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Atmospheric Chemistry and Physics Discussions

Interactive comment on "COMET: a Lagrangian transport model for greenhouse gas emission estimation – forward model technique and performance for methane" *by* A. T. Vermeulen et al.

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In his general comment referee #2 rightly concludes that the COMET model is similar to approaches taken by Lagrangian box models developed in the 80's and 90's, even more so as we started development of the COMET model ourselves in the early 90's. It is also true that the COMET model ignores some processes that could influence the concentrations during atmospheric transport. The main concept of the model we describe in this paper is to capture for long time-series most of the variability of concentrations at receptor points with the least possible complexity in the model. We acknowledge that under some circumstances the processes mentioned by referee #2 will have significant impact, but we wanted to develop a robust model that delivers with modest demands satisfying answers for the vast majority of the hourly observations in

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stations close (<1000 km distance) to the major source areas over a multi-year period. The COMET model was not developed to study complex situations with stratospheric injections and bifurcation of flows along frontal systems and to predict the concentration at background stations. We don't see why source-receptor relationships should be exclusively computed only with 3D Eulerian models or LPDM's, especially considering that all model simulations we have seen, agree that the concentration 'footprint' of surface observations is contained within a relatively small area around the observation site with distances of maximum 500-1000 km, with contributions decaying exponentially with distance (e.g. Gloor, 2002; Bergamaschi 2005). We think and try to demonstrate in this paper that for these limited distances the single trajectory describes grosso modo the transport of tracers and the resulting concentrations quite well. The challenge for more complex models will be to perform much better. The referee's remarks that single-trajectory models should not be used contain a strong subjective judgement. The trajectory models are as good as the underlying meteorological model, from which the trajectory data is calculated, allows for. In this paper this underlying model is the 23r4 version of the ECMWF operational model. The studies performed in the 80's and 90's to which the referee probably refers were based on much less advanced meteorological data. This sensitivity to the meteorological input data also is valid for state-of-the-art 3D Eulerian and LPD models. We currently also participate with the COMET model in model intercomparisons like the ongoing Transcom Continuous (Law et al, 2006) experiment and the CarboEurope fossil fuel experiment, where we compare results with state-of-the-art Eulerian models like TM5, LMDZ, etc. Preliminary results show that for non-mountaineous sites like Cabauw, Macehead and Hegyhatsal, the COMET predicted concentrations compare very well with both measurements and other model results, also for tracers like CO2, SF6 and 222Rn.

Specific comments: Page 8: We do not and certainly did not intend to claim in this paper that the approach with time-varying circular areas of influence is new or invented by us. In the revised paper we will add references to similar approaches in the past.

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Page 9: We just turned the Stohl et al (2002) statement around in its implication that in principal a LPD model allows for a more realistic description of the transport process but that more detailed parametrisations of the turbulence parameters are required, leading at this moment to still large uncertainties. The main benchmark to meet is in our opinion the objective forward performance scores of the respective models for surface observation sites. Any model explaining significantly more than 70% of the observed variability of hourly timeseries for one or several years with negligible biases would be candidate.

Page 28: We come to a different conclusion than referee #2 for the reason of model performance deterioration for smaller AOI radii. In the revised paper we will extend the conclusions to attempt to falsify the 'forgotten' conclusion of referee #2.

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