Estimating lockdown induced European NO_2 changes

Jérôme Barre

European Centre for Medium-Range Weather Forecasts, UK

This study provides a comprehensive assessment of NO_2 changes across the main European urban areas induced by the COVID-19 lockdown using satellite retrievals from the Tropospheric Monitoring Instrument (TROPOMI), surface site measurements and simulations from the Copernicus Atmospheric Monitoring Service (CAMS) regional ensemble of air quality models. Some recent TROPOMI-based estimates of NO_2 changes have neglected the influence of weather variability between the reference and lockdown periods. Here we provide weather-normalized estimates based on a machine learning method (gradient boosting) along with an assessment of the biases that can be expected from methods that omit the influence of weather. We also compare the weather-normalized satellite NO_2 column changes with both weather-normalized surface NO_2 concentration changes and simulated changes by the CAMS regional ensemble, composed of 11 models, using recently published emission reductions induced by the lockdown. We show that all estimates show the same tendency on NO_2 reductions. Locations where the lockdown was stricter show stronger reductions and, conversely, locations where softer measures were implemented show milder reductions in NO_2 pollution levels. Regarding average reductions, estimates based on either satellite observations (-23%) surface stations (-43%) or models (-32%) are presented, showing the importance of vertical sampling but also the horizontal representativeness. Surface station estimates are significantly changed when sampled to the TROPOMI overpasses (-37%) pointing out the importance of the variability in time of such estimates. Observation-based machine learning estimates show a stronger temporal variability than the model-based estimates.