

EGU22-2760, updated on 13 Aug 2022
<https://doi.org/10.5194/egusphere-egu22-2760>
EGU General Assembly 2022
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Changes in ambient air quality and atmospheric composition and reactivity in the South East of the UK as a result of the COVID-19 lockdown

Douglas Gregg¹, Kevin Wyche², Mark Nichols³, Harley Parfitt⁴, Paul Beckett⁴, Kirsty Smallbone², and Paul Monks¹

¹University of Leicester, Department of Chemistry, UK (djg46@leicester.ac.uk)

²University of Brighton, Centre for Earth Observation Science, School of Applied Sciences, UK

³Hydrock Consultants Ltd, UK

⁴Phlorum Ltd.m

COVID-19 required governments across the globe put into place a range of measures which resulted in many industries suspending operations and most citizens (i.e., non 'key-workers') staying in their homes. As such, anthropogenic activity around the globe decreased rapidly, to such an extent that emissions of air pollutants began to decline dramatically, with this period now being referred to as an 'anthropause'. In the early stages of the pandemic, remote sensing data from satellites indicated that nitrogen dioxide (NO₂) concentrations had fallen by as much as 30% across China and by as much as 50% across areas of central Europe. Early work using in-situ measurements confirmed these findings, with studies from China, Korea, India, the USA and Europe all reporting decreases in ambient NO_x concentrations. The UK government advised that the general population should avoid 'non-essential' travel and social contact, on 16th March 2020. Subsequently, on 23rd March 2020, the government announced a UK-wide partial 'lockdown', to contain the spread of the virus.

In this work, we combine findings from the University of Brighton's Brighton Atmospheric Observatory and the ESA's Sentinel-5P satellite, to investigate changes in tropospheric Nitrogen Dioxide concentrations in the South East of the UK during the COVID-19 pandemic. BAO comprises a climate controlled, clean laboratory and analytical instruments for making detailed, real-time measurements of tropospheric composition, and is situated in a suburban background environment, roughly 5 km from Brighton city centre.

Maps showing regional daily average NO₂ concentrations as recorded by TROPOMI were created over (a) the period 25/03/2019–22/04/2019 (i.e. the pre-pandemic baseline) and (b) 23/03/2020–20/04/2020 (i.e. post-implementation of lockdown restrictions). TROPOMI measurements were compared to measurements made on the ground using a long-path DOAS (total path length 300m) for the same time periods. The data confirms findings from analysis of in-situ monitor observations made by the Sussex-Air Network and DEFRA Automatic Urban and Rural Network (AURN), extending the reach of the data capture to the entire South East of the UK on a 7

× 7 km resolution scale. In-line with the in-situ monitors, TROPOMI measured a decrease in the concentrations of NO₂ across the entire region during the lockdown, with the regional average value falling by 33%, from 4.9×10^{16} to 3.3×10^{16} molec m⁻². The largest changes in NO₂ were observed in the centre of the region, in the areas surrounding London and at certain coastal locations.

TROPOMI measured NO₂ values across Brighton and Hove during the 2020 lockdown period to be 59% of those measured over roughly the same time period the previous year (with mean values falling from 4.4×10^{16} to 2.9×10^{16} molecule m⁻²), comparing favourably with DOAS, which recorded NO_x values that were ~64% of those measured during the previous two years over roughly the same time period.

The methodology is also extended to London, Birmingham and Manchester, the 1st, 2nd and 6th largest cities within the UK.