Air quality and noise coexposure in the schools of Lille

Étude de la coexposition air-bruit dans des écoles de Lille

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Summary

1. Context

- **First study in 2014 of Cerema with ATMO Nord-Pas-de-Calais: the link between air traffic pollution and indoor air quality in 2 schools of Lille**
- **2014 results**
  - **Particle levels are subject to important 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 $PM_{2,5}$**
  - **For NO_2, no influence of ventilation and season in indoor levels for the two schools (I/O ratio close to 1)**
- **New project for 2016-2017**
  - **Improvement of knowledge on pollutant transfers**
  - **Air and noise co-exposure study**
  - **Fundings: Dreal Hauts-de-France and DGPR**
  - **In consultation with the city of Lille**

2. Objectives

- In connection with the PRSE 3 on coexposure (Air quality and acoustics) of the most sensitive people, children in schools and nurseries in high-stakes areas (trafic, urban, industrial)
- Objective : Providing knowledges on pollutants and noise co-exposure in classrooms, while studying the pollution contribution of outdoor pollution in order to :
  - Best adapt good practice recommendations for improving air quality
  - Study the presence of specific pollutants related to teaching activities or buildings
  - Train school sector actors to perpetuate actions for a better air quality

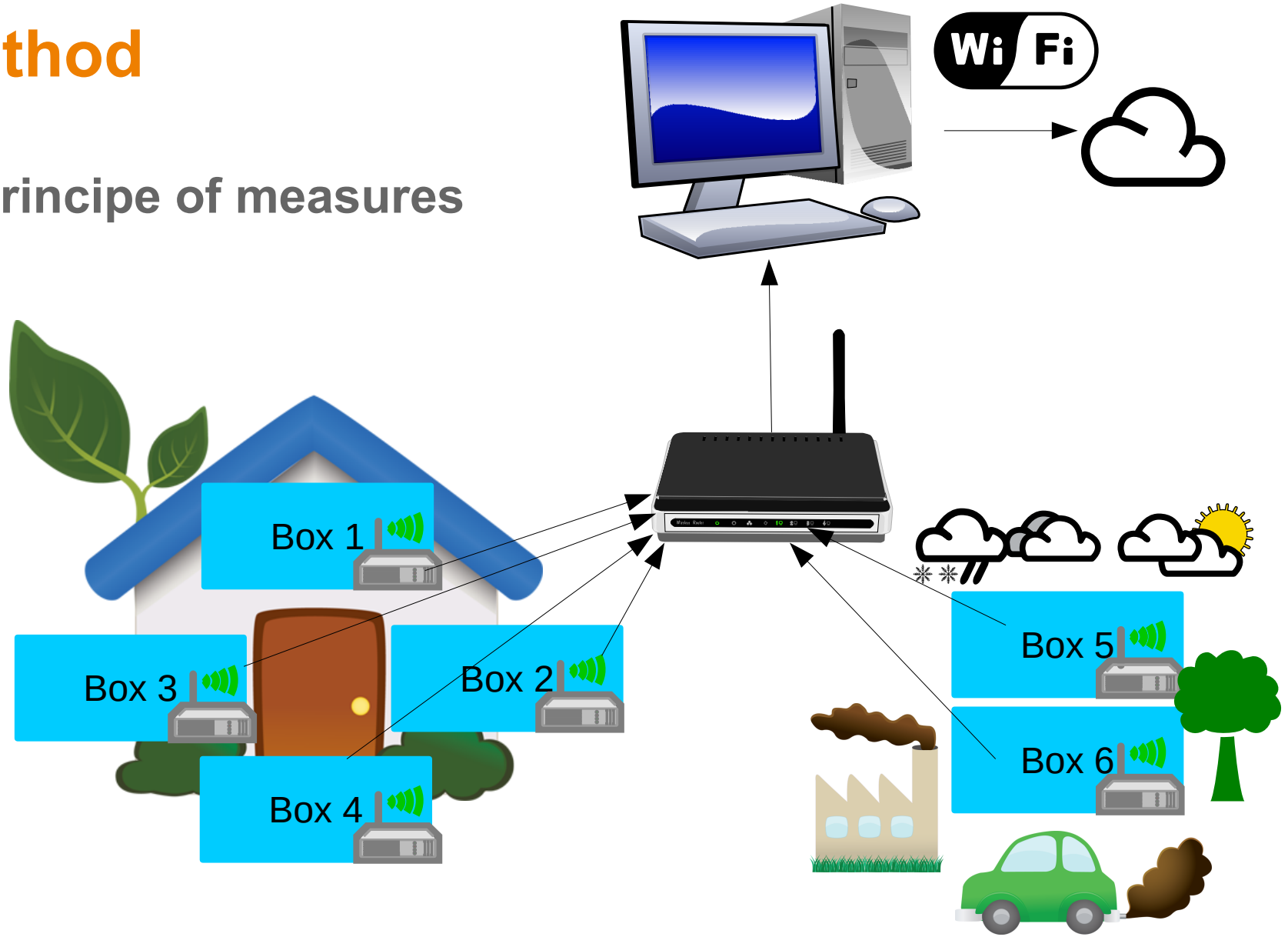
3. Method

- 3 schools selected in consultation with the city of Lille

	School A	School B	School C
Location	Near highway (100m) and others roads	Near industrial site (100m)	Urban background
