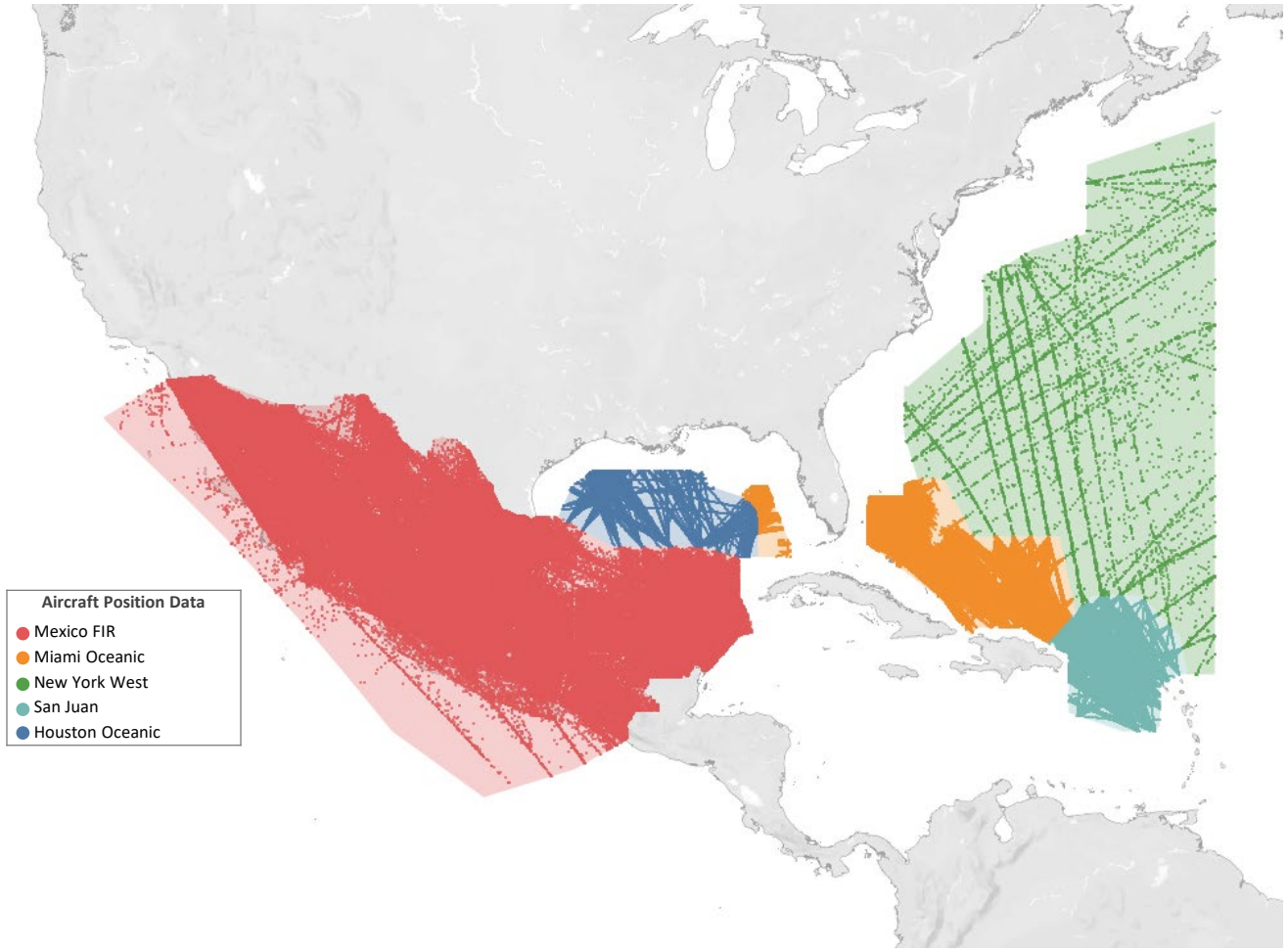


NAARMO 2025 Vertical Safety Analysis for Caribbean FIRs

CAR/SAM Planning and Implementation Regional Group (GREPECAS)
Twenty-Sixth Scrutiny Working Group Meeting (GTE/26)
Mexico City, Mexico, 12-16 October 2026

NAARMO Vertical Safety Analysis For Caribbean FIRs| Traffic Sample and Airspace

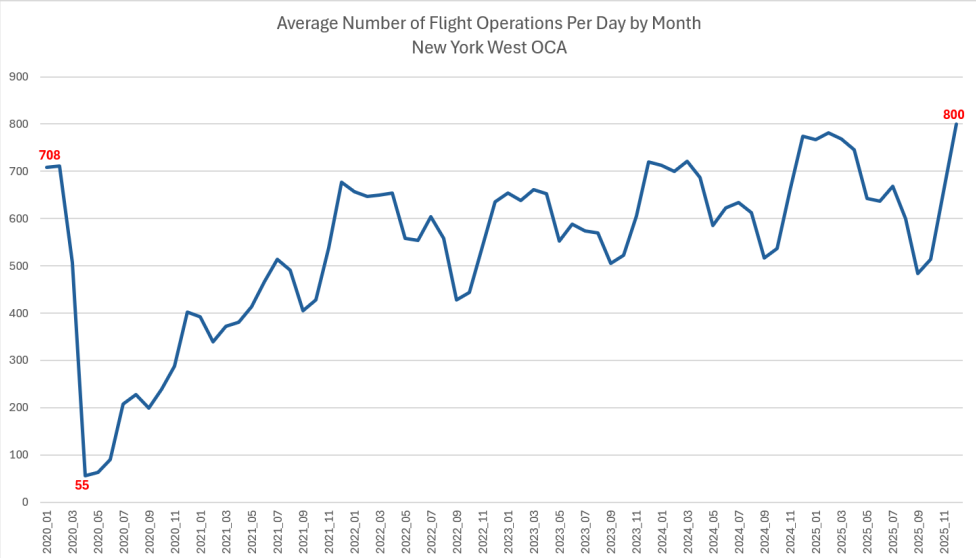
Aircraft Position Data for the Caribbean FIRs

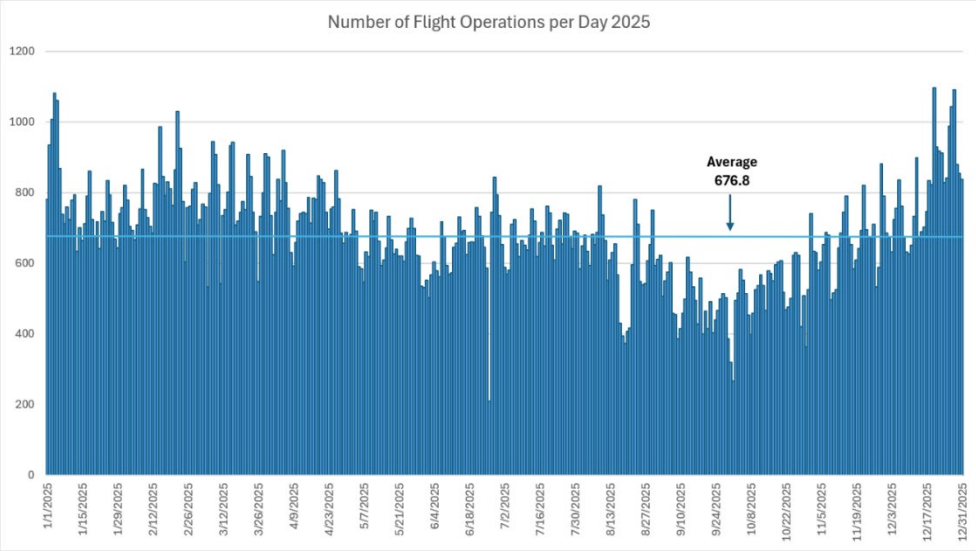


The figure presents the aircraft positions provided in the ATOP DR&A and Traffic Flow Management System (TFMS) data for 23 December 2025. These data include:

- TFMS (Mexico): date, time, latitude, longitude, flight level, aircraft flight identification, aircraft type, origin airport and the destination airport
- ATOP (NYW): all the reported aircraft positions, as well as the pilot-ATC High Frequency (HF) radio communications and Controller Pilot Data Link Communications (CPDLC) messages
- ADS-B(Houston, Miami and San Juan): date, time, latitude, longitude, flight level, aircraft flight identification, aircraft type, origin airport and the destination airport

NAARMO Vertical Safety Analysis For Caribbean FIRs| Traffic Sample and Airspace





The top graph illustrates the average number of daily flight operations per month in the New York West FIR from 2020 to 2025. Seasonal traffic variations are evident, with peak traffic typically occurring between November and April/May. Notably, the data shows that traffic volumes have recovered to pre-pandemic levels:

- By late 2025, the average daily flight operations peak at **800 flights**, surpassing the pre-pandemic levels observed in early 2020.

