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Representativeness analysis of CO$_{2}$ profiles near a tall tower and from commercial airliner programs

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Aircraft profiles for atmospheric trace gases have been collected using both rental aircraft and from commercial airliners. High-accuracy regular in situ CO_2 measurements aboard rental aircraft over northeast Poland have been upgraded since August 2008. During each flight, two profiles are taken with a spatial separation of 20 kilometers. Until now, 74 profiles with continuous CO_2 have been collected. Meanwhile, aircraft profiles for carbon monoxide (CO) have been made aboard commercial airliners within MOZAIC (Measurement of Ozone, water vapor, carbon monoxide and nitrogen oxides by AIrbus in-service airCraft) and for CO_2 within CONTRAIL (Comprehensive Observation Network for TRace gases byAIrLiner) respectively.

Starting from 2011, IAGOS-ERI (Integration of routine Aircraft measurements into a Global Observing System – European Research Infrastructure) will provide continuous CO_2, CH_4 and H_2O measurements using instruments deployed aboard commercial airliners, with many profiles during take-off and landing over airports distributed all over the globe.

These profiles contain not only vertical gradients but also regionally representative information. It is of importance to investigate how these profiles could be used for applications such as satellite validation and inverse modeling to retrieve surface-atmosphere exchange fluxes of greenhouse gases at regional to continental scales. Especially profiles from commercial airliners near major cities, which are potentially influenced by local fossil fuel emissions, need to be assessed with respect to their regional representativeness. We analyzed CO profiles over Frankfurt airport from the MOZAIC and CO_2 profiles from CONTRAIL using STILT (the Stochastic Time Inverted Lagrangian Transport model) combined with a high resolution CO emission map in central Europe. Combining STILT footprints (maps of sensitivities to upstream surface fluxes) with high resolution emission inventories allows to attribute the contribution fossil fuel emissions to local vs. regional sources. In contrast, we analyzed CO_2 profiles over northeast Poland in a similar way, where fossil fuel emissions are insignificant.

The representativeness analysis provides information on under which circumstances such profiles can be used for potential applications, i.e. satellite validation and inverse modeling. The analysis suggests that a combined measurement of CO_2 and CO significantly improves the usability of the regular profiles, where CO serves as the emission tracer.