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CANSO's Approach to Operationalizing Key Performance Indictors

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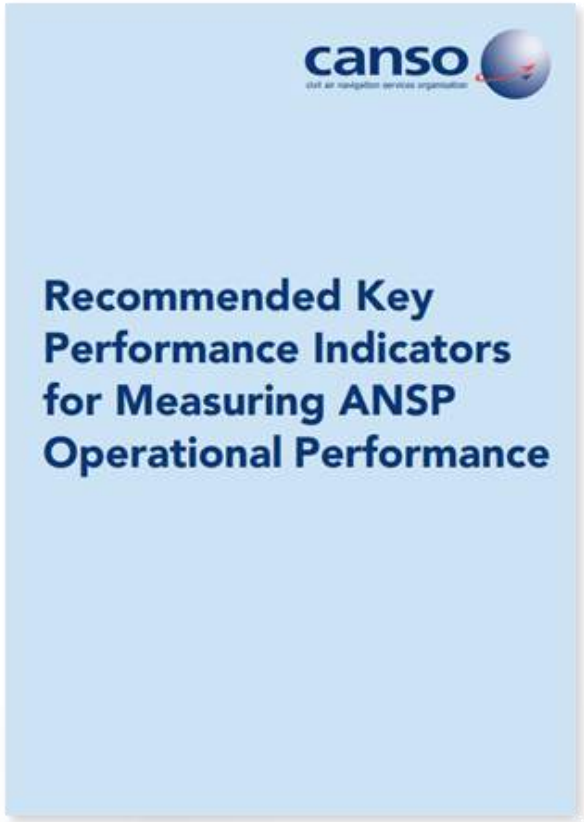
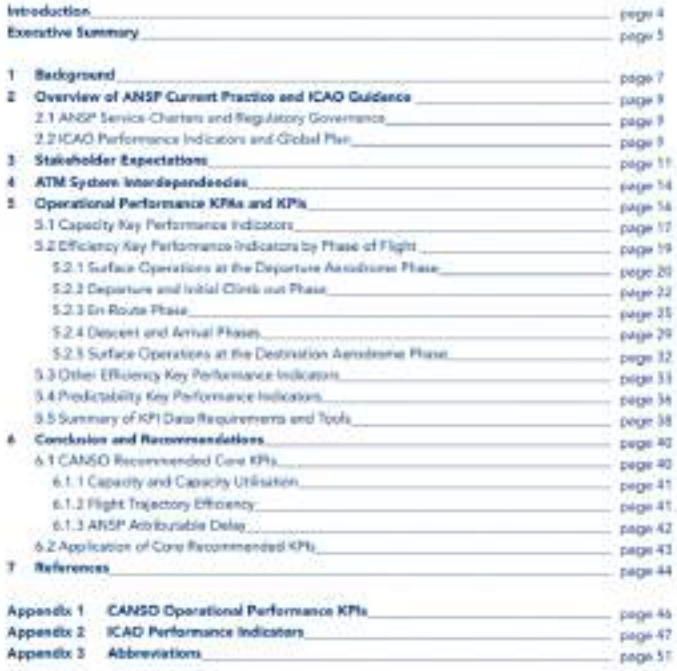
Recommended KPIs for Measuring ANSP Operational Performance

Focus on capacity, efficiency and predictability

- Developed by the CANSO Operational Performance Workgroup
- Aligned with ICAO Doc 9883
- Expanded application specific to ANSP Operational Performance
- Global Benchmarking Workgroup has initiated an update of the document to assess completeness of KPIs and to increase document usability





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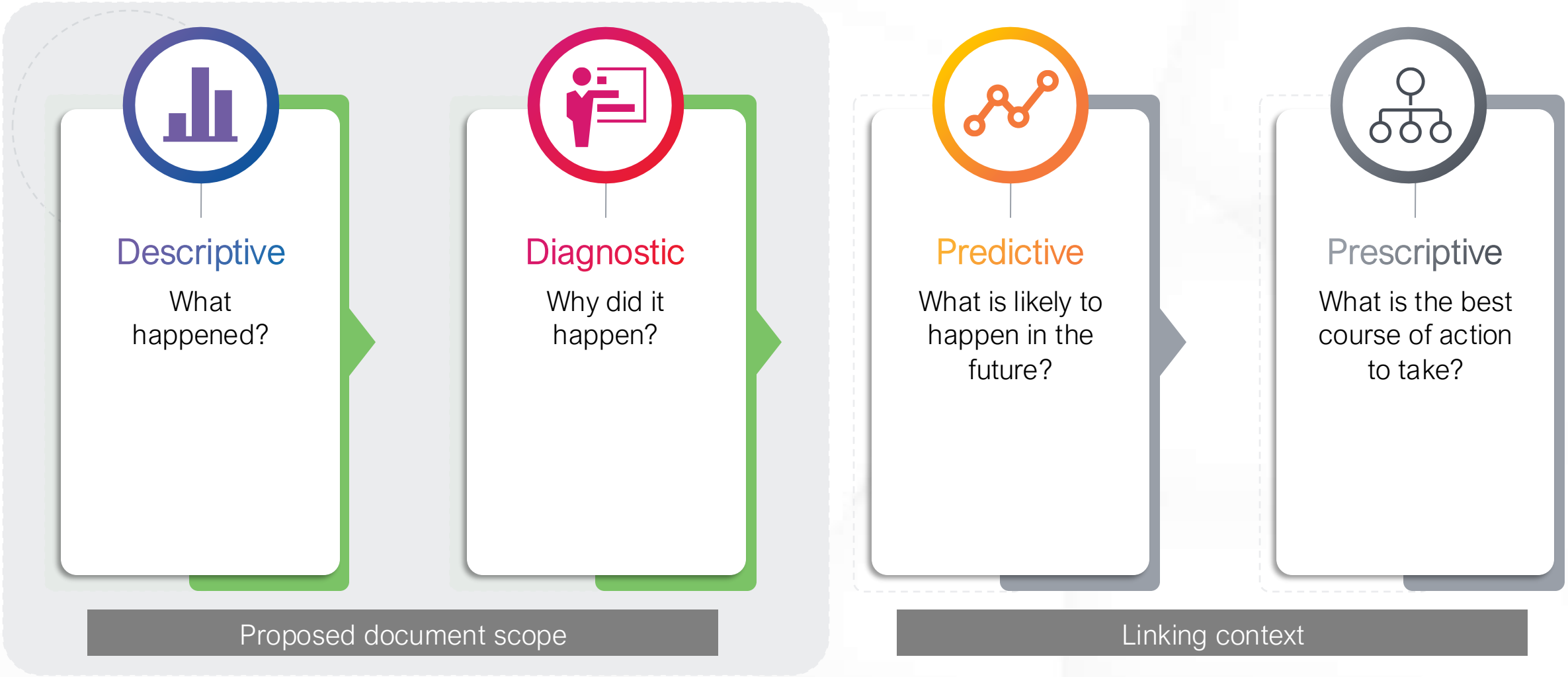
Descriptive and Diagnostic Capabilities Enable Predictive and Prescriptive Analytics



