

# Learning from trees: trees might be responsible for air pollution

## Conclusion

- The lowest number of particles, that represents air quality, is between 11:00 and 15:00 every day, rather than morning or night when human activity is less.
- Air quality is not only affected by the temperature inversion but also by plants detachment and photosynthesis. Figures 3 to 6 show a similar period of the environmental air quality from the 22<sup>nd</sup> to the 23<sup>rd</sup> of August.
- Monstera Deliciosa has the highest PM<sub>0.3</sub> removal efficiency of these three plants with the largest coefficient (58 h<sup>-1</sup> cm<sup>-2</sup>), shown in Table 1.

## Introduction

Particulate matter is a mixture of solid particles and liquid droplets suspended in the air. It is the most harmful form of air pollution, including metallic compounds (nickel compound, lead compound), bacteria and viruses.

### The drawback of the particles

- Environment (Miller, 2011)
  - Reduction of visibility
  - Acid rain
- Human's healthy (Miller, 2011)
  - Respiratory disease
  - Heart attacks
  - Permanent DNA mutations
  - Premature death

### Assumption

- A lit incense stick produced the same amount of differently sized particles for each box.
- At the beginning, 1,000,000 PM0.3 were produced in each box.

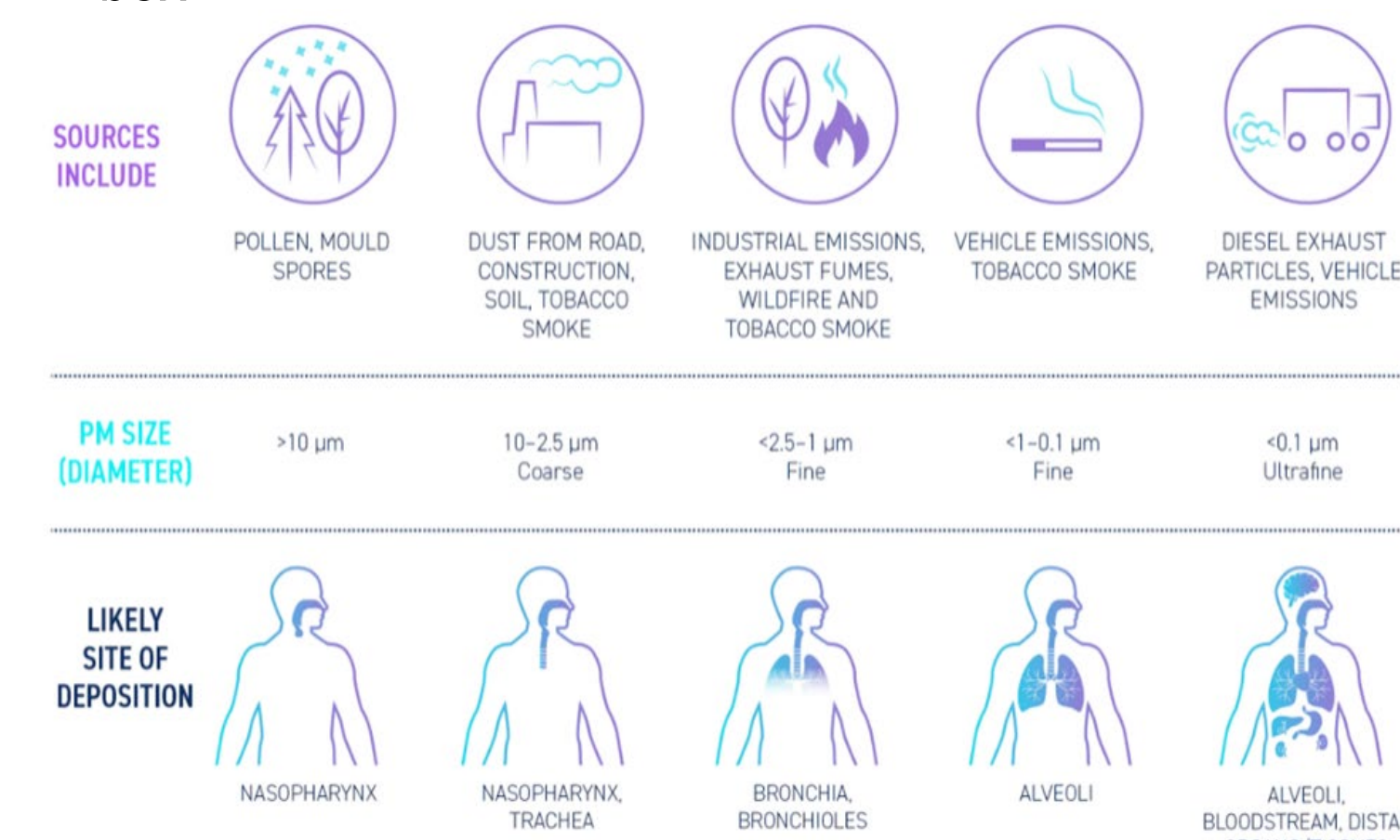


Figure 1: Particulate matter in air pollution and respiratory symptoms (Thecleanbreathinginstitute.com, 2019)

