AIRLINES FOR EUROPE

POSITION PAPER
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NON-CO_2 EMISSIONS MONITORING, VERIFICATION AND REPORTING (MRV) - EU DIRECTIVE 2023/958 (EU ETS)

Abstract

As part of the EU's climate transition plan and the recently reformed EU Emissions Trading System (ETS) Directive 2023/958, aircraft operators will be required to report their non-CO_2 effects from 2025. A *monitoring, reporting, and verification framework* (MRV) for these effects is yet to be developed.

The aim of a non-CO_2 MRV should be to robustly inform policymakers with scientifically validated information to guide future policy frameworks and incentives to minimise non-CO_2 effects and their impact on the climate. Considering this, the primary goal of the future MRV should be to establish an **effective evaluation and steering tool** based on scientific principles.

To achieve this objective, a four-stage process needs to be pursued:

1. Identification of a calculation model and relevant data
2. Advancement of research
3. Official designation of meteorological/climate models
4. Targeted positive incentives

1. **Identification of a calculation model and relevant data:** the choice of the calculation model determines the data required e.g. flight trajectory from which atmospheric effects can be derived[1], aircraft/engine data, and fuel data.

[1] Only a few air transport aircraft have installed sensors that are sufficient for lower atmospheric data collection for assimilation into numerical weather prediction models, and to some extent for fog forecasting, but there is not a commercially available humidity sensor that is capable of contributing data for contrail condition determination. Improved sensors and standards will be needed by our industry, and we continue to advocate for such a capability.

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2. **Advancement of research** to understand better the potential effects of non-CO_2 emissions (including cooling and indirect effects), the implications of different climate metrics, the accuracy of meteorological models on Ice Super Saturated Regions (ISSR) localisation (and what is needed to improve them), contrail properties resulting from varying fuel properties, engine exhaust conditions, emissions, and the potential of mitigation strategies to minimise their impact considering appropriate time horizons.

3. **Official designation of meteorological/climate models** and political decisions to be made on climate metrics: The MRV calculation model and the one used by airlines have to be aligned to set common rules for airlines for the avoidance of contrails while minimising other effects, providing the correct incentives in the MRV: we call for the definition of a European "single source of truth" for operational avoidance: approved meteorological models, contrail and climate models, engine exhaust and emissions data, and the climate metric/time horizon to be used by airlines for avoidance, and by the EU in the MRV.

4. Based on this, **targeted positive incentives** should be created for airlines and the aviation industry to reduce their non-CO2 impact and make sure that they integrate the use of Sustainable Aviation Fuels (SAF), adopt new technologies to determine contrail properties and the consequences of the additional fuel burn due to contrail avoidance.

If the MRV is poorly implemented, it could result in poor outcomes including:

1. **Wrong incentives / No effect**: Currently, there is no scientific basis for establishing an MRV for non-CO_2 effects. Without a scientifically based calculation model, there is a significant risk that the real problem, the emissions themselves and their potential effects, will not be effectively understood. Consequently, a large administrative burden would be created without any substantial benefit to the climate. Lack of a commonly recognised metric would lead to unnecessary avoidance and uncoordinated operational decisions by aircraft operators.

2. **There is no scientifically agreed CO_2 equivalent for non-CO_2 effects:** Introducing a blanket CO_2 equivalent without a stronger scientific understanding of the issue is

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premature. The EU is at risk of failing to minimise the climate impact of aviation due to misinterpreting data which is not fully understood or defined.

3. **Required data is not available:** Aircraft operators do not incorporate things like humidity data into their flight planning or post-flight-analysis process and cannot easily access it. Their knowledge of non-CO_2 effects relies on modelling which is currently highly uncertain. It is essential for all stakeholders to collaborate in the collection and consolidation of such data.

Three types of mitigating solutions are currently considered:

1. **Operational avoidance** i.e. avoiding the formation of persistent contrails by avoiding flying through areas where persistent contrails form (Ice Super Saturated Regions, or ISSRs) at times where the contrails will have a net warming effect over their lifetime (i.e. pre-dusk and overnight). However, changing the flight level may lead to extra fuel burn, costs, and CO_2 emissions. Operational avoidance requires prediction of contrail formation conditions, persistence, and integrated lifetime radiative properties to minimise unnecessary detours. It also requires clear EU science-based guidelines to arbitrate between CO_2 and non-CO_2 effects. Accurate predictions depend on atmospheric conditions (such as temperature, humidity, wind, and ambient cloud cover), aircraft characteristics (such as aircraft geometry, weight, engine exhaust conditions and emissions) and fuel characteristics (aromatic content, sulfur content, hydrogen content).
2. Reducing the climate impact of contrails formed by using **cleaner fuel** such as Sustainable Aviation Fuels (SAF) or low aromatics fuels. More research is needed to quantify the benefit of SAF or low aromatic fuels in reducing contrail radiative forcing.
3. The application of **lean-burn combustion chambers** with very low particulate matter emissions.

