Meteorol. Z. (Contrib. Atm. Sci.), Vol. **33**, No. 1, 3–4

Editorial

Conference on Transport, Atmosphere and Climate (TAC-5)

Robert Sausen[1]*, Stefanie Meilinger[2] and Johannes Quaas[3]

[1]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
[2]Hochschule Bonn-Rhein-Sieg, Internationales Zentrum für Nachhaltige Entwicklung, Sankt Augustin, Germany
[3]Universität Leipzig, Institut für Meteorologie, Leipzig, Germany

Contrary to most other sectors of human activity that lead to a climate forcing, the transport sector appears to have significant difficulties in reducing its emissions. This applies in particular to air traffic. In aviation the non-CO_2 effects are large in relation to its CO_2-induced climate impact, if measured in terms of radiative forcing or effective radiative forcing (e.g., Prather et al., 1999; Sausen et al., 2005; Lee et al., 2009; Lee et al., 2021). The non-CO_2 climate effects of aviation, such as NO_x-induced effects or contrails, are larger than the non-CO_2 effects of ground-based emissions. The induced radiative forcings are larger than those arising from emissions close to the surface as the emissions live longer and the temperature difference to the surface is high. As our understanding of air traffic's atmospheric impact improves, mitigation methods and related tools evolve.

The environmental impact of transport has been of interest for intensive research for more than three decades. On dedicated international conferences topics related to the impact of transport on the atmospheric composition and on climate were discussed and new results were presented: After the European Conference on Aviation, Atmosphere and Climate at Friedrichshafen (Lake Constance, Germany) in 2003, five International Conferences on Transport, Atmosphere and Climate (TAC) were held in order to update our knowledge on the atmospheric impacts of aviation, and to also include all other modes of transport: at Oxford (United Kingdom) in 2006, at Aachen (Germany) and Maastricht (Netherlands) in 2009, at Prien am Chiemsee (Germany) in 2012, at Bad Kohlgrub (Germany) in 2015, and finally at Bad Aibling (Germany) in 2022[1]. The long gap between TAC-4 and TAC-5 was caused by the COVID-19 pandemic.

This issue of METEOROLOGISCHE ZEITSCHRIFT comprises 8 papers from contributions of the latest TAC conference which all cover aviation related topics.

Yu and Miake-Lye (2024) estimate the volatile contribution to measurements of non-volatile particulate matter emissions from aircraft engine at ground level. This helps to evaluate the quality of measurements according to ICAO standards.

Rolf et al. (2023) reports on the quality of compact hygrometers for airborne measurements. Such instruments are necessary to obtain better water vapour measurements which cover a large fraction of the global atmosphere at flight altitude. They would form a desired input for the prediction of humidity by means of weather forecast models, a necessary step towards reliable prediction of persistent contrails.

Jones and Miake-Lye (2023) simulate the impact of the number of non-volatile particulate matter particles and the fuel sulphur content on the number of ice particles formed in an aircraft plume. They formulate the hypothesis that a low sulphur content might lower the number of activated particles.

Hofer et al. (2024) study the impact of alternative fuels on formation and persistence of contrails. They find that contrails are also formed if kerosene is replaced by methane or liquid hydrogen.

Gierens (2023) presents a formulation for calculating the transmission of clouds that are randomly aligned in the vertical. This will allow to forecast whether contrails can be observed by satellites and to estimate whether it might be worthwhile to avoid certain contrails.

Keles et al. (2024) give an example how to apply climate response models in aircraft design. They use two different CRMs (AirClim and LEEA) to estimate the total climate impact of different aircraft types. They find that turboprop aircraft have a smaller climate impact per passenger kilometer than regional jets.

Zengerling et al. (2023) apply so-called algorithmic climate change functions. They show that flying slower and lower reduces the climate impact without introducing new aircraft.

*Corresponding author: Robert Sausen, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, 82234 Weßling, Germany, e-mail: robert.sausen@dlr.de

[1]See also https://www.pa.op.dlr.de/tac/.

