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Climate optimized aircraft trajectories and risk analysis of climate impact mitigation: FlyATM4E

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Aviation aims to reduce its climate impact, comprising CO_2 and non-CO_2 effects, by identifying climate-optimized aircraft trajectories. Such climate-optimized routes avoid regions of atmosphere where aviation emissions have a large impact on climate, e.g. by formation of contrails or strong NO_x-induced ozone formation. Implementing such climate-optimized routings requires that air traffic management has spatially and temporally resolved information on these non-CO_2 climate effects available during the trajectory planning process.

An overall modelling chain is required in order to expand the current flight planning procedure by considering climate impact during trajectory optimization in the overall optimization process. We explore a concept how to provide such information as an advanced MET Service: based on numerical weather prediction data and using algorithms climate change functions (aCCFs) such spatially and temporally resolved information can be provided. By integrating an uncertainty and risk analysis, we enable air traffic management (ATM) to identify climate-optimized aircraft trajectories which provide a robust and eco-efficient reduction in aviation's climate impact. Climate optimization in this feasibility study, which is part of the SESAR ER project FlyATM4E, considers CO_2 as well as non-CO_2 effects, such as contrails and contrail-cirrus, water vapour, and NOx-induced effects on ozone and methane.

We will present the overall modelling concept which has been developed to explore climate-optimized aircraft trajectories considering individual weather situations in a series of one-day case studies. This concept also explores the robustness of estimated benefits in terms of mitigation of climate effects. The approach comprises a comprehensive uncertainty analysis, that provides alternative estimates as upper and lower limit estimates to reflect low level of scientific understanding or unknown efficacy of individual effects, resulting from state-of-the-art understanding from climate science. We also explore how to incorporate different physical climate metrics, as well as the usage of ensemble forecast data. We will present how these individual

sources of uncertainty are statistically combined in order to provide a risk analysis together with the performance analysis of the identified alternative trajectory solutions, and hence identify robustness of mitigation gains on alternative trajectories. Finally, we will present an verification concept relying on numerical global chemistry-climate modelling with EMAC in order to explore such alternative routings during a one-year simulation.

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