WMO Aeronautical Meteorology Scientific Conference 2017
Centre International de Conférences - Météo-France - Toulouse - France 6th - 10th November 2017
Session 2 - Integration, use cases, fitness for purpose and service delivery

Abstract

Climate-optimised aircraft trajectories based on advanced MET service for sustainable aviation

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Comprehensive assessment of the climate impact of flight movements is of increasing interest to the aviation sector as a requirement for identifying climate-optimal aircraft trajectories when developing strategies for sustainable aviation. Climate impact assessment needs to quantify impacts of CO_2 and non-CO_2 emissions, comprising in particular effects of contrail-cirrus, and nitrogen oxides on atmospheric ozone and methane. However, such comprehensive environmental impact information is generally not available during flight planning and generation of such data is not yet operational practice. Hence, the purpose of this study is to present a concept how such information can be made available via climate and environmental change functions (ECFs), which have the potential to serve as an interface to air traffic management. The work presented here relates to the SESAR2020 Exploratory Research project **ATM4E** (Air Traffic Management for Environment) which aims to develop MET services required for climate-optimisation, as well as to present a methodology which allows to establish a multi-criteria environmental impact assessment directly in the flight planning process, and to study changing traffic flows due to environmental optimization.

In the light of collaborative decision-making this MET service concept initially developed for climate optimisation of aircraft trajectories is expanded to a full environmental assessment, by representing additionally air quality and noise impacts by distinct environmental change functions. This simultaneous provision and integration of environmental change functions via advanced MET services enables to perform a multi-criteria environmental assessment during trajectory planning. For a use case climate-optimised aircraft trajectory, we present the mathematical formulation of the objectives functions required for environmental assessment and optimisation of aircraft trajectories. In that context we present ideas on future implementation of such advanced meteorological services into air traffic management and trajectory planning by relying on ECFs. These ECFs represent environmental impact due to changes in air quality, noise and climate impact.

In a case study for Europe prototype ECFs are implemented and a performance assessment of aircraft trajectories is performed for a one-day traffic sample. For a single flight fuel-optimal versus climate-optimized trajectory solutions are evaluated using prototypic ECFs and identifying mitigation potential leading to the identification of a Pareto-front relating climate impact mitigation potential with economic costs. The ultimate goal of such a concept is to make available a comprehensive assessment framework for environmental performance of aircraft operations, by providing key performance indicators (KPIs) on climate impact, air quality and noise, as well as a tool for environmental optimisation of aircraft trajectories. When developing future sustainable aviation, a quantitative validation of environmental performance requires an expansion of currently defined environmental KPIs.
Having available such advanced MET service for the use case “climate-optimisation” would allow planning of climate-optimised trajectories during the different phases of flight planning, as well as studying and characterising changes in traffic flows due to environmental optimisation and associated trade-offs between distinct strategic measures.