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Bridging the scales in a eulerian air quality model to assess the impact of megacity pollution export at the regional level

Guillaume Siour (1,2), Augustin Colette (1), Bertrand Bessagnet (1), Isabelle Coll (2), Frederik Meleux (1), and Laurent Menut (3)

(1) Institut National de l'Environnement Industriel et des Risques (INERIS), Verneuil en Halatte, France, (2) Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA), UPC-UPEC-UMR CNRS 7583, CMC, 61 avenue du Général de Gaulle, 94000 Créteil, France, (3) Institut Pierre Simon Laplace/Laboratoire de Météorologie Dynamique (LMD), École Polytechnique/ENS/UPMC/CNRS, Palaiseau, France

Investigations of the impact of megacities on the atmospheric environment benefit from a multiscale approach, because megacities provide a large part of the total anthropogenic emissions of trace species that have an impact on air quality at all scales. At the local scale, the accumulation of these primary compounds is responsible for severe respiratory problems and for the alteration of buildings. At the regional scale, they lead to the formation of secondary compounds such as ozone or organic particulate matter witch - in addition to their adverse effects of health - have an impact on the climate equilibrium. Bridging the local and regional scales in a dynamic fashion would thus improve the characterisation of local pollution export from megacities and their regional impact.

One of the main objectives of the CityZen project is to assess the interactions between spatial scales. This paper contributes to this activity with a focus on local to regional exchanges. The spatial interactions are often represented through off-line coupling of Chemistry Transport Models (CTM). The interactions from the global to the regional scale are well represented by state-of-the-art nested models. However the off-line coupling from the local to the regional and continental scales introduces a bias in the representation of local plumes on the chemistry of the larger scale. Such phenomena can be captured by means of two way nesting in a coupled model or data assimilation. But these approaches remain relatively costly. We present here the development and the results of an alternative multiscale approach making use of a horizontal stretched grid in the Eulerian CTM CHIMERE.

This method consists in the introduction of local zooms over megacities in a continental chemistry-transport simulation within a single grid with variable resolution. It allows bridging online the spatial scales from the city ($\sim$1km resolution) to the continental area ($\sim$50km resolution). The CHIMERE grid being regular in latitude and longitude, the resolution is stretched over a latitude and a longitude band. At the intersection of these bands, we obtain a finer grid that is linked in real-time with the coarse resolution simulation at the larger scale.

The specific meteorological problems associated with this approach are discussed. They mainly derive from the difficulty of interpolating the two different meteorological datasets to a unique grid of variable resolution. Furthermore, these two datasets need to be consistent with each other. The use of the WRF mesoscale model in a two-way nested approach was identified as the best solution and is described here.

The CHIMERE model was run over a continental domain including the European megacity areas studied in the CityZen project (notably the Po Valley and the BeNeLux). In the first part of this presentation we will expose the validation work conducted over the stretched grid by comparing the model results to ground-based measurements. The calculation of the megacity regional impact obtained from this approach will then be discussed.