Winter Period	23/11/2016 to 20/12/2017	18/01/2017 to 15/02/2017	01/03/2017 to 29/03/2016
Summer Period	13/04/2017 to 10/05/2017	10/05/2017 to 02/06/2017	14/06/2017 to 12/07/2017
Ventilation	No	No	No
Double-glazing windows	Yes	Yes	Yes

3. Method

- Principe of measures



3. Method

- Pollutants in each boxes

Pollutants		Indoor Box	Outdoor Box
Confort parameters	Temperature	x	
	Hygrometry	x	
Confinement : CO_2		x	
Formaldehyde		x	
Nitrogen dioxyde : NO_2		x	x
Ozone : O_3		x	x
Particles : $PM_{2.5}$ et PM_{10}		x	x
Total Volatile Organique Compounds : TVOC		x	
Acoustic parameters		x	x
Meteorological conditions	Temperature		x
	Hygrometry		x
	Direction of wind		x
	Strenght of wind		x

3. Method

- Questionnaire
  - Description of the buildings and classrooms (age, location, type of construction, ventilation, area, …)
  - Description of the occupation of the classrooms:
    - BETA file : time and frequency of users presence
    - Activities : paint, glues, …
    - Cleaning
    - Opening windows and doors

Cerema
Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement

CARNET HEBDOMADAIRE – Projet SCOL'AIR (à remplir par le personnel enseignant)

Date de la campagne :

Désignation de la salle :

Enseignant :

Nous vous demandons de décrire l'emploi du temps de votre classe
du lundi .../../2017 à 7heures
au samedi .../../2017 à 18 heures

Cinq jours scolaires consécutifs sont à priori observés (sauf si le rythme scolaire de la classe est court)

!!!Avertissement : remplir le tableau au jour le jour

RYTHME SCOLAIRE
La semaine scolaire est-elle répartie sur :

Six jours (du lundi au samedi) ?	
Cinq jours (du lundi au vendredi) ?	
Quatre jours ?	
Autre cas. Préciser :	

