The first Coronavirus (COVID-19) lockdown (March-May 2020): temporary drop in anthropogenic emissions reveals the dynamic of CO\(_2\) fluxes and concentrations in urban areas

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The worldwide restrictions imposed to contain the spread of Coronavirus (COVID-19) disease markedly affected social and economic systems, undeniably disrupting people’s habits. At the same time, the reduction of industrial and commercial activities and limitation of movements led to significant decline in most greenhouse gas (GHG) emissions, improving urban air quality. Nevertheless, worldwide CO\(_2\) emission reduction was not accompanied by detectable CO\(_2\) concentration decreasing, that continued to grow at a global scale.

The relationship between emission rate and urban atmospheric GHG concentrations represents a fundamental tool for monitoring activities aimed at indicating strategies to reduce and buffer GHG concentrations in the urban atmosphere. Generally, the occurrence of many different GHG sources (e.g. industry activities, domestic heating) in urban areas does not allow to evaluate the efficiency of short-term interventions on a specific source of contamination to mitigate urban air pollution (i.e. traffic restriction or reduction of energy use). The COVID-19 lockdown has provided a unique opportunity to empirically evaluate the effect on CO\(_2\) urban plume of both total and sector-specific anthropogenic emission cutting related to traffic dramatic decrease, followed by the stop of the domestic heating and the progressive resumption of urban normal functions at the end of the lockdown period.

In Italy, the first country in Europe to adopt stringent restrictions, the lockdown (mainly consisting of movement limitation of all people and restrictions involving commercial and industrial sectors) was established from March 9, 2020, during and until the end of the heating season, to May 4, 2020, when vehicular traffic and economic activity progressively resumed. In this study, real-time data of concentration and carbon isotopic composition of CO\(_2\) at ground level (2 m height) and of eddy covariance (EC) CO\(_2\) flux at ~33 m above the ground level were measured in the historical center of Florence (Italy), from April 2 to June 4, 2020 and from February 1 to June 4, 2020, respectively. As expected, a clear stepwise decrease in CO\(_2\) fluxes occurred, evidencing a rapid
response of the EC measurements to drop in the urban emissions related to COVID-19-containment measures and domestic heating switch-off. Accordingly, during the observation period a relatively small decrease (i.e. few ppm) in the CO$_2$ concentrations at both ground level and 33 m height was recorded. Moreover, an overall increasing trend of $^{13}$C/$^{12}$C ratios of CO$_2$ and daily CO$_2$-enhancement was observed concomitantly with the gradual easing of severe COVID-19 restrictions.

These trends highlighted that the COVID-19-related short-term (few months) drastic reduction of anthropogenic emission caused, at a local scale, a rapid response of CO$_2$ urban plume. Hence, the COVID-19 crisis made us aware of the importance of our actions to fight the CO$_2$-related climate change, although a worldwide CO$_2$ atmospheric concentration reduction requires a radical and long-lasting CO$_2$ emission cutting and lifestyle changes from each of us.