EMS Annual Meeting Abstracts
Vol. 18, EMS2021-436, 2021
https://doi.org/10.5194/ems2021-436
EMS Annual Meeting 2021

Diverse response of surface ozone to COVID-19 lockdown in China

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Ozone (O_3) is a key oxidant and pollutant in the lower atmosphere. Significant increases in surface O_3 have been reported in many cities during the COVID-19 lockdown. Here we conduct comprehensive observation and modeling analyses of surface O_3 across China for periods before and during the lockdown. We find that daytime O_3 decreased in the subtropical south, in contrast to increases in most other regions. Meteorological changes and emission reductions both contributed to the O_3 changes, with a larger impact from the former especially in central China. The southward-shifted wind with increased temperature, enhanced planetary boundary layer height, decreased cloud fraction and precipitation favored the O_3 increase in north and central China, while the northward-shifted wind with decreased temperature and then biogenic volatile organic compounds (VOCs) emissions, increased cloud fraction and precipitation reduced O_3 in south China. As for the emission reduction, the drop in nitrogen oxide (NO_x) emission contributed to O_3 increases in populated regions, whereas the reduction in VOCs contributed to O_3 decreases across the country. Due to a decreasing level of NO_x saturation from north to south, the emission reduction in NO_x (46%) and VOC (32%) contributed to net O_3 increases in north China; the opposite effects of NO_x decrease (49%) and VOC decrease (24%) balanced out in central China, whereas the comparable decreases (45-55%) in the two precursors contributed to net O_3 declines in south China. Our study highlights the complex dependence of O_3 on its precursors and the importance of meteorology in the short-term O_3 variability.