

Air pollutants transfer from road in the schools of Lille

Emmanuel Roux¹, Christine Bugajny¹, Gaëtan Cheppe², Olivier Savy², Peggy Desmettres³

¹ Cerema Nord-Picardie ² City of Lille, Service Risques Urbains et Sanitaires, Direction de l'Habitat ³ Atmo Hauts-de-France

Objectives of the project

The City of Lille has launched a project, *Scol'Air*, relating to the improvement of air quality in schools in PRSE2. The Cerema and Atmo Nord-Pas-de-Calais undertook specific measurements in two schools in Lille. The objective of the Cerema team is to study the relation between outdoor air pollution and indoor air quality in order to recommend better practices for improving air quality. Two schools were selected for this study according to their road pollutants exposure and building properties.

Indoor air quality is a subject of concern for the following reasons:

- time spent in closed premises (homes, offices, schools or public buildings) is largely superior to time spent outdoors (about 90%)
- certain categories of people (pregnant women, children...) are highly sensitive to toxic pollutants
- the number and variety of pollutants from domestic sources are very important and some of them are difficult to identify

Various parameters govern the transfer process:

- outdoor levels
- weather conditions: season, temperature, humidity, atmospheric pressure
- building internal factors: process on material surfaces, air tightness
- ventilation: air exchange rate
- occupant behaviors: tobacco smoke, cooking
- physical and chemical properties of pollutants: reactivity, deposition, size of particles

Schools selection

Two schools were chosen to be measured by Atmo Nord-Pas-de-Calais and Cerema: Thierry Launay school and Buisson Briand school.

The following criteria for the choice were:

- feasibility of the project as a whole within the school (metrology but also educational project, which the teaching staff took on board)
- geographical exposure to air pollution: use of urban modelling platform
- building characteristics : age, ventilation, type of opening

	Type of location	Distance to highway road	Building age	Ventilation?	Type of opening
Thierry Launay School	Urban	100m	1960	No ventilation	Single glazing
Briand Buisson school	Urban	300m	Rehabilitation 2013	VMC double flow	Double glazing

Technical informations for the two schools



Location of the two schools

Materials

The pollutants selected for the study, based on several references and technical and financial feasibility criteria were: NO₂, O₃, PM₁₀ and PM_{2.5} as well as weather conditions (wind direction and speed, temperature and humidity...).

We chose to use Airpointer® which can measure multi-parameters simultaneously with reference methods. Comfort parameters such as temperature, humidity, and carbon dioxide, have also been measured by Atmo Nord-Pas-de-Calais.

Analyzers nephelometers ADR-1500 and PDR-1500 were used enabling real-time measurement of the mass concentration of airborne dust in the air for PM_{2.5}.

Air permeability was measured to have a result on the air exchange rate of the instrumented classroom.



Relation between indoor/outdoor concentrations for PM_{2.5}

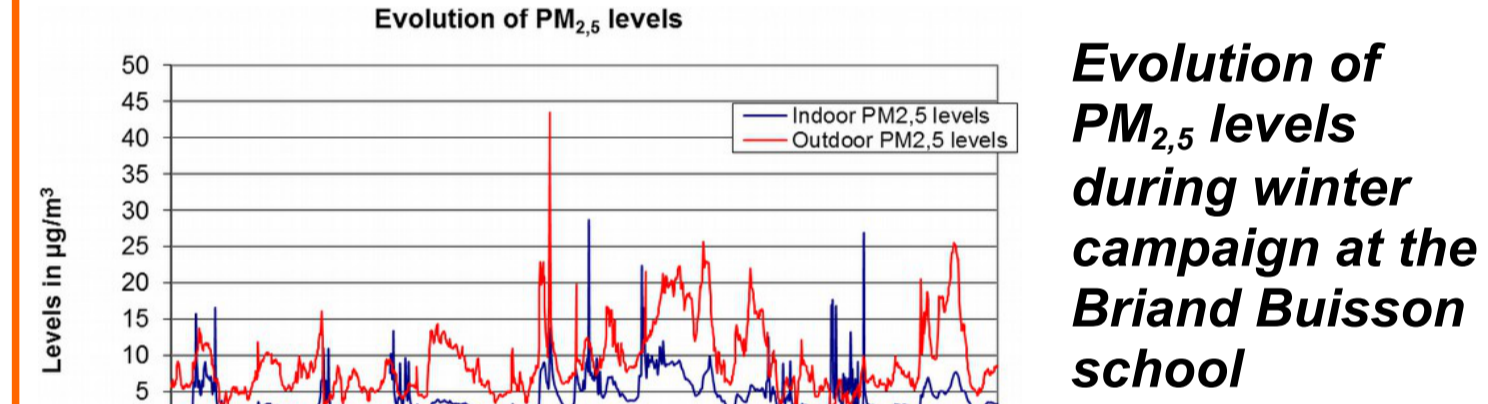
	Thierry Launay school		Briand Buisson school	
	Winter campaign (February 2014)	Summer campaign (May 2014)	Winter campaign (February 2014)	Summer campaign (May 2014)
Average I/O	1,22		0,5	1,07
Average I/O without children	0,81	No Data	0,39	0,88
Average I/O with children	2,27		0,99	2,17

