BRAZIL / EUROPE

Comparison of Operational Air Navigation System Performance

2019-2025

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Preface

The journey continues in partnership

This fifth edition of the bi-regional Brazil-Europe comparison report of Air Navigation System Performance continues to add transparent and robust data to support an informed discussion about operational performance in both regions. Further, it showcases the close collaboration between DECEA and EUROCONTROL. This report is jointly developed by the Performance Section of the Department of Airspace Control (DECEA) and EUROCONTROL's Performance Review Unit (PRU).

For any questions, please do not hesitate to contact one of the authoring organisations.

Performance Section, DECEA
Performance Review Unit, EUROCONTROL

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SÉRGIO Rodrigues Pereira BASTOS Junior

DIRECTOR GENERAL OF DECEA

DECEA

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This publication marks the fifth edition of the collaborative performance report between DECEA and EUROCONTROL - an important milestone that reflects the strength and maturity of our partnership. Building on previous editions, this report expands the airport sample, deepens the analysis of key performance indicators, and introduces, for the first time, a study on horizontal flight efficiency. Together, these advancements consolidate the report as a valuable tool to support data-driven decision-making, promote sector modernization, and foster continuous improvement in air navigation operations. We hope this initiative continues to inspire collaboration not only between Brazil and Europe, but across the global aviation community.

”

Dr. Piotr IKANOWICZ

CHAIRMAN OF THE PERFORMANCE REVIEW COMMISSION

EUROCONTROL/PRC

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Five editions in, the Brazil–EUROCONTROL comparative performance report stands as a testament to what sustained institutional commitment can achieve.

This edition raises the technical bar by expanding the airport sample and introducing Horizontal Flight Efficiency studies alongside our established indicators. Notably, the report reveals distinct regional signatures in arrival predictability, contrasting the high proportion of early arrivals in Brazil with the network-wide capacity constraints observed in Europe. These refined insights reinforce this work as a vital reference for benchmarking and the identification of best practices.

EUROCONTROL and the Performance Review Commision is proud to continue this journey with DECEA, fostering continuous improvement across both regions.

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Executive Summary

The Performance Section of the Brazilian Department of Airspace Control (DECEA) and the Performance Review Unit (PRU) of EUROCONTROL jointly developed this edition of the Brazil–Europe Comparison of Air Navigation System Performance report. This bi-regional report builds on previous comparative analyses and is based on commonly agreed performance metrics and definitions, enabling a consistent assessment of air navigation service performance over time. By extending the observation period to 2019–2025, this edition supports a comprehensive analysis of long-term performance trends, encompassing the pre-COVID, the pandemic disruption, and the subsequent recovery phase.

This report and previous editions are available via the web-portals of both organisations:

- https://ansperformance.eu/global/brazil or
- https://performance.decea.mil.br/.

This edition expands on the previous comparisons of the Brazilian and European air navigation systems by focussing on the observed performance post COVID, extending the time frame, and incorporating additional analyses. For example, a more detailed characterisation of the Brazilian and European network is included. An initial assessment of horizontal flight efficiency demonstrates the widening scope of this report. This is also complemented by an exploratory assessment of the runway pressure to characterise operational concepts at the study airports. Both aspects promise to enable further analyses and studies for future editions. These focussed topics allow to address discussions about performance benefits and may help to highlight the differences between the operations in both regions.

Figure 1: Key Performance Areas addressed in this edition

The report focuses on a subset of the eleven Key Performance Areas identified by the ICAO Global Air Navigation Plan, in particular Predictability, Capacity and Efficiency.

The 2025 bi-regional comparison of the Brazilian and European air navigation systems highlights a transition from pandemic recovery to a new baseline of normalized, organic growth.
Key take-aways from this edition include:

- **Strategic Institutional Alignment**: The sustained collaboration between DECEA and EUROCONTROL remains a cornerstone of this initiative. By sharing high-fidelity data and operational experiences, both organizations continue to drive the evolution of global ATM performance management and the validation of ICAO GANP indicators.
- **Workforce Efficiency and Scalability**: While traffic levels increased, the Brazilian ATCO workforce remained remarkably stable (+0.1% growth). This indicates that DECEA is successfully decoupling traffic growth from linear workforce expansion through technological and procedural optimisation.
- **Traffic Characterisation and System Pressure**: The operational environment in Europe is characterized by significantly higher pressure, with a traffic density nearly five times that of Brazil.
    - *Fleet Mix Complexity*: Brazil manages a unique wake turbulence environment, with "Light" aircraft making up to 30% of the mix at airports like SBEG, whereas the European study airports are almost exclusively "Medium" and "Heavy".
    - *Infrastructure Benchmarking*: European single-runway hubs like London Gatwick and Lisbon operate at a higher peak load index, providing vital benchmarks for Brazilian airports like Santos Dumont (SBRJ) to exploit as demand matures.
    - These factors directly influence "achievable" throughput and peak-load management strategies.
- **Predictability and Scheduling Buffers**: Distinct punctuality signatures were observed in 2024 and 2025.
    - Brazil maintained a high proportion of "significantly early" arrivals (29% in 2025), suggesting conservative schedule buffering by operators.
    - Europe faced continued schedule robustness challenges, with 26% of arrivals more than 15 minutes late, driven by network-wide capacity constraints and high reactionary delays.
    - These variations have ripple effects on other performance measures as demand patterns change.
- **Tactical Operational Efficiency**: This report focuses on Additional Taxi-in, Taxi-Out, and Additional ASMA times. These metrics serve as primary indicators for measuring tactical system pressure, airport congestion, and the efficiency of sequencing and metering within the terminal area.
- **Technical Deep-Dives**: Following up on last year's first deep dive, this report continues to evolve a deeper technical characterisations of operational concepts or performane drivers. The fifth edition includes initial comparative studies on Horizontal Flight Efficiency (HFE) and runway slot pressure..

This report will be updated throughout the coming years under the umbrella of the DECEA-EUROCONTROL memorandum of cooperation. It is also planned to establish a web-based rolling monitoring with regular updates. Future editions will complement the data time series and support the development of further use-case analyses. The lessons learnt of this joint project will be coordinated with the multi-national Performance Benchmarking Working Group (PBWG) and the ICAO GANP Study sub-group concerned with the further development of the GANP Key Performance Indicators (KPIs).

1 Introduction

1.1 Background

Air transportation is a key economic driver in Brazil and Europe. Both regions share the political goal of a performance-based approach to foster the continual growth and efficiency of air transport. It is recognised that Air Navigation Services (ANS) play a critical role in terms of limiting the constraints on airspace user operations. Accordingly, the analysis and regional comparison of operational ANS performance informs about trends over time, the success of change implementation, and potential performance benefit pools for future exploitation.

With a view to a tighter collaboration between Brazil and Europe, DECEA and EUROCONTROL signed a cooperation agreement in 2015. This agreement encompasses various activities, including the cooperation and joint initiatives in the domain of operational performance benchmarking of ANS.

The close technical collaboration of the Performance Section of DECEA and EUROCONTROL's Performance Review Unit comprises the further development and validation of proposed ICAO GANP indicators, regular performance related data exchange, and the production of regional or multi-regional performance reports. An essential part of this work entails the identification and validation of comparable data sources, the development of a joint data preparatory process, and supporting analyses to produce this report or contribute to the aforementioned international activities.
This report represents the fifth edition of a jointly developed comparison report providing insights into the observed operational performance in Brazil and Europe.

1.2 Performance Areas

Establishing a set of shared definitions and a mutual understanding is essential to facilitate comparisons and operational benchmarking activities. Therefore, the work presented in this report is rooted in prior work conducted by ICAO, other regional or multi-regional operational benchmarking initiatives (e.g., PBWG [1]), and practices within various regional or organisational settings.

The key performance indicators (KPIs) utilised in this study have been developed through a rigorous process that integrates the best available data from both the DECEA Performance Section and PRU. It is important to note that the comparative analysis in this iteration of the report does not encompass all eleven Key Performance Areas (KPA) as presented in Figure 1.

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[1] The Performance Benchmarking Working Group (PBWG) comprises participants from Brazil (DECEA), China (CAA-OSC), Japan (JCAB), Singapore (CAA), Thailand (AEROTHAI), United States (FAA-ATO), and EUROCONTROL.

From an indicator perspective, the DECEA Performance Section and PRU have reached a consensus to concentrate on operational benchmarking and aligning their efforts with the performance indicators proposed by ICAO in conjunction with the update of the Global Air Navigation Plan (GANP). Discussions are on-going, and future work may also include aspects of cost-effectiveness.

1.3 Geographical Scope

This report's geographical focus encompasses Brazil and Europe.

Airspace control in Brazil is a fully integrated civil-military operation. The Brazilian Air Force is responsible for air defence and air traffic control functions. This ensures air traffic safety while contributing to military defence efforts. Within this framework, the Department of Airspace Control (DECEA) operates as a governmental entity under the authority of the Brazilian Air Force Command. DECEA plays a pivotal role in coordinating and furnishing human resources and technical equipment to all air traffic service units operating within the Brazilian territory.

DECEA is the cornerstone of the Brazilian Airspace Control System (SISCEAB). The department provides air navigation services for the vast airspace jurisdiction covering 22 million square kilometres, including oceanic areas. The Brazilian airspace is further divided into five Flight Information Regions (FIR) and the areas of responsibility of these integrated Centres for Air Defence and Air Traffic Control (CINDACTA) are depicted in Figure 1.1.

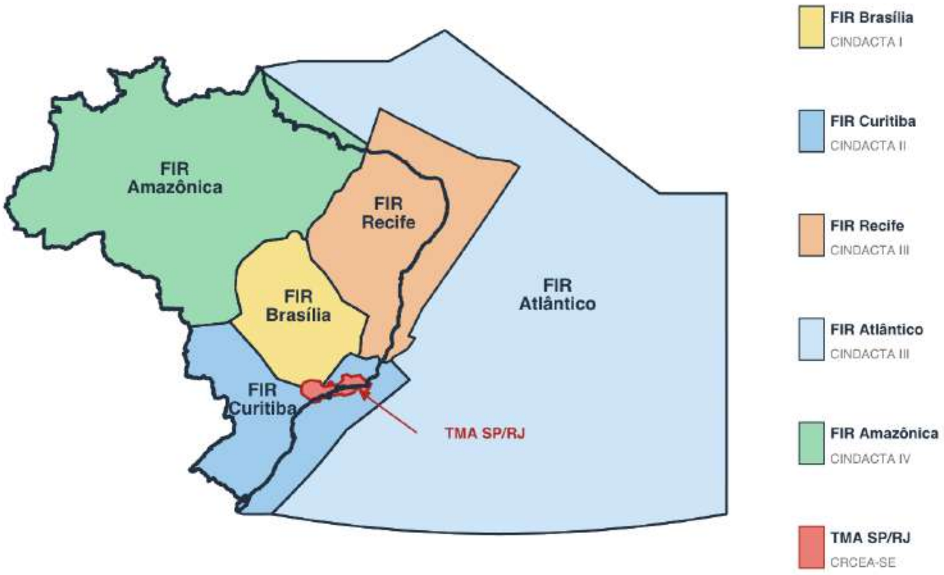

Figure 1.1: Brazilian Airspace Structure/FIRs (CINDACTAs)

The CINDACTAs merge civilian air traffic control with military air defence operations. In addition to the CINDACTAs, there's the Regional Center of Southeast Airspace Control

(CRCEA-SE). The latter is tasked with managing air traffic in the densely congested terminal areas of São Paulo and Rio de Janeiro.

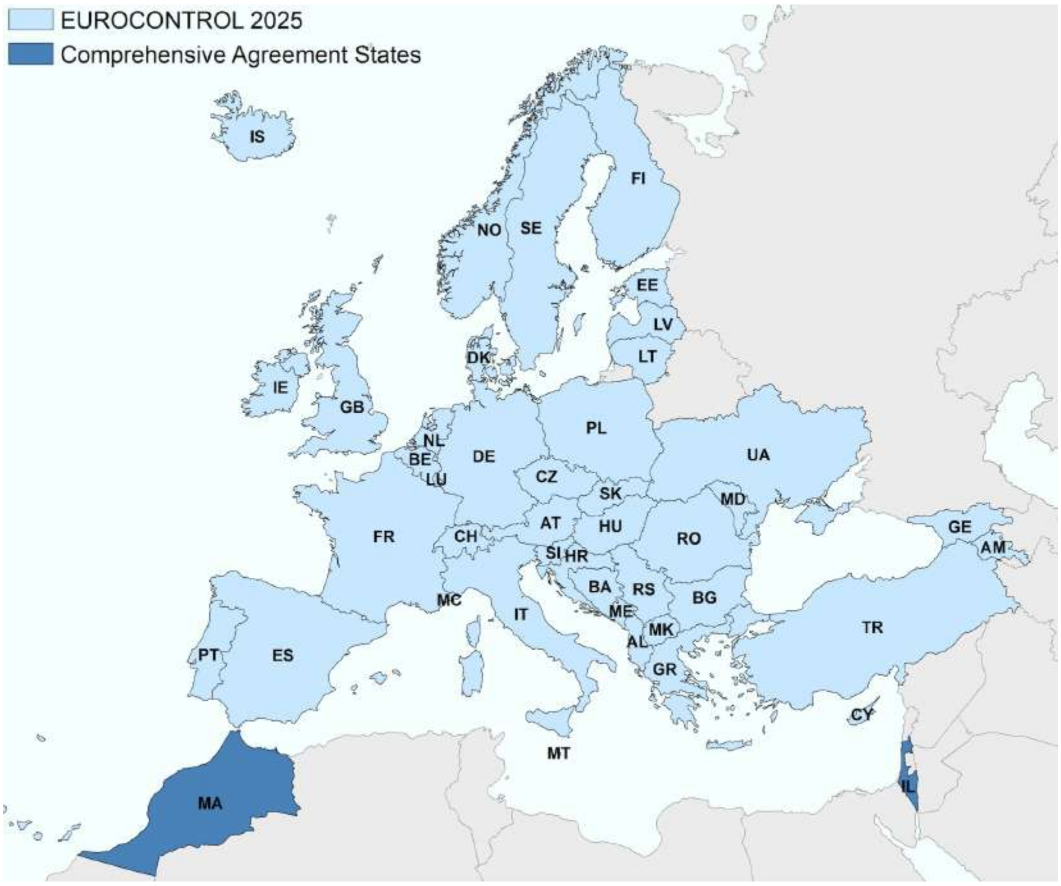

Figure 1.2: European Airspace and EUROCONTROL Member States

In this report, Europe, i.e. the European airspace, is defined as the area where the 42 EUROCONTROL member states provide air navigation services, excluding the oceanic areas and the Canary islands (c.f. Figure 1.2). In 2016, EUROCONTROL signed a comprehensive agreement with Israel and Morocco. Both comprehensive agreement States will successively be fully integrated into the working structures of EUROCONTROL, including performance monitoring, in the coming years. Within this report, these states are included in the reported network traffic volumes.

EUROCONTROL is an inter-governmental organisation working towards a highly harmonised European air traffic management system. In general, air traffic services are provided by - predominantly national or local - air navigation service providers entrusted by the different EUROCONTROL member states. Dependent on the local and national regimes, there is a mix of civil and military service providers, and integrated service provision.
The Maastricht Upper Area Control Center is operated by EUROCONTROL on behalf of 4 States (Netherlands, Belgium, Luxemburg, and Germany). It is the only multi-national cross-border air traffic service unit in Europe at the time being. Across Europe a number of cross-border arrangements are in place. Given the European context and airspace structure, the European area comprises 37 ANSPs with 62 en-route centres and 16 stand-alone Approach Control Units (i.e. totalling 78 air traffic service units).

Europe employs a collaborative approach to managing and servicing airspace and air traffic. This includes the integration of military objectives and requirements which need to be fully coordinated within the ATM System. A variety of coordination cells/procedures exists between civil air traffic control centres and air defence units reflecting the local practices. Many EUROCONTROL member states are members of NATO and have their air defence centres / processes for civil-military coordination aligned under the integrated NATO air defence system.

Further details on the organisation of the regional air navigation systems in Brazil and Europe will be provided in the next chapter.

1.3.1 Network and Inter-regional Traffic Flow

Both regions exhibit distinct traffic flow patterns shaped by their geographic extent, population distribution, and economic geography. In Brazil, traffic is concentrated along a few high-density corridors connecting the major metropolitan areas — notably the Rio de Janeiro–São Paulo–Brasília triangle — while a significant share of movements crosses multiple FIR boundaries due to the continental scale of the country. In Europe, traffic flows are characterised by a dense network of cross-border routes, where intra-regional movements are the norm rather than the exception, reflecting the proximity of major city pairs across national boundaries. It also shows the historic roots of the European network with each State operating a major national hub and flag carrier connecting to other European states and serving international connections.

Understanding these network-level flow patterns is essential to contextualise the performance comparison presented in this report. Differences in traffic distribution, route structure, and inter-regional connectivity directly influence the operational demands placed on each air navigation system and, consequently, the performance outcomes observed.

For this report, regional traffic is defined by the geographic scope of the Brazilian air navigation system and the combined European system as domestic level air traffic. Accordingly, the Brazilian network level accounts for flight operations within the domestic airspace, while European network traffic refers to the inter-region traffic.

1.3.2 Study Airports

In previous editions of this report, the airport sample comprised 10 airports in each region, selected on the basis of IFR traffic volume and operational relevance. Building on this foundation, this edition expands the sample to 12 airports per region, adding two airports in each region to better capture the diversity of operational contexts within both air navigation systems.

In Brazil, Recife International Airport (SBRF) was included given its position among the top-30 busiest airports in the country and its role as a significant international hub serving the Northeast region. Eduardo Gomes International Airport (SBEG), located in Manaus, was also added as the most important gateway for the Northern region of Brazil, serving as a key node for both domestic connectivity and international flights to neighbouring South American countries.

In Europe, the sample was extended to include Athens International Airport (LGAV) and Istanbul Airport (LTFM), two major hubs that strengthen the geographic representativeness

Table 1.1: List of study airports for the Brazil / Europe operational ANS performance comparison

Brazil	Europe
Brasília (SBBR)	Amsterdam Schiphol (EHAM)
São Paulo Guarulhos (SBGR)	Paris Charles de Gaulle (LFPG)
São Paulo Congonhas (SBSP)	London Heathrow (EGLL)
Campinas (SBKP)	Frankfurt (EDDF)
Rio de Janeiro S. Dumont (SBRJ)	Munich (EDDM)
Rio de Janeiro Galeão (SBGL)	Madrid (LEMD)
Belo Horizonte Confins (SBCF)	Lisbon (LPPT)
Salvador (SBSV)	Barcelona (LEBL)
Porto Alegre (SBPA)	London Gatwick (EGKK)
Curitiba (SBCT)	Zurich (LSZH)
Recife (SBRF)	Istanbul (LTFM)
Eduardo Gomes (SBEG)	Athens (LGAV)

of the European sample and reflect the growing importance of South-eastern Europe in international air traffic flows.

Figure 1.3 provides an overview of the location of the chosen study airports within both regions. The airports are also listed in Table 1.1.

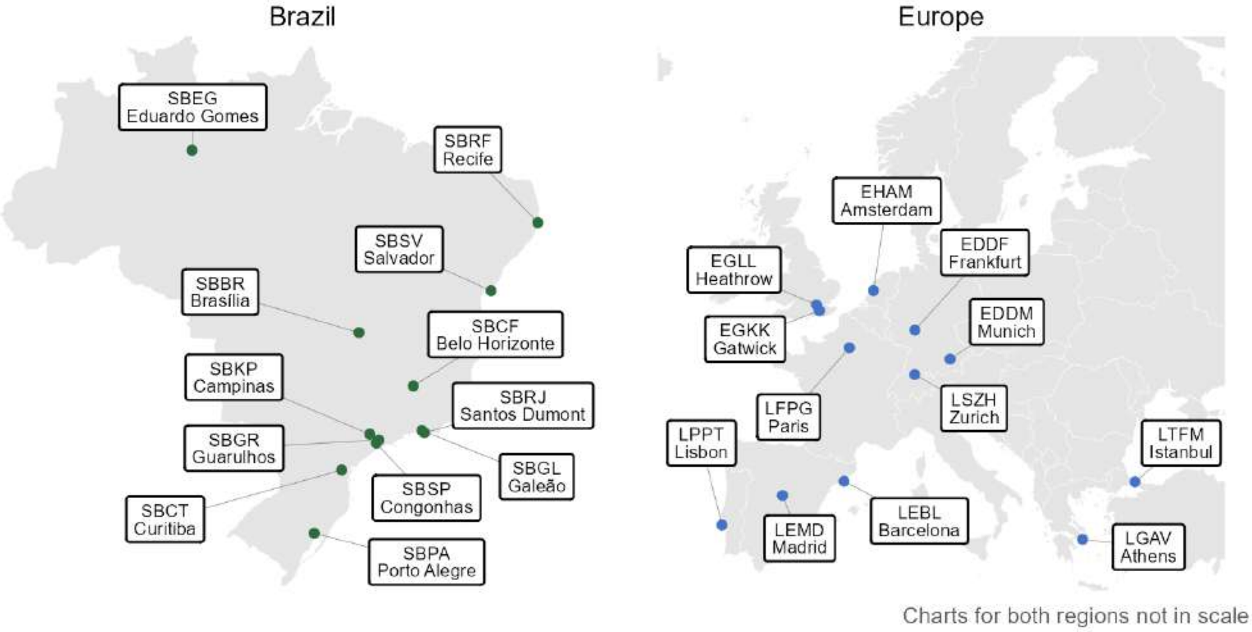

Figure 1.3: Study airports of Brazil/Europe Comparison

1.3.3 Temporal Scope

This report focuses on the period from January 2019 to December 2025 with a focus on the post-pandemic years. This report continues to build a timeline with comparable data to be augmented in future editions.

Throughout the report, summary statistics will be given with reference to calendar years of this comparison study unless highlighted specifically.

1.4 Data Sources

The nature of the performance indicator requires the collection of data from different sources. DECEA Performance Section and PRU investigated the comparability of the data available in both regions, including the data pre-processes, data cleaning and aggregation, to ensure a harmonised set of data for performance comparison purposes.

DECEA's data sources for this edition were expanded to include SETA Millennium, a system that extracts flight data directly from ATC systems. This addition complemented the tower-collected operational records already in use and was further combined with official ANAC (Brazilian CAA) data on scheduled commercial flights in Brazil. Together, these sources cover key parameters such as operation timestamps, gate entry and exit times, and flight origin and destination, increasing the precision of the analysis.

Within the European context, PRU has established a variety of performance-related data collection processes. For this report the main sources are the European Air Traffic Flow Management System (ETFMS [2]) complemented with airport operator reported data. These sources are combined to establish a flight-by-flight record. This ensures consistent data for arrivals and departures at the chosen study airports. The data is collected on a monthly basis and typically processed for the regular performance reporting under the EUROCONTROL Performance Review System and the Single European Sky Performance and Charging Scheme (EUROCONTROL 2019).

1.5 Structure of the Report

This third edition of the Brazil-Europe comparison report is organised as follows:

- **Introduction** – overview, purpose and scope of the comparison report; short description of data sources used;
- **Air Navigation System Characteristics** – high-level description of the two regional systems, i.e. areas of responsibility, organisation of ANS, and high-level air navigation system characteristics;
- **Traffic Characterisation** – network level and airport level air traffic movements; peak day demand, and fleet composition observed at the study airports;
- **Predictability** observed arrival and departure punctuality;
- **Capacity and Throughput** assessment of the declared capacity at the study airports and the observed throughput, including runway system utilisation comparing achieved peak throughput to the declared capacity;
- **Efficiency** analysis of taxi-in, taxi-out, and terminal airspace operations
- **Topic Studies** presents a high-level view on the use of point merge operations at two study airports, and a center-level characterisation; and
- **Conclusions** summary of this report and associated conclusions; and next steps.

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[2] Enhanced Traffic Flow Management System

2 Air Navigation System Characterisation

This section presents key characteristics of the air navigation systems of Brazil and Europe. In broad strokes, the provision of air navigation services in both regions relies on similar operational concepts, procedures, and supporting technologies. Nonetheless, there are several distinctions between the two systems, which help to account for the similarities and differences in key performance indicators documented in this report.

2.1 Organisation of Air Navigation Services

One of the major differences between the air navigation systems of Brazil and Europe is the respective organisational structure. In Brazil, a single entity serves as the primary air navigation services provider, i.e. the Department of Airspace Control (DECEA). In contrast, in Europe, each member state has delegated the responsibility for service provision to either national or local providers.

DECEA holds the vital role of overseeing all activities related to the safety and efficiency of Brazilian airspace control. Its mission encompasses the management and control of all air traffic within the sovereign Brazilian airspace, with a significant emphasis on contributing to national defence efforts. To achieve this, DECEA operates a comprehensive and fully integrated civil-military system.

In 2021, a public company, NAV Brasil, was created to take over some facilities that were linked to an older airport infrastructure provider company in Brazil (INFRAERO). Today, NAV Brasil provides aerodrome control services, non-radar approach, meteorology and aeronautical information for the respective locations. Despite serving a significant number of air transport movements, NAV Brasil does not plan to establish radar facilities or provide en-route services.

The Brazilian airspace, covering an area of approximately 22 million square kilometres (8.5 million square nautical miles of non-oceanic airspace), is divided into five Flight Information Regions. These regions are further subdivided and managed by five Area Control Centers (ACC), 59 Tower facilities (TWR), one digital tower (D-TWR), 42 Approach Units (APP) and 70 AFIS/Remote-AFIS.

The non-oceanic airspace in Europe covers an area of 11.5 million square kilometres. When it comes to the provision of air traffic services, the European approach involves a multitude of service providers, with 37 distinct en-route Air Navigation Service Providers (ANSPs), each responsible for different geographical regions. These services are primarily organised along state boundaries and associated FIR borders, with a number of limited cross-border agreements in place between adjacent airspaces and air traffic service units. A noteworthy exception to this predominantly national approach is the Maastricht Upper Area Control, which represents a unique multinational collaboration offering air traffic services in the upper airspace of northern Germany, the Netherlands, Belgium, and Luxembourg.

Civil-military integration levels across European countries vary. National souvereignty and defense remain a national responsibility, and civil-military coordination for airspace and flight operations follows a variety of models. These range from stand-alone units to fully integrated and jointly operated services. With most Member States of EUROCONTROL being member of NATO, there is also strong coordination of the military dimension through joint assets and capabilities. Within the European context, the central coordination of Air Traffic Flow Management (ATFM) and Airspace Management (ASM) is facilitated by the Network Manager. The design of airspace and related procedures is no longer developed and implemented in isolation in Europe. Inefficiencies in the design and utilisation of the air route network are recognised as contributing factors to flight inefficiencies in the region. Therefore, as part of the European Union's Single European Sky initiative, the Network Manager is tasked with developing an integrated European Route Network Design. This is achieved through a Collaborative Decision-Making (CDM) process involving all stakeholders.

Another critical responsibility of the Network Manager is to ensure that air traffic flows do not exceed the safe handling capacity of air traffic service units while optimising available capacity. To accomplish this, the Network Manager Operations Centre (NMOC) continuously monitors the air traffic situation and proposes flow management measures through the CDM process in coordination with the respective local authorities. This coordination typically occurs with the local Flow Management Positions (FMP) within the respective area control centres. Subsequently, the NMOC implements the relevant flow management initiatives as requested by the authorities or FMPs.

2.2 High Level System Comparison

Table 2.1 summarises the key characteristics of the Brazilian and European air navigation systems for 2023, 2024, and 2025. The data reflects a period of consolidation and growth in both regions, albeit at different paces and driven by distinct structural factors.

Table 2.1: High Level Comparison 2025

	BRAZIL			EUROPE		
KPA	**2023**	**2024**	**2025**	**2023**	**2024**	**2025**
geographic area (non-oceanic million km^2)[1]	8.5	8.5	8.5	10.9	10.9	10.9
number of en-route ANSPs[2]	1	1	1	37	37	37
number of TWR[1]	57+1 DTWR	57+1 DTWR	59+1 DTWR	374	373	n/a
number of APP[1]	41	41	42	268	266	n/a
number of ACC[1]	5	5	5	57	57	57
number of ATCOs in OPS[1]	3677	3890	3893	16973	17186	n/a
controlled flights[3]	1801109	1995139	2109588	10144258	10633991	11046028
flights ATCO	490	497	542	598	619	n/a
traffic density (non-oceanic flights/km^2)	0.18	0.19	0.21	0.93	0.976	n/a

[1] *Europe excludes Ukraine, Georgia, Serbia, Canary Islands and Oceanic areas.*

[2] *Europe excludes Ukraine, Georgia and Serbia.*

[3] *Europe controlled flights correspond to the ECAC area.*

In Brazil, the number of Air Traffic Controllers (ATCOs) in operations has continued to grow steadily, increasing from 3890 in 2024 to 3893 in 2025 — a rise of 0.1%. In Brazil, the number of Air Traffic Controllers (ATCOs) in operations remained broadly stable between 2024 and 2025, rising marginally from 3,890 to 3,893 — an increase of just 0.1%. Despite this near-plateau in workforce size, controlled traffic continued to grow over the same period, suggesting that productivity gains and operational efficiency improvements have played an increasingly important role in sustaining capacity. This trend reflects a broader strategic shift within DECEA, where investments in technological modernisation and process optimisation are enabling the existing controller workforce to handle a growing volume of flights, demonstrating that sustainable growth in air traffic management need not rely solely on workforce expansion.

In Europe, ATCO numbers showed only a mild variation over the period, moving from 16973 in 2023 to 16973 in 2024. This more conservative modulation reflects not only the slower pace of traffic recovery in the region but also a strategic orientation toward investment in technology, automation, and operational efficiency as levers to absorb demand. In Europe, there exists a mix of organisational models and labour contracts ranging from public service to fully commercial organisation, which tends to produce more measured responses to anticipated changes in air traffic demand. Figure 2.1 illustrates this divergence in workforce evolution alongside the traffic index for both regions.

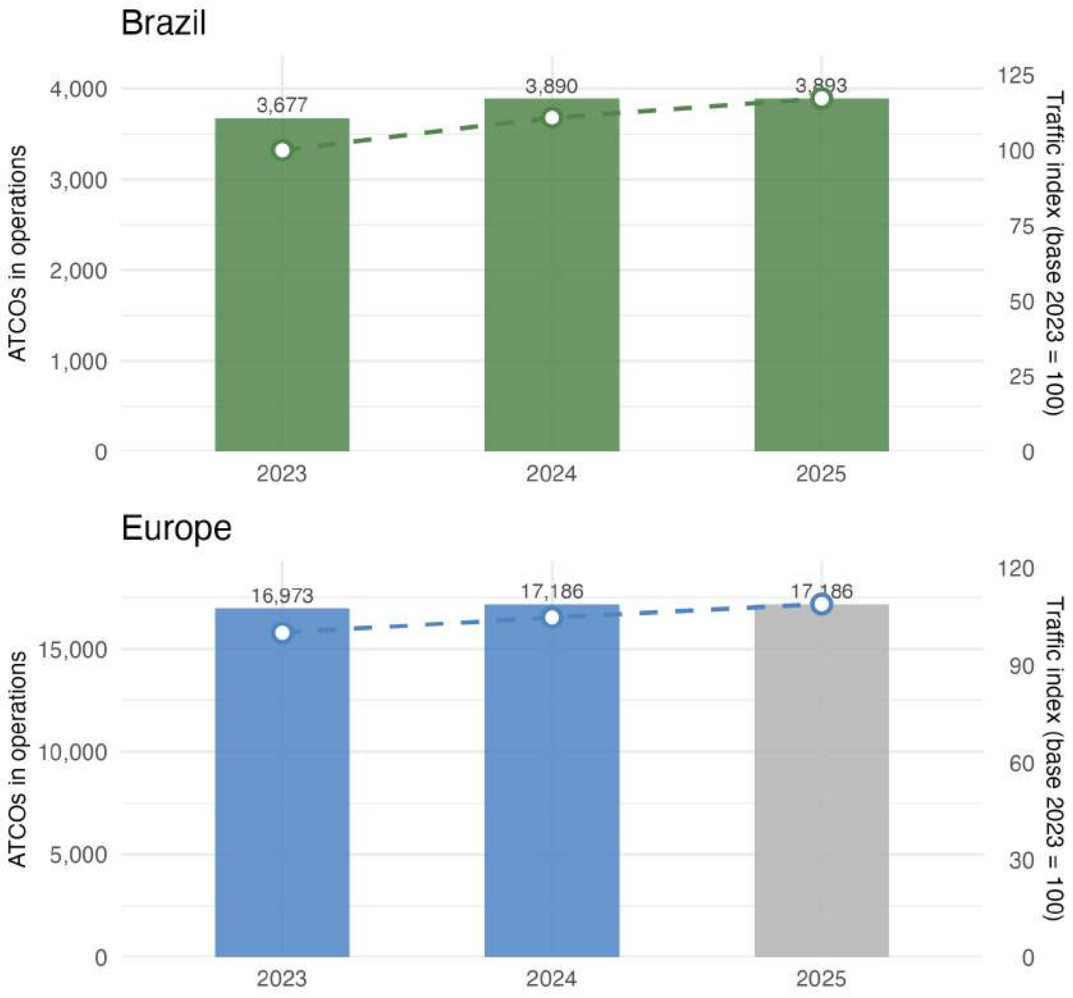


Figure 2.1: ATCO comparison

The traffic density indicator — expressed as controlled flights per square kilometre of non-oceanic airspace — provides a structural lens through which the operational differences between both regions can be better understood. In 2025, Europe operated at a density of 0.985 flights/km², significantly higher than Brazil's 0.21 flights/km². Despite this gap, Brazil's density has grown consistently over the period, reflecting the continued expansion of domestic aviation. This contrast underpins many of the operational differences discussed throughout this report, particularly regarding coordination complexity, capacity constraints, and network organisation.

