Indoor air quality in New Zealand homes and schools

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Outline

- Introduction to air quality
- Why focus on indoor air quality
- An example of indoor air quality in a NZ school
- Indoor air quality in NZ homes

What is air?

Breath - 12 to 20 times a minute taking in 11,000 litres of air every day

Without air we can not survive

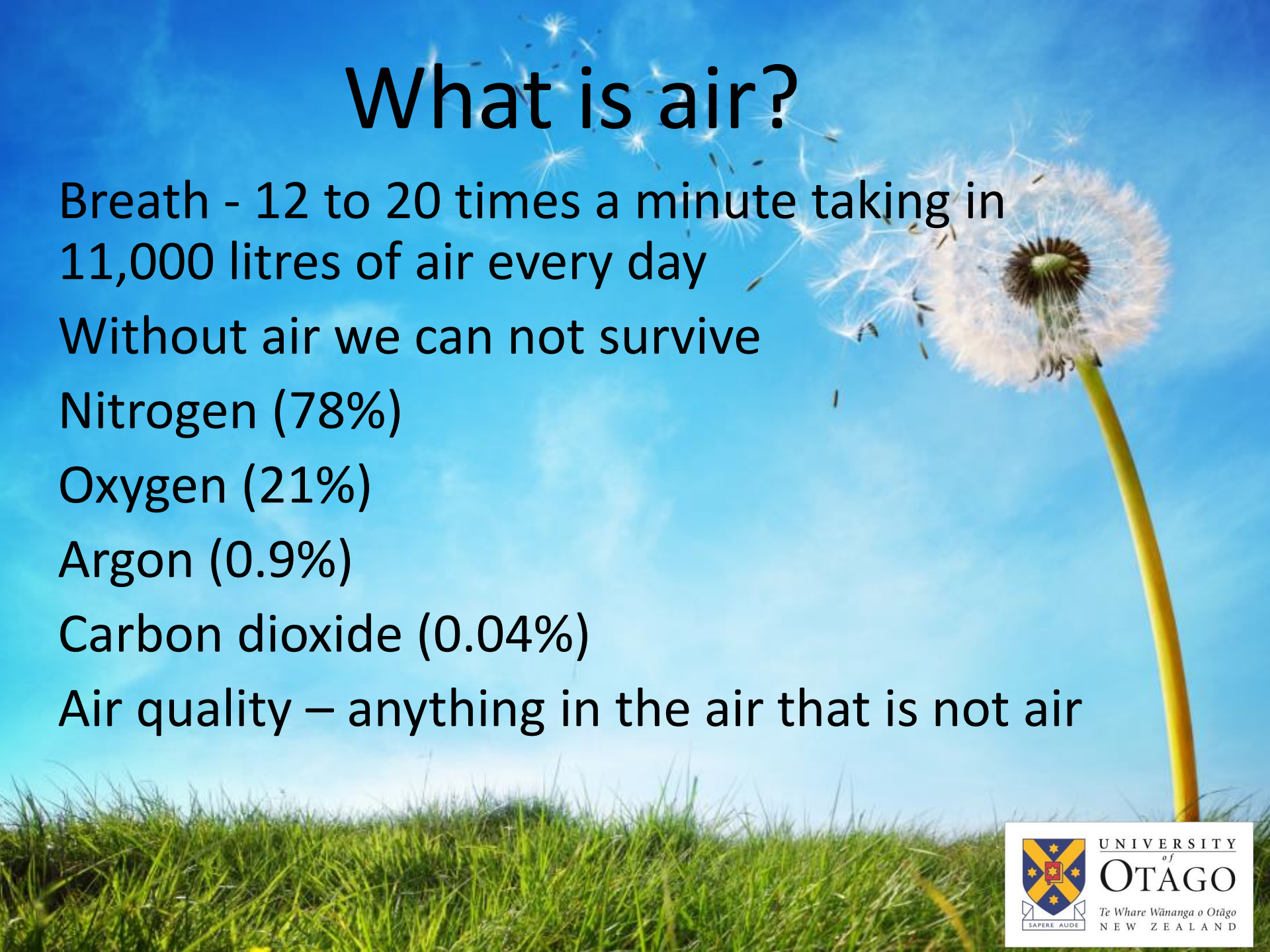
Nitrogen (78%)

Oxygen (21%)

Argon (0.9%)

Carbon dioxide (0.04%)

