Is covid-19 solving our air pollution problem? Some new data from the UK

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What is our air pollution problem?

The World Health Organisation (WHO) estimates that air pollution kills an estimated 7 million people per year worldwide, and some 4.2 million premature deaths per year are caused by exposure to ambient (outdoor) air pollution[1]. The WHO estimates that 91% of the world's population lives in places where air pollution levels exceed the WHO limits reflected in its guidelines.

Air pollution is considered to be 'the largest environmental health risk in Europe' (EEA). In 2016, according to the European Environment Agency (EEA), the following numbers of premature deaths are attributable annually to certain specific pollutants –

412,000	attributed to PM 2.5 particulates
71,000	attributed to NO_2
15,100	attributed to O_3 ozone.[2]

[1] WHO Ambient Air Pollution - https://www.who.int/airpollution/ambient/health-impacts/en/

[2] EEA Health Impact of Air Pollution - https://www.eea.europa.eu/themes/air/health-impacts-of-air-pollution/health-impacts-of-air-pollution

The numbers are coming down, in part because of measures such as those contained in the EU's Clean Air Package of 2015, but air pollution remains one of the most significant causes of premature death across Europe, with nitrogen dioxide (NO_2) being the primary cause of Air Quality Management Area declarations[3]

Covid-19: an opportunity?

As the covid-19 lockdown has lead to a sudden reduction in road traffic, there has never been a better opportunity to ask the question: is air pollution reducing in our cities, and if so, is this due to less traffic on the roads? To begin to find an answer, this article will take a first glimpse at new air quality data from the normally frenetic Marylebone road in central London. Raw provisional data from the Marylebone AURN air quality monitoring site was downloaded from the Air Quality England[4] website and then processed to give the figures discussed below.

Pollutant data from a London street

NO_x

How has the lockdown affected NO_x pollutant concentrations in the air? Let's look at the first four weeks of the lockdown (23/03/20 – 27/04/20) and compare them to those same four weeks over the last three years. Figure 1 below shows the average pollutant concentrations of NO_x for each year of study, with respect to wind speed and direction. The centre of the plot represents the average pollutant concentration under zero wind speed conditions, and then wind speed increases radially outward with wind speed direction. The wind speed is important because it significantly affects the reported pollutant concentrations. We can directly compare emissions from multiple years by focusing on the colour of the wind speed/direction areas common to all years under consideration. The colour scale with associated concentrations is on the right hand side, while the year is at the top of each plot. We can immediately see that NO_x emissions this year appear much lower than in previous years, because the graph appears far bluer.

[3] DEFRA – Trends in Primary Nitrogen Dioxide in the UK
[4] Air Quality England – https://www.airqualityengland.co.uk/