Beyond the absolute number of controllers, the ratio of controlled flights per ATCO in operations offers a complementary perspective on how each system organises its workforce relative to demand. Figure 2.2 shows that Europe consistently records a higher flights-per-ATCO ratio compared to Brazil. This difference reflects not only the traffic density gap between the two regions but also distinctions in airspace organisation, sector design, and the distribution of responsibilities across control units.

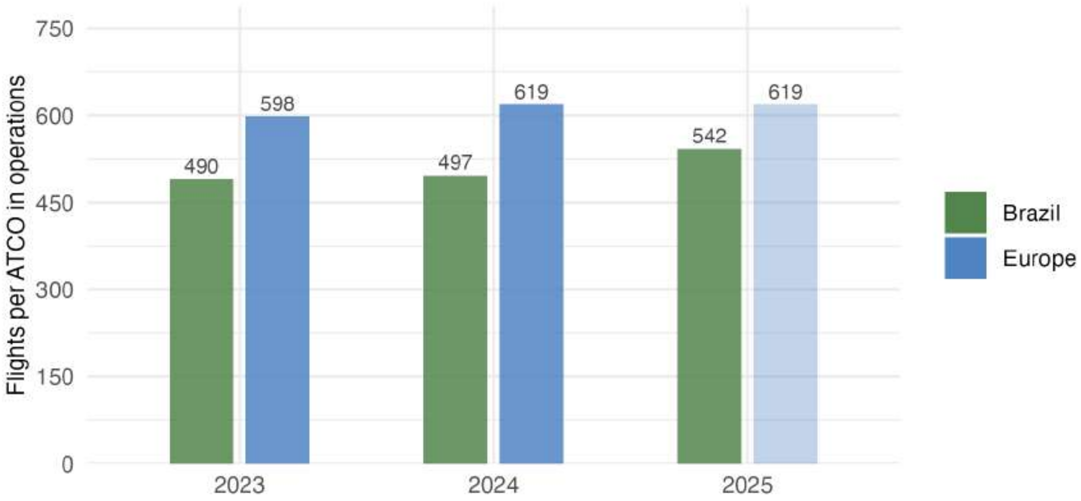


Figure 2.2: ATCO ratio

Both regions operate with similar operational concepts, procedures, and supporting technology. Considering the non-oceanic dimension of the airspace, Brazil services an area approximately 22% smaller than Europe. Brazil, with lower traffic density relative to its airspace, faces a more challenging cost-benefit ratio in maintaining communication coverage and surveillance for regions with low traffic volumes. The higher traffic density in Europe influences all aspects of flight management — in particular, the European region faces more considerable challenges in coordinating efforts to address operational constraints and service current demand. The contrast between one single en-route ANSP in Brazil and 37 in Europe is one of the most structurally significant differences between the two systems. This fragmentation is precisely the rationale behind the Network Manager's coordinating role in Europe — ensuring that flow management decisions, route network design, and capacity planning are addressed collectively rather than in isolation. Brazil's unified structure under DECEA allows for more centralised decision-making, which may offer advantages in terms of system-wide responsiveness, though it also places considerable institutional responsibility on a single entity

2.3 Regional Approach to Operational Performance Monitoring

The previous report detailed the historic setup of the performance monitoring systems in Brazil and Europe.

The implementation of the performance-based approach is not a fundamental new activity in Europe. The Performance Review Commission (PRC) was established within EUROCONTROL in 1998 aiming to establish and implement an independent European air traffic management (ATM) performance review capability in response to the European Civil Aviation Conference (ECAC) Institutional Strategy. The main goal of the PRC is to offer impartial advice on pan-European ATM performance to EUROCONTROL's governing bodies. Supported by the Performance Review Unit (PRU), the PRC conducts extensive research, data analysis, and consultations to provide objective insights and recommendations. EUROCONTROL's performance review system, a pioneering initiative in the late 1990s, has influenced broader forums like ICAO's global performance approach and the Single European Sky (SES) performance scheme. Collaborating internationally, particularly with ICAO, the PRC aims to harmonise air navigation practices. The PRC produces annual reports, e.g. Performance Review Report (PRR) and ATM Cost-Efficiency (ACE), and provides operational performance monitoring through various data products and online tools (https://ansperformance.eu). Continuous efforts are made to expand the online reporting for stakeholders and ensure access to independent performance data for informed decision-making.

It is noteworthy to recall that DECEA, influenced by ICAO publications, embraced a performance-based approach, notably advancing the national state-of-the-art in collaboration with EUROCONTROL. Beginning with the SIRIUS Brazil Program in 2012, DECEA faced challenges defining metrics, but made significant progress after signing a Cooperation Agreement with EUROCONTROL in 2015. DECEA published crucial documents for ICAO's Global Air Navigation Plan, prompting an organisational transformation and adaptation of practices. Establishing the ATM Performance Section in 2019, akin to EUROCONTROL's PRU, DECEA accelerated the build-up of expertise in operational performance monitoring. This culminated in the publication of the first Brazilian ATM Performance Plan for 2022–2023. Building on this foundation, DECEA has continued to strengthen and broaden its performance management culture in recent years. This has been achieved through dedicated training courses on ATM performance, the organisation of an annual performance seminar bringing together national and international stakeholders, and successive updates to the national ATM Performance Plan. In parallel, DECEA has made significant technical advances in the calculation of new indicators that had not previously been assessed at the national level, most notably Vertical Flight Efficiency (VFE) and Horizontal Flight Efficiency (HFE). These additions represent a meaningful step forward in aligning Brazil's performance monitoring framework with international best practices and expanding the analytical scope of the national system.

Actively fostering an open culture of knowledge-sharing within South America, DECEA has engaged in workshops and seminars, inviting EUROCONTROL for this collaborative effort. The recurrent use of common indicators and the close technical collaboration during joint analyses enrich not only both regions but also carry a broader global impact. Embracing transparency, both agencies have made their indicators and databases publicly accessible, perpetuating a culture of reciprocity for mutual advancement. The lessons learned from this collaboration are systematically shared with the multinational Performance Benchmarking Working Group (PBWG) and the Performance Expert Group of the ICAO GANP Study Group, responsible for developing GANP Key Performance Indicators (KPIs) — reinforcing this collaboration as a reference model for ANS performance management globally. Updated dashboards, previous work, and supporting historical data are available at https://ansperformance.eu/global/brazil/ or https://performance.decea.mil.br/.

2.4 Summary

The characteristics of the air navigation systems in Brazil and Europe presented in this chapter highlight both the commonalities and the structural differences that shape operational performance in each region. Both systems rely on similar operational concepts, procedures, and supporting technology, yet they differ significantly in their organisational models, workforce dynamics, and traffic density. In 2025, Brazil continued to expand its aviation sector, with a controller workforce that remained broadly stable while managed to support sustained traffic growth — reflecting efficiency gains and operational improvements rather than workforce expansion alone. Europe, in turn, consolidated its network with a more measured approach to capacity building. The traffic density gap — with Europe operating at approximately four times the density of Brazil — remains a key structural difference that helps explain many of the performance variations documented throughout this report. At the institutional level, both DECEA and EUROCONTROL have continued to strengthen their performance monitoring frameworks, with Brazil advancing the calculation of new efficiency indicators such as Vertical Flight Efficiency (VFE) and Horizontal Flight Efficiency (HFE) and building its performance culture through training and annual seminars. Together, these developments reinforce the value of the bilateral collaboration and set the foundation for the traffic and performance analysis presented in the following chapters.

3 Traffic Characterisation

To facilitate operational benchmarking comparisons, it is crucial to have a good understanding of the level and composition of air traffic as the underlying demand and its evolution. This chapter presents air traffic characteristics for both regions, structured progressively from a network-level overview to an airport-level assessment covering traffic volumes, peak day demand, and fleet composition at the 12 study airports in each region.

3.1 Network Characterisation

To address the changes in air traffic and develop a better understanding of the nature of the air transportation network, this section characterises the network structure of both regions — progressing from overall traffic volumes to the distribution within each region, the flows connecting Brazil and Europe, and the broader international context.

3.1.1 Overall Traffic Volume

In 2025, Brazil handled approximately 2.1 million controlled flights, representing approximately 19% of the traffic serviced in Europe over the same period. Overflights account for a small share of the total air traffic momvements in both regions. As shown in Figure 3.1, both regions recorded growth over the 2023–2025 period, though the underlying dynamics differ significantly.

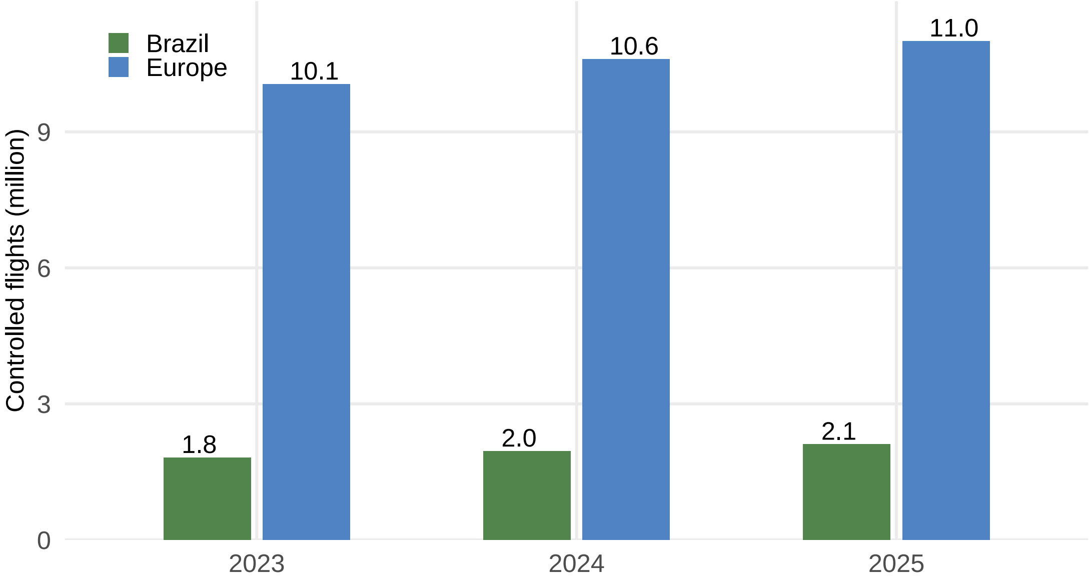


Figure 3.1: Overall traffic volume

Brazil continued to expand its aviation sector, with traffic growing consistently across the three years — a trajectory that reflects sustained organic demand rather than cyclical fluctuation. In Europe, traffic levels also grew over this period, though at a more moderate pace, with the network continuing to consolidate and recover from the COVID decline and ripple effects from the Russian war of aggression against Ukraine. The different pace of growth across both regions reinforces the importance of understanding each system's structural context when comparing operational performance.

Figure 3.2 shows the 7-day rolling average of daily movements in Brazil and Europe from 2019 to 2025. In Brazil, traffic levels recovered swiftly from the sharp drop observed in 2020 and have continued to grow steadily since 2022, surpassing 2019 levels and maintaining a stable profile with only modest seasonal variation throughout the year. The Brazilian air transport market does not exhibit strong seasonal peaks, reflecting a demand pattern driven primarily by domestic and regional connectivity rather than leisure-driven flows. In the European region, the recovery trajectory is clearly visible — from the sharp collapse in 2020 through a gradual rebuilding of demand across 2021 and 2022, reaching and consolidating at 2019 levels by 2024 and 2025. Europe's traffic pattern, however, remains characterised by strong seasonal variation, with a pronounced surge in demand during the summer months that stands in clear contrast to the more stable Brazilian profile. This seasonal asymmetry is an important structural feature to bear in mind when comparing operational performance indicators across both regions throughout this report.

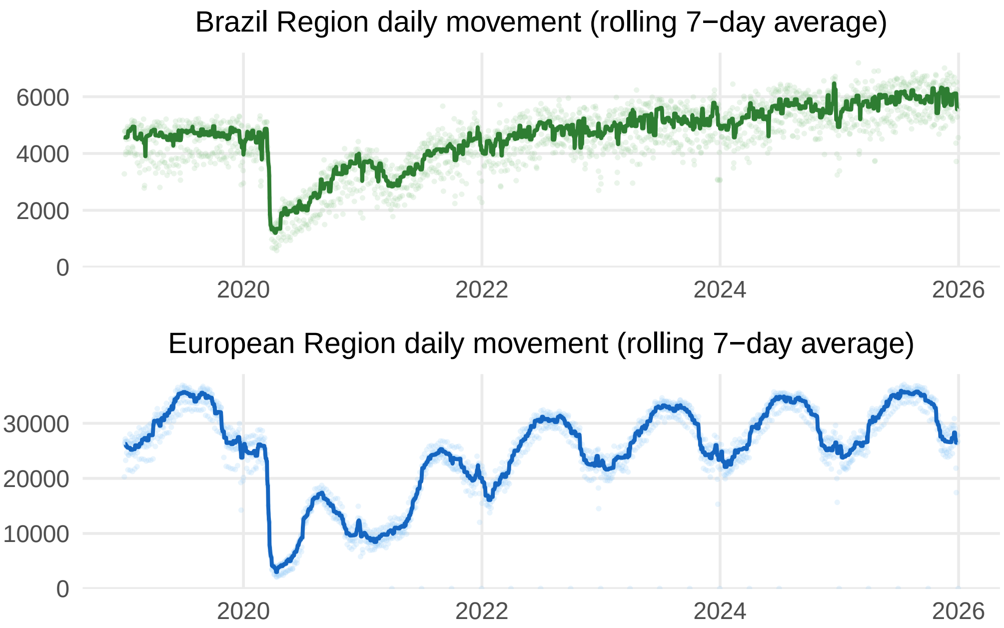


Figure 3.2: Regional daily air traffic

3.1.2 Traffic Distribution Within Each Region

While the total volume of traffic provides a first measure of the scale of operations in each region, it does not capture how that traffic is distributed across the network. Figure 3.3 presents the cumulative share of departures by airport rank for both regions in 2025. The distribution of air traffic in Brazil confirms that most flights are concentrated in a small number of airports. In 2025, the 10 busiest airports in Brazil handled 36% of all departing flights, whereas in Europe the top 10 airports account for 21% of all departures. The spread remains broadly constant up to the 50th rank, narrowing with the top 100 airports — marking 80% of all departures in Brazil and 74% in Europe. This reflects the historical development of the European network, where the traditional focus on national hubs resulted in a higher number of major national aerodromes interconnecting across the continent.

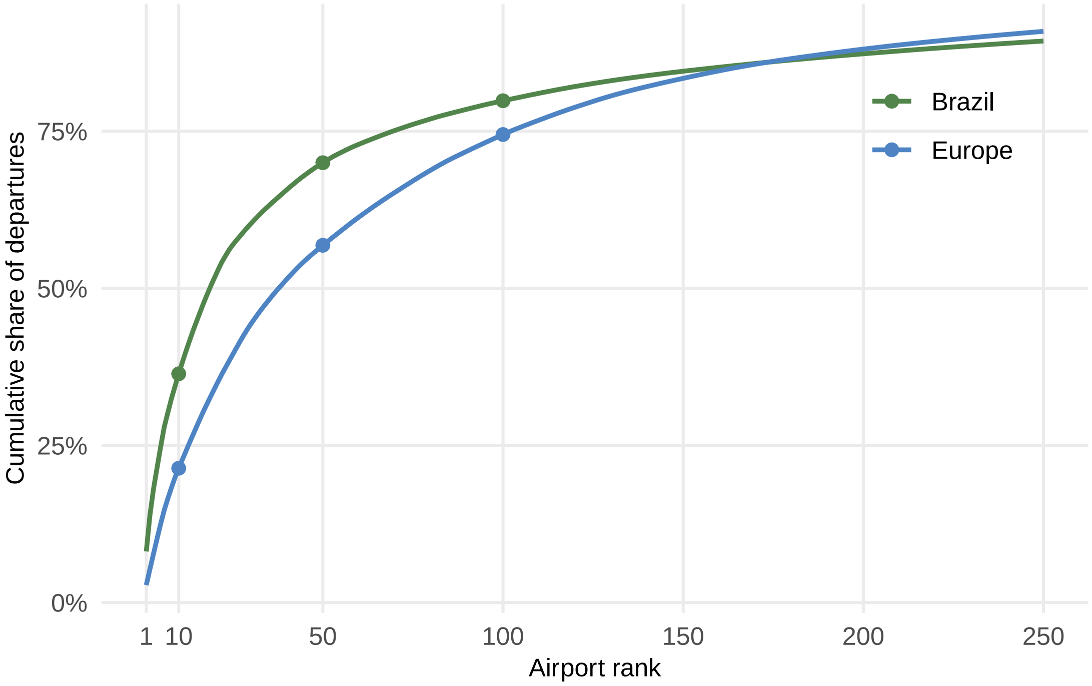


Figure 3.3: traffic share - ranked departures per region

Figure 3.4 shows the distribution of domestic/regional and international departures in 2025. In both regions, the share of flights operating externally accounts for 14% of total traffic in Brazil and 20% in Europe. The majority of flights operate within each region, accounting broadly for about -/+ 80%. This domestic dominance is particularly pronounced in Brazil, where the continental scale of the country sustains a large volume of intra-national movements. In Europe, the relatively short distances between states mean that many flights classified as *international* are functionally comparable to domestic short-haul routes in Brazil. Accordingly, in this report, intra-European air traffic is considered “regional” traffic, equivalent to domestic traffic in other regions or large national airspace and air navigation systems.

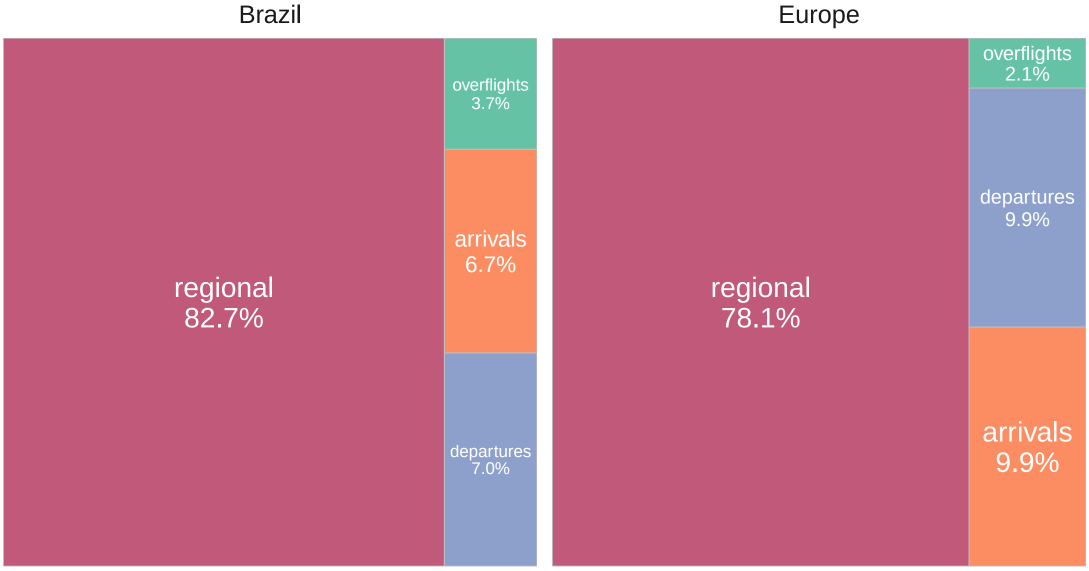


Figure 3.4: traffic distribution 2025 - within region, departures, arrivals, and overflights

3.1.3 Flows Between Brazil and Europe

Figure 3.5 shows the change in rank among the main Europe-to-Brazil connections. The strongest connection shifted from Lisbon-Guarulhos (LPPT-SBGR) in 2024 to Madrid-Guarulhos (LEMD-SBGR) in 2025.

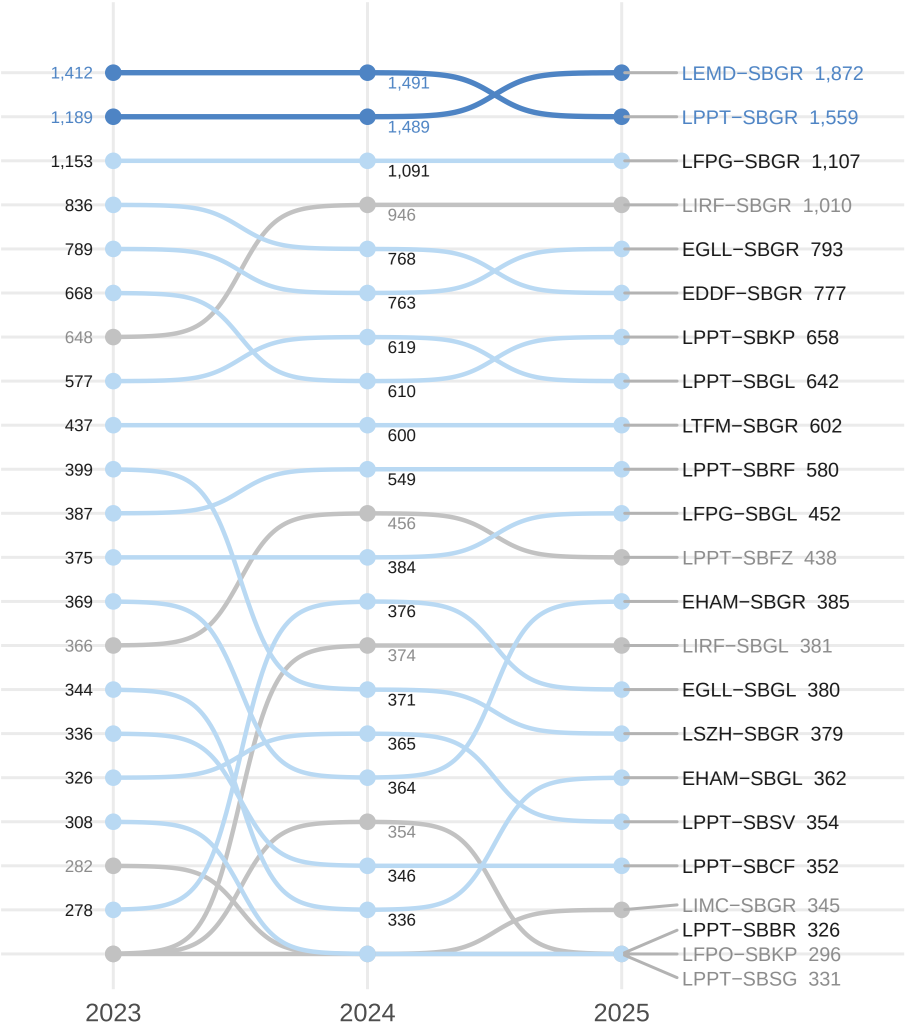


Figure 3.5: Rank change for selected Europe-to-Brazil connections

Figure 3.6 shows the connections from Europe to Brazil in 2025. Individual non-study airport connections with fewer than 90 flights per year are aggregated into an “other” group. Traffic from Brazil to Europe accounts for 0.9% of the total departures from Brazilian airports.

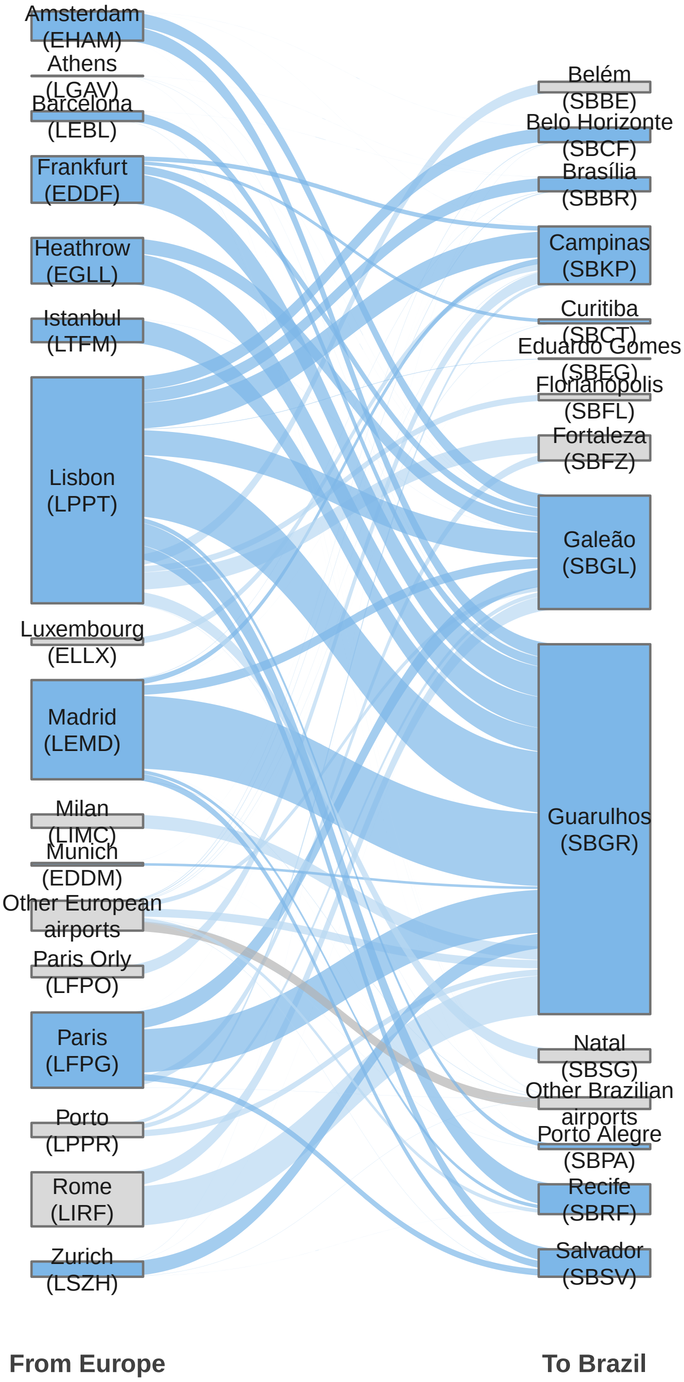


Figure 3.6: Inter-regional connections between Brazil and Europe

Guarulhos (SBGR) and Madrid (LEMD) are the main airports sustaining connectivity between both regions, reflecting the historically close ties between Brazil and Europe. In this edition, Madrid emerges as the leading European hub in terms of flight operations to Brazil, while Lisbon (LPPT) continues to play a significant role as a gateway between the two regions.

3.1.4 Connections to Other World Regions

From a broader international perspective, both regions are interconnected with the rest of the world in distinct ways. Figure 3.7 shows the spread of international traffic from each region. For Brazil, connections to other South American states represent the major international destinations. For Europe, the Middle East, North America, and Africa represent the largest international markets. The chart aligns Brazil-to-Europe and Europe-to-Brazil traffic on a common counterpart-region row to support comparison. Connections to other regions or below a certain limit of regular flights are not presented. The potential impact of such connections will be further analysed in future editions.

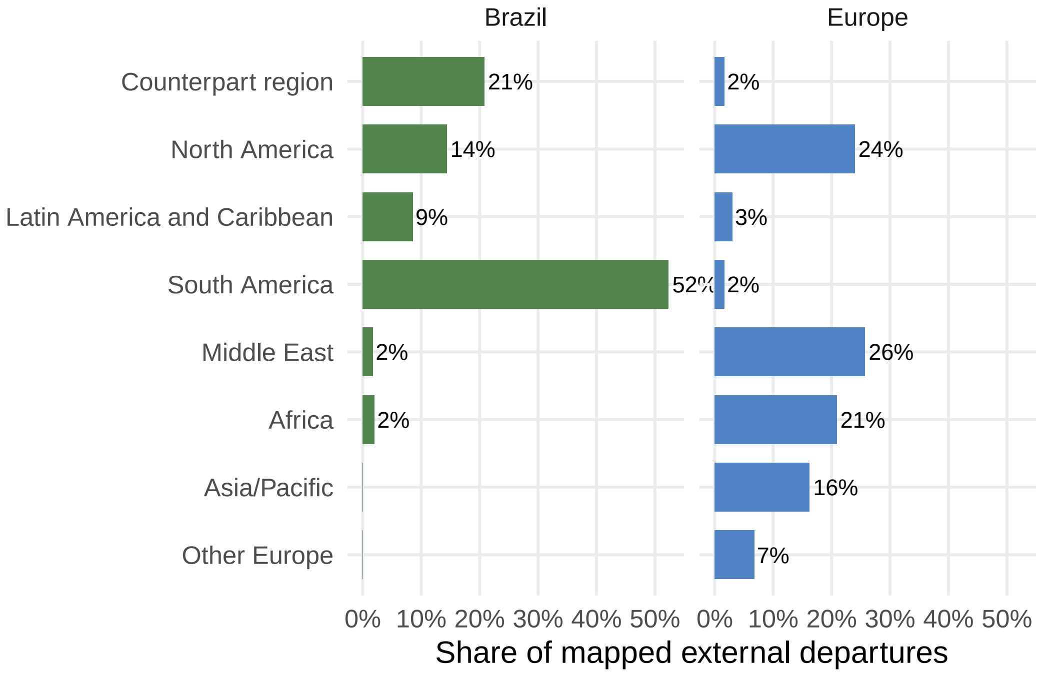


Figure 3.7: Connections to Others Regions

Figure 3.8 provides a closer look at the main country-level external connections. For Brazil, the focus remains on South America, with just under 45.000 flights operated to adjacent countries in 2025. Argentina and Chile together account for approximately half of these movements, confirming the strength of the southern cone corridor. For Europe, the comparison shows the main external country destinations across North America, the Middle East, Africa, and Asia/Pacific, balancing the number of displayed bars with the Brazilian panel.

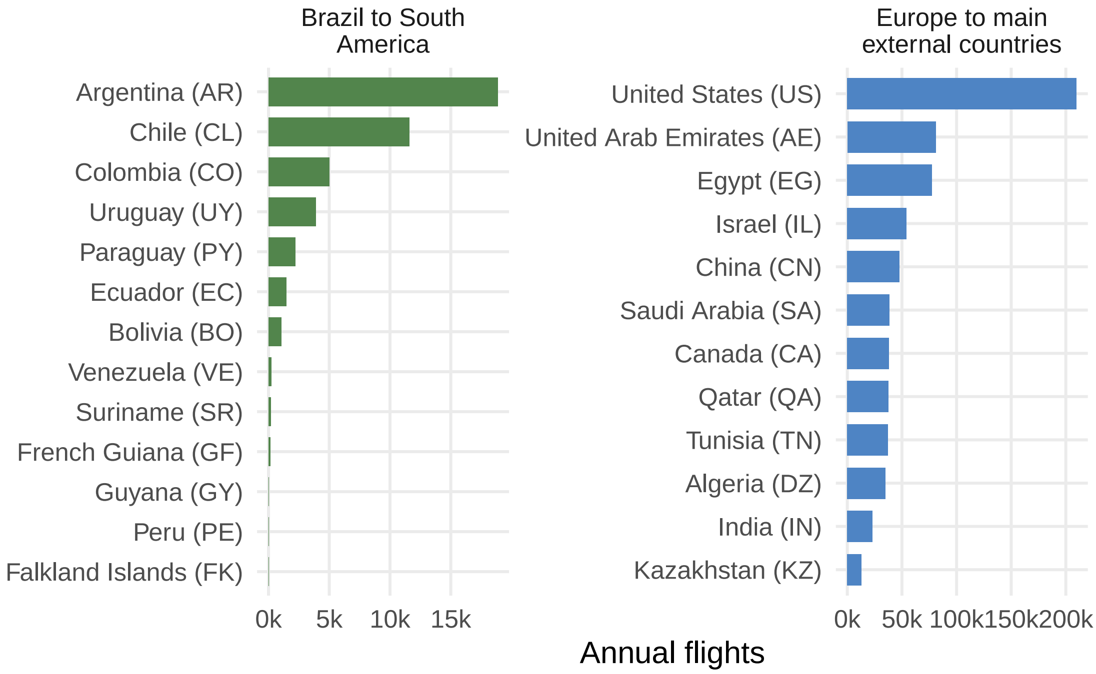


Figure 3.8: Main external country connections

3.2 Airport Level Air Traffic Movements

The previous section characterised the air traffic network at a macro level. As airports represent nodes in this overall network, changes to the overall traffic situation ripple down to the airport level. At this level, performance is measured in terms of airport movements — that is, the combined count of arrivals and departures handled at each location. This demand on airport form a substantial input to understand how the operational performance measures in this report developed over time. With this report the analysis is extended to performance levels observed at 12 key airports in each region.