Air quality – anything in the air that is not air



Air pollutants

Gases

CO, CO_2, SO_2, VOC, NO, O_3

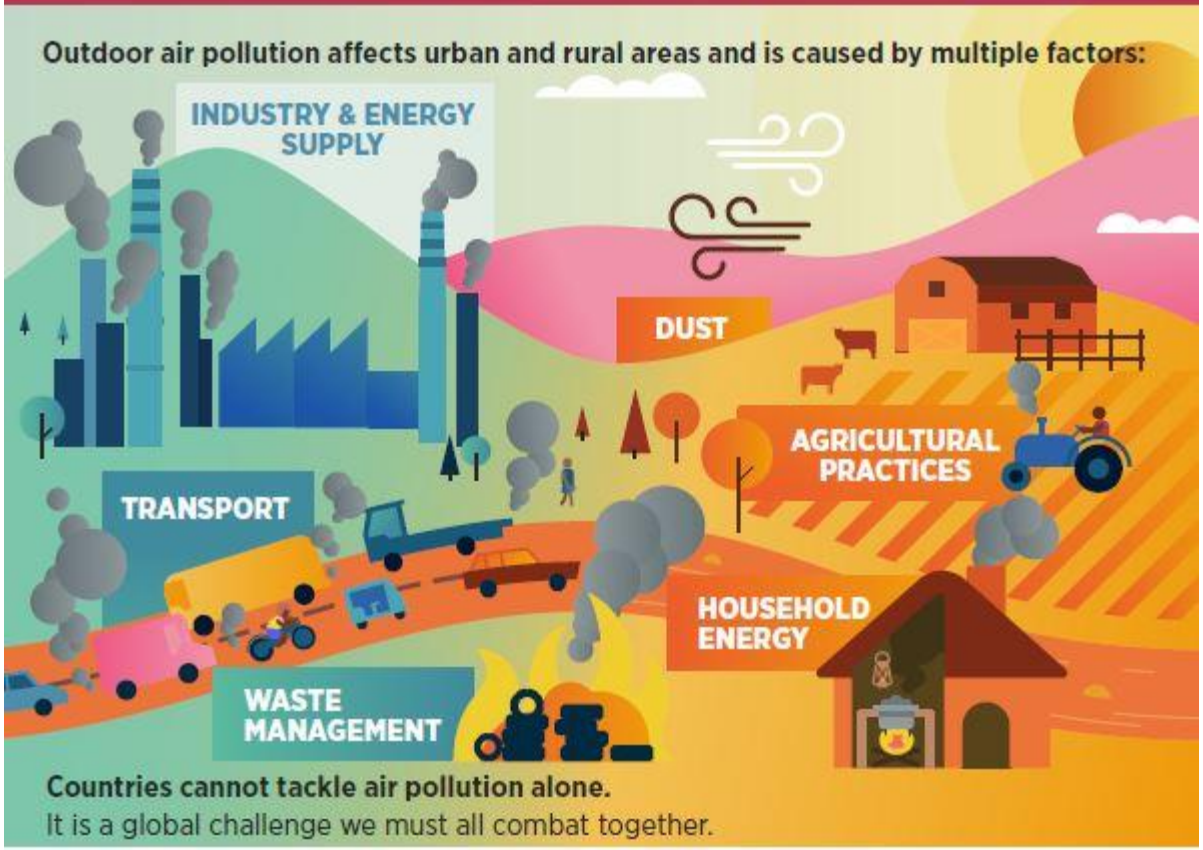
Particles

Particulate matter (PM_{10}, $PM_{2.5}$,ultrafine)

Biological

Bacteria, viruses, moulds, dust mites, pollen

WHAT ARE THE SOURCES OF AIR POLLUTION?



CLEAN AIR FOR HEALTH #AirPollution World Health Organization

Natural sources

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Man-made sources

Global scale

- 91% of the world's population live in places where air quality exceeds the WHO guidelines
- Over 7 million premature deaths every year as a result of exposure air pollution

  4.2 million outdoor air

  3.8 million household exposure

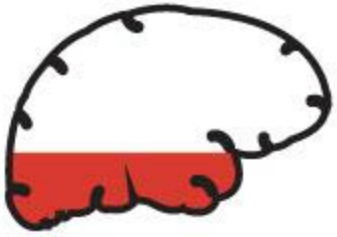
THE

INVISIBLE KILLER

Air pollution may not always be visible, but it can be deadly.

29%

OF DEATHS FROM
LUNG CANCER



24%

OF DEATHS FROM
STROKE

25%

OF DEATHS FROM
HEART DISEASE

43%

OF DEATHS FROM
LUNG DISEASE

New Zealand scale

In 2012, air pollution from human-made PM_{10} was associated with:

- 1000 premature deaths
- 520 extra hospitalisations for cardiovascular and respiratory diseases
- 1.35 million restricted activity days

Why is indoor air quality important?

Spend up to 90% of time indoors

Indoor air quality can be two-to-five times more polluted than outdoors

Indoor air pollution sources

- Infiltration of outdoor sources inside
- Indoor sources

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Indoor environments

Homes - work places - schools and early child education – public and private buildings

Aims

1. To determine the concentration of air pollutants ($PM_{2.5}$, PM_{10}, NO_2) at an urban New Zealand school, and
2. To establish the source of the air pollution.

Methods

Indoors

- Continuous measures of $PM_{2.5}$ and PM_{10}
- Temperature, humidity, CO_2
- Hourly Streaker air particulate samples
- Egg NO_2

Outdoors

- Continuous PM_{10}
- Hourly Streaker air particulate samples

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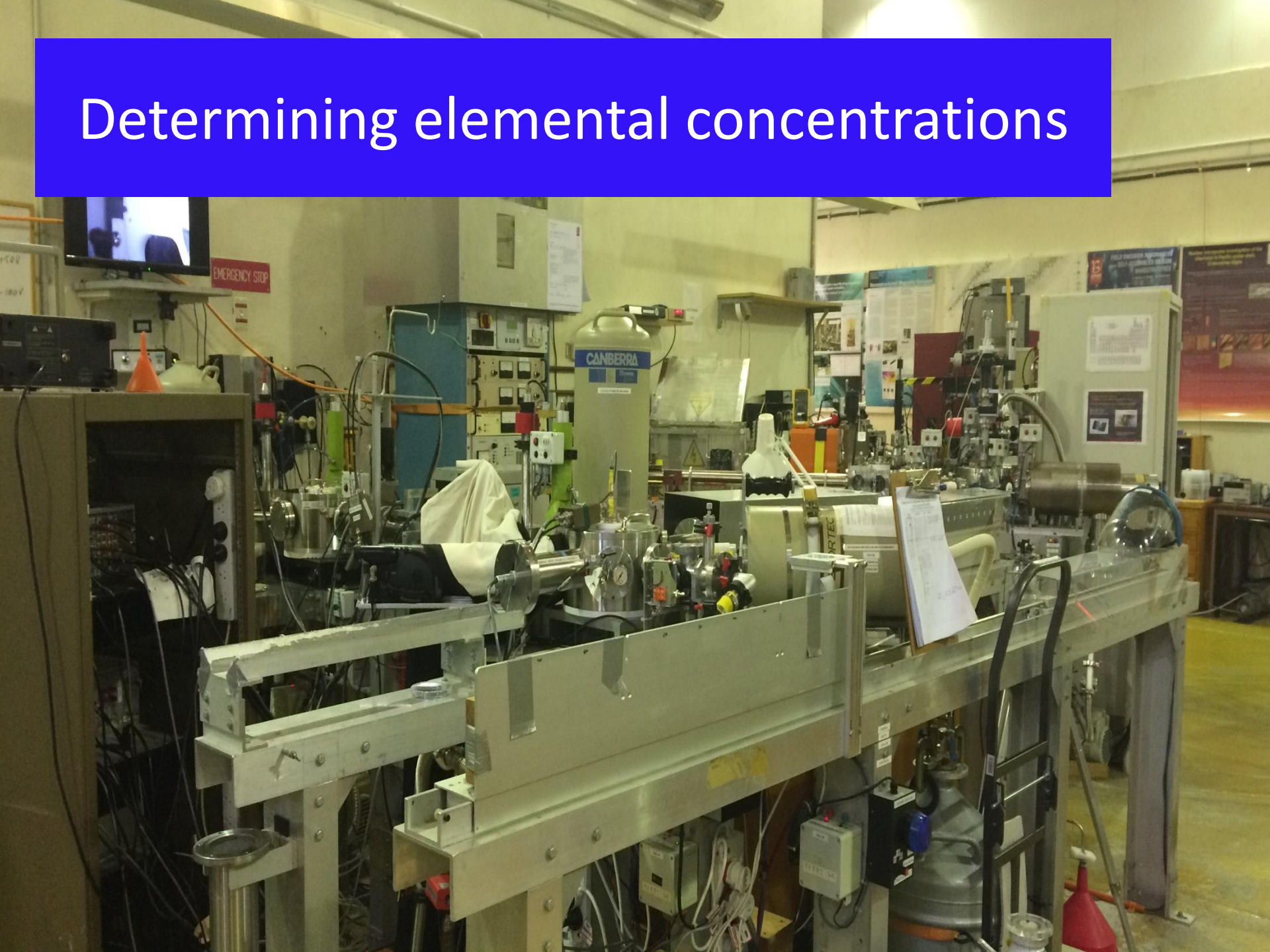
Siope's
Resources


