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High resolution modeling of CO_2 over Europe: implications for representation errors of satellite retrievals

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Abstract. Satellite retrievals for column CO_2 with better spatial and temporal sampling are expected to improve the current surface flux estimates of CO_2 via inverse techniques. However, the spatial scale mismatch between remotely sensed CO_2 and current generation inverse models can induce representation errors, which can cause systematic biases in flux estimates. This study is focused on estimating these representation errors associated with utilization of satellite measurements in global models with a horizontal resolution of about 1 degree or less. For this we used simulated CO_2 from the high resolution modeling framework WRF-VPRM, which links CO_2 fluxes from a diagnostic biosphere model to a weather forecasting model at 10×10 km^2 horizontal resolution. Sub-grid variability of column averaged CO_2, i.e. the variability not resolved by global models, reached up to 1.2 ppm with a median value of 0.4 ppm. Statistical analysis of the simulation results indicate that orography plays an important role. Using sub-grid variability of orography and CO_2 fluxes as well as resolved mixing ratio of CO_2, a linear model can be formulated that could explain about 50% of the spatial patterns in the systematic (bias or correlated error) component of representation error in column and near-surface CO_2 during day- and night-times. These findings give hints for a parameterization of representation error which would allow for the representation error to taken into account in inverse models or data assimilation systems.

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