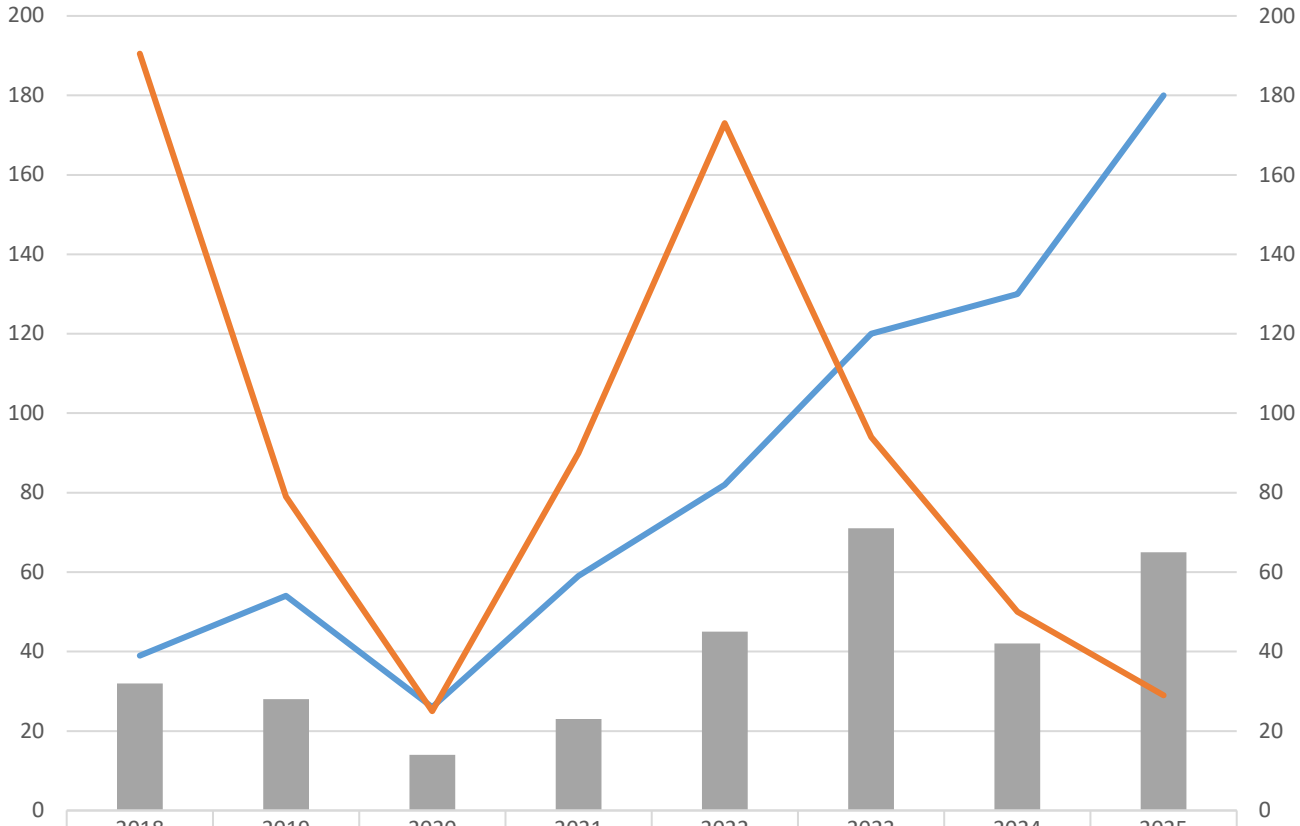
As shown in the bottom graph, the average number of daily flight operations within New York West FIR in calendar year 2025 is **677**, reflecting an increase from the estimated 607 daily flights in 2024:

- an **increase** in daily flight operations.
- a trend toward increased traffic volume, peaking near the end of the year

NAARMO Vertical Safety Analysis For Caribbean FIRs| Reported Large Height Deviations (LHDs)

The chart presents a comparison of:

- The reported number of Large Height Deviations
- Time spent at an incorrect flight level
- The flight levels crossed without ATC clearance from 2018 through 2025
  - There were 180 reported reviewed occurrences
  - The **increase** in the number of validated reports corresponds with traffic counts

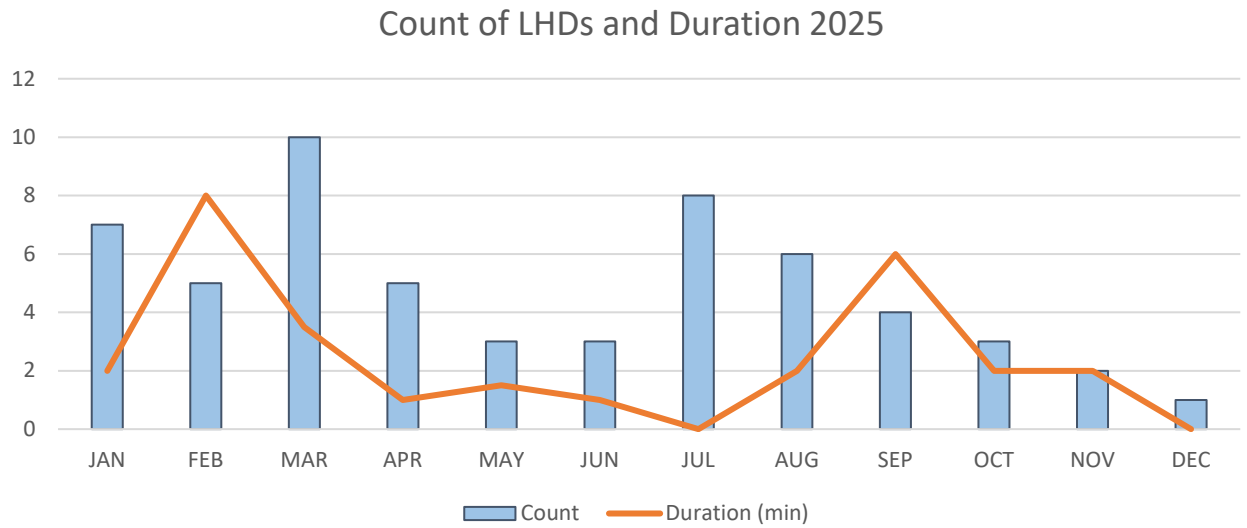


	2018	2019	2020	2021	2022	2023	2024	2025
Total RVSM Levels Crossed	32	28	14	23	45	71	42	65
Number of Validated LHD Reports	39	54	26	59	82	120	130	180
Total Time at Incorrect FL (Min)	190.5	79	25	90	173	94	50	29

NAARMO Vertical Safety Analysis For Caribbean FIRs| Reported Large Height Deviations (LHDs)

There were **180** reported occurrences reviewed by the scrutiny group. The scrutiny group determined that **57** reports were actual LHD occurrences during calendar year 2025.

- The total duration spent at an incorrect flight level was **29** minutes.
- The total uncleared flight levels crossed were **65**.