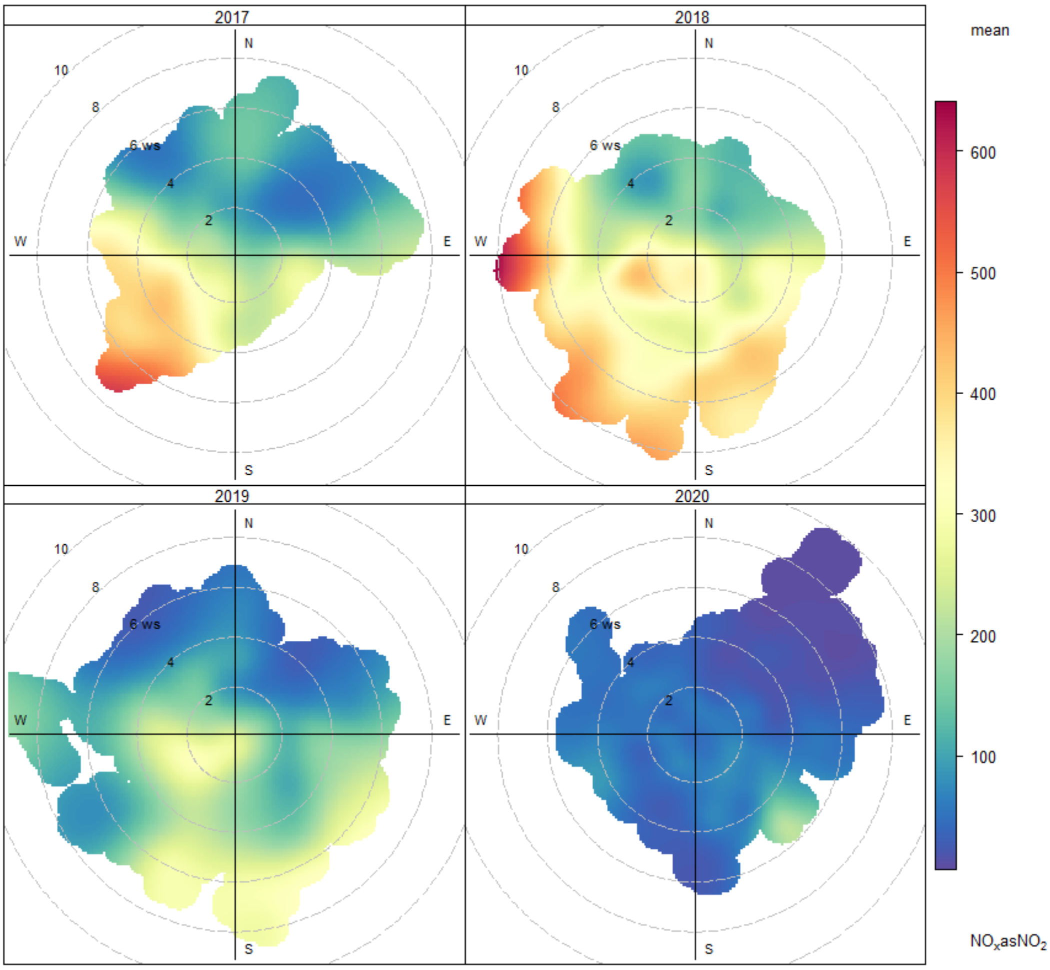

Figure 1. Bipolar plots of NO_x concentrations (μg/m^3) at Marylebone Road Air Quality site for 23rd March – 27th April for years 2017-2020. The centre of each plot represents a wind speed of zero, increasing radially outward. A colour scale indicates NO_x concentration for that wind speed/direction (processed using the openAir package [5]).

NO and NO_2

NO_x is made up of two chemicals, nitrogen monoxide (NO) and nitrogen dioxide (NO_2). As discussed in the introduction, NO_2 is a pollutant of major health concern. NO, however, is much less harmful, and so it is important to distinguish between these two pollutants when considering air quality effects on health.

The next set of graphs show the levels of NO and NO_2 with time, for the four weeks since the UK went into lockdown. The black lines are for 2020, while the coloured lines show the same time periods for 2017-2019. Comparing NO_2 and NO separately for these years reveals that though both show a decrease, this is greatest for NO. Studying the emissions with time for the four periods in question allows us to see how this difference arose. Emissions are a little lower than previous years for the first 80 hours of the lockdown, but then quickly diverge, remaining far lower than for previous years. By the end of lockdown week four, NO shows an 88% decrease on average compared to the three previous years, while NO_2 decreased by 61% on average.

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[5] Carslaw DC, Ropkins K (2012). "openair — An R package for air quality data analysis." *Environmental Modelling & Software*, **27–28**(0), 52–61. ISSN 1364-8152, doi: 10.1016/j.envsoft.2011.09.008.

