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Philips Foundation

Manchester Urban Observatory Measurements of Air Quality in Schools with Phillips Air Purifiers

Thomas Bannan, David Topping, James Evans

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Childhood exposure to particulate matter (PM), NO_x, O_3 and black carbon (BC) can impair lung development, cause respiratory inflammation (Lin et al., 2011) and there is evidence to suggest that attainment can also be compromised. There are many sources of PM both outside and within schools, very often outside the control of the school and therefore active measures that can reduce a child's exposure in the school setting is desirable.

One cost effective mitigation strategy is the use of High Efficiency Particulate Air (HEPA) filters, such as those provided by Phillips in this study. HEPA filters have been widely tested in controlled environments and shown to be effective at reducing PM (e.g. Peck et al., 2016), however evaluating their performance in the environment in which they are to be used is essential as performance is affected by factors such as climate, room size, pollution levels and the air exchange rate with other rooms within the building or outside (e.g. Dai et al., 2018).

In this study the Manchester Urban Observatory working with the University of Manchester collaborated with Global Action Plan and the Phillips Foundation to assess the effectiveness of Phillips Air Purifier, Series 3000i in a school setting.

The Manchester Urban Observatory attended 6 schools during the measurement period with various air quality instrumentation.

Russell Scott Primary School

UOM here deployed the following instrumentation;

1. 2 x Portable Optical Particle Spectrometers (both indoor)
2. 2 X Aethalometers (both indoor)

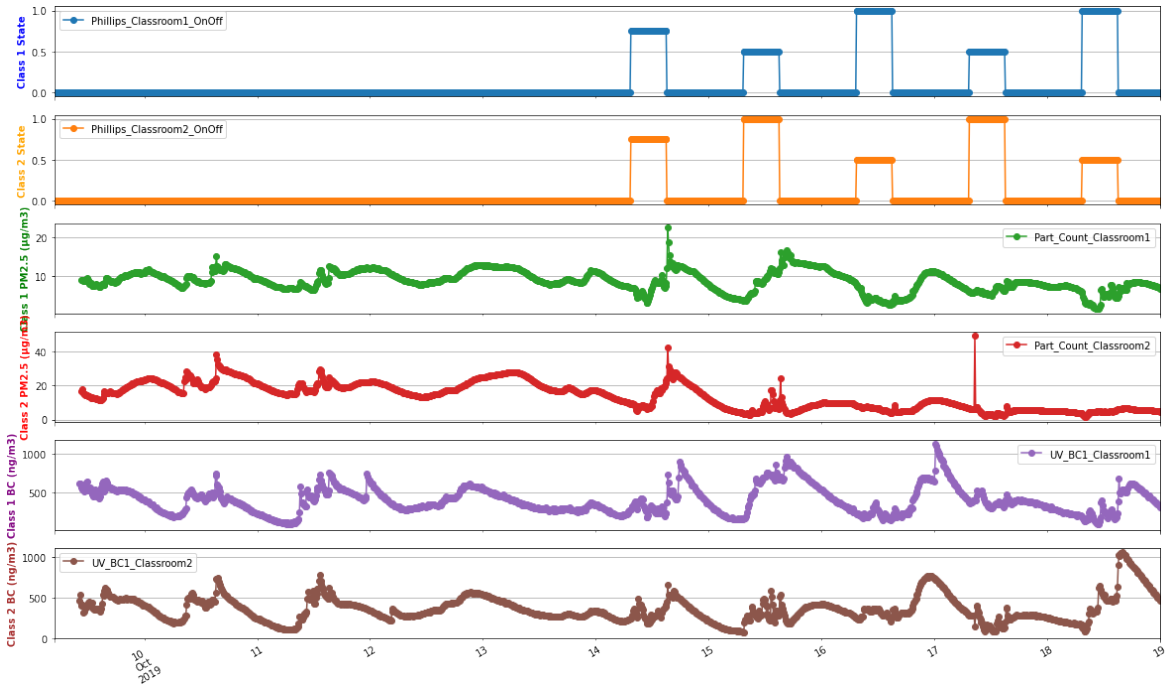

Figure 1: time series of Phillips air purifiers cycling in classroom 1 and classroom 2. 0 = off and out of school hours. 0.75 = both classrooms on. 1 = on and in classroom hours. 0.5 = off and in classroom hours. Green and Red time series shows PM 2.5. measurements using the Portable Optical Particle Spectrometer in classroom 1 and 2 respectively. Purple and brown show BC measurements in using the MA350 Aethalometer in classroom 1 and 2 respectively.

