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THE IMPACT OF COVID-19 RESTRICTIONS ON CARBONACEOUS AEROSOLS AT RURAL BACKGROUND SITE: IMPORTANCE OF VERTICAL DISTRIBUTION

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INTRODUCTION

Novel coronavirus disease 2019 (COVID-19) emerged in China in late 2019 and became a global outbreak in early 2020 (WHO, 2022). As in many other countries, Czech authorities took a number of preventive and control measures to prevent the spread of the disease, including city lockdowns and restrictions on numerous activities (traffic, economy, personal limitations). These measures led to a reduction in emissions from most anthropogenic sources, and improvements in air quality were observed in many megacities (Chauhan and Singh, 2020). However, little is known about the impact of COVID -19 on rural background site representing background air pollution. Atmospheric elemental (EC) and organic carbon (OC) are among the major constituents of ambient aerosols that have attracted growing interest due to their adverse effects on human health, atmospheric visibility, and climate warming (Mauderly and Chow, 2008; Bond et al., 2013). The objective of this study is to characterize the effects of COVID -19 lockdowns on carbonaceous aerosols at a rural background site using continuous in situ vertical distribution measurements.

EXPERIMENTAL SETUP

Ground-based (4 m a.g.l.) long-term monitoring of EC and OC has been initiated in 2013 at the National Atmospheric Observatory Košetice (NAOK; 49°35'N, 15°05'E) in the central Czech Republic using a semi-continuous thermal-optical OCEC analyzer (Sunset Laboratory Inc., USA). In late 2019, a second OCEC analyzer was installed at the top of the tower (230 m a.g.l.) and measurements were performed simultaneously with the ground from December 2019 to June 2021. Both instruments sampled with a time resolution of 4 h, including 20 min of OC /EC thermo-optical analysis according to the abbreviated EUSAAR-2 protocol (Cavalli et al., 2010; Mbengue et al., 2018). Sampling systems were equipped with a carbon parallel plate diffusion denuder (Sunset Lab) to avoid positive artifacts caused by absorption of volatile organic compounds on the quartz microfiber filter (Turpin et al., 2000). A total of 1955 pairs of OC/EC sampling points were measured during the campaign.

RESULTS AND CONCLUSIONS

In this study, EC and OC at 4 m elevation and EC at 230 m elevation showed a similar seasonal pattern with higher values in winter and lower values in summer. OC, measured at 230 m height showed an opposite behavior with slightly higher values in spring and summer, probably related to the increased contribution of secondary organic carbon (SOC). Concentrations were generally higher at 4 m, where there was also a better correlation between EC and OC, suggesting a greater influence of local sources near the surface. In contrast, measurements at 230 m may be more influenced by aged and long-range transported aerosols. These results are confirmed by source apportionment / receptor modeling (Conditional Bivariate Probability Function the Potential Source Contribution Function).

To examine the impact of Covid lockdowns, ground-level measurements of OC and EC from the pre-Covid period (2017-2019) were compared to the values recorded during the Covid period (2020-2021). The results show that the restrictions during the COVID lockdowns did not systematically lead to a decrease in the values of OC and EC at the rural background site. This is particularly true for the second lockdown for EC in the spring and for OC in all seasons (Fig. 1).

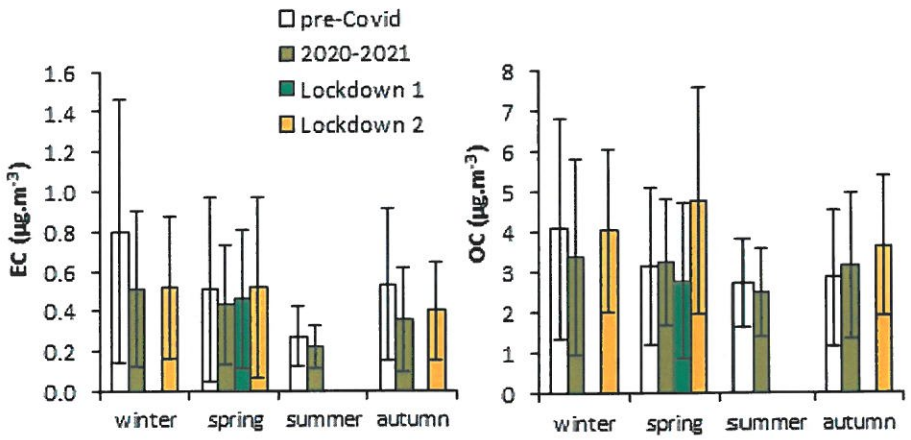

Fig. 1: Seasonal mean concentrations of OC, EC, measured at 4 m a.g.l. during pre – COVID (from 2017–2019) and COVID (2020-2021) periods.