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Recommended Key Performance Indicators for Measuring ANSP Operational Performance

Participate in the Review

Document review goals

1. Usability
   - Clarity on what is being measured
   - Definitions
   - Greater emphasis on data accessibility linked to evolution of KPIs
   - Interdependencies and correlations
   - Outliers and exceptions
2. Appropriateness
   - Completeness of KPIs
   - Contextual measures
3. Format
   - Update layout to improve accessibility
   - Increase use of visuals
   - Include case studies
4. Other
   - Downstream use of KPIs
   - Identification and attribution of variation
   - Data sharing and collaboration

Contact James Carr at **james.carr@navcanada.ca** to participate

Interregional Flight Performance

Interregional Flight Performance

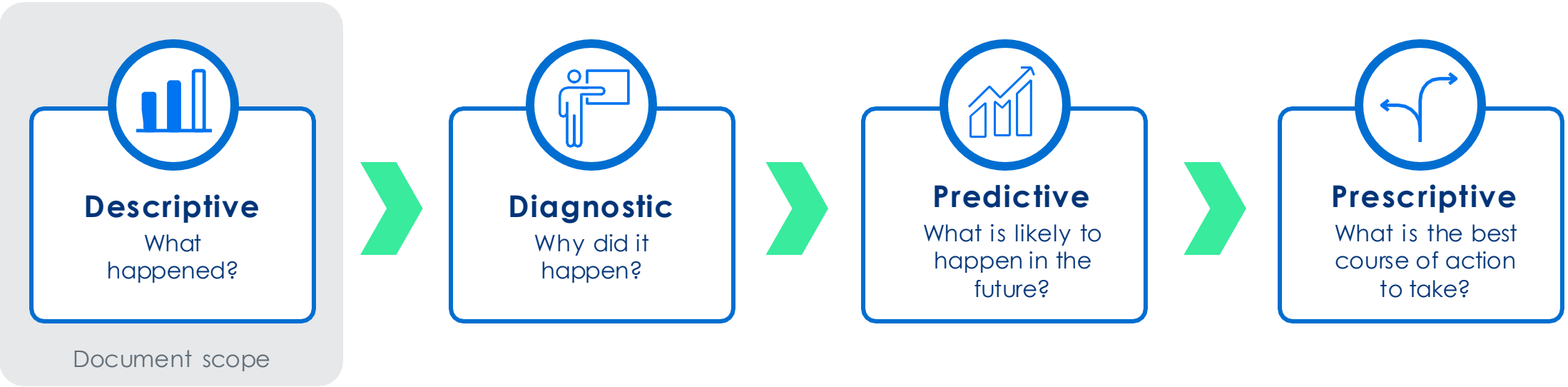
As the **collective "Voice of Airspace"**, CANSO has a strategic goal to become the **authoritative source on airspace**. By accessing ATM flight efficiency performance, CANSO can better:

- Drive productive dialog towards **collectively raising the bar on performance**
- **Identify actions to support collaboration** and assist with **ATM challenges**
- **Defend ATM performance** where reasons for inefficiency are structural

Within this context, **ALG has collaborated with CANSO** to create an interregional flight performance report with the objective to **generate data-driven discussions on interregional flight performance**

Report aim

This report aims to provide a **descriptive overview** of the **horizontal performance**, **average flight time** and **flight time variability** across key **interregional routes**, serving as a foundation for **expert analysis and diagnostic discussions**