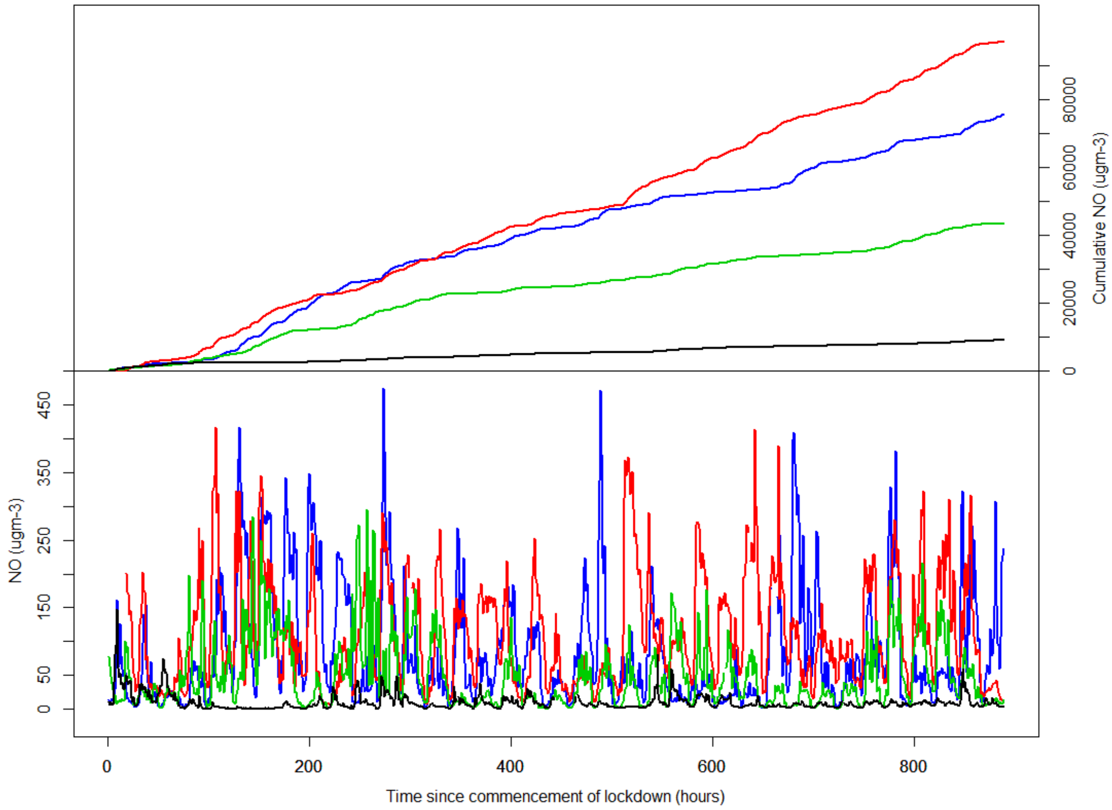

Figure 2. NO concentrations (µg/m³) as a function of time for the first four weeks since the UK lockdown was commenced. Transient concentrations on the bottom graph are plotted cumulatively on the top graph. Blue lines are 2017, red lines are 2018, green lines are 2019 and black lines are 2020.