The effect of the COVID-related lockdowns could be better observed by examining the correlation of EC and OC between 4 m and 230 m (Fig. 2). Indeed, the correlation coefficient which was around 0.20 during the pre-lockdown, especially for EC, increased steeply during the two controlled periods (up to 0.85 and up to 0.70 during lockdown 1 and 2, respectively). The higher correlation during the lockdowns suggests that aerosols collected at 4 m and 230 m were influenced by common sources and/or transported simultaneously at the sampling site. Because the COVID restrictions resulted in reduced emissions from local anthropogenic sources, the receptor site was influenced primarily by aged aerosols transported over long distances. This is consistent with the increased concentration of SOC, which follows the same behavior observed for OC during the second lockdown.

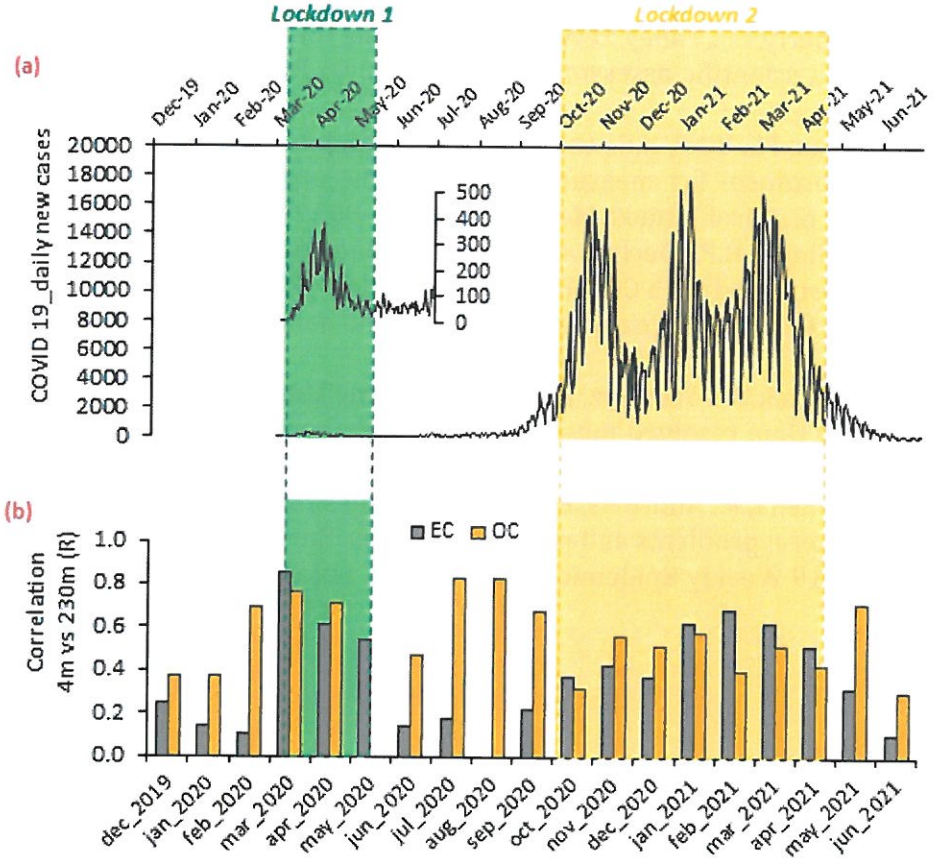

Fig. 1: Time series of a) Number of coronavirus COVID_19 daily new case in Czechia, and b) monthly correlation coefficient between EC and OC at 4 m and those at 230 m from December 2019 to Jun 2021.

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