	Lundi		Mardi		Mercredi		Jeudi		Vendredi		Samedi	
	Matin	Après-Midi	Matin	Après-Midi	Matin	Après-Midi	Matin	Après-Midi	Matin	Après-Midi	Matin	Après-Midi
Présence d'occupants dans la pièce (Cocher les plages de présence des occupants dans les tableaux suivants) :												
	7h00	13h30	7h00	13h30	7h00	13h30	7h00	13h30	7h00	13h30	7h00	13h30
	7h15	13h45	7h15	13h45	7h15	13h45	7h15	13h45	7h15	13h45	7h15	13h45
	7h30	14h00	7h30	14h00	7h30	14h00	7h30	14h00	7h30	14h00	7h30	14h00
	7h45	14h15	7h45	14h15	7h45	14h15	7h45	14h15	7h45	14h15	7h45	14h15
	8h00	14h30	8h00	14h30	8h00	14h30	8h00	14h30	8h00	14h30	8h00	14h30
	8h15	14h45	8h15	14h45	8h15	14h45	8h15	14h45	8h15	14h45	8h15	14h45
	8h30	15h00	8h30	15h00	8h30	15h00	8h30	15h00	8h30	15h00	8h30	15h00
	8h45	15h15	8h45	15h15	8h45	15h15	8h45	15h15	8h45	15h15	8h45	15h15
	9h00	15h30	9h00	15h30	9h00	15h30	9h00	15h30	9h00	15h30	9h00	15h30
	9h15	15h45	9h15	15h45	9h15	15h45	9h15	15h45	9h15	15h45	9h15	15h45
	9h30	16h00	9h30	16h00	9h30	16h00	9h30	16h00	9h30	16h00	9h30	16h00
	9h45	16h15	9h45	16h15	9h45	16h15	9h45	16h15	9h45	16h15	9h45	16h15
	10h00	16h30	10h00	16h30	10h00	16h30	10h00	16h30	10h00	16h30	10h00	16h30
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	11h45	18h15	11h45	18h15	11h45	18h15	11h45	18h15	11h45	18h15	11h45	18h15
	12h00	18h30	12h00	18h30	12h00	18h30	12h00	18h30	12h00	18h30	12h00	18h30
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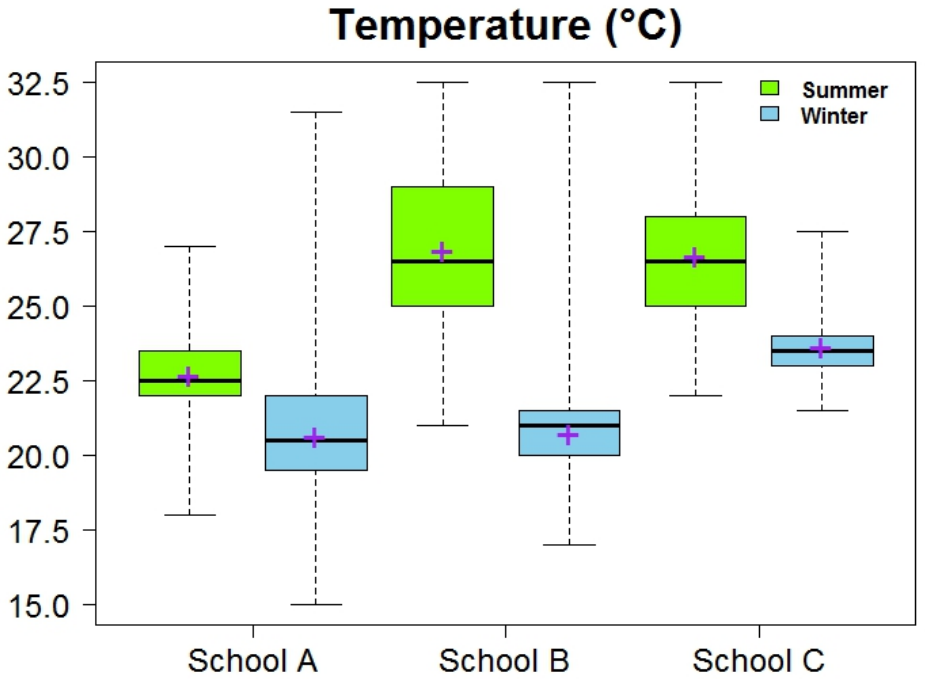
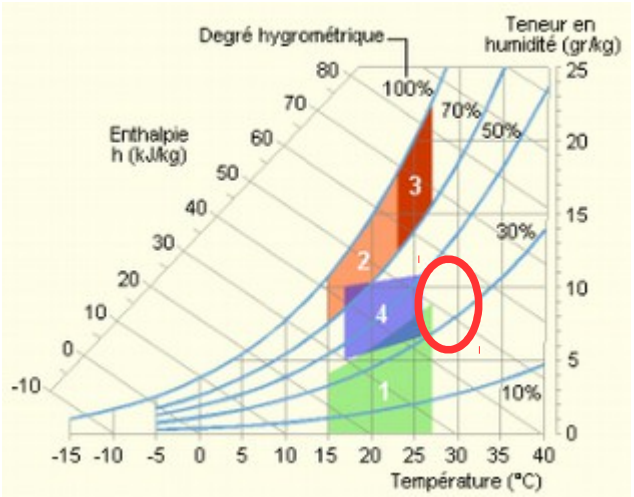
	12h30	19h00	12h30	19h00	12h30	19h00	12h30	19h00	12h30	19h00	12h30	19h00
	12h45	19h15	12h45	19h15	12h45	19h15	12h45	19h15	12h45	19h15	12h45	19h15
	13h00	19h30	13h00	19h30	13h00	19h30	13h00	19h30	13h00	19h30	13h00	19h30
	13h15	19h45	13h15	19h45	13h15	19h45	13h15	19h45	13h15	19h45	13h15	19h45

