Flight trajectories optimization for warming contrail avoidance

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Aviation contributes to about 3.5% of the total anthropogenic climate change when including non-CO_2 effects (Lee et al. 2021). Among non-CO_2 effects, the contrail-cirrus radiative forcing is the largest (~2/3) with large uncertainties. The most critical affecting factor is the huge weather-induced variability of the radiative impact of individual contrails. The previous research demonstrated the potential of largely avoiding contrail formation with limited increase of flight time (<2%) over a subset of transatlantic flights (Yin et al. 2018). Nevertheless, the large uncertainties of contrail effects impose challenges on formulating adequate mitigation measures. The Horizon Europe funded project BeCoM (https://www.becom-project.eu) aims to improve the confidence in forecasting persistent contrail formation, hence enabling a large reduction in the global mean contrail radiative forcing. This is facilitated by confidently forecast of Ice superstation regions (ISSRs), the reduced weather-dependent individual contrail radiative effects, and the successful avoidance of strongly warming contrails via trajectory optimization.

This research, as a part of BeCoM project, focuses on the climate-optimized flight trajectories for warming contrail avoidance. As the first step, we analyze the daytime and nighttime contrail climate impact of eco-efficient flight trajectories, using an air traffic simulator (AirTraf, Yamashita et al. 2020) based on a selected set of European traffic samples. By artificially eliminating the cooling contrail during the postprocessing, we observed that the mitigation potential in daytime is mostly driven by cooling contrail, which requires a closure analysis given the large uncertainties in weather predictions. Nevertheless, as further steps, we plan to: (1) implement the revised ISSRs conditions from BeCoM project; (2) optimize flight trajectories to avoid warming contrails; (3) analyze the potential mitigation gain of aviation's climate impact. The expected results will provide insights into how the forecast of ISSRs affect the flight routings for contrail avoidance and allow us to identify the mitigation potentials of contrail climate effects.

Keywords: Persistent contrails; Flight trajectory optimization; Warming contrail avoidance

Acknowledgement: This research has received funding from the Horizon Europe research and innovation programme under GA n° 101056885

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