propane	1.66	2.35	2.69	1.15	0.86	1.35	2.00
Freon 22 (Chlorodifluoromethane)	1.50	5.87	1.44	1.94	0.88	1.63	2.22
Freon 12 (Dichlorodifluoromethane)	3.19	3.11	2.78	2.86	2.68	2.70	2.92
Propyne	0.05	0.06	0.07	0.03	0.04	0.03	0.04
Chloromethane	1.48	1.44	1.32	1.38	1.22	1.21	1.37
Isobutane (2-Methylpropane)	1.49	2.14	0.59	0.48	0.29	0.74	0.47
Freon 114 (1,2-Dichlorotetrafluoroethane)	0.15	0.14	0.13	0.13	0.13	0.13	0.13
Vinylchloride (Chloroethene)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Butene/2-Methylpropene	0.26	0.33	0.30	0.21	0.19	0.18	0.18
1,3-Butadiene	0.07	0.08	0.09	0.05	0.05	0.04	0.04
Butane	1.25	2.23	0.97	0.67	0.48	0.67	0.89
t-2-Butene	0.05	0.06	0.04	0.03	0.03	0.02	0.03
2,2-Dimethylpropane	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Bromomethane	0.07	0.07	0.06	0.17	0.07	0.21	0.08
1-Butyne	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c-2-Butene	0.05	0.07	0.04	0.03	0.02	0.02	0.02
Chloroethane	0.02	0.02	0.02	0.01	0.01	0.01	0.02
3-Methyl-1-Butene	0.05	0.06	0.04	0.03	0.03	0.02	0.03
2-Methylbutane	2.52	4.36	1.98	1.29	1.12	1.27	1.44
Freon 11 (Trichlorofluoromethane)	1.81	1.76	1.63	1.55	1.47	1.51	1.60
1-Pentene	0.09	0.10	0.08	0.06	0.05	0.05	0.06
2-Methyl-1-Butene	0.16	0.18	0.13	0.09	0.09	0.08	0.09
Pentane	1.01	1.37	0.89	0.84	0.57	0.45	0.62
Isoprene (2-Methyl-1,3-Butadiene)	0.66	0.53	0.82	0.77	0.45	0.48	1.68
t-2-Pentene	0.14	0.15	0.12	0.09	0.09	0.08	0.10
Ethylbromide	0.00	0.00	0.00	0.01	0.00	0.00	0.00
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c-2-Pentene	0.07	0.08	0.06	0.05	0.05	0.04	0.04
Dichloromethane	0.57	0.55	0.47	0.48	0.46	0.43	0.50
2-Methyl-2-Butene	0.14	0.13	0.15	0.11	0.11	0.10	0.12
Freon 113 (1,1,2-Trichlorotrifluoroethane)	0.77	0.74	0.65	0.66	0.65	0.67	0.70
2,2-Dimethylbutane	0.08	0.10	0.08	0.06	0.05	0.05	0.06
Cyclopentene	0.02	0.01	0.02	0.01	0.01	0.01	0.01
t-1,2-Dichloroethene	0.07	0.11	0.04	0.06	0.02	0.02	0.02
4-Methyl-1-Pentene	0.01	0.01	0.00	0.00	0.00	0.00	0.00
3-Methyl-1-Pentene	0.01	0.01	0.01	0.01	0.01	0.00	0.01
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Volatile Organic Compound	Concentration of the Averages over 24 Hours (ug/m3)						
	Jun16	Jun 22	Jun 28	Jul 4	Jul 10	Jul 16	Jul 22
Cyclopentane	0.16	0.21	0.16	0.12	0.08	0.06	0.09
2,3-Dimethylbutane	0.16	0.20	0.15	0.10	0.09	0.07	0.09
t-4-Methyl-2-Pentene	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Methyl-t-Butyl Ether (MTBE)	-	-	0.00	0.00	0.00	-	-
2-Methylpentane	0.63	0.85	0.55	0.34	0.32	0.27	0.35
c-4-Methyl-2-Pentene	0.02	0.02	0.02	0.01	0.01	0.01	0.01
3-Methylpentane	0.43	0.48	0.35	0.23	0.22	0.20	0.25
1-Hexene/2-Methyl-1-Pentene	0.06	0.07	0.06	0.05	0.04	0.04	0.05
c-1,2-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexane	0.57	0.43	0.37	0.26	0.23	0.22	0.28
Chloroform	0.26	0.36	0.45	0.16	0.14	0.14	0.19
t-2-Hexene	0.03	0.03	0.03	0.03	0.02	0.01	0.02
