

Summary:

The authors applied comprehensive analysis to study the emission sources, generation mechanisms, and potential sinks of urban particulate matter (PM) through the particle number and mass concentration data from observation sites in four European cities. By comparing the PM concentration differences between the lockdown and reference periods, the authors analyzed the impact of COVID-induced lockdowns on emission intensity and atmospheric physicochemical processes, and consequently, the changes in PM concentrations. The apportionment of the sources/generation mechanisms of PM was quantified by positive matrix factorization (PMF) approach. This study found that nucleation, road traffic, and diffuse urban emissions were the dominant sources to mean PM number concentration, while formation of secondary inorganic aerosol contributes most to the PM's mass concentration. Lockdown was found to have varied impacts on the abovementioned PM sources and mechanisms.

General suggestions:

1. This paper studied the impacts of lockdown on PM concentration and their determinant factors. Given the lockdown starting/ending date in each country is varied, it would be better to add a figure to illustrate what principle/index you used here to determine the lockdown time periods for four countries (i.e., the proxy vehicle mobility data or other ancillary index).
2. The daily and weekly cycles of each major factor in Fig 3. represent the typical emission/formation patterns of PM. Does this pattern change during the lockdown period? A comparative figure between lockdown and reference year on different time-scale cycles may help to illustrate the shift of anthropogenic activities and its impact on PM concentration.
3. Do current PMF factors quantify the contributions of transported or aging non-anthropogenic PM from upwind regions? Or any of the additional factors can be added to partially explain the contribution of PM's mid-/long-range transport from non-anthropogenic emissions.
4. The deweathering/detrending technique is needed especially comparing the lockdown effects on pollutant concentration. The authors have stated that such technique has not been applied here because some of the PMF factors are associated with meteorological parameters. It would be recommended to add a similar PMF analysis on the deweathered data to exclude the effects of interannual variations on PNC or PMC. The factors such as road traffic solid fraction is less biased after conducting detrending process.

Line-by-line suggestions:

1. Line-107 (Table 1 title): May use the full name of ACTRiS when it first appears.
2. Line-228 & 232 (Figure 3 & 4 title): Briefly explain how the G values used here was computed. What does the magnitude of G values stand for.
3. Line-232 (Figure 4 title): The figure indicates the normalized G values. Briefly introduce how does the normalization was conducted.
4. Figure 2 & 3: Recommend to enlarge the figure and adjust the image layout for a better visualization of the results. The shaded area in Fig. 3 is a bit difficult to distinguish.
5. Figure S7, temperature row: Is the magnitude of temperature in this figure the absolute or relative temperature?