### Aims

- To investigate the absorption rate of particles on different plant leaves
- To correlate the effect of photosynthesis with absorption behaviour

### Methods

- Using a particle counter (PCE-PCO1) to measure outdoor data to find the trend change of air quality in the environment.
  - Experiment setup** (Controlled Experiments)
    - 4 boxes were used, with different plants in each box
    - An empty box used as control
- to determine the number of particles removed by plants

### Abbreviation

PM - Atmospheric Particulate Matter

### References

Miller, B.G. (2011) '4.5.3.2 Health Effects', in *Clean Coal Engineering Technology*. Elsevier.  
 Thecleanbreathinginstitute.com. (2019). *Risk factors*. [online] Available at: <https://www.thecleanbreathinginstitute.com/evidence/risk-factors/> [Accessed 12 Oct. 2019].  
 Young, T.M. (2018) '4.5.5 Temperature Inversions', in *Performance of the Jet Transport Airplane - Analysis Methods, Flight Operations, and Regulations*. John Wiley & Sons.

## Results

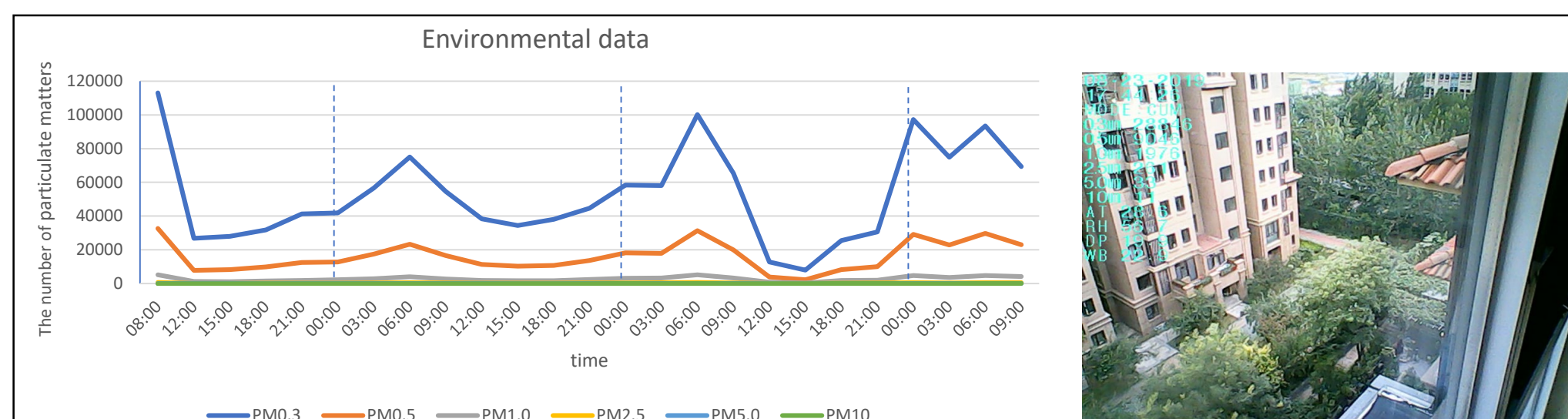


Figure 2: The number of PM in the environment for 3 days from 21<sup>st</sup> to 24<sup>th</sup> of August, in Tianjin, China

