Climate optimization of aircraft operations and design

A review and implications on modelling requirements Pages

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Climate optimization of aircraft operations and design: A review and implications on modelling requirements

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Aviation is a highly necessary transport sector in our modern society. It guarantees mobility on a short- and long-range spectrum and is still a growing sector. However, aviation also contributes significantly to the anthropogenic climate change via CO_2 and non-CO_2 effects. One possibility to reduce the climate impact of aviation would be to optimize the aircraft at the design level. Another possibility is to optimize the operations, e.g. to avoid climate sensitive regions in the flight route. To derive modelling capabilities, we review the climate impact of aviation with a focus on climate optimization of aircraft operations and design.
The overall climate impact of aviation based on CO_2 and non-CO_2 effects is analyzed under consideration of contrails and different emissions like CO_2, NO_x, and H_2O. The connection to the related temperature change is shown via the climate sensitivity for each species. An overview over the most common climate metrics, including radiative forcing, global warming potential, global temperature potential, and the average temperature response is given in order to find the most suitable climate metric for aircraft design purposes. During previous studies within various projects, e.g. WeCare, REACT4C, and ATM4E, climate optimization strategies for aircraft operations were investigated. The aircraft routes regarding the flight path or altitude can be adjusted in regard to climate considerations, also in dependence on the current weather situation. In these projects, climate change functions and algorithmic climate change functions were developed which could potentially facilitate the climate optimized routings. The aircraft design for climate optimization differs from the approach to optimize the design for reduced cost or reduced fuel burn. For the climate impact, flying slow and low is beneficial which was shown in the project CATS, but this is not reflected in the current aircraft design. Therefore, previous studies propose redesigned aircraft. The relation between climate, aircraft operations and aircraft design is used to point out the requirements for modelling resulting from that. The focus is on the connection between climate and operations on one side, and on the connection between climate and design considerations on the other side. Currently, the model capacity for aircraft design does not support the climate optimized design. Therefore, deriving climate functions for aircraft design is highly important which will be one of the main goals in the Clean Sky 2 project GLOWOPT (Global-Warming-Optimized Aircraft Design).