Geophysical Research Abstracts
Vol. 20, EGU2018-14529, 2018
EGU General Assembly 2018

Personal exposure of NO_2 for cyclist, car drivers and in indoor environments

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Nitrogen Dioxide (NO_2) is currently the most critical air pollutant in Europe. In Germany more than 50% of environmental monitoring stations next to streets exceed the EU limit of 40μg/m^3 (yearly average). Beside health effects, NO_2 influences also acid rain, ozone and the oxidation capacity of the atmosphere. The main source is traffic, especially of diesel engines. However our knowledge of the NO_2 concentration, its distribution and real personal exposure is relatively low, as it is based only on very few measurement stations per city, few passive sampler sites (providing only mean concentrations over longer time periods) and models. Real personal exposure of NO_2, e.g while driving on the bicycle, in a car, walking along a street or staying indoor, remain unclear, but is the more relevant parameter for health effects. State of the art CLD instruments are typically not easily applicable for these tasks due to their sensitive and time-consuming operation and low cost sensors are prone for large measurement errors at ambient concentrations.

We apply our newly developed NO_2 ICAD (Iterative Cavity Enhanced DOAS) instrument (now Airyx GmbH) based on direct optical absorption to such measurements. The instrument is ideally suited for such studies, as it feature high accuracy, and is relatively small, mobile and can easily be operated with a battery pack.

We focus here on the personal exposure of cyclists and car passengers. Measurements were performed in several German cities. The results show a very strong variability of the NO_2 exposure depending on the location of the cycle path. Cycle paths along main roads exhibit on average the highest exposure, typical also higher than the concentrations at the environmental measurement stations. The concentration is already about 25% lower if only a separate cycle path is present, and lowest at side roads, as expected. In total the personal exposure as a cyclist can be reduced up to 70% by selecting alternative paths in a city. This should have a larger influence on urban cycle path planning.

Also car drivers themselves are exposed to NO_2 as these concentrations are blown with the air ventilation into the cabin. Typical concentrations in a car are much higher than at environmental measurement stations. In tunnels exposure reaches values of 1000μg/m^3, at main traffic roads concentrations are typical above 200μg/m^3. Very high NO_2 car indoor exposure is also observed while driving on a highway. Low exposure is found mainly on less frequented roads. The reasons for these findings will be discussed.

We also show that the use of special indoor car filters reduces the NO_2 concentration in the car by more than 90%. We show that this works very reliably and thus significantly reduces the personal exposure.

An overview of these different studies is shown. We finish with a small indoor NO_2 air pollution study with candles.