Air Traffic Management Bureau, CAAC

2022
Report of Civil Aviation Airspace Development in China

August 2023

Air Traffic Management Bureau, CAAC

Foreword

2022 is a transitional year for the 14th-Five-Year-Plan and an extraordinary year. In the face of the continuous impact of the repeated epidemic and industry difficulties, the ATM system has worked hard and forged ahead. Under the strong leadership and specific guidance of CAAC, the ATM system has firmly grasped the new situations and new tasks, always adhered to the general principle of seeking progress while maintaining stability, closely focusing on the characteristics of the development stage of civil aviation during the 14th Five-Year Plan, actively implemented high-quality development goals, striving to overcome the adverse effects in all aspects, and successfully completed the following work relating to airspace: building a north-south air artery to connect two world-class airport groups in Beijing-Tianjin-Hebei and Guangdong-Hong Kong-Macao Greater Bay Area, so as to realize the full connection of the Beijing-Guangzhou Corridor; optimizing the airspace of the approach control areas of Guangzhou, Wuhan and Changsha, so as to promote the operation efficiency of congested hub airports; supporting the dual hubs construction of regional civil aviation passenger and cargo, and promoting the implementation of arrival and departure route plan for Ezhou airport; strengthening the researches and application of new technologies, promoting the application of PMS at Beijing Capital Airport and Guangzhou area, optimizing Continuous Descent/Climb Operation (CDO/CCO) in Urumqi and Guangzhou approach control areas, speeding up the researches on the application of Established on RNP-AR APCH (EoR) technology in North and Northwest China.

In 2023, the ATM system will forge ahead, adhere to the guidance of the new development concept, further strengten the foundation and tap the potential, strive to promote the optimization of the national backbone air route network, orderly carry out in-depth airspace adjustment in congested areas and terminal areas, effectively improve the

efficiency of airspace operation, and comprehensively improve the airspace assessment capabilities, in order to provide a solid airspace resource assurance for better promoting the smooth implementation of the "14th Five-Year" development plan of civil aviation and ensuring the attainment of the goals of high-quality development of civil aviation.

We are very grateful to the international aviation community for its long-term support and assistance. Information sharing and mutual exchanges have enabled us to perform better. It's our hope that this report can provide aviation stakeholders with useful information or references.

Sincerely,

Wen Xuezheng

Deputy Director General

Air Traffic Management Bureau, CAAC

August, 2023

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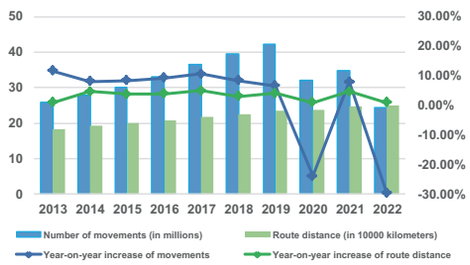
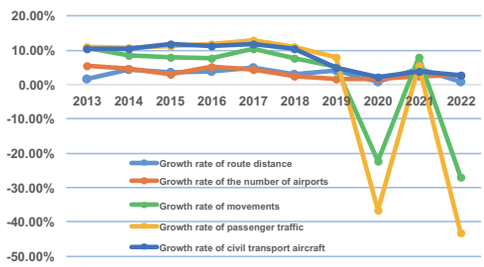
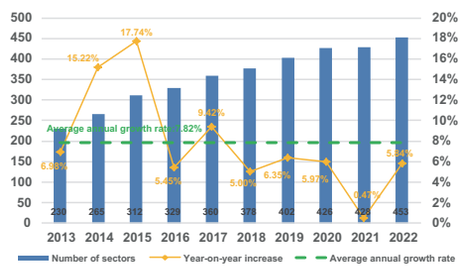
I. General

By the end of 2022, there were a total of 1104 air routes in China, with a total distance of 250 000 km, a net increase of 2293 km over the previous year. Route and flight density of airspace was about 0.023 km per sq km, while traffic density of airspace was about 0.28 flights per sq km. There were 254 transport airports[1] across the country. There were 18 874 city pairs and 12 250 flight routes, with the non-linear coefficient of flight routes between city pairs based on flight plan averaging at about 1.125. The number of entry and exit points totaled 47, allowing efficient connection with neighboring countries and regions.

