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On the Validation of Air Quality Models in Megacities using Satellite Measurements: A Case Study in the Pearl River Delta

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Recently, many efforts have been made to improve satellite measurements of air pollutants for applications on a regional scale [1-3]. These improved measurements can be used to validate chemistry transport simulations in megacities. However, special care must be taken for such validations, because the trace gas retrieval algorithm depends in part on the chemistry transport simulation itself. In our study, we compared chemistry transport simulations with nitrogen dioxide (NO_2) measurements of the Ozone Monitoring Instrument (OMI) in the Pearl River Delta (PRD) megacity (South China). Our objective was to determine the feasibility to validate models using current satellite products.

The Community Multiscale Air Quality (CMAQ) Modelling System, has been used to model air pollutants in winter 2006/2007. The model domain encloses the PRD with a horizontal grid resolution of 3 km. We included an improved vertical advection scheme and updated emissions using the newest inventory available.

In the OMI NO_2 retrieval algorithms [4,5], an air mass factor (AMF) converts slant column densities (SCD) to vertical column densities (VCD). The AMF describes the instrument sensitivity and depends on surface reflectance, atmospheric scattering and the NO_2 profile shape. We computed improved AMFs with the radiative transfer model SCIATRAN using terrain height, NO_2 profile shapes and aerosol profiles taken from CMAQ. These model-dependent parameter are validated with NO_2 and aerosol concentrations of the PRD air quality network. Updated surface reflectances are taken from MODIS.

The OMI measurements are mapped to the CMAQ grid using a newly developed gridding algorithm [6]. Finally, the VCDs have been converted to ground concentrations using the NO_2 profile shapes.

In our validation, we removed the dependency of the trace gase retrieval on a chemistry transport model. As a result, the retrieval uncertainties of the satellite product were reduced significantly. The approach allows to analyse every model dependency on the AMFs and to determine its impact on the VCDs. In our final product, the new gridding algorithm results in smoother distributions and reconstructs extreme values more accurately. The presented method is suitable to validate local chemistry transport simulations with satellite measurements.

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