To provide the right incentives for airlines to minimise non-CO_2 effects, the MRV should first set common rules for all flight operators in Europe via a single source of truth (approved meteorological data with ISSR location, appropriate contrail and climate models, engine exhaust and emissions data and climate metric for CO_2 vs. non-CO_2 arbitration). It should then set the right incentives for operators.

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Introduction

The impact of aviation on the atmosphere extends beyond radiative forcing caused by CO_2 emissions. Oxides of nitrogen (NO_x), oxidised sulfur species (SO_x), soot particles and other components of the jet engine exhaust influence the global radiation balance - either directly as greenhouse gases, indirectly through chemical processes in the atmosphere, or by contributing to the formation of clouds and condensation trails. These findings have been estimated by the Intergovernmental Panel on Climate Change (IPCC)[2] in their reports and partially quantified by Lee et al. 2021[3] in terms of effective radiative forcing (ERF), including the level of scientific understanding for each type of forcing. Latest scientific studies find the non- CO_2 effects have a net warming effect in the same order of magnitude as CO_2. However, there are still significant uncertainties regarding the contribution of individual flights whose effects can be cooling or warming, depending on the circumstances.

It is of utmost importance for climate mitigation efforts that the MRV is established on a sound footing based on scientific data. This task is particularly challenging because there is currently no scientific consensus on the climate metric to be used for quantifying the full climate effects of flights.

A major deficiency in the legislative policy concerning the future MRV system is the lack of explanation regarding the calculation model and climate metric that the authorities and the European Commission intend to use for evaluating the non-CO_2 effects of flights, the intent to provide a common playing field both for MRV and operational mitigation measures, as well as a proposal for incentives. Establishing a science-based model is a crucial prerequisite for determining the necessary data.

According to most recent scientific reports on the matter, the largest impact for aviation in terms of non-CO_2 emissions is caused by **condensation trails** – so-called contrails - contrail cirrus-clouds and **oxides of nitrogen** (NOx).

The latest Intergovernmental Panel on Climate Change (IPCC) report from April 2022 confirms these conclusions. These emissions result in changes in the chemical

[2] Climate Change 2022 – Mitigation of Climate Change, April 2022, IPCC Link

[3] Lee, DS. et al. (2021), The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018, Atmospheric Environment, Vol. 244, 1 January 2021.

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composition of the global atmosphere and cloudiness, disrupting the earth-atmosphere radiation budget[4].

However, their precise impact under specific conditions needs to be studied further. Non-CO_2 effects can cause **both warming and cooling effects** and, unlike CO_2, do not follow a linear pattern but contribute to both positive and negative Effective Radiative Forcing (ERF). Estimating aviation's non-CO_2 effects is a complex challenge for today's atmospheric modelling systems. It is difficult to calculate the contributions caused by a range of physical processes in the atmosphere, including air movement patterns, chemical transformations, microphysics, or radiation.

Core Requirements for the MRV

1. The MRV should adhere to scientific principles

The ultimate goal of monitoring, reporting and verification efforts for non-CO_2 effects must be to precisely measure emissions in full, understand their interaction with the atmosphere and accurately quantify individual effects to effectively reduce the emissions and their potential climate impact. **A rushed implementation of an MRV with rigid structures** based on incomplete information **will endanger the progress and prevent it from developing effective mitigation strategies**. For this reason, a scientifically based calculation and evaluation method for non-CO_2 emissions should be developed, along with a model to identify the non-CO_2 effects of individual flights. This is a critical component of the entire system. In addition to flight data, weather data of sufficient quality are necessary. A scientific approach should be employed – gathering emission data and flight trajectories, understanding non-CO_2 effects, promoting emissions reduction and developing mitigation strategies. A progressive introduction of the MRV should be envisaged until the needed technical and operational strategies to minimise non-CO_2 effects are developed and verified.

The data collected within the MRV has the potential to quickly evolve into a powerful dataset for further research efforts, aimed at achieving a better understanding of non-CO_2 effects. The entire MRV system, which includes weather, flight, and emission data, must be independently tested and verified, preferably through measurement. Default

[4] When water vapour is ejected from the exhaust nozzle of an aircraft engine into sufficiently cold air, it condenses and freezes around soot and other particles, creating small ice crystals. In certain atmospheric conditions, these ice crystals create layers of cirrus clouds, causing a 'blanket' effect which keeps warmer air trapped in the lower atmosphere.