4. Indoor results

- Issue of summer comfort related to schools buildings
  - Temperature values (median) in classrooms of two schools > 26°C
    - Discomfort for children/teachers during periods of high heat (>25°C with some values > 30°C)
    - Direct orientation of the sun, no way to refresh (opening windows through)

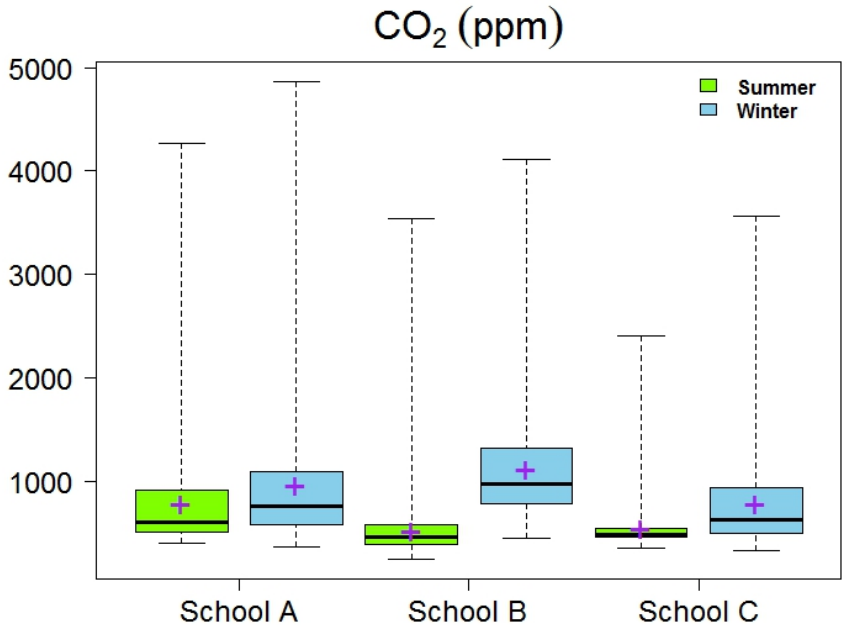


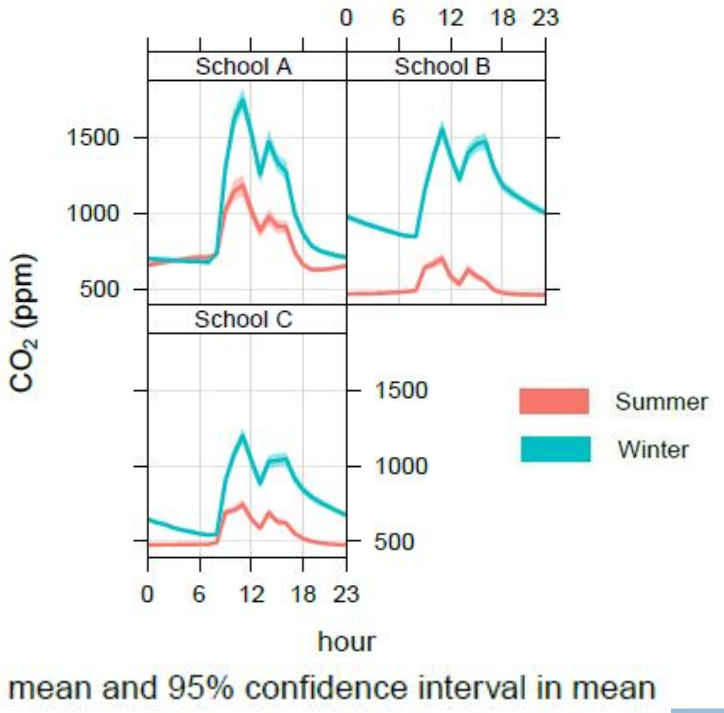


1 : Zone à éviter vis-à-vis des problèmes de sécheresse.
2 : Zone à éviter vis-à-vis des développements de micro organismes
3 : Zone à éviter vis-à-vis des développements d'acariens
4 : Polygone de confort hygrothermique