EDWARDS

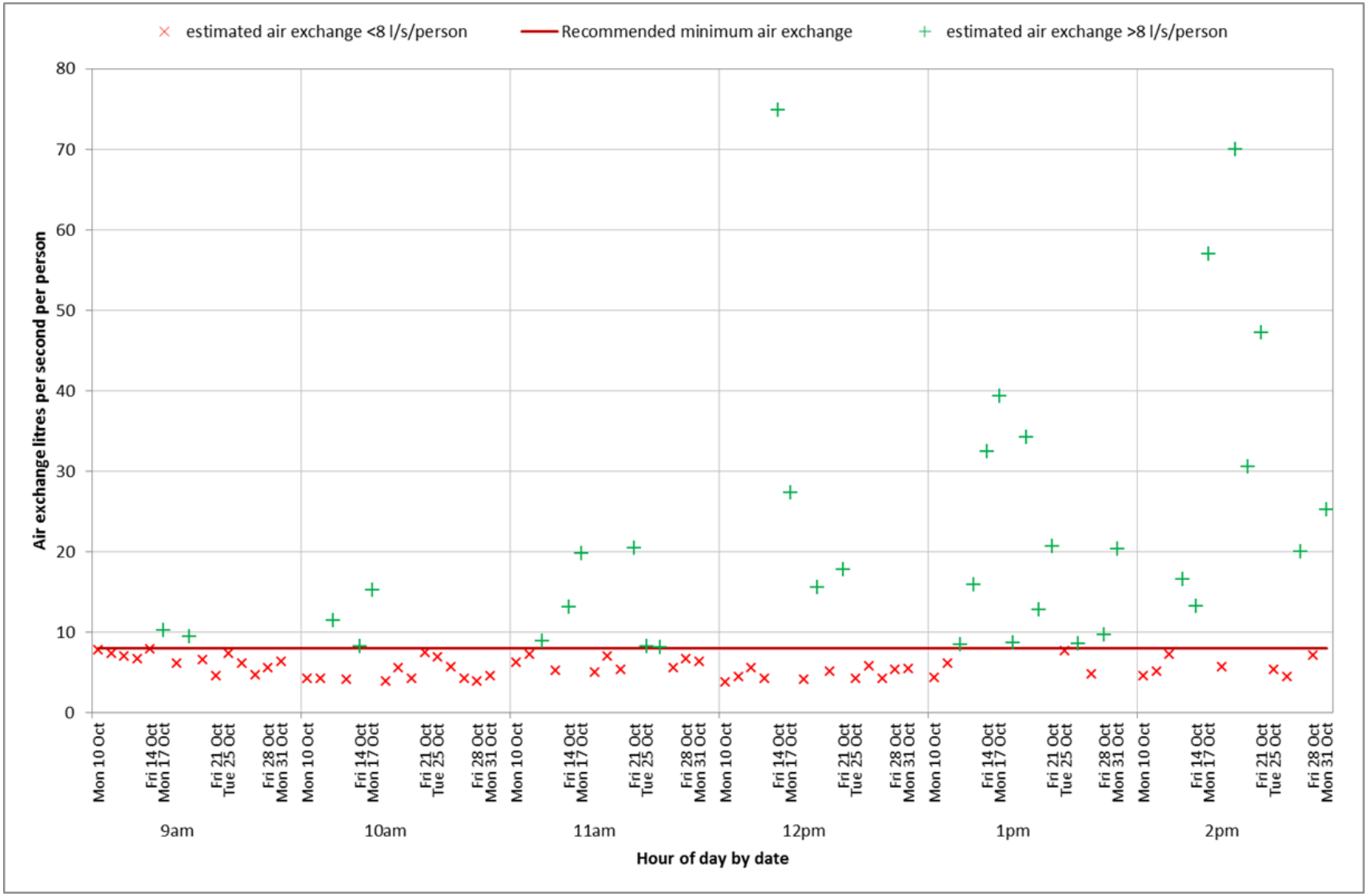
Determining elemental concentrations



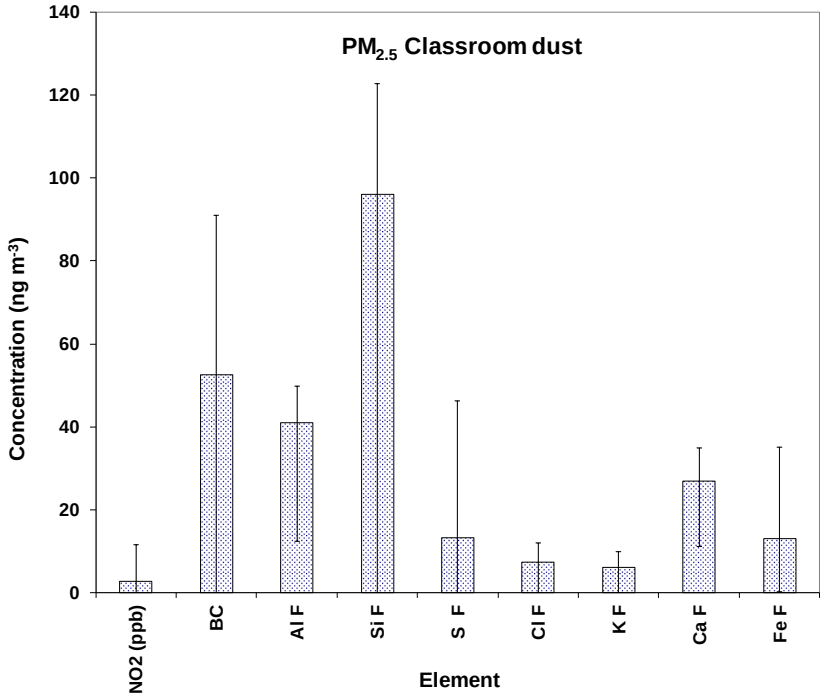
Indoor findings

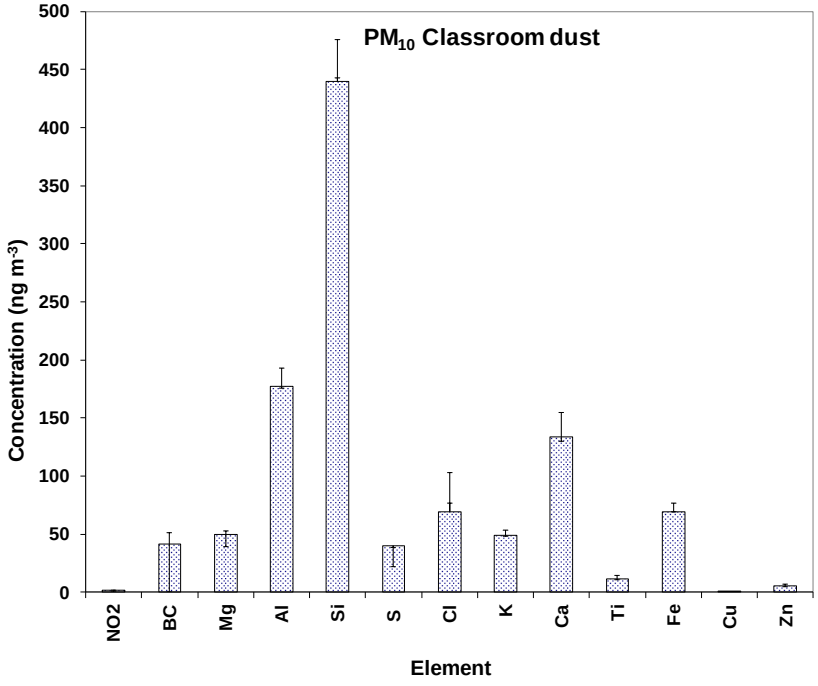
Variable	Average	Range
$PM_{2.5}(\mu g/m^3)$	6.9	<1.0-10.9
$PM_{10}(\mu g/m^3)$	30.1	10.0-75.0
Temperature(^oC)	19.4	14.0-23.2
