Geophysical Research Abstracts, Vol. 7, 07626, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07626

Greenhouse gas emission verification by inverse modelling of Tall Tower observations of vertical concentration gradients in the mixing layer

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At the tall tower of Cabauw (The Netherlands) we measured from June 2000 to May 2004 high precision, half-hourly, vertical concentration profiles of ambient CH_4. Measurement heights were 20, 60, 120 and 200 m AGL. The COMET Lagrangian transport model was adopted to use for the same time period hourly 96-hour backward trajectories. Mixing layer depth was determined from ECMWF model data using the Critical Richardson number approach. Forward calculated methane concentrations show a high correlation with the measured vertically averaged concentrations of the mixing layer (r^2=0.70). Using 'uncertainty' trajectory data, an estimate can be made of the quality of the trajectories at individual hours. Using criteria for the error related to the uncertainty in the trajectory path the selected data show model-measurement correlations with values for r^2 of 0.93.

Several optimization methods have been tested on the inversion of the COMET derived Source-Receptor Matrix (SRM) and will be discussed. The robustness and Monte Carlo simulated error estimates of the calculated emission rates as a function of important parameters as model error, length of the concentration time series, background concentration data and source area configuration are also considered. The potential and requirements for application of tall tower measurements of other important greenhouse gases like N_2O, SF_6 and HFC's for emission verification by inverse modeling are also shown.