4. Indoor results

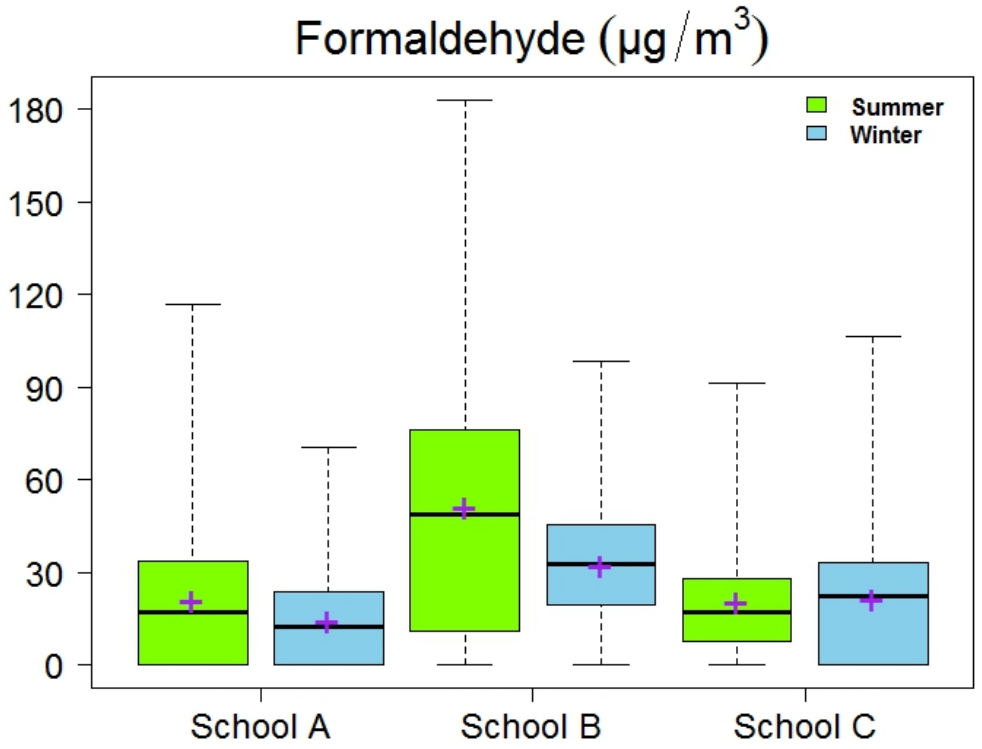
- Issue of air change rate (CO_2)
  - For schools A and B : median [CO2] ~ 1000 ppm with some values > 3000 ppm
    - No ventilation and no windows aeration (outdoor noise for school A)
    - In winter [CO2] > 1000 ppm with children in classrooms
  - School C: median and average less important
    - Classroom 3 : practices of opening windows at each break
    - Classrooms are bigger





4. Indoor results

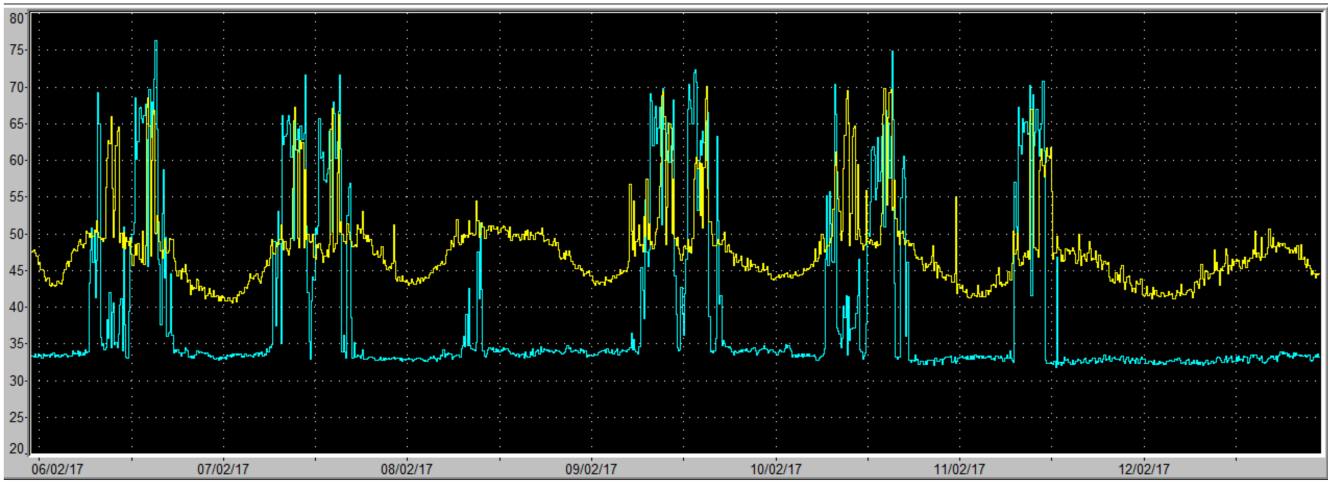
- Issue of formaldehyde
  - School law for ERP (decree n°2015-1926): Limit value 100 µg/m³
  - School B : median [CH_2O] summer ~ 50 µg/m³ with some values > 150 µg/m³
    - [CH_2O] related to T°C, sun and no air exchange rate of the classrooms
  - Schools A and C: median [CH_2O] less important (< 30 µg/m³)