Humidity (%rh)	60.8	42.1-76.7
CO_2 (ppm)	887.8	418-1626
NO_2 ($\mu g/m^3$)	56.4	13.2-99.6

Ventilation rates



Classroom dust





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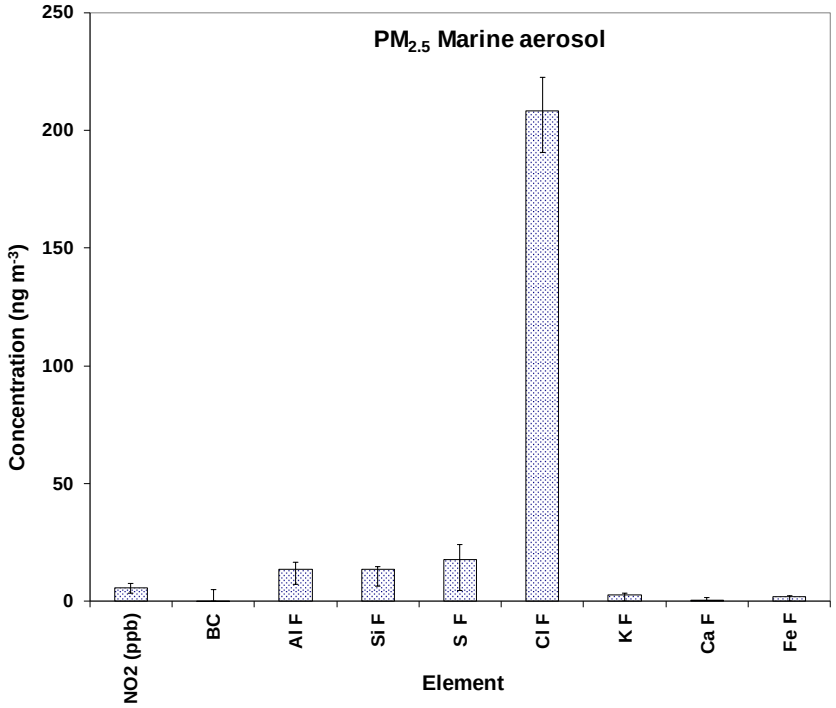
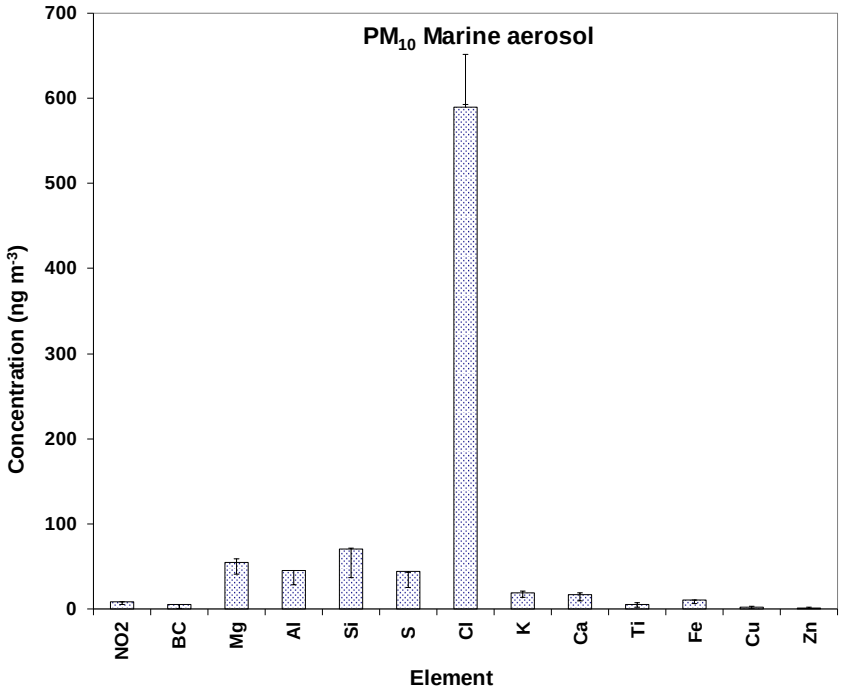
Marine aerosol