Figure 3.9: Airport level traffic

3.2.1 Movement Evolution at Study Airports

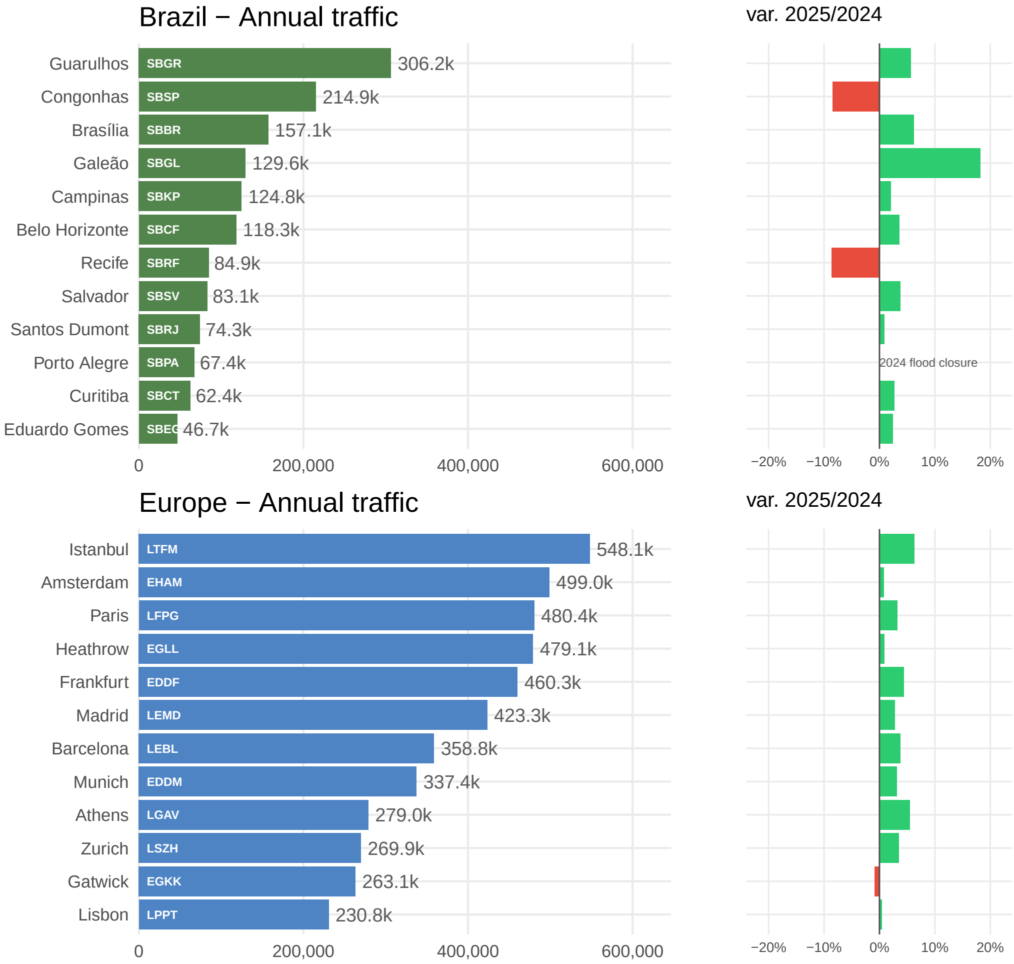


Figure 3.10: Annual traffic at study airports in 2025 and variation 2025/2024

Figure 3.10 presents the airport movement evolution for the study airports from 2024 to 2025. In Europe, airports have generally observed increases in movement levels across the period, reflecting a network in a phase of gradual consolidation. The Brazilian scenario is more heterogeneous — while some airports such as Galeão (SBGL) and Guarulhos (SBGR) registered increases, others such as Congonhas (SBSP) and Recife (SBRF) saw declines in 2025. Meanwhile, Santos Dumont (SBRJ) showed very little variation overall. This divergence highlights the uneven pace of growth among Brazil's major airports, reflecting broader structural and operational differences in the national aviation landscape.

It is also important to emphasise that Brazil's movements are distributed across a much larger number of airports compared to Europe. As discussed in Section 3.1, Brazil's extensive network dilutes movement concentration at the top airports, suggesting a modest redistribution across a broader set of airports — potentially due to regional market dynamics, strategic airline adjustments, or temporary infrastructure constraints. Europe's busiest airports have slightly increased their share of total network movements, reflecting the growing reliance on major hubs across the region.

3.2.2 Monthly Movement Patterns

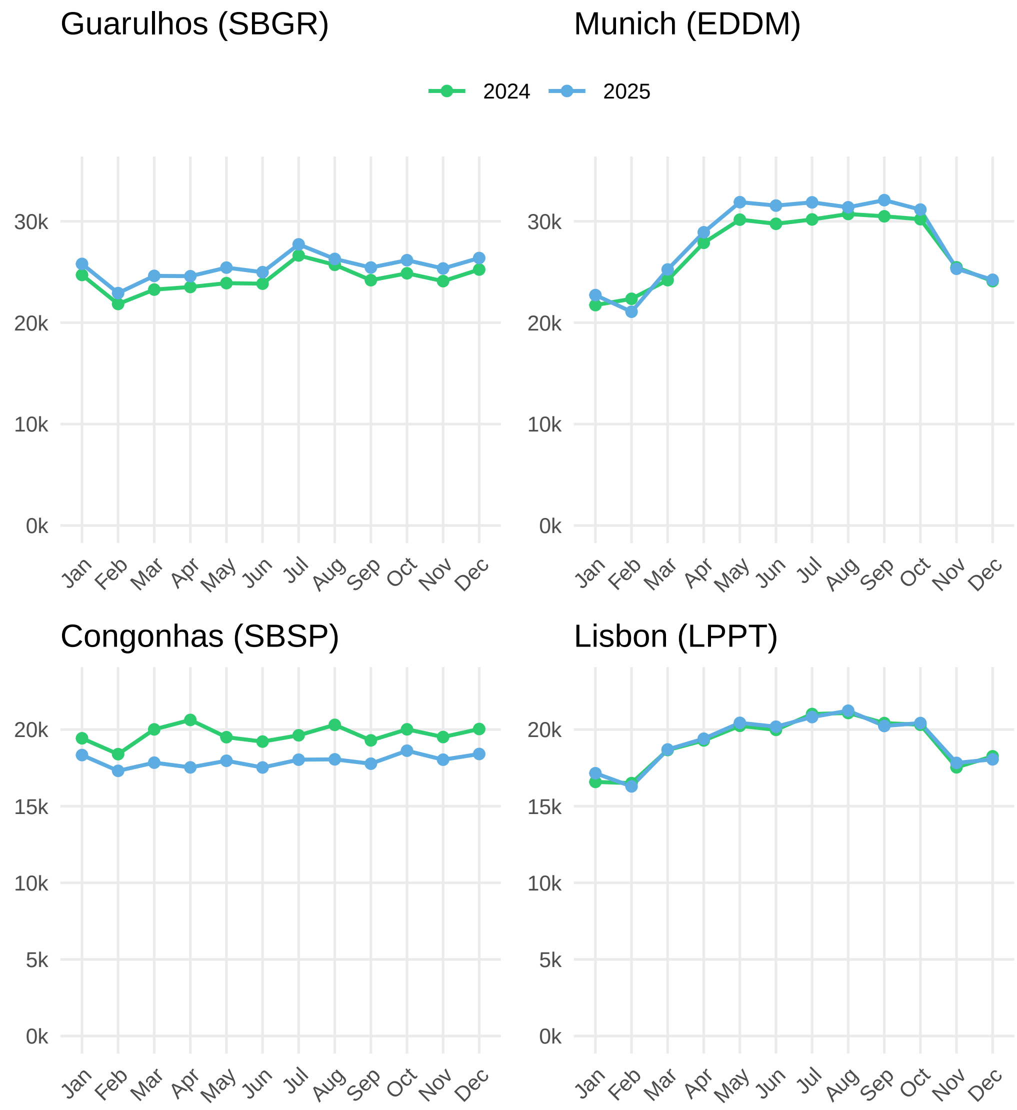


Figure 3.11: Monthly traffic evolution at comparable study airports

Figure 3.11 shows the monthly evolution of movements at Guarulhos (SBGR) and Munich (EDDM), as well as at São Paulo Congonhas (SBSP) and Lisbon (LPPT). These airport pairs were selected to illustrate the contrasting movement profiles between the two regions at comparable levels of network importance. For SBGR, a steady increase in monthly movements is visible in 2025 compared to 2024, with July standing out as the month with the highest volume. Operations at EDDM show a more pronounced seasonal pattern, with movements building up from late spring to peak levels during the summer months. This contrast reinforces the structural difference between Brazil's more stable year-round demand and Europe's tourism-driven seasonality. Comparing SBSP and LPPT shows a similar dynamic at a smaller scale. Movement levels at SBSP are moderate and stable throughout the year, servicing predominantly national and regional traffic. Lisbon, in turn, exhibits a clear summer peak in movements, consistent with its role as a major gateway for leisure and connecting traffic between Europe and the Atlantic region.

3.3 Peak Day Traffic

While the annual traffic provides insights in the total air traffic volume and the associated demand, it does not provide insights on the upper bound of achievable daily movement numbers. The latter depends on demand, operational procedures and/or associated constraints, and the use of the runway system infrastructure. The peak day traffic is determined as the 99th percentile of the total number of daily movements (arrivals and departures). The measure represents thus an upper bound for comparison purposes.

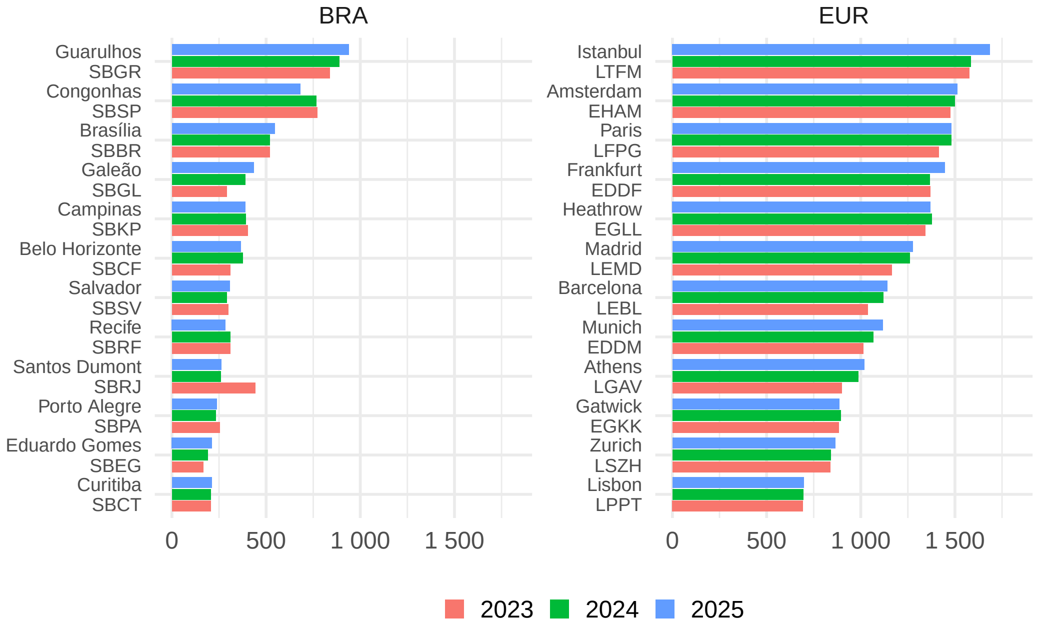


Figure 3.12: Airport peak daily traffic (2023 - 2025)

Figure 3.12 shows the evolution of peak day traffic between 2023 and 2025 across the Brazilian and European airports included in this study. The peak day measurement is as a useful complement to traffic levels and average daily movement metrics. It provides a reference to the achievable daily service rate that can highlight nuances of the operational context and constraints at comparable airports and approach areas.

Overall, the data shows a more differentiated development of operational volumes across the Brazilian study airports. On the European side, the year-by-year comparison highlights the on-going recovery and first consolidation effects post the pandemic. Consistent with the overall traffic increase, most European airports recorded an increase in peak day traffic between 2024 and 2025, while a number of the largest airports show only marginal changes that point to daily service rates already close to their current upper operating range.

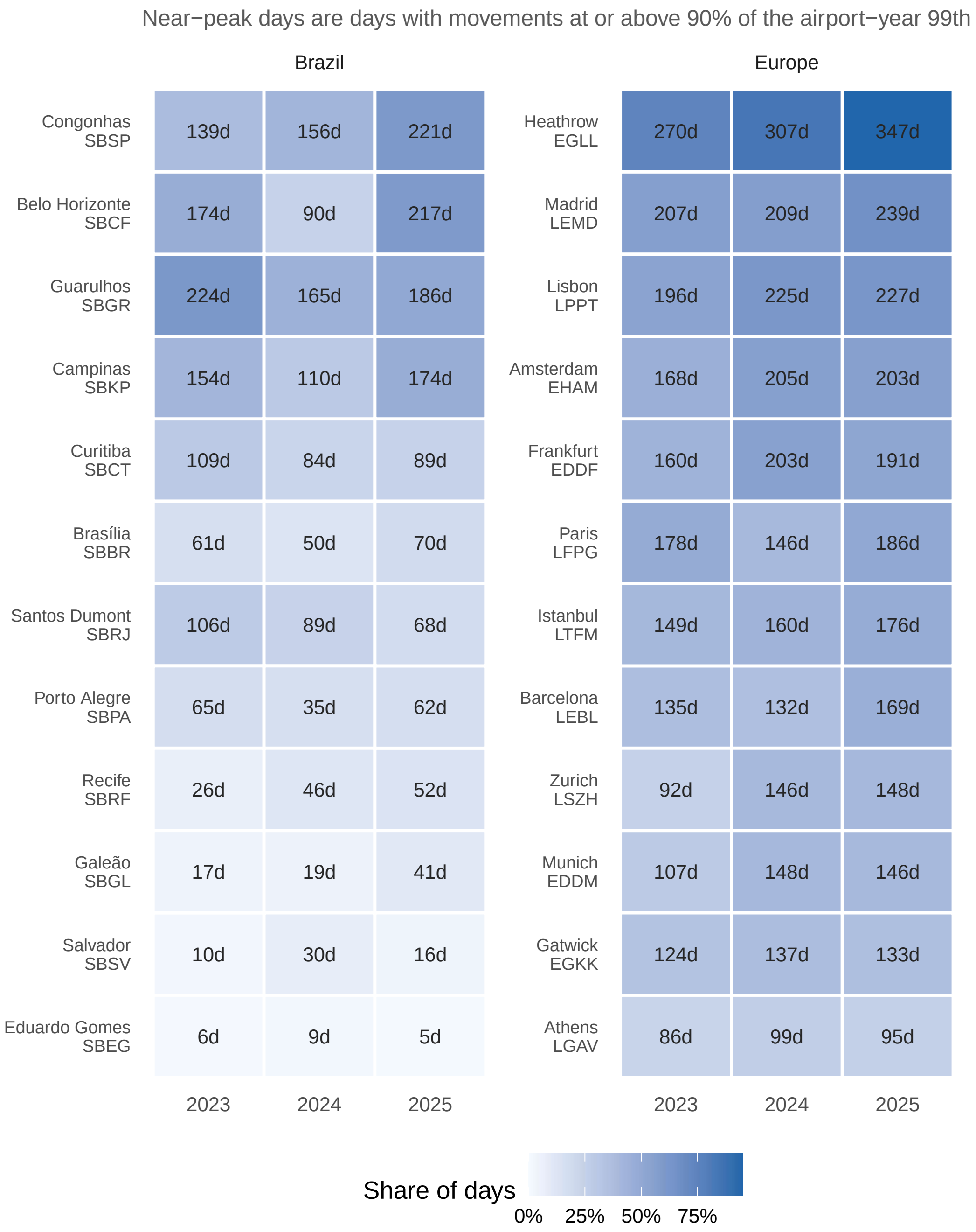
Still, some variations stand out on the Brazilian side:

- Guarulhos (SBGR), Galeão (SBGL), and Brasília (SBBR) recorded increases in their peak day movements, reflecting their greater capacity to absorb traffic and some redistribution of demand within the national network.
- Congonhas (SBSP), on the other hand, shows a notable drop in 2025, while Santos Dumont (SBRJ) remains well below its 2023 peak day value following the operational restrictions implemented during 2024, which limited its capacity and led to the transfer of some flights to SBGL.
- In the case of Porto Alegre (SBPA), even though it was severely affected by floods starting in May 2024, the data shows only a limited recovery in its 2025 peak day value and remains below the level observed in 2023.

Regarding the peak day traffic at European airports:

- Istanbul (LTFM) shows the highest peak day traffic among the European study airports in 2025 and continues to increase compared to the previous years.
- Significant increases are observed at Frankfurt (EDDF), Munich (EDDM), Athens (LGAV), Barcelona (LEBL), and Madrid (LEMD) over the 2023 to 2025 period. As major gateways, this also reflects the increase in international air traffic and the continued strengthening of network connections by the major carriers operating from/to these airports.
- Marginal to no changes between 2024 and 2025 evidence that the peak operations at Paris Charles de Gaulle (LFPG), London Heathrow (EGLL), Amsterdam (EHAM), and Lisbon (LPPT) reach their daily maximum service rate.

The comparison between the Brazilian and European contexts reinforces the importance of considering each network's structure, operational model, and geographic distribution when evaluating operational performance at and around airports. It also shows how peak day traffic can offer unique insights — especially during periods of recovery or transition — by highlighting the maximum operational load airport services can sustain regardless of their average daily traffic.



Brazil	2023	2024	2025	Europe	2023	2024	2025
Congonhas SBSP	139d	156d	221d	Heathrow EGLL	270d	307d	347d
Belo Horizonte SBCF	174d	90d	217d	Madrid LEMD	207d	209d	239d
Guarulhos SBGR	224d	165d	186d	Lisbon LPPT	196d	225d	227d
Campinas SBKP	154d	110d	174d	Amsterdam EHAM	168d	205d	203d
Curitiba SBCT	109d	84d	89d	Frankfurt EDDF	160d	203d	191d
Brasília SBBR	61d	50d	70d	Paris LFPG	178d	146d	186d
Santos Dumont SBRJ	106d	89d	68d	Istanbul LTFM	149d	160d	176d
Porto Alegre SBPA	65d	35d	62d	Barcelona LEBL	135d	132d	169d
Recife SBRF	26d	46d	52d	Zurich LSZH	92d	146d	148d
Galeão SBGL	17d	19d	41d	Munich EDDM	107d	148d	146d
Salvador SBSV	10d	30d	16d	Gatwick EGKK	124d	137d	133d
Eduardo Gomes SBEG	6d	9d	5d	Athens LGAV	86d	99d	95d

Figure 3.13: Share of days operating near the airport-year peak traffic level

Figure 3.13 complements the peak-day comparison by showing whether high-demand days occur repeatedly during the year or only as isolated events. For each airport and year, the reference level is calculated from that airport-year's own 99th percentile of daily movements. This keeps the measure focused on the shape of demand within each year, rather than on absolute size differences between airports.

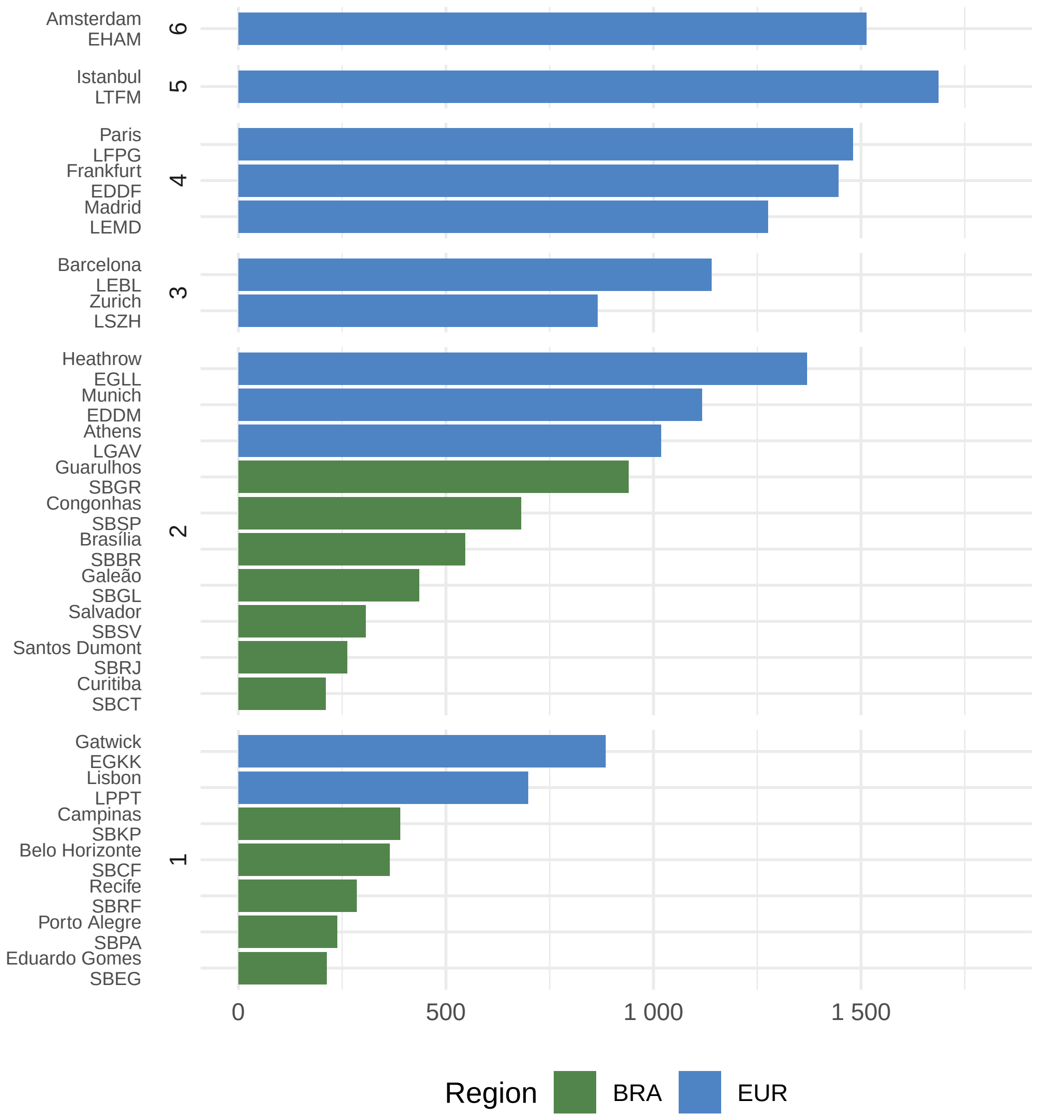


Figure 3.14: Airport peak daily service rate (99th percentile, 2025)

Analysing the 2025 peak day data, as presented in Figure 3.14, with Brazilian and European airports grouped by number of runways, we observe that seven European airports operate with three or more runways and are therefore not directly comparable to Brazilian airports. However, it is important to note that in many of these cases, the runway system does not support fully independent operations on all available runways. Such constraints reduce the available runway system capacity, and thus, the serviced peak traffic is also impacted by the runway system configuration. For example, operations at Amsterdam (EHAM) cannot make use of all six runways at the same time. Operations at Zurich (LSZH, 3 interdependent runway system) range above the order of single runway operations at Lisbon (LPPT, 1 runway). As a result, peak traffic performance is also shaped by the specific runway system configuration.

When focusing on airports with up to two runways, European airports still generally show higher peak day movements compared to the Brazilian ones. This difference can be attributed to more robust infrastructure and operational systems in Europe. Additional benefits are exploited by dedicated operational concepts. For example, London Heathrow implemented time-based separation on final which adds to achieving a high level of runway system throughput even in high wind situations.

This shows the importance of analysing peak day traffic as a complementary indicator to average daily movements, especially during periods of recovery or operational adjustments. Future research may highlight the impact of the runway system configuration on the service rate under the associated runway use.

3.4 Fleet Mix

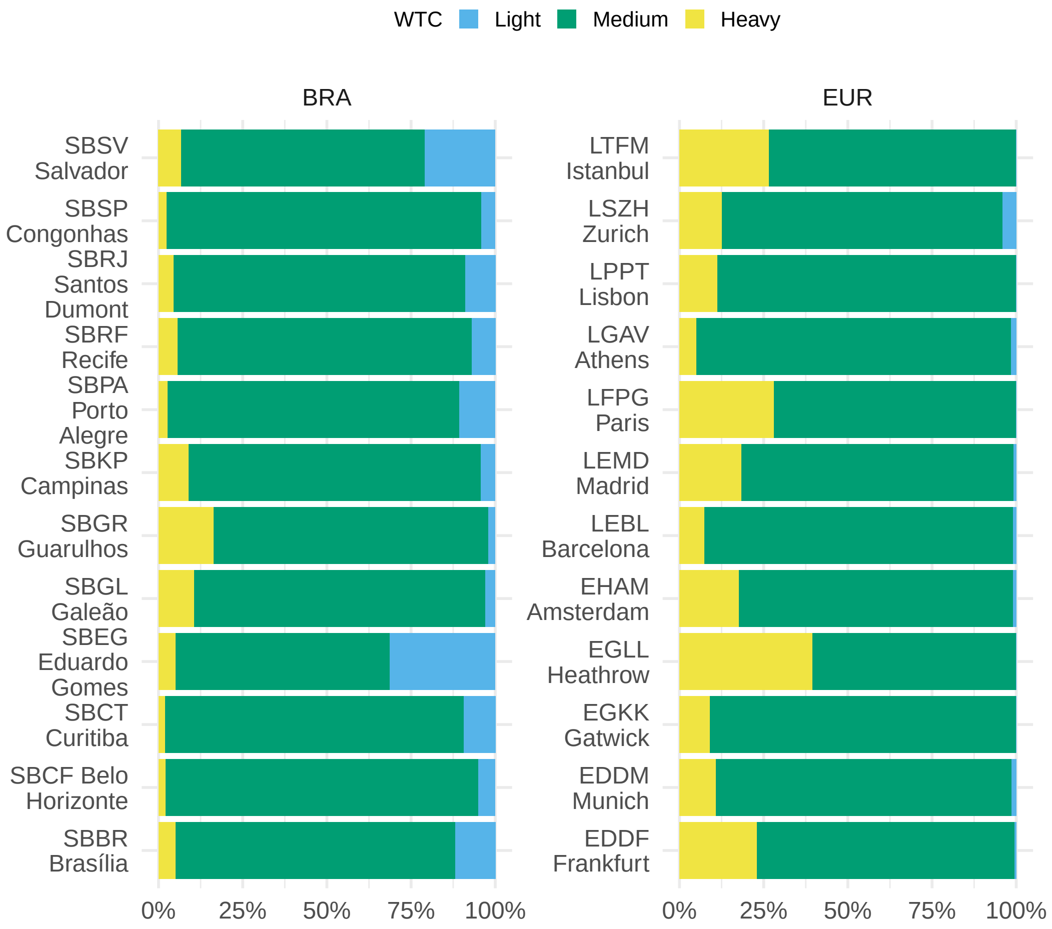


Figure 3.15: Fleet mix observed at the study airports in 2025

Figure 3.15 confirms the dominance of the “medium” aircraft category at the airports analysed in both Brazil and Europe. Fleet mix plays a key role in airport capacity, directly impacting traffic flow and operational efficiency. Generally, a higher share of “heavy” aircraft can reduce runway throughput due to wake turbulence separation requirements and longer landing and take-off times.

In Brazil, the main international hubs, Guarulhos (SBGR), Galeão (SBGL), and Campinas (SBKP), show the highest share of “heavy” aircraft among the Brazilian study airports, reinforcing their role as the country’s key international gateways. Guarulhos remains the strongest Brazilian heavy-aircraft profile, while Galeão and Campinas continue to combine international, domestic, and cargo-related operations, contributing to a more diverse fleet profile and operational complexity.

Some Brazilian airports such as Brasília (SBBR) and Salvador (SBSV) serviced a significant share of "light" aircraft. This category that is nearly absent among the European airports analysed. The notable exemption is Zurich (LSZH). In Salvador, light aircraft account for about one fifth of all movements, while the share is even higher at Eduardo Gomes (SBEG), reflecting the specific regional and logistical roles of these airports.

On average, the share of "heavy" aircraft remains higher at the European study airports. The major European hubs like Heathrow (EGLL), Charles de Gaulle (LFPG), Istanbul (LTFM), and Frankfurt (EDDF) operate with a higher proportion of "heavy" aircraft, in line with their function as global connection points. These structural differences reflect how each region organizes its connectivity: Brazil tends to centralize long-haul operations in a few key airports. The European network evidences the national focus on air transport development. With a significant higher number across a broader set of hubs traditionally servicing the national capitals.

Based on continuous monitoring throughout the year, this pattern has proven to be remarkably stable. The distribution of aircraft categories has remained consistent even during periods of disruption, such as extreme weather or localized infrastructure constraints. These observations suggest that the fleet mix at the analysed airports is shaped more by long-term structural factors than by short-term fluctuations, as airspace users operate and renew their fleet servicing these airports within their economic and operational context.

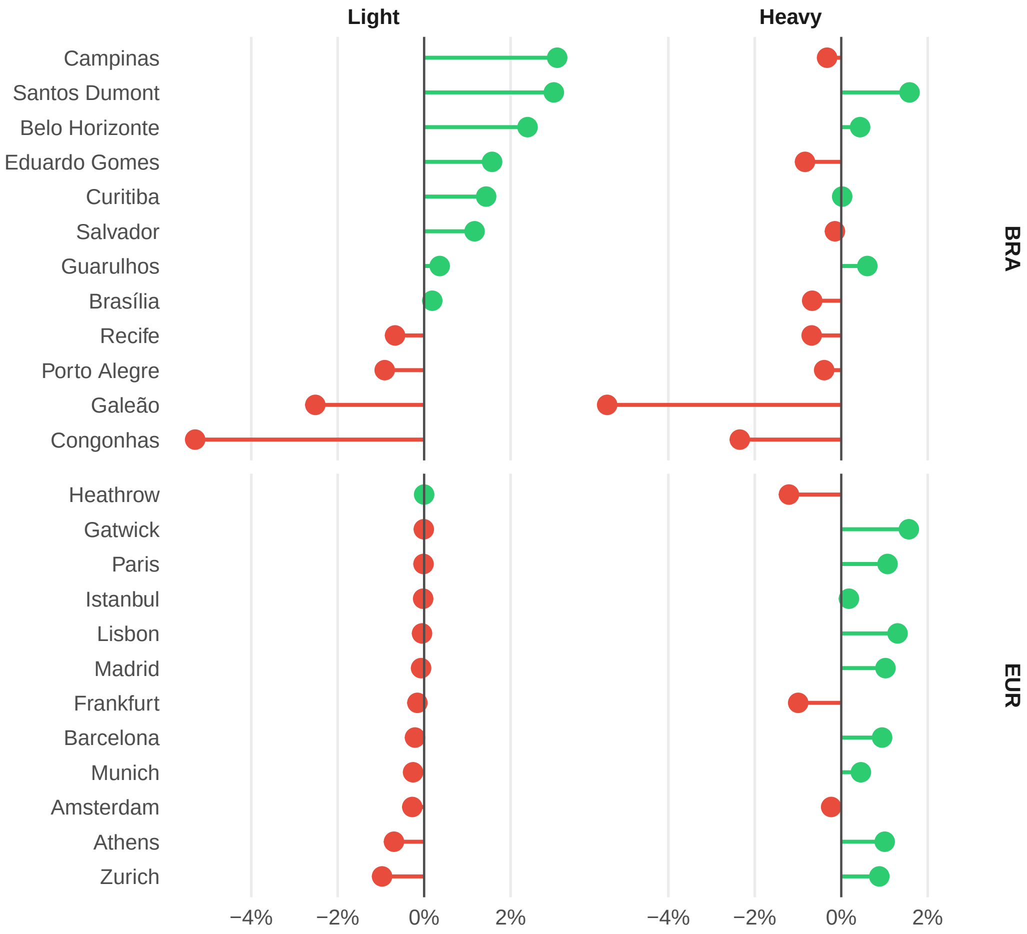


Figure 3.16: Change in heavy and light aircraft share at the study airports (2023 and 2025)

Figure 3.16 provides a complementary view of this structural difference by focusing on the two categories that create the clearest contrast between the regions. Between 2023 and 2025, the European airports remain clustered along a high-heavy, very-low-light profile, with Heathrow (EGLL), Paris Charles de Gaulle (LFPG), Frankfurt (EDDF), Istanbul (LTFM), and Madrid (LEMD) maintaining the strongest heavy-aircraft component. In Brazil, the spread is wider: Guarulhos (SBGR), Galeão (SBGL), and Campinas (SBKP) continue to anchor the heavier end of the Brazilian group, while Eduardo Gomes (SBEG), Salvador (SBSV), Brasília (SBBR), Porto Alegre (SBPA), and Curitiba (SBCT) retain a visibly higher light-aircraft component. The 2023 to 2025 movement therefore reinforces the interpretation that the difference is structural rather than a temporary annual fluctuation, even as local changes are visible at airports affected by network adjustments and demand recovery.

