Summary:

This research mainly studies how the 2020 pandemic-resulted lockdown affects the concentrations of atmospheric pollutants in the ambient environment. It utilizes observational data, modeling results, and related statistical analyzes of particulate matters (PM) and PM's associated parameters, nitrogen oxides (NO_x), and ozone (O_3) at the ground level to illustrate the correlations between the changes of pollutants' concentration and different lockdown phases. The observational data in each region contains at least one urban area site and one regional background site. By doing this, the authors revealed the relative contributions of the anthropogenic factors in the total emission change. The correlation analysis shows the reduction of activities in transportation sectors during the lockdown doesn't necessarily lead to a decrease in PM in the studied European cities. The increasing particle absorption angstrom exponent (AAE) suggests an enhanced emission of biomass burning from the domestic heating sources during the lockdown period. And the observational evidence of increased atmospheric oxidation states facilitates the formation of secondary aerosols. Therefore, the reduction of primary emissions from vehicles was possibly compensated by both the increase of domestic emissions and the new particle formations. It needs more observational constraints to quantify the complex mechanism related to the change of PM concentrations.

General suggestions:

1. Three lockdown phases were defined in this study. I suggest that the authors would add a figure to illustrate what principle/index you used (i.e., the proxy mobility data or any other ancillary index) to divide the three periods (e.g., an index which shows an obvious change at the beginning and the ending of the "during lockdown" phase).
2. PNSD and AAE coefficients are computed based on 2017-2019 historical data. Did they follow the same estimation process as it shows in Eqn 1-3? Then why are the other pollutants data (PM, NOx, etc.) based only on the 2019 data? A longer-period base may be better to exclude the influences of severe weather climatology in certain years.
3. Histogram figures: I suggested that showing all the studied measurement cites name even if certain data in some cities/areas may be unavailable, and in a fixed order as well. For example, in Fig. 2A, there are 15 cities (out of 16) shown in the x-axis (Granada is missing). In Fig 6A., Helsinki and Athens data are missing, Seville is substituted by Granada.
4. The main results are shown in the format of histogram plots and tabulated statistics. I suggest that the authors diversify the illustration/visualization style of the outcomes of this study. Some main statistical conclusions of this study are not necessarily drawn from the comparisons between mobility index and pollutants concentration at each location. Such collective significance (or insignificance) can be illustrated in correlation scatter plots (with confidence intervals).
5. Table S3 shows the instruments and the related wavelength range for AAE measurements. Here, according to the definition of AAE, what exact wavelength pairs did the authors use to compute AAE value? Did you use (1) the lower-upper-bound wavelength pair or (2) a fixed

wavelength pair which all types of instruments cover? (The later one makes more sense to me)

6. The variation of AAE value doesn't necessarily mean the change of BC amount in the total particles. Biomass burning contributes a lot of light-absorbing organic carbon (i.e., brown carbon) particles which have a distinct absorption spectrum than black carbon. A detailed analysis of chemical composition of light-absorbing particles may exceed the scope of this study, but it is worth mentioning the contribution of other species which contribute a different AAE value.

Line-by-line suggestions:

1. Line-187: Is N_{small}/N_{tot} here is defined as $N_{15\text{-}70nm}/N_{15\text{-}800nm}$? Did the authors use the same 800 nm upper bound for those sites which have a larger (or lower) upper bound for PNSD? Using different size limits to measure the small particles fraction may lead to biases for a group statistical analysis.
2. Line-193: "these variables are much less sensitive to weather conditions than e.g. atmospheric concentrations." I think it is not strictly correct here to state AAE and PNSD are less sensitive to weather conditions, given that the weather or meteorological conditions play important roles in particle transport and formation.
3. Line-318: "at no sites", there indeed a few sites show O_3 decrease in Fig. 6.
4. Table 1: The first 16 sites are "urban sites" and the others are associated "regional background" sites according to the main text. What does the "background" in column "Type" of the first 16 sites stand for? Please clarify if "background" here stands for any specific measurement or meteorological conditions.
5. Table 2: How did the authors compute the percentage of increase or decrease in this table? Are they percentage change of the ratio Obs_{2020}/Exp_{2020}? If so, what is the base value for each ratio (Is the base value the historical ratio magnitude, or the ratio of the previous lockdown phase in 2020)?