There are currently 11 FIRs in China (including Taipei FIR and Hong Kong FIR), covering a total area of about 10.81 million sq km. By the end of 2022, there were 15 high-altitude control areas, 24 medium and low altitude control areas and 48 approach (terminal) control areas across the country. A total of 453 area and approach (terminal) control sectors have been approved (Figure 1).







Flight information regions (FIRs)	11
Total area of FIRs (in 10000 sq km)	1081
Total number of airports	254
Total number of routes	1104
Total mileage of routes (in 10000 km)	25.0
Mileage of fixed routes (in 10000 km)	19.5
Mileage of temporary routes (in 10000 km)	5.5
Mileage of international routes (in 10000 km)	14.7

Figure 1　Overview of China's civil aviation airspace in 2022

Throughout 2022, the ATM system provided support for 5.264 million movements for transport aviation and 24.486 million movements for various flights, representing year-on-year decreases of 34.68% and of 29.47% respectively.

1　Transport airports in Hong Kong, Macao and Taiwan are not included.

II. Static Airspace Organization

1. Airports

In 2022, there were a total of 254 transport airports in China, including 73 international airports and 181 domestic airports. Throughout China, 246 airports, accounting for 96.85% of the total, have made public their PBN procedure design, with 8 airports yet to publish their PBN procedure design (Figure 2).

Figure 2　Airport classification across China

At present, 46 airports at which the ATM system provides ATC service have finished their PBN procedure design. Among them, 44 have achieved partial or full separation of the arrival and departure routes.

By the end of 2022, the number of runways at 254 transport airports across the country totaled 284. There were 2 airports with four runways, 4 airports with three runways and 16 airports with two runways, accounting for 0.79%, 1.57% and 6.30% of the total of airports respectively.

2. Waypoints and unit route segments

By the end of 2022, there were 604 waypoints where 3 or more routes converged or intersected (Figure 3).

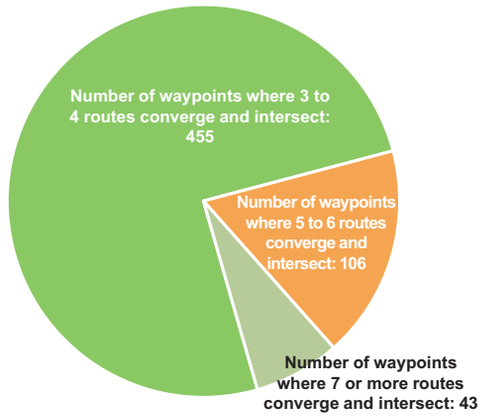


Figure 3　Convergence and intersection of air routes

3. Air routes

By the end of 2022, there were 1104 air routes nationwide, covering a total distance of 250 000 km with no duplicated calculation. Among them, there were 817 fixed routes, covering a distance of 194 768km, accounting for 77.86% of the total; and 287 temporary routes

spanning 55 395 km, accounting for 22.14% of the total.

Compared with 2021, 2022 recorded a net increase of 32 air routes, covering a total distance of 2293 km, a year-on-year increase of 0.93%. To be more specific, there was a net increase of 23 fixed routes, covering a total distance of 945 km, and a net increase of 9 temporary routes, totaling 1348 km. A net increase of 7 international air routes and 25 domestic ones reached compared with 2021, covering a distance of over 386 km and 1907 km respectively.

Overall, the optimization of China's airspace resources has always been based on consolidating the high-quality development foundation of civil aviation, and the overall growth of air routes has maintained a stable trend, showing the characteristics of "slow increase and steady growth, gradual opening up, and being fine and flexible":

— Seven large capacity air corridors, including Beijing-Kunming, Guangzhou-Lanzhou, Shanghai-Lanzhou, Shanghai-Harbin, China-South Korea, Shanghai-Chengdu and Beijing-Guangzhou, and two parallel routes from Lanzhou to Urumqi and Chengdu to Lhasa were successively launched, which partly changed the structure of national air route network, initially established a route network operation pattern dominated by unidirectional operation, effectively improved the safe operating margin and assurance capabilities of trunk air routes, continuously optimized air route resources, and significantly improved the airspace operational environment.

— On the basis of strengthening trunk air routes, air routes connecting busy airports were emphasized, and arrival and departure routes at middle and small-sized airports were increased, as a result, in 2022, the total distance of arrival and departure routes reached 45,153 km, with an average annual growth rate of 4.90% over the past five years.

