Ground-level ozone and nitrogen deposition in the Czech Republic: assessment of long-time trends and spatial changes

Czech Hydrometeorological Institute

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The aim:

To present recent findings in ambient ozone (O_3) levels and nitrogen (N) deposition fluxes over the Czech Republic (CR) based on long-term monitoring data

Major findings:

- In spite of substantial decrease in emissions (*Figure 1*) in both the CR and neighbouring countries, O_3 levels and N deposition remain still fairly high.
- O_3 concentrations do not decrease (*Figure 2*) in line with emission decrease. It is evident in North-west region and some cities likely due to changing time patterns in local NO and NO_2 emissions, in particular, with the increasing ratio in NO_2/NO_X (*Figure 3*).
- In recent years, i. e. since 2014, O_3 levels are on steady increase (*Figure 4*) at all sites irrespective of their type and environment they represent: rural, mountain, background (*Figure 5*).
- We have found a gradual deformation of seasonality profiles including a slow shift of the maximum daily mean O_3 concentrations over a calendar year towards the later months, evident at all sites though to a different extent, with the maximum shift of one month over the period of 23 years. This shift is most pronounced for mountains whereas it is much smaller for urban sites (*Figure 6*).
- We have demonstrated significant relationship between explanatory meteorological variables and O_3 levels (*Figure 7*).
- The year-to-year variability of O_3 is high due to changes in meteorology (*Figures 8 and 9*), with prominent year of 2003.
- In contrast, the year-to-year variability of N deposition is fairly low (*Figures 10 and 11*).
- Areas under high ozone and nitrogen loads are spatially disjunct in Czech forests (*Figure 12*).
- The highest O_3 exposures are in the southern and the highest N depositions in the northern Czech Republic. In contrast to our assumption, only 1 322 km_2, i.e. 4.6% of the total forested area (28,782 km_2) are overlapping areas with a potential risk due both to high O_3 exposures and to N deposition (*Figure 12*).

Details in:

Hůnová, Bäumelt, 2018. Atmos Environ 172, 157–167.
Hůnová et al., 2019. Sci Total Environ 656, 567–575.
Hůnová et al., 2019. Front For Glob Change 2, 31.
Hůnová et al., 2020. Sci Total Environ 699,134378.
Hůnová et al., 2020. Sci Total Environ 746, 141038.

