Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 8, 6587-6596, 2008
www.atmos-chem-phys.net/8/6587/2008/

Modelling representation errors of atmospheric CO_2 mixing ratios at a regional scale

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Abstract. Inverse modelling of carbon sources and sinks requires an accurate quality estimate of the modelling framework to obtain a realistic estimate of the inferred fluxes and their uncertainties. So-called "representation errors" result from our inability to correctly represent point observations with simulated average values of model grid cells. They may add substantial uncertainty to the interpretation of atmospheric CO_2 mixing ratio data. We simulated detailed variations in the CO_2 mixing ratios with a high resolution (2 km) mesoscale model (RAMS) to estimate the representation errors introduced at larger model grid sizes of 10–100 km. We found that meteorology is the main driver of representation errors in our study causing spatial and temporal variations in the error estimate. Within the nocturnal boundary layer, the representation errors are relatively large and mainly caused by unresolved topography at lower model resolutions. During the day, convective structures, mesoscale circulations, and surface CO_2 flux variability were found to be the main sources of representation errors. Interpreting observations near a mesoscale circulation as representative for air with the correct footprint relative to the front can reduce the representation error substantially. The remaining representation error is 0.5–1.5 ppm at 20–100 km resolution.

Final Revised Paper (PDF, 1155 KB) Discussion Paper (ACPD)

Citation: Tolk, L. F., Meesters, A. G. C. A., Dolman, A. J., and Peters, W.: Modelling representation errors of atmospheric CO_2 mixing ratios at a regional scale, Atmos. Chem. Phys., 8, 6587-6596, 2008. Bibtex EndNote Reference Manager