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The Global Impacts of COVID-19 Lockdowns on Short-Lived Climate Forcers: Highlights from a Critical Review

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The coronavirus-19 (COVID-19) pandemic led to government interventions to limit the spread of the disease that are unprecedented in the last decades. Stay at home orders and other measures led to sudden decreases in atmospheric emissions, most visibly from the transportation sector. We present a review of the current knowledge and understanding of the influence of these emission reductions on atmospheric pollutants concentration and notably air quality with a focus on NO_2, $PM_{2.5}$, and O_3 based on more than 200 papers utilizing observations from ground-based and satellite remote sensing instruments. We use the government stringency index as an indicator for the severity of lockdown measures and show how key air pollutants change as the stringency index increases. Changes in NO_2 and $PM_{2.5}$ mass concentration are well-studied globally. The observed decrease of NO_2 with increasing stringency index is in general agreement with emission inventories that account for the lockdown. Due to the important influence of atmospheric chemistry on O_3 and $PM_{2.5}$ concentrations, their responses may not be linear with respect to primary pollutants. At most sites, we found O_3 increased, whereas $PM_{2.5}$ decreased slightly, with increasing stringency index. Changes in the $PM_{2.5}$ composition are found to be understudied and not well-quantified so far. We highlight future research needs for utilizing the emerging data sets covering a full seasonal cycle as a preview of a future state of the atmosphere in a world with targeted permanent reductions of emissions. Finally, we emphasize the need to account for the effects of meteorology, long-term trends, and atmospheric chemistry when determining the lockdown effects on pollutant concentrations, especially on $PM_{2.5}$.