Intervention reduced BC by 32.3% during times when the purifiers were on in comparison to the reference measurement.

Intervention reduced PM 2.5 by 37.4% during times when the purifiers were on in comparison to the reference measurement.

These numbers are very dependent on local conditions and the length of experiment is very short. It is therefore difficult to place too much confidence in these numbers despite some good signs.

St Ambrose

UOM here deployed the following instrumentation;

1. 2 x Portable Optical Particle Spectrometers
2. 2 X Aethalometers

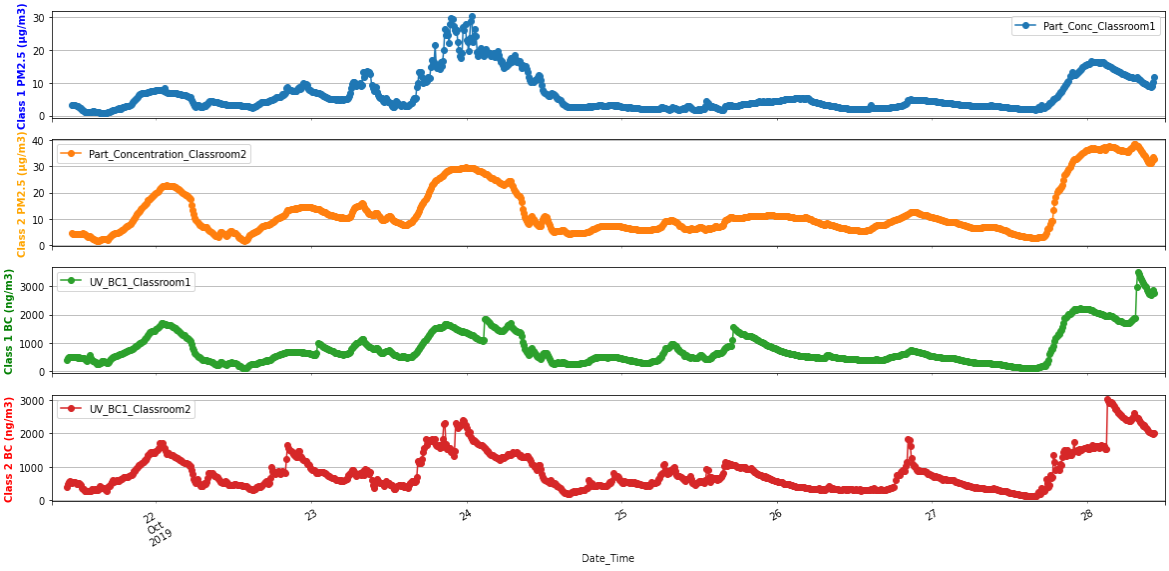

Figure 2: Blue and Orange time series shows PM 2.5. measurements using the Portable Optical Particle Spectrometer in classroom 1 and 2 respectively. Green and Red show BC measurements in using the MA350 Aethalometer in classroom 1 and 2 respectively.

Phillips data provided in this school does not support analysis of the effectiveness of the purifiers as the experimental design was not followed to a sufficient level.

It is a UOM recommendation that this school be prioritized in future studies due to building design and proximity to a large source of emissions that will affect air quality significantly. Use of classrooms, i.e. closed windows and very often closed doors were observed during installations and collection.