3.5 Summary

This chapter provided a comprehensive overview of air traffic dynamics across Brazil and Europe, covering both network-wide and airport-level perspectives.

The data confirms that Brazilian air traffic has surpassed pre-pandemic levels, reflecting a phase of real growth, while Europe continues a gradual recovery, marked by strong seasonal peaks and a more fragmented network structure. If current trends persist, Europe is expected to return to pre-pandemic traffic levels by 2025/2026, particularly driven by robust summer activity and the continued normalisation of regional and international demand. Despite these differences, both regions show signs of stability and resilience, even when affected by disruptions such as extreme weather or regulatory adjustments. Events like the prolonged closure of Porto Alegre (SBPA) and restrictions at Santos Dumont (SBRJ) highlighted the sensitivity of localized operations and the capacity of the network to adapt.

At the airport level, Brazilian traffic remains highly concentrated in a few major hubs, whereas European operations are more spread across several national gateways. This reflects the historical evolution of the European network with a high number of national hubs across its member countries. At the same time, the pattern shows a tremendous growth opportunity for Brazil as continual growth can serve as a motor for higher levels of interconnectivity. While the Brazilian system shows a steady "all-year" demand pattern, there is a pronounced seasonal pattern in Europe typically culminating during the summer holiday season.

The peak day analysis complemented the annual view by illustrating the operational limits reached under maximum demand. Although volumes remained stable overall, individual airports showed notable variations—either from growth, as in SBGL and SBCF, or contraction, as seen in SBRJ. European peak service rates show the overall recovery pattern and first signs of reaching the available capacity for the major hubs.

Finally, the fleet mix analysis reinforced the structural differences in how each region operates: Brazil shows a higher presence of light aircraft in some regional airports and a centralised model for long-haul traffic. Light-type traffic at the study airports in Europe remain the exemption and are typically routed to nearby smaller regional airports. A higher share of heavy aircraft is observed at the top-European airport in this study. This roots as well in the historical evolution with many European states operating their own flag carriers and global connections. The wider spread of international connections across all chosen airports shows a less centralised global connectivity model.

Together, these findings establish a base to understanding the operational performance indicators in the next chapters.

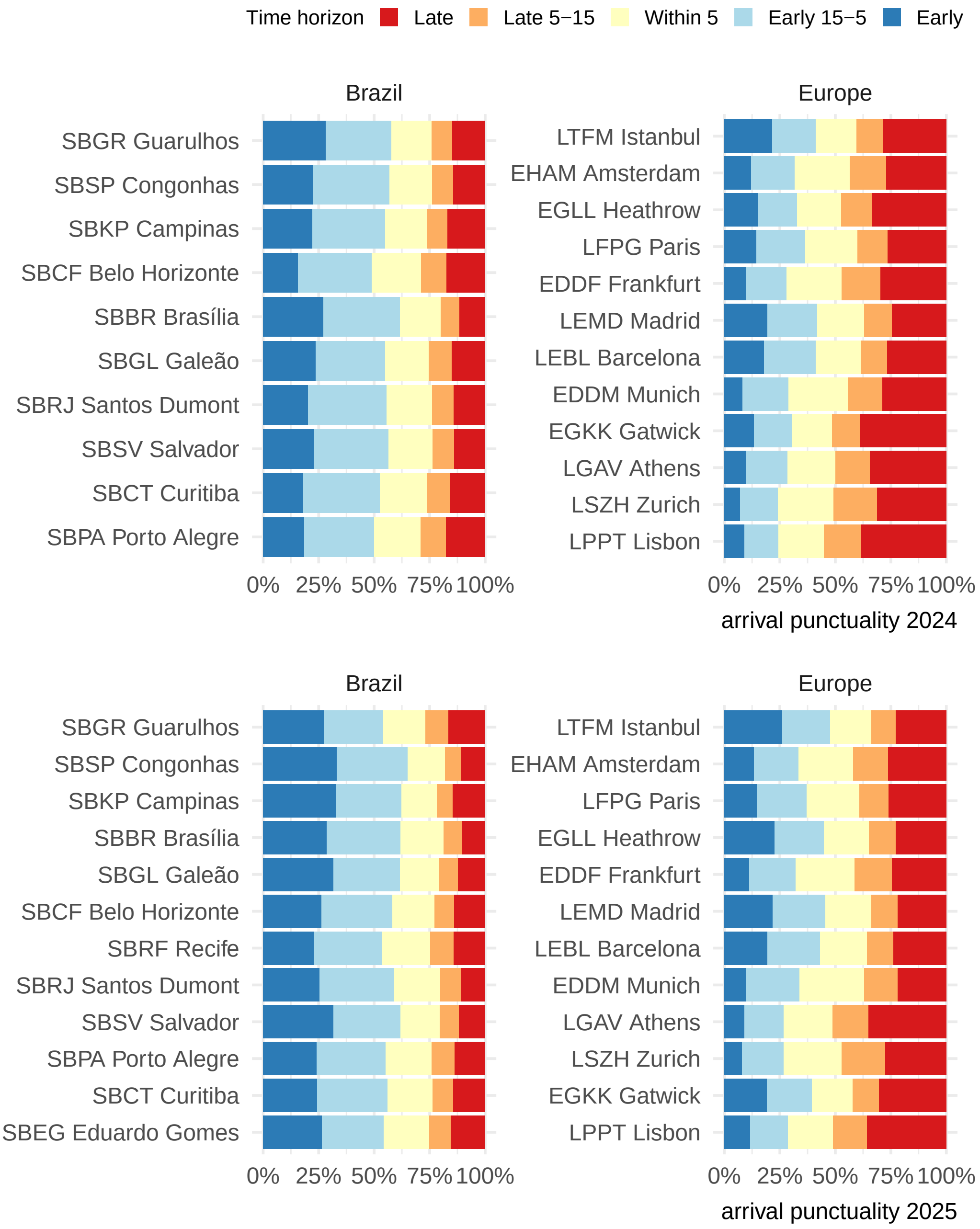
4 Predictability

The preceding sections have demonstrated that both air navigation systems exhibit unique reactions to the broader developments in air transport. Predictability plays a crucial role in these systems, impacting their functioning during both the strategic phase, where airline schedules are formulated, and the operational phase, where Air Navigation Service Providers (ANSPs) and stakeholders manage the delicate balance between demand and capacity. Enhanced predictability stands to be advantageous for ANSPs, mainly when serving airspace users, as it contributes to highly efficient operations, even during periods of peak demand. This chapter focuses on arrival and departure punctuality observed at the study airports as a driving factor for predictability.

4.1 Arrival Punctuality

The arrival punctuality shows the predictability of landing operations at airports, based on the scheduled in-block time (SIBT). It considers a 15-minute window for early or late arrivals and expresses the percentage of flights arriving at the gate within that margin.

Figure 4.1a shows the 2025 data and reaffirms key structural differences in punctuality behaviour between Brazilian and European airports. Brazilian airports continue to report a high share of early arrivals, with 29% of flights arriving more than 15 minutes ahead of schedule across the study airports. This represents an increase from 23% in 2024 and reinforces the schedule-buffering point. In contrast, early arrivals accounted for 16% of European arrivals. This pattern, observed consistently over recent years, reflects the use of built-in buffer times in Brazil's scheduling practices. While these buffers help airlines improve on-time performance records, they can reduce predictability and complicate planning for air traffic management and airport operations.



(a) Evolution of arrival punctuality at study airports (2024 vs 2025)

Compared to Brazil, Europe observed a high level of delayed arrivals in 2025. Across the European study airports, 26% of arrivals were more than 15 minutes late. This nevertheless marks an improvement against 2024, when 30% of European arrivals were delayed by more than 15 minutes. The highest share was observed at LPPT, where 36% of arrivals were late. Capacity constraints on the European network level - amplified by local constraints - rippled throughout the whole network and contributed to the poor overall delay performance.

Across both regions, the share of flights arriving within the -/+ 15 minute window remains the key measure of operational predictability. In 2025, 58% of Brazilian arrivals and 58% of European arrivals were within this interval. For Europe, this share increased from 56% in

2024.

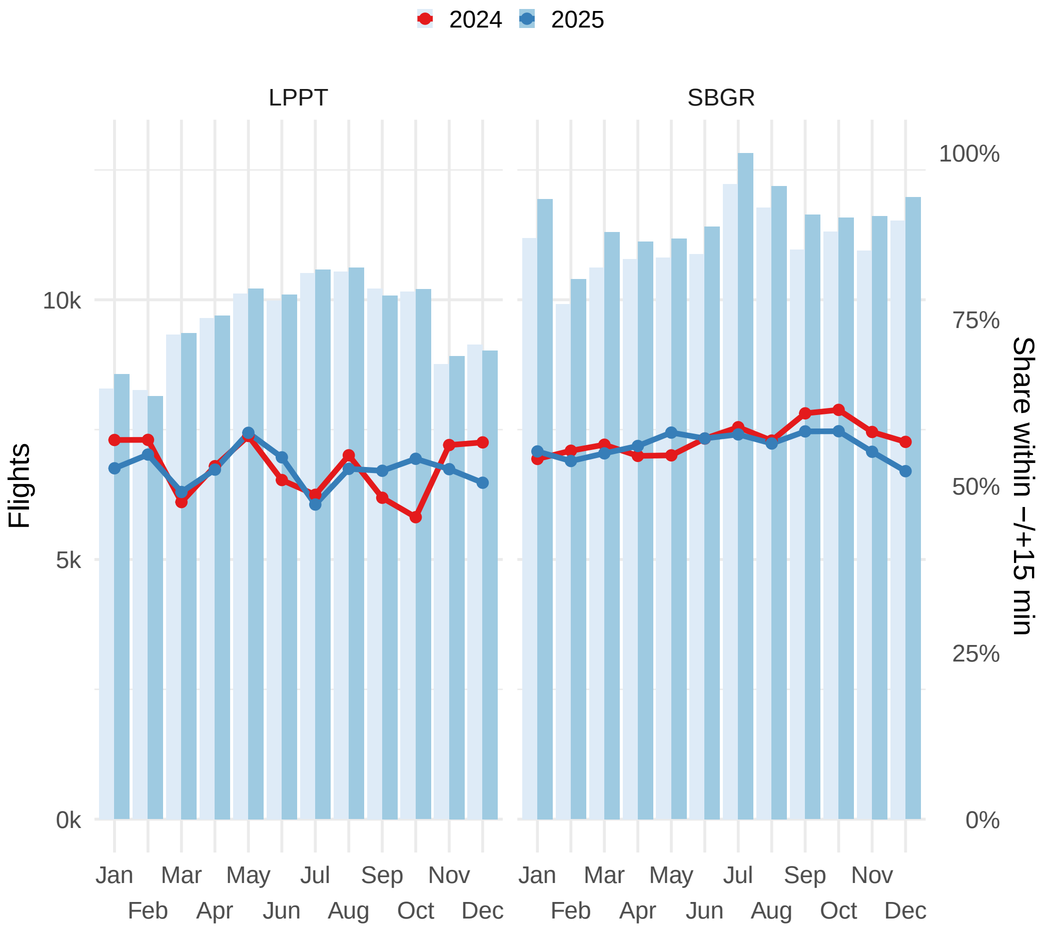


Figure 4.2: Total flights and arrival punctuality at two comparison study airports

To contextualise regional contrasts, Figure 4.2 presents a side-by-side comparison between Guarulhos (SBGR) and Lisbon (LPPT) between 2024 and 2025. Despite LPPT handling less traffic compared to SBGR, it continued to show a lower share of arrivals within the -/+15 minute window. Compared to Figure 4.1a it is interesting to note - broadly assuming an average annual arrival punctuality of 50% of flights arriving between -/+15 minutes of their scheduled time - that the share of early and late arrivals is more balanced at SBGR, while LPPT observed a high share of late arrivals.

This comparison underscores how operational structure, traffic complexity, and scheduling strategies directly influence punctuality outcomes. In Brazil, concentrated demand at a few major hubs - especially SBGR, the country's busiest airport - makes it harder to sustain performance within the target window. The higher level of traffic can amplify network disruptions leading to a high share of delay across all airports and ripple effects propagate through the network.

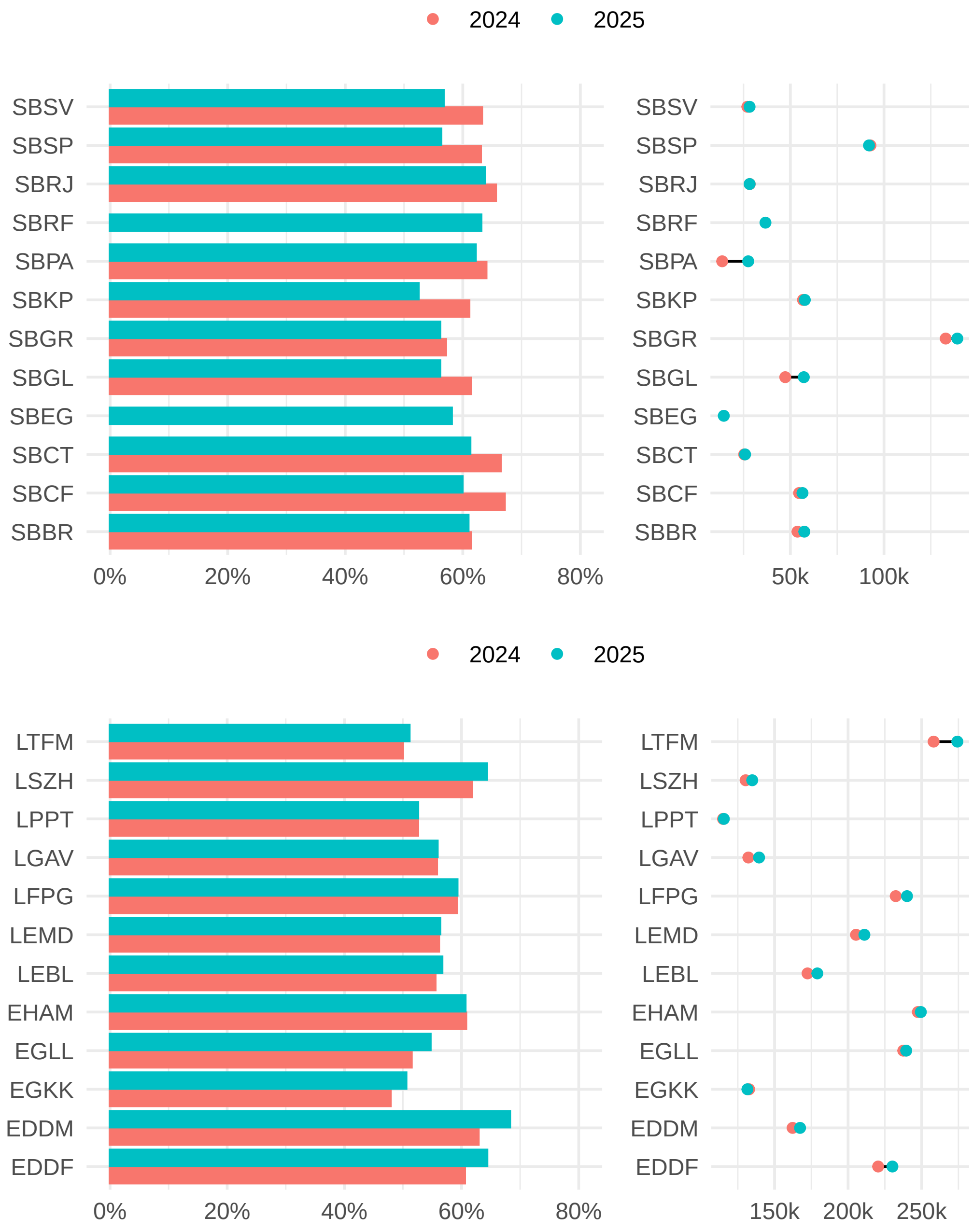


Figure 4.3: Evolution of arrival punctuality -/+15 min vs arrival traffic

Figure 4.3 presents a side-by-side view of airport-level arrival punctuality and movement evolution between 2024 and 2025. While differences exist in the share of early and late arrivals, the number of flights arriving within -/+15 minutes of their scheduled time ranged higher in Brazil than in Europe. The majority of European arrival operations at the study airports failed to meet a 60% threshold. This is contrasted by the higher success rate observed across the Brazilian study airports, though the high early-arrival shares show that predictability still differs from punctuality as perceived by passengers.

The previous section highlighted the overall arrival punctuality observed at the study airports. Lower levels of punctuality can negatively impact predictability of operations and thus put a stronger strain on resources managing the arrival flow. Next to the arrival airspace capacity, stronger variations of the scheduled arrival times pose challenges for the surface management, as taxi operations, including stand allocation and availability, might result in changes of the taxi patterns, queuing within the taxiway and apron/stand system.

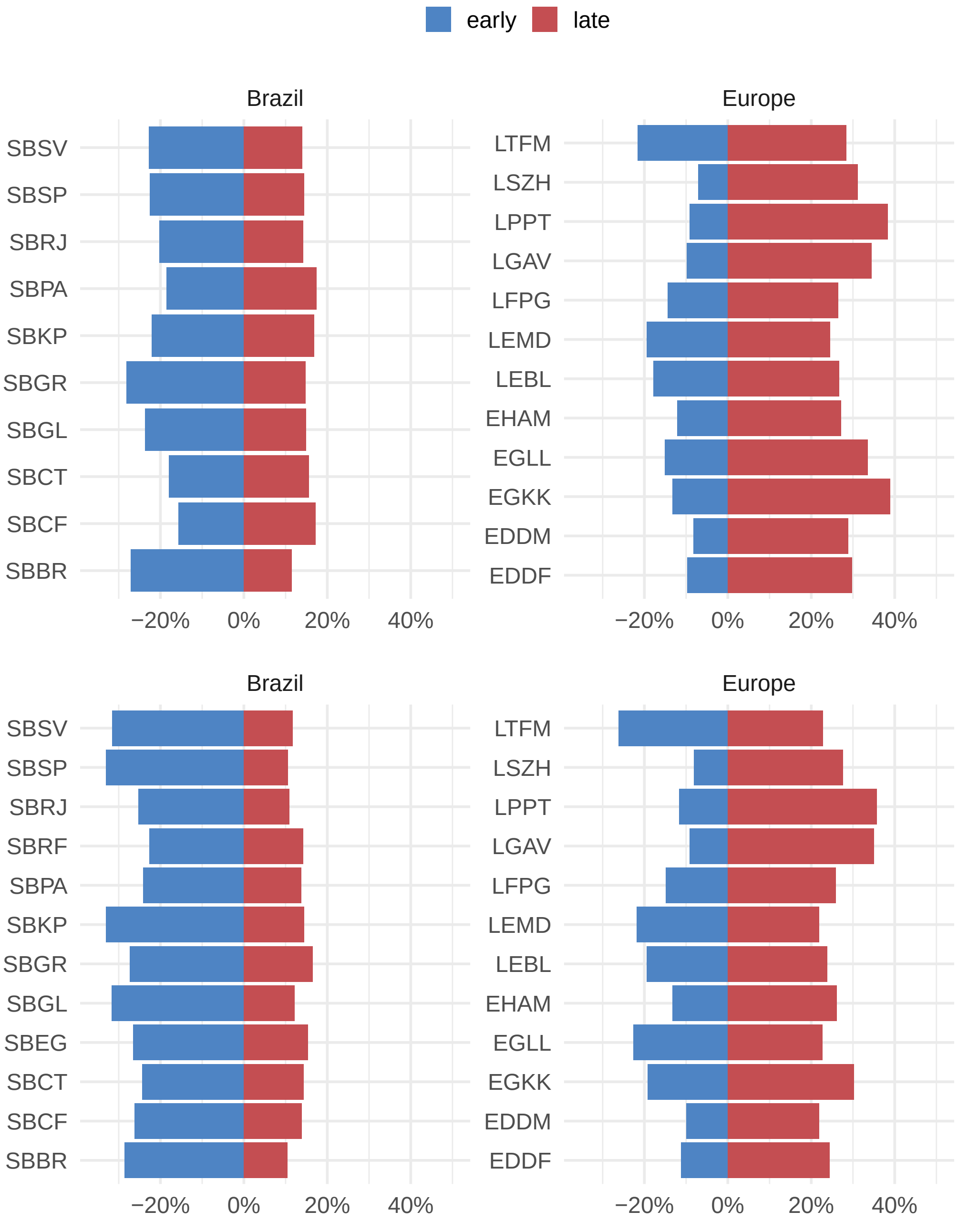


Figure 4.4: Change of share of early and late arrivals (2024 vs 2025)

Figure 4.4 compares the share of early and late arrivals at each study airport, considering arrivals more than 15 minutes ahead of or behind schedule in 2024 and 2025. From a broader perspective, air traffic in Brazil continues to show a tendency toward early arrivals, while in Europe, delayed arrivals are more prevalent. Thus, it appears that Brazilian operators tend to apply conservative buffering of their arrival schedules. The network level implications on the arrival punctuality in Europe throughout 2024 and 2025 can be clearly seen.

SBSP remained the Brazilian airport with the highest share of early arrivals in 2025, with 33% of flights landing ahead of schedule. As a key hub in Brazil's network, this may reflect a deliberate strategy by airlines to better manage connections and mitigate delays within their own schedules. However, from a flow management perspective, this lack of precision poses operational challenges, as it complicates the allocation of resources and the sequencing of arrivals within controlled airspace and on the ground.

In Europe, delayed arrivals remain the dominant off-schedule pattern. There is a varied explanation of the overall poor arrival punctuality performance across the airports. It is important to understand that disruptions stemming from the transition from pandemic to post-pandemic, and the overall network capacity constraints amplified each other. Airport operators were identified as the major contributors to primary delays, followed by ATFM delays. However, the aforementioned reactionary effect was the main driver of knock-on delays (EUROCONTROL Central Office of Delay Analysis 2023) [1].

4.2 Departure Punctuality

The departure punctuality reflects the predictability of take-off operations at monitored airports. It is based on the comparison between the scheduled off-block time (SOBT) and the actual off-block time (AOBT), using a 15-minute tolerance window for early or late departures. The indicator expresses the percentage of flights that leave the gate within this time margin.

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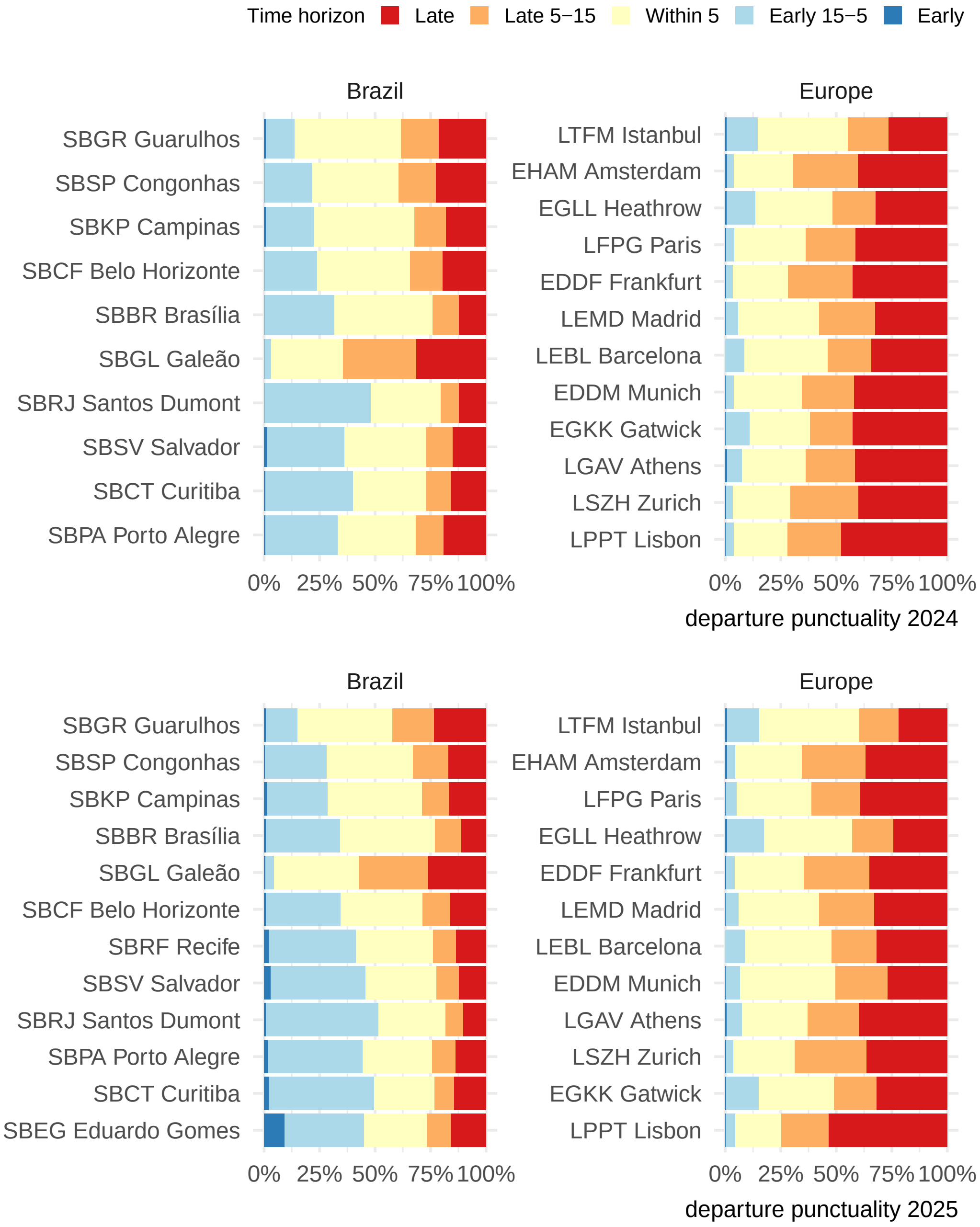
[1] See CODA report at https://www.eurocontrol.int/publication/all-causes-delays-air-transport-europe-annual-2022.



(a) Evolution of departure punctuality at study airports (2024 vs 2025)

Figure 4.5a presents the departure punctuality results for the study airports. The 2025 data show that, overall, airports perform better in managing outbound traffic, although challenges remain. Different from arrival punctuality, where Brazilian airports showed a high share of early arrivals and wide variability across the network, departure punctuality metrics appear comparatively stronger, especially in terms of flights departing within the punctuality (-/+ 15 min) time window.

Departure punctuality appeared higher in Brazil in 2025 than in Europe. The share of departures within the -/+15 minute window reached 81% across the Brazilian study airports compared with 66% across the European study airports. The European value improved materially from 62% in 2024, but still indicates that about one third of departures remained outside the punctuality window. Further research may help to clarify the factors driving this phenomenon.

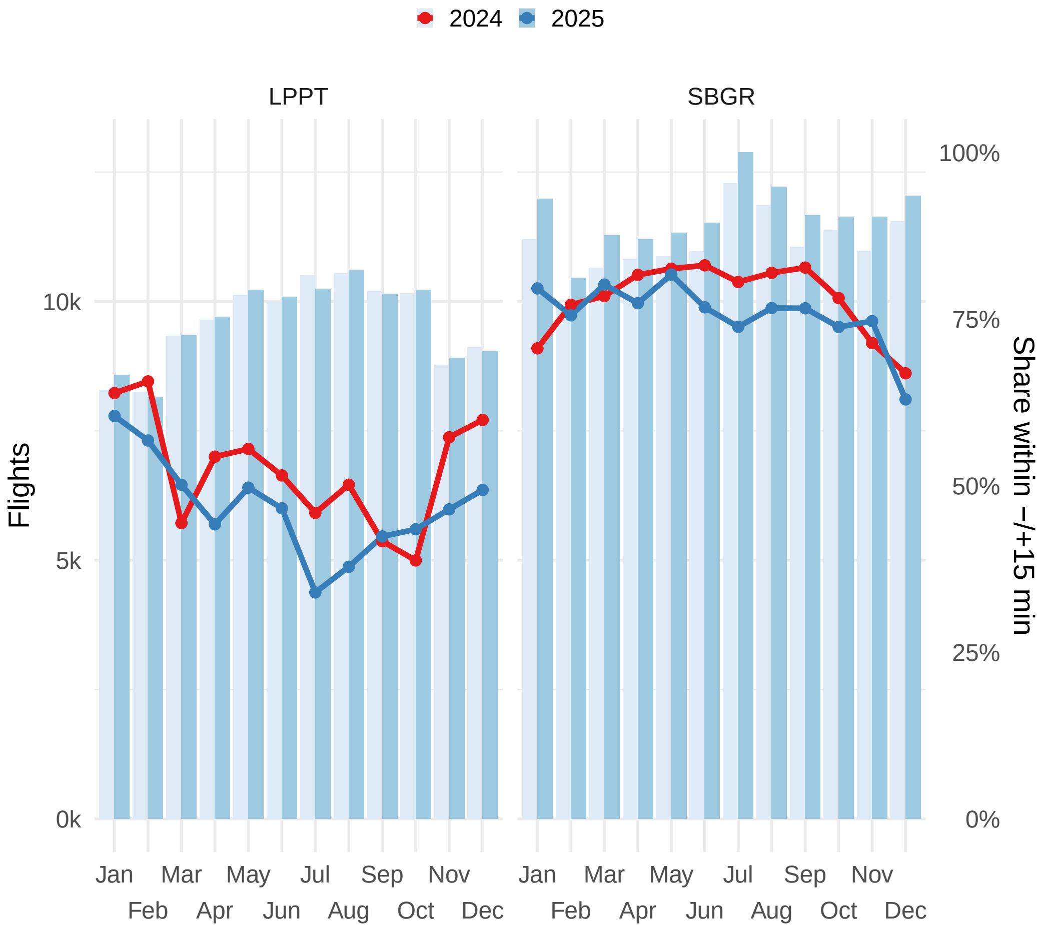


Figure 4.6: Departure punctuality at two comparison study airports

Comparing the observed punctuality performance for departures at Lisbon (LPPT) and Guarulhos (SBGR), c.f. Figure 4.6, depicts the lower level of departure punctuality at LPPT. It appears that the punctuality performance followed broadly the seasonal development. This is in line with the earlier commentary on the network level effects impacting the overall delay situation through increased reactionary delays driven by significant ATFM delay constraints. The departure performance observed at Guarulhos is in line with the arrival punctuality pattern showing the same behaviour across 2024 and 2025.

The preceding section highlighted how the general traffic conditions in the previous years influenced the dependability of arrival schedules. In this section, we assess the degree of departure punctuality measured as the difference between the scheduled departure versus the observed actual off-block time. Figure 4.7 shows the overall departure punctuality at Brazilian and European airports in 2024 and 2025.

