

# Title: ATC Pre-Departure Delays in Europe (2017–2023)

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## 1.0 Introduction

Air Traffic Control (ATC) pre-departure delay is a critical performance indicator for European aviation, as it reflects network congestion, operational inefficiencies, and capacity limitations within the air traffic management (ATM) system. This analysis examines ATC pre departure delay trends across major European airports using data from the ANS Performance repository covering 2017 to 2023. The objective is to explore temporal patterns, assess the impact of the COVID19 pandemic on delay behaviour, and identify airports that contributed most significantly to accumulated delay.

## 2.0 Data and Methods

Seven annual datasets (2017–2023) were merged into a single structured file. After standardising column names and converting timestamps, total ATC pre-departure delay was computed as the sum of regulated and non-regulated delay components. A 7-day rolling mean was applied to visualise daily variability, while monthly averages were derived to analyse seasonality. Airport-level delays were aggregated to identify cumulative contributors.

## 3.0 Results

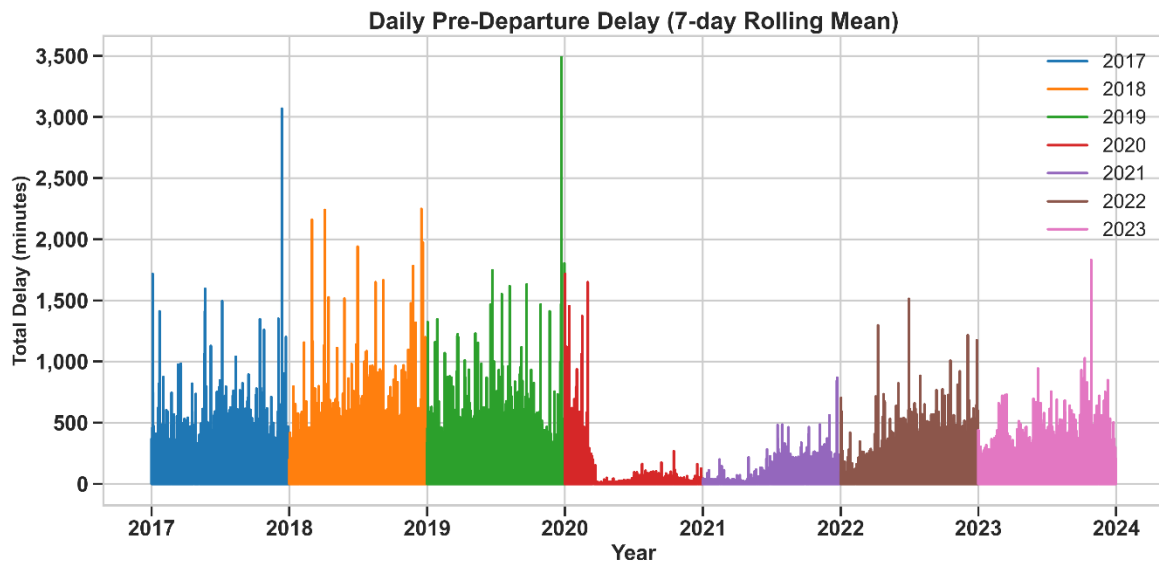
### 3.1 Summary Statistics of Total ATC Pre-Departure Delay (2017–2023)

	mean	median	min	max	std	count
2017	59.26	0.0	0.0	20221.0	249.93	113339.0
2018	67.93	0.0	0.0	15304.0	298.61	113466.0
2019	65.65	0.0	0.0	24164.0	293.52	113906.0
2020	11.92	0.0	0.0	11832.0	113.04	107311.0
2021	15.02	0.0	0.0	5760.0	70.84	112727.0
2022	45.25	0.0	0.0	10130.0	182.22	113630.0
2023	40.94	0.0	0.0	11006.0	174.75	113690.0

**Table 1:** Summary Statistics

Table 1 summarises yearly delay statistics. Pre-COVID years (2017–2019) show high mean delays (59–68 minutes) and large maxima, indicating persistent congestion. In 2020, all metrics fall sharply, mean delay drops to 11.92 minutes and maximum delay reduces by more than half, showing the fall in air traffic during COVID-19 restrictions. Delay levels increase again from 2021–2023 but remain below pre-pandemic values, suggesting partial recovery.

