

The forgotten climate damages of aviation

Flying is three times more harmful to the climate than often assumed. Germanwatch puts forward proposals for a precise and fair documentation and reduction of non-CO₂ effects

Background

[According to scientific reports](#), non-CO₂ effects cause approximately two thirds of the climate impact of air traffic. To date, **politics and the industry neglect these non-CO₂ effects in their efforts to achieve climate-compatible air traffic**. However, these effects must be fully recorded and reduced in order to comply with the limits set in the Paris Agreement and to end distortions of competition between the different means of transport. A scientifically and practically tested model that captures non-CO₂ effects on a flight-by-flight basis is available and could be integrated into existing policy instruments such as the EU Emissions Trading System (EU ETS) without burdening industry or administration with additional data collection.

Recommendations

To reduce the significant non-CO₂ effects of aviation quickly and effectively, we recommend the following measures to the German government:

- The European Parliament proposes to introduce a monitoring, reporting, and verification scheme (MRV scheme) for non-CO₂ effects ([P9_TA\(2022\)0230, Amendment 51](#)) and to implement flight-specific pricing within the EU Emissions Trading Scheme (EU ETS) based on the MRV scheme. The German government should actively support this proposal in the trilogue negotiations. Flight-by-flight pricing would reward airlines for choosing routes that reduce non-CO₂ effects. This could effectively mitigate these significant climate damages.
- An early and rapidly increasing quota should promote the production and use of Sustainable Aviation Fuels (SAFs), starting with 0.3% in 2025 and increasing to 2.5% by 2030. A sub-quota should promote the particularly clean e-kerosene with at least 0.1% starting in 2025 and increasing to at least 2% by 2030.
- To keep the non-CO₂ effects of fossil fuels as low as possible, the share of aromatic compounds (hydrocarbons that contribute to the formation of soot, ice crystals, and contrails) should immediately be reduced to 8%. In addition, further incentives should be provided to purify kerosene from nitrates and sulphur particles through hydrotreating.
- To reduce flying, alternatives to air travel, such as a dense network of European cross-border train connections, should be systematically developed and promoted.

The **European Parliament's current proposal for a system that monitors, reports, and verifies non-CO₂ effects** ([P9_TA\(2022\)0230, Amendment 51](#)) accomplishes this. Therefore, **the German government should actively support this proposal in the trilogue negotiations.**

Thereby, policymakers would be responsive to the pleas of the population to price in the climate impact of air travel equally to that of other means of transport. In a [2019 survey](#) on the possible introduction of a kerosene tax in the EU, around 72% of the respondents were in favour, compared with 71% in Germany. According to a [2021 survey by the International Air Transport Association \(IATA\)](#), the majority of air passengers (73%) at a global level also want the aviation industry to focus on reducing its climate impact in the future.

Existing regulations have yet to address non-CO₂ effects

As early as in 1999, the Intergovernmental Panel on Climate Change (IPCC) first described non-CO₂ effects of aviation in its report "[Aviation and the Global Atmosphere](#)". According to current knowledge, **their warming effect on the climate is two to five times greater than that of CO₂ emissions.** Non-CO₂ emissions include nitrogen oxides, soot particles, sulphur dioxide, and water vapour. In particular, water vapour contrails have a [significant climate effect](#): Especially at low temperatures and at high altitudes of 8,000 to 12,000 metres, in so-called ice-saturated regions of the atmosphere, contrails can develop into large-scale cirrus clouds. These ice clouds reflect the heat radiation of the earth and thus have a considerable greenhouse effect. In addition to long-term air and environmental pollution, the emission of substances such as [soot particles and nitrogen oxides](#) also has a net warming effect on the climate.

However, the EU ETS, which has included air traffic since 2012, has so far only considered the flight industry's CO₂ emissions. This means that the EU ETS has neglected two thirds or more of the climate impact of air traffic. In fact, not even CO₂ emissions are fully covered, since the EU ETS so far only includes intra-European flights. By allocating CO₂ certificates free of charge, it also reduces incentives for companies to promote the conversion to climate-neutral processes. A reform of the EU ETS is therefore urgently needed. New targets, such as replacing fossil fuels with CO₂-neutral, sustainable alternatives (Sustainable Aviation Fuels), would reduce non-CO₂ effects, but not eliminate them. To bring them as close to zero as possible, further measures are needed, such as redirecting flights to lower altitudes, taking cold weather into account, and curbing the growth of air traffic overall, for example by expanding the more climate-friendly rail network.

Recommendations for regulation and containment

The aviation industry can and must reduce non-CO₂ effects. There are simple ways to do this. Policymakers, both at EU and national level, should take the following actions.

1. Monitoring

The collection methods for non-CO₂ effects are different from those for CO₂ emissions. This is because **non-CO₂ effects**, unlike CO₂ effects alone, **depend on when and where the emissions are released.** According to a research project of the German Aerospace Centre and the German Federal Environment Agency, in which they conducted 380 research flights, a flight-specific documentation of the effects is possible and requires **only negligible additional data collection.** The data collection should consider the following factors:

- Fuel flow,
- mass of the aircraft,

- ambient humidity,
- latitude, longitude, time, and altitude of the aircraft in the air,
- ambient temperature.