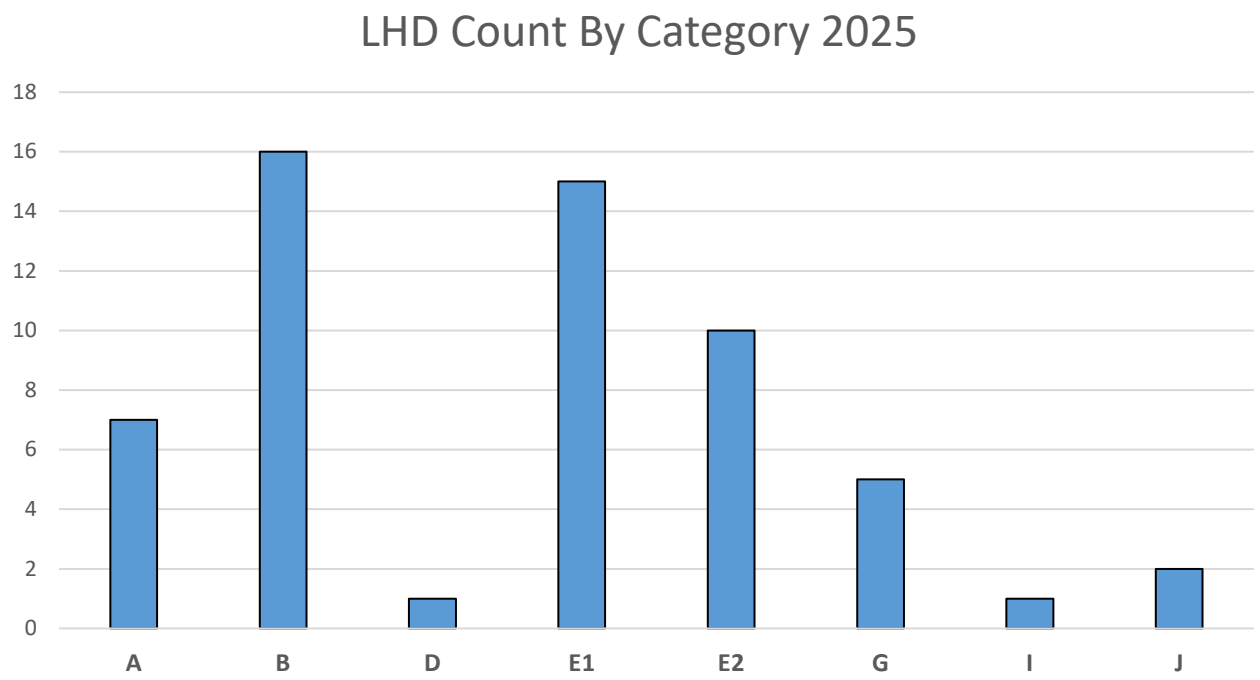


Month	Count	Duration at Unexpected FL (mins)	Number of Unexpected FLs Crossed
Jan-25	7	2	11
Feb-25	5	8	0
Mar-25	10	3.5	13
Apr-25	5	1	12
May-25	3	1.5	0
Jun-25	3	1	0
Jul-25	8	0	16
Aug-25	6	2	1
Sep-25	4	6	3
Oct-25	3	2	1
Nov-25	2	2	2
Dec-25	1	0	6
TOTAL	**57**	**29**	**65**

There were approximately an average of **5** events per month with March being the highest in count, and February in duration.

NAARMO Vertical Safety Analysis For Caribbean FIRs| Reported Large Height Deviations (LHDs)

- Category B had the highest number of reported LHDs (**16**)
- **3** technical risk LHDs:
  - **2** in Category J (TCAS RA followed correctly)
  - **1** in Category I (weather-related causes)

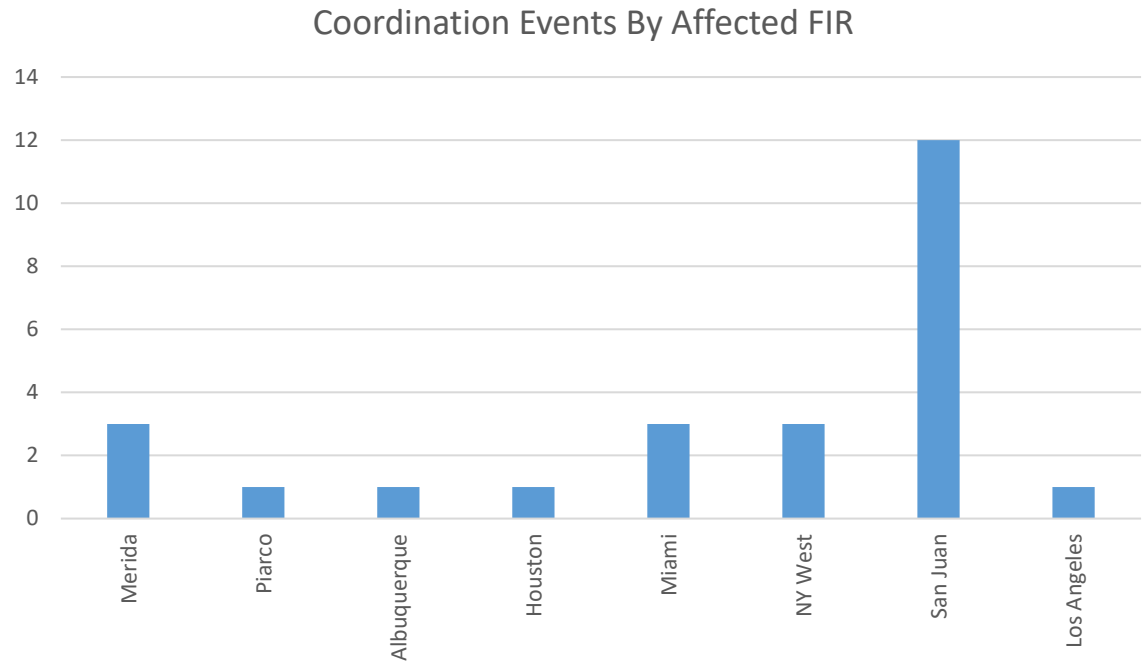


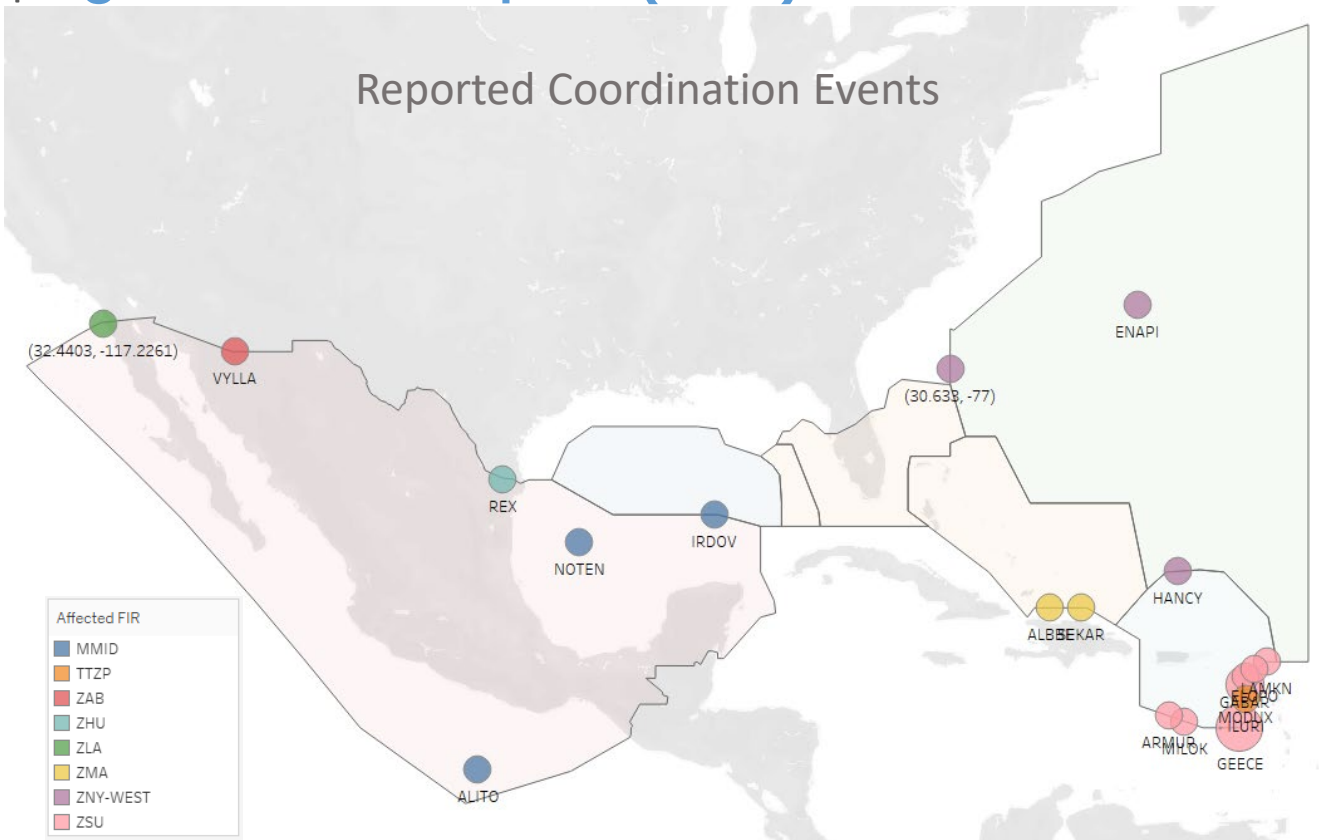
LHD Category Code	LHD Category Description	Number of LHD	Duration at Incorrect FL (minutes)	Number of Incorrect FLs Crossed
A	Flight crew failing to climb / descend the aircraft as cleared	7	0	10
B	Flight crew climbing /descending without ATC clearance	16	3	30
D	ATC system loop error; (e.g., ATC issues incorrect clearance or flight crew misunderstands clearance message)	1	0	0
E1	Coordination errors (wrong FL, time, route) in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues	15	13.5	9
E2	Negative Coordination in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues	10	12.5	0
G	Aircraft contingency event leading to sudden inability to maintain assigned flight level	5	0	16
I	Turbulence or other weather related causes	1	0	0
J	TCAS resolution advisory; flight crew correctly following the resolution advisory	2	0	0
	TOTAL	**57**	**29**	**65**

