Air pollution returns to European capitals: Paris faces largest rebound

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Paris has seen the largest increase in deadly NO2 pollution among European capitals, as restrictions on transport are lifted, new analysis of official air quality monitoring data by Centre for Research on Energy and Clean Air has found.

A side-benefit of lockdowns has been the return of low-pollution levels and blue skies in many European cities. However, as lockdown measures are eased in European cities, air pollution levels are rebounding. The increase in pollution is not an inevitable price to be paid for freedom of movement - clean transport solutions can enable mobility without pollution.

The rapid return of air pollution in Paris, where NO2 pollution levels have more than doubled (+120%) from the cleanest 30-day period during lockdown, is a particular concern: NO2 air pollution exceeding legal limits was responsible for 4,300 deaths in Paris in 2005-2009, according to a detailed French study. NO2 pollution causes an estimated 1,300 new cases of child asthma in the city, 1/3 of all new cases[1]. The European Court of Justice condemned France in 2019 for insufficient action against NO2 pollution.

In this document, we look at this rebound in large European cities and aim to see where it is the fastest or most pronounced, or where, on the contrary, cities have managed to maintain air pollution levels at lower levels.

[1] The estimated rate is 360 cases per 100,000 children aged 1-18 years.

Key findings

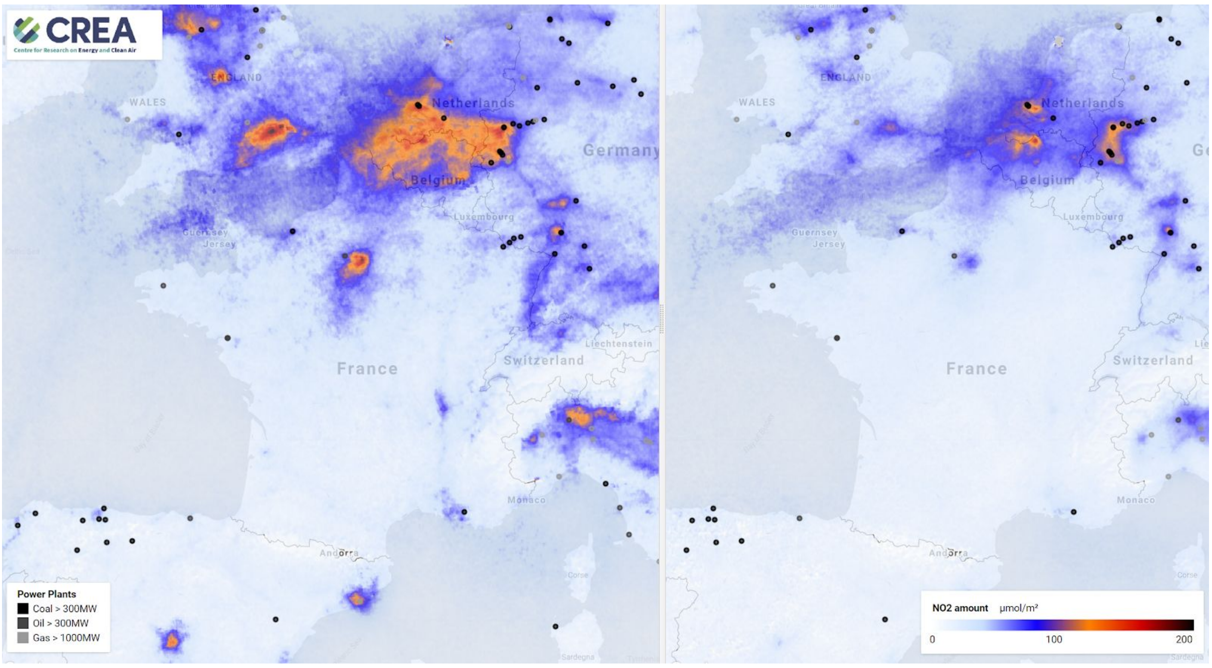
- Large European cities have seen a significant decrease of air pollution after the outbreak of COVID-19, even after accounting for weather conditions.
- Bucharest, Paris, Lisbon and Milan have seen the largest reductions in air pollution during the COVID-19 lockdown measures, demonstrating the benefits to be reaped if air pollution can be reduced in a more sustainable way. However, these cities also were among the most-polluted European cities before the pandemic outbreak.
- Air pollution has already bottomed out and started to converge towards pre-COVID-19 levels in all cities, albeit at differing paces.
- All cities but Budapest still remain below the pre-COVID-19 levels after accounting for weather conditions.

