CLIMOP: CLIMATE ASSESSMENT OF INNOVATIVE MITIGATION STRATEGIES TOWARDS OPERATIONAL IMPROVEMENTS IN AVIATION

A. Tedeschi[1] & the ClimOP Project Team*,

* *Koninklijk Nederlands Lucht- en Ruimtevaartcentrum (NLR),*
* *Technische Universiteit Delft (TUD),*
* *Deutsches Zentrum für Luft- und Raumfahrt (DLR),*
* *Amigo Srl, İstanbul Teknik Üniversitesi (ITU),*
* *International Air Transport Association (IATA),*
* *Società Esercizi Aeroportuali (SEA)*

[1] *Deep Blue Srl, Piazza Buenos Aires 20, 00198, Rome, Italy, E-mail: alessandra.tedeschi@dblue.it*

Abstract. Since the end of the 20th century, the urgency of climate change has attracted worldwide attention. The aviation sector is often seen as a major contributor to climate impact and environmental issues, even though its contribution to the anthropogenic greenhouse effect is only about 5%. The aviation industry, considering the expected sector growth, has been working on improvements at different levels. However, more incisive operational improvements remain undervalued. ClimOp aims to contribute to the reduction of the climate impact of aviation by identifying a set of harmonized mitigation strategies. These will be developed from a preliminary list of most-promising operational improvements assessed through different modelling tools. After a validation process with all aviation stakeholders, the mitigation strategies will be proposed as recommendations to policymakers, fostering their implementation.

Keywords: operational improvements, mitigation, climate, impact.

1. INTRODUCTION

Aviation emissions alter the concentration of atmospheric greenhouse gases and trigger the formation of contrails and cirrus clouds. Consequently, the overall impact on climate from aviation emissions has been estimated to roughly 5% of the total anthropogenic radiative forcing (Lee *et al.* 2010). During the last years, the aviation sector has put considerable efforts to stabilise the CO_2 emissions at 2020 levels through a combination of technological innovations and regulation. Unfortunately, a lot needs to be done to reduce the overall impact of aviation on climate. As a matter of fact, ATAG (2018, 2020b) estimated that in 2017 the burning of 341 billion litres of jet fuel produced 859 million tonnes of CO_2, equal to the 2% of man-made CO_2 emissions. In 2019 the global production of CO_2 was over 43 billion tonnes, while flights produced 915 million tonnes (ATAG 2018, 2020a).
In 2008, industry leaders took action to reduce the climate impact of aviation by committing to a high-level strategy based on three major goals (ATAG 2010):

1. Improve the fuel efficiency of a 1.5% average annual from 2009 to 2020.
2. Maintain CO_2 emissions at 2020 levels (carbon-neutral growth).
3. Decrease CO_2 aviation net emissions of 50% by 2050, relative to 2005 levels emissions.

This strategy translated into significant improvements of the fuel efficiency, which brought the aviation industry to surpass its first goal reaching an annual efficiency increase of 2.1% on average between 2009 and 2016 (ATAG, 2018). The implementation of the wingtip technology alone in the aircraft design allowed to save up to 80 million tonnes of CO_2 since 2000 (ATAG 2015, 2018). While these results are encouraging, a comprehensive assessment of all operational improvements with the potential to reduce the climate impact of aviation is still lacking. To address this need, a very diverse Consortium of organisations active in the aviation domain and representative of the research community (ITU, TUD, NLR, and DLR), small-medium enterprises (AMIGO and Deep Blue), airlines (IATA), and airports (SEA Milan), have joined to run the ClimOp project.
ClimOp aims to contribute to the reduction of the climate impact of aviation and provide a harmonized set of the most-effective mitigation strategies. To achieve this result, ClimOp will compile a preliminary list of operational improvements (for example electric taxiing, flexible

runway usage, intermediate stops and formation flights) and subsequently assess them through different modelling tools. After validating the results with all aviation stakeholders, a set of mitigation strategies and recommendations will be proposed to policymakers to foster the implementation of the proposed operational improvements.