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conservative values for emission reporting should be avoided. The resulting dataset should be available to research institutes to investigate the non-CO_2 climate effects based on a solid foundation of data.

2. The MRV should provide strategic and operational guidance to address non-CO2 emissions

The fully developed MRV system should not only be a tool to collect airline reporting data but also provide guidance to the airline industry on minimising non-CO_2 emissions as well as their potential effects. For example, the system should furnish data for future forecasting tools, thereby aiding the planning of flights with minimal climate impact. Similarly, the system should integrate the targeted use of SAF due to their role in addressing the radiative forcing of contrails. In parallel, airlines should not be fined for the creation of additional CO_2 emissions that are generated by the avoidance of non- CO_2.

3. Administrative efforts and costs must be considered

Today's EU Emissions Trading System (ETS) reporting processes, tools, and auditing mechanisms will be insufficient to handle the substantial increase in the complexity of the data to be reported under a non- CO_2 MRV scheme. Some of the requested data cannot be provided by airlines, while other relevant parameters must be calculated based on yet-to-be-defined and agreed-upon methods.

Four-dimensional trajectories add complexity to the data structure; Engine exhaust conditions, NO_x and soot emissions must be modelled based on flight data and cannot be approximated with constant values or a fixed factor on fuel, as is done with CO_2. The sulfur and aromatic content of jet fuel is not known to the airlines for each delivery and humidity is not measured by onboard aircraft systems. The merging of multiple data sources will be necessary to encompass the holistic approach of the future planned MRV.

It must be thoroughly assessed which stakeholder should contribute what data, not only to keep the administrative efforts for airlines and authorities at a reasonable level but also to ensure consistency in the MRV database.

4. If non-CO_2 effects are to be regulated, positive steering incentives should be implemented

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The EU ETS and its affiliated national systems in the United Kingdom and Switzerland cover all intra-EU/UK/CH flights. As free allowances are phased out in the coming years, more emissions certificates will need to be purchased by airlines. A4E estimates compliance costs for all European aircraft operators will rise to a yearly figure of EUR 6.5 billion by 2030 for CO_2 alone[5]. In the global aviation market, this cost factor imposes a significant risk of carbon leakage, resulting in the redirection of air traffic flows outside of Europe. Expanding the ETS scope to cover non-CO_2 effects with the current mechanisms exacerbates this risk and would not reduce non-CO_2 and its impacts. Given the very specific behaviour of non-CO_2 effects, bespoke measures are more appropriate. Pricing them across all flights covered by the EU ETS would not actually result in non-CO_2 mitigation, whilst jeopardising the integrity of the carbon pricing mechanism itself.

Positive incentives should be developed to encourage airlines to concretely mitigate non-CO_2 emissions and their potential effects (for instance using SAF, new engine technology, flight level changes, or the circumnavigation of specific flight areas). A solution may be to incentivise airlines to avoid ISSRs through a bespoke system, which could be linked to other policies.

5. Define the governance and management of the data gathered

Although it may be possible to technically collect some data as recommended by the ETS Directive, there may be limited and different data collection and storage capabilities (e.g. depending on the type of aircraft, engine types) for much of this information. This directly impacts all components of the MRV system.

Data governance and management, including confidentiality and open access considerations, remain undefined. Collecting the required data sets would require the establishment of clear terms and conditions for using and processing the data reported by operators and providing a framework that ensures protection of confidential information.

[5] Airlines for Europe A4E (2021): Distortion of aviation competitiveness and carbon leakage risks linked to "Fit for 55" measures. 210707-A4E-Memo-Fit-for-55-competitive-distortion-and-carbon-leakage.pdf.

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Summary

Data sharing and collaboration to stimulate research and development, including sharing of flight and technical data, will be key to better understanding and ultimately developing mitigation approaches for limiting the impact of non-CO_2 ERF[6]

This quote by the Science-Based Targets Initiative (SBTi) summarises the importance of data sharing for understanding and ultimately mitigating non-CO_2 climate impacts.

The introduction of an MRV presents **a unique opportunity to develop a platform for consolidated non-CO_2 emission data**. However, many unknowns remain, some due to a lack of data transparency and others due to ongoing basic research. The MRV must accommodate this and evolve based on the current level of knowledge.

Understanding aircraft emissions and their climate impact is critical to developing efficient mitigation strategies to minimise aviation's environmental impact. The MRV must incentivise the actual reduction of non-CO_2 emissions and their negative effects and not merely add administrative burdens and costs. Ultimately, it is about providing a framework to reduce the climate impact and cost of operations.