Policy recommendations

Nitrogen dioxide pollution originates from fossil fuel burning in vehicles, power generation and industry. Shifting to clean energy sources, reducing overall energy needs with smart solutions, and strengthening emissions standards can restore the air quality experienced during the lockdowns, in a sustainable way.

- Align COVID-19 recovery policies with protecting public health from air pollution and climate change - speed up the shift to clean energy and clean transport
- Support cycling and walking - providing space and infrastructure for walking and cycling could transform our transportation systems. This will not only help maintain social distancing during the COVID-19 outbreak, but will also create healthy lifestyle and transportation choices for long term. In the future, such infrastructure should be made the priority in urban planning.
- Ensure hygiene and social distancing measures in public transport. Consider spending on increasing the frequency and numbers of public transportation services, as well as investing in expanding geographical coverage. By increasing public transport capacity now, we can mitigate against further transmission of COVID-19. If that capacity is maintained in the long-term, society can benefit from reduced traffic, decongested cities, and improved air quality in the future.
- Electrify public transport. Diesel buses in particular are a significant source of NO2 emissions - electrification can make public transport cleaner and more attractive. Ensure rapid elimination of fossil fuels in power generation to make electric vehicles zero-emission.

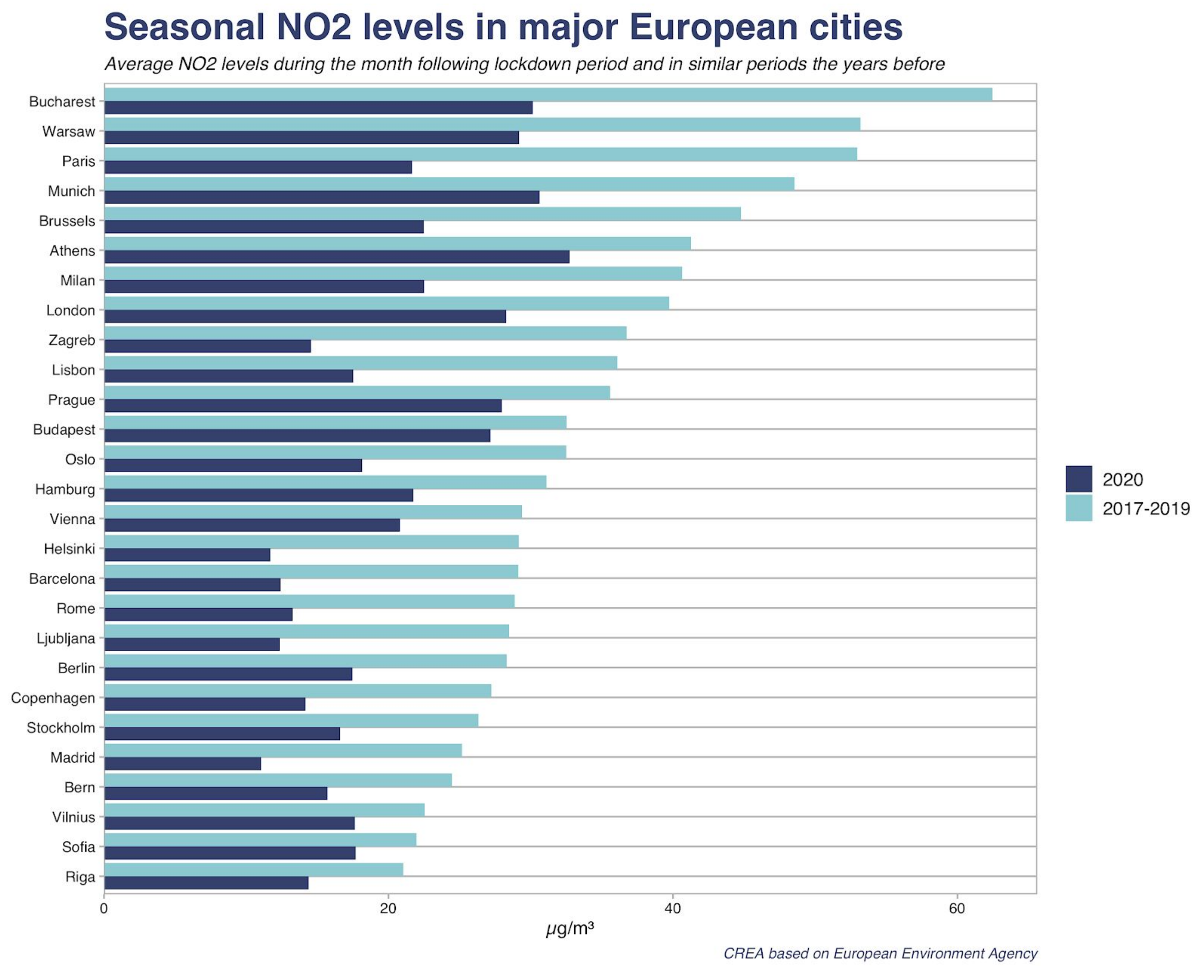
- Get highly emitting vehicles off the road. Low and zero emission zones, stronger vehicle emission standards and strengthened enforcement to prevent cheating can all alleviate emissions from private cars and encourage other means of transport. The shift towards electric vehicles can also be accelerated by targeting economic stimulus at building infrastructure for clean energy powered charging stations.