NAARMO Vertical Safety Analysis For Caribbean FIRs| Significant LHD Reports (LHDs)

In 2025, a total of **25** reported Large Height Deviations (LHDs) were attributed to errors in ATC coordination, specifically within categories **E1** and **E2**.

San Juan was affected by the highest number of events with **12**, followed by Mérida and Miami with **3** events each.



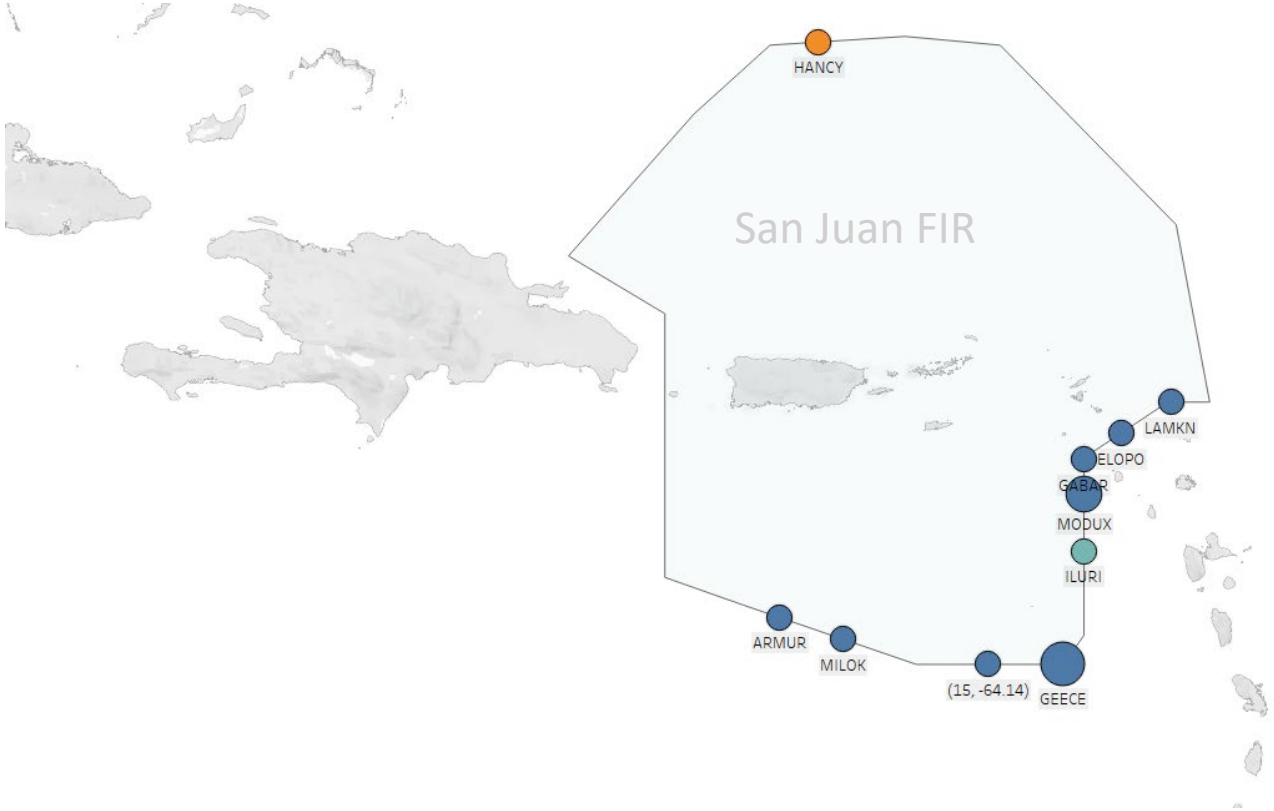


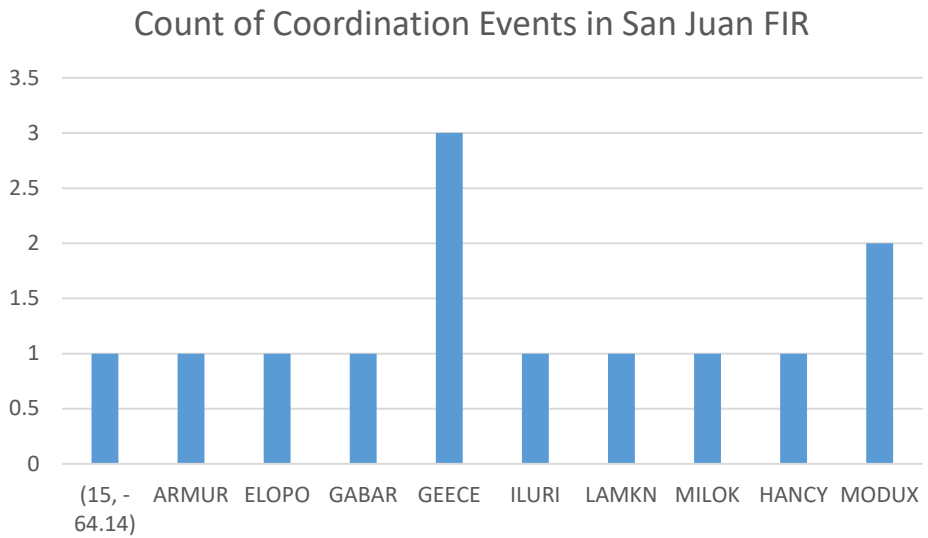
The map displays the approximate locations of these coordination-related events. Bubble color represents the affected FIR, while bubble size indicates the number of events at each location.

NAARMO Vertical Safety Analysis For Caribbean FIRs| Significant LHD Reports (LHDs)

In 2025, **52%** of all the reported coordination events occurred in the San Juan area.

The map displays event locations with bubbles placed over each fix. Bubble size reflects the number of events at each site, and **blue** bubbles indicate events where San Juan was the affected FIR.