2-Ethyl-1-Butene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t-3-Methyl-2-Pentene	0.00	0.00	0.02	0.00	0.02	0.00	0.02
c-2-Hexene	0.02	0.02	0.01	0.01	0.01	0.01	0.01
c-3-Methyl-2-Pentene	0.03	0.02	0.03	0.03	0.03	0.02	0.03
2,2-Dimethylpentane	0.03	0.02	0.02	0.01	0.01	0.01	0.01
1,2-Dichloroethane	0.09	0.08	0.07	0.07	0.06	0.05	0.05
Methylcyclopentane	0.37	0.37	0.32	0.20	0.18	0.15	0.19
2,4-Dimethylpentane	0.12	0.12	0.10	0.07	0.07	0.05	0.06
1,1,1-Trichloroethane	0.03	0.03	0.02	0.02	0.03	0.02	0.03
2,2,3-Trimethylbutane	0.02	0.01	0.01	0.01	0.01	0.01	0.01
1-Methylcyclopentene	0.02	0.01	0.02	0.02	0.02	0.01	0.01
Benzene	0.63	0.79	0.82	0.38	0.36	0.42	0.47
Carbontretrachloride	0.62	0.60	0.45	0.46	0.49	0.52	0.55
Cyclohexane	0.33	0.18	0.13	0.10	0.11	0.07	0.09
2-Methylhexane	0.65	0.44	0.32	0.25	0.22	0.18	0.22
2,3-Dimethylpentane	0.25	0.23	0.18	0.14	0.13	0.10	0.12
Cyclohexene	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3-Methylhexane	0.68	0.52	0.37	0.31	0.26	0.21	0.25
Dibromomethane	0.03	0.03	0.03	0.03	0.03	0.03	0.03
1,2-Dichloropropane	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Bromodichloromethane	0.00	0.03	0.03	0.00	0.01	0.01	0.01
1-Heptene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichloroethene	0.10	0.05	0.03	0.11	0.03	0.02	0.03
2,2,4-Trimethylpentane	0.32	0.47	0.42	0.24	0.24	0.17	0.21
t-3-Heptene	0.01	0.00	0.00	0.01	0.01	0.00	0.01
Heptane	1.01	0.41	0.28	0.23	0.18	0.14	0.19
c-3-Heptene	0.00	0.00	0.03	0.00	0.00	0.00	0.00
t-2-Heptene	0.01	0.01	0.01	0.01	0.01	0.00	0.01
c-2-Heptene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c-1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,2-Dimethylhexane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methylcyclohexane	0.89	0.27	0.19	0.15	0.12	0.09	0.28
2,5-Dimethylhexane	0.09	0.06	0.06	0.04	0.03	0.03	0.06
2,4-Dimethylhexane	0.11	0.08	0.07	0.05	0.04	0.03	0.07
t-1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Bromotrichloromethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Volatile Organic Compound	Concentration of the Averages over 24 Hours (ug/m3)						
	Jun16	Jun 22	Jun 28	Jul 4	Jul 10	Jul 16	Jul 22
2,3,4-Trimethylpentane	0.10	0.13	0.12	0.07	0.07	0.05	0.07
Toluene	2.52	3.73	2.68	1.78	1.79	1.50	3.58
2-Methylheptane	0.37	0.16	0.11	0.09	0.08	0.06	0.38
4-Methylheptane	0.12	0.05	0.04	0.03	0.02	0.02	0.12
1-Methylcyclohexene	0.01	0.00	0.00	0.00	0.00	0.00	0.00
3-Methylheptane	0.31	0.13	0.10	0.07	0.06	0.05	0.31
Dibromochloromethane	0.01	0.01	0.01	0.00	0.00	0.00	0.01
c-1,3-Dimethylcyclohexane	0.41	0.19	0.08	0.07	0.05	0.04	0.87
t-1,4-Dimethylcyclohexane	0.14	0.05	0.03	0.02	0.02	0.01	0.26
2,2,5-Trimethylhexane	0.03	0.04	0.04	0.02	0.02	0.01	0.02
1,2-Dibromoethane (EDB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Octene	0.12	0.07	0.05	0.05	0.04	0.03	0.04
Octane	0.81	0.25	0.15	0.13	0.11	0.08	0.61