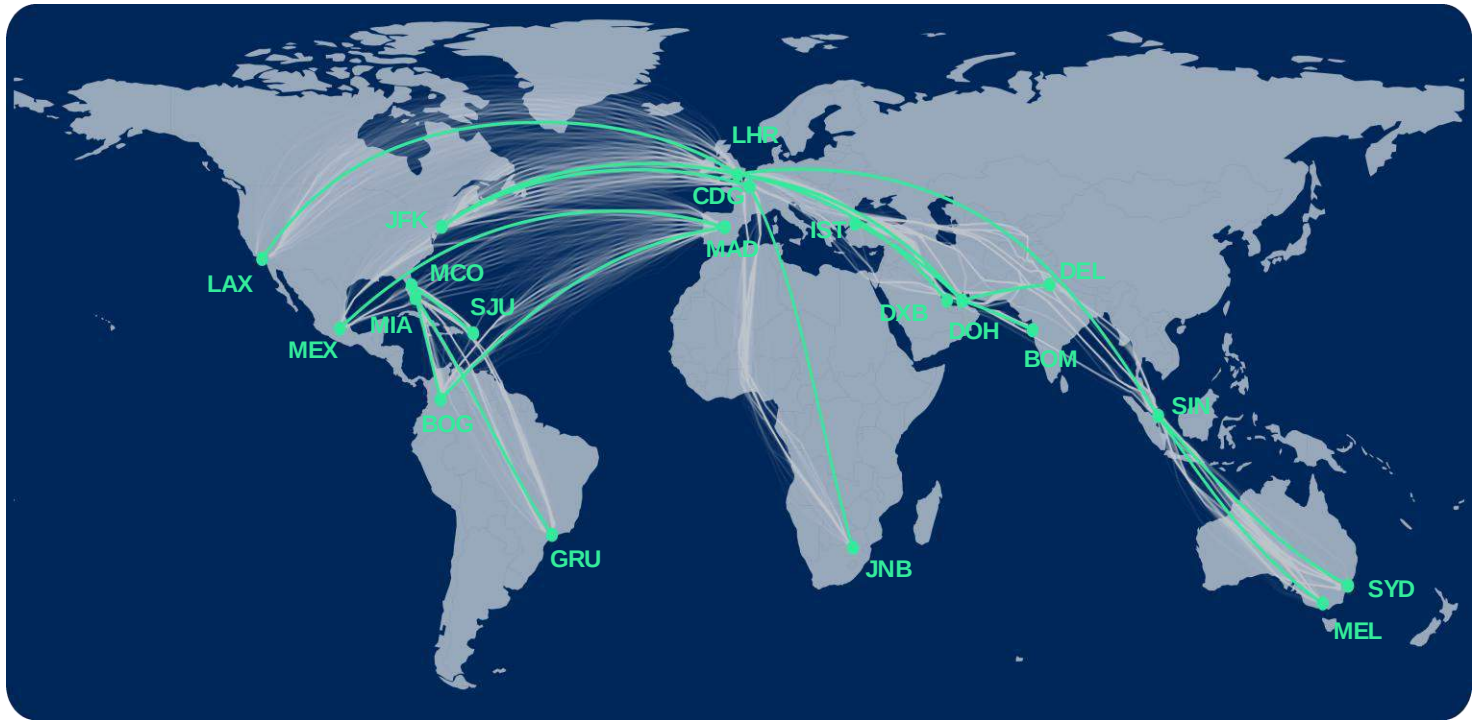


Through a **descriptive lens**, this report outlines the current operational environment across key routes. Its role is to **summarize observed patterns** and **support informed discussions** going forward

Selected routes and time scope

Routes in both directions across **17 city pairs** – each connecting cities in **different international regions** – were selected based on **annual traffic volume** and data quality

City pair	Routes
Bogota - Madrid	BOG ⇌ MAD
Bogota – Miami	BOG ⇌ MIA
Ciudad de México – Madrid	MEX ⇌ MAD
Doha – London	DOH ⇌ LHR
Dubai – Istanbul	DXB⇌ IST
Dubai – London	DXB ⇌ LHR
Dubai – Mumbai	DXB ⇌ BOM
Dubai – New Delhi	DXB ⇌ DEL
Johannesburg – Paris	JNB ⇌ CDG
London – Los Angeles	LHR ⇌ LAX
London – New York	LHR ⇌ JFK
London – Singapore	LHR ⇌ SIN
Melbourne – Singapore	MEL ⇌ SIN
Miami – São Paulo	MIA ⇌ GRU
New York – Paris	JFK ⇌ CDG
Orlando – San Juan	MCO ⇌ SJU
Singapore – Sydney	SIN ⇌ SYD



This report is based off ADS-B data for the year **2024**

Key Performance Indicators

The computed KPIs have been obtained from CANSO's *Recommended Key Performance Indicators for Measuring ANSP Operational Performance* and offer a measure of **horizontal performance** as well as **variability in flight times**

KPI09 - En-Route Direct Route Distance Extension

En-route flight phase 'extensions' in direct flights between airports with respect to the GCD

- **Data required:** ADS-B only
- **Formula:** Excess distance with respect to GCD: $actual$ flight $distance - GCD$
- **KPI Forms:** Total or Average excess distance in Km

KPI17 – Average Flight Time

Measures the aviation system's ability to maintain flight efficiency as traffic increases

- **Data required:** ADS-B only
- **Formula:** SUM(Flight time)/#ATMs
- **KPI Forms:** Minutes/flight

KPI20 – Travel time variation

Variability of the entire gate-out to gate-in travel time or may sub-divided by phase of flight

- **Data required:** ADS-B only
- **Formula:** 85th (P2) - 15th (P1)
- **KPI Forms:** Minutes/flight