Satellite-based nitrogen dioxide pollution measurements show the drop in pollution in April-May 2019 (left) and 2020 (right).

All cities have seen a significant decrease in air pollution

We look at NO_2 concentrations in European cities with more than 1 million population. As can be seen in the chart below, all cities have seen a significant decrease of air pollution compared to the previous years. Thanks to this reduction, all cities are now below the 40µg/m^3 limit set by EU regulations[2]. Yet many remain above 20µg/m^3, threshold above which the risk of death increases according to the WHO.



After accounting for weather conditions[3], Paris saw the second largest decrease attributable to lockdown (first one in relative terms), representing a 60% fall compared to

[2] Note that this limit is an annual average one whilst the chart only represents average over a single month.
[3] See methodology section below for more details.

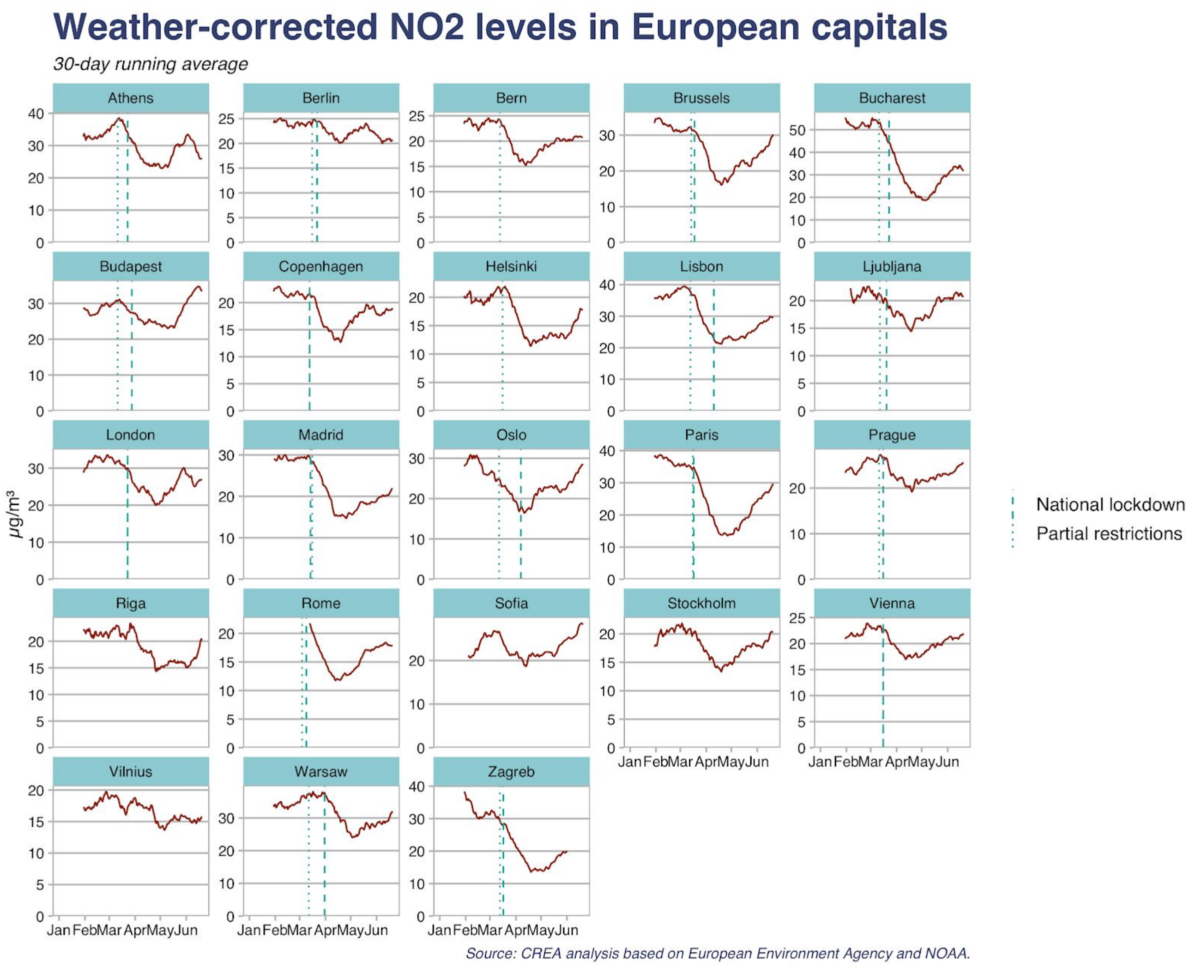
its pre-COVID level. This highlights the potential benefits to be reaped through more ambitious transport policies.

!ALQ	O=<M;LAGF (µg/m³) - (%)	!ALQ	O=<M;LAGF (µg/m³) - (%)
Bucharest	35 (65%)	London	10 (33%)
Paris	21 (60%)	Copenhagen	9 (42%)
Lisbon	17 (44%)	Bern	9 (37%)
Milan	17 (47%)	Oslo	8 (34%)
Zagreb	16 (54%)	Munich	8 (22%)
Brussels	16 (49%)	Prague	8 (29%)
Madrid	14 (49%)	Ljubljana	7 (31%)
Warsaw	13 (35%)	Vienna	5 (23%)
Athens	11 (32%)	Hamburg	5 (20%)
Barcelona	11 (43%)	Budapest	4 (16%)
Helsinki	10 (47%)	Berlin	4 (18%)