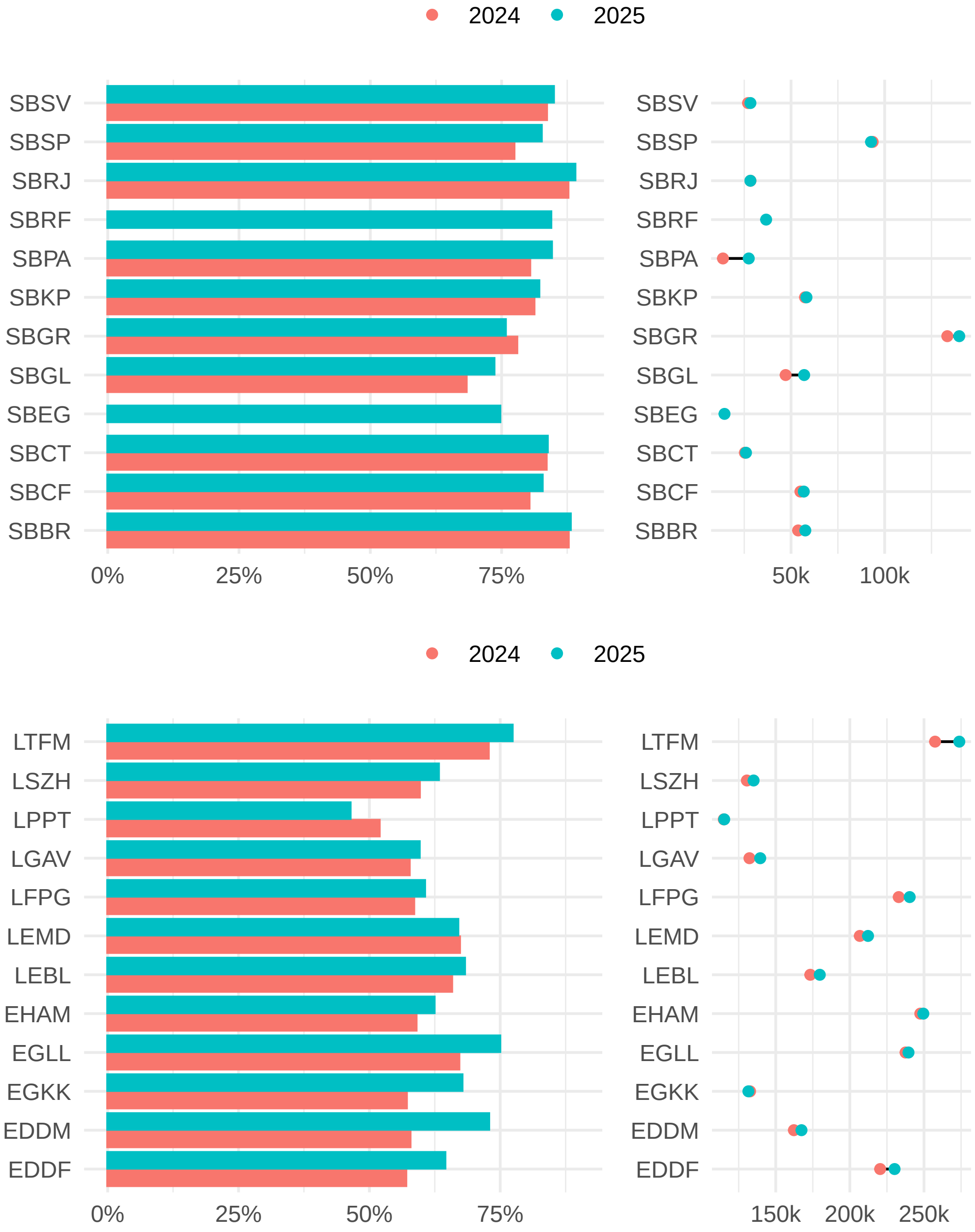


Figure 4.7: Evolution of departure punctuality -/+15 min vs departure traffic

In analogy to the previous section, Figure 4.7 shows a side-by-side view of departure punctuality and movement evolution between 2024 and 2025 for each of the study airports.

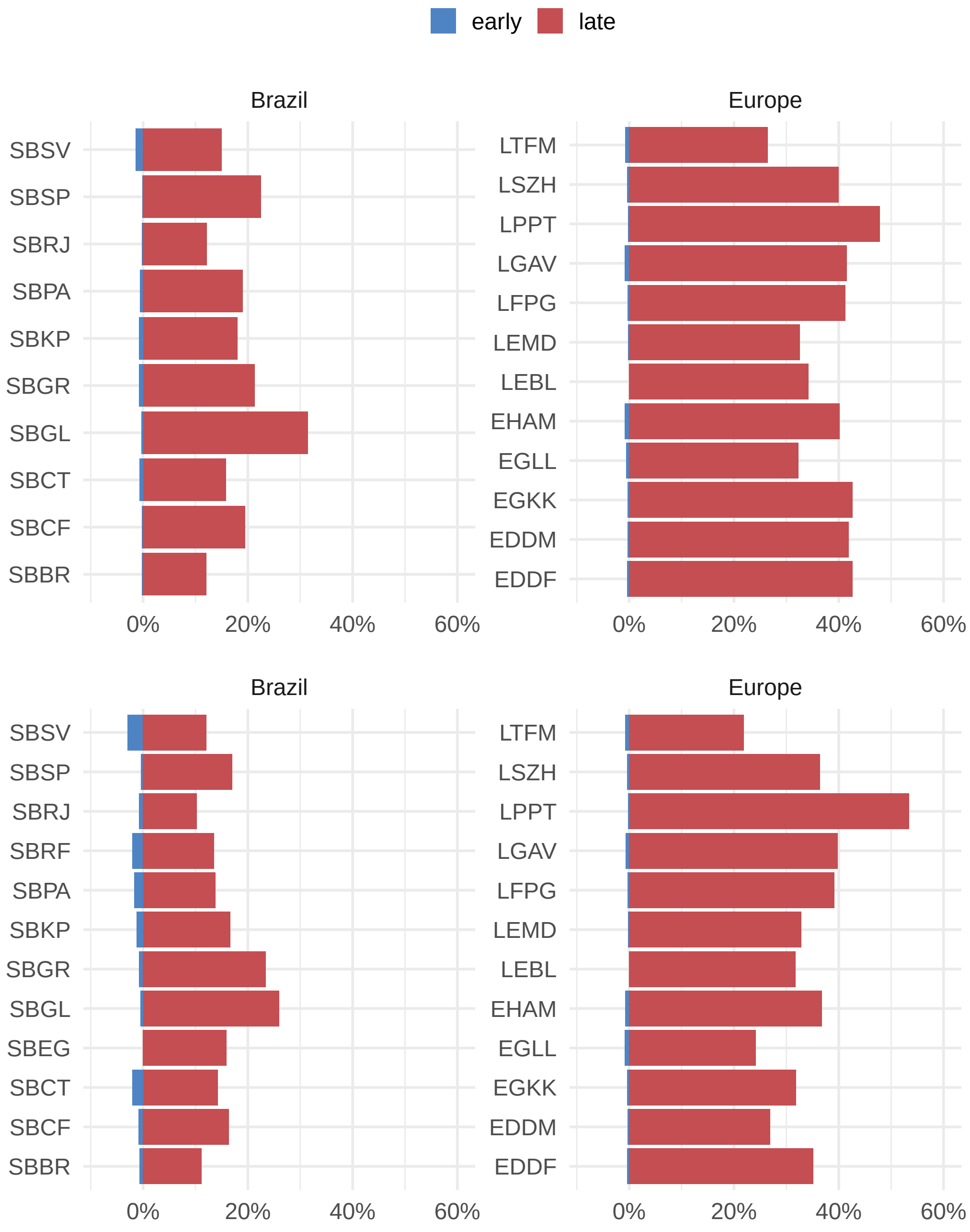


Figure 4.8: Change of share of early and late departures (2024 vs 2025)

The change of the share of early and late departures in 2024 and 2025 is shown in Figure 4.8. The observed departure punctuality at Brazilian and European airports demonstrates a positive operational behaviour: early departures before scheduled time are relatively small in both regions, which is favourable for maintaining schedule stability.

In Brazil, the patterns observed in 2024 and 2025 are notably similar across the study airports, indicating consistent operational practices. Despite this, most Brazilian airports maintained a balanced distribution, with a large proportion of flights departing within the -/+ 15-minute window.

There is stark contrast in terms of overall departure punctuality between Brazil and Europe. In Europe, 33% of departures were more than 15 minutes late in 2025. The highest share was observed at LPPT, where 53% of departures were late. Lisbon (LPPT) is therefore the strongest departure outlier in 2025 and provides a concrete anchor for the comparison with Guarulhos (SBGR). The amplification effect is evident. Delayed departures for regional flights will ultimately cause downstream delays. Disrupted schedules pose challenges to the local capacity management and surface operations. However, they also contribute to challenges of flow control on the network level. The associated imbalances influenced negatively the overall network sequencing and flow management.

While surface movement operations appear stable at most airports, the growing share of late departures at specific locations signals the need for continuous monitoring and management interventions to assure the predictability of operations.

4.3 Summary

Arrival and departure punctuality play an important role in terms of balancing demand and capacity.

Arrival punctuality revealed distinct regional patterns. Brazilian airports continued to show a high share of early arrivals, largely due to the use of built-in buffer times in flight schedules. While this improves on-time performance metrics, it complicates air traffic management by reducing predictability. In contrast, European airports generally maintained lower shares of early arrivals and a higher share of delayed arrivals. A closer operational comparison of the behaviour at Guarulhos (SBGR) and Lisbon (LPPT) highlighted the challenges faced by large, high-density hubs in sustaining punctuality under growing demand.

Departure punctuality showed a distinct difference between both regions and when compared to the wider spread of the arrival punctuality. Early departures remained relatively rare, supporting schedule stability. However, challenges persisted at European airports where late departures remained high. Overall, the departure punctuality in Europe was poor compared to Brazil. These patterns emphasize how local operational and network constraints, weather disruptions, and surface management practices directly influence performance.

In both regions, maintaining high predictability levels remains critical to support efficient surface operations, arrival sequencing, and passenger experience. Continuous adaptation, proactive operational planning, and effective resource management are essential to sustain and improve predictability, especially as traffic demand continues to grow. As both regions are committed to move toward trajectory-based operations, the management of highly predictable air traffic flows will require attention.

5 Capacity and Throughput

Maintaining an optimal network flow necessitates an equilibrium between airport capacity and flight demand. This section delves into assessing capacity and throughput using various key performance indicators (KPIs) at the airport level. Airspace users expect sufficient capacity provision addressing the levels of demand. With higher levels of capacity utilisation, airspace users will experience congestion and constraints (e.g. higher inefficiency, increased delay/lower punctuality and predictability). However, planning and staffing for peak situations may come at significant costs to airspace users as well. In that respect it is essential to understand the trade-off between capacity provision and capacity consumption (i.e. traffic demand) as it impacts the overall system performance. Capacity and throughput analyses therefore show to what extent air navigation services are capable of accommodating the demand. The previous sections showed the level of overall traffic recovery in both regions. The increasing demand put strain on the systems and local knock-on effects amplified the uncertainty and variability of the expected traffic levels. This chapter may therefore also highlight the flexibility of air navigation services to accommodate such distortions of the schedule.

5.1 Peak Declared Capacity

Peak Declared Capacity refers to the highest movement rate (arrivals and landings) at an airport using the most favourable runway configuration under optimal conditions. The capacity value might be subject to local or national decision-making processes. The indicator represents the highest number of landings an airport can accept in a one-hour period.

In both regions, peak capacity is declared by the respective authority. In Brazil, this function is performed by DECEA. Within the European region, the airport peak capacity is determined on a local or national level. The processes consider local operational constraints (e.g. political caps, noise quota and abatement procedures) and infrastructure related limitations (e.g. apron/stand availability, passenger facilities).

The capacity of airports (and the associated runway system) is predominantly influenced by their infrastructure. The existence of independent parallel runways, e.g. Brasilia (SBBR) and Munich (EDDM), can support decisively the resulting capacity. Furthermore, operational procedures can lead to an increase in airport capacity. London Heathrow (EGLL), in the past, and Guarulhos (SBGR) in recent years show that changes in operational procedures can help the airport absorb significant traffic increases or reduce the additional sequencing time in the terminal airspace. Guarulhos, for example, benefited from the implementation of segregated operations under VMC conditions, and Heathrow increased its capacity through the introduction of time-based separation on final.

Previous reports showed the relatively stable nature of the overall peak declared capacity. It is anticipated that future changes to the overall capacity level will depend on changes to the declaration process or significant changes of the operational concepts. Accordingly, this edition works with the most recent declared maximum (global) capacities for each study airport.

Figure 5.1 shows the declared peak capacity for the study airports. As observable in the case of Amsterdam Schiphol (EHAM, 6 runways), the number of runways is not a direct indication of the maximum capacity. For example, the two-runway airports Brasilia (SBBR), London Heathrow (EGLL), and Munich (EDDM) share a similar runway system layout and range above the 3-runway systems of Barcelona (LEBL) and Zurich (LSZH). London Gatwick (EGKK) is renowned for its maximisation of its single-runway throughput. Please note that Lisbon (LPPT) was added to this comparison report and capacity values for earlier years were not available at the time of writing.

As mentioned above, the capacity declaration/determination process takes into account the varying local conditions and constraints. It balances the need to accommodate growth vs policy priorities and public interests. A potential area for further research could be a closer investigation of the operational concepts deployed and the variations of the declared capacity with the local runway system characteristics.

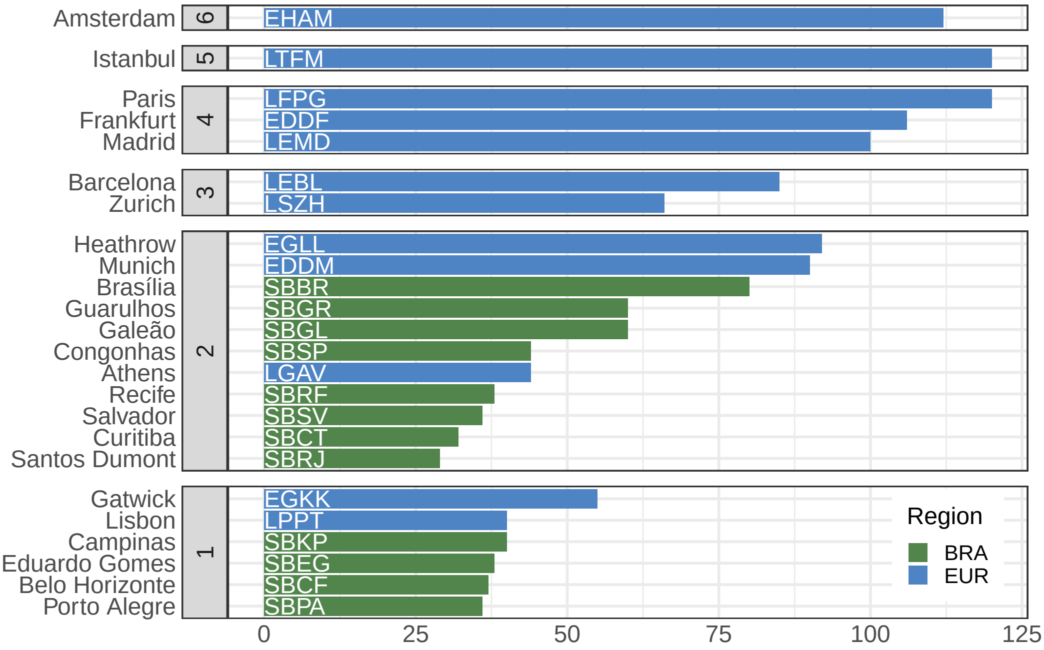


Figure 5.1: Peak declared capacity 2025 [flights/hour]

5.2 Peak Arrival Throughput

This comparison report uses the GANP KPI to measure the peak arrival throughput as the 95th percentile of the hourly number of landings observed at an airport (ICAO 2019). The measure gives an indication of the achievable landing rates during "busy-hours". It is an indication to what extent arrival traffic can be accommodated at an airport. For congested airports, the throughput provides a measure of the effectively realized capacity. Throughput is a measure of demand and therefore comprises already air traffic flow or sequencing measures applied by ATM or ATC in the en-route and terminal phase. For non-congested airports, throughput serves as a measure of showing the level of (peak) demand at this airport.

Figure 5.2 compares the observed annual peak arrival throughput at the study airports in Brazil and Europe. On average, the busiest hour of the Brazilian airports under study did not suffer a significant reduction. This signals that peak arrival demand remained fairly constant during the pandemic. An increased arrival peak throughput was serviced at Brasilia (SBBR), Guarulhos (SBGR), and Confins (SBCF). Services at Galeão (SBGL) observed a significant shift in the traffic pattern. The peak arrival throughput fell sharply with the pandemic and has not yet recovered. This overall picture is contrasted by the pandemic related drop of overall traffic at European airports. The overall reduction resulted in significantly lower peak hours. The recovery pattern is also visible in the peak arrival throughput behaviour.

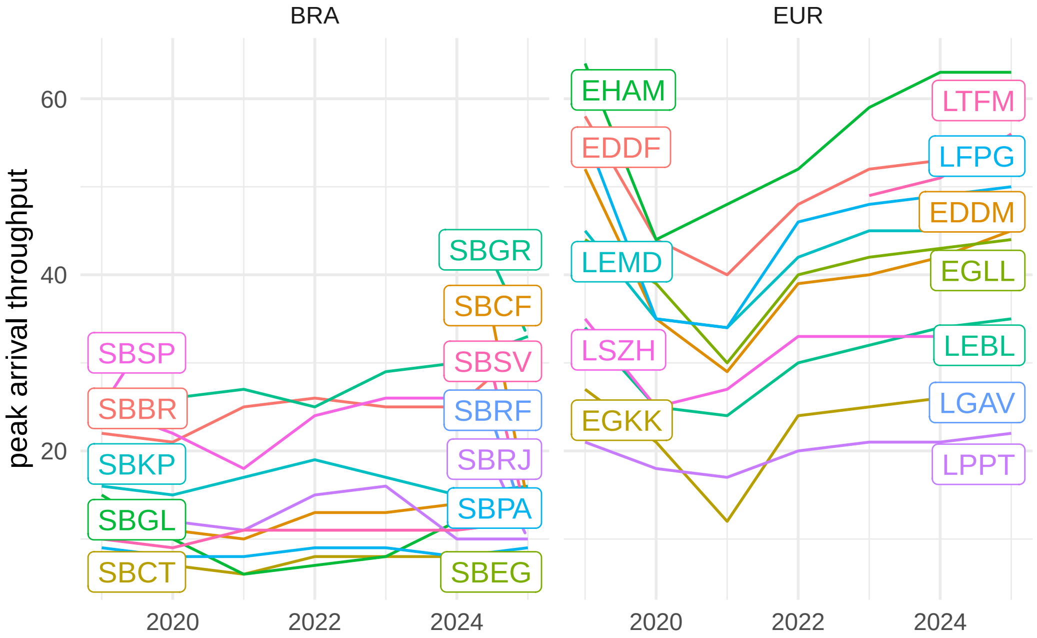


Figure 5.2: Evolution of annual arrival throughput at study airports

With Figure 5.2, a further difference between both regions becomes apparent. The peak arrival throughput represents the achieved peak service rate utilising the available arrival runway system capacity. On average, the peak arrival throughput is higher in Europe than in Brazil based on the available infrastructure. It is interesting to see that arrival operations at SBGR and Brasilia (SBBR) range at the level of Gatwick (EGKK), while Congonhas (SBSP) remains above Lisbon (LPPT). At the same time, it offers growth potential when these airports are compared to the achievable arrival throughput at dual independent runway operations at Munich (EDDM) or even Heathrow (EGLL).

While the peak arrival throughput varied in Brazil over the past years, the pattern is more homogeneous. Larger variations are explainable with local demand changes. However, compared to Europe, Brazil did not show the scale effects of lower air traffic demand during the pandemic phase. In light with the overall traffic recovery also the pressure on the arrival runway system increased at the European airports. Lisbon (LPPT) shows a level of variation. This suggests that even during the pandemic, operational peaks were serviced consistently at the same level.

5.3 Peak Departure Throughput

In analogy to the previous section, Figure 5.3 shows the peak departure throughput. The latter is determined as the 95th percentile of the hourly number of departures.

A similar picture emerges for the peak departure throughput in both regions. In Brazil, Congonhas reduced the peak departure throughput in comparison with 2024. Curitiba, Porto Alegre, Santos Dumont, and Confins maintained broadly the same level as in 2024. For the other Brazilian airports, the peak departure throughput increased. A continual increase of the peak departure throughput is observed at SBGR, exceeding in 2025 the pre-pandemic 2019 level. This suggests a concerted effort and more efficient use of the runway system for the departure phase.

The pattern in Europe is characterised by the continual air traffic recovery for the majority of the airports. A lesser pronounced variation is observed at Lisbon (LPPT) for which the peak departure rate remained fairly stable over the past years.

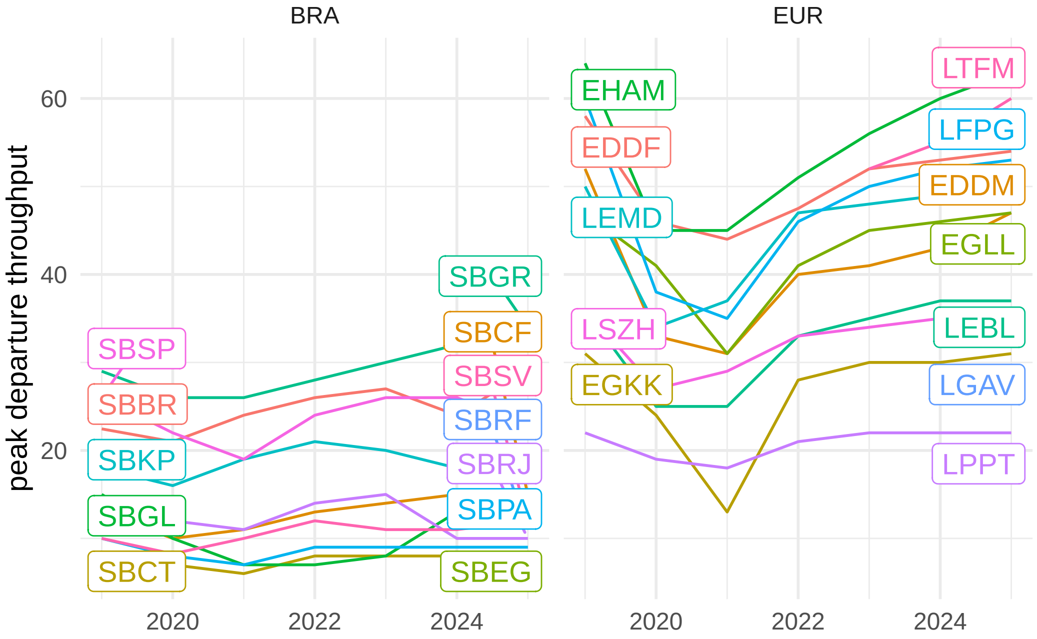


Figure 5.3: Evolution of departure throughput at study airports

5.4 Declared Capacity and Peak Throughput

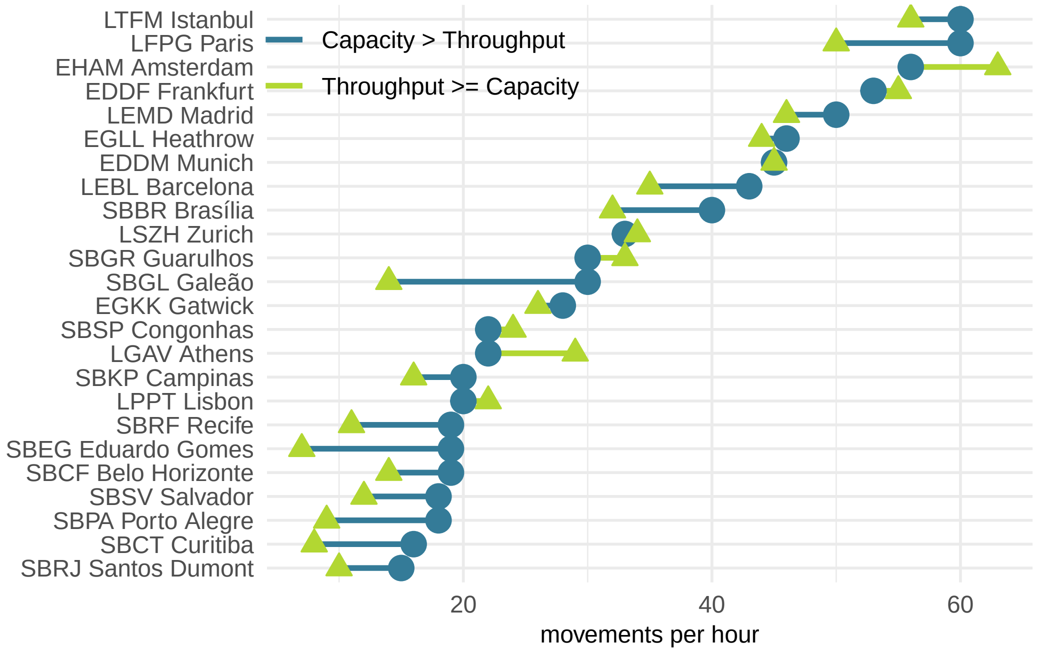


Figure 5.4: Comparison of declared capacity and throughput for arrival phase.

Comparing the peak declared (arrival) capacity and throughput serviced at the different airports reveals a varying picture. On average, Figure 5.4 evidences that operations at the majority of the airports do not yet observe capacity constraints. In many instances, the achieved throughput ranges about 10 flights per hour below the maximum declared capacity. In 2025, a particularly low utilisation was observed at Galeão (SBGL), where the spread between proxy arrival capacity and peak throughput exceeds 15 flights per hour. Further sizeable margins remain visible at Eduardo Gomes (SBEG), Paris Charles de Gaulle (LFPG), Porto Alegre (SBPA), Brasilia (SBBR), Curitiba (SBCT), Recife (SBRF), and Barcelona (LEBL). It is also noteworthy that a subset of airport services operate at or above their proxy maximum arrival capacity (e.g. EHAM, LGAV, SBGR, SBSP, EDDF, LPPT, and LSZH, with EDDM at parity). These airports are also characterised by a combination of complexity of the aerodrome layout and operational context. It will be interesting to study how these airports facilitate higher levels of demand. Higher peak throughput rates than the proxy arrival capacity were observed at Amsterdam (EHAM), Athens (LGAV), Guarulhos (SBGR), Congonhas (SBSP), Frankfurt (EDDF), and marginally at Lisbon (LPPT) and Zurich (LSZH). The offsets at EHAM and LGAV, and to a lesser extent at SBGR and SBSP, suggest that the simplified 50% proxy for arrival capacity can understate what is operationally achievable at some airports. In the case of Amsterdam (EHAM) there is a political cap on the number of operations per year. This may result in a determined (and declared) hourly rate that does strictly speaking not apply to the operational peak situations.

The analysis of the spread of the declared capacity versus the achieved throughput is useful. However, it provides no indication on how often the demand reaches the declared capacity level. For this purpose, this report determines two characteristic points, i.e. the *BLI* base load index, and the peak load index *PLI*.

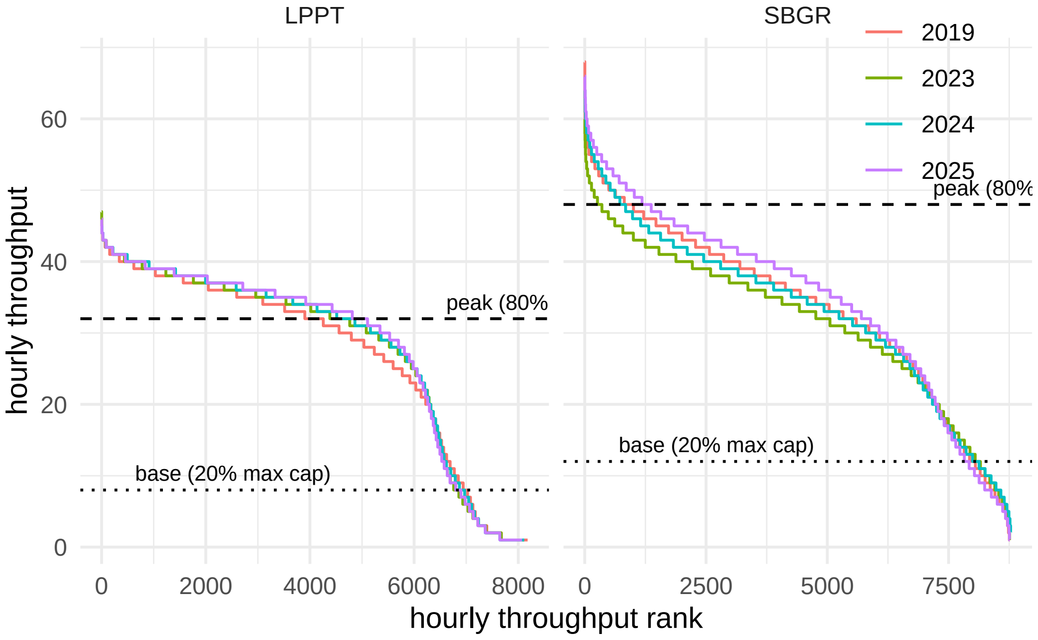


Figure 5.5: Ranked hourly throughput at LPPT and SBGR

Comparing the achieved hourly throughput at Guarulhos (SBGR) and Lisbon (LPPT), the ranked-hourly-throughput example depicts a higher level of peak throughput traffic numbers at SBGR. The overall patterns are similar across the studied years. Lisbon (LPPT) observed an increase in its overall traffic throughputs as the hourly throughputs for 2023 and 2025 exceed the pre-pandemic levels of 2019, with 2024 remaining at a comparable level. Guarulhos (SBGR) experienced a bounce-back with the continual increase in its hourly throughput from 2023 to 2025, bringing the upper part of the ranked curve back closer to the pre-COVID 2019 pattern.

In terms of demand pressure, Lisbon observed a substantially higher share of hours with throughputs above 80% of its declared capacity than SBGR, and this share increased further in 2025. As the overall ordered throughput shows a gradual reduction gradient at Guarulhos (SBGR), combined with a large spread of the peak and base level, there exists available capacity at the airport. Lisbon shows a narrower spread. On top, the existence of night flying restrictions is clearly visible for LPPT with its distribution tail.

The ranked-hourly-throughput example shows that multiple factors influence the interplay between the declared capacity and observed throughputs. Similar to comparing only the number of runways and not the runway system utilisation, focussing on the difference between declared capacities, demand periods and operating conditions does not readily allow to compare operations at different airports. For this report, we define peak operating conditions, if the total hourly throughput reaches or exceeds 80% of the declared capacity levels, and accordingly, base load levels, if 20% of more are observed. The peak load index (PLI) accounts then for the number of operating hours at or above the peak level, and respectively, the base load index (BLI) for hours at or above the 20% base traffic level.

Figure 5.6: Capacity utilisation trajectory (base load index vs peak load index)

Figure 5.7: Capacity utilisation heatmap by region, load index, airport, and year

The BLI/PLI plot summarises the observed utilisation of the available (i.e., declared) capacity at the study airports in the different regions. It shows the full 2019-2025 airport-year trajectory, while labels are limited to automatically selected 2025 airports that mark different parts of the regional load profile: peak pressure, high base load with limited peaks, low utilisation, and peaky imbalance. Based on this report, airports showing a BLI higher than 0.75 observe a consistent level of demand across the operating hours, while congestion due to peak operating conditions starts to become visible around a PLI of 0.3. Lower PLI values suggest concentrated demand banks, while higher levels of the PLI demonstrate a more consistent use of the available capacity. In Brazil, we observe a high utilisation of the capacity at Sao Paulo (SBSP) in 2019, 2023, 2024, and 2025 comparable to or above pre-COVID levels. For a majority of the airport across the years, no substantial peak loads were measured. This suggests that there is substantial capacity to sustain future growth of air traffic. Rio de Janeiro Santos Dumont (SBRJ) observed moderate loads confirming the role of the airport within the Brazilian system. The major hub in Brazil, SBGR, shows a relatively high base-load-index (BLI), while the peak-load-index (PLI) remains far below the levels observed at LPPT or SBSP. Within the European context, a high utilisation of the available system capacity was observed for London Heathrow, Lisbon, Frankfurt, Gatwick, and Zurich, while EDDF and LSZH combine very high base loads with more moderate peak-load conditions. This suggests that for many of these airports the daily traffic loads returned to similar or higher levels of capacity utilisation than pre-COVID. For the majority of European airports, the peak load index ranges relatively low. This suggests that most of the airports operate currently concentrated short peaks or having growth potential available in terms of traffic load.