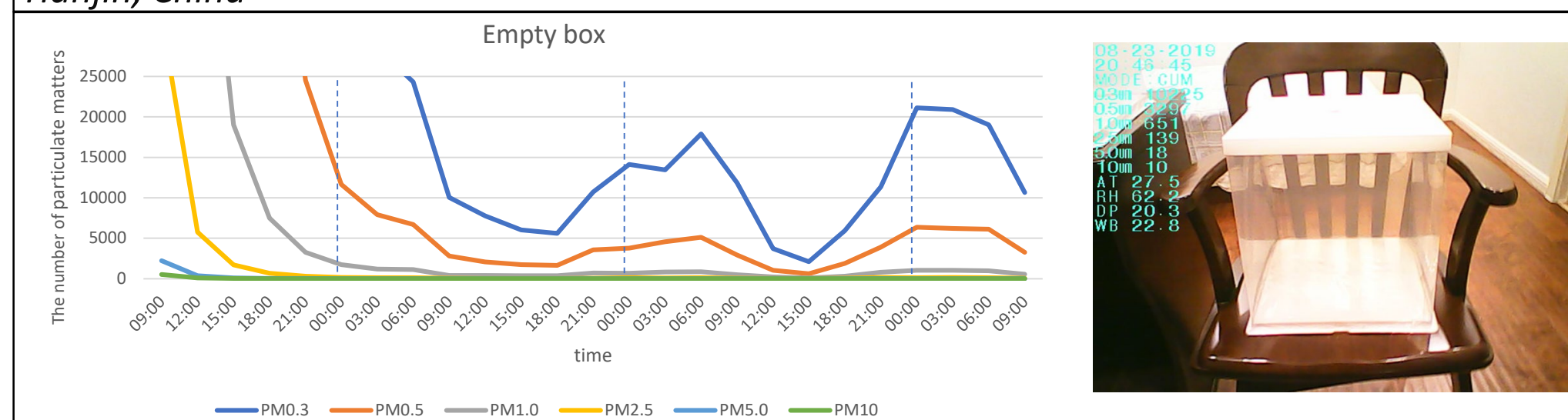


Figure 3: The number of PM in an empty box as control for 3 days from 21<sup>st</sup> to 24<sup>th</sup> of August, in Tianjin, China

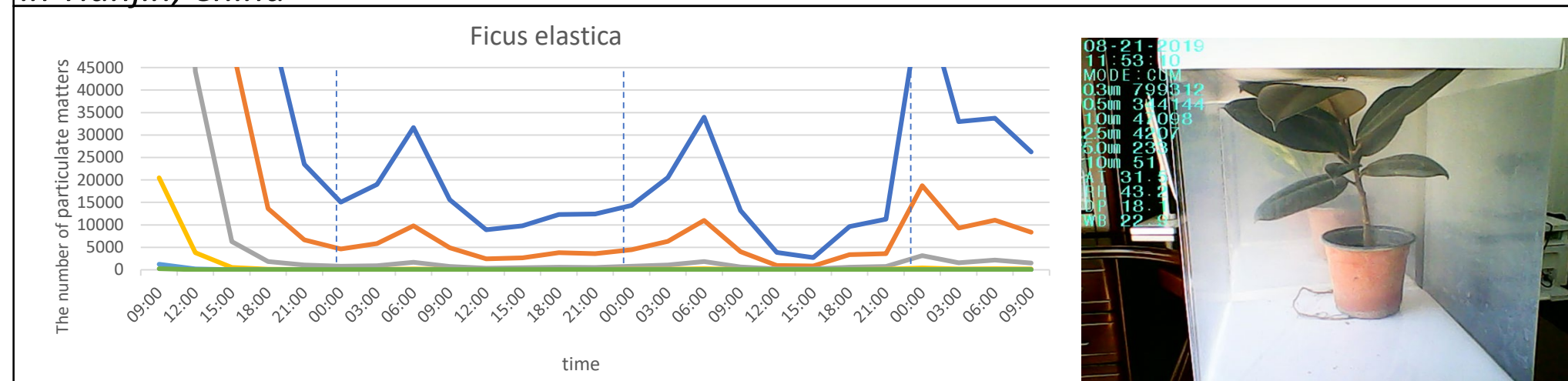


Figure 4: The number of PM surrounding Ficus Elastic in a box for 3 days from 21<sup>st</sup> to 24<sup>th</sup> of August, in Tianjin, China