Beaver Road Primary School

UOM here deployed the following instrumentation;

1. 2 x Portable Optical Particle Spectrometers

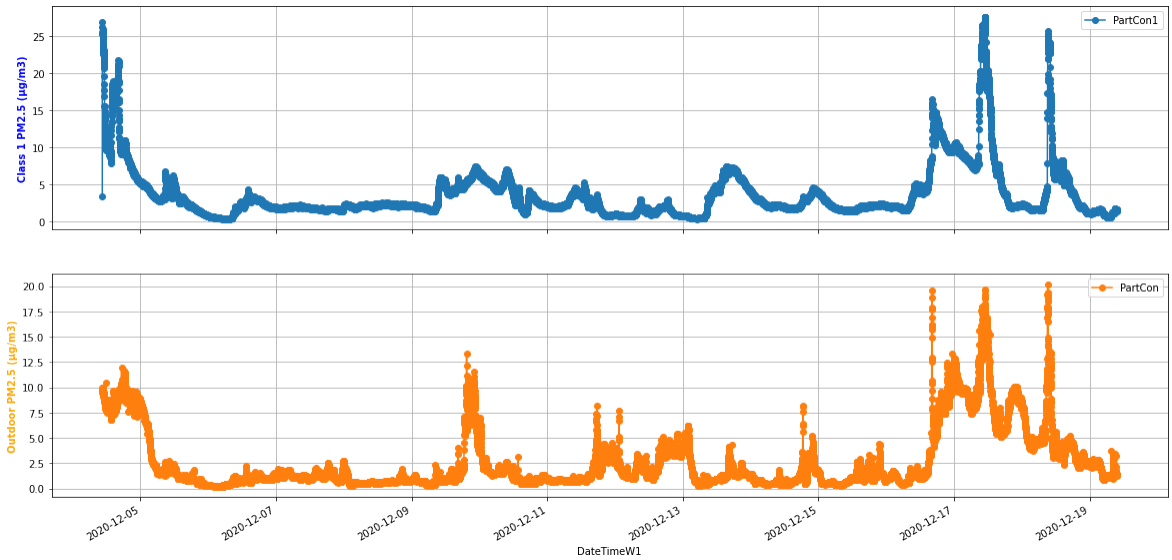

Figure 3: Blue and Orange time series shows PM 2.5 of indoor and outdoor respectively.

Data from the purifiers was not accessible in this school, therefore UOM data cannot be used here.

St Mary's Reddish

UOM here deployed the following instrumentation;

1. 2 x ARISense Units for one week.

Data from the purifiers was not accessible in this school, therefore UOM data cannot be used here.

Cannon Burrows Primary School

UOM here deployed the following instrumentation;

1. 3 x Portable Optical Particle Spectrometers (2 indoor and 1 outdoor)

Only data where there are outdoor and indoor data running concurrently will the data be considered as unfortunately the Philips purifiers were turned on and off at roughly the same time and therefore no reference data is available to rule out local changes in air quality affecting the measurements at these times. The outdoor monitor was unfortunately unplugged by staff/pupils at the school and is the reason for the large break in measurements seen here.

