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CFD Based air quality modeling for the investigation of the impact of a vegetation barrier along a motor way

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Abstract

A CFD-based micro scale air quality model is used in the framework of the Dutch Air Quality Innovation Program (IPL) to investigate the impact of a vegetation barrier along a motorway on the local air quality. The IPL-program, initiated by the Dutch ministries for Transport, Public Works and Water Management (Rijkswaterstaat) and for Housing, Spatial Planning and Environment (Ministry of VROM), has the ambition to come up with a strategy to improve local air quality in the vicinity of motorways and so called hotspots. One of the seven braches of the project is the investigation, both by the means of in situ measurements and by modelling, of the effect of line vegetation along a motorway.

The used CFD model, Envi-met (www.envi-met.com), distinguishes itself from other CFD-models due the implementation of a detailed vegetation model which describes the interaction of local vegetation, not only on the wind field, but also on the thermodynamic processes and the diffusion and deposition of gases and particulate matter. Recently, at the Flemish Institute for Technological Research, the dispersion model has been extended with a chemical ozone module describing the reaction of ozone and nitrogen oxide and the photolysis of NO_2.

In a first exercise the model is used to model a five day measurement campaign which was executed before in the summer of 2006 along the A50 close to the village of Vaassen, The Netherlands. A comparison between model results and measurements has been done. Simultaneously the model results are used to better understand the physics playing a role regarding to the vegetation barrier along the motorway. Both the model as the measurement campaign indicate that he vegetation has an effect on the local air quality. Due to the barrier the concentrations will be higher on the motor way, but also just behind the vegetation. Further downwind a large area with a mean reduction of more than 5% of the concentrations of nitrogen oxide and particulate matter can be found. For NO_2 the reduction is even more than 10% compared to the reference state without any vegetation. The model also shows that the local change of wind field and turbulence has the biggest effects on the concentrations, while the actual deposition of gases and PM inside the canopy is of lower order.

During the summer of 2008 a second intensive measurement campaign has been carried out again along the A50, but now close to Valburg. This measurement location differs from Vaassen in the sense that the motor way is elevated by three to four meters compared to ground level. This affects the local wind and turbulence field, and has an influence on the local concentrations as well. Measurements have been taken both behind deciduous trees and conifers and in the open field. Currently these measurements are being evaluated throughout the Envi-met model. Not only the effect of the vegetation barrier, but also the effect of the elevated motor way is investigated. Results of this comparison will be presented as well.

Keywords: CFD, micro scale, urban air quality, vegetation barrier