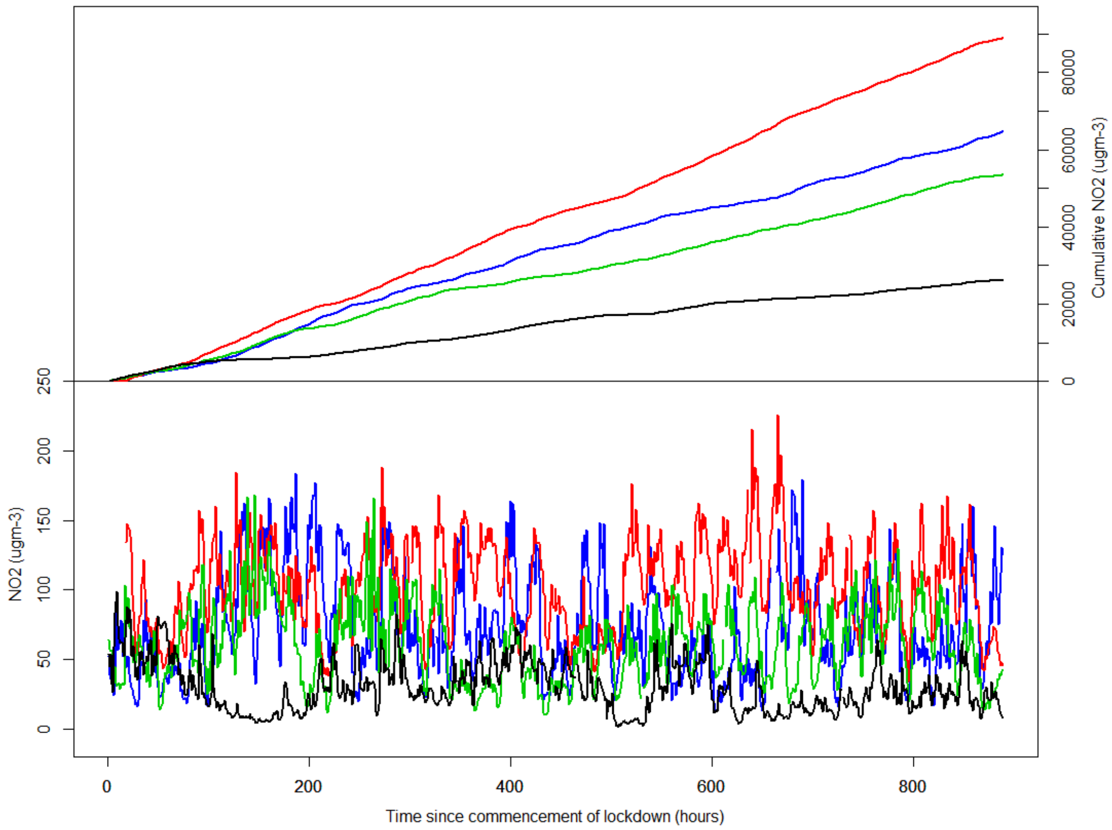

Figure 3. NO_2 concentrations (µg/m³) as a function of time for the four weeks since the UK lockdown was commenced. Transient concentrations on the bottom graph are plotted cumulatively on the top graph. Blue lines are 2017, red lines are 2018, green lines are 2019 and black lines are 2020.

Petrol vehicles produce negligible NO_2 emissions compared to diesel vehicles[6], and so any proportionate decrease in NO emissions indicates a proportionate decrease in petrol vehicles. The NO has decreased more than NO_2. Though the air quality improvement has likely arisen from both petrol (gasoline) and diesel vehicle reductions, petrol vehicle use must have reduced more. With the introduction of the ultra-low emission zone (ULEZ) in place from 18th April 2019 focusing on limiting older diesel cars, we would actually expect the proportion of diesel vehicles on London roads to be decreasing compared to petrol vehicles, so this opposing trend can be quite surprising… until we consider the lockdown currently in place.

Cars vs. Vans

In 2017, 89% of all petrol use for road transport was by households, compared to 40% for diesel vehicles[7]. The lockdown is likely to drastically reduce light duty vehicles - predominantly taxis and personal vehicles - as people are told to only leave their houses to buy essential goods and work from home where possible. However, the diesel-based, medium-duty and heavy-duty traffic will be less impacted, with transportation of goods still necessary, perhaps even including an increase in home delivery vans. The evidence presented from Marylebone Road appears to support this theory.

Better tech, stricter laws?

It is conceivable that this decrease in NO and NO_2 compared to previous years is driven by technological advances and stricter government legislation, including the introduction of the ULEV. However, the two plots below showing NO and NO_2 data for the last few months indicates that this is not the main cause, as the decrease has occurred at the end of March and into April. These plots also confirm that NO is decreasing more than NO_2, with more flattening of the cumulative NO curve from around the time that the lockdown was enforced. A red line denotes the official commencement of the lockdown at midnight on 23rd March, though throughout the week prior to this announcement the official guidance was dissuading people from making unnecessary journeys from their homes.

