Inter-Annual Variability of CO and CH_4 Observations Interpreted by a Global Lagrangian Transport Model

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A Lagrangian particle dispersion model (based on FLEXPART, Version 8.0) was set up to simulate global CO and CH_4 concentrations. Three million particles were constantly advected forward in time and allowed to pick up emissions during surface contact. Concentrations in the model were driven by 8-daily emission fields that reflect variability in biomass burning. Degradation of CO and CH_4 (and CO production from CH_4) was taken into account using an OH climatology with monthly resolution and pressure and temperature dependent reaction rates. Next to the less diffusive character of the Lagrangian context, the benefit of this approach is the potential to analyse contributions to the concentrations at receptor sites not only by source region and source category (as could be done in the Eulerian context as well) but also by age of an air mass. This age is given by the transport time from a certain source region.

Here we analyse a multi-year run of the model (2001-2007) and discuss inter-annual variability of CO and CH_4 as observed within the World Meteorological Organization/Global Atmosphere Watch (GAW) programme. In total 60 observational data sets of CO and 69 data sets for CH_4 were analysed. Monthly receptor concentrations at the sites' location were extracted from the model. Changes and anomalies in source region contributions at these sites were revealed and exceptional transport pathways highlighted.

In the Lagrangian context it is necessary to sum contributions of individual particles over a certain period of time to derive a robust concentration estimate at a given location in space. The temporal resolution of receptor concentrations is therefore limited by the number of particles passing through a receptor volume. We demonstrate the ability of our model setup to realistically simulate concentration variability at receptor sites on a day-to-day basis. This capability is further proven by the successful simulation of previously studied inter-continental transport events with duration of one to two days.

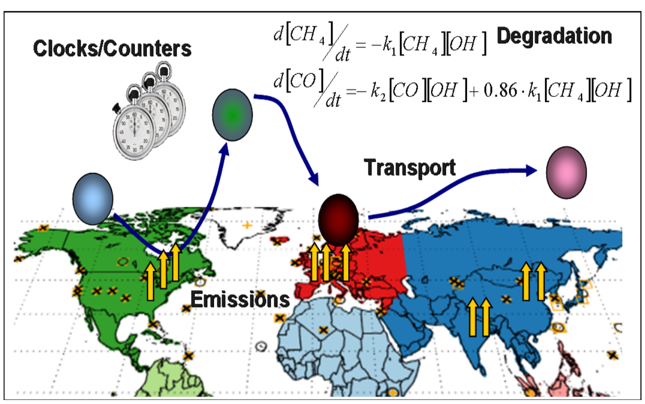

Figure 1. Conceptional representation of the model showing the model elements (global) transport, emissions (from 6 source regions plus the ocean), degradation (coupling CO and CH_4 to OH), and Clocks/Counters (needed to derive age spectra and source contributions at receptor points).

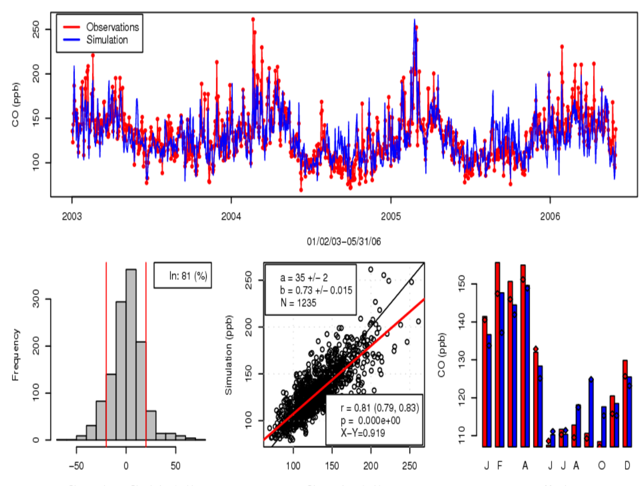

Figure 2. Comparison of model and observation for CO measurements at GAW station Jungfraujoch in the Swiss Alps.