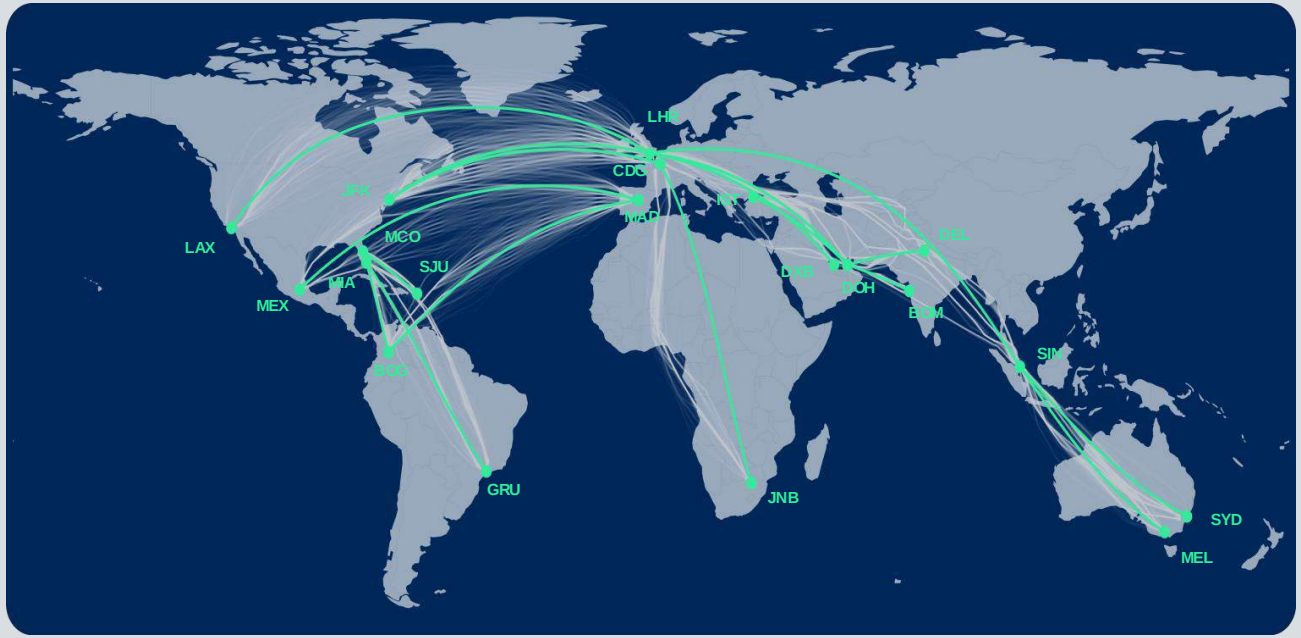
CONSIDERATIONS

Measures are **restricted to the en-route environment**:
- 40 NM from origin
- 100 NM from destination

KPI normalization ensures comparability across routes:
- Extension →normalized by Great Circle Distance (GCD)
- Time Variability →normalized by average travel time

2024 PERFORMANCE KPIs

		2023	2024	Δ
Traffic [# ATMs]		118 494	124 585	+5.1 %
Flown Distance [NM]	*Total*	313 M	335 M	+7.2 %
	Per Flight	2639	2691	+2.0 %
En-Route Extension [NM]	*Total*	9.7 M	13.2 M	+35 %
	Per Flight	82	106	+29 %
En-Route Flight Time [min]	*Total*	38.8 M	41.3 M	+6.4 %
	Per Flight	327	331	+1.1 %
Flight Time Variability [min]	*Per Flight*	27.6	28	+1.4 %



Based on three core KPIs from CANSO's 21-metric framework, the analysis examines 17 high-traffic routes – 3% of global interregional flights by traffic – backed by strong ADS-B data.

INSIGHTS

DRIVING ACTIONS THROUGH DATA

2024 AIR TRAFFIC PERFORMANCE

- **GEOPOLITICAL CONFLICTS AS THE CAUSE OF AIR TRAFFIC PERFORMANCE DEGRADATION IN SOME ROUTES FOR 2024**

  En-route distance extension drop with respect to 2023 is mainly due to conflict-related airspace closures, especially in Central Africa, Southwest Asia, and northern South America – impacting several key interregional flows.

- **CONSISTENT OPERATION IN THE NETWORK DESPITE ROUTING CONSTRAINTS**

  While the mentioned geopolitical events have led to extension performance drop, flight time variability has been resilient. Increases in variability are usually tied to short-term disruptions, not long-term constraints.

- **DISRUPTION TO SURVEILLANCE DATA**

  ADS-B data has been increasingly compromised in comparison to 2023 due to jamming and spoofing in conflict zones, requiring careful filtering for consistent performance computation.

CANSO's BENCHMARKING

- **GLOBAL AIR TRAFFIC PERFORMANCE AWARENESS**

  CANSO's benchmarking strengthens international routes monitoring, which support CONOPS planning, trend analysis, and systemic performance tracking.

- **REGIONAL COLLABORATIVE DIALOG ACROSS ANSPs AND AIRLINES**

  Interregional air traffic performance monitoring uses ATM performance metrics to foster dialogue, identify collaboration opportunities, and build a shared understanding of interregional performance levels.

- **INTEGRATED LOCAL APPLICATION**

  CANSO's benchmarking framework offers an analytical lens that can highlight systemic regional patterns, enabling actions at local scope. Such monitoring systems can also be highly beneficial when applied at airport, ANSP and airline level.

Report structure

The report is organized in **two sections**

Routes overview

Identify general trends, differences between routes covering similar distances and highlight directional differences within each city pair

- **Performance metrics across routes:** Key metrics for all routes – traffic, distance, extension, time, and variability
- **Flight distance distribution:** Spread of actual distances per route, with the GCD as reference
- **Average en-route extension:** Typical distance flown per route exceeding the direct great-circle-distance
- **Flight time average and variability:** Typical time to fly through a route and the consistency of this flight time
- **Integrated Performance assessment:** Simultaneous visualization of en-route extension and time variability, with traffic and GCD as context

City pair factsheets

Provide detailed KPI results for each route direction within a city pair, including year-over-year comparisons, monthly trends, and trajectory maps

- **KPIs outcomes:** Number of ATMS and average flight distance, flight time, en-route extension and flight time variability per city pair
- **Year-over-year percentage increase:** Percentage difference for each metric compared to the same period in the previous year
- **Trajectories maps:** Visual comparison of flight trajectories for the current and previous year
- **Metrics monthly trends**: Evolution of all metrics over the past 24 months, shown month by month

Performance Metrics Across Routes

Provides a comparative overview of KPIs across all analysed routes, including traffic levels, distance flown, extensions, and temporal variability

Routes 1-9

City pair	Route	Traffic (# ATMs)	Avg. Flight Distance (NM)	Avg. Extension lower bound – upper bound (NM)	Avg. Flight Time (min)	Flight Time Variability (min)
Bogota - Madrid	BOG ➔ MAD	2907	4295	89-97	503	33
	MAD ➔ BOG	3091	4329	123-131	546	43
Bogota – Miami	BOG ➔ MIA	3488	1232	48-63	156	12
	MIA ➔ BOG	3487	1222	42-53	153	10
Ciudad de México – Madrid	MEX ➔ MAD	2076	4914	139-150	552	41
	MAD ➔ MEX	2076	4982	209-218	633	67
Doha – London	DOH ➔ LHR	3186	2817	113-124	367	28
	LHR ➔ DOH	3186	2797	96-103	332	23
Dubai – Istanbul	DXB➔ IST	3249	1648	139-152	221	28
	IST ➔ DXB	3249	1642	135-146	196	19
Dubai – London	DXB ➔ LHR	3760	2990	142-157	391	33
	LHR ➔ DXB	3761	2975	134-143	346	23
Dubai – Mumbai	DXB ➔ BOM	5642	935	23-34	111	18
	BOM ➔ DXB	5642	935	32-34	123	22
Dubai – New Delhi	DXB ➔ DEL	4750	1113	66-73	128	22
	DEL ➔ DXB	4749	1151	82-111	158	33
Johannesburg – Paris	JNB ➔ CDG	366	4963	380-401	609	20
	CDG ➔ JNB	366	4989	393-428	606	20