The heatmap, Figure 5.7, shows the full airport-year detail and infrastructure utilisation across the year. Splitting the base-load and peak-load indices into separate panels makes it easier to scan the evolution of each load characteristic by airport. We observe a solid use of the study airports in both regions in terms of base traffic levels. The lower traffic levels during the main COVID years are well reflected. Grey cells indicate years where the current input data do not yet support a BLI/PLI estimate. Amongst the study airports, there is a higher share of European airports with more peak operating hours than in Brazil. This might be related to the overall role of the airports and underlying connectivity structure and demand levels already described in earlier chapters. Future work on understanding the drivers between operational concepts and demand may reveal further characteristics of the service provision in both systems.

5.5 Summary

This chapter analysed the relationship between airport capacity, throughput, and demand management across Brazilian and European airports.

On average, declared peak capacities at Brazilian airports tend to be lower than in Europe, suggesting greater flexibility to accommodate future traffic growth at major Brazilian hubs. In contrast, many European airports will increasingly depend on novel operational concepts to achieve further gains, as their existing runway infrastructure and separation standards already impose operational limits.

Comparing the utilisation of capacity based on a new indicator revealed interesting patterns. Most airports currently operate with a margin between declared capacity and observed peak throughput, suggesting that, at present, runway system capacities are not a limiting factor in either region.

Notably, in 2025, low utilisation was observed at Galeão (SBGL), Eduardo Gomes (SBEG), and Paris Charles de Gaulle (LFPG), where the spread between capacity and peak throughput remained large. Conversely, São Paulo Congonhas (SBSP), Guarulhos (SBGR), Amsterdam Schiphol (EHAM), and Athens (LGAV) emerged as airports servicing peak arrival rates close to or above the proxy arrival capacity used in this report.

Overall, the findings highlight that while current capacities are sufficient, maintaining system performance amid projected air traffic growth will increasingly depend on operational innovations and efficient management strategies in both regions.

6 Efficiency

Operational efficiency is a critical component in assessing the management and execution of operations. It provides insights into the management of arrival and departure flows and the associated separation and synchronisation activities. Inefficiencies can have an impact on user operations in terms of delays or excessive fuel burn. In light of the previous chapters, it is therefore interesting to study how the available capacity was utilised to service demand during the different flight phases.

The measures reported in this comparison report are based on the observed travel time for surface operations (i.e. taxi-in and taxi-out) and during the arrival phase. These travel times are compared with an associated reference time for a group of flights showing similar operational characteristics. The determined difference (i.e. additional time) measures the level of inefficiency. It must be noted that high performance operations will still yield a certain share of measured additional times. Operational efficiency therefore aims at minimising rather than eliminating these additional times as they cannot be zero.

6.1 Additional Taxi-In Time

The additional taxi-in time measures the travel time of an arriving aircraft from its touchdown, i.e. the actual landing time, to its stand/gate position, i.e. actual in-block time. This elapsed taxi-in time is compared to an anticipated reference time for aircraft arriving at the same runway and taxiing to the same (group of) stand/gate position(s). Research has shown that taxi times are not dependent on the type of aircraft. The additional taxi-in time indicator provides a measure of the management of inbound surface traffic.

For this report, the Brazilian and European taxi-in results are calculated from a harmonised PBWG data extraction format to demonstrate the benefits of global harmonisation. Based on the ICAO GANP guidance, the reference times for both regions are determined from the 2024 sample using the 20th percentile method by airport, phase, runway, and stand/gate position.

6.1.1 Annual Evolution of Additional Taxi-in Times

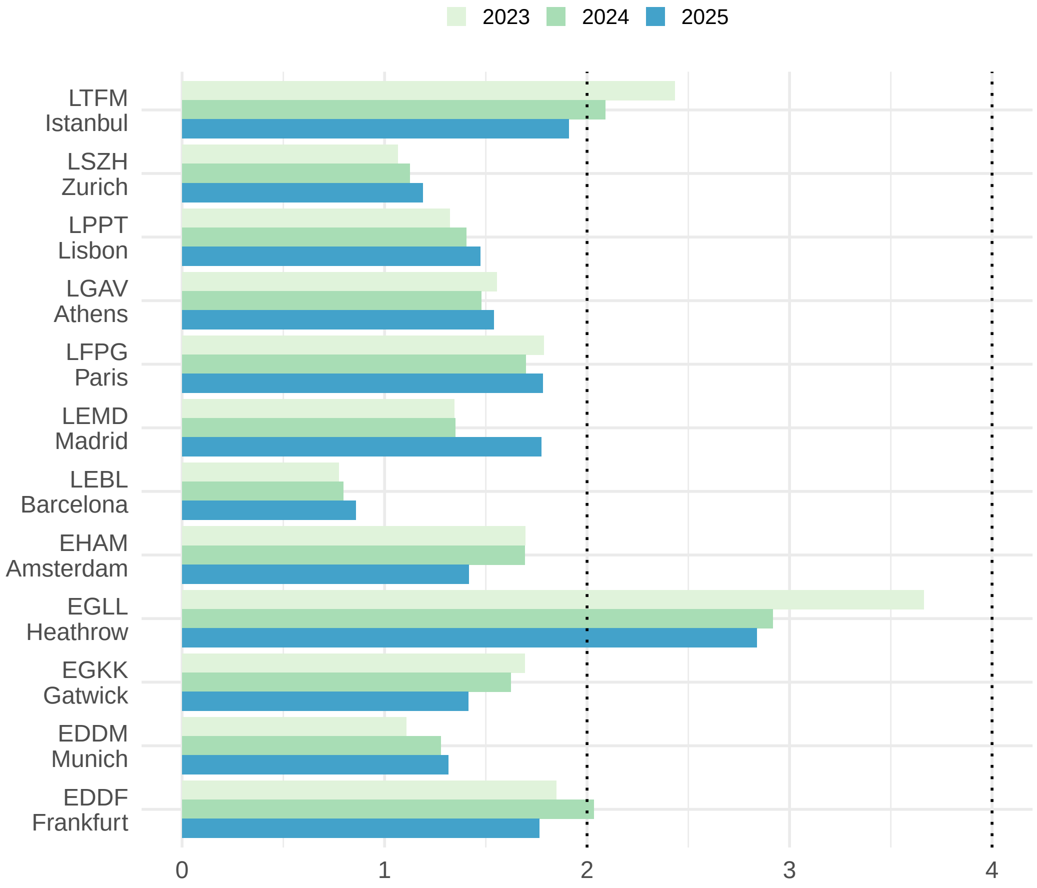


Figure 6.1: Europe - Additional taxi-in time [min/arr] (2023-2025, 2024 GANP p20 reference)

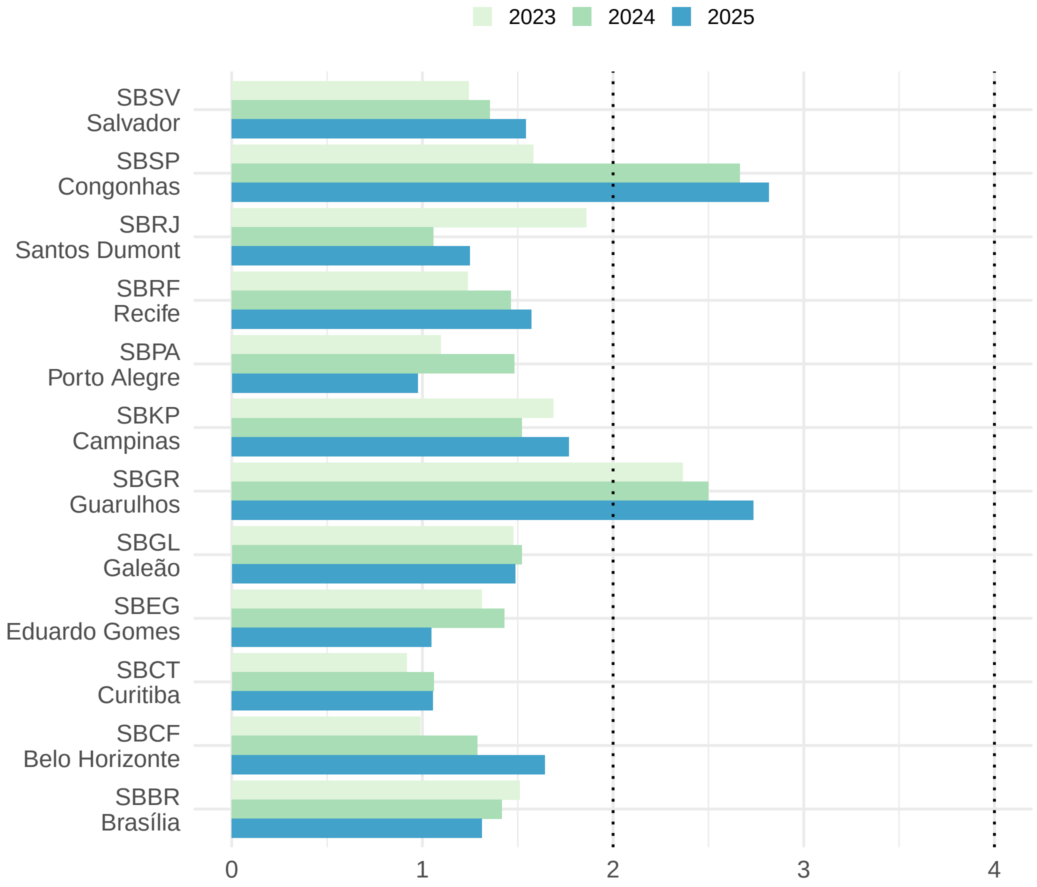


Figure 6.2: Brazil - Additional taxi-in time [min/arr] (2023-2025, 2024 GANP p20 reference)

The annual development of the average additional taxi-in times at the study airports is depicted by Figure 6.1 and Figure 6.2. The 2-minute threshold per arrival continues to serve as a practical reference point for evaluating taxi-in efficiency. This report expands the Brazilian and European airport set to 12 airports: for Brazil, the new entries are Recife (SBRF) and Eduardo Gomes/Manaus (SBEG), and for Europe, Athens (LGAV) and Istanbul (LTFM).

6.1.2 Monthly Variation of Additional Taxi-in Times

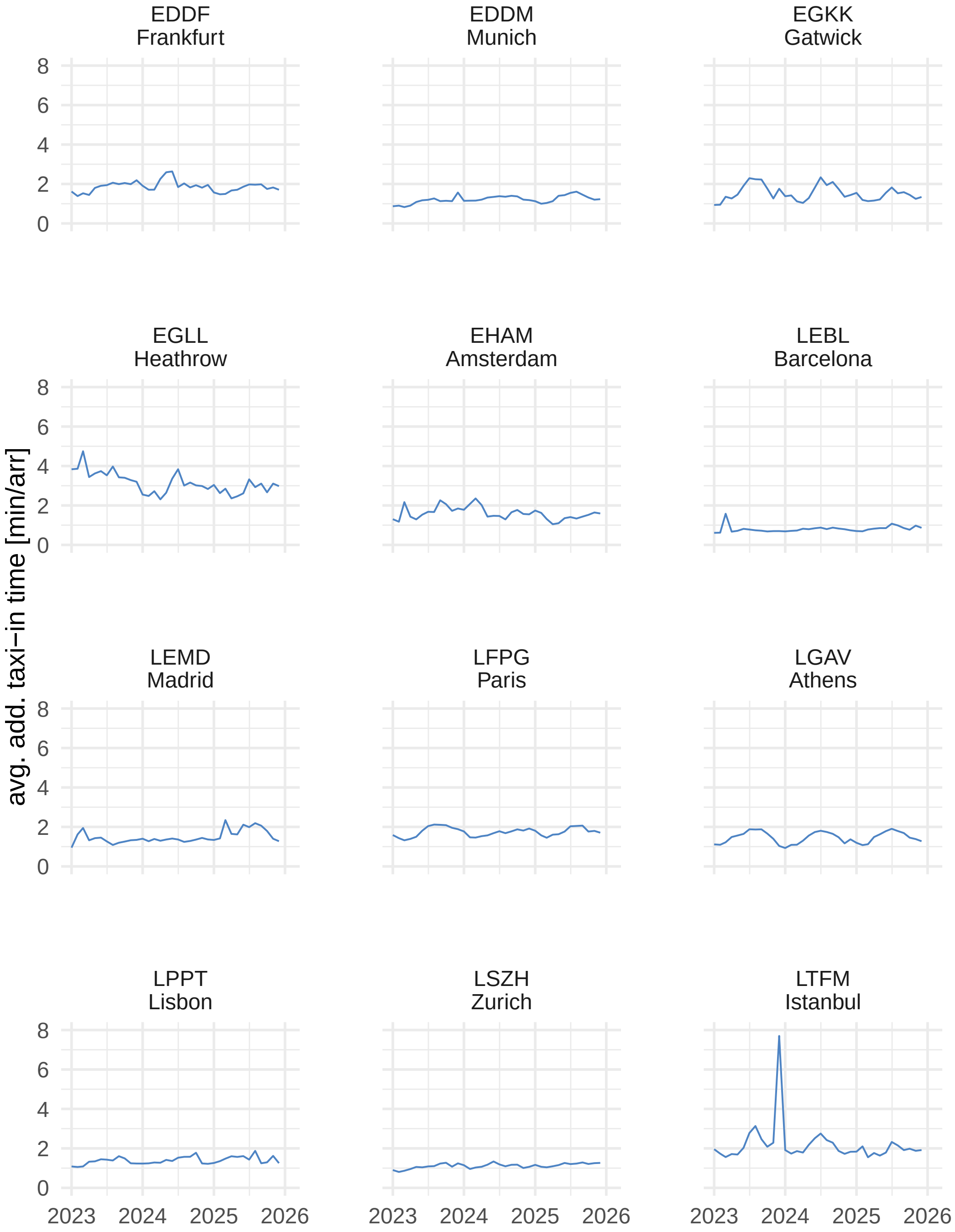


Figure 6.3: Europe - Monthly evolution of average additional taxi-in time

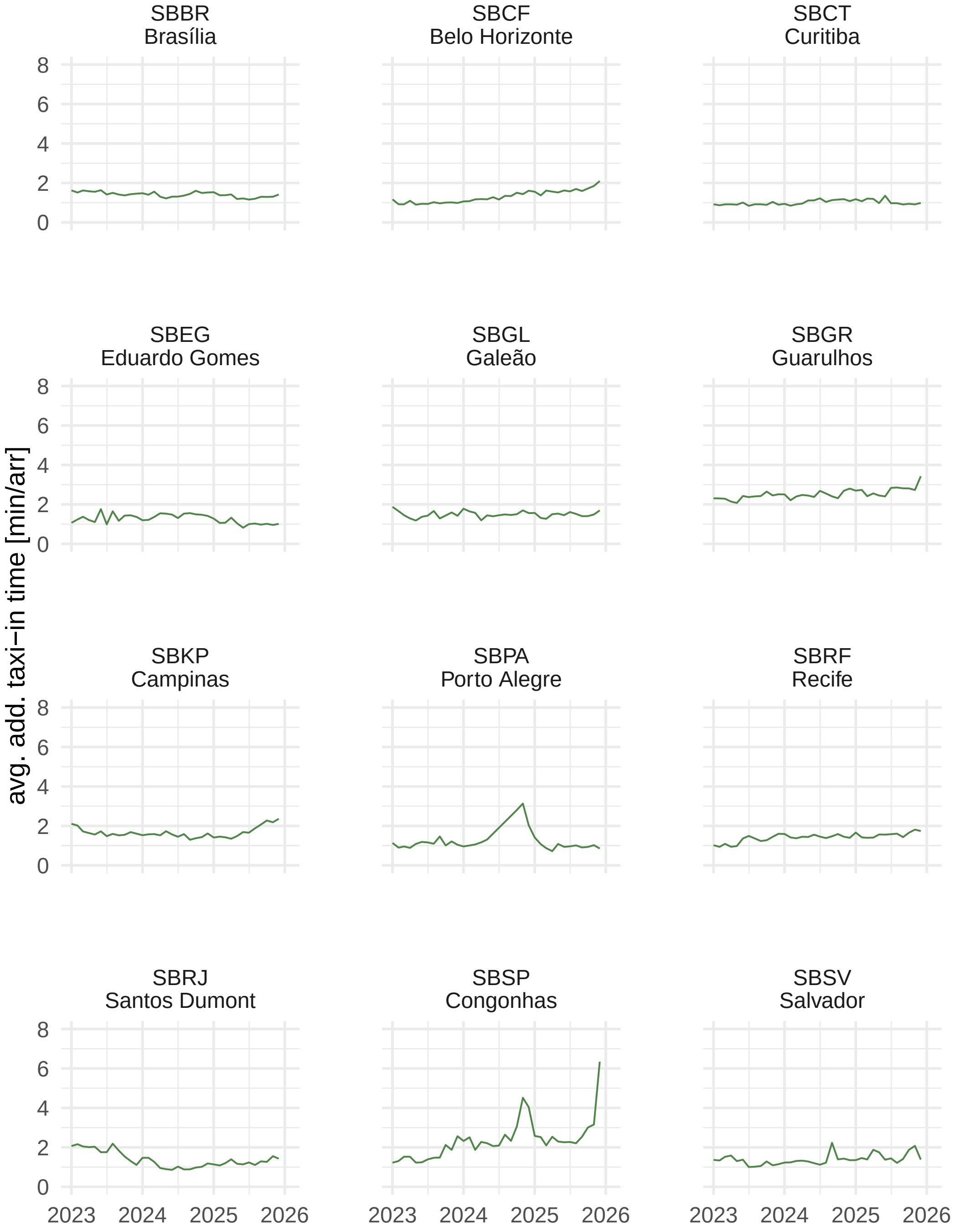


Figure 6.4: Brazil - Monthly evolution of average additional taxi-in time

The evolution of the taxi-in time at the study airports, shown in Figure 6.3 and Figure 6.4, reinforces the annual comparison and provides a check on the seasonal variation of the surface movement indicator.

6.2 Taxi-Out Times

6.2.1 Annual Evolution of Additional Taxi-out Times

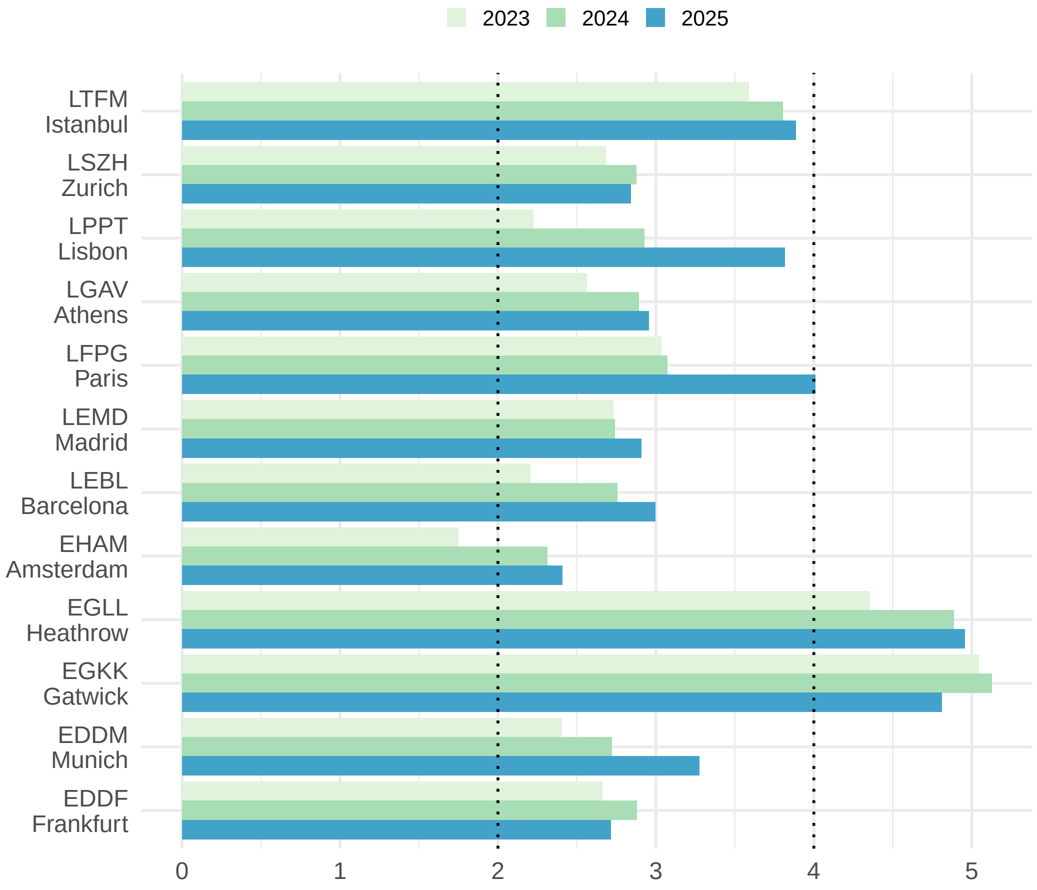


Figure 6.5: Europe - Average additional taxi-out time [min/dep] (2023-2025, 2024 GANP p20 reference)

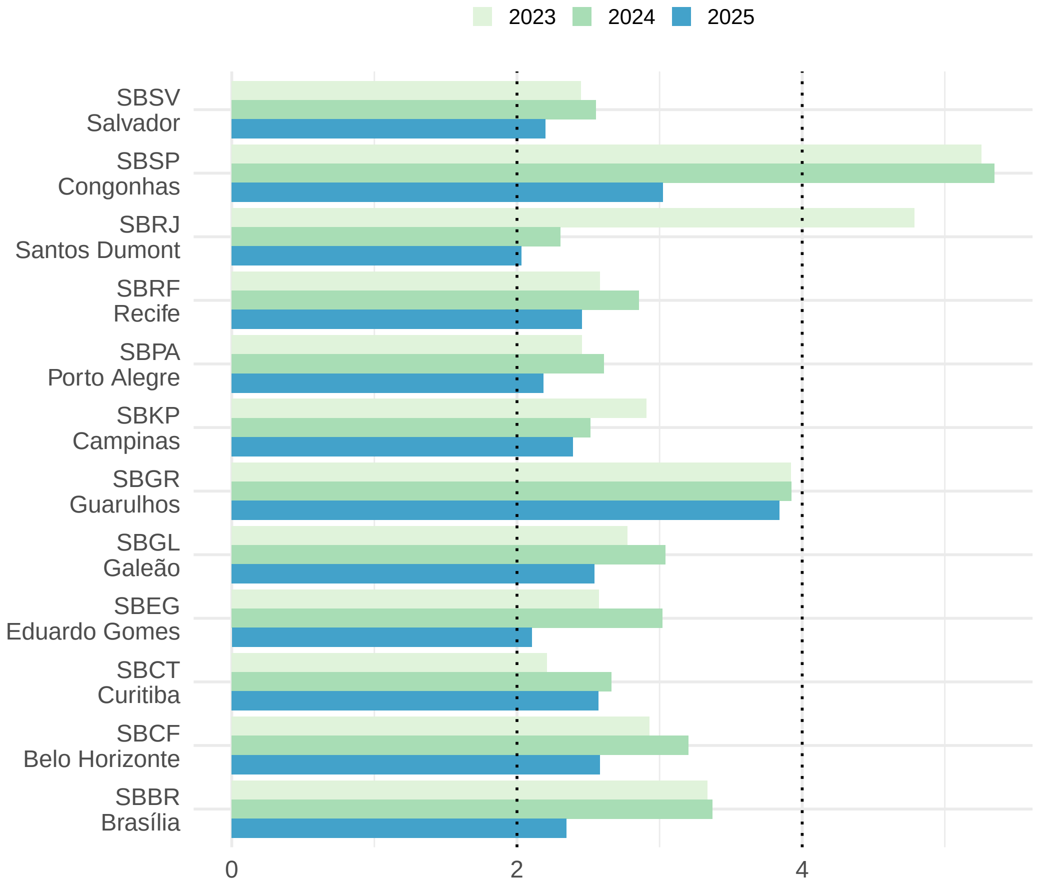


Figure 6.6: Brazil - Average additional taxi-out time [min/dep] (2023-2025, 2024 GANP p20 reference)

On average, higher additional times for taxi-out are observed across airports (see Figure 6.5 and Figure 6.6). The taxi-out phase requires a higher level of management of the surface movements. Departure procedures and flow control can impact the departure queue.

6.2.2 Monthly Variation of Additional Taxi-out Times

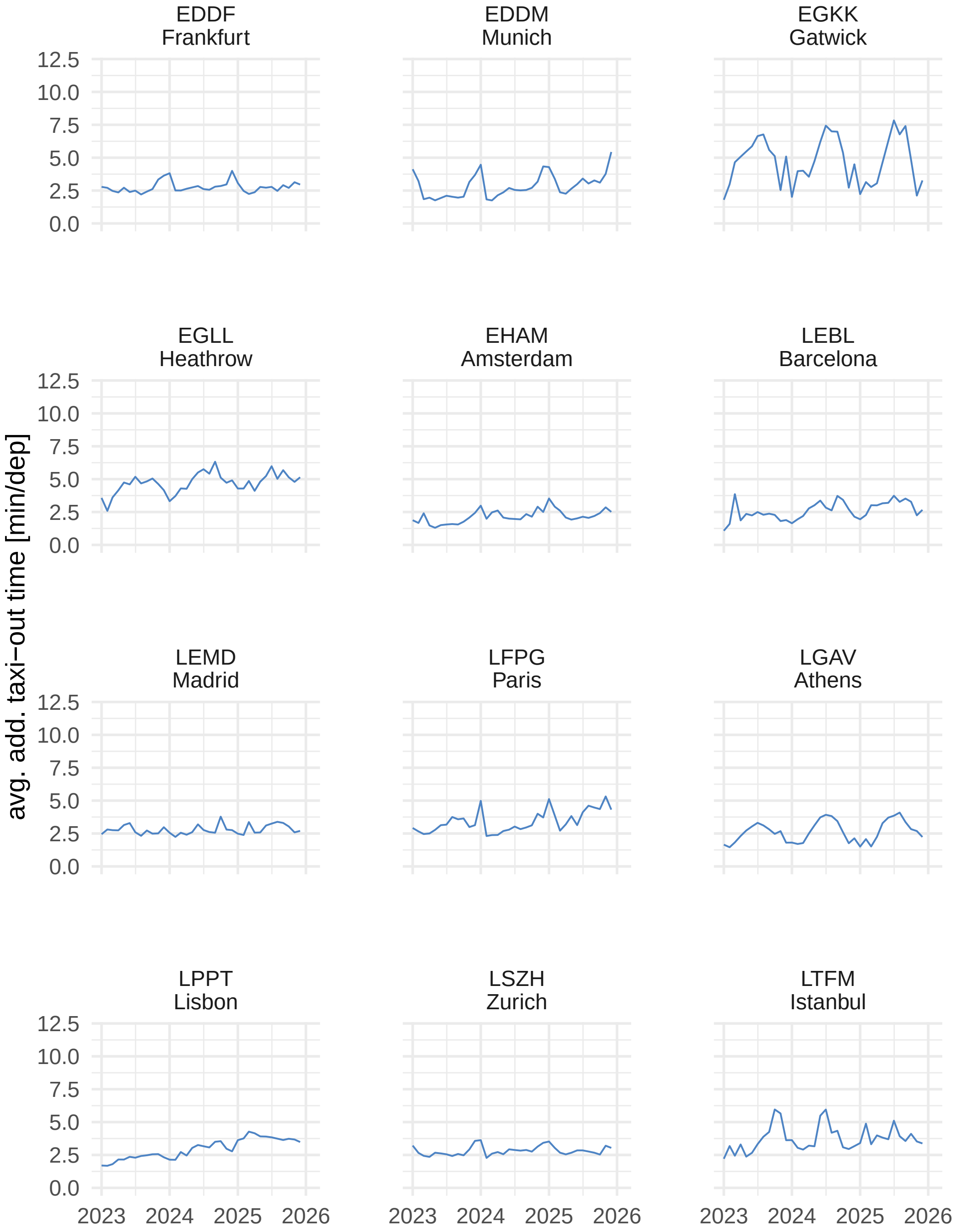


Figure 6.7: Europe - Monthly evolution of average additional taxi-out time

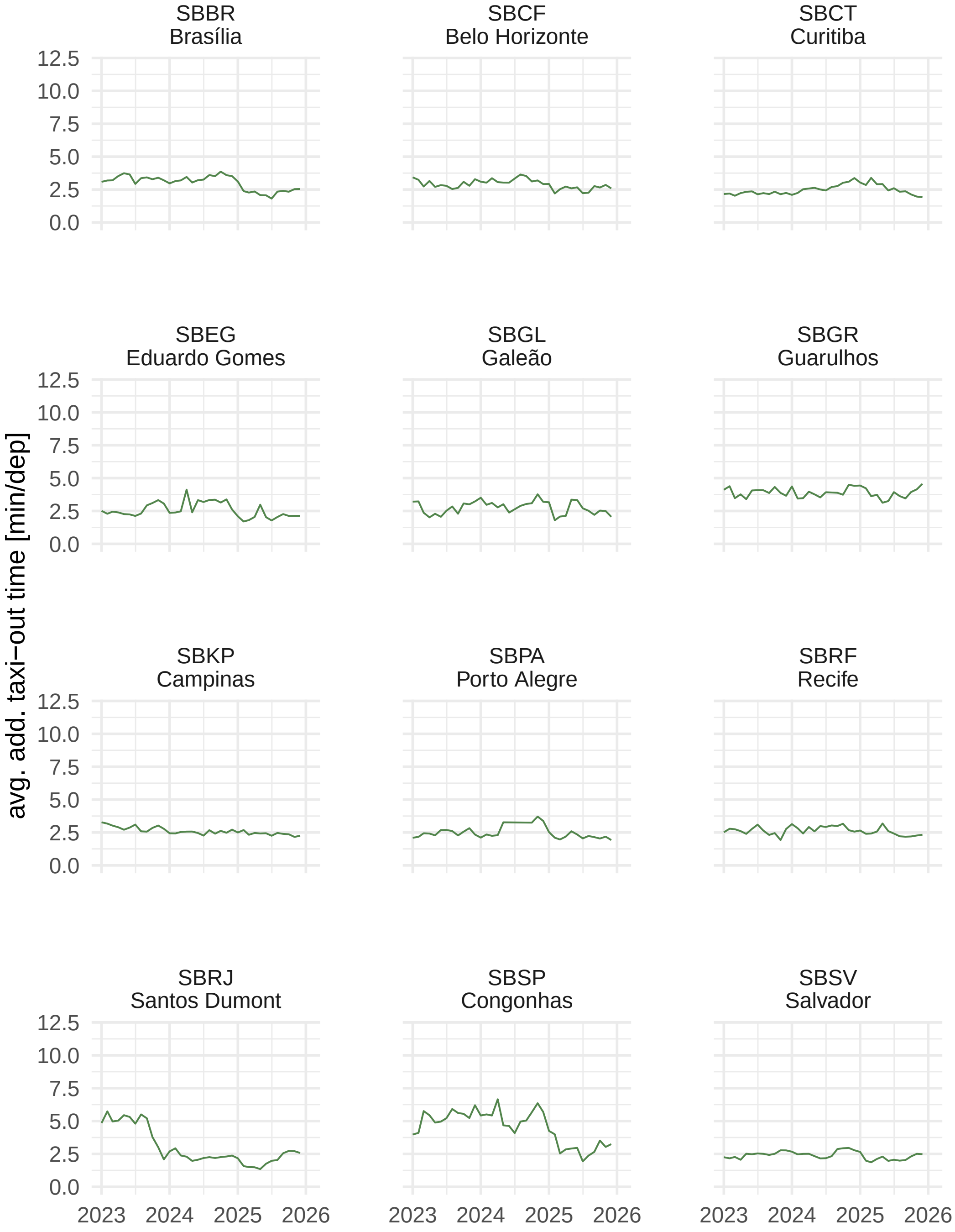


Figure 6.8: Brazil - Monthly evolution of average additional taxi-out time

The monthly evolution in Figure 6.7 and Figure 6.8 complements the annual comparison and highlights seasonal variation in the additional taxi-out times.