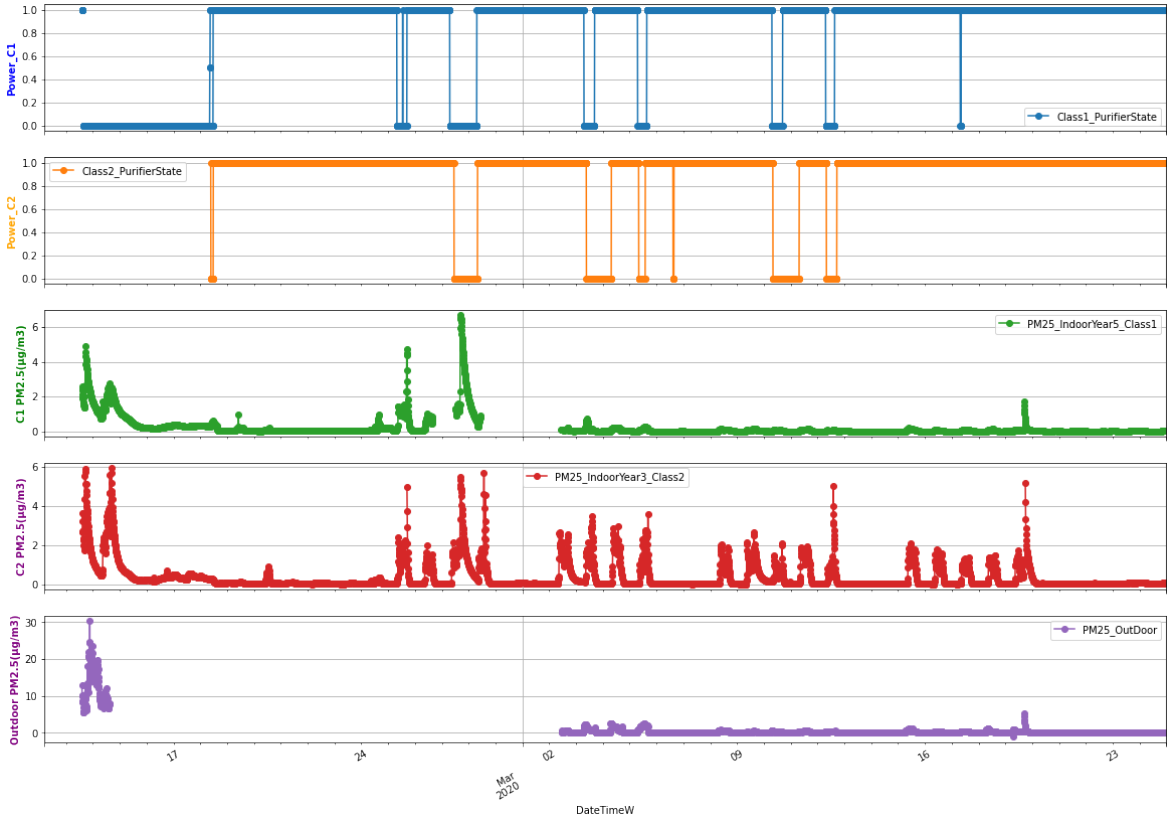

Figure 4: time series of Phillips air purifiers cycling in classroom 1 and classroom 2. 1 = on and 0 = off. Green and Red time series shows PM 2.5. measurements using the Portable Optical Particle Spectrometer in classroom 1 and 2 respectively and purple shows the outdoor measurements.

An average 14% reduciton in PM 2.5 was observed as a result of the intervention across the full measurment period.

Medlock Primary School

UOM here deployed the following instrumentation;

1. 2 x ARISense Units (1 in a classroom with purifier and 1 in a corridor to provide a reference measurement)

Figure 5: time series of Phillips air purifiers cycling in classroom 1. 1 = on and 0 = off. Orange series shows PM 2.5, Green shows NO2 and Red show O3 as measured by ARISense Units.

In comparison to the reference instrument there was no significant change in PM2.5, NO_2 or O_3 when the purifiers were on and off.

NO2 was on average <1% lower when the purifiers were on.

O3 was on average 3% lower when the purifiers were on.

PM2.5 was on average 2.2% lower when the purifiers were on.

Conclusion

1. Children's exposure to poor air quality can affect their development. Active measures that can reduce a child's exposure in the school setting is therefore desirable.
2. High Efficiency Particulate Air (HEPA) filters have been widely tested in controlled environments and shown to be effective at reducing PM (e.g. Peck et al., 2016), however evaluating their performance in the environment in which they are to be used is essential
3. Over a short subsection of the experiment there was evidence to suggest that the Phillips Intervention reduced PM 2.5 by 37.4% during times when the purifiers were on in comparison to a reference measurement.
4. Much of the usable measurements showed no indication of air quality improvement as a result of the use of purifiers, likely as a result of high air exchange rate with outdoor or other adjacent rooms.
5. The amount of UOM measurement data that could be used to assess the effectiveness was very low due to poor compliance with experimental design from Schools. A recommendation would be to control the purifiers remotely to ensure experimental design is accurately followed.

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