4. Control areas and control sectors

By the end of 2022, there were 15 high-altitude control areas, 24 medium and low altitude control areas, 46 approach control areas and 2 terminal control areas.

In 2022, a total of 453 control sectors were approved nationwide, including 282 area control sectors and 171 approach (terminal) control sectors.

During the whole year, 25 area control sectors and 14 approach control sectors were newly approved, representing a respective increase of 5.22% and 6.88%.

During the decade from 2013 to 2022, the average annual growth rate in the number of

sectors approximated 7.82%. 2022 witnessed a year-on-year growth of 5.84%, lower than the average annual growth rate.

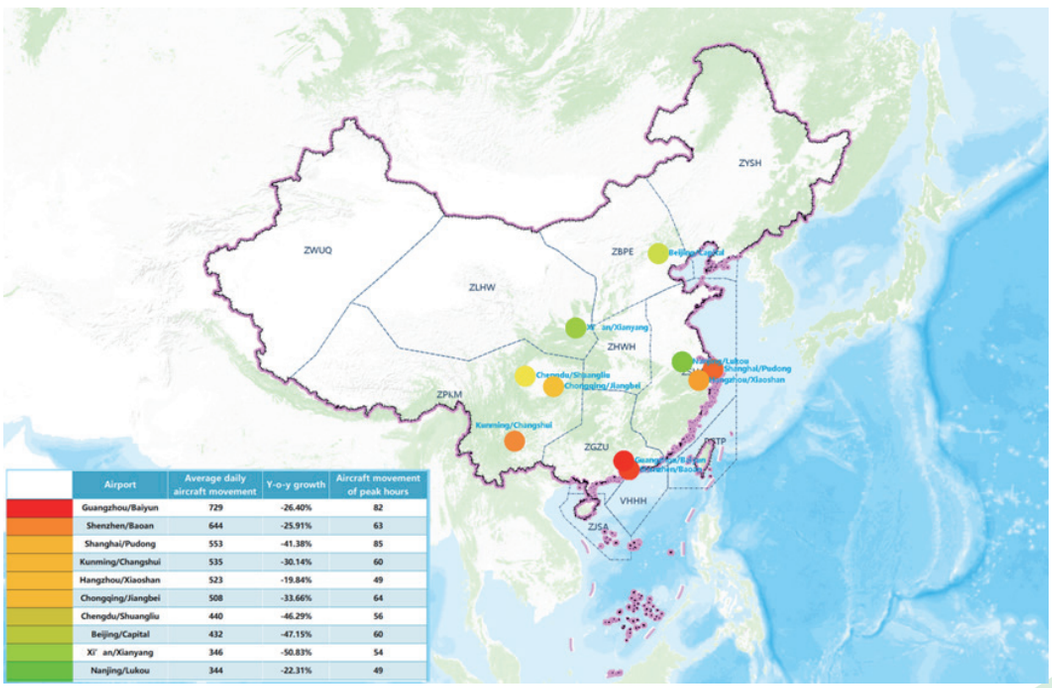
5. FIRs

There are 11 FIRs in China, which are Beijing, Shanghai, Shenyang, Guangzhou, Wuhan, Lanzhou, Urumqi, Kunming, Sanya, Taipei and Hong Kong FIRs, covering a total area of 10.81 million sq km.

III. Analysis of Airspace Operation

1. Airports

In 2022, the ATM system provided ATC service for 5.264 million transport movements, a y-o-y decrease of 34.68%. Major airports[2] saw a y-o-y decrease of 34.09% in the number of movements to 4.222 million, with the average daily number of movements standing at 252, a y-o-y decrease of 34.03%. Guangzhou Baiyun, Shenzhen Baoan, Shanghai Pudong, Kuming Changshui and Hangzhou Xiaoshan airports were the top five in terms of the annual number of movements, accounting for 6.30%, 5.57%, 4.78%, 4.62% and 4.52% of the total handled by major airports respectively (Figure 4).



