EMS Annual Meeting Abstracts
Vol. 18, EMS2021-469, 2021
https://doi.org/10.5194/ems2021-469
EMS Annual Meeting 2021

Response of surface ozone concentration to emission reduction and meteorology during the COVID-19 lockdown

Adrien Deroubaix[1], Benjamin Gaubert[2], Idir Bouarar[1], Thierno Doumbia[3], Yiming Liu[4], Trissevgeni Stavrakou[5], Sabine Darras[6], Nellie Elguindi[3], Claire Granier[3,7], Forrest Lacey[2], Jean-François Müller[5], Xiaoqin Shi[1], Simone Tilmes[2], Tao Wang[5], and Guy Brasseur[1,2,4]

[1]Environmental Modeling Group, Max Planck Institute for Meteorology, Hamburg, Germany
[2]Atmospheric Chemistry Observations and Modeling Laboratory, National Center for Atmospheric Research, Boulder, USA
[3]Laboratoire d'Aérologie, Université de Toulouse, Toulouse, France
[4]Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, China
[5]Royal Belgian Institute for Space Aeronomy, Brussels, Belgium
[6]Observatoire Midi-Pyrénées, Toulouse, France
[7]NOAA Chemical Sciences Laboratory, University of Colorado, Boulder, USA

During the COVID-19 pandemic, the first lockdown period (March-May 2020) has led to an unprecedented reduction in pollutant emissions. For 3⁄4 of the more than 1,100 available monitoring stations in Europe, the average NO2 concentrations decreased by at least 25% (2.7 µg.m-3) compared to the average concentrations recorded during the same period of the previous seven years. The relative reduction was of similar magnitude in both urban and rural areas.

We further investigate the spatial distribution of the O3 change. Relative to the seven years average, positive anomalies were observed in northern Europe and negative anomalies in southwestern Europe. However, the level of total oxidant (Ox = O3 + NO2) remained unchanged except in southwestern Europe where it decreased.

At the global scale, the ozone concentration increased only in a few NOx-saturated regions. After presenting data from monitoring stations in Europe, we analyze the drivers of the change in surface ozone concentrations using the global Community Earth System Model. We contrast global simulations of the atmospheric composition with and without lockdown adjusted anthropogenic emissions for the COVID-19 period.

By comparing the situation in Europe with that of the United States and China, we show that the reduced cloudiness in northern Europe played a significant role by shifting the photochemical partitioning between NO2 and O3 toward more ozone, while in the North China Plain, enhanced ozone concentrations resulted primarily from reduced emissions of primary pollutants.

These results illustrate the complexity of the processes affecting ozone in the troposphere and hence the difficulty of implementing efficient regulations targeting air quality impacts.