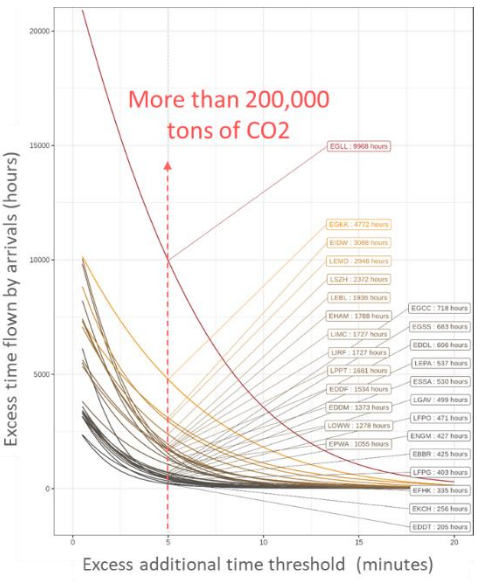
Reducing fuel burn and CO2 emissions for arrivals in terminal areas by acting on ground delays

What is at stake?

Arrival congestion in terminal areas leads to airborne delays resulting from holding or vectoring, which in turn increase fuel consumption and CO2 emissions. Today, flow management mechanisms use ground holding to balance demand and capacity, and limit congestion. However, this still results in persistently high values of airborne delays, which remain globally higher than ground delays: 2.17 vs 1.14 minutes on average for the top 27 European airports in 2019. This leads to more than 43,000 hours of arrival airborne delays above a 5-minute margin in the last 50NM, and corresponds to more than 200,000 tons of CO2.

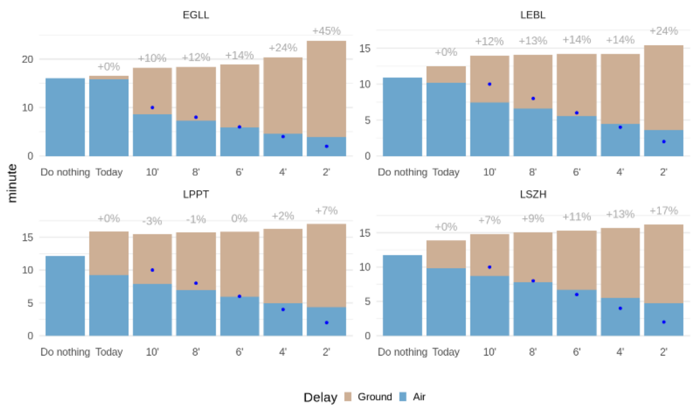


What can we do about it?

Reducing these airborne delays by further acting on ground delays at departure airports, as already promoted in the past, is one option to act rapidly on fuel burn and CO2 emissions. This would rely on existing network management mechanisms, possibly complemented by a new decision support tool for flow managers. One challenge lies in the decision making to trigger ground delays few hours in advance under uncertainties in airborne delays prediction and during flight execution. Two additional constraints have been considered: maintain the runway pressure and contain any increase of the total delay (ground and airborne).

What can we expect?

To investigate the theoretical feasibility of this idea, we performed a sensitivity analysis, considering a control of the average airborne delay per 30 minutes period, and varying the target from 10 down to 2 minutes. We relied on a simulation model of the arrival flow management process with a simplified regulation mechanism to trigger ground delays and realistic uncertainties on off-block, take-off time and flight duration. We selected four European airports subject to significant airborne delays in 2019. We considered standard days and extracted results of the peak periods with airborne delays exceeding 10 minutes in the simulated "do nothing" scenario, for a total duration of 1,900 hours and with 60,000 flights.



Simulation results show that airborne delays can be effectively controlled, until a 6 minutes or even a 4 minutes target. With the 6 minutes target scenario, for the four airports (weighted average), the cumulated airborne delays decreases by 56% compared to the "today" scenario (from 7 down to 3 hours) leading to a reduction of 19 tons of CO2 per peak hour, with no apparent detrimental effect on the runway throughput. However, with the uncertainties and exempted flights, the average total delay (airborne + ground) increases by 10% (from 8 to 9 hours), and the 90th percentile of the ground delay per flight from 13 to 29 minutes.

What's next?

These trends confirm the interest to extend these investigations. In the short term, we will look at improving the model in terms of delay control and realism, and extending the application to the full year and to more airports. Obviously though, there are operational limits in an increased usage of ground delays. Medium term work should then investigate the impact on the network, on departure airports and airspace user's operations, considering trade-offs between the cost of delays versus environmental/fuel costs. In addition, a form of quick win purely based on procedural changes may also be envisaged in live trials.

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