Table 2: Key Operational Performance Metrics by City Pair – Including Traffic, Flight Distance, En-Route Extensions, Average Flight Time and Variability (2024 data)

Performance Metrics Across Routes

Provides a comparative overview of KPIs across all analysed routes, including traffic levels, distance flown, extensions, and temporal variability

Routes 10-17

City pair	Route	Traffic (# ATMs)	Avg. Flight Distance (NM)	Avg. Extension lower bound – upper bound (NM)	Avg. Flight Time (min)	Flight Time Variability (min)
London – Los Angeles	LHR → LAX	3638	4755	119-154	600	37
	LAX → LHR	3637	4748	132-147	543	32
London – New York	LHR → JFK	7781	2951	85-92	393	36
	JFK → LHR	7778	2919	42-60	335	31
London – Singapore	LHR → SIN	2543	6172	415-433	715	34
	SIN → LHR	2561	6184	440-445	772	49
Melbourne – Singapore	MEL → SIN	3884	3162	39-50	402	29
	SIN → MEL	3856	3183	63-70	373	22
Miami – São Paulo	MIA → GRU	1525	3569	143-170	427	26
	GRU → MIA	1524	3544	138-145	428	21
New York – Paris	JFK → CDG	3895	3076	45-57	355	32
	CDG → JFK	3894	3133	105-114	415	37
Orlando – San Juan	MCO → SJU	6308	908	8-15	112	12
	SJU → MCO	6313	921	13-29	128	16
Singapore – Sydney	SIN → SYD	3219	3352	69-97	391	25
	SYD → SIN	3198	3318	56-63	419	31

Table 2: Key Operational Performance Metrics by City Pair – Including Traffic, Flight Distance, En-Route Extensions, Average Flight Time and Variability (2024 data)

Flight Distance Distribution

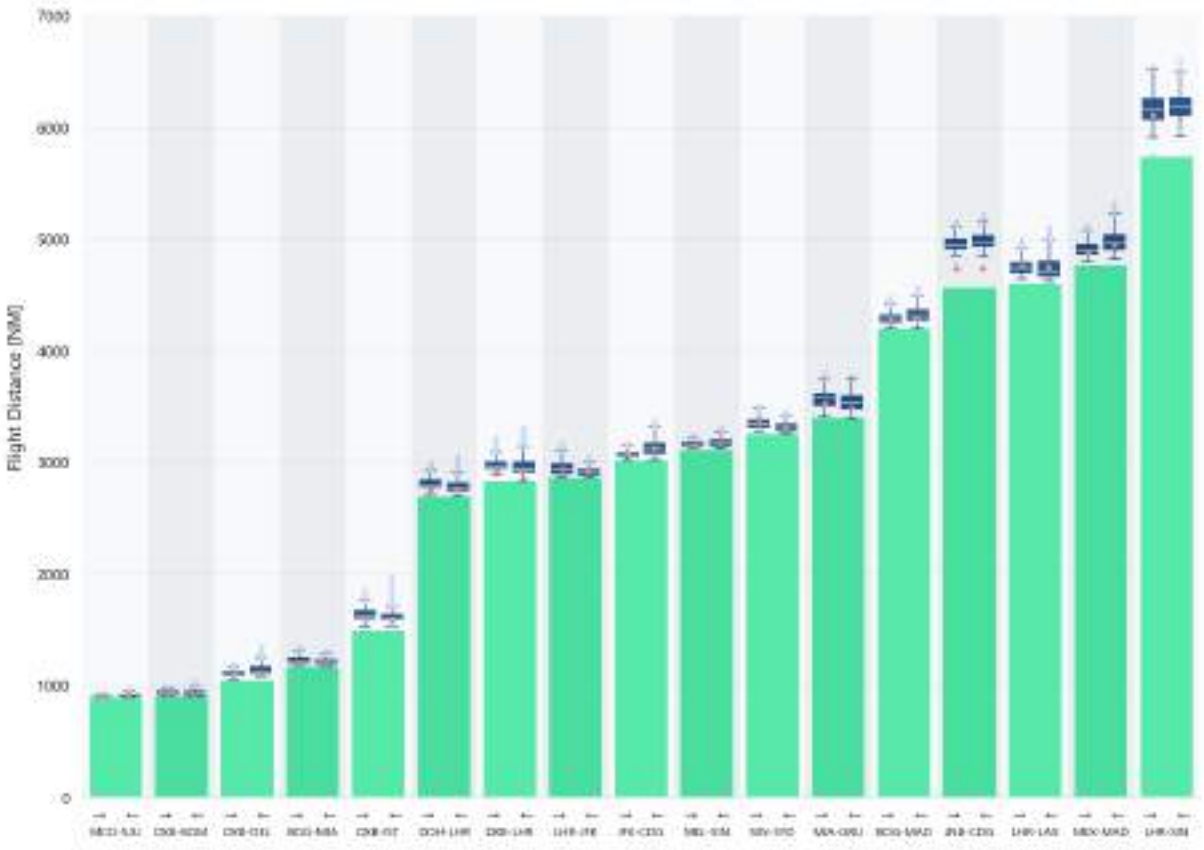
Shows the statistical distribution of actual en-route distances flown, providing insight into the typical and extreme values observed across flights, with the GCD as reference

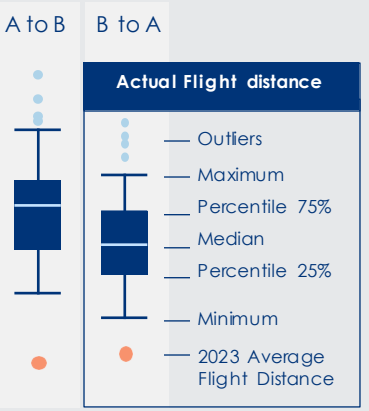
Flight Distance Analysis

Within this plot, a first point of interest is the presence of routes with large dispersions compared to others of similar Great Circle Distance (GCD). This suggests considerable variability in how these routes were operated throughout 2024. In some cases, this reflects punctual re-routings, in others a gradual shift in preferred trajectories over time, and on others it indicates the co-existence of distinct routings for the same city pair.