6.3 Mapping Additional Taxi-in and Taxi-out Times

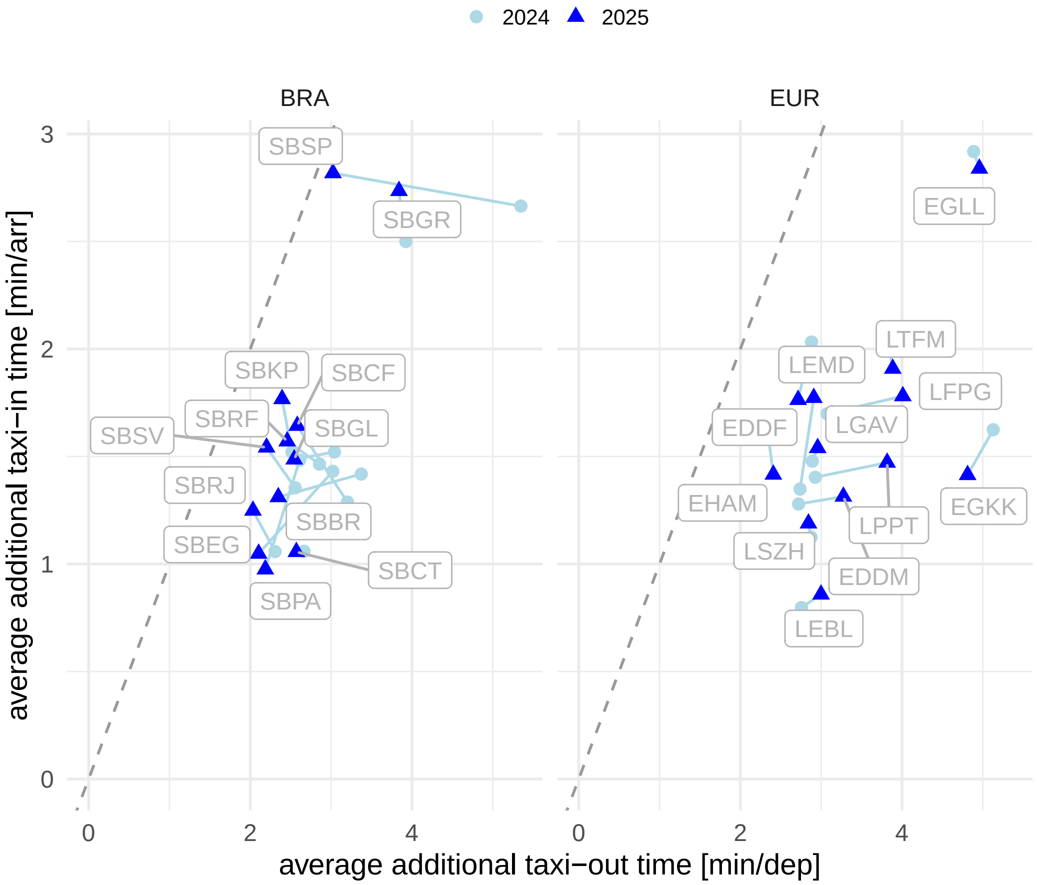


Figure 6.9: Mapping of additional taxi-in and taxi-out times (2024-2025)

This analysis builds on the previous sections. Figure 6.9 compares the relationship between the taxi-in and taxi-out performance observed at the study airports. It also shows that on average taxi-out operations accrue more additional time than taxi-in operations.

6.4 Additional Time in Terminal Airspace

The additional time in terminal airspace is calculated as the difference between the actual flying time from entering the sequencing area and a reference time for comparable arrivals. Previous research and guidance suggest that the reference time can be built for flights sharing similar operational characteristics.

The ASMA data for both regions are being further harmonised and follow the ICAO GANP 20th percentile approach for determining reference times. For Brazil, the refreshed data preparation now supports both 40 NM and 100 NM arrival sequencing areas for 2023-2025. For Europe, the ASMA comparison is extended to cover both ranges while the harmonised ASMA preparation is being aligned with the Brazilian update.

6.4.1 Additional ASMA Time at 40 NM

The 40 NM view gives a closer-in terminal-airspace perspective. For this report, this range is available for Brazil and provides an additional view on the terminal arrival segment closer to the aerodrome.

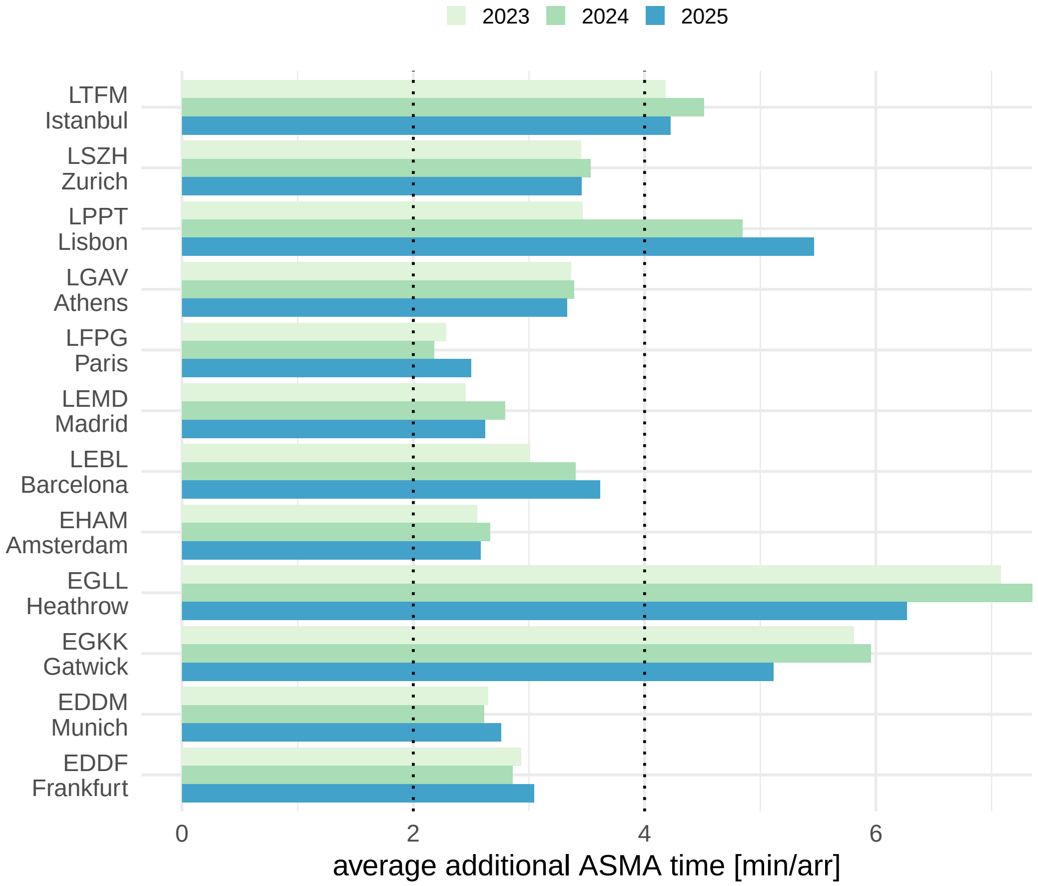


Figure 6.10: Europe - Additional ASMA time at 40 NM (2023-2025)

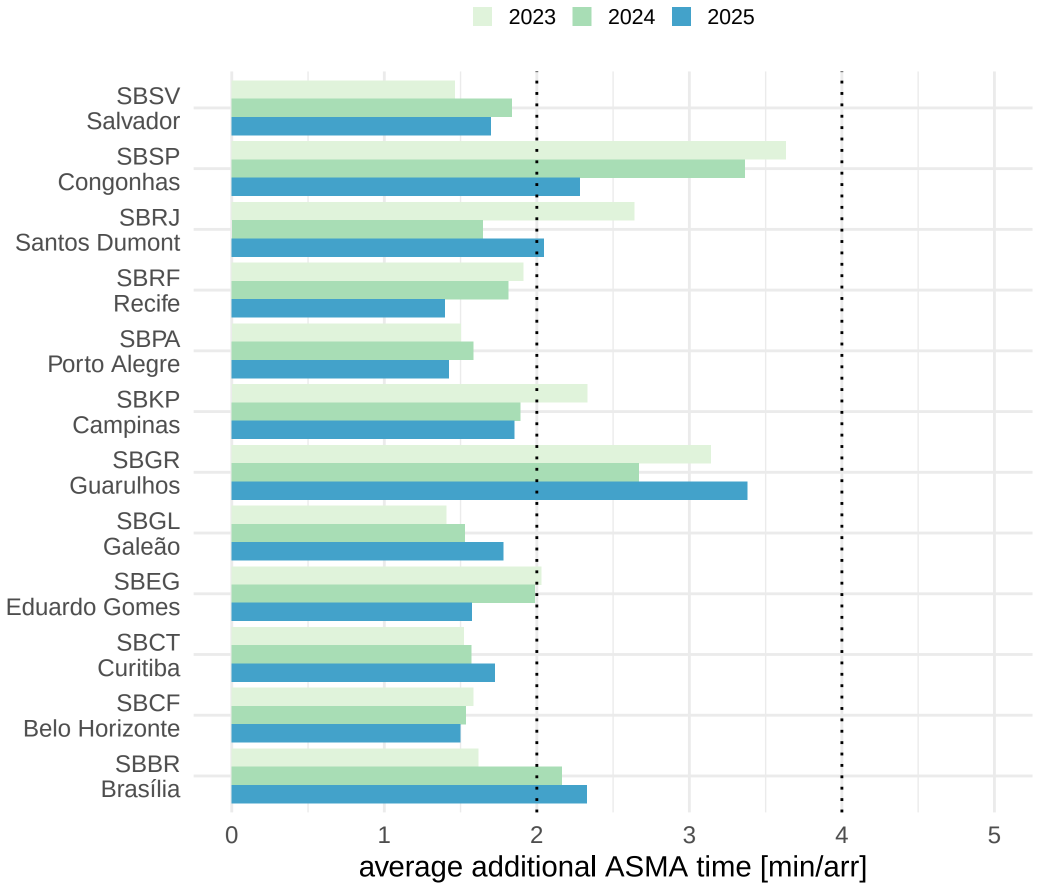


Figure 6.11: Brazil - Additional ASMA time at 40 NM (2023-2025, 2024 GANP p20 reference)

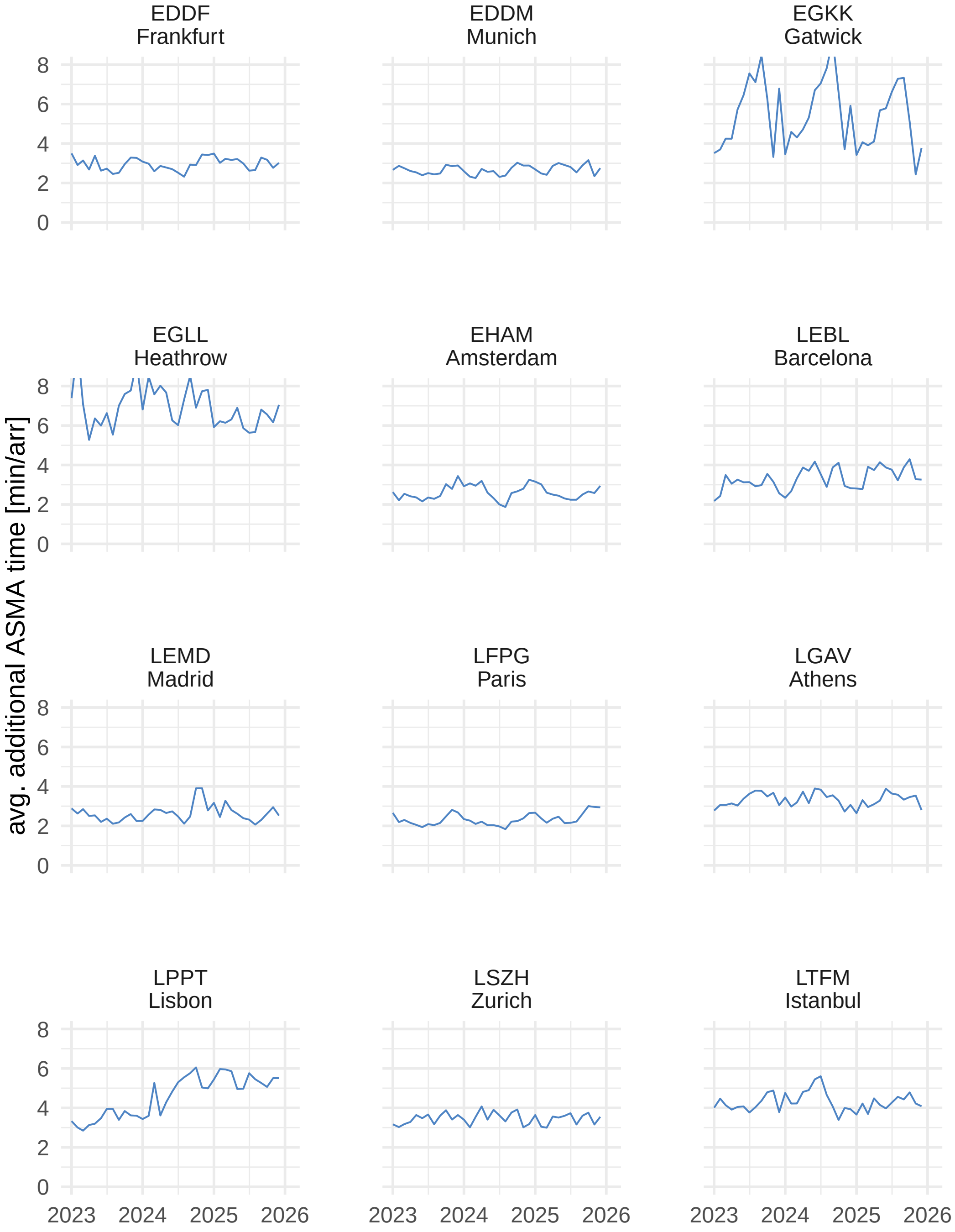


Figure 6.12: Europe - Monthly evolution of additional ASMA time at 40 NM

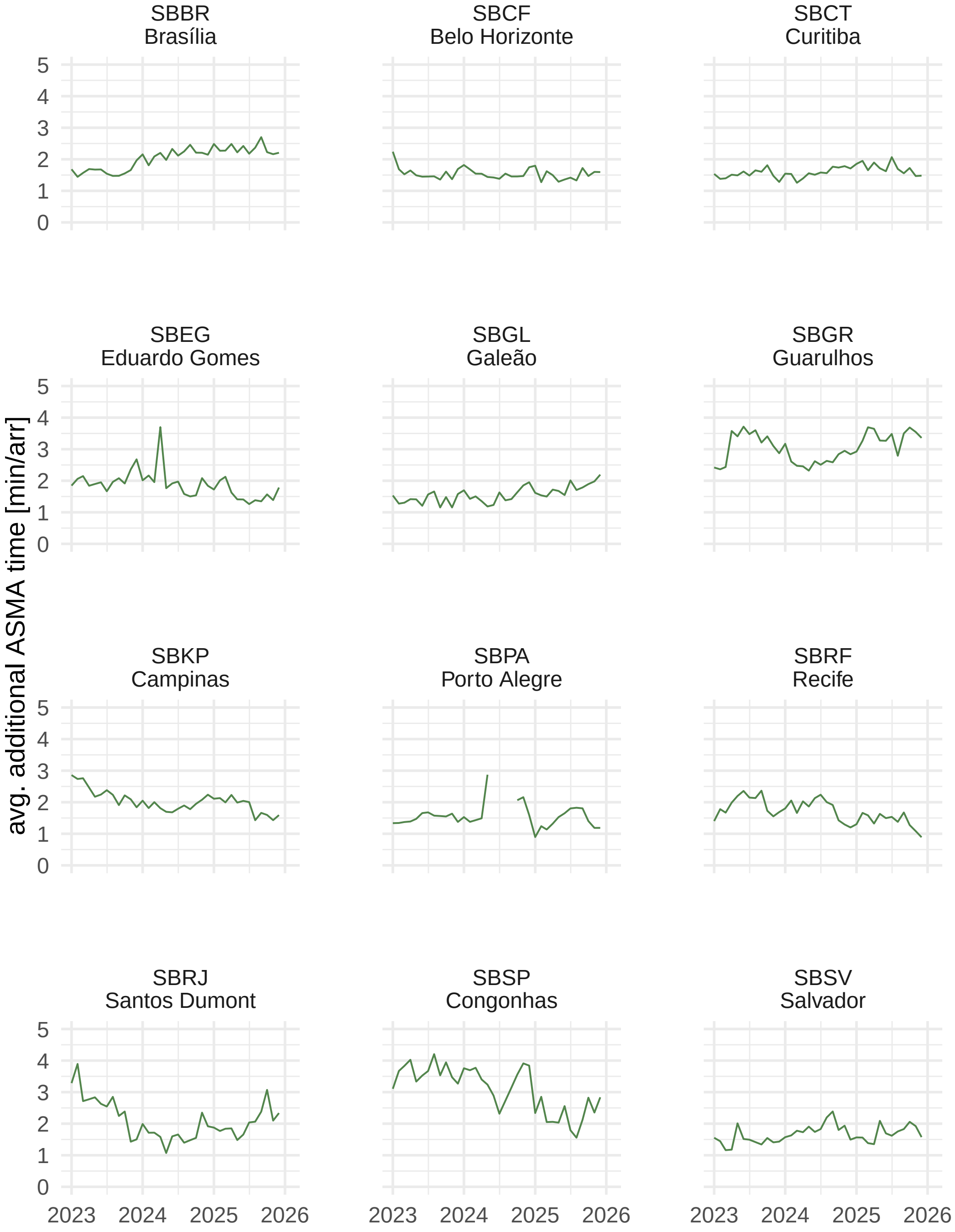


Figure 6.13: Brazil - Monthly evolution of additional ASMA time at 40 NM

The 40 NM results in Figure 6.10, Figure 6.11, Figure 6.12, and Figure 6.13 provide the closer-in view of arrival sequencing. For Brazil, the 40 NM results are lower than the 100 NM values, as expected for the shorter arrival segment. At the Brazil regional level, the 40 NM average remains close to 2.2 minutes per arrival in 2024 and 2025. The monthly timeline shows that the closer-in ASMA measure still varies across the study airports and across the year.

6.4.2 Additional ASMA Time at 100 NM

The 100 NM measure remains the headline indicator for additional time in terminal airspace. It captures the longer arrival sequencing horizon and is most comparable to the historical ASMA/KPI08 presentation in previous BRA-EUR reports.

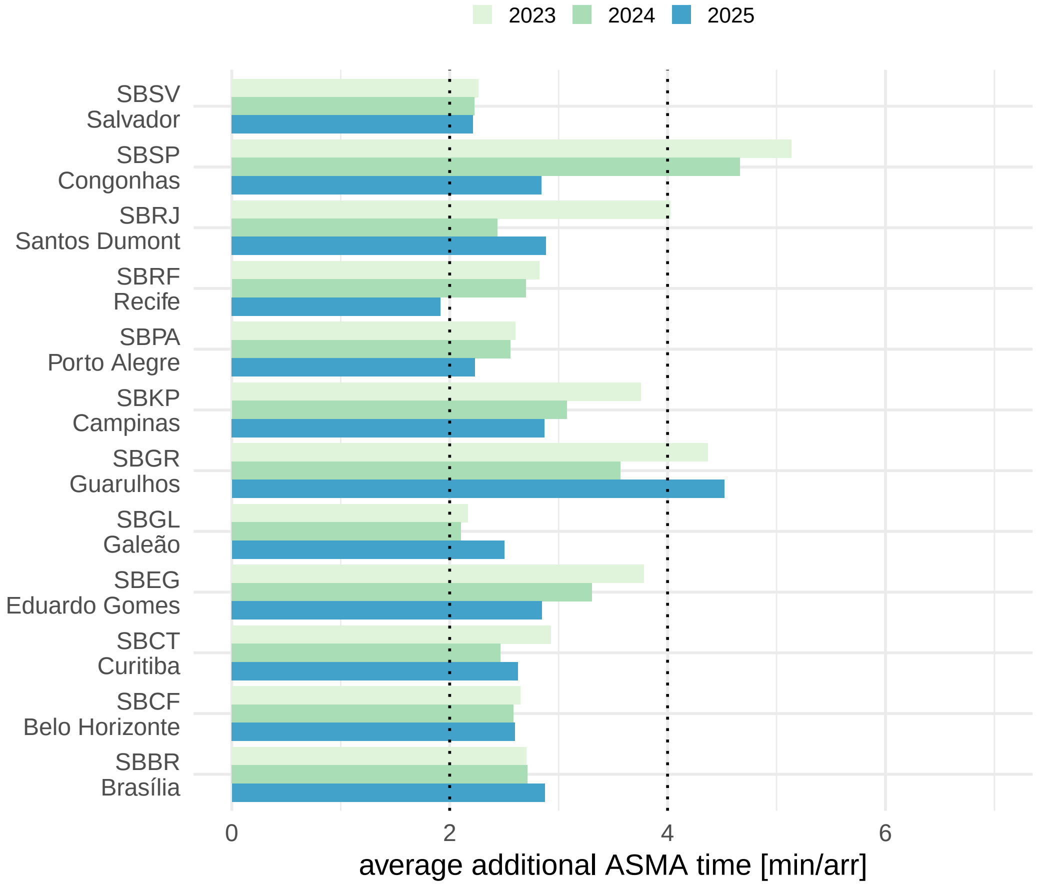


Figure 6.14: Brazil - Additional ASMA time at 100 NM (2023-2025, 2024 GANP p20 reference)

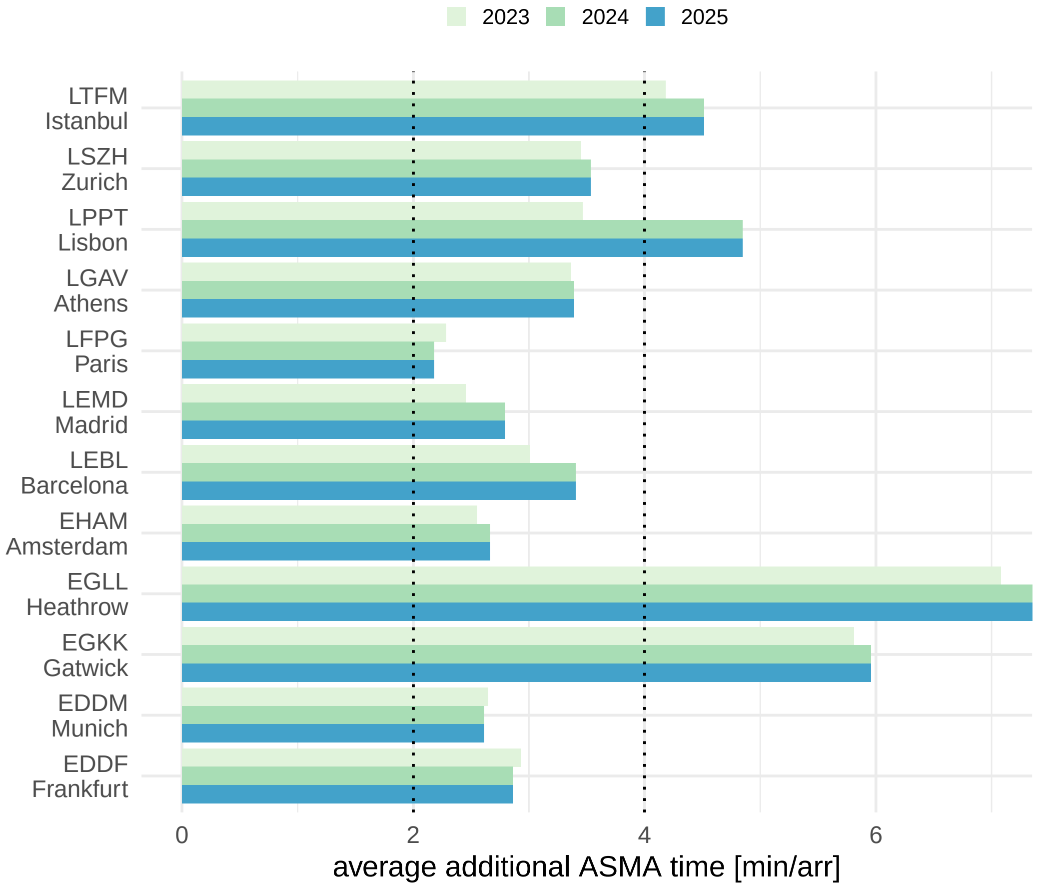


Figure 6.15: Europe - Additional ASMA time at 100 NM (2023-2025)

Figure 6.14 shows a gradual improvement in the Brazil weighted average at 100 NM, from about 3.6 minutes per arrival in 2023 to about 3.0 minutes in 2025. The highest additional times remain concentrated at the larger and more constrained arrival systems. Congonhas (SBSP) improves materially in 2025, while Guarulhos (SBGR) increases again and remains the highest Brazilian airport in the 2025 sample.

Figure 6.15 keeps the European comparison visible at the established 100 NM range. The European regional average remains close to 3.6-3.8 minutes per arrival over the 2023-2025 period.

Figure 6.16: Brazil - Monthly evolution of additional ASMA time at 100 NM

The monthly 100 NM timeline in Figure 6.16 provides the multi-year view for the Brazil arrivals. It shows that the annual averages mask substantial month-to-month variation, especially at Congonhas (SBSP), Santos Dumont (SBRJ), Guarulhos (SBGR), and Eduardo Gomes (SBEG). This makes the ASMA output useful beyond the annual indicator because the same approach can support follow-up checks for airport-level operational patterns.

6.4.3 Comparison by ASMA Range

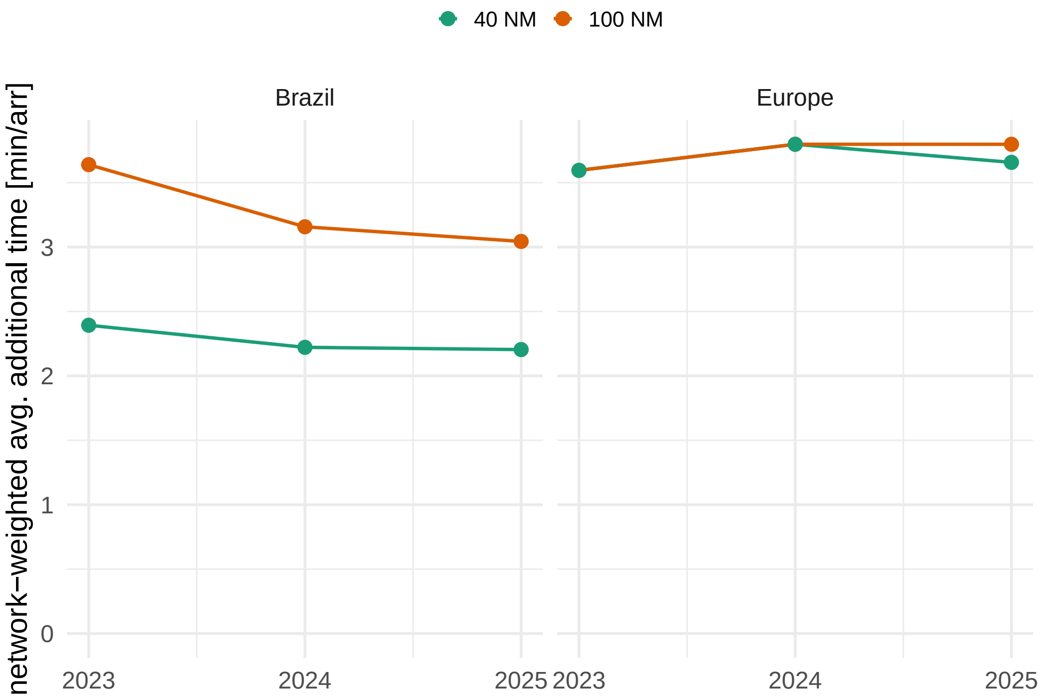


Figure 6.17: Regional additional ASMA time by range

Figure 6.17 compares the regional averages for the available ASMA ranges. For Brazil, the 100 NM average remains higher than the 40 NM average, which indicates that a meaningful share of the additional time is accrued before aircraft enter the closer-in 40 NM area. At 40 NM, the European regional average remains higher than the Brazilian regional average over the 2023-2025 period. At 100 NM, Brazil and Europe are within the same order of magnitude over the 2023-2025 period. The Brazilian 100 NM values show a gradual reduction, while the European 100 NM values and the 40 NM values in both regions remain comparatively stable in this comparison report.

6.5 Summary

This chapter analysed operational efficiency through the assessment of additional taxi-in, taxi-out, and terminal-airspace ASMA times. The 2025 update extends the comparison for the selected study airports and applies the ICAO GANP 20th percentile approach to the harmonised taxi-time indicators for both regions.

For taxi-in, the 2-minute threshold per arrival remains a useful practical reference point. The annual and monthly views indicate that taxi-in additional times remain generally contained, while constrained airport systems continue to show higher values. For taxi-out, additional times are higher than for taxi-in, reflecting the operational complexity of departure sequencing, surface movement management, and flow restrictions.

The ASMA section provides a first harmonised view of additional time in terminal airspace for both regions at 40 NM and 100 NM. The 40 NM values are lower, as expected for the closer-in arrival segment, while the 100 NM values capture a wider share of arrival sequencing and terminal airspace management. At 40 NM, the European regional average remains higher than the Brazilian regional average, while at 100 NM both regions are within the same order of magnitude in this comparison. Further harmonisation of the ASMA data will support a more robust side-by-side interpretation in future updates.

7 Topic Studies

For this report, the joint work between the performance groups at DECEA and EUROCONTROL involved the preparatory action for assessing operational sequencing concepts for runway system throughput during peak times and introducing an enroute performance measure, i.e., horizontal flight efficiency (HFE).
This chapter provides a first summary of the work to help refine the future work.

7.1 Runway Slot Pressure

This topic study uses 15-minute runway throughput to assess runway slot pressure during busy operations at the study airports. The analysis does not yet measure movement-by-movement inter-arrival time; instead, it uses slot-implied arrival spacing as a first proxy for how tightly arrival flows are packed under representative runway system configurations. This provides a basis for future inter-arrival studies and helps compare operational concepts observed in Brazil and Europe.

For each airport, the analysis identifies the 17 busiest local operating hours and retains stable runway system configurations observed across rolling one-hour windows. The stacked bars in Figure 7.1 show whether busy operations are concentrated in one dominant runway configuration or spread across several configurations.

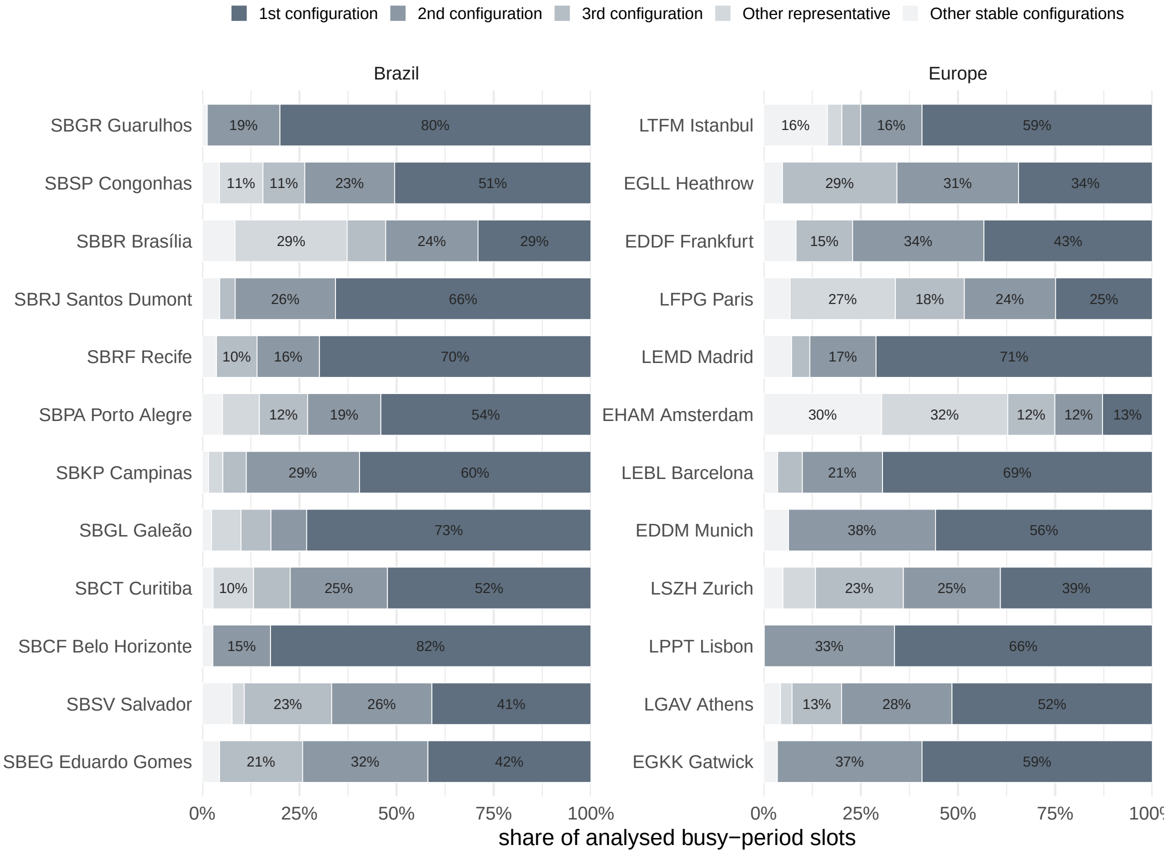


Figure 7.1: Runway system configuration shares during busy local operating hours

Runway slot pressure is expressed as the slot-implied minutes per arrival, calculated as 15 minutes divided by the number of arrivals in a 15-minute slot. Lower values indicate more tightly packed arrival flows. Figure 7.2 ranks airports by the median value and shows the interquartile range observed during representative busy-period configurations.