DOI 10.1127/metz/2024/1228
Gebrüder Borntraeger Science Publishers, Stuttgart, www.borntraeger-cramer.com

Sausen et al. (2023) demonstrated in a complex real life trial including evaluation by satellite images and calculation of statistical significance that persistent contrails can be avoided by flying up to 2000 ft (two flight levels) higher or lower.

References

Gierens, K., 2023: Transmission formulation for random stacks of clouds. – Meteorol. Z. **33**, 51–54, DOI: 10.1127/metz/2023/1186.

Hofer, S., K. Gierens, S. Rohs, 2024: Contrail formation and persistence conditions for alternative fuels. – Meteorol. Z. **33**, 43–49, DOI: 10.1127/metz/2024/1178.

Jones, S.H., R.C. Miake-Lye, 2024: Contrail Modeling of ECLIF2/ND-MAX flights: Effects of nvPM Particle Numbers and Fuel Sulfur Content. – Meteorol. Z. **33**, 35–41, DOI: 10.1127/metz/2024/1188.

Keles, F., O. Weiss, R. Pouzolz, 2024: Application of a climate impact evaluation methodology to compare turboprop and jet aircraft. – Meteorol. Z. **33**, 55–65, DOI: 10.1127/metz/2024/1188.

Lee, D.S., D.W. Fahey, P.M. Forster, P.J. Newton, R.C.N. Wit, L.L. Lim, B. Owen, R. Sausen, 2009: Aviation and global climate change in the 21st century. – Atmos. Environ. **43**, 3520–3537.

Lee, D.S., D.W. Fahey, A. Skowron, M.R. Allen, U. Burkhardt, Q. Chen, S.J. Doherty, S. Freeman, P.M. Forster, J. Fuglestvedt, A. Gettelman, A.R.R. DeLeon, L.L. Lim, M.T. Lund, T.J. Millar, B. Owen, J.E. Penner, G. Pitari, M.J. Prather, R. Sausen, L.J. Wilcox, 2021: The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. – Atmos. Environ. **244**, 1–29. DOI: 10.1016/j.atmosenv.2020.117834.

Prather, M., R. Sausen, A.S. Grossman, J.M. Haywood, D. Rind, B.H. Subbaraya, 1999: Potential climate change from aviation. In: Penner, J.E., D.H. Lister, D.J. Griggs, D.J. Dokken, M. McFarland (Eds.): Aviation and the Global Atmosphere. A Special Report of IPCC Working Groups I and III. Cambridge University Press, Cambridge, UK, 185–215.

Rolf, C., S. Rohs, H.G.J. Smit, M. Krämer, Z. Bozóki, S. Hofmann, H. Franke, R. Maser, P. Hoor, A. Petzold, 2023: Evaluation of compact hygrometers for continuous airborne measurements. – Meteorol. Z. **33**, 15–34, DOI: 10.1127/metz/2023/1187.

Sausen, R., I. Isaksen, V. Grewe, D. Hauglustaine, D.S. Lee, G. Myhre, M.O. Köhler, G. Pitari, U. Schumann, F. Stordal, C. Zerefos, 2005: Aviation radiative forcing in 2000: An update on IPCC (1999). – Meteorol. Z. **14**, 555–561.

Sausen, R., S. Hofer, K. Gierens, L. Bugliaro, R. Ehrmanntraut, I. Sitova, K. Walczak, A. Burridge-Diesing, M. Bowman, N. Miller, 2023: Can we successfully avoid persistent contrails by small altitude adjustments of flights in the real world? – Meteorol. Z. **33**, 83–98, DOI: 10.1127/metz/2023/1157.

Yu, Z., R.C. Miake-Lye, 2024: Volatile contributions to aviation nvPM: a mass spectrometric analysis of nvPM emissions. – Meteorol. Z. **33**, 5–14, DOI: 10.1127/metz/2024/1185.

Zengerling, Z.L., F. Linke, C.M. Weder, S. Dietmüller, S. Matthes, P. Peter, 2023: Flying low and slow: Application of algorithmic climate change functions to assess the climate mitigation potential of reduced cruise altitudes and speeds on different days. – Meteorol. Z. **33**, 67–81, DOI: 10.1127/metz/2023/1157.