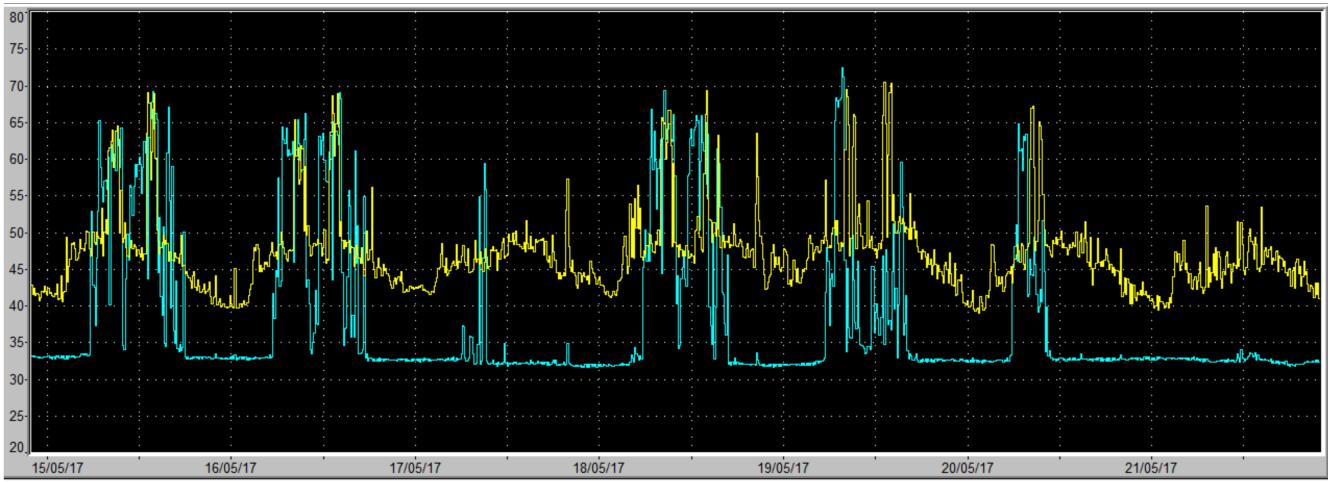
4. Indoor results

- Acoustic levels for school B
  - Background noise 32dB in classrooms (> 60db with traffic noise)
  - Difference of 25dB whether with and without children
  - Estimate isolation of school: 17db

Acoustic levels in classroom 1 (blue) and outdoor (yellow) during a week on school B (dB(A))