Table 1 - Reduction of NO2 levels attributed to lockdowns

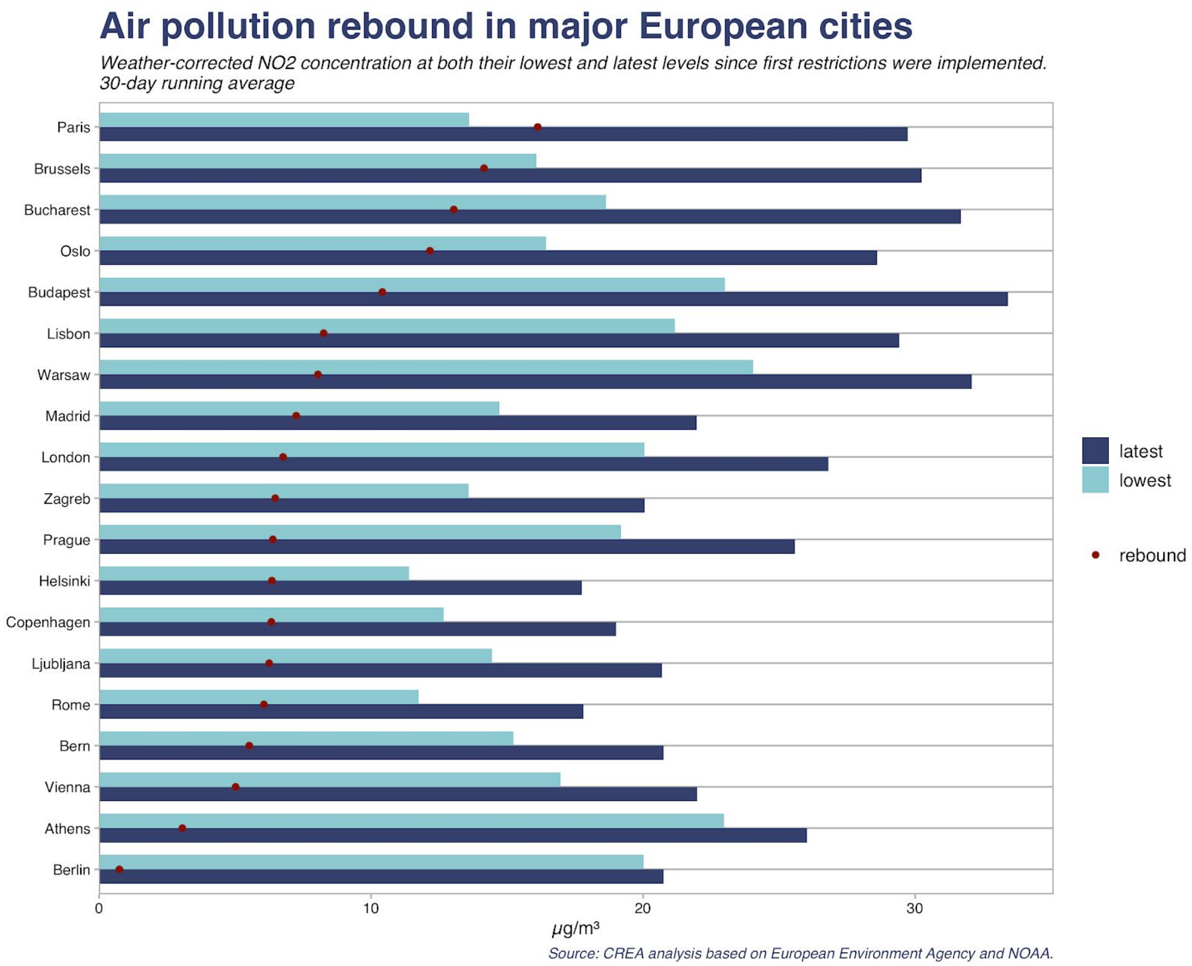
Rebounds towards pre-COVID-19 levels have already begun

Air pollution has already bottomed out in all analysed cities and started to converge towards pre-COVID-19 levels. The chart below shows these ‘rebounds’ after accounting for weather conditions:



The impact of first restriction measures and full lockdowns can clearly be seen, with sharp decreases of NO2 levels shortly after their implementation. On average, cities reached their minimum level 24 days after first measures were implemented, and initiated their ‘rebound’ of air pollution.