	Airport	Average daily aircraft movement	Y-o-y growth	Aircraft movement of peak hours
	Guangzhou/Baiyun	729	-26.40%	82
	Shenzhen/Baoan	644	-25.91%	63
	Shanghai/Pudong	553	-41.38%	85
	Kunming/Changshui	535	-30.14%	60
	Hangzhou/Xiaoshan	523	-19.84%	49
	Chongqing/Jiangbei	508	-33.66%	64
	Chengdu/Shuangliu	440	-46.29%	56
	Beijing/Capital	432	-47.15%	60
	Xi' an/Xianyang	346	-50.83%	54
	Nanjing/Lukou	344	-22.31%	49

Figure 4 Top 10 airports in average daily aircraft movements

2 Major airports refer to the 46 airports at which the ATM system provides ATC service.

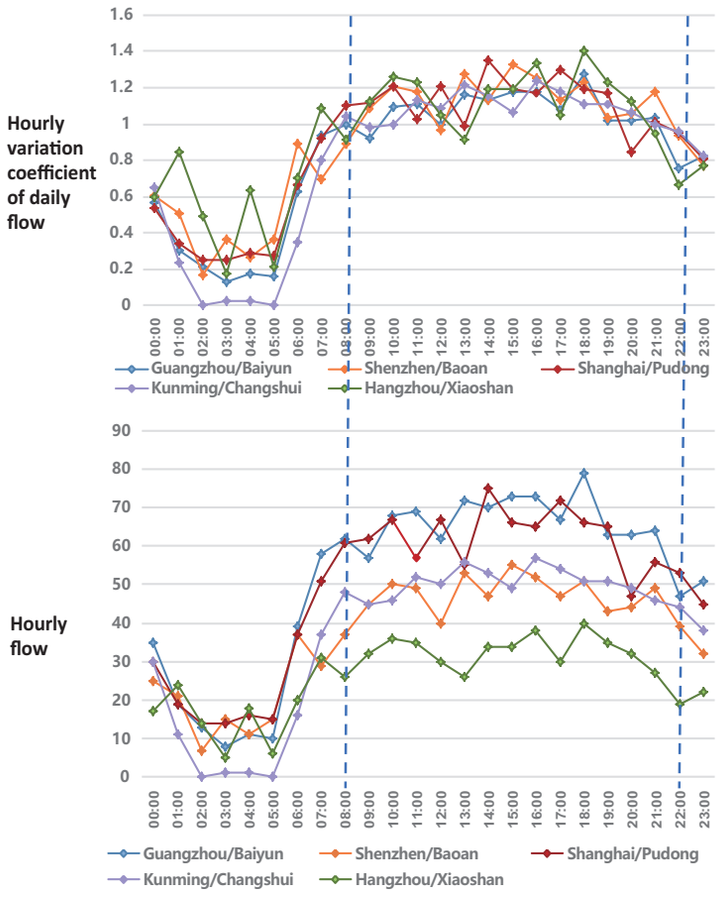


Figure 5 Peak day daily traffic flow time - varying coefficient of the top five airports

An analysis of the coefficient of variation of the hourly flows[3] and the peak hour flow at the above five airports was conducted using traffic data from the peak day (Feb.16, 2022). As can be seen from Figure 5, on the whole, most airports were in heavy-traffic operation from 08:00 to 21:00 which was shorter than the peak hours in 2021. Moreover, the amplitude of the time-varying coefficient of daily flow decreased during the high level operation, which indicated that each airport has taken corresponding optimization measures for the hourly peak traffic flow, balanced the traffic flow distribution, and made the flight operation more stable. On the other hand, 08:00-09:00 and 20:00-21:00 were at a low ebb of the high level, especially after 20:00, the hourly traffic volume decreased significantly compared with the previous year, and the number of night flights decreased significantly. On the whole, the time-varying coefficient of daily traffic flow was between 14:00-19:00, and basically maintained at 1.0-1.4. Among them, the time-varying coefficient of Guangzhou Baiyun Airport fluctuated relatively gently and the traffic flow rate kept high. The time-varying

3 Daily traffic flow time-varying coefficient = airport hourly traffic flow/median hourly traffic flow.

coefficient of Hangzhou Xiaoshan Airport fluctuated obviously and the number of flights was relatively small, with clear crest and trough characteristics, clear boundary between busy and idle, and more concentrated inbound and outbound flights, which was conducive to further enhancing the flight density of the airport and improving the assurance capabilities.

