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Assessing representation errors of IAGOS CO_2, CO and CH4 profile observations: the impact of spatial variations in near-field emissions

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Airborne platforms have their main strength in the ability of collecting mixing ratio and meteorological data at different heights across a vertical profile, allowing an insight in the internal structure of the atmosphere. However, rental airborne platforms are usually expensive, limiting the number of flights that can be afforded and hence on the amount of data that can be collected. To avoid this disadvantage, the MOZAIC/IAGOS (Measurements of Ozone and water vapor by Airbus In-service airCraft/In-service Aircraft for a Global Observing System) program makes use of commercial airliners, providing data on a regular basis. It is therefore considered an important tool in atmospheric investigations.
However, due to the nature of said platforms, MOZAIC/IAGOS's profiles are located near international airports, which are usually significant emission sources, and are in most cases close to major urban settlements, characterized by higher anthropogenic emissions compared to rural areas.
When running transport models at finite resolution, these local emissions can heavily affect measurements resulting in biases in model/observation mismatch. Model/observation mismatch can include different aspects in both horizontal and vertical direction, for example spatial and temporal resolution of the modeled fluxes, or poorly represented convective transport or turbulent mixing in the boundary layer.
In the framework of the IGAS (IAGOS for GMES Atmospheric Service) project, whose aim is to improve connections between data collected by MOZAIC/IAGOS and Copernicus Atmospheric Service, the present study is focused on the effect of the spatial resolution of emission fluxes, referred to here as representation error.
To investigate this, the Lagrangian transport model STILT (Stochastic Time Inverted Lagrangian Transport) was coupled with EDGAR (Emission Database for Global Atmospheric Research) version-4.3 emission inventory at European regional scale. EDGAR's simulated fluxes for CO, CO_2 and CH4 with a spatial resolution of 10x10 km for the time frame 2006-2011 was be aggregated into coarser and coarser grid cells in order to evaluate the representation error at different spatial scales.
The dependence of representation error from wind direction and month of the year was evaluated for different location in the European domain, for both random and bias component. The representation error was then validated against the model-data mismatch derived from the comparison of MACC (Monitoring Atmospheric Composition and Climate) reanalysis with IAGOS observations for CO to investigate its suitability for modeling applications.
We found that the random and bias components of the representation error show a similar pattern dependent on wind direction. In addition, we found a clear linear relationship between the representation error and the model-data mismatch for both (random and bias) components, indicating that about 50% of the model-data mismatch is related to the representation error. This suggests that the representation error derived using STILT provides useful information for better understanding causes for model-data mismatch.