2. METHODOLOGY

ClimOp employs a sound six-step methodology that puts the focus on stakeholders' needs by utilizing an iterative validation process. The overall goal of the methodology is to allow ClimOp generating a link between its outcomes and the sectors of interest. A scheme of this methodology is shown in Fig. 1.

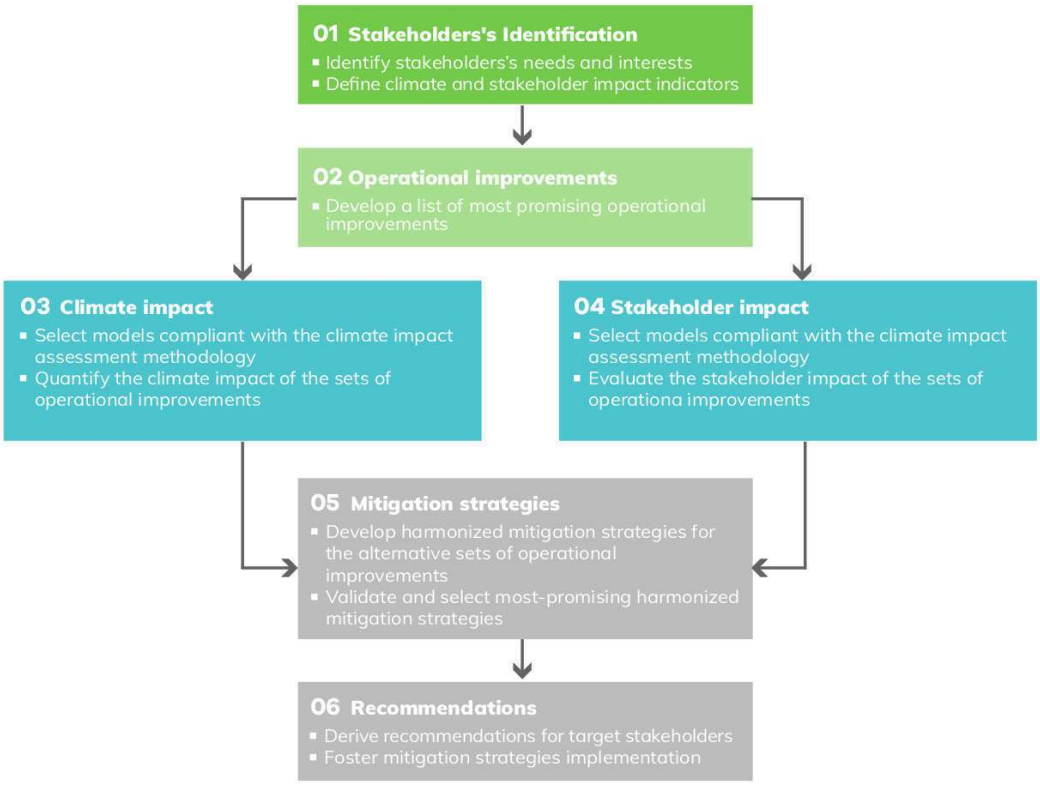

Figure 1. The six-step methodology employed in ClimOp.

As a first task, a set of Key Performance Indicators (KPIs) will be identified to evaluate how future changes of the operations in aviation will impact the climate and the different stakeholders involved in these operations. KPIs that will be taken into consideration include, for example, tonnes of fuel burnt per year, taxiing time, flight time, tonnes of CO_2/NO_X/etc emitted per year, and the Average Temperature Response (ATR) over 20, 50 or 100 years.
Subsequently, the project partners will make a list of the most-promising operational improvements (OIs hereinafter) exploiting their expert judgment. The feasibility and efficacy of these OIs will be assessed with a variety of modelling tools that enable the ClimOp partners to quantify their net impact on the climate and on the involved stakeholders. The results of this analysis will drive the development of harmonized mitigation strategies combining several OIs whose consequences reinforce each other's positive impact on the climate. Alternative mitigation strategies will be proposed to the stakeholders for an iterative process of validations. This validation process will help select the most effective and feasible mitigation strategies, which will then be translated into recommendations for policymakers which will foster the implementation of the proposed operational improvements in the aviation domain.