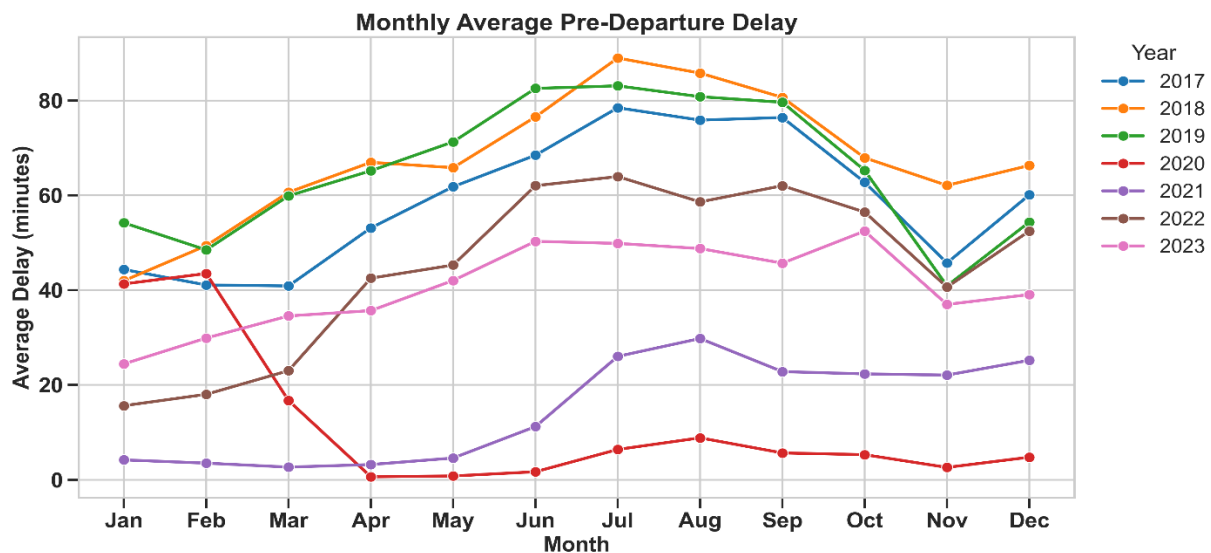
### 3.2 Daily Delay Patterns



**Figure 1: Daily ATC Pre-Departure Delay**

**Figure 1** shows a 7-day rolling mean of daily delays. The years 2017–2019 exhibit strong volatility with pronounced peaks, some exceeding 3,000 minutes. This pattern shifts drastically in 2020, where delays collapse to near-zero levels due to COVID-19 travel restrictions and extensive flight cancellations. Gradual recovery becomes visible from mid-2021 onward, although delay levels remain below pre-pandemic peaks. The temporal discontinuity in 2020–2021 highlights the unparalleled operational disruption caused by the pandemic.

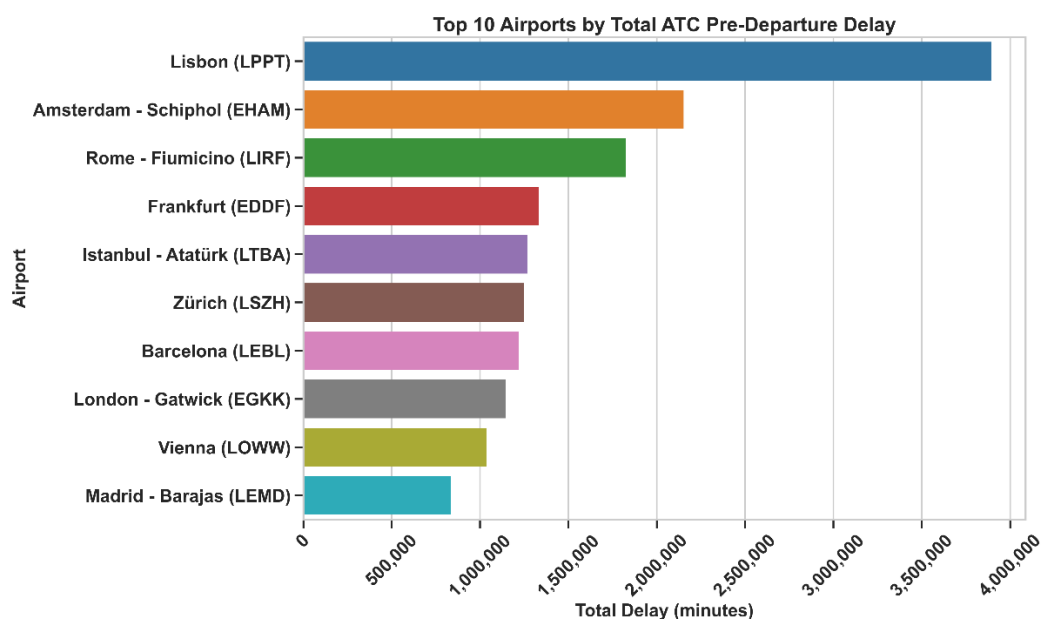
### 3.3 Seasonality of Delays



**Figure 2: Monthly Average ATC Pre-Departure Delay**

**Figure 2** displays monthly average delays for each year. Pre-COVID years follow a consistent seasonal pattern: delays rise into the summer months (June–August), reflecting increased demand and airspace saturation. The seasonal cycle breaks sharply in 2020, which records minimal delay across all months. Delays in 2022 and 2023 increase again but do not fully reach the magnitudes observed in the years preceding the pandemic.