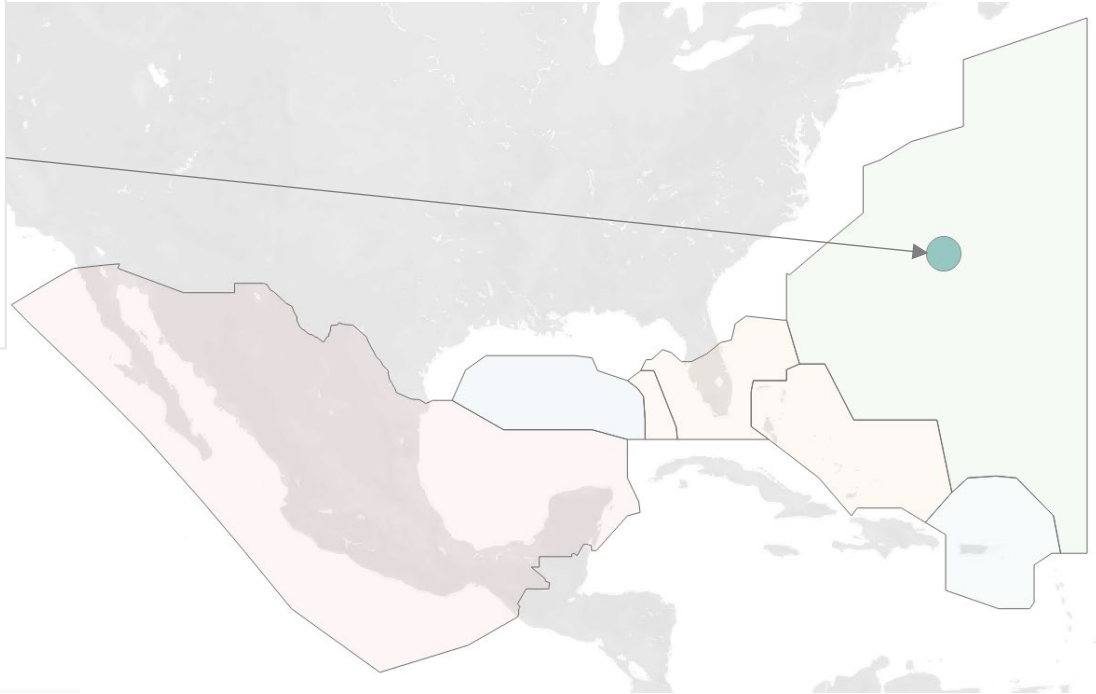


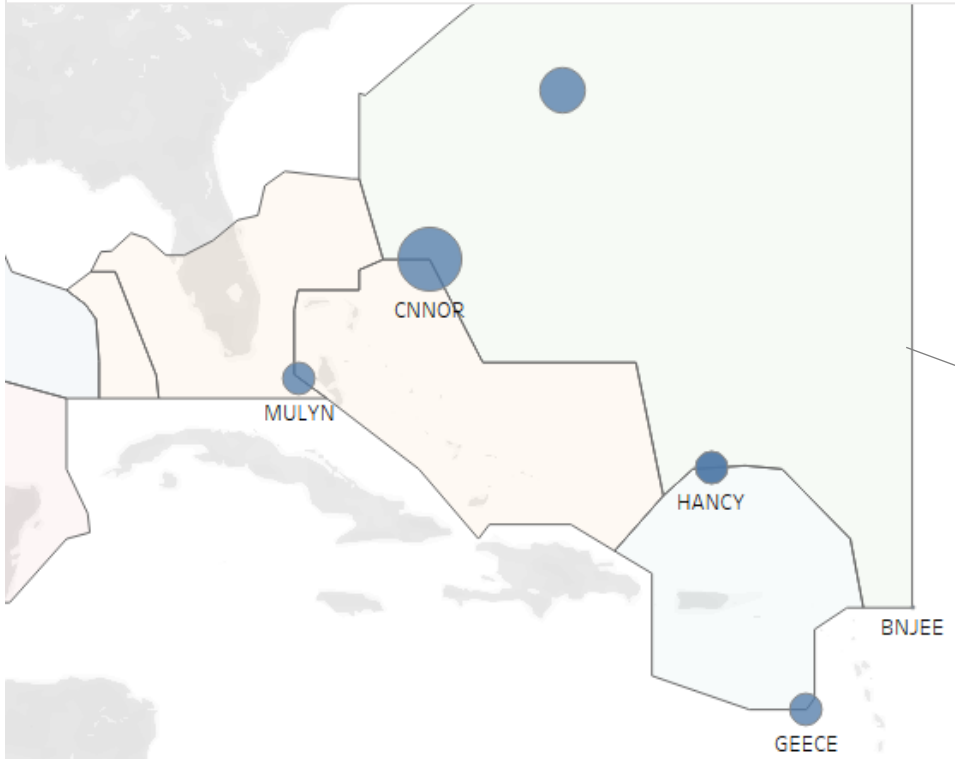
The graph displays the number of coordination events at each fix in San Juan FIR.

- GEECE has the highest count, with 3 events, making it the most active coordination point
- MODUX follows with 2 events

NAARMO Vertical Safety Analysis For Caribbean FIRs| Significant LHD Reports (LHDs)

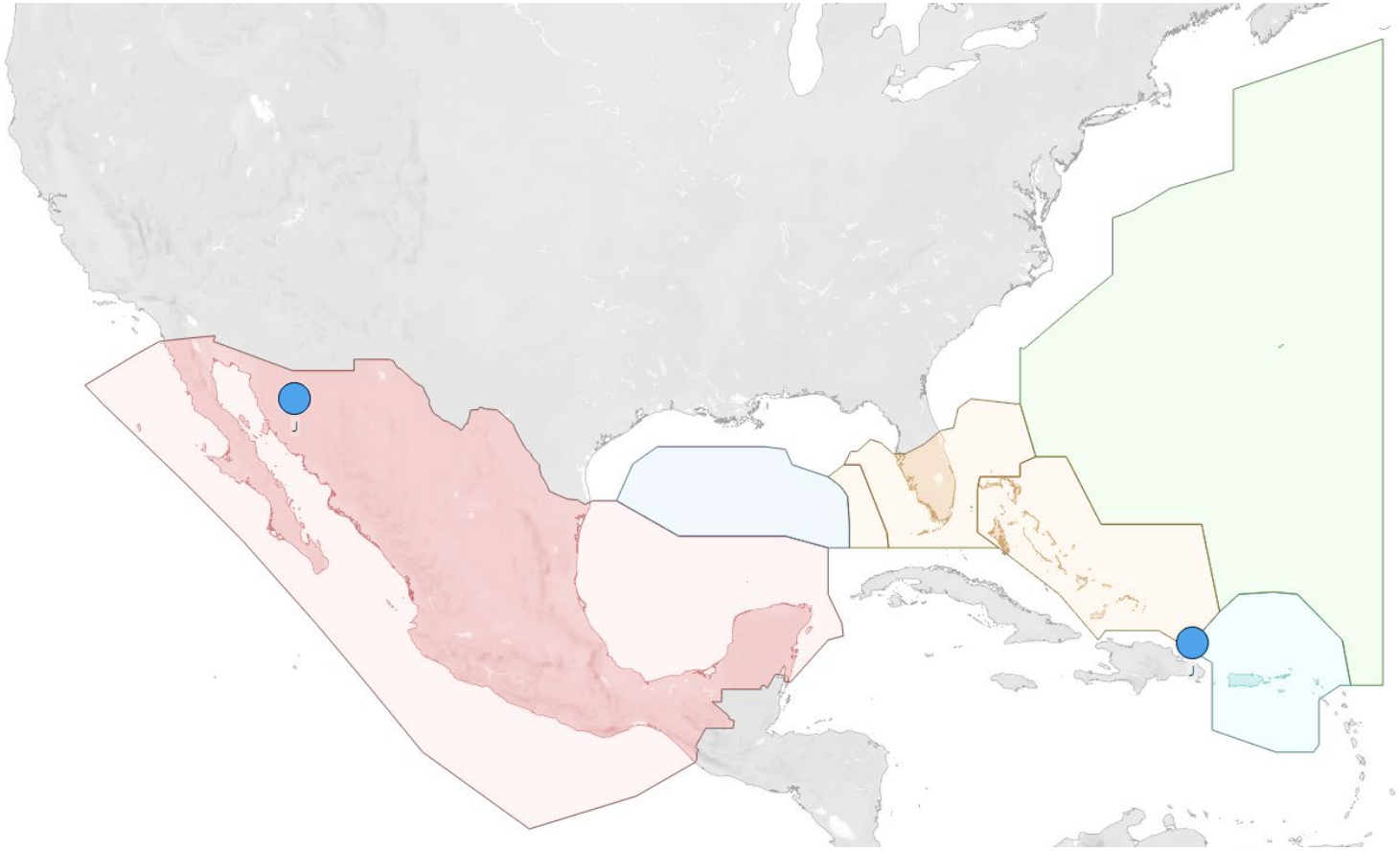
The largest contributor to operational vertical risk in 2025 was an event in ZNYW airspace involving opposite-direction traffic. The aircraft's flight plan was deleted preventing the flight from being coordinated. The aircraft was not protected in the airspace for approximately **4** minutes. The occurrence was assigned LHD category E2, with a secondary category of F, reflecting a coordination error during the ATC transfer associated with a technical issue.





Seven Category A events were reported in NY West and Miami/San Juan, all involving flight levels crossed without clearance. In one event, a pilot acknowledged and correctly read back a crossing restriction but failed to meet the assigned altitude, resulting in losses of nonradar separation with three aircraft under ZNY control. The event was classified as Category A, with a secondary classification of E1.