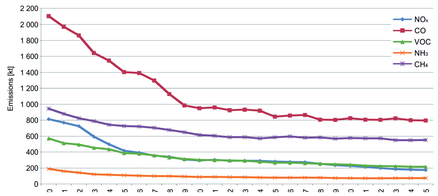

Fig. 1. Overall Czech emissions [kt] related to O_3 formation and N deposition

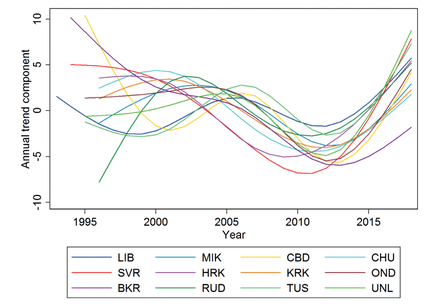

Fig. 4. Time trends in ambient O_3 levels

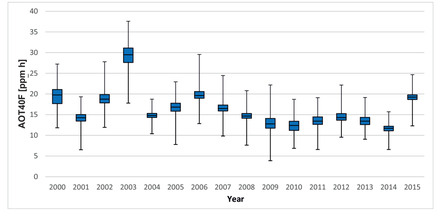

Fig. 8. Cumulative O3 exposures (AOT40F), Czech forests, 2000–2015

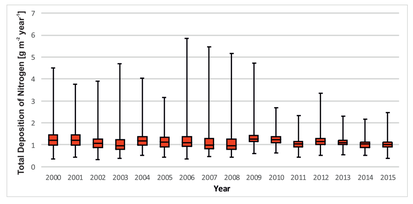

Fig. 10. Annual N deposition, Czech forests, 2000–2015

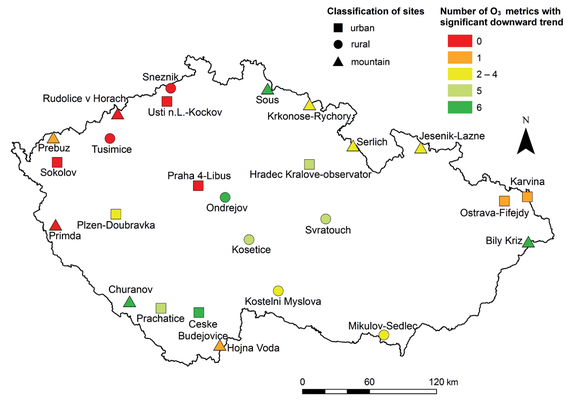

Fig. 2. Geographic pattern of trends in ambient O_3 levels

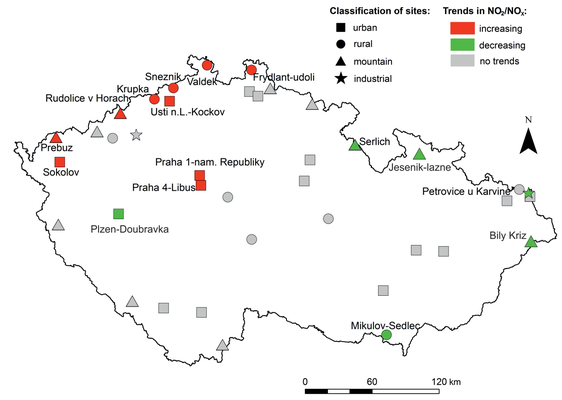

Fig. 3. Geographic pattern of trends in ambient NO_2/NO_x levels

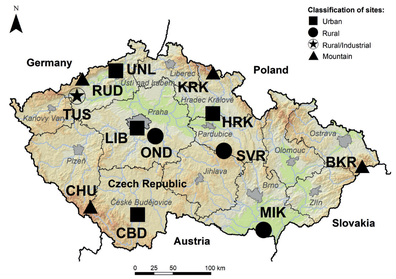

Fig. 5. Location of the examined stations

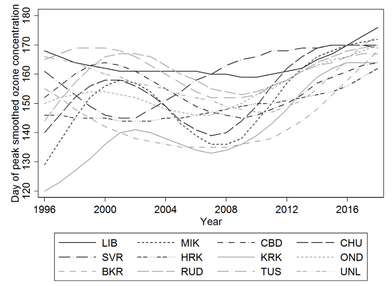

Fig. 6. Day of peak smoothed O_3 concentrations for individual sites

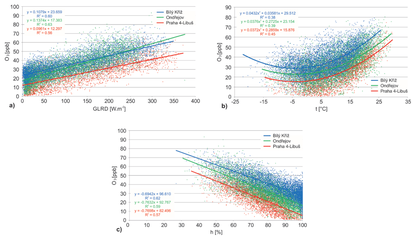

Fig. 7. Association between global radiation and O_3 (a), temperature and O_3 (b), and relative humidity and O_3 (c) at urban, rural, and mountain sites in 2004–2015

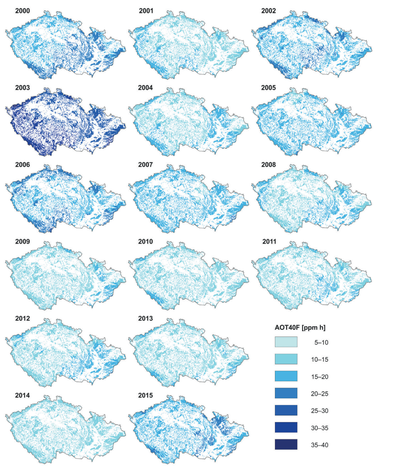

Fig. 9. The spatial patterns of AOT40F in 2000–2015

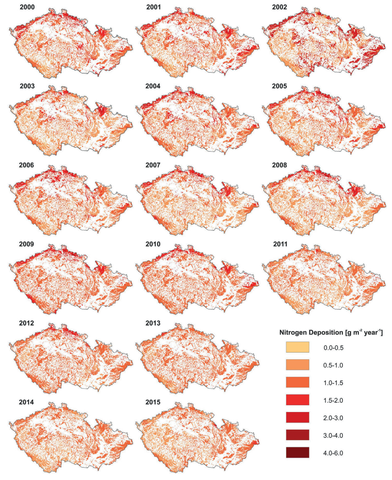

Fig. 11. The spatial patterns of N deposition in 2000–2015

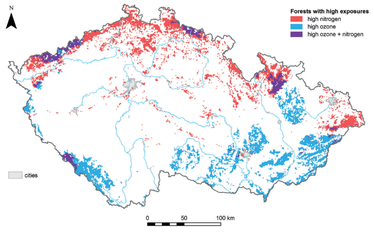

Fig. 12. Map showing forests at risk due to high O_3 exposures and N deposition, CR, 2000–2015

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