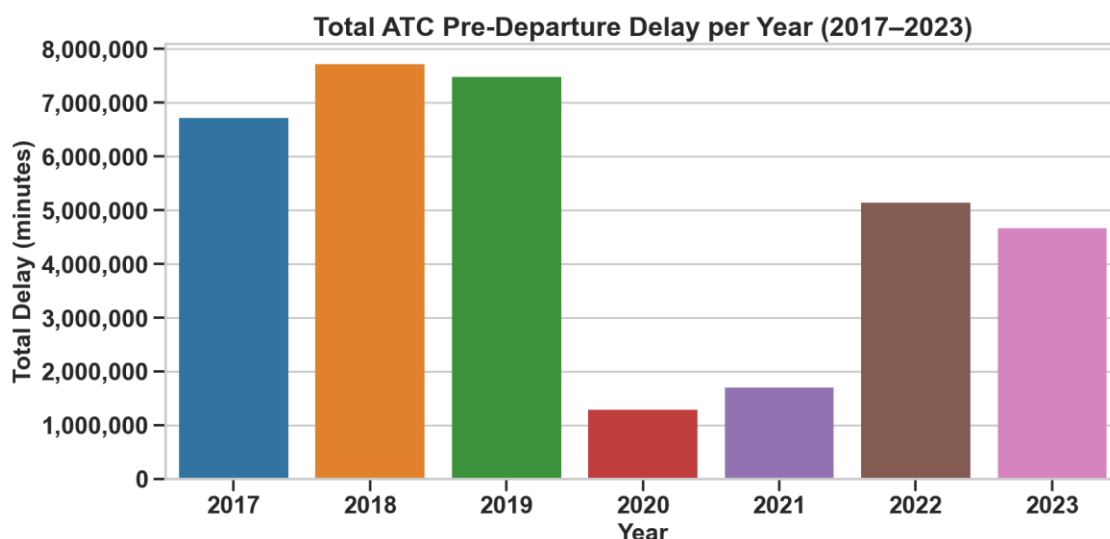
### 3.4 Airport-Level Contributions



**Figure 3: Top 10 Airports by Total ATC Pre-Departure Delay**

**Figure 3** ranks the top ten airports by cumulative delay from 2017–2023. Lisbon (LPPT) emerges as the dominant contributor, with over 4 million minutes of delay—substantially more than any other airport. Other high-traffic hubs such as Amsterdam Schiphol (EHAM), Rome Fiumicino (LIRF), Frankfurt (EDDF), and Istanbul Atatürk (LTBA) also appear prominently. These results reflect both traffic volume and structural capacity constraints at major European hubs.

### 3.5 Yearly Total Delay Comparison



**Figure 4 : Total ATC Pre-Departure Delay per Year**

Figure 4 shows the total accumulated ATC pre-departure delay per year. Delay levels are highest in 2017–2019, reflecting sustained congestion before the pandemic. In 2020, total delay drops dramatically due to reduced traffic during COVID-19 restrictions. Delays begin to rise again from

2021 onward but remain below pre-pandemic totals, indicating a gradual but incomplete recovery of the European network.

## 4.0 Discussion

Across all figures, the COVID-19 pandemic stands out as a defining structural break in ATM performance. The near elimination of ATC delays in 2020 highlights the dependency of delay formation on traffic demand rather than systemic inefficiency alone. Although delays begin to rise again post-2021, they do not immediately return to historical highs, suggesting a gradual and uneven recovery in European airspace usage.

## 5.0 Conclusion

This analysis demonstrates clear seasonal patterns, significant airport-level bottlenecks, and a major disruption caused by COVID-19. Understanding these trends is essential for forecasting future capacity needs and improving air traffic flow management. Further work could incorporate weather data or passenger volumes to deepen the analysis.

## 6.0 References

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The report presents compelling new results strongly backed by the data. 14 possible points

Professional quality graphics. 13 possible points

The report demonstrates analysis techniques optimally suited to the topic of the report. 13 possible marks