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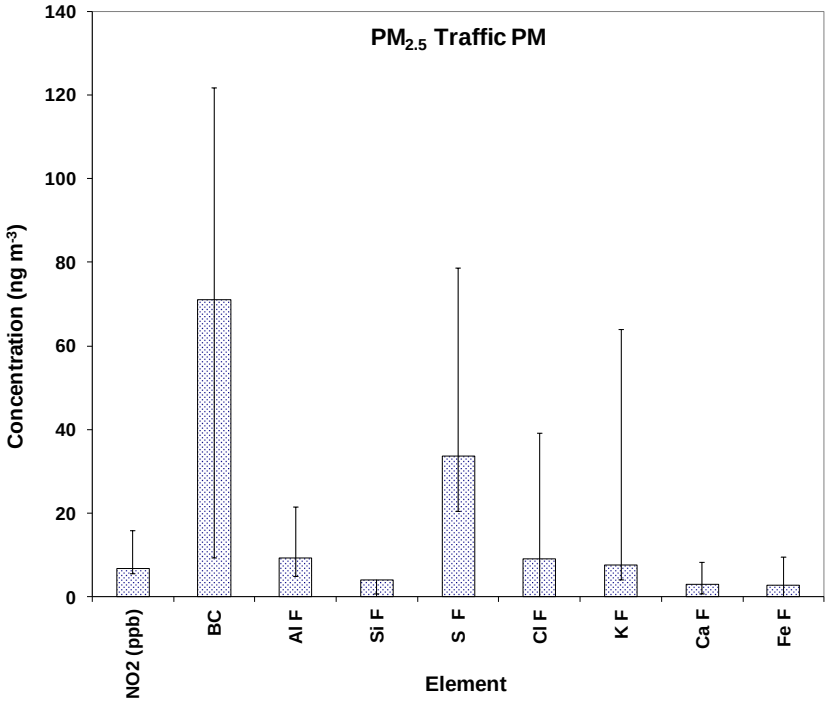
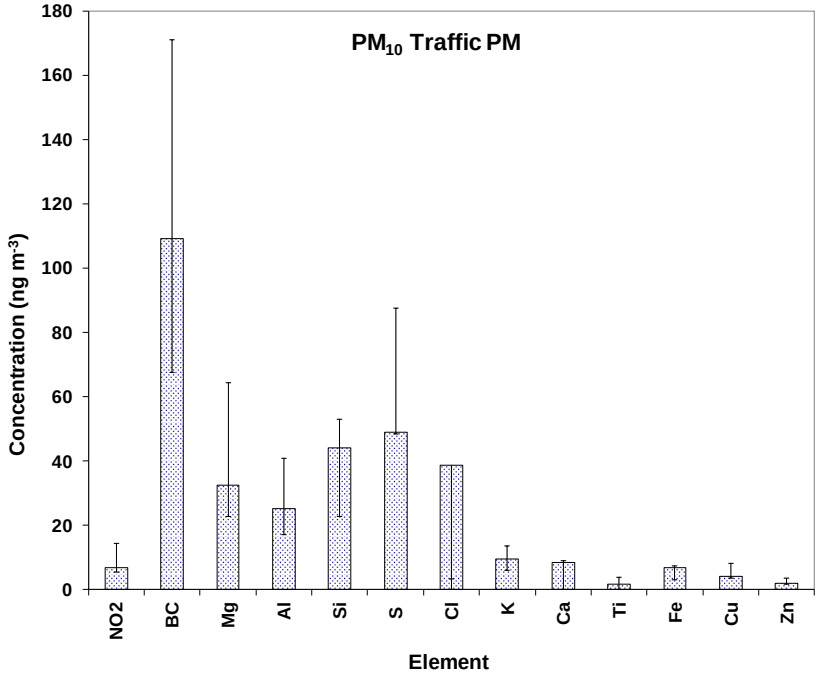
Traffic pollution





