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

Atmos. Chem. Phys., 4, 2521-2541, 2004
www.atmos-chem-phys.net/4/2521/2004/

Simulating the global atmospheric black carbon cycle: a revisit to the contribution of aircraft emissions

J. Hendricks[1], B. Kärcher[1], A. Döpelheuer[2], J. Feichter[3], U. Lohmann[4,*], and D. Baumgardner[5]
[1]DLR-Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
[2]DLR-Institut für Antriebstechnik, Köln, Germany
[3]Max-Planck-Institut für Meteorologie, Hamburg, Germany
[4]Dalhousie University, Halifax, Canada
[5]Centro de Ciencias de la Atmósfera, Universidad Nacional Autonoma de Mexico, Mexico City, Mexico
[*]now at: ETH, Institut für Atmosphäre und Klima, Zürich, Switzerland

Abstract. The black carbon (BC) burden of the upper troposphere and lowermost stratosphere (UTLS) is investigated with the general circulation model (GCM) ECHAM4. The special focus is the contribution of aircraft emissions to the UTLS BC loading. Previous studies on the role of aircraft emissions in the global BC cycle either neglect BC sources located at the Earth's surface or simplify the BC cycle by assuming pre-defined BC residence times. Here, the global BC cycle including emissions, transport, and removal is explicitly simulated. The BC emissions considered include surface sources as well as BC from aviation. This enables a consistent calculation of the relative contribution of aviation to the global atmospheric BC cycle. As a further extension to the previous studies, the aviation-induced perturbation of the UTLS BC particle number concentration is investigated. The uncertainties associated with the model predictions are evaluated by means of several sensitivity studies. Especially, the sensitivity of the results to different assumptions on the BC hygroscopic properties is analysed. The simulated UTLS BC concentrations are compared to in-situ observations. The simulations suggest that the large-scale contribution of aviation to the UTLS BC mass budget typically amounts to only a few percent, even in the most frequented flight regions. The aviation impact far away from these regions is negligible. The simulated aircraft contributions to the UTLS BC particle number concentration are much larger compared to the corresponding mass perturbations. The simulations suggest that aviation can cause large-scale increases in the UTLS BC particle number concentration of more than 30% in regions highly frequented by aircraft. The relative effect shows a pronounced annual variation with the largest relative aviation impact occurring during winter.

Final Revised Paper (PDF, 1706 KB) Discussion Paper (ACPD)

Citation: Hendricks, J., Kärcher, B., Döpelheuer, A., Feichter, J., Lohmann, U., and Baumgardner, D.: Simulating the global atmospheric black carbon cycle: a revisit to the contribution of aircraft emissions, Atmos. Chem. Phys., 4, 2521-2541, 2004. Bibtex EndNote Reference Manager