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Editorial: Impact of the COVID-19 lockdown on the atmosphere

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Editorial on the Research Topic
Impact of the COVID-19 lockdown on the atmosphere

The most dominant impact of human activities on the atmosphere is particle and gaseous pollution (Ramanathan et al., 2001). The rapidly rising trend in anthropogenic pollution levels has been evidenced for many decades in satellite and *in-situ* measurements (Akimoto, 2003). These high amounts of pollutants have impacted air quality, hydrology, and climate, posing grave risks to the ecosystem and economy (Settele et al., 2014). The economic slowdown caused by the COVID-19 pandemic measures led to a reduction in transportation, industrial emissions, and energy use (Fadnavis et al., 2021). Thus lockdowns resulted in a decline in emissions of aerosol particles and gaseous pollutants globally. These effects were more pronounced over densely populated regions e.g., South and East Asia. The remote sensing observations showed a cleaner atmosphere with a ~30% reduction in aerosol optical depth over Asia during the lockdown period between April and May 2020 (Soni, 2021). The latest research conducted on pollutants levels during the lockdown period highlights the impact of reduced pollution levels on atmospheric processes through changes in clouds, radiative forcing, atmospheric heating, and circulation. The Research Topic here explores the atmospheric impacts in response to the reduction in amounts of anthropogenic pollutants. Does reduced level of pollutants during the lockdown period provide a pathway for climate mitigation strategies?

To summarize, this Research Topic presents nine researched articles addressing the key questions raised on our Research Topic. Here, we summarize the highlights of the papers. This research will be helpful for pollution control and climate mitigation strategies for policymakers.

Mallik et al. highlight interesting effects of pollution levels. They show signatures of reduced emission on levels of atmospheric trace gases and aerosol particles contributing to air pollution over multiple sites in India's capital Delhi. A clear impact of lockdown is observed for AOD, PM, NO_2, CO, and SO_2 as a result of emission changes while changed precursor levels led to a change in ozone chemical regimes impacting its concentrations.

Singh et al. provide a comprehensive analysis of Particulate Matter at New Delhi, India, and Riyadh, Saudi Arabia during the COVID-19 lockdown period. Their findings reveal different trends in PM10 during the pre-lockdown and the lockdown period in Riyadh, showing considerable influence from sand and anthropogenic sources during the lockdown periods.

Features of pollution parameters over an urban and adjoining rural region in India during COVID-19 are addressed by Sonbawne et al. This study reports that despite a reduction in NO_2, there is an increase in ozone amount at Delhi and Panchgaon during the lockdown. The observed enhancement in ozone may be resultant of the complex photochemical processes that involve the presence of NO_2, CO, Volatile Organic Compounds (VOCs), and water vapor.

Aerosol variations over India during the lockdown period using multiple satellite observations are reported by Bhawar et al. These observations show a 40% reduction in aerosol optical depth over the Indo-Gangetic Plain. On the contrary, central India showed ~12% AOD enhancement. This study reveals that the increase in AOD is because of transported biomass-burning aerosols. The biomass-burning aerosols forms a layer near 2–4 km that produced a heating of 3–4 K/day and a consequent negative radiative forcing at the surface of ~ −65 W/m^2 (±40 W/m^2) over the central Indian region.

Asutosh et al. report the intensification of rainfall over India during the lockdown period, the spring of 2020. The satellite data and model simulations show that the reduction in anthropogenic emissions during the COVID-19 lockdown period have enhanced the precipitation by 5–25% over India. The precipitation enhancement results from the combined effect of an enhancement in cloud cover, a reduction in aerosol-induced cloud invigoration, and dynamical changes. The paper reports an advantage of anthropogenic pollution reduction for water availability besides benefits to air quality, human health, and crop yield.

Further, Lawand et al. show the variability of aerosol and clouds over North India and Myanmar during the COVID-19 lockdown period. They study shows that aerosol particles originating from biomass burning lead to cloud dissipation/burning and precipitation reduction (−1 to −4 mm) over Myanmar. Whereas, the aerosol reduction over North India favors cloud formation, i.e., increase in cloud cover leading to precipitation enhancement indicating the anti-Twomey effect.

Wang et al. report the impact on air quality during the COVID-19 lockdown in Northeast China. They report the impacts on large-scale weather circulation patterns that affected the northeast region. They found that under the influence of the updraft in front of the trough, the ozone concentration is higher. The changes in the concentrations of $PM_{2.5}$, NO_2, CO, SO_2, and O_3 in the three cities, namely Shenyang, Changchun, and Harbin, during the lockdown period tend to first decrease and then increase, while the changes in O_3 concentration are cyclical and increased significantly during this period.

Changes in urban gas-phase persistent organic pollutants during the COVID-19 lockdown in Barcelona are reported by Prats et al. This study highlights variations in the composition of polycyclic aromatic hydrocarbons (PAHs), polychlorobiphenyls (PCBs), hexachlorobenzene (HCB), pentachlorobenzene (PeCB), and organophosphate flame retardants (OPFRs) present in the gas-phase fraction of the atmosphere of Barcelona during the lockdown and before this period.

Milićević et al. address the impact of the COVID-19 restrictive measures on urban traffic-related air pollution in Serbia. Their analysis shows a positive correlation of daily NO_2 concentrations with mobility and their significant reduction during restriction measures at all the selected monitoring stations. The O_3 concentrations were increased at all measuring stations and are negatively correlated to mobility. The findings suggest the justification for the use of traffic reduction strategies as a measure to improve air quality.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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