Equivalent BC properties during the COVID-19 spring 2020 lockdown period in Brussels, Belgium, compared to non-lockdown periods

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ultra-fine particles in urban atmosphere important for air quality
relevant part of UFP are light-absorbing particles
important sources in cities and residential areas are traffic emissions, domestic heating
relative contributions need to be known in order to be able to apply effective reduction measures
Covid-19 lockdown / imposed experiment / effect on air quality important to know
meteorology important factor
Author

Function

Institute

Instruments / Location

Aethalometer Magee Sci AE31

- aerosol light absorption coefficient
- mass concentration of light-absorbing aerosol
- 7 wavelengths UV-A to near-IR
- wavelength dependency
- information on aerosol type

situated in Uccle, a sub-urban, residential area in the South of Brussels

aethalometer data since 2014

additional instrumentation (i.a.):
- nephelometer TSI 3563
- ceilometer Vaisala CL 51
- meteorological data
- Irceline air quality station
Vlaamse Milieumaatschappij June 2020

lockdown period Belgium
18 March – 04 May

VRT May 2020, verkeerscentrum

Chemical Transport Modelling

Traffic in Flanders spring 2020

----- freight

----- normal cars

Random Forest Modelling / Irceline July 2020
mass concentration eq-BC / monthly values 2014 – 2021

eq-BC @ 660 nm / ngm$^{-3}$

mean ± stand-dev

median / 10- , 90- percentile
Absorption Angstrom Exponent calculated between wavelengths 370 and 660 nm

AAE = exponential behaviour of absorption between two wavelengths
AAE near 1 marks fresh combustion (traffic) soot
higher AAE → other sources like biomass burning, domestic heating more important
eq-BC and AAE for different time periods

s1 – winter
s2 – spring
s3 – summer
s4 – autumn
average values
absorption coefficient (Mm$^{-1}$)
lockdown period for 2019
for 2020
2-week periods 2020
Interpretation

- all four periods show distinctly lower values than 2019 and 2014-18 period
- 2nd half of March 2020 highest values – relatively cold, stable conditions during night and morning
- morning ‘rush-hour’ peak visible in three of the four periods (stable conditions during morning; still traffic, in particular freight)
- lowest values in 1st half of April (incl Easter) and 1st half of May (incl long weekend over 1 May)

→ clearly lower absorption coefficient during Covid-lockdown compared to former years
source regions and meteorology

Dispersion model:
Lagrangian particle transport model FLEXPART 9.02 in backward mode
period: 01-Dec-2013 to 30-Nov-2021; 3-hourly

Meteo data input:
3-hourly data with 0.5° grid resolution from ECMWF ERA-5

output:
potential source regions or ‘residence time’; relates to the chance that air arrived at sample site at a given day passed over that region

grouped according to
year / season / vertical level / lockdown period / ‘local radius’ around sample site (50 km)

vertical levels ( m agl ):
l1 = 0 – 100 / l2 = 100 – 200 / l3 = 200 – 500 / l4 = 500 – 1000 / l5 = 1000 – 2000
l6 = 2000 – 5000
source regions lockdown period

2019
vertical level
0-100 m agl

windroses 10 m

2020
vertical level
0-100 m agl

vertical level
0-100 m agl
deviation from the average lockdown period per layer!
lockdown period and height level contribution

deviation from the average lockdown period
lockdown period and parameter deviation

deviation from the average lockdown period

from RMI-Climato-Dep: less precipitation longer sunshine duration
SUMMARY

In general, period 2014 – 2021:
- eq-BC mass concentration decreasing trend – yearly, seasonal
- Absorption Angstrom Exponent increasing trend – yearly, seasonal

Lockdown-period:
- absorption coefficient distinctly lower
- daily cycle of absorption coefficient distinctly less pronounced
- AAE distinctly higher values and daily cycle less pronounced

→ fresh combustion aerosol (~ traffic soot) decreases
→ absorbing aerosol from other sources (most probably heating) more relative weight but – 2021 similar values

Disentangling lockdown effect – meteorology
- meteorology different during lockdown period 2020
- wind speed lower / less precipitation / higher sunshine duration
- within lower vertical levels (0 – 1000 m) higher share of ‘local’ contribution
- but higher vertical levels (1000 – 5000 m) higher share of ‘local’-total contribution
→ more locally and from higher up
→ meteo signal ambiguous – not only pointing to better/worse air quality conditions
Thank you very much