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PEGASOS campaign data for optimizing atmospheric chemical composition by 4D-var data assimilation within EURAD-IM modelling system

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Modelling systems to analyze the complex atmospheric chemical processes deal with significant uncertainties of key parameters and input information, most prominently emission rates and chemical background information. The sophisticated 4D-var assimilation scheme for gas-phase included in the EURopean Air pollution Dispersion – Inverse Model (EURAD-IM), is used to provide more accurate initial values and emission rates of gas-phase species, being the key to better estimate anthropogenic and biogenic pollutant concentration patterns, as well as to understand their interactions at a given air-shed. WRF model is the meteorological driver to the EURAD-IM system.

Within this study, data measured by the Zeppelin NT bone instruments on the PanEuropean Gas-AeroSOls Climate Interaction Study (PEGASOS) scientific campaign were assimilated by the EURAD-IM system as a complement to routine measurements (satellite retrievals and ground-based stations - O_3, NO_2 and CO). The campaign took place in the Po-valley region during a high concentrations of OH radical episode on 12th July 2012. It offered large data sets of high quality measurements (O_3, NO, NO_2, CO, CH_2O, HONO, OH- and HO_2-), helping to study and understand the emission patterns and the chemical consistency in this region. However, the airborne measurements are spatially and temporally limited that poses challenges on how they can support the assimilation analysis result in the EURAD-IM system. To this end, the current study applies the 4D-var data assimilation method within the EURAD-IM to determine whether and how the campaign data are able to indicate corrections to the model analysis and thus improving air quality prediction. Further, the optimization of emission rates in nested grids of 1km resolution is studied, addressing the issue of the representativity of observations such as NO_2. Taking advantage of the high quality airborne campaign measurements, special focus is given on the analysis of the vertical mixing in the boundary layer, studying the atmosphere's vertical structure.

The high resolution nesting technique has shown to improve the representativity of NO_2 observations in the finest grid, being able to identify traffic emissions patterns and more accurate concentrations. Furthermore, the layered chemical composition of the PBL was improved by the assimilation of the airborne measurements in general for all the species studied. The assimilation of the scientific campaign data is proved to enhance the model analysis on a vertical perspective of gas phase concentrations.