There was no significant difference between the number of movements handled during peak hours and the average hourly movements handled among the above five airports. However, Baiyun airport handled a relative large number of flights during the peak hour, with the number of flights during the peak hour exceeding the daily hourly average by 53.8%.

In terms of the number of movements handled during the peak hour, Shanghai Pudong (85) Guangzhou Baiyun (82), and Chongqing Jiangbei (64) ranked top three. In terms of the number of movements handled during the peak day, Guangzhou Baiyun (1261 for the peak day), Shanghai Pudong (1196) and Chongqing Jiangbei (923) ranked high. In 2022, the peak hour and peak day of Kunming Changshui airport relatively stayed the same as the pre-COVID-19 level in 2019. Affected by COVID-19, the figures for other airports declined, lower than the level of previous years (Figure 6、Figure 7).

	2018	2019	2020	2021	2022
Shanghai/Pudong	96	99	92	82	85
Guangzhou/Baiyun	86	90	96	89	82
Chongqing/Jiangbei	65	63	62	72	64
Shenzhen/Baoan	67	68	67	68	63
Chengdu/Tianfu				35	63
Kunming/Changshui	59	60	63	58	60
Beijing/Capital	107	104	98	76	60
Beijing/Daxing		28	59	67	59
Chengdu/Shuangliu	67	68	67	66	56
Shanghai/Hongqiao	59	61	58	59	55

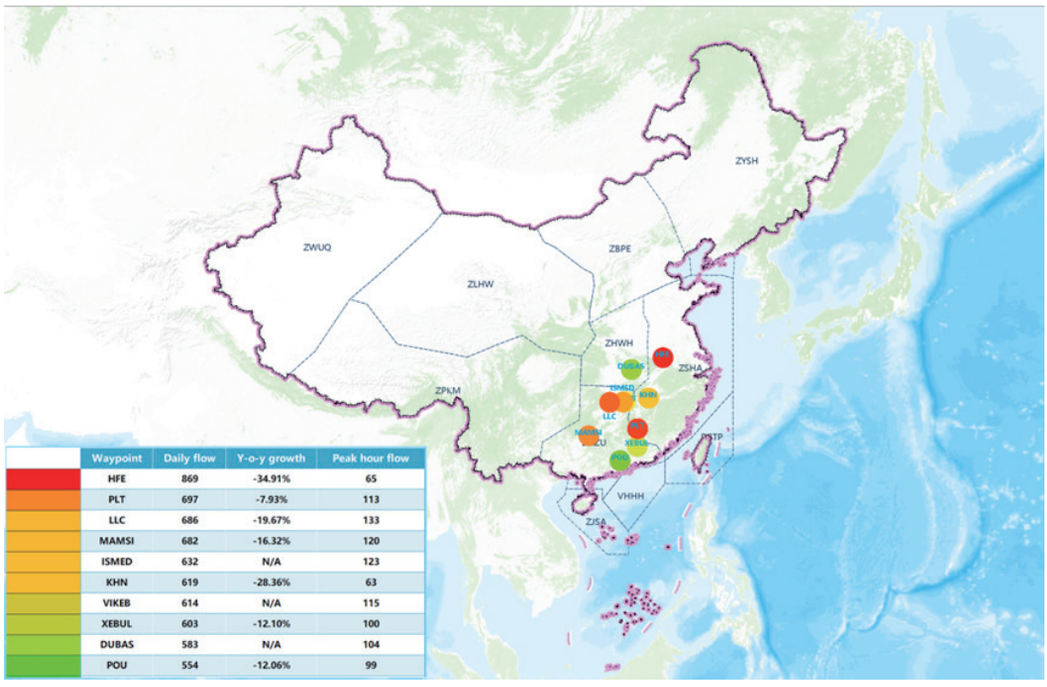
Figure 6　Movements handled during the peak hour in recent 5 years by Beijing, Shanghai and Guangzhou airports

	2018	2019	2020	2021	2022
Guangzhou/Baiyun	1441	1491	1511	1555	1261
Shanghai/Pudong	1556	1527	1502	1440	1196
Shenzhen/Baoan	1142	1127	1233	1247	1028
Kunming/Changshui	1115	1095	1082	1012	994
Chongqing/Jiangbei	913	1011	1011	1009	923
Xi'an/Xianyang	973	1042	1121	1096	867
Beijing/Capital	1854	1830	1669	1117	846
Hangzhou/Xiaoshan	923	889	898	932	807
Chengdu/Shuangliu	1040	1114	1127	1103	766
Chengdu/Tianfu				433	736

