ICAO Symposium on Non-CO_2 Aviation Emissions

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Session 3: Mitigating Non-CO_2 Aviation Emissions – What is possible

Part II - Innovative Operations

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Airlines are…

Responsible for the climate impact

Accountable towards society and regulators

Responsible for reducing the overall climate impact of their flights

Airlines need to…

Monitor non-CO2 effects and understand the drivers (fleet, fuel, network, schedule)

Design and implement an effective mitigation strategy

Acknowledge the impact and inform their customers

Integrate in climate goals

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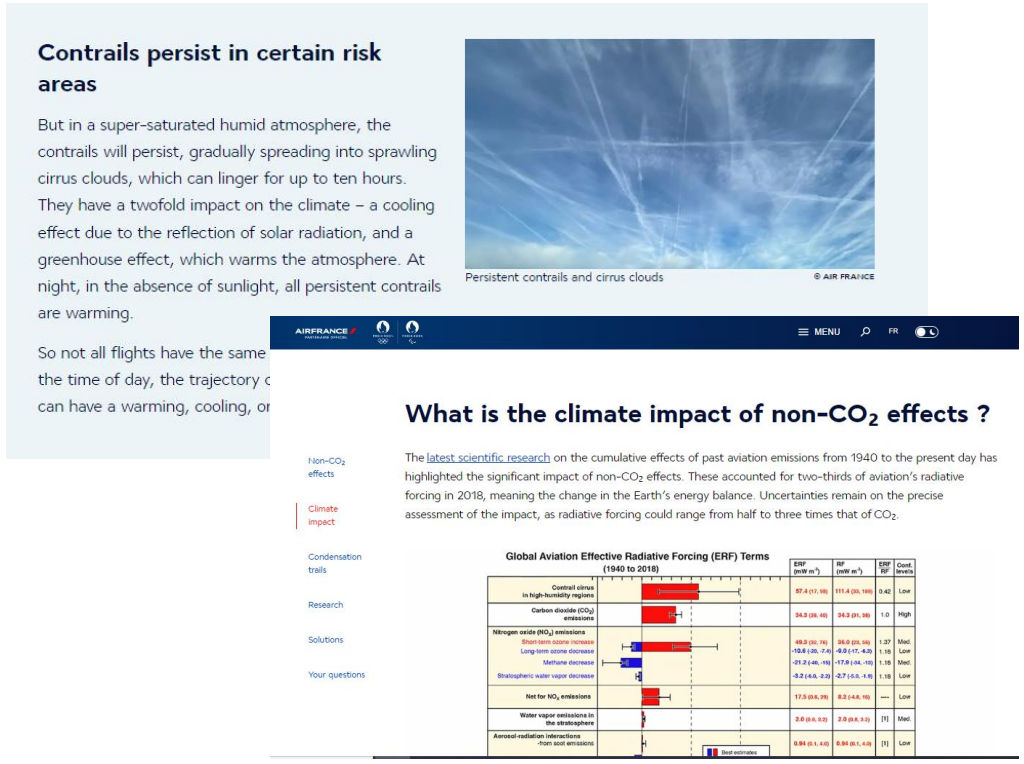
Transparency and consistency of our communication

Communication (Website)



Contrails persist in certain risk areas

But in a super-saturated humid atmosphere, the contrails will persist, gradually spreading into sprawling cirrus clouds, which can linger for up to ten hours. They have a twofold impact on the climate – a cooling effect due to the reflection of solar radiation, and a greenhouse effect, which warms the atmosphere. At night, in the absence of sunlight, all persistent contrails are warming.

So not all flights have the same
the time of day, the trajectory c
can have a warming, cooling, or

Persistent contrails and cirrus clouds © AIR FRANCE

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What is the climate impact of non-CO_2 effects ?

Non-CO_2 effects
Climate impact
Condensation trails
Research
Solutions
Your questions

The latest scientific research on the cumulative effects of past aviation emissions from 1940 to the present day has highlighted the significant impact of non-CO_2 effects. These accounted for two-thirds of aviation's radiative forcing in 2018, meaning the change in the Earth's energy balance. Uncertainties remain on the precise assessment of the impact, as radiative forcing could range from half to three times that of CO_2.

Global Aviation Effective Radiative Forcing (ERF) Terms (1940 to 2018)

https://corporate.airfrance.com/en/other-impacts-aviation-climate

The reduction of uncertainties and the choice of a single climate metric are key to inform customers.

More and more corporate customers request non-CO2 impacts translated into CO2 equivalent in their annual carbon footprint.