Another relevant pattern involves routes where the minimum observed flight distance remains well above the GCD. This indicates that, even under optimal conditions, these routes cannot follow a direct trajectory - typically due to persistent constraints in the airspace between origin and destination.

While not directly confirmed by the data, observed patterns likely stem from a mix of factors such as geopolitical tensions, airspace restrictions, oceanic routing, and airline-specific practices, though geopolitical constraints appear to play a central role in many cases.





GCD

Each bar shows the great-circle distance in green, with boxplots on top representing actual flight distances for each direction between the city pair. The box indicates where the middle 50% of flights fall, while the line inside marks the median. The "whiskers" show minimum and maximum values, with blue dots representing outliers.

Figure 1: Distribution of En-Route Flight Distances compared to Great Circle Distances (GCD) across Selected Routes (2024 data)

Average En-Route Distance Extension

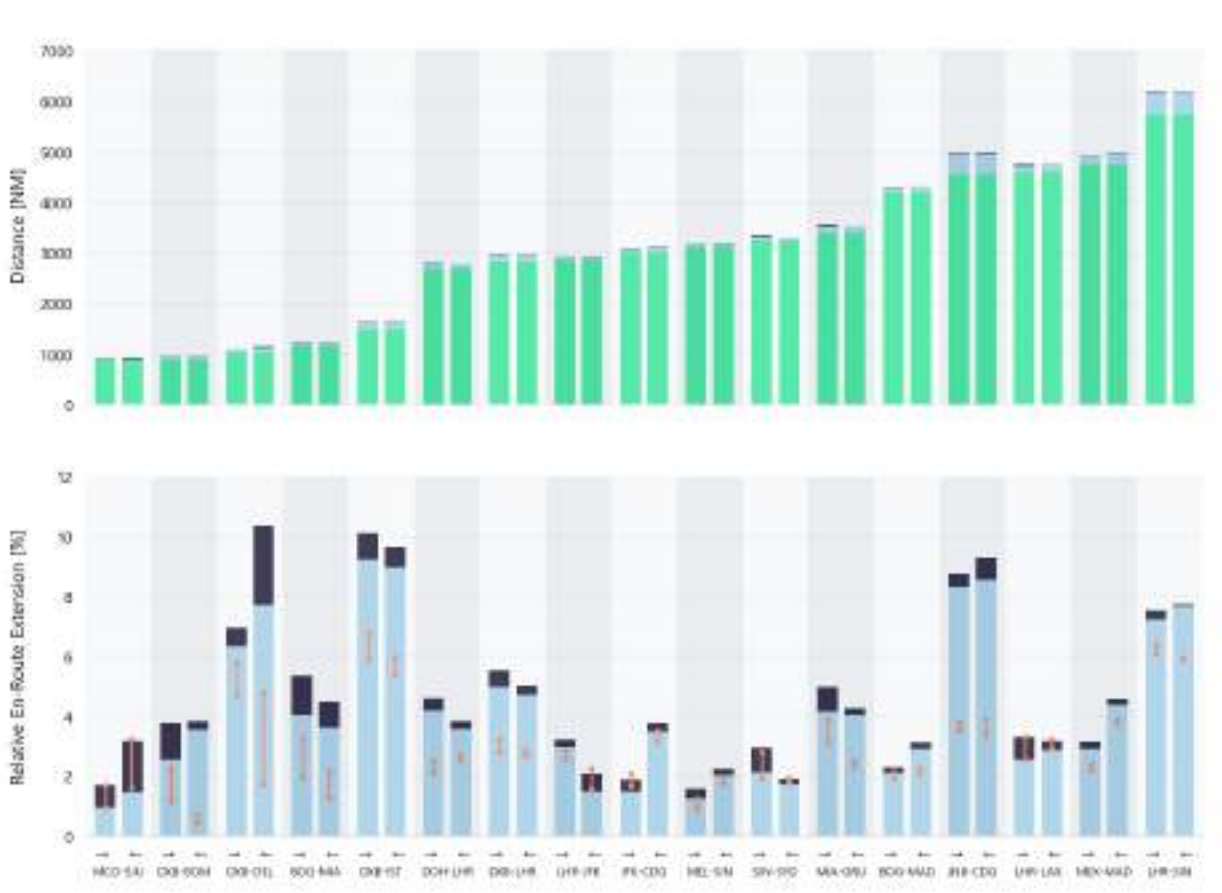
Represents the average extra distance flown beyond the GCD calculated en-route, capturing potential routing or traffic constraints

En-Route Distance Extension Analysis

The analysis of average en-route extension builds on the patterns observed in flight distance distributions. Some routes show systematically high extensions relative to their GCD, suggesting persistent structural restrictions to the routes. These may be linked to regional airspace constraints or long-standing routing conventions.

Directional asymmetries in extension are also frequent, with one direction showing consistently higher extension than the other. This may reflect differences in airspace availability, routing procedures, or traffic management strategies such as for routes traversing the North Atlantic which must follow the NAT-OTS due to high airspace utilisation and reduced radar coverage.

In several cases, wide gaps between the upper and lower bounds of en-route extension suggest constraints related to airport entry or exit procedures, as these differences imply that flights cannot align their arrival or departure paths with the trajectory defined by the GCD.



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CANSO defines en-route extension relative to two GCD-based references:

1. **Lower Bound:** The GCD between the points where the actual flight path intersects the 40 NM (origin) and 100 NM (destination) circles
2. **Upper Bound:** The GCD between the airport-to-airport path intersecting those same circles. This represents the minimum possible en-route path and therefore the maximum extension. This is the GCD represented in the plot with a green bar.

