Do satellite tropospheric NO₂ data improve modelling of ground level ambient NO₂ 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 (NO₂), 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 NO₂ in modelling annual average NO₂ concentrations across the Netherlands.

Methods
We used 2007 ground level NO₂ 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 NO₂ 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 km².
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.