Figure 7　Comparison of peak day movements of the top 10 airports in recent 5 years

2. Heavy-traffic waypoints

The top 10 waypoints handling the highest average daily traffic flow in 2022 are shown in Figure 8. HFE (Luogang VOR), PLT (Panlong VOR), LLC (Laoliangcang VOR), MAMSI, ISMED, KHN (Xiangtang VOR), VIKEB and XEBUL, mainly located in central-south and east China, ranked high, all handling a daily average of more than 600 flights. These waypoints still handled a large number of flights, and were the ones where several heavy-traffic air routes converged or intersected. They handled traffic flow on the north-south and east-west trunk air routes, and were surrounded by a dense network of 6 air routes in average. Taken as the converging points of air routes in a complex airspace organization, they were conducive to the optimization and improvement in the overall operational efficiency of regional air route network.



	Waypoint	Daily flow	Y-o-y growth	Peak hour flow
	HFE	869	-34.91%	65
	PLT	697	-7.93%	113
	LLC	686	-19.67%	133
	MAMSI	682	-16.32%	120
	ISMED	632	N/A	123
	KHN	619	-28.36%	63
	VIKEB	614	N/A	115
	XEBUL	603	-12.10%	100
	DUBAS	583	N/A	104
	POU	554	-12.06%	99

Figure 8 Top 10 ACC waypoints in average daily flow

The top 3 waypoints in terms of the minimum y-o-y decrease in average daily flow were PLT (Panlong VOR), POU (Pingzhou VOR) and XEBUL, with y-o-y decrease of 7.93, 12.06 and 12.10 percentage points respectively. The detailed description of these waypoints as follows:

— PLT (Panlong VOR) was a congested waypoint where A599 and G471 converged. 736

flights passed through this waypoint, connecting the Pearl River Delta, Hainan Province and Eastern China.

— POU (Pingzhou VOR) was where B330, G471, R473 and multiple air routes converged. 602 flights passed through this waypoint which was high in traffic flow throughout the year.

— XEBUL was where G471 and multiple air routes converged. 522 flights between the Pearl River Delta, Hainan Province and Eastern China passed through this waypoint.

In general, the busy waypoints in 2022 were mainly on such trunk routes as A599, B330, G586, R343 and W46, serving as the core points to ensure the smooth operation of the "main traffic artery" in the air. As air traffic continued to recover and grow after COVID-19, further efforts should be made to optimize local airspace, mitigate operation pressure at each waypoint, and achieve capacity expansion and efficiency improvement of the route network.

3. Heavy-traffic entry and exit points

In 2022, China saw a total of 660807 inbound and outbound flights, a y-o-y increase of 24.34%. Data of the top 20 entry and exit points handling the most traffic flow over the past three years can be seen in Figure 9. In general, most entry and exit points saw their yearly traffic flow volume going upward in different degrees. The waypoint RULAD (China-Kazakhstan) ,IKELA (Hong Kong) and TEBAK (China-Vietnam) experienced the significant y-o-y growth of 80.7%,73.4% and 72.3% in traffic flow volume. However, the point INTIK (China-Mongolia) saw a biggest drop of 57.29% in traffic flow volume, followed by POLHO (China-Mongolia) and NIXAL (China-Mongolia) which experienced drops of 11.7% and 10.0%. Over the past three years, traffic at AGAVO (China-South Korea), BUNTA (China-Vietnam), TEBAK (China-Vietnam) and RULAD (China-Kazakhstan) went upward every year, while traffic at POLHO (China-Mongolia), NIXAL (China-Mongolia) went downward every year. Some entry and exit points such as ASSAD (China-Vietnam) and MAGIT (China-Russia) presented the momentum of fluctuation.