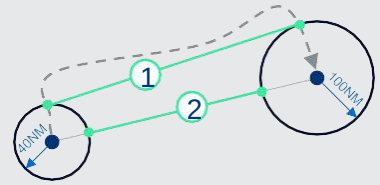


Figure 2: Average En-Route Extension across Selected Routes (2024 Data). Top: Absolute Extension and GCD (NM) | Bottom: Relative Extension (% of GCD)

CITY PAIRS FACTSHEET

MIAMI – SÃO PAULO

GENERAL OVERVIEW

MIA → GRU

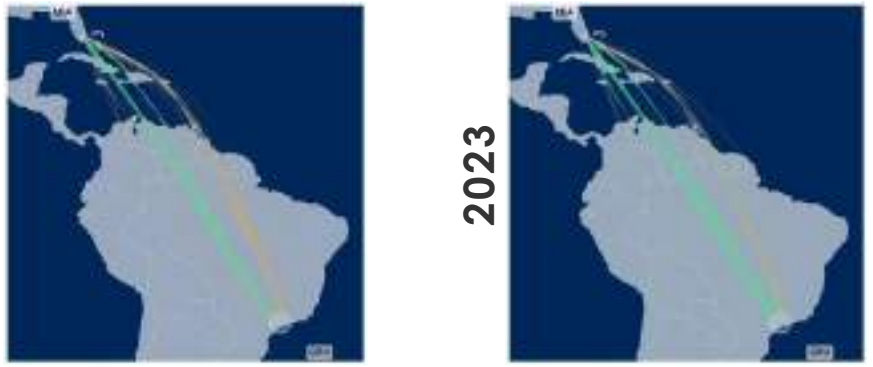
Traffic
1525
#ATMS
▲ +9 %

Flight Distance (Avg.)
3569 NM
▲ +38 NM

Flight Time (Avg.)
427 min
➡ +0 min

Extension (Lower to Upper, Avg.)
143 to 170 NM
▲ +36 NM / +38 NM

Flight Time Variability (85–15 Percentile Range)
26 min
▲ +3 min



0.6 En-route extension [%] 6.6

GRU → MIA

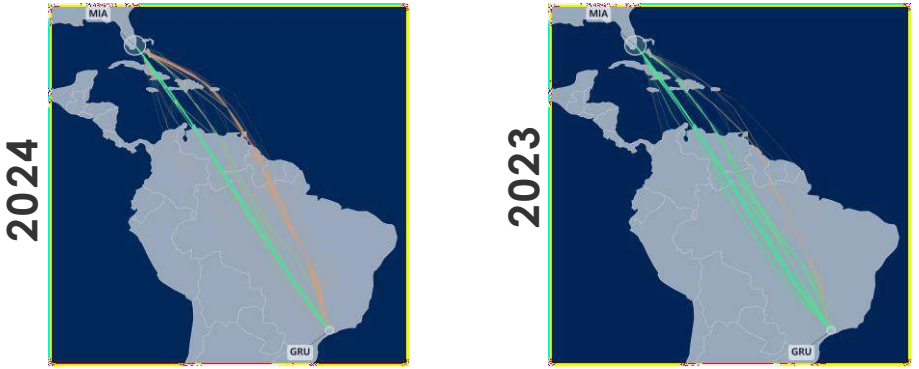
Traffic
1524
#ATMS
▲ +9 %

Flight Distance (Avg.)
3544 NM
▲ +59 NM

Flight Time (Avg.)
428 min
➡ +0 min

Extension (Lower to Upper, Avg.)
138 to 145 NM
▲ +58 NM / +59 NM

Flight Time Variability (85–15 Percentile Range)
21 min
➡ +0 min



0.6 En-route extension [%] 6.6

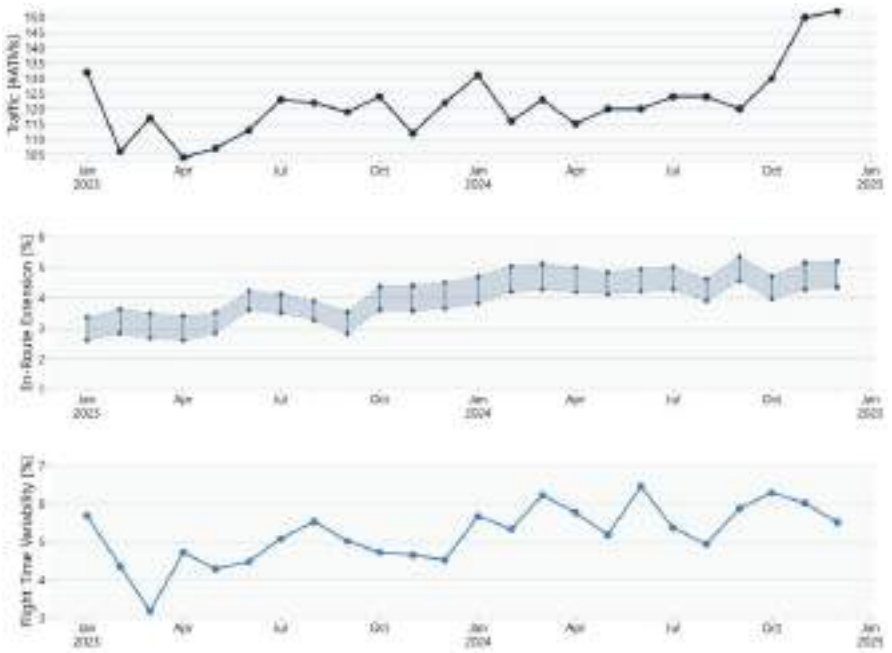
Values correspond to 2024, with changes measured against 2023.

