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The impact of wildfires in Ukraine on carbon flux and air quality changes by carbon-containing compounds

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Wildfires remain among the most challenging problems in Ukraine. Each year numerous cases of open burning contribute to huge carbon emissions and turn into forest fires. Using the Global Fire Emissions Database (GFED4), there were studied an average burned fraction in Ukraine, which equals of about 0.2-0.3. 90% of wildfires appeared on agricultural lands. The total contribution to carbon emissions is $0.2-1.0 \text{ g}\cdot\text{m}^2\cdot\text{month}^{-1}$ with the increasing trend of about $1-2 \text{ g}\cdot\text{m}^2\cdot\text{month}^{-1}$ per decade. There are three periods with the highest carbon emissions: April, July-August and September-October. While a summer maximum is corresponding to unfavorable temperature and moisture regimes, the main reason of wildfires in spring and autumn is the agricultural open burning. Based on the Sentinel-5P data, it was found that wildfires significantly change the seasonality of carbon monoxide (CO) variations. If maximal CO content is mainly observed in winter at the end of the heating season, in Ukraine the highest CO values continue to exist in April until the open burning stops and the resulting forest fires are extinguished. Wildfires caused the CO content increase to $4.0-5.0 \text{ mol}\cdot\text{m}^{-2}$ which is comparable to the most polluted Ukrainian industrial cities. As a result, air quality deterioration observed at the distances more than 200 km from the burned areas. Using the Enviro-HIRLAM simulations, there were estimated black carbon (BC) distribution, which showed elevated content within the lowest 3-km layer. BC content reaches 600 ppbm near the active fires, 150 ppbm at the distance up to 100 km and 30 ppbm at the distance of about 200-500 km.