Winter

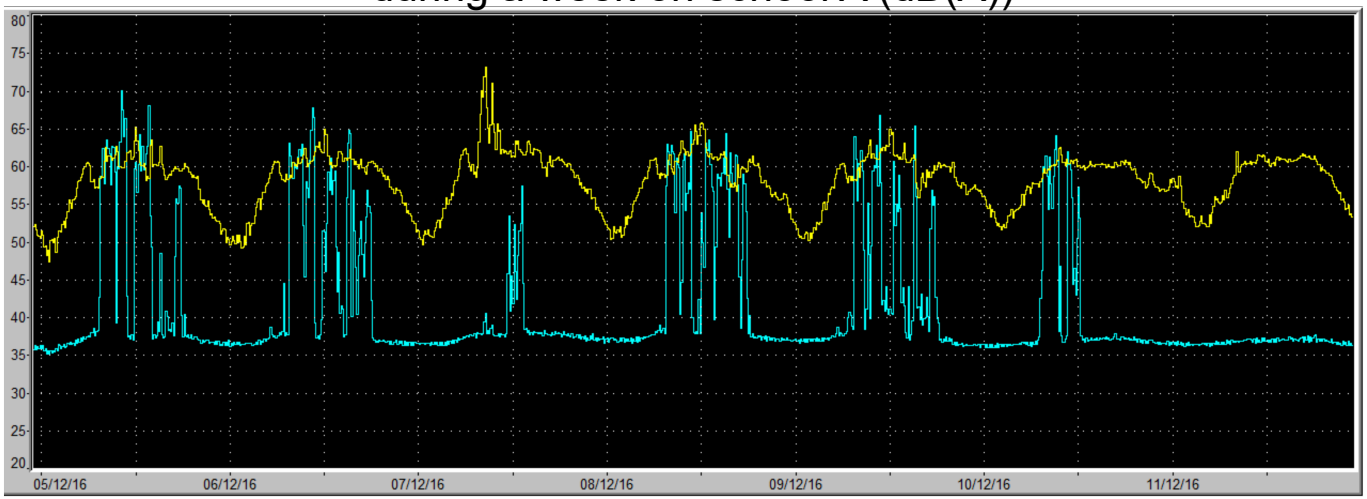


Summer

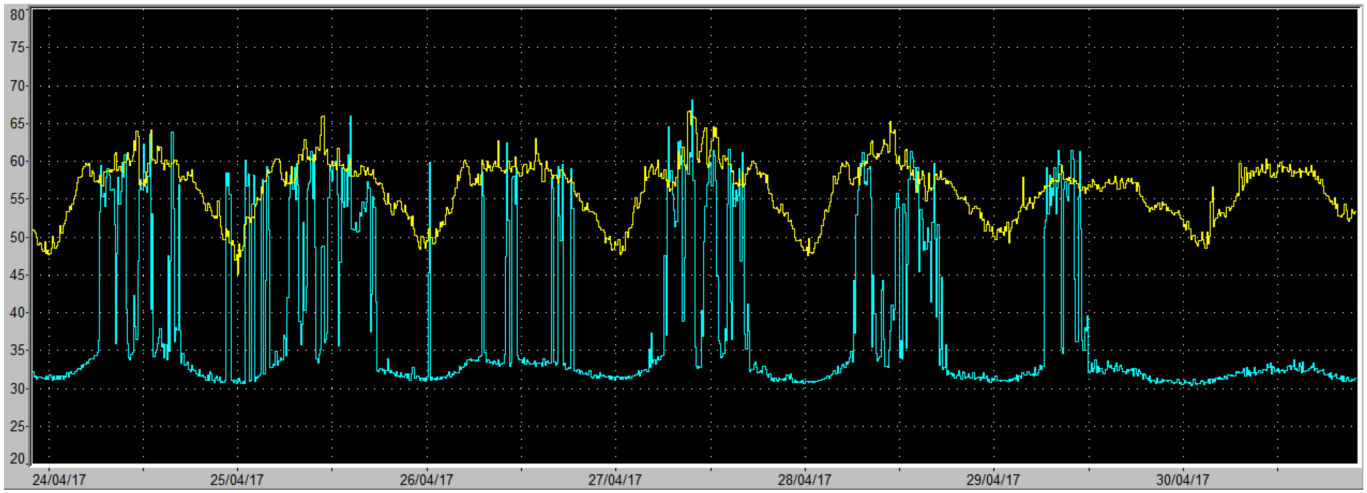
4. Indoor results

- Acoustic levels for school A
  - Difference of 25dB whether with and without children
  - Background noise 35dB (> 60db with traffic)
  - Estimate isolation of school : 24db

Acoustic levels in classroom 1 (blue) and outdoor (yellow) during a week on school A (dB(A))