As can be seen in the chart below, Paris is the city with the sharpest rebound, followed by Brussels and Bucharest. Note: we quantify the ‘rebound’ as the difference between the ‘lowest’ and the ‘latest’ 30-day mean, until June 20.

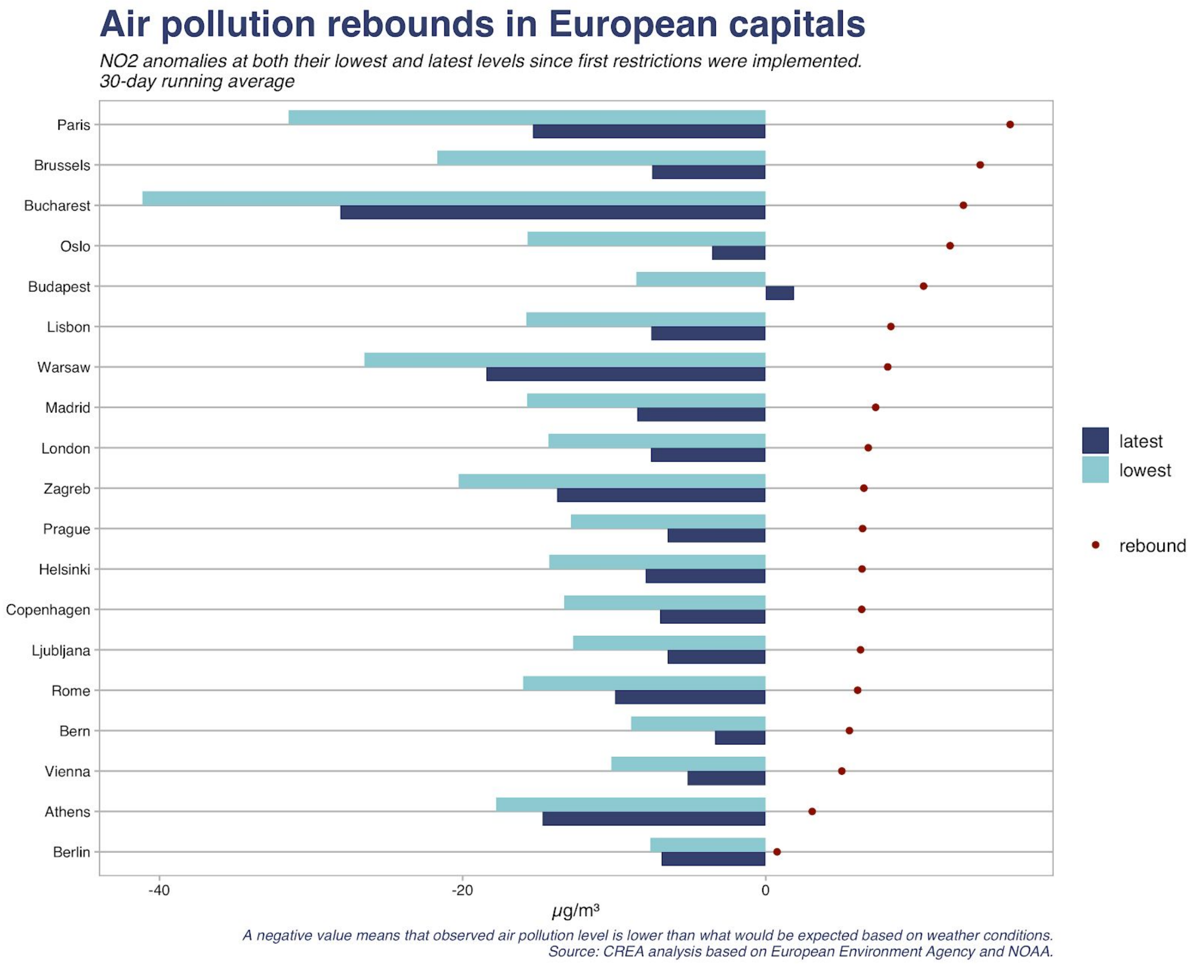


Perhaps not surprisingly, cities with the largest rebounds such as Paris, Brussels and Bucharest are precisely those with the largest initial reduction of NO_2 levels. In other terms, and from a policy perspective, these cities are those where new transport-related measures could bring about the largest air quality improvements.

