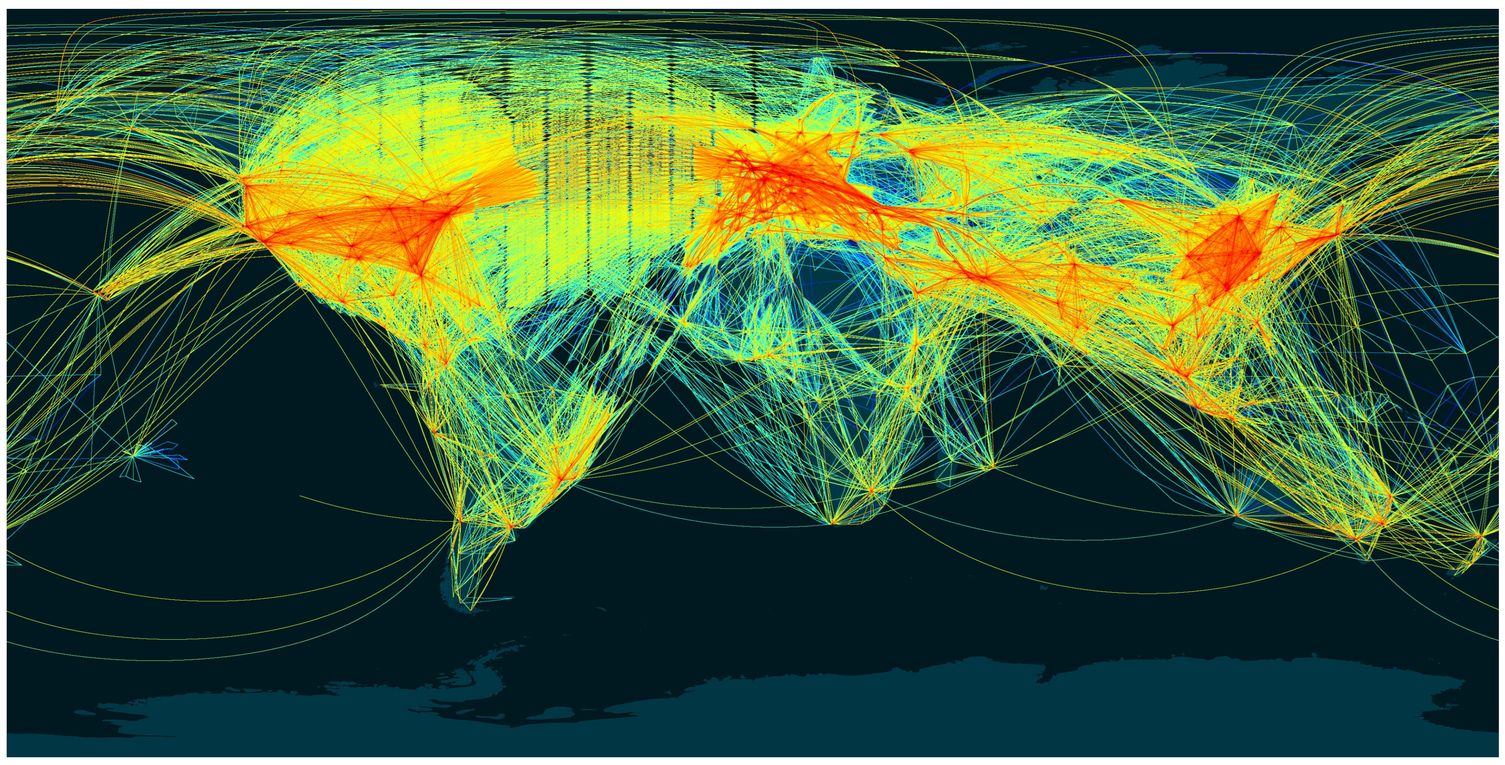
#ArchitectingAviation

Global impact assessment
Emissions and climate impact of flight operations

Technology assessment of improved or disruptive technologies and aircraft designs regarding their emission amounts and climate impact due to flight operations.



Global emission inventory for the year 2023 with consideration of actual flown trajectories for Europe (if available)

Assessments in context of EXACT2

Global impact assessment

- Assessing future emissions and climate impact of aviation on a global level in order to quantify the temporal development of global mean near surface temperature change

Technology assessment

- Assessing technology improvements of future generation aircraft benchmarked against current state-of-the-art aircraft regarding their emissions and climate impact

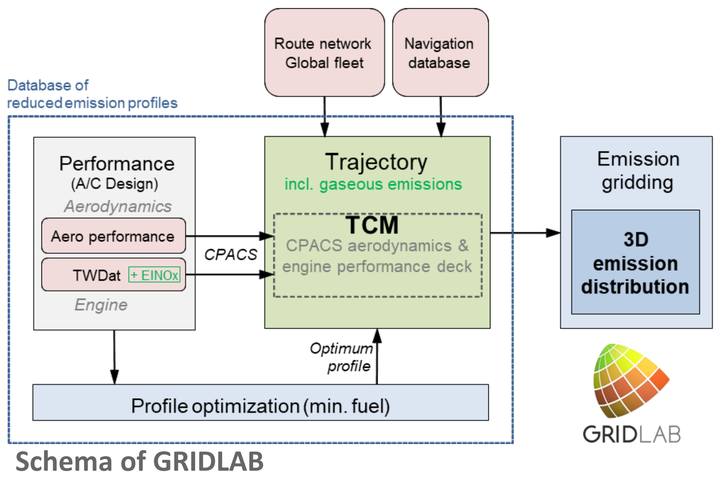
Introduction

The most obvious contribution to climate impact of aviation comes from flight operations themselves. Beside CO_2 emissions, also so-called non-CO_2 climate effects caused by e.g. the NO_x emissions or the formation of contrails are important. Those non-CO_2 effects are strongly dependent on the location where the emissions are released, i.e. altitude, geographic latitude and longitude and time. Therefore, it is important to consider the operational context of the aircraft within the fleet, especially the route network, on which the aircraft is operated.