Results of I/O ratio with or without children in the two schools for PM_{2.5}

- ✓ I/O ratio for PM_{2.5} is higher when children are in classrooms (the median I/O ratio is higher than 2 in summer but temporarily, I/O ratio can reach 9)

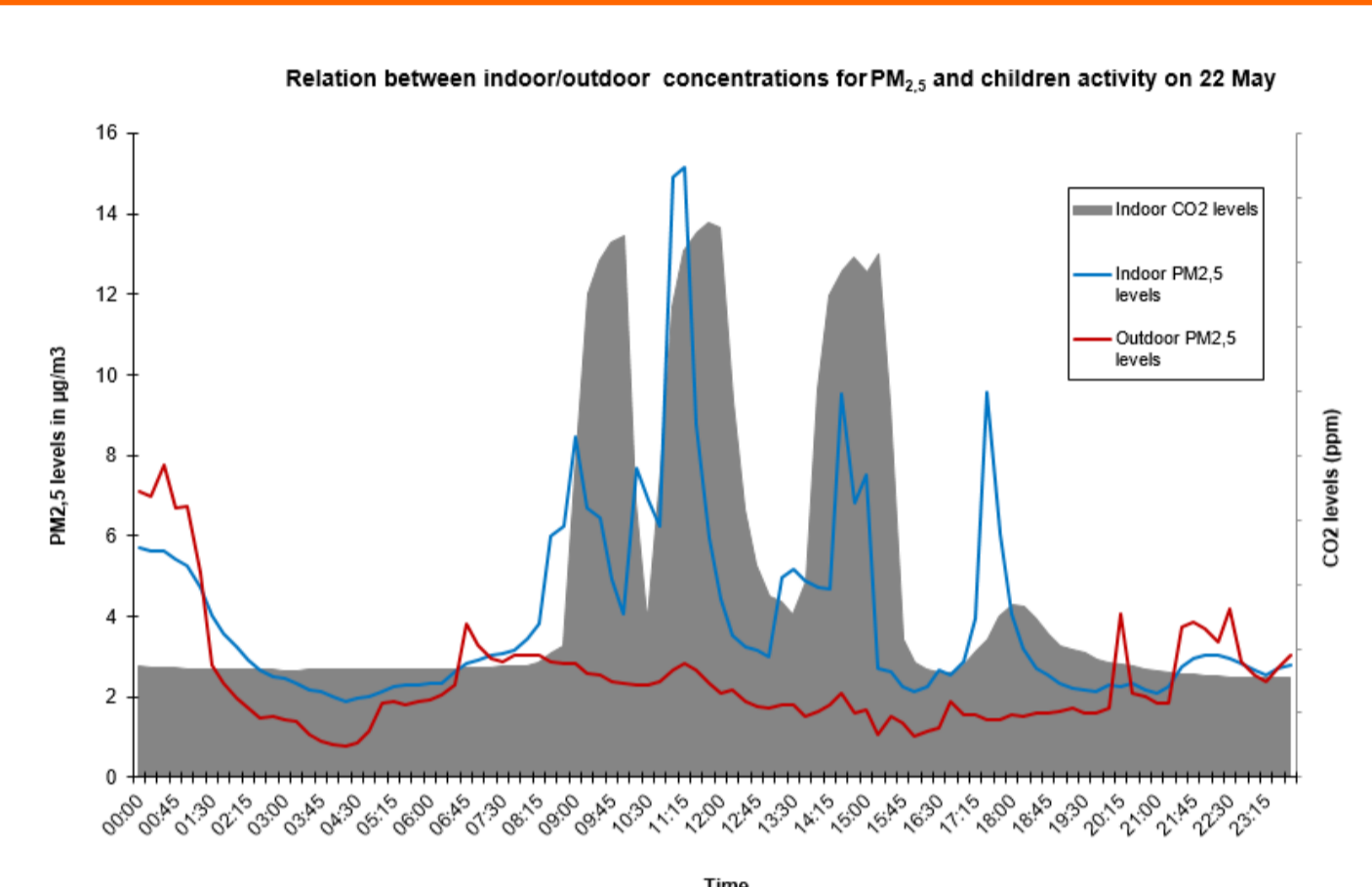
- ✓ Influence of season in Briand Buisson School (2 more time between summer and winter) => maybe due to ventilation