[6] SBTI Sector Guidance Aviation, August 2021

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Annex I

Establishing a Monitoring, Reporting, and Verification Framework for Non-CO_2 Effects. Comments on the EU Call for Tender

The EC issued **a call for tenders in April 2023**, aimed at garnering support for establishing the non-CO_2 MRV[7]. As a European airline association with extensive experience in relevant basic and applied research in close collaboration with the scientific community, and being subject to today's ETS reporting, we would like to comment on the feasibility of some aspects of this tender as follows.

We have identified a significant gap in the tender call as **it primarily focuses on data requirements while neglecting the crucial task of determining a model to calculate non-CO_2 effects.** Overall, we view the very specific requirements for the structure of the MRV, as well as the timeline for implementation, as posing a substantial risk to the aforementioned core requirements. The specification of the required data implies the interlinking of several data sources. Some fundamental data, e.g., for emission modelling, is currently not available to airlines and is subject to proprietary information of engine manufacturers or has not been investigated yet. Immense joint efforts from research facilities and aviation industry stakeholders are necessary to better understand the impact of aviation's non-CO_2 effects on the climate and develop a model for the calculation of non-CO_2 effects. This would enable the implementation of effective mitigation strategies. The quality of the numerical weather data for assessing the non-CO_2 climate impact will be a critical factor for the quality of the system. A rigid reporting framework set for 2025 endangers the above-mentioned core requirement #1: *Adherence to scientific principles*, as the unknowns are currently substantial.

These conclusions are drawn from reading the following extracts in the April 2023 call for tenders:

1. The expected output (a CO_2 equivalent for every single flight), the data to be included in the MRV, and the timeline for completion of the project are strictly predefined, and "*variants (alternatives to the model solution described in the tender specifications) are not allowed*".

[7] CLIMA/2023/OP/0005 eTendering - Data (europa.eu).

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Comment: Today's level of scientific understanding of non-CO_2 effects does not allow for the quantifying a CO_2 equivalent for a single flight and a respective ready-to-use model capable of calculating non-CO_2 effects for a single flight based on scientific knowledge is not yet available[8]. Some research projects[9] are striving to develop and test such models, with the risk that they will not comply with forthcoming EC requirements. However, data reporting within the MRV framework can produce a significant database for further research on the topic. Prohibiting variants and adhering to a tight schedule may result in inefficient or misguided steering.

2. *"This MRV framework must contain, at a minimum, the three-dimensional (3D) aircraft trajectory data available, ambient humidity, and temperature to enable CO_2 equivalents per flight to be produced"*.

Comment: Humidity is not measured on aircraft at sufficient scale or accuracy. It must, therefore, be retrieved, for example, from a numeric atmospheric model. This implies that multiple data sources have to be interlinked. To make a proper link, a three-dimensional aircraft trajectory is not sufficient; time must be added as a fourth dimension. Improving the quality and providing accurate weather data for the MRV process is considered a societal task of great importance for the success of the entire MRV process. Competent authorities need to be appointed and entrusted with the tasks of further improving weather data and providing them regularly in sufficient quality.

3. *"(...) the contractor must ensure the collection and storage of the monitored data, including a user-friendly IT solution and a secure databank"*.

Comment: In view of the complexity of the topic, we consider it unrealistic to design, build, and launch such an IT solution within the given timeframe. Reporting tools, processes and auditing will be completely different from those known by the EU ETS.

[8] Some models compute exactly this metric (DLR CoCiP, MIT APCEMM, however availability and accuracy of comprehensive data inputs to those models, and scientific uncertainty in computing the lifetime radiative properties of the contrails remain problematic.
[9] E.g. D-KULT funded by German Aeronautical Research Program, CICONIA, SESAR3.

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4. *"(…) where appropriate, the use of conservative default values in line with the precautionary principle"*.

   Comment: Default conservative values for emissions reporting should be avoided. The emission logging must be as accurate as possible since the data will be used for impact assessment and for steering.

5. *"Ensure the MRV framework is able to take into account the use of blends of fuels, including the use of Sustainable Aviation Fuels and alternative jet fuel (e.g., with lower aromatics and sulfur content)"*.

   Comment: Aromatics content greatly impacts the soot emissions. It is essential that these values are part of the MRV. On the practical side, to report these two parameters for every single flight, it will be necessary for the fuel suppliers to intensify their fuel composition monitoring[10].

[10] Fuel is entered into the airport supply system in different batches, by different suppliers, with or without SAF blend at different moments in time. It is therefore untraceable to identify the content of the fuel in the aircraft flying a given trajectory at a given time.

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