Do satellite tropospheric NO_2 data improve modelling of ground level ambient NO_2 concentrations?

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Background and aims

In recent years, land use regression modelling has increasingly been applied to model the concentration of pollutants such as nitrogen dioxide (NO_2), particles smaller than 2.5 or 10 micrometer (PM2.5 or PM10). For large study areas, modelling the regional background trend is challenging in LUR modelling. The aim of our study is to assess the value of satellite observations of NO_2 in modelling annual average NO_2 concentrations across the Netherlands.

Methods

We used 2007 ground level NO_2 concentrations and geographic information system data from 144 monitoring sites spread over the Netherlands. In total, 26 sites were regional background, 78 sites urban background and 40 were close to major roads. For the 144 monitoring sites, we obtained the annual average tropospheric NO_2 concentration for 2007 from the Ozone Monitoring Instrument (OMI) on board of the NASA Aura satellite. Annual average OMI data reflect a spatial scale of about 10x10 km^2.

We calculated the correlation between measured satellite and ground level NO_2 concentrations for all sites and for background sites only. We next evaluated whether adding satellite observations improved land use regression models.

Results

Annual average satellite observations of tropospheric NO_2 correlated very well with annual average urban and regional background (R=0.74) and especially regional background surface NO_2 concentrations (R=0.88). As expected, fine scale variation in surface concentration related to traffic within 100s of meters was not well represented. A LUR model including satellite NO_2 observations to represent regional variation explained 84% of the variability in surface NO_2 at background locations. LUR models including geographical coordinates or indicator variables instead of satellite NO_2 had lower overall R^2 of 74 and 65%.).

Conclusion

Satellite NO_2 observations agreed well with measured surface concentrations at background locations and improved land use regression models including regional indicators or functions of geographic coordinates.