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Developing high-resolution simulations of tropospheric NO_2 over Flanders using WRF-Chem

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Atmospheric chemistry is critical in determining air quality and thus impacts climate change. Anthropogenic species are released into the atmosphere, and undergo complex photochemical transformations leading to the production of secondary pollutants, among which ozone and particulate matter. This can induce adverse effects on human health, visibility, ecosystems and local meteorology. The combination of state-of-the-art atmospheric models with accurate atmospheric measurements of atmospheric species abundances is needed to evaluate whether atmospheric models can successfully simulate the chemical and physical processes occurring, and hopefully monitor the emissions of anthropogenic compounds and help in the implementation and verification of abatement policies.

In this work, ground-based, airborne and spaceborne measuring techniques are used to evaluate the performance of the full chemistry on-line WRF-Chem model over Antwerp in Flanders, Belgium, one of the areas with the highest NO2 pollution in the world. The model is configured to allow two nested domains with spatial resolution changing from 5 to 1km, so as to pinpoint the most pollutant sources in the region, and applied to simulate the urban air quality over the Antwerp agglomeration.

We will briefly discuss the choices and adaptations made regarding the physical parameterizations, emission inventories and chemical mechanism. The model performance is evaluated through comparison with various observation types. The physics parameterizations in WRF model are evaluated through comparison against ground-based data from two meteorological stations in the Antwerp region. The WRF-Chem NO2 distributions are evaluated against (1) hourly measured concentration values from monitoring stations in Flanders, (2) vertical columns measured by an airborne hyperspectral imager APEX, providing a 2-dimensional spatial mapping, on 27 and 29 June 2019, and (3) spaceborne NO2 columns over Belgium obtained from the high-resolution TROPOMI instrument aboard S5p. The consistency of the model biases across the three datasets will be discussed, and recommendations will be made for improving model performance in this region.