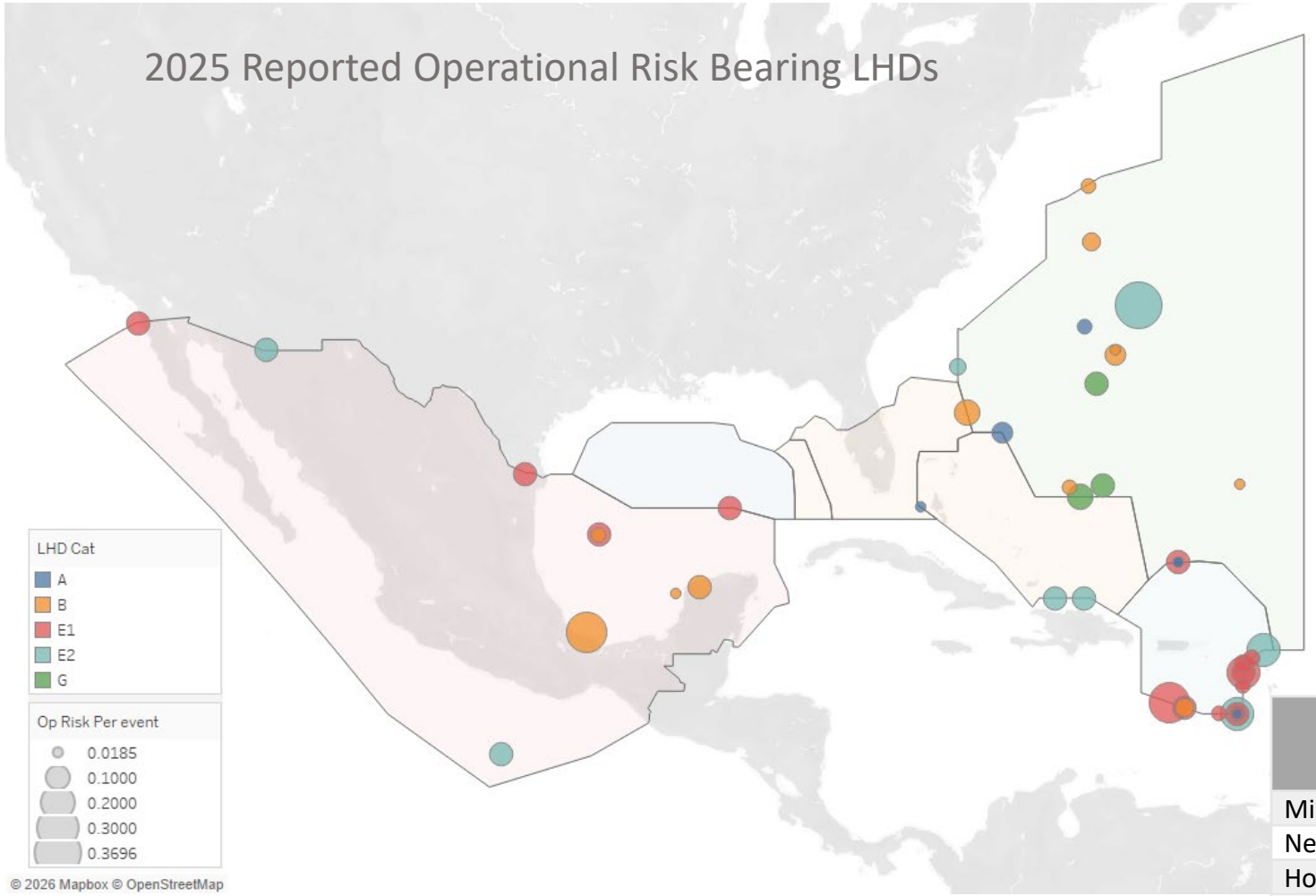
NAARMO Vertical Safety Analysis For Caribbean FIRs| Significant LHD Reports (LHDs)



Two Category J (TCAS) events were reported in 2025, one in the Miami/San Juan airspace and one in Mexico airspace.

In both events, proper separation was maintained; however, the aircrafts' rates of climb or descent triggered TCAS alerts. Both events were handled appropriately and did not contribute to the vertical operational risk estimate.

NAARMO Vertical Safety Analysis For Caribbean FIRs| Operational Risk Bearing LHD Reports



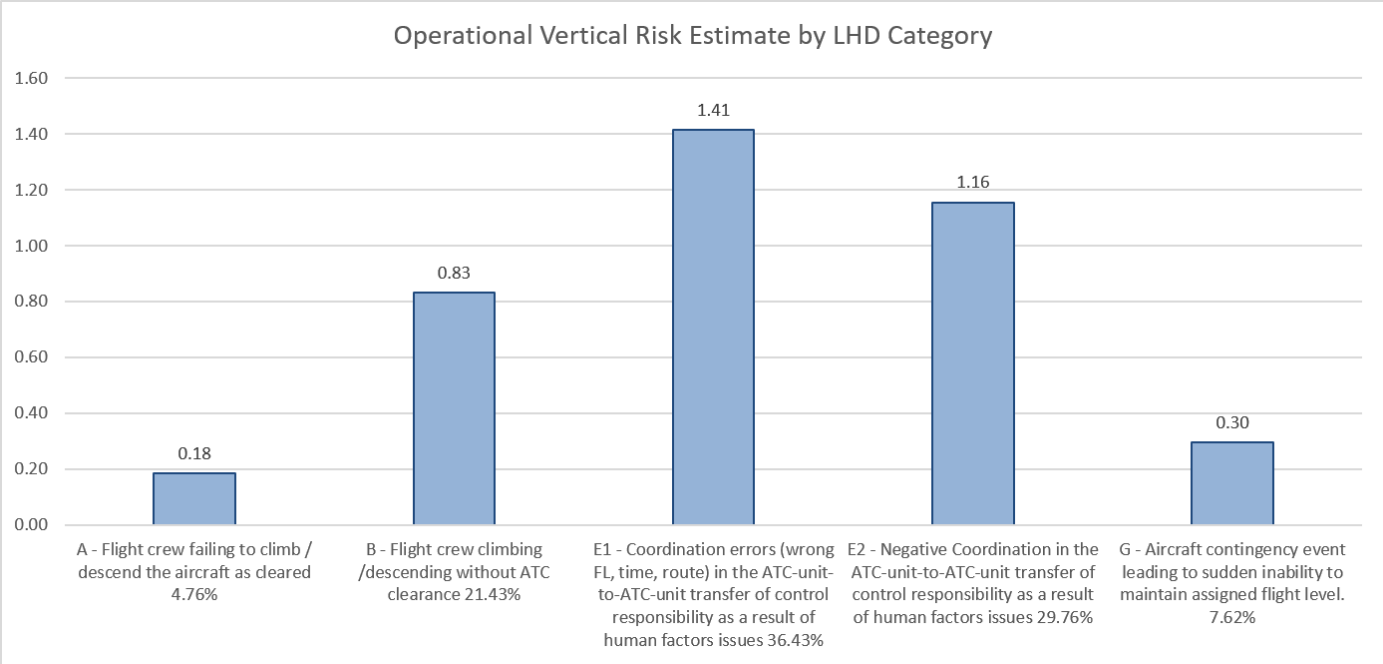
The operational risk-bearing LHD events are separated into four areas.

- Miami Oceanic/San Juan
- New York West
- Houston Oceanic
- Mexico

The figure illustrates the approximate locations of operational LHDs in 2025, with the size of each circle indicating the vertical collision risk estimate for the corresponding reported LHD.

