Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 5, 85-95, 2005
www.atmos-chem-phys.net/5/85/2005/

Intercomparison between Lagrangian and Eulerian simulations of the development of mid-latitude streamers as observed by CRISTA

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Abstract. During the CRISTA-1 mission three pronounced fingerlike structures reaching from the lower latitudes to the mid-latitudes, so-called streamers, were observed in the measurements of several trace gases in early November 1994. A simulation of these streamers in previous studies employing the KASIMA (Karlsruhe Simulation Model of the Middle Atmosphere) and ROSE (Research on Ozone in the Stratosphere and its Evolution) model, both being Eulerian models, show that their formation is due to adiabatic transport processes. Here, the impact of mixing on the development of these streamers is investigated. These streamers were simulated with the CLaMS model (Chemical Lagrangian Model of the Stratosphere), a Lagrangian model, using N_2O as long-lived tracer. Using several different initialisations the results were compared to the KASIMA simulations and CRISTA (Cryogenic Infrared Spectrometer and Telescope for the Atmosphere) observations. Further, since the KASIMA model was employed to derive a 9-year climatology, the quality of the reproduction of streamers from such a study was tested by the comparison of the KASIMA results with CLaMS and CRISTA. The streamers are reproduced well for the Northern Hemisphere in the simulations of CLaMS and KASIMA for the 6 November 1994. However, in the CLaMS simulation a stronger filamentation is found while larger discrepancies between KASIMA and CRISTA were found especially for the Southern Hemisphere. Further, compared to the CRISTA observations the mixing ratios of N_2O are in general underestimated in the KASIMA simulations. An improvement of the simulations with KASIMA was obtained for a simulation time according to the length of the CLaMS simulation. To quantify the differences between the simulations with CLaMS and KASIMA, and the CRISTA observations, the probability density function technique (PDF) is used to interpret the tracer distributions. While in the PDF of the KASIMA simulation the small scale structures observed by CRISTA are smoothed out due to the numerical diffusion in the model, the PDFs derived from CRISTA observations can be reproduced by CLaMS by optimising the mixing parameterisation. Further, this procedure gives information on small-scale variabilities not resolved by the CRISTA observations.

Final Revised Paper (PDF, 4527 KB) Discussion Paper (ACPD)

Citation: Khosrawi, F., Grooß, J.-U., Müller, R., Konopka, P., Kouker, W., Ruhnke, R., Reddmann, T., and Riese, M.: Intercomparison between Lagrangian and Eulerian simulations of the development of mid-latitude streamers as observed by CRISTA, Atmos. Chem. Phys., 5, 85-95, 2005. Bibtex EndNote Reference Manager