Comparing and combining different climate mitigation measures in aviation

Zarah Zengerling[1], Florian Linke[1], Markus Kühlen[1], Benjamin Lührs[1], Malte Niklaß[1], Katrin Dahlmann[2], Volker Grewe[2], Christine Frömming[2], Sigrun Matthes[2], Annette Temme[3] and Volker Gollnick[4]

[1] *German Aerospace Center (DLR), Institute of Air Transport, Hamburg, Germany*

[2] *German Aerospace Center (DLR), Institute of Atmospheric Physics, Oberpfaffenhofen, Germany*

[3] *German Aerospace Center (DLR), Institute of Flight Guidance, Braunschweig, Germany*

[4] *Hamburg University of Technology, Institute of Air Transport Systems, Hamburg, Germany*

In the context of aviation's significant contribution to anthropogenic climate change from CO_2 and non-CO_2 emissions, ambitious climate goals have been defined for the aviation industry that require an implementation of extensive measures from technical, regulatory and operational perspectives [1,2]. While technical innovations including new aircraft designs and alternative fuels are expected to contribute significantly in the long run as they are associated with late entry-into-service, operational measures can benefit from their fast implementation with the current world fleet. Regulatory implementation enablers can further support the required changes to the air transport system. While the current state of research comprises a broad variety of studies on individual climate mitigation measures, a direct comparison and combination of the achieved results is typically not directly possible due to different reference cases, application scopes, and modelling assumptions as well as different maturities and expected realization times. However, a direct comparability is required to identify especially effective and efficient measures as well as to combine individual approaches in order to compare the resulting potentials towards the defined climate goals.

This study aims to address the lack of comparability by developing an approach to compare and combine different climate mitigation measures. We consider different concepts addressing technical, operational as well as regulatory aspects [e.g. 3 – 6]. Based on the individual assessment of climate mitigation measures, we expand a previously developed generalization approach [7] to scale individual results from measures-specific studies to a comparable scope considering varying traffic samples, assessment methods as well as temporal and spatial boundary conditions of the individual studies. Differences in maturities and possible entry-into-service times are also incorporated. Hence, different combinations of mitigation measures can be analysed regarding their climate mitigation potential in terms of temperature change as well as their operational applicability. Finally, possible combinations of the selected measures can be contrasted with defined climate goals.

References:

[1] D. Lee, et al.: The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. Atmospheric Environment 244 (2021).

[2] V. Grewe, et al.: Evaluating the climate impact of aviation emission scenarios towards the Paris agreement including COVID-19 effects. Nature Communications 12 (2021).

[3] M. Kühlen, et al.: From passenger itineraries to climate impact: Analyzing the implications of a new mid-range aircraft on the global air transportation system. 25th Air Transport Research Society World Conference, Antwerp, Belgium (2022).

[4] M. Niklaß, et al.: Note on the Non-CO2 Mitigation Potential of Hybrid-Electric Aircraft Using "Eco-Switch", Journal of Aircraft (2022).

[5] M. Becker, et al.: Untersuchungen zum Ansatz der Vermeidung nächtlicher Kondensstreifen zur Reduktion der Klimawirkung des Luftverkehrs. Deutscher Luft- und Raumfahrtkongress, Dresden, Germany (2022).

[6] M. Niklaß, et al.: Concept of climate-charged airspaces: a potential policy instrument for internalizing aviation's climate impact of non-CO2 effects. Climate Policy 21, 1066–1085 (2021).

[7] Z. Zengerling, et al.: Operational improvements to reduce the climate impact of aviation – A comparative study from EU project ClimOP. Applied Sciences (2023, under review).