Furthermore, the type of fuel that is used matters, as the degree of purity of the fuel also has a significant impact on the non-CO₂ effects of the aircraft. Airlines and weather services already collect all of these data, so that additional data collection is not required. Based on the above-mentioned [study by the Federal Environment Agency and German Aerospace Centre](#), standardised software can easily calculate the CO₂ equivalents per flight based on the obtained data. To this end, the EU should decide to introduce a Measurement, Reporting, and Verification (MRV) scheme for non-CO₂ effects, analogous to the existing MRV system for CO₂ emissions under the EU ETS Directive. The **European Parliament** [adopted such a proposal](#) on 8 June 2022 in relation to the **Commission's proposal to revise the EU ETS for aviation**. The collection and publication of these data build the central base for reducing and ultimately avoiding the effects in the next step. While immediate voluntary action by the aviation industry is desirable, the EU still needs to set a consistent framework.

2. Pricing

As the European Parliament reaffirmed, the **EU ETS** would be an effective and efficient tool for the pricing of non-CO₂ effects. For each tonne of CO₂ equivalent, airlines would have to provide a corresponding amount of certificates. Flight-by-flight pricing would provide targeted incentives for airlines to reduce emissions especially on those flights that cause the greatest climate damage—and thus the highest costs. In combination with mitigation measures (see point 3: Mitigation), this can effectively reduce the climate damage caused by aviation and counterbalance the existing distortion of competition between different means of transport.

However, the European Parliament's proposal should be further developed in two key areas:

- The European Parliament calls on the European Commission to submit a proposal by the end of 2026 with the aim to include non-CO₂ effects in the EU ETS. However, a **levy obligation** based on flight-by-flight recording can and should already be included in the ETS Directive **from 1 January 2025 onwards**.
- In the event of a delay in flight-based pricing, **a factor of 3** should be included in the EU ETS for CO₂ emissions **starting in 2025**—contrary to the proposal of the European Parliament which aims to include a factor of 1.8 from 31 December 2027 onwards and to increase it annually to a factor of 2 by the end of 2029. This factor corresponds to the scientific knowledge that CO₂ emissions account for only one third of the climate damage caused by air traffic, and should continuously be adjusted according to the current state of research.

3. Mitigation

In addition to pricing, target-oriented measures can reduce the climate impact of non-CO₂ effects.

1. By avoiding ice-saturated regions in the **routing** of planes, for example by flying lower or flying around relevant weather conditions, the formation of large-scale cirrus clouds can be reduced. It is therefore crucial that the pricing of non-CO₂ effects is calculated on a flight-by-flight basis, as this creates incentives for airlines to reduce them, given that they are flight-dependent. Studies ([Matthes et al., 2021](#); [Castino et al., 2021](#)) indicate that flights that avoid ice-saturated airspace are significantly more climate-friendly, despite their possibly slightly increased CO₂ emissions caused by their somewhat longer flight route. Space- or time-dependent no-fly zones could also have a steering effect in this respect.

2. Until a substantial proportion of SAFs has been achieved in aviation fuels, it is necessary to reduce **the particularly harmful aromatic compounds in jet fuels**. Aromatic compounds are ring-shaped hydrocarbons that contribute to the formation of soot, ice crystals, and contrails. An immediate reduction of the levels of aromatic compounds in fossil fuels can be achieved by hydrotreating. Hydrotreating is a simple process that would only slightly increase fuel prices. However, political incentives are still lacking, which is why only few fossil fuels are treated this way at the moment. According to the European Parliament's proposal, fuel suppliers and the European Aviation Safety Agency are to report on the content of aromatic compounds, naphthalene, and sulphur with immediate effect. In addition, the Commission is to submit regulatory proposals by 1 January 2024, and the level of aromatic compounds is to be reduced as much as possible. Currently, the limitation on aromatic compounds in fuels is 25%, while in practice a fuel mix usually contains an amount of aromatic compounds of 15 to 20%. To provide the industry with more incentives to purify fuels through hydrotreating, the share of aromatic compounds in kerosene should be limited to 8% starting in 2023. Under current fuel standards, this is the minimum to ensure continued compatibility with aircraft fuel systems. In addition, research on how to reduce this proportion even more is required. Initial positive research results (CE Delft, 2022) indicate that this is a promising option.
3. SAFs reduce not only CO₂ emissions but also non-CO₂ effects since they do not contain aromatic compounds and thus produce fewer ice crystals in contrails. Therefore, a **quota for SAFs** is needed. The European Commission has already made a corresponding proposal which the European Parliament made even more ambitious. Based on the production commitments of the industry, however, the quota should be more ambitious than the Commission's proposal, starting with 0.3% in 2025 and reaching 2.5% by 2030. In addition, an e-kerosene quota should be introduced with at least 0.1% in 2025 and increasing to 2% by 2030.

According to the current state of research, the measures described above will not be enough to reduce non-CO₂ effects to close to zero by the 2040s. Since it cannot be assumed that measures such as capturing CO₂ directly from the air will ever fully offset the significant indirect climate effects of aviation at acceptable costs, additional measures and policy frameworks are needed to curb growth and, where possible, **reduce aircraft movements**. This especially includes strengthening the alternatives to air transport, in the case of intra-European transport, for example, through a massive expansion of the rail network and of long-distance train connections. Promoting fast passages on ships and digital conferences can also play an essential role. To stimulate the modal shift towards more climate-friendly means of transport, existing distortions of competition between different means of transport due to hidden and climate-damaging subsidies for air transport must also be stopped.

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