CITY PAIRS FACTSHEET

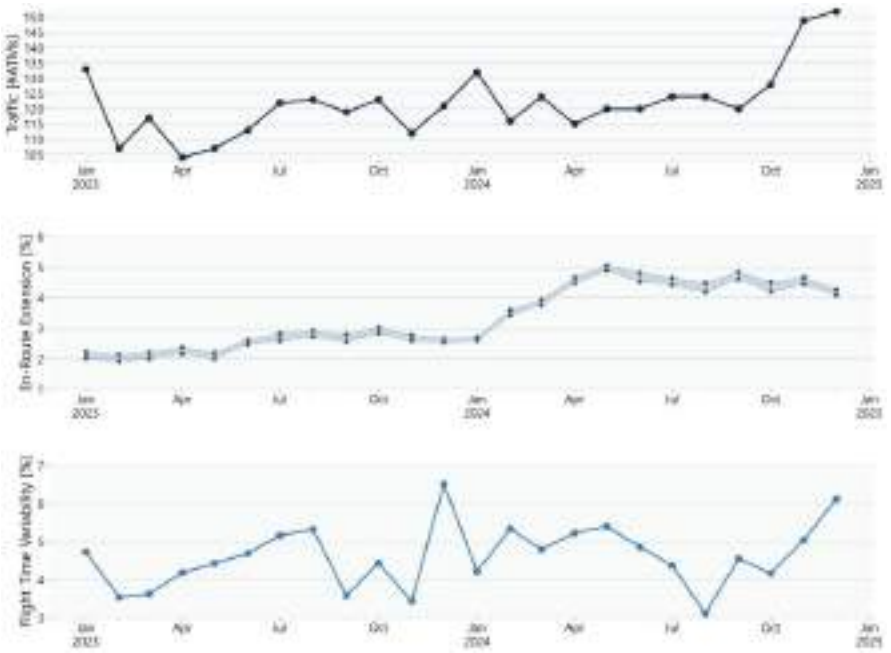
MIAMI – SÃO PAULO

TEMPORAL EVOLUTION

MIA → GRU



GRU → MIA



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Global Air Navigation Services Performance Report

CANSO

Global Air Navigation Services Performance Report

Focus on cost efficiency and productivity

The CANSO Global Air Navigation Services (ANS) Performance Report is produced annually by CANSO's Global Benchmarking Workgroup (GBWG), with analytical support provided by Egis.

The 2023 report presents data for 48 ANSPs and includes performance indicators for the year 2023, along with trend data covering the period from 2019 to 2023.

To facilitate a credible comparison of performance, the ANSPs that submitted data to CANSO were grouped into three comparator categories based on the number of IFR hours managed.

Goal to provide a truly global perspective by increasing ANSP participation.

2022 Report

Global Air Navigation Services Performance Report

Focus on cost efficiency and productivity

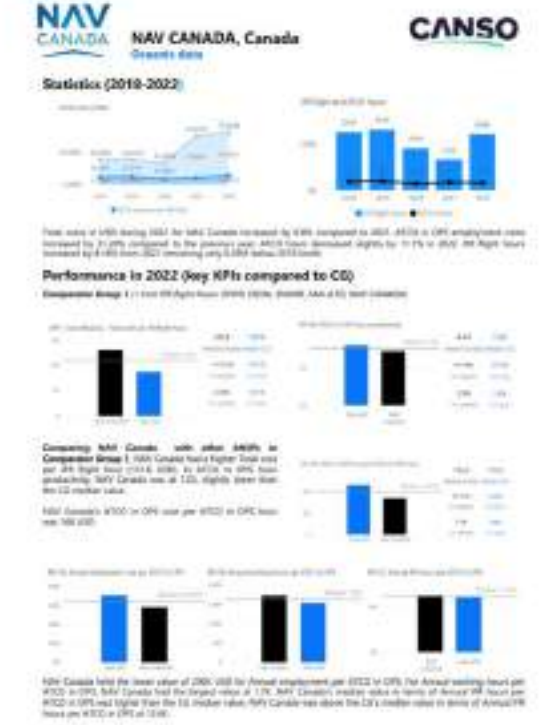
2022 Performance Data

The following section presents 2022 performance data and 2018-2022 trend data for both continental and oceanic activities in line with the CANSO ANS Performance Framework levels 1-3 (see Figure 2b) and list of KPIs below.

	KPI	Numerator	Denominator	Figure	
Cost Efficiency and Productivity Performance Indicators				**Continental 2022/Trend**	**Oceanic 2022**
1	cost per IFR flight hour	Total costs	IFR flight hours	Figure 3	Figure 14
2A	ATCO in OPS employment cost per ATCO in OPS hour	Employment costs for ATCOs in OPS	ATCOs in OPS hours	Figure 4, Figure 5	Figure 15,16
2B	ATCO in OPS hour productivity	IFR flight hours	ATCOs in OPS hours	Figure 6	Figure 17
2C	Cost excluding ATCOs in OPS employment costs per IFR flight hours	Costs excluding employment costs for ATCOs in OPS	IFR flight hours	Figure 7	Figure 18
2D	Employment costs of ATCOs in OPS as a percentage of total costs	Employment costs for ATCOs in OPS	Total costs	Figure 8	Figure 19
3A	Annual employment cost per ATCO in OPS	Employment cost for ATCOs in OPS	No. of ATCOs in OPS (FTE)	Figure 9, Figure 10	Figure 20, Figure 21
3B	Annual Working hours per ATCO in OPS	ATCOs in OPS hours	No. of ATCOs in OPS (FTE)	Figure 11	Figure 22
3C	Annual IFR hours per ATCO in OPS	IFR flight hours	No. of ATCOs in OPS (FTE)	Figure 12	Figure 23
3D	Ratio of frontline service staff to ATCO in OPS	No. of frontline service support staff (FTE)	No. of ATCOs in OPS (FTE)	Figure 13	Figure 24
Joint Continental and Oceanic Cost Efficiency Performance Indicators				**Continental and Oceanic 2022/Trend**	
CE1	Cost per IFR flight hour	Total costs	IFR flight hours	Figure 25	
CE2D	Employment costs of ATCOs in OPS as a percentage of Total costs	Employment costs for ATCOs in OPS	Total costs	Figure 26	

Continental

Oceanic



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THANK YOU

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