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[6] DEFRA – Remote sensing of NO2 exhaust emissions from road vehicles (2013)

[7] Office for National Statistics – Road transport and air emissions (2019)

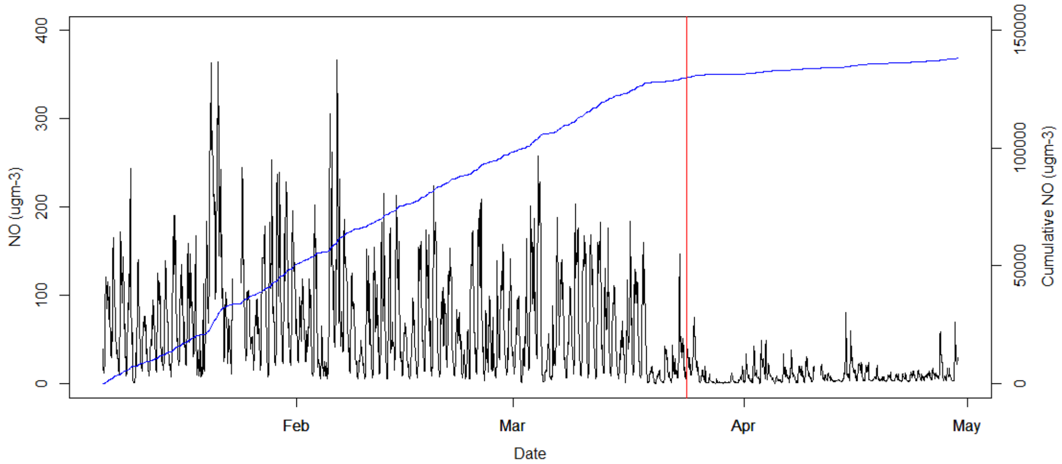

Figure 4. Atmospheric NO concentrations (μg/m³) are Marylebone Road monitoring site (transient concentrations in black, cumulative concentrations in blue). A red line denotes the commencement of the UK lockdown.

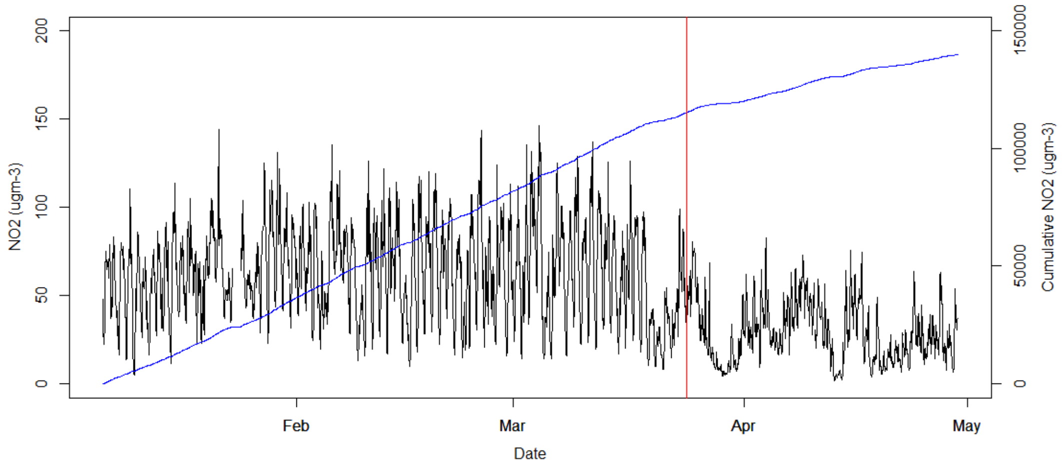

Figure 5. Atmospheric NO_2 concentrations (μg/m³) are Marylebone Road monitoring site (transient concentrations in black, cumulative concentrations in blue). A red line denotes the commencement of the UK lockdown.

Final thoughts

The data presented suggests the power of strict traffic reductions to curb our air pollution levels, examining the NO and NO_2 pollutant emissions from one London street as an example. However, the data also suggests the need for a targeted approach if the concentrations of the most toxic pollutants are to be abated. It is unlikely that the numbers of vehicles on the road will ever be this low again in the near future, but as the economy restarts, similar impacts could be achieved by targeting the heaviest polluting vehicles – through stricter periodic technical inspections and MOTs, for example. There will be much about the lockdown we will wish to forget, but it may also contain important lessons to learn.