Winter

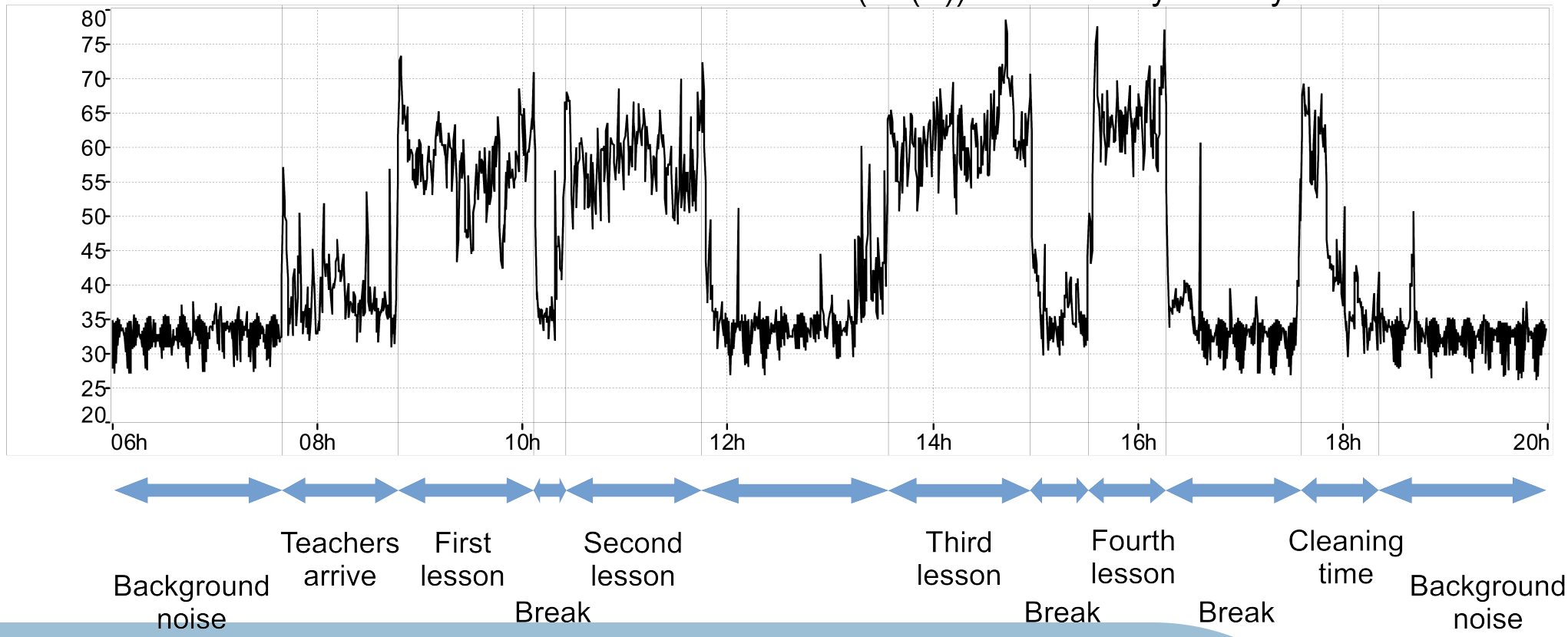


Summer

4. Indoor results

- Acoustic
  - Focus on a typical day
    - Correlation with the presence of children or teachers (difference of 20 to 30dB)

Acoustic level in a classroom 1 and outside (dB(A)) for Thursday 11 may



4. Indoor results

- **Acoustic - Analyses of data with 2 classrooms of 2 schools**
  - **School B**
    - **Classroom noise is lower in summer, probably due to the open windows**
    - **Background noise is higher in winter, probably due to the heating equipment**
  - **School A**
    - **Outside and inside the classrooms : levels equals**

		Background noise	Classroom noise	Background noise	Classroom noise	Outside noise
School B		Classroom n°1		Classroom n°2		
	Summer	32,7	64,4	30,6	64,7	48,0
	Winter	33,5	66,4	31,5	65,0	48,2
School A		Classroom n°1		Classroom n°4		
	Summer	32,5	62,4	33,2	58,9	59,3
	Winter	32,2	62,4	37,8	61,4	60,7

5. Feedback of small sensors

- **Advantages**
  - Equipment easily set up
  - Live data access => possibility to inform the teachers
  - Lightweight and quiet for classrooms
  - Fine and accurate data in schools
- **To improve**
  - Communication of the box with the collector depending to the distance, the walls…

    => Choose a good place
  - No calibration sometimes => lack of information on drift
  - High sensor detection limit for O_3 (20 µg/m³) and NO_2 (38 µg/m³)

6. Conclusion and prospects

- **Conclusion**
  - **Problematic of summer comfort related to schools buildings**
  - **High [CO_2] in some schools and classrooms => Air exchange rate low**
  - **High [CH2O] in summer for one school (specific studies to do)**
  - **Good isolation against outdoor noise**
- **Prospects**
  - **Study the relation between Indoor and Outdoor for NO_2, PM and O_3**
  - **Study the [VOCT] indoor**
  - **Best adapt good practices recommendations to improve air quality and noise in schools**

Thank you for your attention