Across the airports in both regions, Figure 7.2 shows a pattern of predominant runway system configurations. Multi-runway systems show a wider variability of combinations with certain configurations dominating the operational use. Predominant configurations reflect local conditions comprising - inter alia - traffic dependent approach/departure routings, including associated noise abatement procedures, sequencing techniques, and predominant wind conditions.

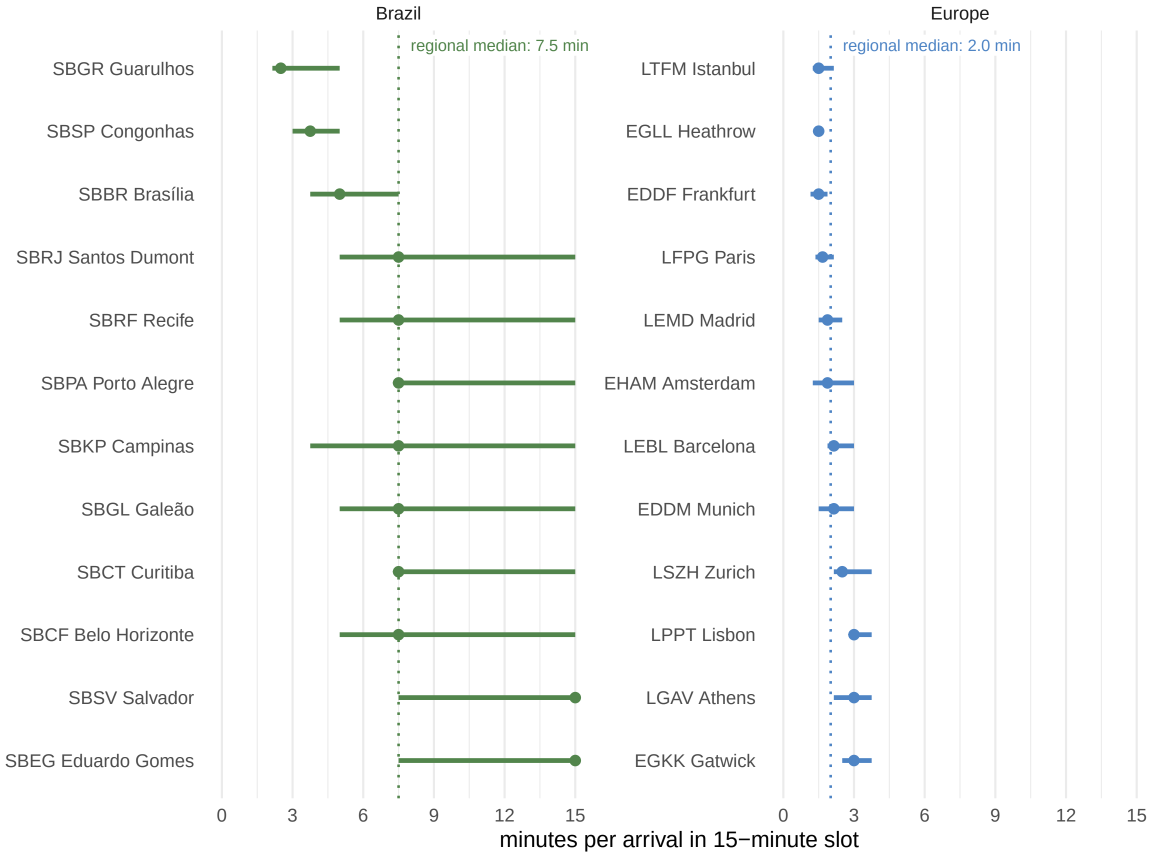


Figure 7.2: Runway slot pressure during representative busy-period configurations

Figure 7.2 serves as a proxy for runway system configuration utilisation. Across the predominant configurations, we observe a distribution of runway system movements per 15-minute slot (arrivals and departures in mixed mode operations or single mode arrivals and departures). The higher demand pressure on European airports is characterised by a smaller distribution of the overall observed movements per 15-minute slot. As a proxy, the average across the 12 European airports is 2.0 min per movement or about 7.5 movements per quarter hour and runway. Airports in Brazil show a wider variability given the range of traffic demand. The slot pressure proxy across the airports ranges about 3 times higher in Brazil. The top airports in Brazil, i.e., Guarulhos/SBGR, Congonhas/SBSP, and Brasília/SBBR range within the order of magnitude of the European airports. This confirms observations made earlier in this report. Figure 7.2 also shows the growth potential of airports in Brazil with increasing traffic.

7.2 Horizontal Flight Efficiency

The horizontal flight efficiency (HFE) topic study compares the 2025 network-level results for Brazil and Europe and explores selected aerodrome pairs with broadly comparable great-circle distance. Brazil implemented the HFE algorithm for the first time for this report cycle; the results are therefore considered preliminary and are presented as a first validation-oriented comparison.

At network level, the HFE indicator shown here expresses horizontal flight inefficiency, calculated from the ratio of flown to achieved distance and aggregated on a monthly basis (c.f. Figure 7.3). On a network level there is a distinct difference between the horizontal flight inefficiency based on the planned and actual flown trajectories. On average, the HFE values for the actual flown trajectories range within the same order of magnitude, i.e., the 3-4% range. The Brazilian results show a higher level of variability across the year with a slight decreasing trend from January to December. Additional research will help to understand this behaviour better. There is a clear seasonal pattern on the European side coinciding with the peak tourism season during the summer. On the planning side, Brazil offers a lower level of inefficiency with the KEP ranging solidly below 2%. Europe shows a 2-2.5 times higher level of inefficiency with the classical seasonal pattern.

A key difference between both regions becomes visible from this high-level comparison: Operational realities appear to increase the level of enroute inefficiency within the Brazilian system with KEA > KEP. The European pattern shows the characteristics of a rigid planning system. The planning side is less efficient than the actual enabled flight path, KEP > KEA. In both regions the offset between the planned and actual trajectory efficiency accounts on average for 1.5-2%.

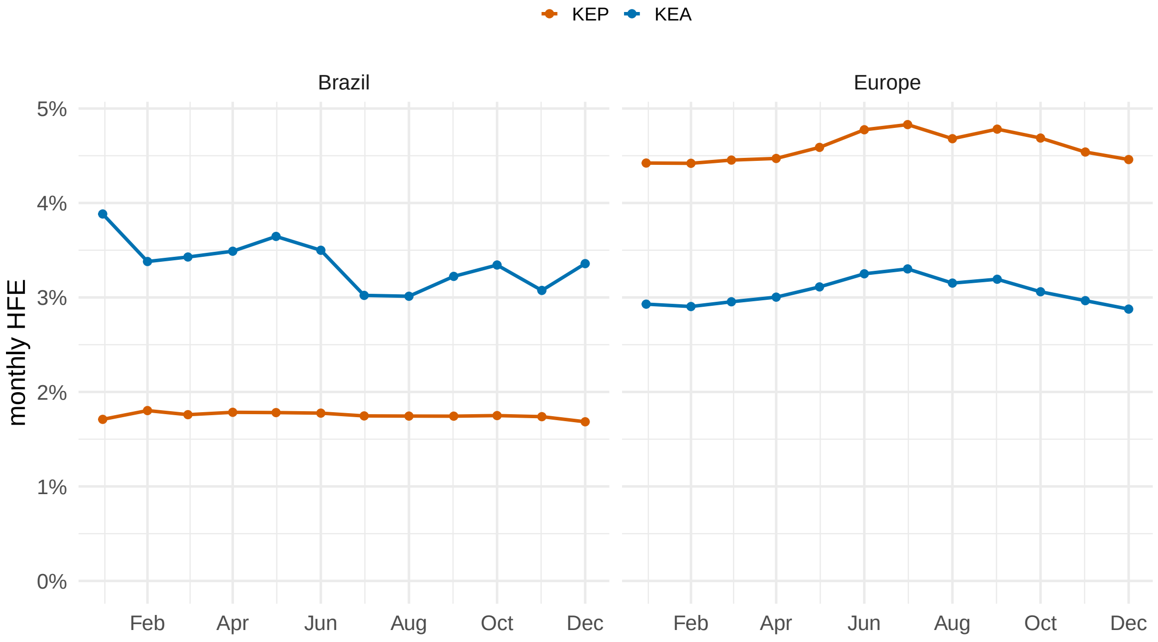


Figure 7.3: Monthly network-level horizontal flight efficiency in 2025

The selected aerodrome-pair comparisons focus on directional connections with broadly similar great-circle distance. For this report a set of distinct distances were selected to provide a deeper understanding of the observed differences on the network level and gain insight on how the overall network, airspace structure and associated procedural aspects affect the HFE measure.

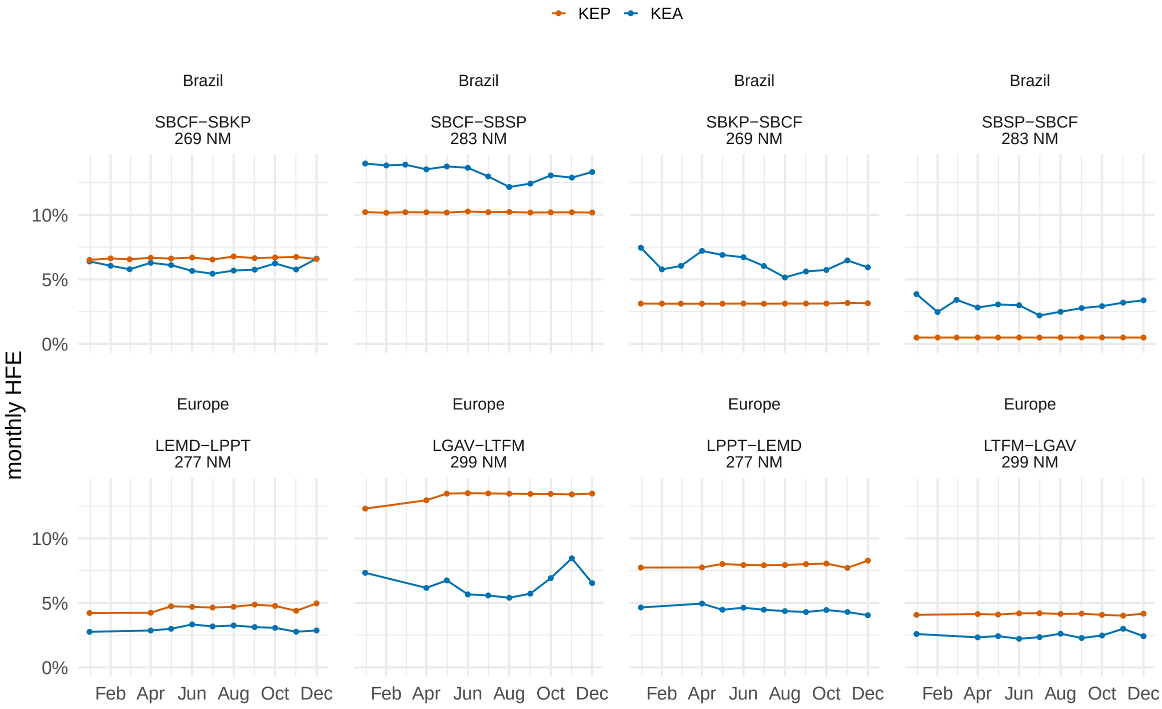


Figure 7.4: Monthly HFE for selected short-distance aerodrome pairs

Figure 7.4 shows HFE values for short-range aerodrome connections (just under 300NM). The results confirm the overall pattern observed on the network level. In general, the observed actual horizontal flight inefficiency (KEA) is higher than the planned KEP. A notable exception is the flight connection from Belo Horizonte/SBCF to Campinas/SBKP where there is only a marginal difference between KEP and KEA. On the European side, Figure 7.4 shows the classical KEP > KEA pattern. For the connection from Athens/LGAV to Istanbul/LTFM there is a higher offset between the KEP and KEA value suggesting that planning side constraints are regularly compensated for with the provided enroute services. In comparison with the other horizontal flight efficiency bands, there appears a higher level of inefficiency on shorter routes as departure and arrival procedures and shorter/no lower-upper airspace transition impact the route selection and air traffic services.

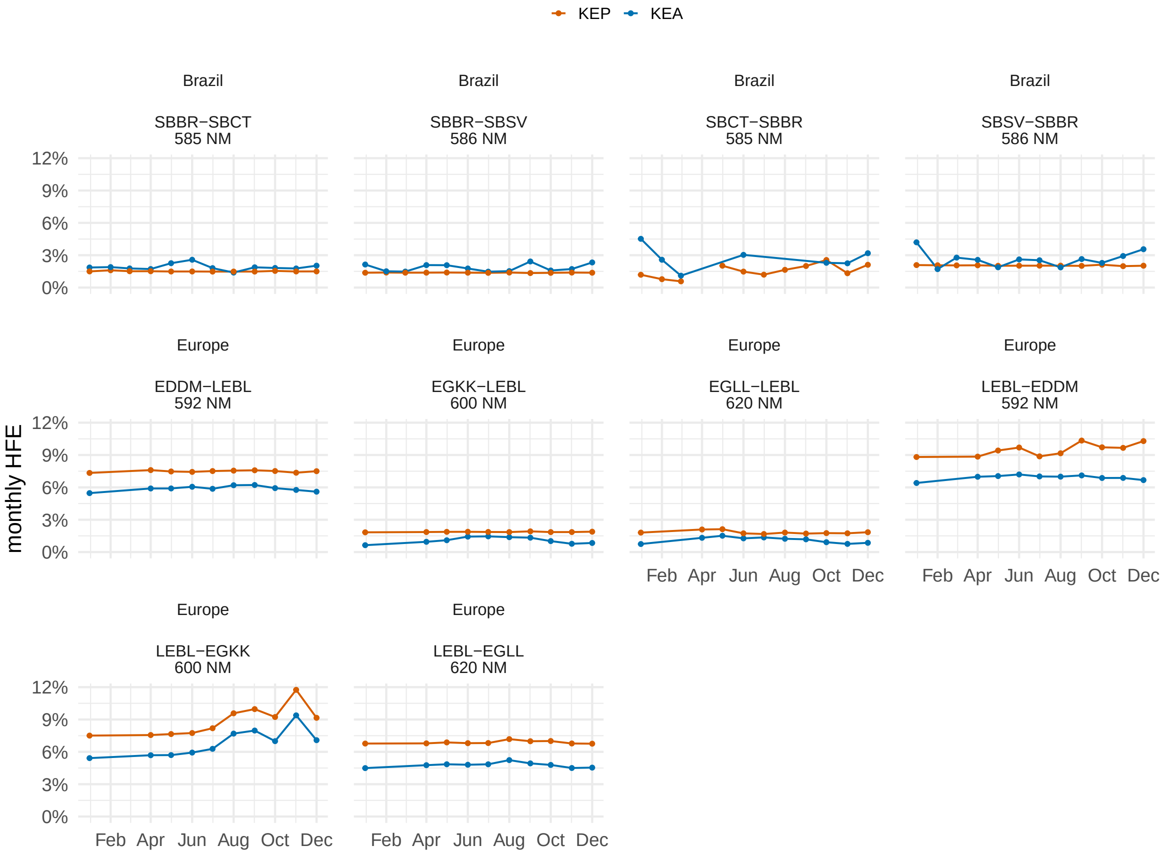


Figure 7.5: Monthly HFE for selected aerodrome pairs around 600 NM

The first mid-distance band, Figure 7.5, shows a series of airports with a great circle distance of around 600NM. The data for Brazil suggests that this mid-level band sees a relatively close realisation of the flight paths as planned. The results for Europe vary depending on the chosen aerodrome pair and direction of flight. This suggests a higher impact of procedural aspects at this distance.

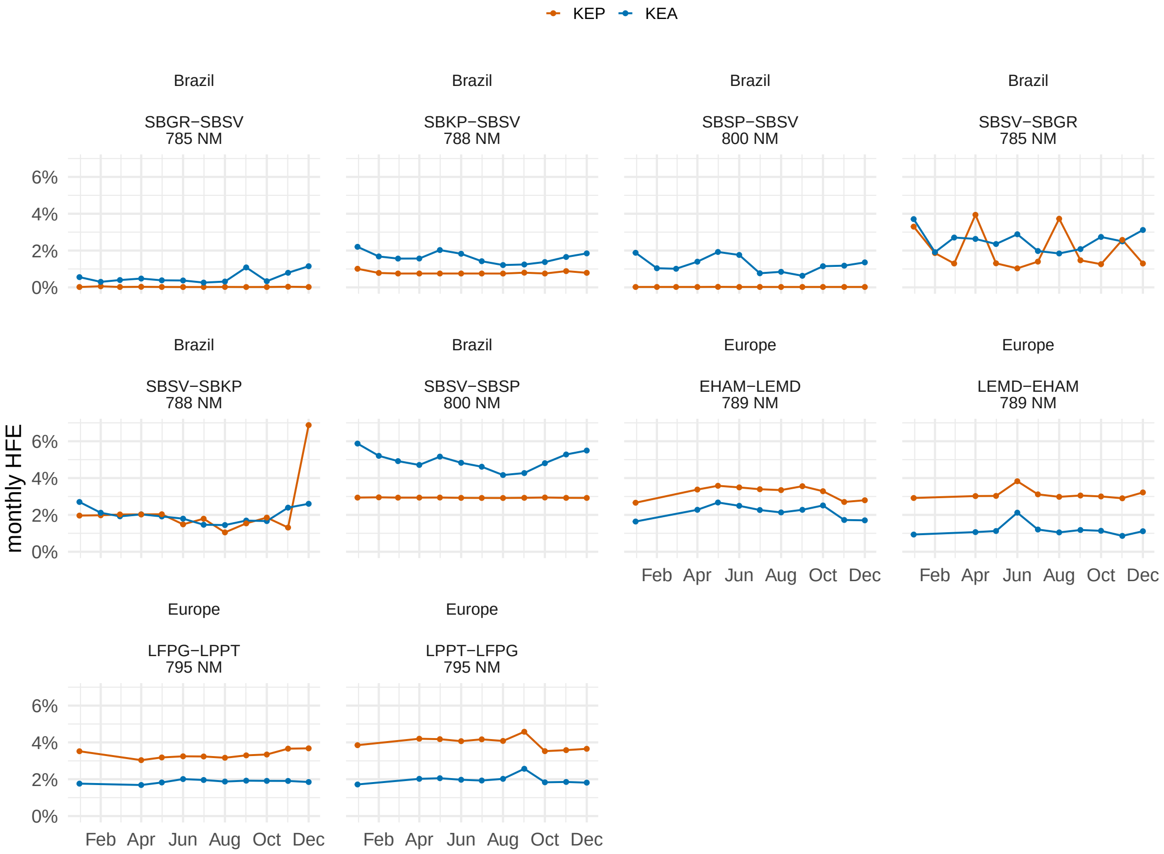


Figure 7.6: Monthly HFE for selected aerodrome pairs around 780-800 NM

The second mid-distance band confirms the observations made for the shorter midband. On average, the observed horizontal inefficiencies are higher for this distance. This signals that the results also depend on the aerodrome pair chosen. Arrivals to Congonhas/SBSP show a higher level of difference between the planned and actual flown trajectory. The European results are fairly constant for this level band. This suggests that between the chosen aerodrome pairs, the seasonal effect is less visible and more of a systemic nature.

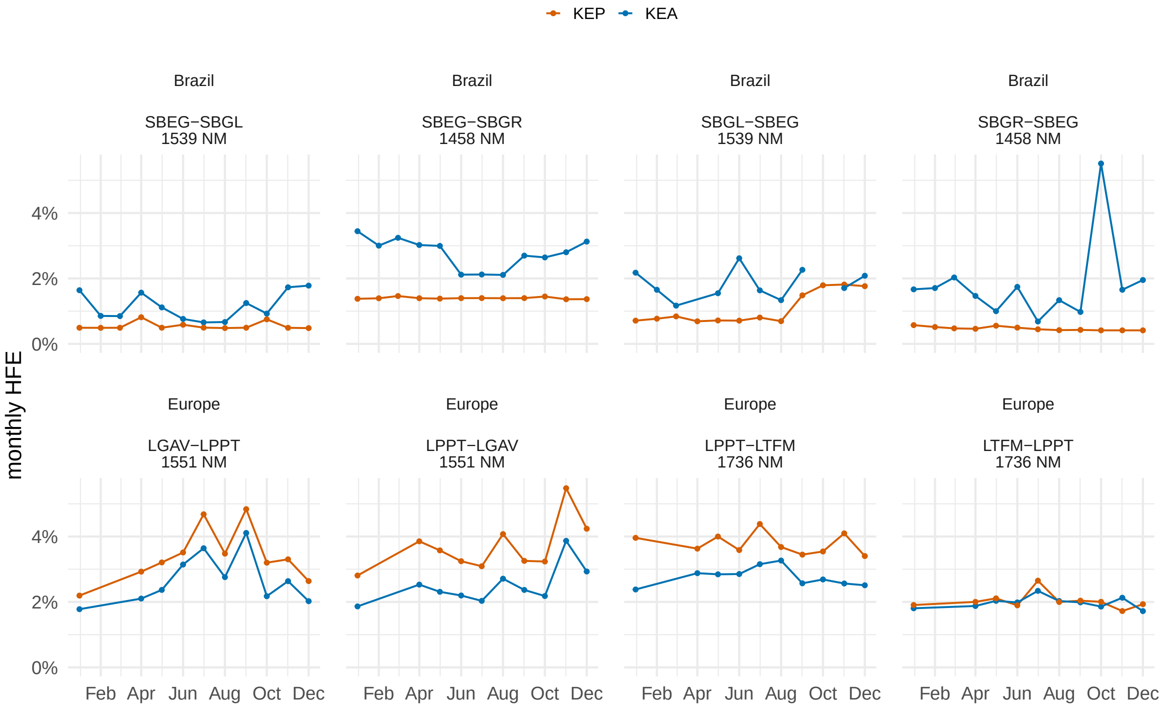


Figure 7.7: Monthly HFE for selected long-distance aerodrome pairs

With Figure 7.7, this report studies the behaviour of the HFE indicator for aerodrome pairs with a great circle distance of around 1500NM or more. In both regions, the aforementioned pattern of behaviour between KEP and KEA is confirmed. This suggests that longer flights (3-4 hours) experience a similar level of inefficiency to the mid-distance flights. For the European airspace, the connection from Istanbul/LTFM to Lisbon/LPPT shows an interesting pattern, as KEP and KEA broadly coincide, while the other direction of flight shows the classical offset pattern.

7.3 Summary

This chapter highlighted two topics of interest for both parties. It offers a first glimpse into operational concepts, their implementation, and observed performance.

As was pointed out earlier in this report, the increasing demand pressure in both systems requires a high level of operational efficiency. One critical aspect in this is the utilisation of the runway system capacity. To study the implication of different sequencing concepts and techniques, this report investigated the principal sequencing behaviour during peak operating hours at the study airports. Runway slot pressure of the runway system configuration was introduced as a proxy for the inter-arrival sequencing, both in single runway and mixed mode operations. It measures the serviced demand pressure on the runway system during 15-minute slots. As a proxy, it gives already a good indication on the sequencing techniques/practices. For the studied airport operations, we observe an average of 2.0 min for Europe versus an average of 7.5 min per runway system movement.

The HFE results demonstrate an emerging capability on the Brazilian side. The data preparatory action now allows for the continual extraction and calculation of the horizontal flight efficiency measure across the network. In this report, the groups focussed on the overall observed network level performance and then studied a subset of aerodrome pair connections with similar great-circle distance.

Both groups are interested in advancing the state-of-the-art in assessing network- and center-level aspects. To move towards a more granular comparison, this report showcases the behaviour on a runway system configuration level and a network-wide measure in Brazil and Europe. This approach allowed for a high-level comparison on a set of harmonised indicators suitable to describe the scope of the service provision. This is useful to characterise the similarities and differences between both regions. Future work will revolve around the validation of the findings and its integration to the corpus of this report and the associated performance measures.

8 Conclusions

A Mature Partnership in a Shifting Landscape
The 2025 edition of the Brazil-Europe Comparison Report marks a significant milestone in the long-term collaboration between DECEA and EUROCONTROL. This year's work reinforces the value of bi-regional benchmarking as a tool for validating ICAO Global Air Navigation Plan (GANP) indicators in diverse operational contexts. The data reveals that both regions have moved beyond recovery, with Brazil consistently operating above 2019 traffic levels and Europe consolidating its network-wide stability.

Key Operational Insights

The technical analysis across the Key Performance Areas (KPAs) has identified several critical takeaways:

- **System Resilience and Scalability**: A standout finding is the decoupling of traffic growth from workforce expansion in Brazil. By maintaining a stable ATCO headcount (0.1% change) while managing increased movements, DECEA has demonstrated high levels of operational efficiency and successful technological integration.
- **Fleet Mix and Throughput Constraints**: The report identifies a structural disparity in fleet composition. The high proportion of Light aircraft in Brazil (up to 30% at some airports) introduces wake-turbulence complexities not seen in the Medium/Heavy dominated European hubs. This affects "achievable" throughput comparisons between the two regions.
- **Infrastructure and Density**: With European traffic density nearly five times that of Brazil, the European system operates under higher pressure. However, benchmarking single-runway hubs like London Gatwick and Lisbon shows a "growth dividend" for Brazilian airports like Santos Dumont (SBRJ) to exploit as demand matures. This also offers growth potential for other Brazilian operations.
- **Predictability and Scheduling Buffers**: Distinct punctuality signatures were observed. Brazil's high rate of "early arrivals" (29% in 2025) suggests conservative scheduling by operators, whereas Europe's delays (26% late arrivals) are driven by network-wide capacity constraints and reactionary effects.

- **Tactical Operational Efficiency**: Efficiency is specifically measured through the lens of additional time during high-workload phases:
  - *Surface Movement (Taxi-Out)*: Additional taxi-out time provides a direct indicator of departure management and airport congestion.
  - *Terminal Arrival Phase (ASMA)*: Additional ASMA time highlights the efficiency of sequencing and metering into the terminal area.

Evolution of Methodology

This edition continues the evolution toward additional topic-centric analysis. The introduction of initial studies on Horizontal Flight Efficiency (HFE) and runway slot pressure provide the basis for expansion of future reports.
The introduction of HFE to this report portfolio a shift toward expanding the reported network-wide performance measures matures.
The runway slot pressure investigation offers to provide additional analysis on the behaviour of the airport centric measures during peak and non-peak traffic situations. It may also help to inform and validate on-going work on the international level. may expand on a more granular performance management.

The Way Forward

The DECEA-EUROCONTROL partnership remains committed to the continuous improvement of ATM performance. It is planned to augment the report and its future editions with a rolling web-based monitoring, including regular updates of the underlying data. With these regular updates and future report editions the time series of the different measures will be continuously tracked. As witnessed by this report, the continual expansion of the scope is facilitated through the initial deep dives reported. This forms the basis to refine future editions.

The joint work will also help to promote the approach and state-of-the-art with the international benchmarking community. Both groups are contributing to the ICAO GANP Performance Expert Group (GANP-PEG) and the multi-national Performance Benchmarking Working Group (PBWG). The continued harmonisation of the performance related data, the refinement of the guidance material and application of the performance framework start paying dividends. For example, PBWG concluded in its most recent meeting to collaborate on topics of mutual interest for which this report supports the continued research and validation with international partners.

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List of Acronyms

Category	Acronym	Definition
General	**ACC**	Area Control Centre
	ANS	Air Navigation Services
	ANSP	Air Navigation Service Provider
	APP	Approach Control Unit
	ASM	Airspace Management
	ATC	Air Traffic Control
	ATCO	Air Traffic Controller
	ATFM	Air Traffic Flow Management
	ATM	Air Traffic Management
	CDM	Collaborative Decision Making
	CDO	Continuous Descent Operations
	FIR	Flight Information Region
	FIS	Flight Information Service
	FMP	Flow Management Position
	GANP	Global Air Navigation Plan
	IFR	Instrument Flight Rules
	RNAV	Area Navigation
	RWY	Runway
	SES	Single European Sky
	SLOT	ATFM Slot / Departure Slot
	TWR	Aerodrome Control Tower
	UTC	Coordinated Universal Time
	VMC	Visual Meteorological Conditions
	WTC	Wake Turbulence Category
Performance	**AOBT**	Actual Off-Block Time
	ASMA	Arrival Sequencing and Metering Area
	HFE	Horizontal Flight Efficiency
	KPA	Key Performance Area
	KPI	Key Performance Indicator
	PLI	Planned Landing Interval
	PRR	Performance Review Report
	SIBT	Scheduled In-Block Time
	SOBT	Scheduled Off-Block Time
	TXIN	Taxi-In Time
	TXOT	Taxi-Out Time
	VFE	Vertical Flight Efficiency

(continued)

Category	Acronym	Definition
Organisations	**ANAC**	Agência Nacional de Aviação Civil (Brazilian Civil Aviation Authority)
	CAA	Civil Aviation Authority
	CINDACTA	Integrated Centre for Air Defence and Air Traffic Control (Brazil)
	CRCEA-SE	Regional Centre of Southeast Airspace Control (Brazil)
	DECEA	Departamento de Controle do Espaço Aéreo (Brazilian Airspace Control Department)
	ECAC	European Civil Aviation Conference
	EUROCONTROL	European Organisation for the Safety of Air Navigation
	FAA	Federal Aviation Administration (United States)
	ICAO	International Civil Aviation Organization
	INFRAERO	Empresa Brasileira de Infraestrutura Aeroportuária
	JCAB	Japan Civil Aviation Bureau
	NATO	North Atlantic Treaty Organization
	NMOC	Network Manager Operations Centre (EUROCONTROL)
	PBWG	Performance Benchmarking Working Group
	PRC	Performance Review Commission (EUROCONTROL)
	PRU	Performance Review Unit (EUROCONTROL)
Brazil Airports	**SBBR**	Brasília International Airport
	SBCF	Belo Horizonte Confins International Airport
	SBCT	Curitiba International Airport
	SBEG	Eduardo Gomes International Airport (Manaus)
	SBGL	Rio de Janeiro Galeão International Airport
	SBGR	São Paulo Guarulhos International Airport
	SBKP	Campinas Viracopos International Airport
	SBPA	Porto Alegre International Airport
	SBRF	Recife International Airport
	SBRJ	Rio de Janeiro Santos Dumont Airport
	SBSP	São Paulo Congonhas Airport
	SBSV	Salvador International Airport
Europe Airports	**EDDF**	Frankfurt Airport (Germany)
	EDDM	Munich Airport (Germany)
	EGKK	London Gatwick Airport (United Kingdom)
	EGLL	London Heathrow Airport (United Kingdom)
	EHAM	Amsterdam Schiphol Airport (Netherlands)
	LEBL	Barcelona El Prat Airport (Spain)
	LEMD	Madrid Barajas Airport (Spain)
	LFPG	Paris Charles de Gaulle Airport (France)
	LGAV	Athens International Airport (Greece)
	LIRF	Rome Fiumicino Airport (Italy)
	LPPT	Lisbon Humberto Delgado Airport (Portugal)
	LSZH	Zurich Airport (Switzerland)
	LTFM	Istanbul Airport (Turkey)

BRAZIL / EUROPE

Comparison of Operational Air Navigation System Performance

2019-2025