Geophysical Research Abstracts
Vol. 16, EGU2014-6776, 2014
EGU General Assembly 2014

Inverse Modeling for the anthropogenic emission estimation by 4D-var

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A key to better understanding the complex atmospheric processes is the quantitative determination of the emission patterns. Emissions of urban areas contribute to influence greater areas than the actual city area. These influences can be local (air-pollution, heat islands), regional (air-pollution, precipitation) or potentially global (long range transport and vertical transport into the UTLS levels).
That is why our study deals with the estimations of the anthropogenic emission strength and the chemical evolution of urban air-sheds, using the techniques of Inverse Modeling. The chemical four-dimensional data assimilation system that is applied within the European Air Pollution and Dispersion chemistry-transport model and its inverse modeling module (EURAD-IM), is already generalized by including not only chemical state estimates, but also emission rate optimization. This achievement follows the objectives of data assimilation and provides an accurate and consistent image of the atmosphere.
In the present work an extension of this state is done for a better estimation of the emission factors. A novel approach has been produced, which gives the best estimation of the multivariate covariance matrices of the optimization problem. This is done by updating the emission factor error covariance matrix to 24 emitted species, as well as by adapting the adjoint code to the new online emission model by TNO.
Joint optimization of the initial values of the chemical constituents and the emission rates takes place in the study of two special episodes in North Rhine-Westphalia (NRW) region in Germany: an ozone episode in July 2010 and an aerosol episode during the winter of 2012. The nesting techniques that are applied go from 15 km resolution, for the European domain, down to 5 km resolution for Central Europe, and is scheduled to end with 1 km resolution for NRW, implying an indispensable knowledge of the emission patterns. For the assimilation, different kind of observational data are used, giving a more efficient result.