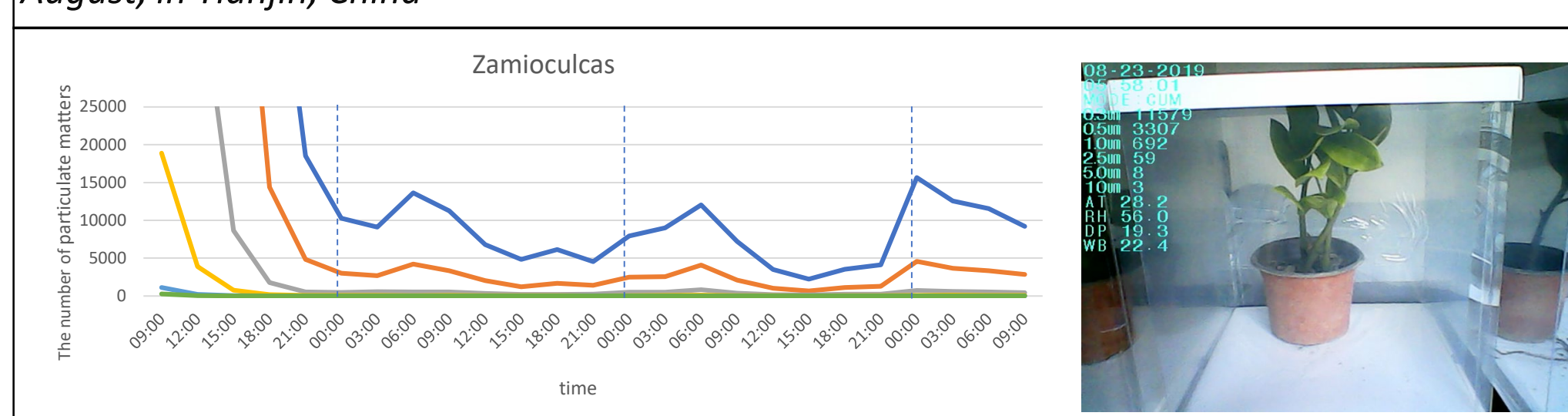


Figure 5: The number of PM surrounding Zamiculcas in a box for 3 days from 21<sup>st</sup> to 24<sup>th</sup> of August, in Tianjin, China

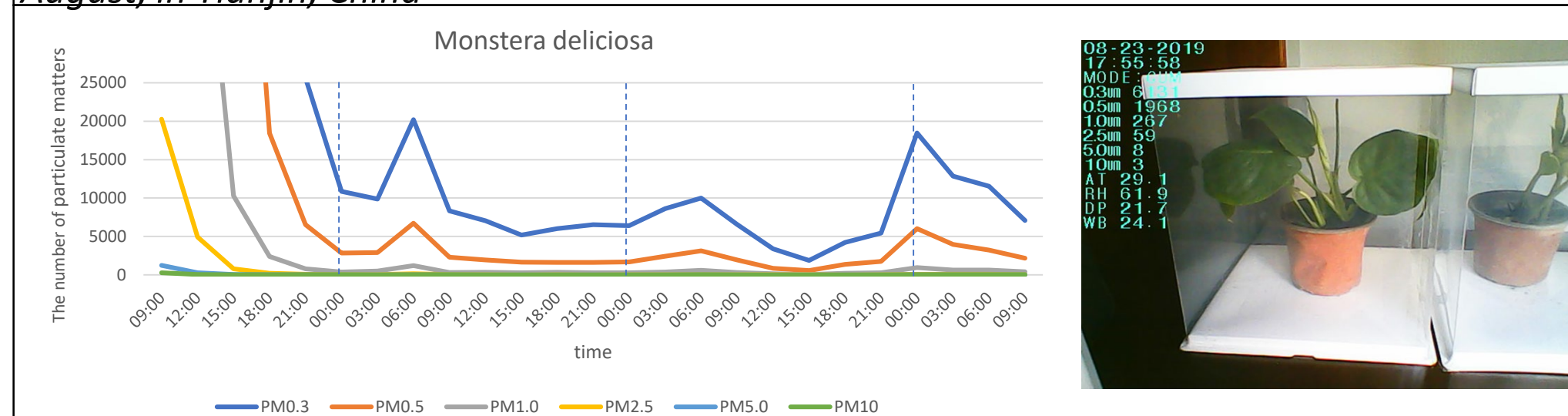


Figure 6: The number of particulate matters surrounding Monstera Deliciosa in a box for 3 days from 21<sup>st</sup> to 24<sup>th</sup> of August, in Tianjin, China

