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CFD dispersion modelling of ultrafine particles in urban street canyon

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Motivation and aims:
Traffic induced ultrafine particles (UFP, diameter < 0.1 μm) are associated with adverse human health and environmental impact. However the uncertainties are large and the current knowledge remains limited. This work aims
1) to study the dispersion of ultrafine particles in a street canyon with a 3D CFD model ENVI-Met,
2) to compare the modelled results with measured UFP concentration in a street canyon, and
3) to show the importance of various parameters playing crucial role in the UFP evolution and concentration (meteorological conditions, traffic emissions, etc).

Methodology:
The ultrafine particles (UFP) are modelled with the three dimensional computational fluid dynamics (3D CFD) model ENVI-met. The model was extended to account for different transformation processes that could have impact on the size and the number of particles (for example coagulation, deposition, etc).The UFP total number emissions are accounted based on the PARTICULATES project results.
In order to validate the results,a measurement campaign was held in a street canyon in Antwerp, Belgium. The study domain contains a small street canyon in combination with a heavily trafficked boulevard perpendicular to it. The concentration of UFP in the street was measured at four different locations (one close to the busy boulevard, two opposite to each other in the middle and one at the other end).

Results:
Two examples are show the complexity and concerns when modeling the UFP dispersion and analyzing the results. The modelled concentration for total number of UFP was compared with measured UFP concentration at four locations in the street. The modelled trend in the UFP concentration well resembles the measured and it is within the uncertainties of the measurements showing an overall a good agreement. The wind direction is found to be of crucial importance for the dispersion of UFP. Besides there is a need of representative meteorological input suitable for modelling the UFP. Emissions are another parameter that alter the concentration of UFP and need to be addressed adequately. In the analysis averaging over long periods (hours) can mask important details and might lead to wrong conclusions. This model simulation and the comparison results can be used to better understand the dispersion of total number UFP concentrations in urban environment.