3. PRELIMINARY RESULTS

3.1. Operational Improvements

In the last years, many OIs have been proven effective in reducing aviation emissions of greenhouse gasses. The members of ClimOp Consortium (2020b) have identified a comprehensive list of potential OIs grouped in four main thematic areas, namely:

1. **Airline network.** This first group of OI includes climate-optimised intermediate stop-over, optimal hub-and-spoke & point-to-point networks, the splitting of long-haul into multiple short-haul flights, and transition from low-capacity, high-frequency to high-capacity, low-frequency flights.
2. **Climate-optimised trajectory.** This category is constituted by avoiding horizontal and vertical climate-sensitive areas, the concept of flying lower and slower, and satellite-based navigation for climate-optimised flight planning.
3. **Terminal movement area** (TMA) mostly regards optimised take-off and approach procedures, to reduce unnecessary waiting time and the related fuel consumption.
4. **Airport ground** operations concern the electrification of ground equipment and operations, more efficient taxiing procedures, renewable energy production at airports and increased runway and airport throughput.

3.2. Key Performance Indicators

The ClimOp consortium (2020a) is selecting a set of KPIs which will be used to quantify the impact of each individual OIs on the climate and on different stakeholders (ANSPs, governments, airlines, airports, manufacturers, passengers, etc.). The purpose is to investigate not only whether an OI, or a combination of OIs, has a net positive effect on climate, but also what are the operational and economical implications for the stakeholders.
ClimOp considers quantitative and qualitative KPIs. The consortium employs quantitative metrics to assess the impact of project results at different levels (environmental, economical, safety, etc.). Instead, qualitative KPIs will evaluate the impact that results have on operating staff and processes and analyse stakeholders' acceptance from a passenger to a society level. Examples of the KPIs that ClimOp will apply to assess the impact of the OIs are the fuel consumption, the flight time, the ATR20 and the ATR100, the number of accidents per flight hour, the emissions tons per year and the taxing time. Some KPIs are transversal and will be used to assess the OIs of all the four thematic areas, for instance the ATR20/100 calculations. Other KPIs are instead specific to some OIs, for example total taxiing time will be used to evaluate improvements in ground operations. The qualitative KPIs will evaluate project aspects that rely on the assessment of human performances, e.g. the possible increase in workload for personnel because of new specific tasks that need to be performed, and stakeholder acceptance, such as the passengers' willingness to pay for more climate-friendly operation.

4. SUMMARY AND CONCLUSIONS

The ClimOp consortium has established a preliminary list of OIs and pre-selected promising KPIs to measure their impact on climate and on the aviation stakeholders. While ClimOp is at an early stage, it has a very clear plan and a sound methodology to define, over the 3.5 years of the project, a harmonised strategy to mitigate the impact on climate of the aviation industry as a whole, and to propose robust recommendations to policymakers to help them foster the implementation of the proposed OIs in the aviation domain.

ACKNOWLEDGMENTS

The ClimOp consortium has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 875503.

REFERENCES

Air Transport Action Group (ATAG), 2010, *Beginner's Guide to Aviation Efficiency*, available at https://www.atag.org/component/attachments/attachments.html?id=615

ATAG, 2015, *Aviation Climate Solutions*, available at https://www.atag.org/our-publications/latest-publications.html

ATAG, 2018, *Aviation Benefits Beyond Borders*, available at https://www.atag.org/our-publications/latest-publications.html

ATAG, 2020a, *Fact sheet 2: Aviation and climate change*, available at https://aviationbenefits.org/downloads/fact-sheet-2-aviation-and-climate-change/

ATAG, 2020b, *Fact sheet 3: Tracking aviation efficiency*, available at https://aviationbenefits.org/downloads/fact-sheet-3-tracking-aviation-efficiency/

ClimOp Consortium, 2020a, *D1.1 – Definition of climate and performance metrics*.

ClimOp Consortium, 2020b, *D1.2 – Inventory of operational improvement options*.

D. Lee, G. Pitari, V. Grewe, et al., 2010, *Transport impacts on atmosphere and climate: Aviation,* Atm. Env. Vol. 44, No. 37, pp. 4678–4734