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# Comparison of wind-induced air pressure fluctuations at sites with different land use

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Previous studies showed at a forest site, that small air pressure fluctuations that are generated during periods of high wind speed significantly enhance topsoil gas transport, which is called pressure-pumping. The strength of these air pressure fluctuations can be described by the pressure pumping coefficient (*PPC*) which is defined as the mean absolute slope between two measurements (0.5 s) per 30 min interval. It was shown that at this site a quadratic relationship exists between the *PPC* and above canopy wind speed.

To investigate the variability of small air pressure fluctuations, high-frequency airflow and air pressure measurements were carried out at ten European and American sites with different land use (grassland, crop, forest, urban). The air pressure fluctuations were generally measured above the soil surface and airflow above the site-specific canopy (above trees in forests, on the top of a high building in the city). The measurements took place between 2016 and 2020 and commonly lasted at least one month per site.

Results show that the site-specific *PPC* increases in a quadratic relationship with above-canopy wind speed at all sites. The data was very close to a quadratic relationship at sites with rather uniform forests and level topography ($R^2 > 0.92$), while more complex sites revealed a larger scattering of this correlation ($R^2 > 0.65$).

At some sites, the *PPC* is also highly dependent on the prevailing wind direction. It is shown that the local surface roughness of the plant canopy can be excluded as a main driver of the PPC. Moreover, analysis of surface roughness parameters suggests that the topographic exposure around the measurement sites is responsible for the variability in the *PPC*.

However, due to the limited data availability and the complexity of the sites (topography, canopy, buildings), it cannot yet be ruled out that other effects have an influence on the *PPC*. In any case,

from the results it can be inferred that wind-induced air pressure fluctuations responsible for pressure-pumping are detectable over a variety of natural and artificial surfaces. It must, therefore, be assumed that they have the potential to increase the diffusion-limited transport rate of trace gases in the soil as well as the soil-atmosphere exchange of trace gases over a large number of surfaces during periods of high wind speed.