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Vertical mixing in atmospheric tracer transport models: error characterization and propagation

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Abstract. Imperfect representation of vertical mixing near the surface in atmospheric transport models leads to uncertainties in modelled tracer mixing ratios. When using the atmosphere as an integrator to derive surface-atmosphere exchange from mixing ratio observations made in the atmospheric boundary layer, this uncertainty has to be quantified and taken into account. A comparison between radiosonde-derived mixing heights and mixing heights derived from ECMWF meteorological data during May–June 2005 in Europe revealed random discrepancies of about 40% for the daytime with insignificant bias errors, and much larger values approaching 100% for nocturnal mixing layers with bias errors also exceeding 50%. The Stochastic Time Inverted Lagrangian Transport (STILT) model was used to propagate this uncertainty into CO_2 mixing ratio uncertainties, accounting for spatial and temporal error covariance. Average values of 3 ppm were found for the 2 month period, indicating that this represents a large fraction of the overall uncertainty. A pseudo data experiment shows that the error propagation with STILT avoids biases in flux retrievals when applied in inversions. The results indicate that flux inversions employing transport models based on current generation meteorological products have misrepresented an important part of the model error structure likely leading to biases in the estimated mean and uncertainties. We strongly recommend including the solution presented in this work: better, higher resolution atmospheric models, a proper description of correlated random errors, and a modification of the overall sampling strategy.

Final Revised Paper (PDF, 8638 KB) Discussion Paper (ACPD)

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