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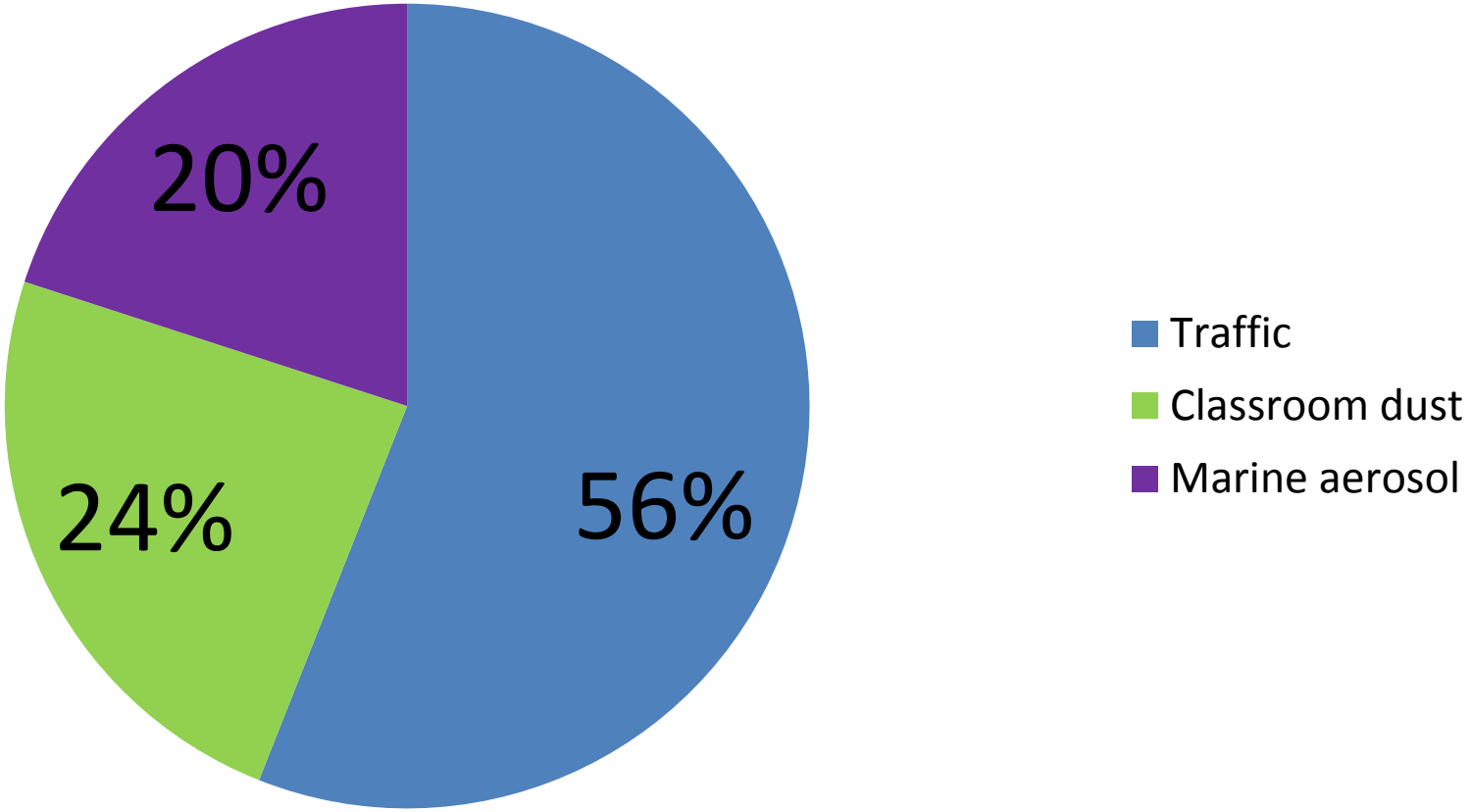
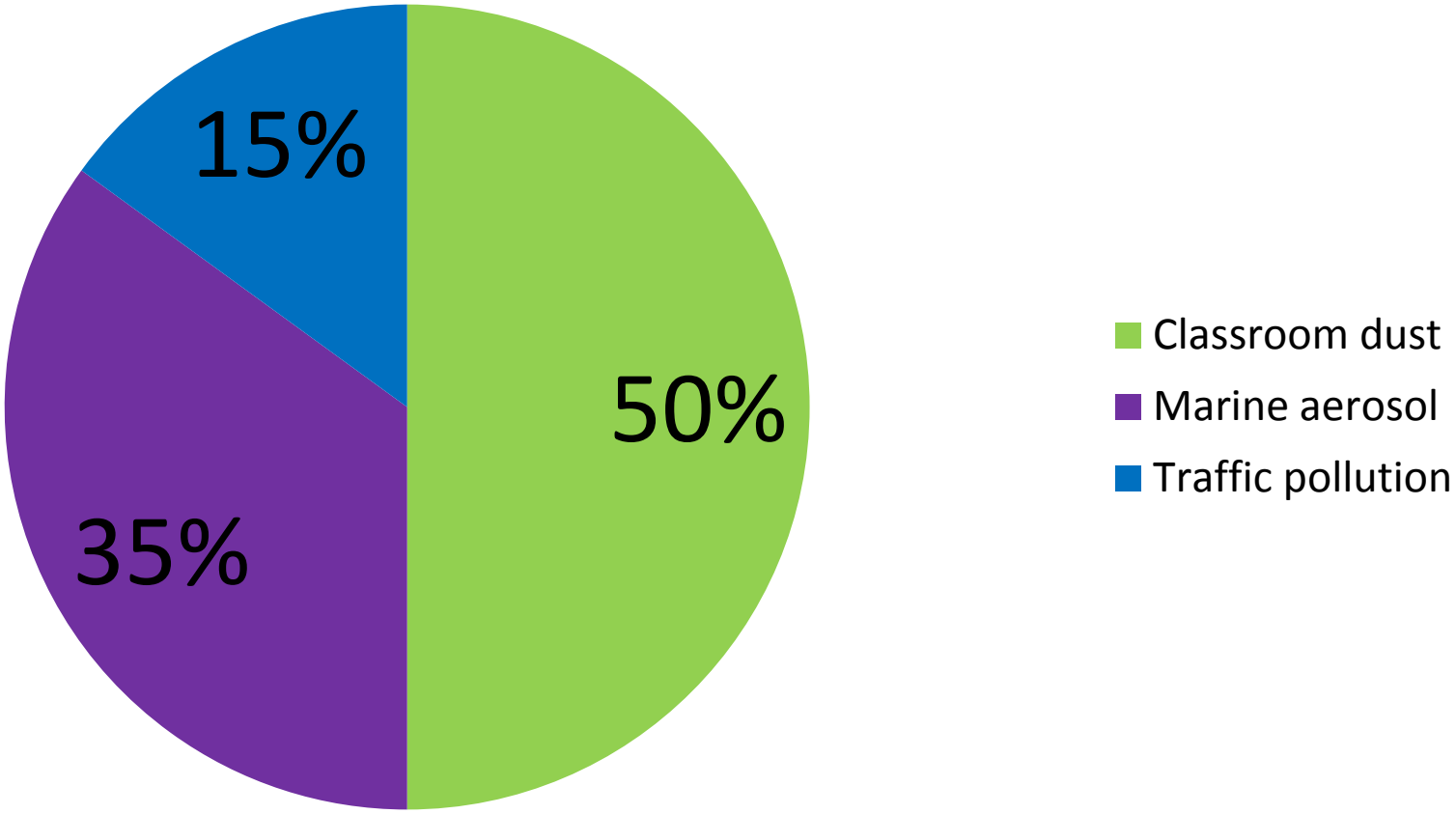
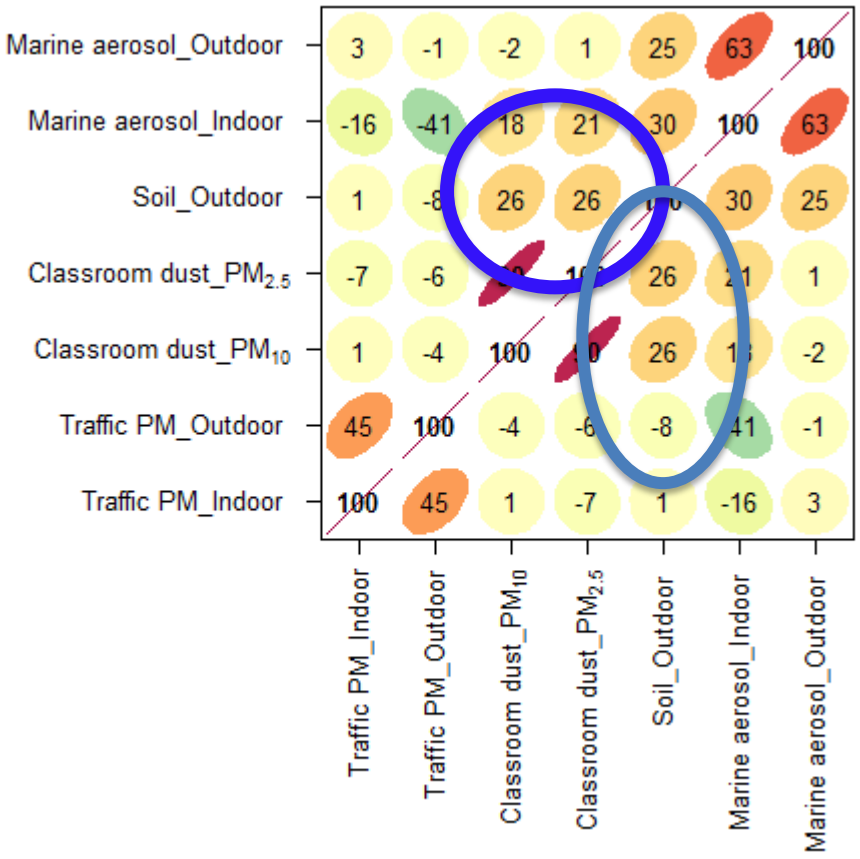
Source contributions to $PM_{2.5}$



