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Evaluation of the multi-annual and seasonal import/export budgets of two European megacities

G. Siour (1,2), A. Colette (1), I. Coll (2), and B. Bessagnet (1)
(1) INERIS, Verneuil en Halatte, France, (2) LISA, Créteil, France siour@lisa.u-pec.fr

One major challenge with respect to air quality survey and urban management is to provide a quantitative estimate of the impact of megacities on their regional and continental environment, and its evolution over time. In order to evaluate the footprint of megacities on air pollution, we investigated the import/export fluxes associated with two major pollution hotspots: the Begium-Netherlands-Luxemburg (BeNeLux) area and the Po-Valley region. A 10-year period (1998 - 2007) was simulated with the regional scale model CHIMERE (see Colette et al. 2011 for details) using EMEP (http://www.emep.int) emissions and meteorological fields provided by the WRF model (http://www.wrf-model.org), at an horizontal resolution of 0.5°.

Several approaches were used to characterize the primary and secondary export of pollutant from these areas: realistic tracer emissions simulating CO export, diagnostic and prognostic flux calculations, as well as an angular export pathway analysis. The diagnostic and prognostic strategies exhibited some differences when looking at short timescales (especially during high O_3 productivity episodes when concentrations evolve at a fast rate between two model output time-steps), but differences remained marginal when integrated over a whole season.

The picture that can be derived from the present study is that the Benelux region is a quite high contributor to the degradation of regional air quality in Northern Europe, due to its broad emitting surface. Furthermore, while our two megacities of interest export NO_x all the year long, strong differences are observed for other compounds. Indeed, BeNeLux exports large quantities of aerosols (whatever the season) and of ozone (in summer), whereas incoming fluxes dominate the ozone and PM10 budget in the Po-Valley at every season. This feature must be linked to the overwhelming presence of biogenic emitters in the surroundings of the Milan urban area, which produce ozone and aerosol at high rates: when these regional air masses are captured by local recirculations along the Mediterranean coast, they affect in return the urbanized area as incoming fluxes. Finally, our modeling studies reveal that air mass recycling in this area is responsible for a prevailing transport of the Po-Valley emissions towards the sea, while the BeNeLux emissions are evenly distributed around the urbanized area. Such results are determinant for emission control management at the European scale. Evaluation of the multi-annual and seasonal import/export budgets of two European megacities.