Airspace	Number of LHD	Duration at unexpected FL (min)	Number of unexpected FLs crossed
Miami Oceanic/San Juan FIRs	22	14.5	15
New York West FIR	23	5.5	42
Houston Oceanic	1	1	0
Mexico	11	8	8
Total	**57**	**29**	**65**

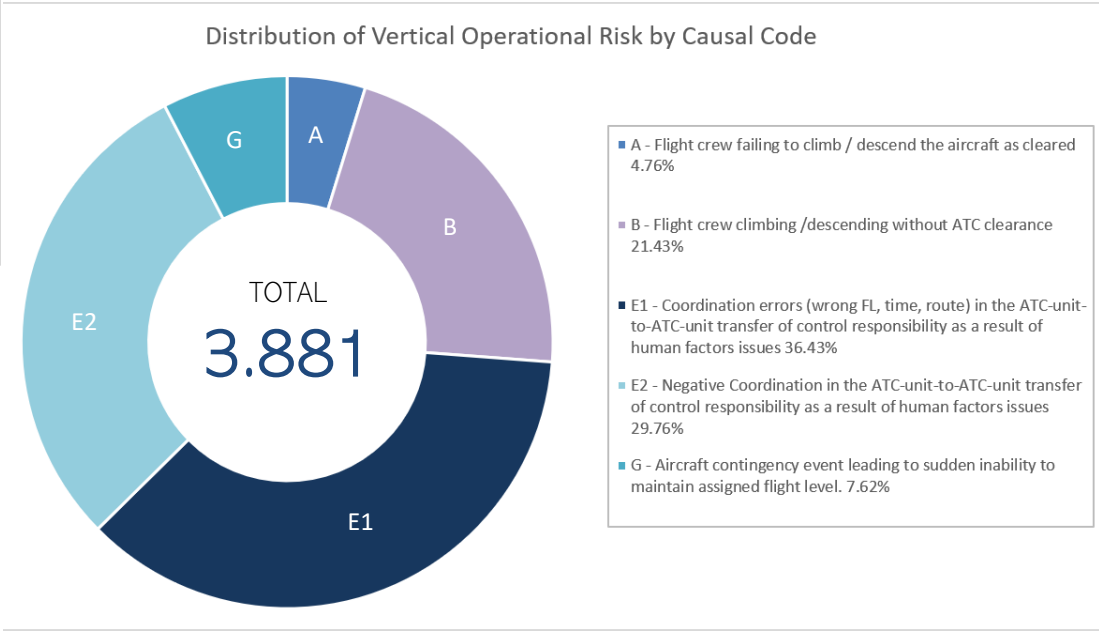
NAARMO Vertical Safety Analysis For Caribbean FIRs| Vertical Collision Risk Estimate



The bar chart presents the estimated vertical risk by LHD category. The vertical risk associated with Category E1 LHD reports is 1.41×10^{-9} fapfh, representing the majority of the total vertical risk. The next highest contributor is Category E2.

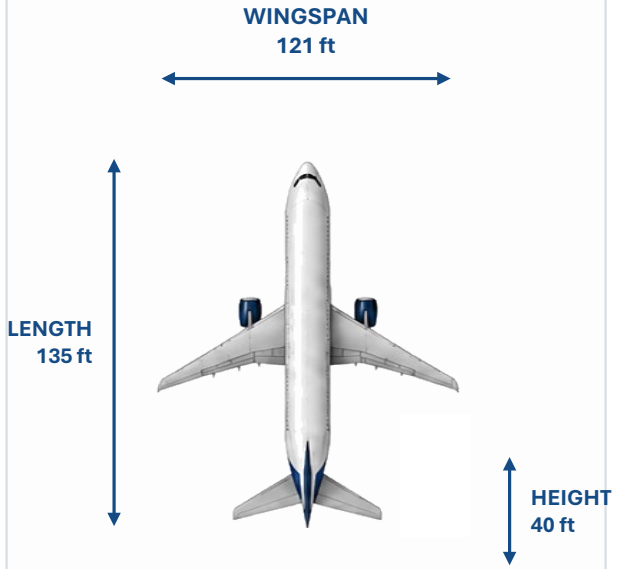
The pie chart shows the Operational Vertical Risk Distribution by LHD category.

- Coordination errors (E1, E2): **66%** of total risk
  - E1 (human factors coordination errors): 36%
  - E2 (no coordination): 30%
- Flight crew without ATC clearance(B): **21%**



NAARMO Vertical Safety Analysis For Caribbean FIRs | Vertical Collision Risk Estimate – AC Dimensions

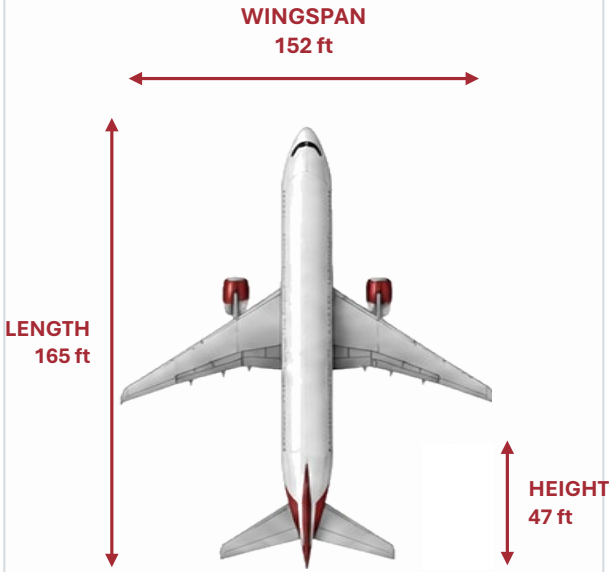
Miami Oceanic / San Juan



Parameters (NM)

Length λL	0.0223
Wingspan λW	0.0199
Height λH	0.0066

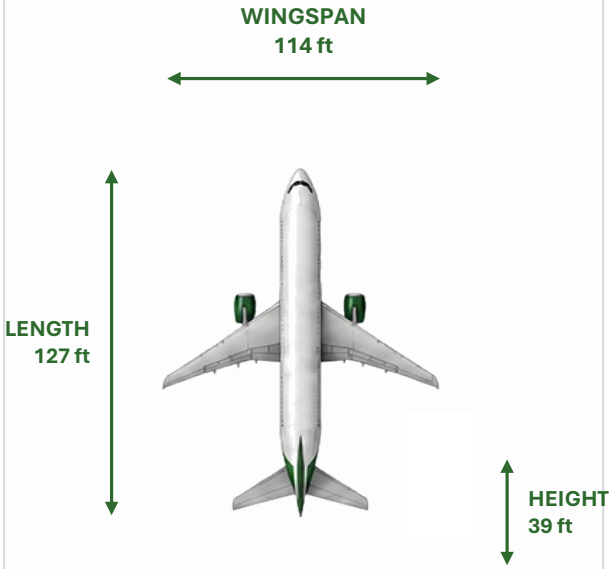
New York West



Parameters (NM)

Length λL	0.0272
Wingspan λW	0.0250
Height λH	0.0077

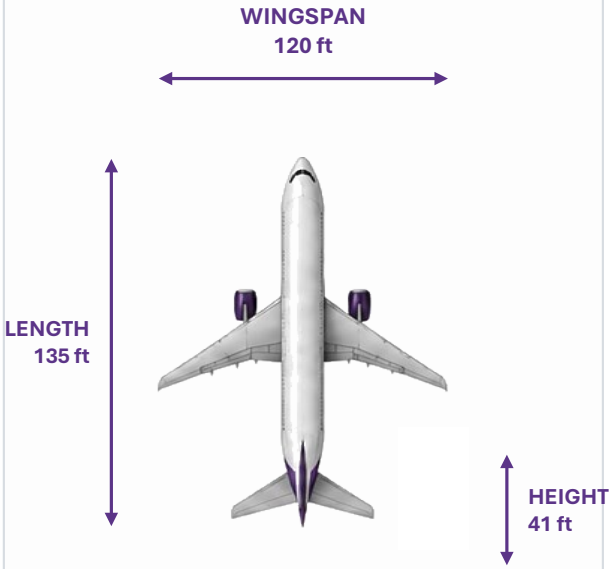
Mexico



Parameters (NM)

Length λL	0.0209
Wingspan λW	0.0188
Height λH	0.0064

Houston Oceanic



Parameters (NM)