- ✓ Difference between the two buildings in winter => Influence of its proximity to highways (A25) and its old design (single glazing and no mechanical ventilation system) for Thierry Launay school



Evolution of PM_{2.5} levels during winter campaign at the Briand Buisson school

- ✓ Indoor and outdoor levels profile of PM_{2.5} are not similar



Evolution of PM_{2.5} levels during a week day during summer campaign in Briand Buisson school

- ✓ Peaks in levels of particles are quite related to the movements in the classroom (five more times)

=> due to resuspension with the movements at beginning / end of the day and start / end of the break (recess and lunch break)

- ✓ Increasing levels of indoor PM_{2.5} at 5 pm/5:30 pm during the cleaning periods

- ✓ When there is no class (Wednesdays) the evolution of the inner PM_{2.5} levels follows the evolution of outdoor levels except when the cleaning staff works (around 11am)

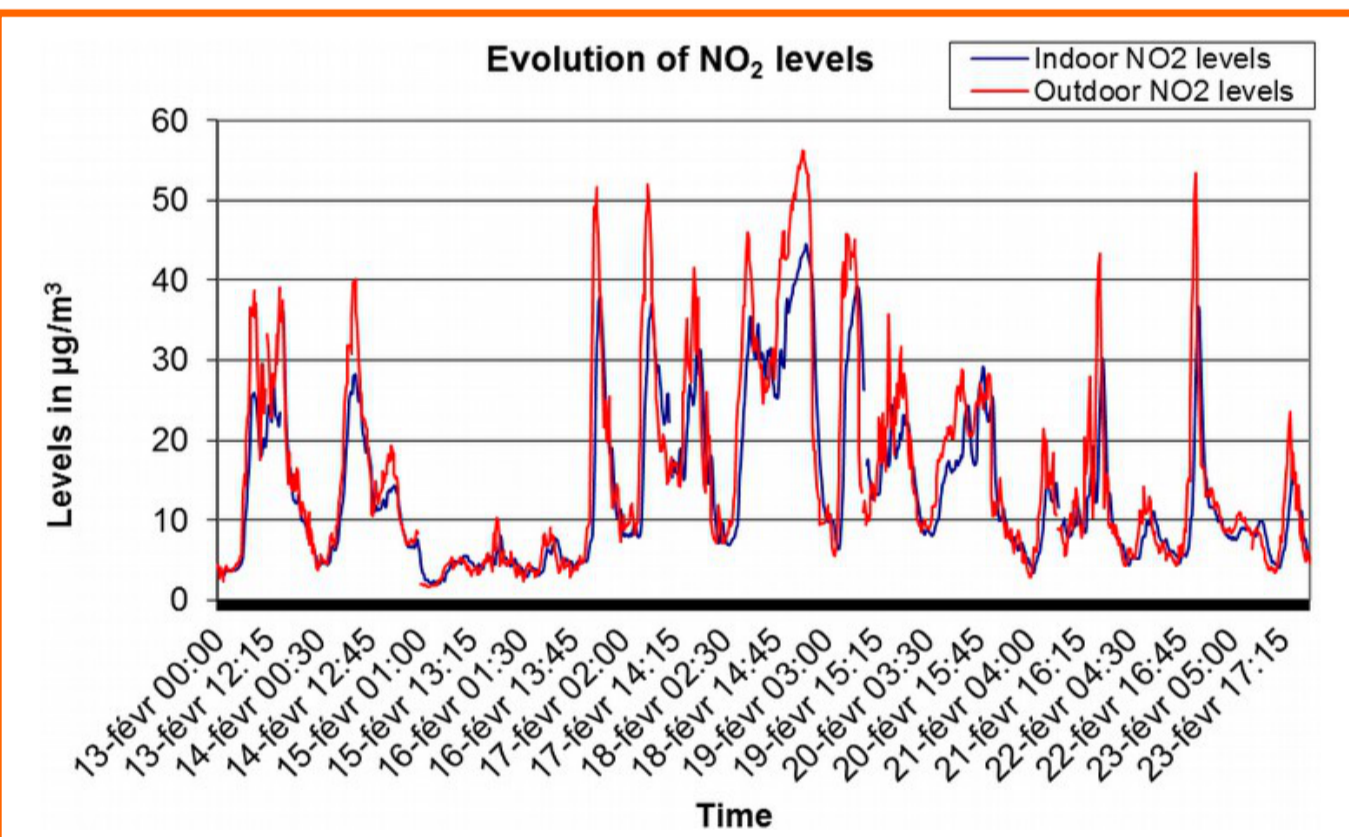
Relation between indoor/outdoor concentrations for NO₂