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Not all flights generate contrails: the key to future mitigation

Learnings from monitoring of our impact

1. **A limited number of our flights (4%*)** are responsible for 80% of the impact
2. But with **peaks up to 50/60 flights per day** highlighting the need for integrated tools
3. We can identify overall trends but **it's not always the same route or flight number that will be responsible** for big hits

For an airline, mitigation will consist in detecting and targeting those flights a few hours before departure

Two mitigation options for airlines

Change flight trajectory to avoid contrail-prone areas

Dedicated SAF refuelings or use of kerosene with fewer aromatics

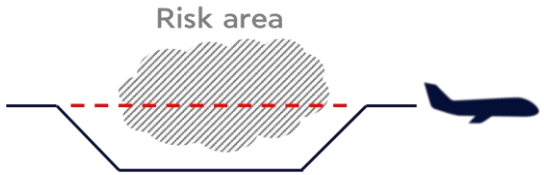
→ Contrail avoidance is too immature to be deployed at scale but could be by 2030

→ Given the challenges**, we expect a small contribution of low aromatic fuels in non-CO2 mitigation by 2030

*monitoring of Air France's impact in 2023 using CoCiP

** availability of SAF, tracking pysical flow, airport logistics, fuel standards inertia

Contrail avoidance is too immature to be deployed without risks of climate damage



Trade-off with CO2: Flight path changes must be implemented only if they are globally beneficial for the climate, as avoidance leads to, in most cases, more fuel consumption and CO2 emissions

4 Pre-requisites to implement contrail avoidance

1. Being able to accurately forecast the climate impact along a flight path
2. Being able to quantify the climate benefit (metric choice)
3. Being able to implement contrail avoidance (operational feasibility)
4. Being able to verify that contrail avoidance was beneficial

→ Main risk is to implement prematurely and cause more climate damage

Airline trials will help estimate the mitigation potential of contrail avoidance (current and future)

Flight modifications are planned

- Not all flights will have a positive trade-off with CO2, or an alternative routing

✈ Run simulations and shadow-mode: promising results from studies

Flight modifications are implemented

- Obtaining flight level changes in a saturated airspace is not easy

✈ Run collaborative trials to assess feasibility and collateral impacts

✈ Translate research into operational guidance

Climate impact is verified

- A weather forecast or climate model is never 100% accurate

✈ Adjust strategy and operational thresholds based on accuracy of forecast

✈ Combine with other solutions (ex SAF) to achieve climate goals

Based on experience, we believe contrail avoidance will pose operational challenges when implemented, particularly in an increasingly congested airspace.

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Air France's actions and roadmap on non-CO_2

1. Supporting science to speed up the technological readiness of mitigation measures

Participation to **IAGOS** since 2013

Cooperation with **Météo France** to improve ISSR forecast since 2021.
3000 observations collected with our **Contrail Observation Program** COOP.

Participation to **European Project CICONIA** 2023-2026 (SESAR 3) to evaluate and enable new concept of operations to reduce non-CO2.
Project includes trials.

2. Monitor our impact and build a mitigation strategy

Analysis of our non-CO2 footprint

Evaluating the efficiency and feasibility of different solutions, to elaborate the best mitigation strategy

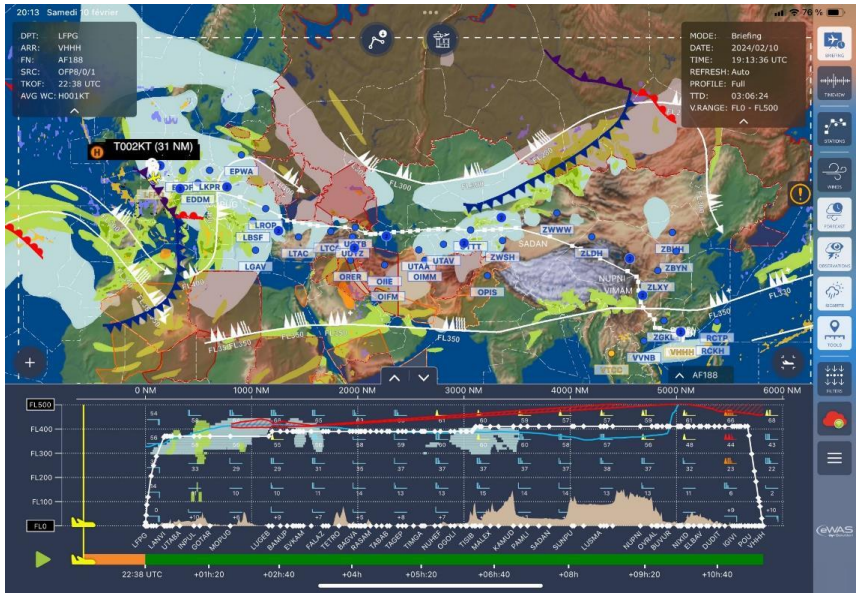
Preparing for the deployment of mitigation measures (governance, tools, processes)

Define a short-term « safe for climate » strategy given the level of maturity and accuracy, as well as the tools available.

Collaboration with Météo France since 2021: A more reliable forecast of persistent contrails available for route planning

1st thing we need : an accurate prediction of persistent contrails & integration in tools

- Launch of COOP, a Contrail Observation Program: ≈3000 observations collected worldwide to help validate Météo France model



Risk area (SAC + ISSR)

Since February 2024, WIMCOT weather product is available for pilots & dispatch key users

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Airline are responsible for mitigation, but the success of mitigation doesn't depend only on us.

The modification of flight plans is quite usual for airlines

Airlines will need integrated tools and process, run more studies and trials, and translate a mitigation strategy into operational decisions.

By 2030, we could be ready to implement at scale: will the solution be mature enough ?

What we need:

International choice of metric: crucial for balance with CO2 and customer information

Accurate prediction of the impact of a single flight: validated weather and climate models

Operational feasibility esp. ATC flexibility to implement trajectory modifications

Verification means to evaluate the benefit of our action

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Thank You

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