Source contributions to PM_{10}



Correlation plot of source contributions



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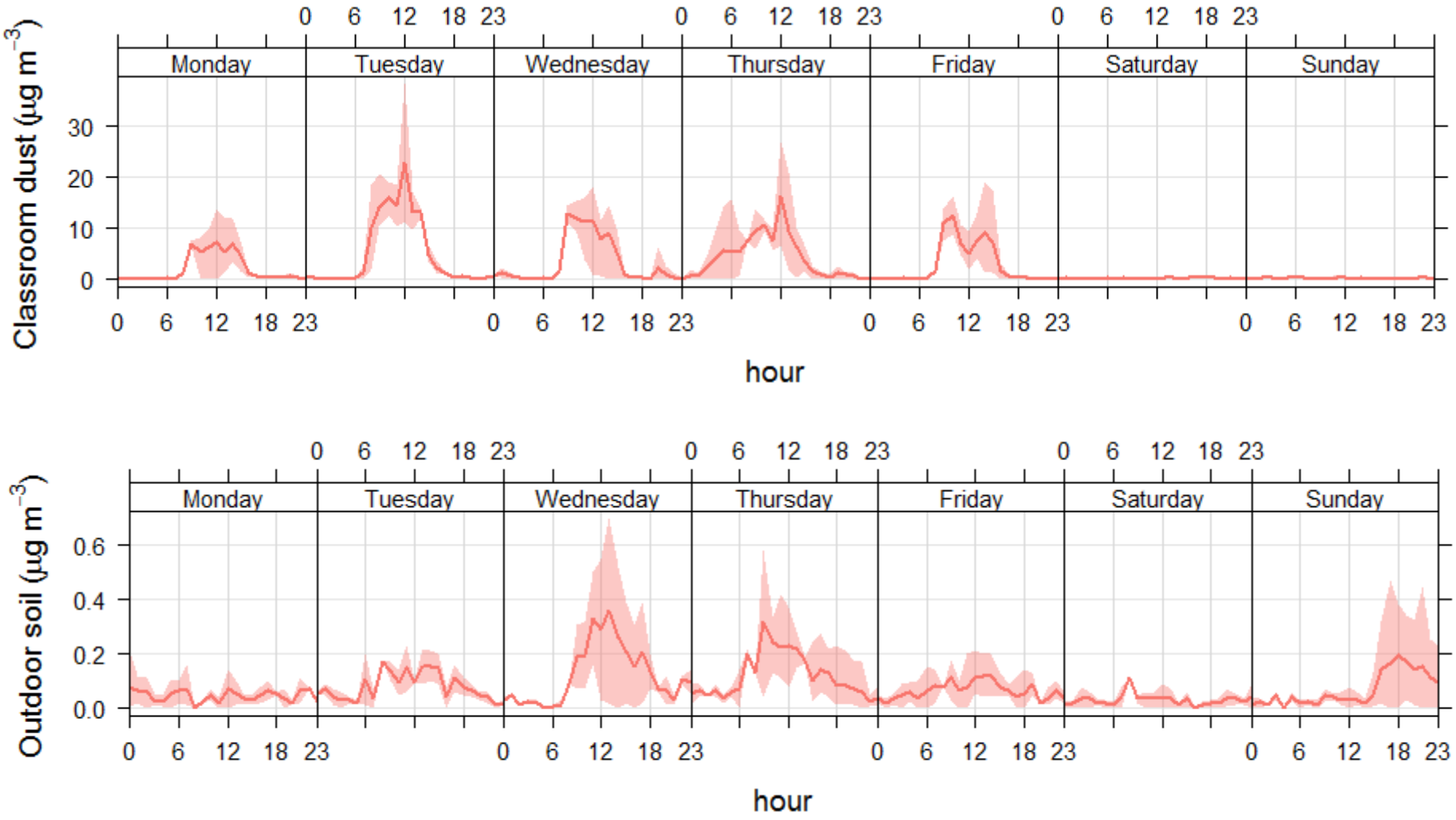
Diurnal variations – dust and soil



