



Operational Insights on Contrails

Airlines have been partnering with universities, research centres and private entities to identify the requirements and limitations for navigational avoidance of high-probability, high-warming contrails. There continues to be several unknowns and limitations associated with accurately predicting where contrail-may form, whether they will be persistent, and if they will have a warming effect. All of which has impacts on operational decisions at tactical and pre-tactical levels.

The Big Picture

The main mitigation strategy to warming effects of contrails is adjustment of trajectories, whether during the flight planning phase, or during flight. However, flight level adjustments may not always be possible, especially in a congested airspace. Additionally, several factors need to be considered, which include; network operations, flow management, airport limitations, passenger experience, crew duty time, slots, etc.

To enable the decision making at pre-tactical or tactical levels, both airline operators and Air Traffic Control (ATC) require several data points for making decisions regarding trajectory adjustments. This primarily boils down to whether there is an accurate prediction of where warming and persistent contrails might form. At the same time, a decision will need be based on an evaluation of trade-offs, e.g., between CO₂ and non-CO₂ emissions, and an assessment of the impacts on the traffic flow or airspace as a whole.

From the trials that have been conducted to-date, it has been observed that trajectory adjustments to avoid contrails will not be required everywhere, at all times, nor at all flight levels. While the trials are showing that only a small percentage of flights may be affected, those flights will be concentrated in the same high-probability high-warming contrail regions, which makes navigational avoidance more challenging. Contrail-prone regions change with altitude in different parts of the World, and its only in

the mid-latitudes that they coincide with aircraft cruising altitudes.

Pre-Tactical Decision Making

At pre-tactical level an airline will need short- and long-term forecasts of high-probability high-warming contrails to assess whether any of the operated flights may require a trajectory adjustment. By evaluating airspace constraints (through and around the high-probability high-warming contrail regions), different scenarios can be evaluated by dispatch and air crew to make a decision as to whether there needs to be any change to the flight trajectory and flight plan. Dispatch will also need to assess fuel consumption and associated CO₂ emissions of the alternate flight trajectory to identify the difference in non-CO₂ impacts and CO₂ emissions. While tools currently exist to estimate where contrails could form, these are still not ready for operational deployment. Enablers to more accurate forecasting are addressed in IATA's publication on *aviation contrails and their climate effect*¹.

Tactical Decision Making

At the tactical level an airline will need real time data on high-probability high-warming contrails to assess whether in-flight re-planning will be required. In such a case, air crew would make a decision based on the remaining fuel on-board, weather up-dates, and recommendations from the airline operations

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<https://www.iata.org/contentassets/726b8a2559ad48fe9dec6f2534549a6/aviation-contrails-climate-impact-report.pdf>



center regarding the trade-off between non-CO₂ impacts and CO₂ emissions. However, ATC may not be able to grant flight level change request, depending on capacity and traffic volume². In-flight, several operational factors should be considered such as impacts on safety, traffic volume, impacts on efficiency in that specific airspace, impacts on flow management.

Conclusions

Navigational avoidance to mitigate warming effects of contrails may not be possible due to capacity and traffic congestion. Therefore, as an industry we need to continue learning from trials and avoid premature policies that may have unintended safety and efficiency consequences.

Future automation will allow trajectory information exchange which will in turn enable airlines and ATC to efficiently negotiate 4D trajectories. Accordingly, consideration should be made for the integration of capabilities that can provide more accurate, consistent and operationally relevant weather information, e.g., formation of persistent contrails that have a warming effect. Apart from technology, collaborative decision making will be key at strategic planning and tactical levels.

Additional details regarding the science, technology and outcomes from trials are available in IATA's report on aviation contrails and their climate effect (<https://www.iata.org/contentassets/726b8a2559ad48fe9decb6f2534549a6/aviation-contrails-climate-impact-report.pdf>).

Contacts Us

For questions, inquiries, you can send an email to infrastructure@iata.org.

² In one of the trials, only 40% of flight level change requests were approved by ATC for safety reasons.