ATM4E Summary

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ATM4E **project scope** is to explore the feasibility of a concept for environmental assessment of ATM operations working towards environmental optimisation of air traffic operations in the European airspace.

The **first objective** is to establish a multi-dimensional environmental change function (ECF) concept, which will include air quality impact (for key pollutants) and perceived noise in addition to CO2 and non-CO2 climate impact. This constitutes a new metric for environmental impacts.

The **second objective** is to plan flight trajectories which mitigate the environmental impact for characteristic meteorological situations based on different ATM constraint assumptions and optimization strategies and investigate to what extent the resulting changes in traffic flows lead to particular challenges for air traffic management when such optimization is performed.

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The **third objective** is to evaluate environmentally-optimized routes in a future atmosphere in a comprehensive climate-chemistry model allowing a proof of concept of climate-optimisation with daily route analysis.

Finally, a **roadmap** is developed with recommendations and an implementation strategy for the environmental optimization of aircraft trajectories in close collaboration with aviation stakeholders.

Within the scope of this project the term **“change function”** is used for multi-dimensional functions which describe a specific quantitative impact of aircraft operations, e.g. climate-impact of contrail formation per flight kilometre, impact on air quality per specific emission of NOx and particulates or noise impact as 4-dimensional functions, depending on geographic position, altitude and time of flight.

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The project aims to **integrate existing methodologies** for assessment of the environmental impact of aviation, in order to evaluate the implications of environmentally-optimized flight operations to the European ATM network, considering climate, air quality and noise impacts.

The proposed solution is based on an **advanced MET service** which enables flight planning tools to assess environmental impacts of a flight trajectory during the planning process. This MET service provides environmental impacts associated with an aviation emission by environmental change functions (ECFs) as improved information and enhanced awareness on the flight environment for each individual environmental impacts.

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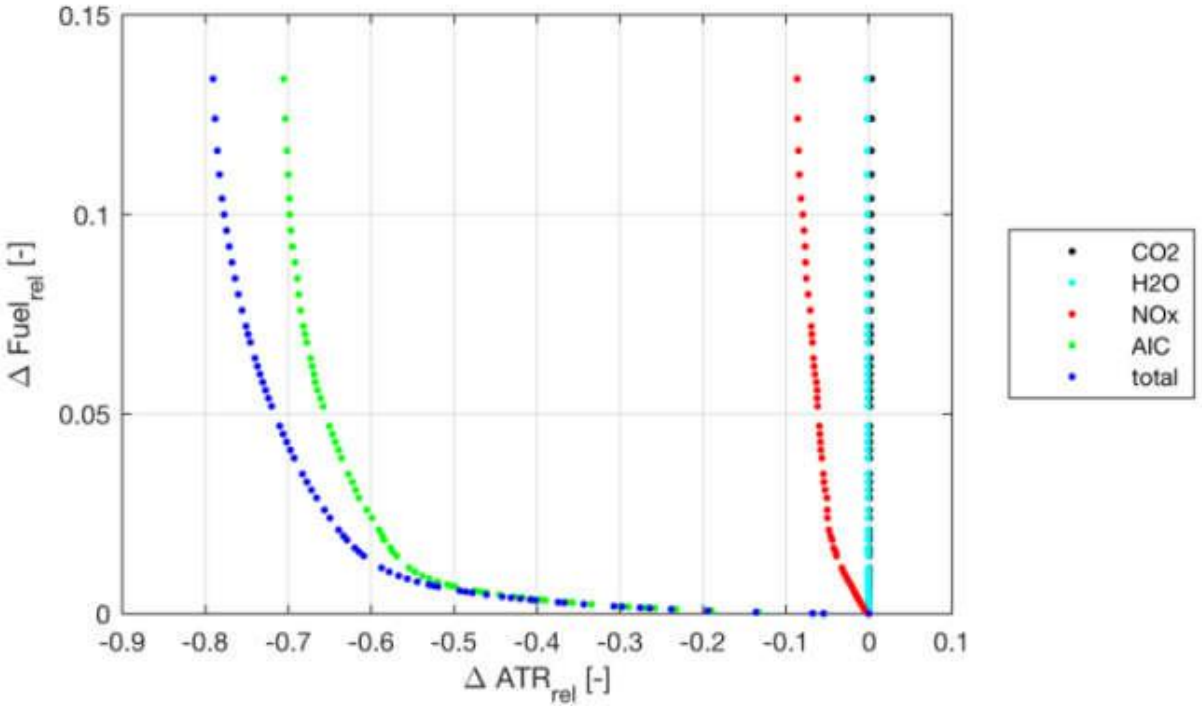
Overall pareto front (blue) for the top 2000 routes of the European Airspace with the individual contributions of CO2 (black), H2O (cyan), NOx (red) and aviation induced cirrus cloudiness (green).

Front: climate impact reduction vs cost increase



The climate impact reduction for this particular day is essentially driven by contrail avoidance (green curve). The second largest effect is caused by the reduction of the climate impact of NOx (red curve).

Conclusions

- It has been established that information on the climate impact of aviation emission can be provided to flight planning systems by the use of **environmental change functions** (ECFs).

- The results show many cases where **reductions in the climate impact** of order 10's of % can be achieved for an increased fuel burn of order of a few percent.
- As the case studies showed, a large fraction of the overall mitigation potential lying in the climate-optimization of European air traffic can already be gained by focussing on **a limited number of "critical" flights** only.

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- It was beyond the scope of ATM4E to examine how airlines could be incentivized to bear **extra costs**, especially where they might be borne by a small number of operators on a given day. Nevertheless, it is the view of the project team that such cost increases seem easily within the scope of appropriate **financial and political instruments**.

- It has also been found that environmental-optimized flight planning on a large scale in Europe could lead to **imbalances in the demand-capacity** situation in specific parts of the airspace assuming that capacity is managed and provided as it is today.

Recommendations for future R&D activities (Next steps)

The results of ATM4E are a proof-of-concept, showing the scientific and technical feasibility. However, it requires **more steps** before it can become operational.

Research & Development Activity 1: Enhancing the technological readiness level of the algorithmic Environmental Change Functions (aECF).

Research & Development Activity 2: Enlarge the aECF concept from a more case study oriented approach in ATM4E to a whole trajectory and full European scale application including performance indicators; expand ECF concept to represent aircraft/engine dependence.

Research & Development Activity 3: Enlarge the aECF concept by a robustness measure, which enables the minimization of the risk of wrong decisions.

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Research & Development Activity 4: Perform a large-scale test of the proposed ATM4E methodology via the simulation of a live-trial which would not re-route real aircraft but would assess whether the decision and verification chain in a situation close to that needed in an operational environment.

Research & Development Activity 5: The implementation of environmental flight planning raises many issues in the political, economic and social domains which are beyond the remit of ATM4E and which would need to be considered in parallel to improvements in the technical and operational aspects of implementation.

The design of equitable and acceptable economic incentives would have to be investigated, especially given the key result from ATM4E that the largest environmental gain, on any given day, is likely to result from re-routing a relatively small number of flights.

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Research & Development Activity 6: Due to changes of traffic flows leading to significant shift of sector load from one set of sectors to another with a clear tendency of relocation to lower altitude sectors, the ATM system has to provide the flexibility to increase sector capacities, e.g. by re-allocating air traffic controllers, whenever required on a day-to-day basis depending on the meteorological conditions.

It is therefore recommended, to conduct further research to study different options how to accommodate an increased traffic density in narrower altitude bands.

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Thank you very much for your attention!

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No [number]

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