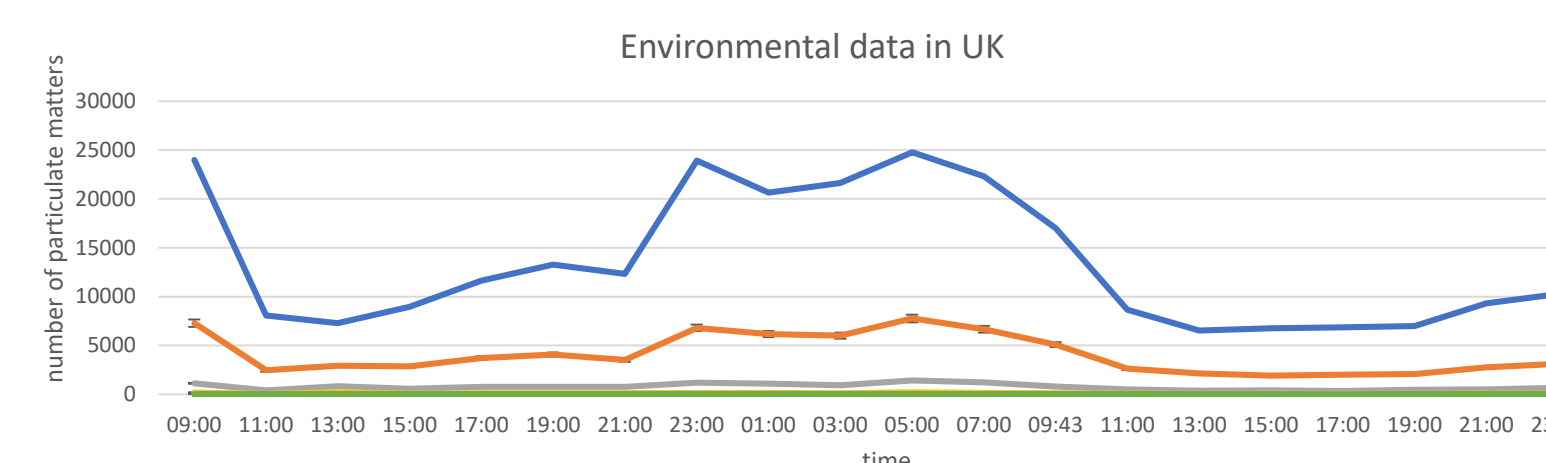


Figure 7: The number of PM in the environment during 38 hours in Newcastle Upon Tyne, UK.

Table 1: The calculations of the coefficient for PM<sub>0.3</sub> removed by a plant per hour per total leafage surface area

Boxes	The time of the number of PM <sub>0.3</sub> from 10 <sup>6</sup> to 1.5×10 <sup>4</sup> (h)	Reduced PM <sub>0.3</sub> per hour (h <sup>-1</sup> )	PM <sub>0.3</sub> removed by a plant per hour (h <sup>-1</sup> )	Total surface area of leafage (cm <sup>2</sup> )	The coefficient of PM <sub>0.3</sub> removed by a plant per hour per total leafage surface area (h <sup>-1</sup> cm <sup>-2</sup> )
Empty	23.0	42826	/	/	/
Ficus elastica	15.0	65667	22841	814	28
Zamioculcas	13.5	72963	30137	541	56
Monstera deliciosa	14.0	70357	27531	472	58

## Discussion

- Figures 2 and 7 show the same overall trend in air quality in China and in the UK. It was found that the lowest number of particles is between 11:00 and 15:00, rather than morning or night when human activity is less.
  - The temperature inversion affects the trend of air quality in the environment. Temperature inversion is when the upper air temperature is higher than the earth's surface temperature thus forming a thermal inversion layer. This leads to particles not being able to diffuse due to a limited air circulation (Young, 2018).
  - The container was designed to eliminate temperature inversion effects, and to determine the correlation between leaf detachment and the number of particles removed.
  - The empty box, Figure 3, shows two smaller peaks as the environment of Tianjin, Figure 2, which is at 06:00 on the 23<sup>rd</sup> of August and on the 24<sup>th</sup> of August at 03:00 for PM<sub>0.3</sub> and PM<sub>0.5</sub>. This indicates that the boxes are not completely sealed and the environment particles were carried into the boxes with air.
  - Figures 3 to 6 show similar results with the controlled box. The results conclude that the number of PM<sub>0.3</sub> decrease with time. In addition, the particles decreased more rapidly in the boxes with plants than the controlled box. This shows that the particles were affected by plants. The figures also show that there are less particles around noon, which indicates the effect of photosynthesis.
  - In fact, the fine particles did not fall quickly to the base of the boxes.
  - Figures 3 to 6 indicate a similar period of the environmental air quality.
  - Table 1 illustrates that the highest efficiency of these three plants is Monstera deliciosa, due to its largest PM<sub>0.3</sub> removal coefficient (58 h<sup>-1</sup> cm<sup>-2</sup>).
- ### Future Work
- Using fully sealed boxes
  - Addition of fans for each box to simulate the natural environment
  - Using electronic microscopes to see the structure change of leaves during a daytime.
  - Finding the fundamental mechanisms of PM captured by trees and grass