The table below details these rebounds in absolute and relative terms (i.e. relative to the lowest value reached).

!ALQ	0=:GMF< ($\mu g/m^3$) - (%)	!ALQ	0=:GMF< ($\mu g/m^3$) - (%)
Paris	16 (118%)	Prague	6 (33%)
Brussels	14 (88%)	Helsinki	6 (56%)
Milan	14 (73%)	Copenhagen	6 (50%)
Bucharest	13 (70%)	Ljubljana	6 (43%)
Oslo	12 (74%)	Rome	6 (52%)
Budapest	10 (45%)	Bern	6 (36%)
Munich	10 (34%)	Hamburg	5 (28%)
Lisbon	8 (39%)	Vienna	5 (30%)
Warsaw	8 (33%)	Barcelona	5 (29%)
Madrid	7 (49%)	Athens	3 (13%)
London	7 (34%)	Berlin	1 (4%)
Zagreb	6 (48%)		

Another way to look at these results is to consider the anomaly, i.e. the difference between the observed air pollution and what would be expected in these weather conditions in ‘normal times’.



The dark blue bars indicate the latest ‘anomaly’ at the moment of writing. As can be seen, in all cities but Budapest, anomalies remain negative meaning most cities still enjoy better air qualities than what could have been expected without COVID-related restrictions.

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Data sources

We selected all European cities with more than 1 million population for which the European Environment Agency publishes air quality measurements.

!ALQ	,ME:=J G> KL9LAGFK
Athens	1
Barcelona	43
Berlin	16
Bern	3
Brussels	7
Bucharest	1
Budapest	5
Copenhagen	3
Hamburg	12
Helsinki	1
Lisboa	3
Lisbon	2
Ljubljana	1
London	2
Madrid	48
Athens	1
Barcelona	43
Berlin	16
Bern	3
Brussels	7
Bucharest	1

!ALQ	,ME:=J G> KL9LAGFK
Milan	16
Munich	3
Oslo	9
Paris	13
Prague	1
Riga	1
Roma	29
Rome	5
Sofia	6
Stockholm	6
Vienna	9
Vilniaus	2
Vilnius	2
Warsaw	1
Zagreb	2
Milan	16
Munich	3
Oslo	9
Paris	13
Prague	1
Riga	1

Dates of lockdown and restriction measures were taken from The Oxford COVID-19 Government Response Tracker (OxCGRT): Hale, Thomas, Sam Webster, Anna Petherick, Toby Phillips, and Beatriz Kira (2020). Oxford COVID-19 Government Response Tracker, Blavatnik School of Government.

Weather correction

The concentration data was corrected for weather impacts using a Gradient Boosting Machine algorithm. Models were trained on every single station with nearby weather data coming from NOAA Integrated Surface Database and for the years 2017-2019. Anomalies in 2020 are then estimated as the difference between weather-based prediction and actual observations. Finally, station level data is averaged at the city level and offsetted by the annual mean to indicate weather-corrected value.

For more detailed information on the methodology, please contact hubert@energyandcleanair.org

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Centre for Research on Energy and Clean Air (CREA) is a new independent research organisation focused on revealing the trends, causes, and health impacts, as well as the solutions to air pollution. CREA uses scientific data, research and evidence to support the efforts of governments, companies and campaigning organizations worldwide in their efforts to move towards clean energy and clean air, believing that effective research and communication are the key to successful policies, investment decisions and advocacy efforts. CREA was founded in December 2019 in Helsinki and has staff in several Asian and European countries.