Conclusions

- PM_{10} concentration higher indoors than outdoors (6.9 cf 30.1 µg/m^3)
- PM_{10} – main source soil on shoes
- $PM_{2.5}$ – main source traffic pollution
- NO_2 – high levels
- Poor ventilation - 6.6 Ls^{-1}



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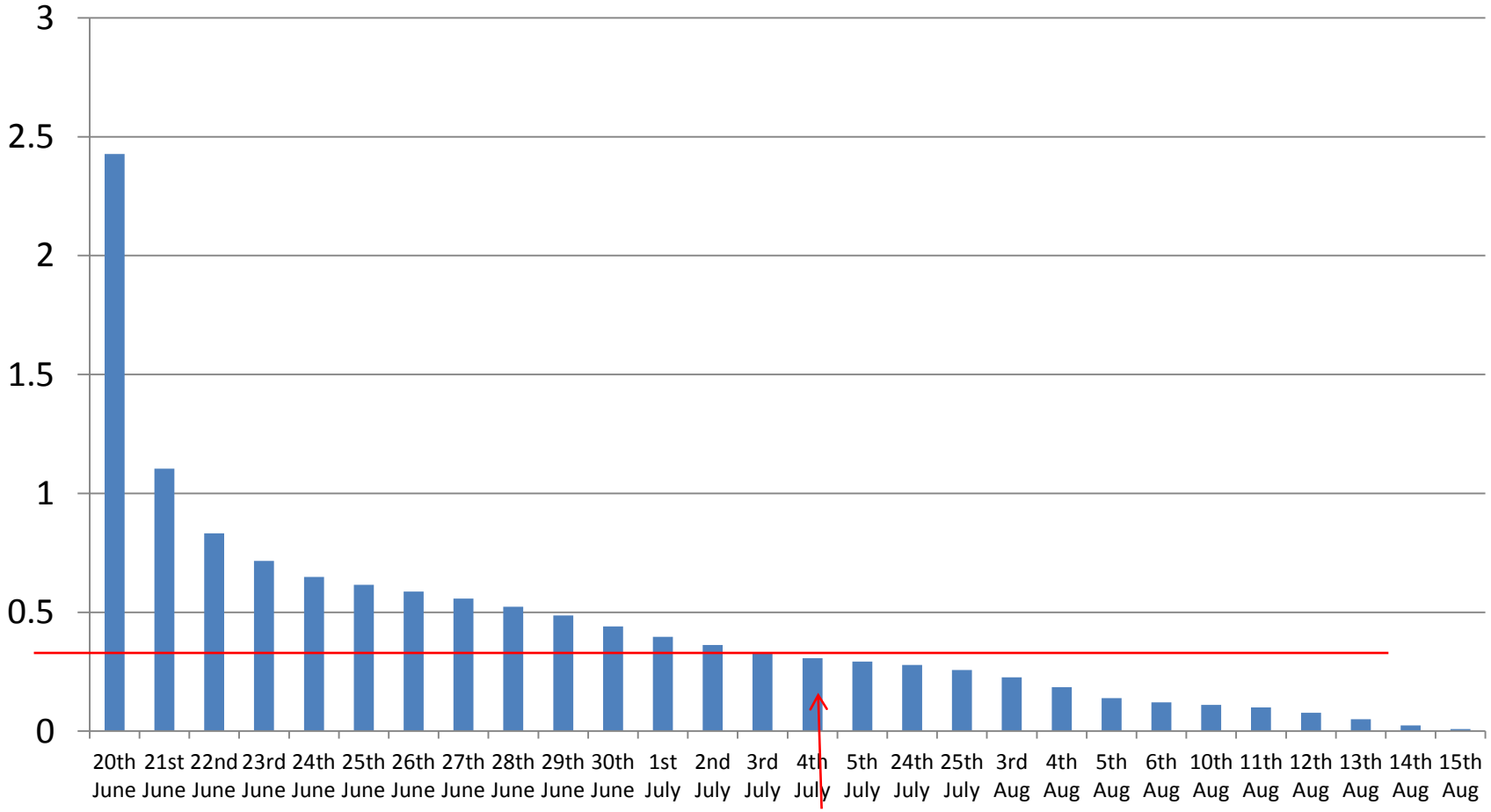
Suggestions to improve indoor air quality in schools

- CO_2
  - Open windows
  - Automatic windows in new buildings
- PM_{10}
  - Footbath
  - Remove shoes
  - Change cleaning routine
  - Smooth flooring
- $PM_{2.5}/NO_2$
  - Slightly more tricky
  - Plant trees (absorb pollution)
  - School could ask for the bus stop to be moved
  - MoE to plan new schools away from main roads


Newtown School

VOCs


3
2.5
2
1.5
1
0.5
0
20th June
21st June
22nd June
23rd June
24th June
25th June
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Sources of indoor air pollution at a New Zealand urban primary school; a case study

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ABSTRACT

Children are particularly vulnerable to the health effects of air pollution and as they spend a large proportion of time at school, this is an important environment for children's exposure to air pollution. Understanding the factors that influence indoor air quality in schools is critical for the assessment and control of indoor air pollution. This study analysed the concentration and sources of air pollution at an urban primary school (5–11 years) in Wellington, the capital of New Zealand. Over a three-week period during spring, indoor measures of particulate matter ($PM_{2.5}$, PM_{10}), temperature, humidity, carbon dioxide (CO_2) and nitrogen dioxide (NO_2) were taken and hourly air particulate matter samples ($PM_{2.5}$, $PM_{10\text{-}2.5}$) were collected inside and outside for elemental speciation analysis. Indoor PM_{10} concentrations during the school day were significantly ($p < 0.001$) higher than outdoor concentrations 30.1 (range 10.0–75.0, SD 1.9) μg m^{-3} c.f. 8.9 (range < 1.0–35.0, SD 6.8) μg m^{-3}. Elemental analysis and receptor modelling of PM samples showed that indoor PM_{10} was primarily composed of crustal matter (soil) elements, possibly brought in on children's footwear. The primary driver of indoor $PM_{2.5}$ was from the infiltration of outdoor pollutants inside, with by-products of motor vehicle emissions the main contributor to indoor $PM_{2.5}$. There is a need for mitigation strategies to reduce exposure to indoor air pollution at school, such as improved cleaning methods, reducing the use of carpet in schools and improved ventilation. The findings from this study will be applicable to many other schools and public buildings with high foot traffic.

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