Length λL	0.0222
Wingspan λW	0.0198
Height λH	0.0068

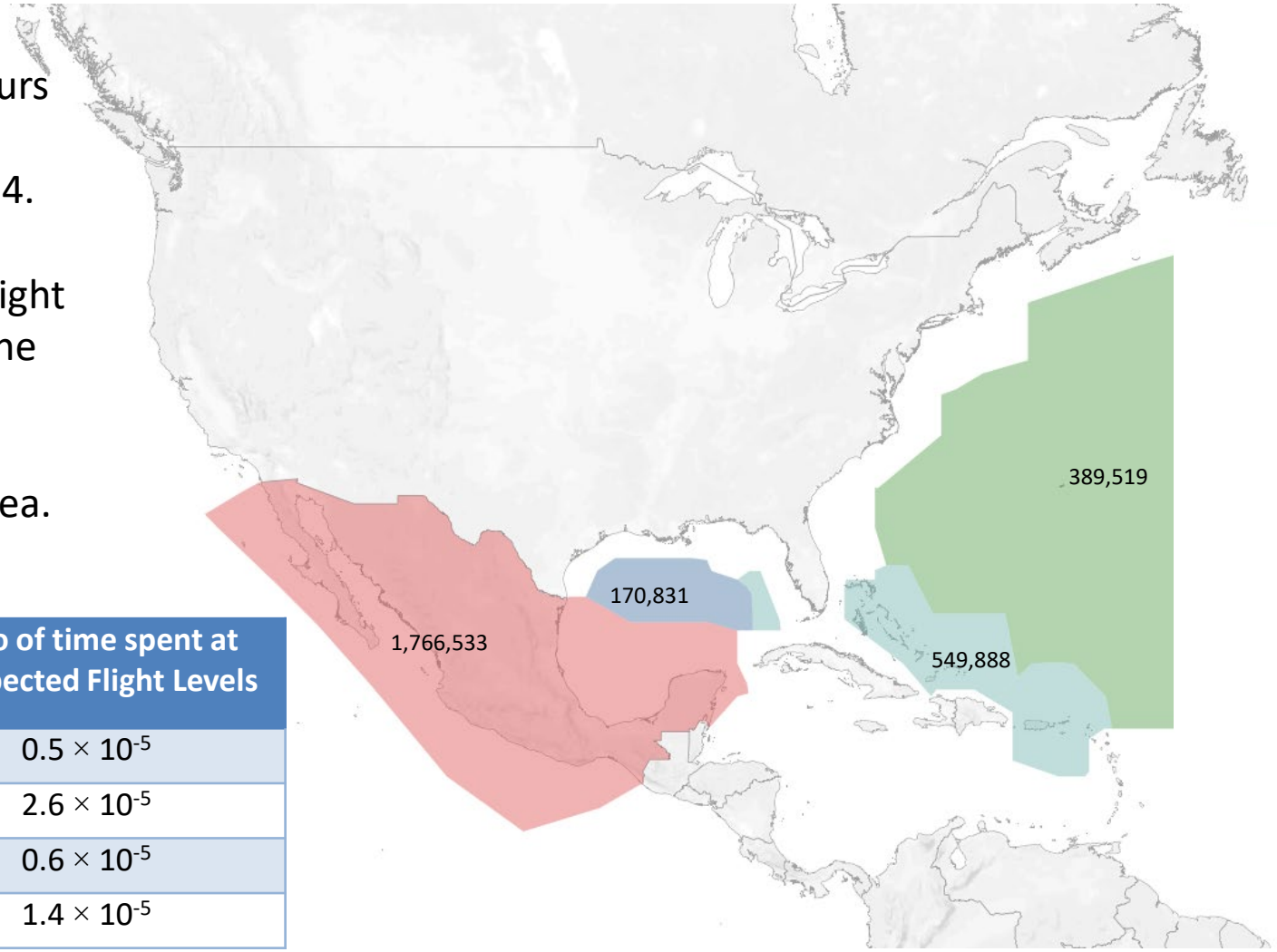
Additional Details / Notes

The Airbus A320 was the leading aircraft type in both Mexico and New York West, while the Boeing 737 MAX 8 (B38M) accounted for the largest percentage of flying hours in Houston Oceanic and the combined San Juan/Miami Oceanic airspace

NAARMO Vertical Safety Analysis For Caribbean FIRs| Vertical Collision Risk Estimate – Flight Hours

Based on the December traffic data, the NAARMO estimates approximately **2,876,771** annual flying hours for 2025 in the airspace where RVSM is applied, compared with 2,498,757 annual flying hours in 2024.

The proportion of flying time spent at unexpected flight level is estimated for each area using the values in the table and dividing by the estimated flying hours for each area. The table provides the flying hours and ratios of time spent at unexpected flight levels by area.



Area	2025 Annual Flying Hours	Ratio of time spent at unexpected Flight Levels
Mexico FIR	1,766,533	0.5×10^{-5}
Miami/San Juan FIRs	549,888	2.6×10^{-5}
Houston Oceanic FIR	170,831	0.6×10^{-5}
New York West FIR	389,519	1.4×10^{-5}

NAARMO Vertical Safety Analysis For Caribbean FIRs| Vertical Collision Risk Estimate

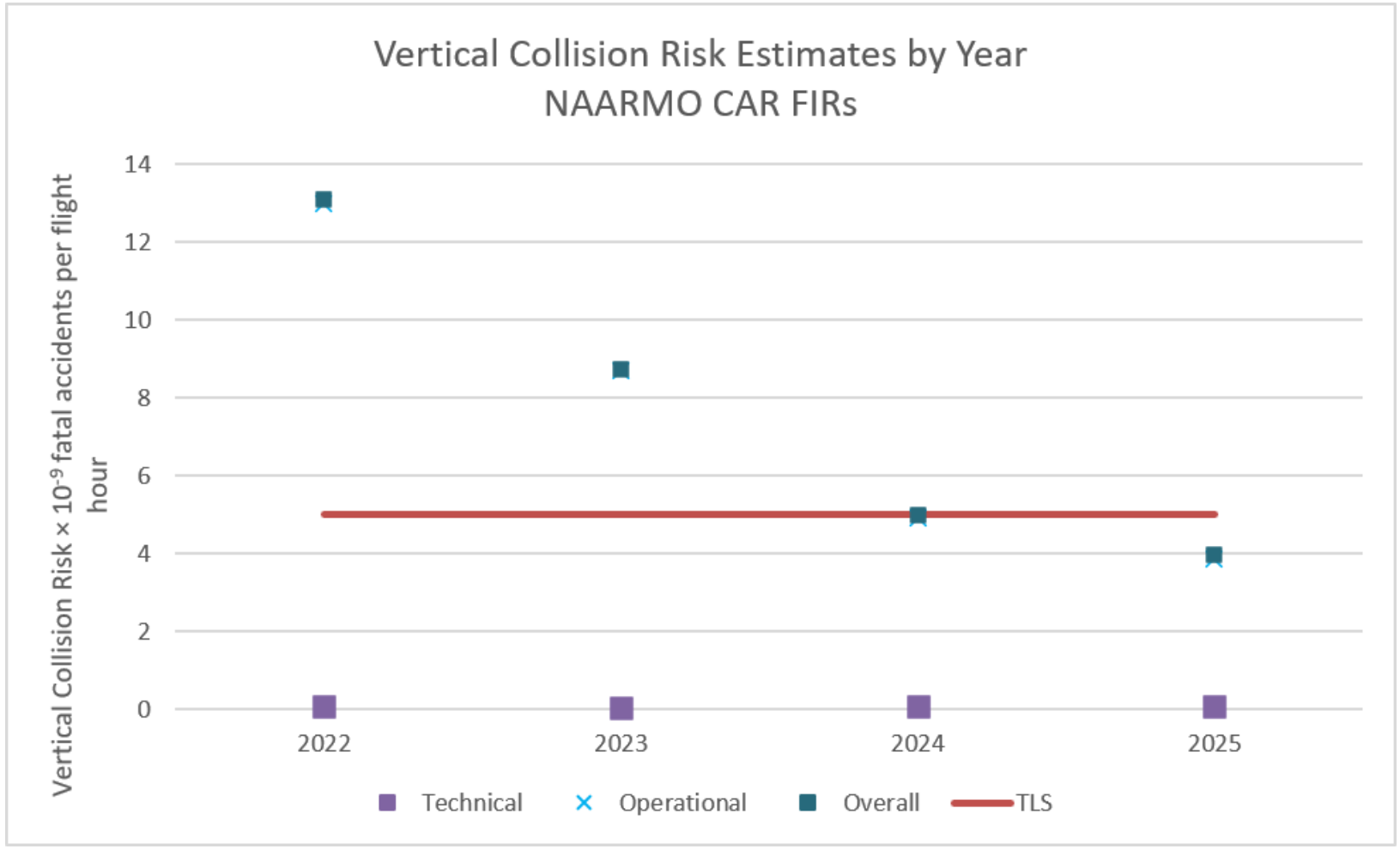
The total risk estimate for the RVSM airspace, **3.96×10^{-9} fapfh**, which meets the overall safety target

Calendar Year	Technical Risk	Operational Risk	Overall Vertical Risk
2022	0.08	13.0	13.1
2023	0.07	8.7	8.75
2024	0.08	4.92	5.00
2025	0.08	3.88	3.96

**values are shown × 10^{-9} fapfh*

The estimated vertical risk for 2025, shows a reduction compared to the 2024 estimate. This decrease is directly linked to the reduced time spent at unexpected flight levels.

- Approximately a **21%** reduction in vertical risk from 2024 to 2025
- Time spent at unexpected flight levels decreased from 50 minutes in 2024 to **29 minutes** in 2025



Questions?