	Thierry Launay school		Briand Buisson school	
	Winter campaign (February 2014)	Summer campaign (May 2014)	Winter campaign (February 2014)	Summer campaign (May 2014)
Average I/O		1,05	0,96	1,05
Average I/O without children	No Data	0,99	0,96	1,03
Average I/O with children		1,35	0,94	1,17

Results of I/O ratio with or without children in the two schools for NO₂

- ✓ No difference between I/O of the two building in summer => no influence of the proximity to highways (A25) and the old design (single glazing) for Thierry Launay school

- ✓ I/O ratio for NO₂ are similar between winter and summer at Briand Buisson school => near 1



Evolution of NO₂ levels during winter campaign at the Briand Buisson school

- ✓ Indoor levels of NO₂ follow outdoor levels with and without the presence of children
- ✓ Mitigation when outdoor levels exceed 40 µg/m³ => due maybe to air exchange rate

Study limitations

- ✓ Breakdowns of sensors due to a power cuts on Thierry Launay school did not allow to collect all data

- ✓ Short period of measures for this first investigation which prevented from having all the weather conditions and only one class per school has been equipped with sensors

Conclusion

- ✓ Respect of the different air standards in Thierry Launay school for NO₂ and PM_{2.5} and in Briand Buisson school during winter for NO₂ and PM_{2.5}

- ✓ Non respect of the different air standards in Briand Buisson school during summer for NO₂ and PM_{2.5}

- ✓ Particle levels are subject to net increases at certain times of the day corresponding to movements (breaks, cleaners...) => resuspension of particles

- ✓ Influence of the proximity to highways (A25) and old design (single glazing and no mechanical ventilation system) for indoor PM_{2.5} levels in Thierry Launay school in winter

- ✓ For NO₂ nor the season neither the ventilation have an influence on indoor levels for the two schools

A new innovative approach in 2017



To follow up this project, a new one has been submitted with fundings from the DREAL Hauts-de-France, in collaboration with the City of Lille. This new approach is based on an innovative sensor technology for the measurement of pollutants and acoustic parameters and accompanied with four classes and two external sites equipped (Tera group devices) in three schools in Lille.

The pollutants measured are:

- ✓ In outdoor air: nitrogen dioxide, ozone, particulate matter (PM_{2.5} and PM₁₀), acoustic and weather parameters

- ✓ In indoor environment: total VOCs, formaldehyde, nitrogen dioxide, ozone, particulate matter (PM_{2.5} and PM₁₀), acoustic parameters, CO₂ and comfort parameters

This work will define and establish air quality and noise indicators for children in the three schools with different characteristics and road/industrial exposure. The objective is to have information about air quality and noise co-exposure. This work should be extended to other communities or other types of buildings.