t-2-Octene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t-1,2-Dimethylcyclohexane	0.21	0.11	0.04	0.04	0.03	0.02	0.46
Tetrachloroethene	0.13	0.19	0.19	0.21	0.18	0.38	0.35
c-1,4/t-1,3-Dimethylcyclohexane	0.09	0.06	0.03	0.03	0.02	0.01	0.33
c-1,2-Dimethylcyclohexane	0.04	0.04	0.02	0.02	0.01	0.01	0.13
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylbenzene	0.38	1.45	0.43	0.27	0.24	0.19	0.28
m,p-Xylene	1.47	6.01	1.39	1.33	0.77	0.58	0.87
Bromoform	0.02	0.02	0.01	0.01	0.01	0.01	0.01
1,4-Dichlorobutane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Styrene	0.07	0.12	1.25	0.14	0.11	0.11	0.10
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Nonene	0.00	0.00	0.06	0.00	0.02	0.03	0.00
o-Xylene	0.47	1.48	0.54	0.34	0.29	0.23	0.29
Nonane	0.49	0.25	0.16	0.19	0.13	0.08	0.45
iso-Propylbenzene	0.03	0.03	0.02	0.02	0.02	0.01	0.02
a-Pinene	0.13	0.22	0.19	0.17	0.07	0.07	0.13
3,6-Dimethyloctane	0.02	0.02	0.01	0.02	0.01	0.01	0.02
n-Propylbenzene	0.07	0.07	0.07	0.05	0.04	0.04	0.05
3-Ethyltoluene	0.18	0.19	0.21	0.13	0.13	0.10	0.12
Camphene	0.15	0.06	0.06	0.18	0.04	0.02	0.04
4-Ethyltoluene	0.10	0.11	0.12	0.07	0.07	0.05	0.06
1,3,5-Trimethylbenzene	0.10	0.09	0.11	0.07	0.06	0.06	0.07
2-Ethyltoluene	0.08	0.09	0.09	0.06	0.05	0.04	0.05
b-Pinene	0.23	0.10	0.10	0.27	0.07	0.03	0.10
1-Decene	0.00	0.01	0.01	0.01	0.01	0.01	0.01
tert-Butylbenzene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2,4-Trimethylbenzene	0.32	0.34	0.39	0.26	0.22	0.18	0.21
Decane	0.26	0.23	0.22	0.27	0.16	0.11	0.13
Benzyl Chloride	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,3-Dichlorobenzene	0.00	0.00	0.00	0.00	0.01	0.00	0.00
1,4-Dichlorobenzene	0.10	0.12	0.16	0.06	0.05	0.05	0.06
iso-Butylbenzene	0.01	0.01	0.01	0.01	0.00	0.00	0.00
sec-Butylbenzene	0.01	0.01	0.01	0.01	0.01	0.00	0.01

Volatile Organic Compound	Concentration of the Averages over 24 Hours (ug/m3)						
	Jun16	Jun 22	Jun 28	Jul 4	Jul 10	Jul 16	Jul 22
1,2,3-Trimethylbenzene	0.08	0.09	0.10	0.06	0.05	0.05	0.06
p-Cymene (1-Methyl-4-Isopropylbenzene)	0.03	0.05	0.04	0.04	0.02	0.03	0.04
1,2-Dichlorobenzene	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Limonene	0.06	0.24	0.13	0.10	0.05	0.08	0.11
Indan (2,3-Dihydroindene)	0.03	0.04	0.04	0.03	0.02	0.02	0.02
1,3-Diethylbenzene	0.01	0.02	0.02	0.01	0.01	0.01	0.01
1,4-Diethylbenzene	0.06	0.06	0.09	0.05	0.04	0.04	0.05
n-Butylbenzene	0.01	0.02	0.02	0.01	0.01	0.01	0.01
1,2-Diethylbenzene	0.01	0.01	0.01	0.01	0.01	0.00	0.00
1-Undecene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Undecane	0.24	0.24	0.29	0.26	0.17	0.12	0.16
1,2,4-Trichlorobenzene	0.00	0.00	0.01	0.01	0.03	0.01	0.01
Naphthalene	0.26	0.32	0.59	0.20	0.21	0.32	0.42
Dodecane	0.22	0.21	0.26	0.21	0.18	0.15	0.19
Hexachlorobutadiene	0.00	0.00	0.00	0.00	0.01	0.01	0.00
Hexylbenzene	0.02	0.01	0.01	0.01	0.02	0.02	0.02