Methods

The climate impact of in-flight and taxi emissions is assessed using the non-linear climate response model AirClim, for which fleet-level emission distributions from GRIDLAB are utilized. For each flight, a flight profile including the emissions along the trajectory is obtained from a database of reduced emission profiles, which was pre-computed for the vehicle concepts under investigation. The database contains profiles for any combination of flight distance and load factor. Each flight's emission profile is then adjusted to the exact length of the flight and mapped on the great-circle connection of the flight.

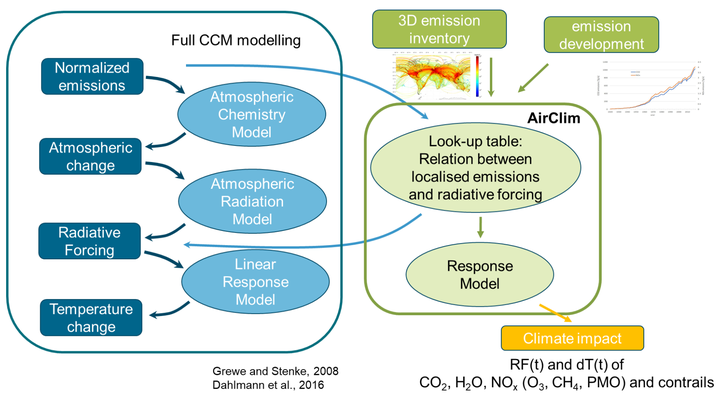
The resulting inventories are fed into the climate response model AirClim, which combines aircraft emissions with pre-calculated atmospheric data from simulations using a climate chemistry model. In addition to CO_2, also water vapor, the effect of nitrogen oxides on ozone and methane and the effect of contrail cirrus (CiC) are considered.



Schema of GRIDLAB

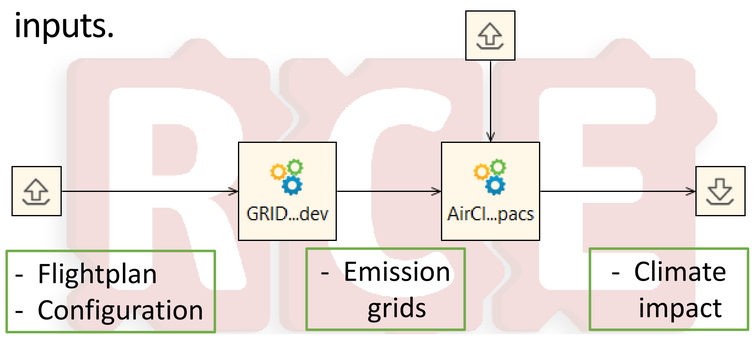
Assumptions

- CO_2 emissions from SAF are assumed as 100% climate neutral
- Particle emissions are reduced by 62% for SAF and 100% for LH2

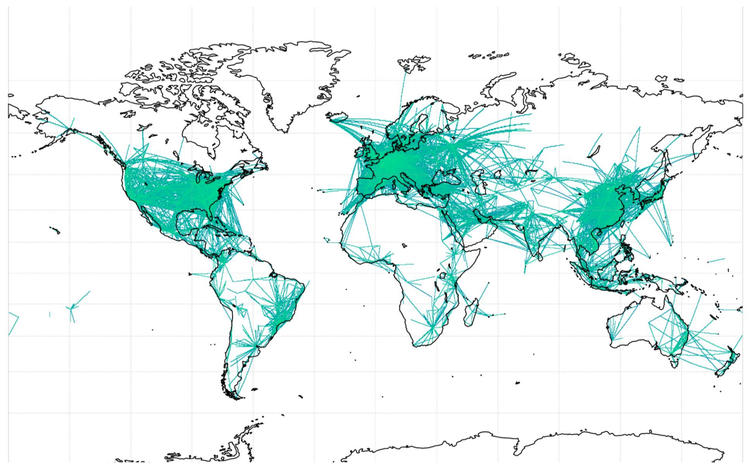


Schema of AirClim

The GRIDLAB-AirClim combination can be called via RCE with either CPACS or EXCEL/csv inputs.



RCE integration of GRIDLAB and AirClim



Representative route network for the D250 aircraft

EXACT2

For the technology assessment, representative flight plans are derived to compare state-of-the-art with future generation aircraft (see D250 above). Identical flight schedules ensure the comparability of results in terms of emissions and climate impact. In contrast to EXACT not only in-flight but also taxi emissions are considered, especially to point out the advantages of PHEP aircraft designs because of their electric taxiing capabilities.

Outlook

EXACT2

- The **first** iteration of EXACT2 was finished in Q3/ 2024. Its main goal was establishing a automated connection between the used tools via RCE and usage of CPACS.
- The **second** iteration will produce first valid results regarding the climate impact improvement of novel aircraft concepts compared to state-of-the-art aircraft. **First results** are expected in **Q2/**2025.

ALICIA

- The GRIDLAB-AirClim combination is used for use case 3 where future emissions and climate impact are assessed and the automated connection is developed.

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