4. Busy route segments and route operational efficiency

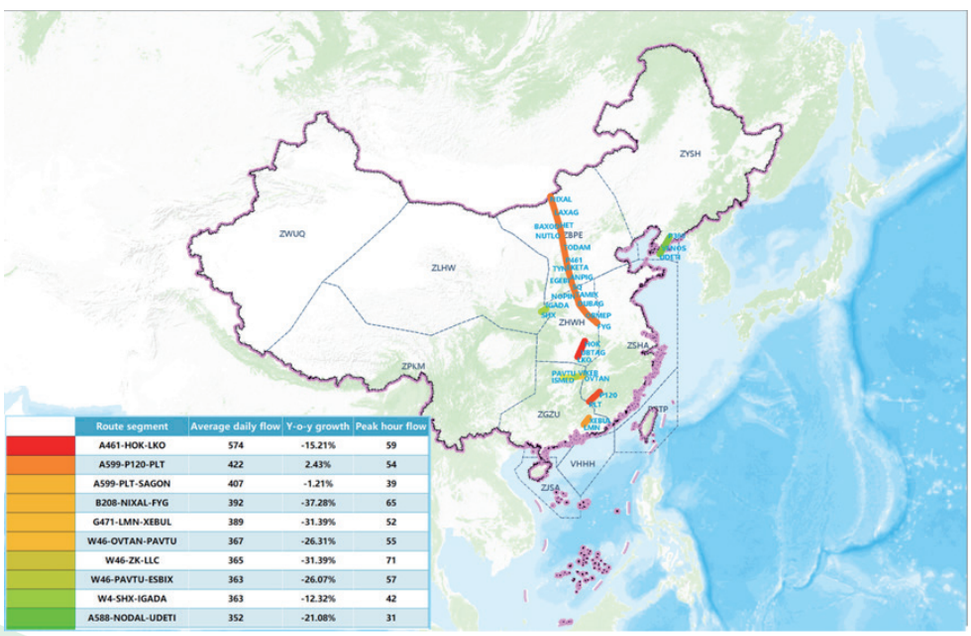
(1) Traffic volume

In 2022, the top 10 domestic route segments with the largest average daily traffic flow were mainly located on such trunk routes as A588, A599 and W46. For flights passing through these

segments, A599-PLT-LEKUV experienced a y-o-y increase of 2.43 percentage points in traffic flow volume(Figure 10).

Ranking	Entry and exit point	2020	2021	2022
1	AGAVO (China-South Korea)	58841	61902	62501
2	IKELA (Hong Kong)	26454	27226	47208
3	BUNTA (China-Vietnam)	22440	31033	45983
4	LINSO (China-Myanmar)	27474	40101	40437
5	TEBAK (China-Vietnam)	9182	20322	35023
6	SIERA (Hong Kong)	42430	24158	32142
7	BEKOL (Hong Kong)	22517	19180	28746
8	RULAD (China-Kazakhstan)	9997	13112	23699
9	SARIN (China-Kazakhstan)	15745	16382	23661
10	SIKOU (Hong Kong)	24098	23231	23342
11	ASSAD (China-Vietnam)	26422	20647	23037
12	POLHO (China-Mongolia)	26218	25578	22583
13	NIXAL (China-Mongolia)	25412	23911	21513
14	EPKAL (Hong Kong)	17715		19060
15	EXOTO (China-Vietnam)	17715		19060
16	TAMOT (Hong Kong)	22213	16385	18574
17	DOSUT (Hong Kong)	17818		16106
18	DONDA (China-Vietnam)	17818		16106
19	MAGIT (China-Russia)	11020	11279	10446
20	INTIK (China-Mongolia)	25412	23911	10212

Figure 9　Top 20 entry and exit points in traffic flow over the past three years



	Route segment	Average daily flow	Y-o-y growth	Peak hour flow
	A461-HOK-LKO	574	-15.21%	59
	A599-P120-PLT	422	2.43%	54
	A599-PLT-SAGON	407	-1.21%	39
	B208-NIXAL-FYG	392	-37.28%	65
	G471-LMN-XEBUL	389	-31.39%	52
	W46-OVTAN-PAVTU	367	-26.31%	55
	W46-ZK-LLC	365	-31.39%	71
	W46-PAVTU-ESBIX	363	-26.07%	57
	W4-SHX-IGADA	363	-12.32%	42
	A588-NODAL-UDETI	352	-21.08%	31

Figure 10　Top 10 route segments in average daily flow

(2) Horizontal flight efficiency

In 2022, the non-linear coefficient of flight routes between city pairs based on flight plan averaged at around 1.125. Figure 11 shows the top 20 busiest routes between city pairs with a flight distance of more than 1 500 km (shown in a descending order in terms of traffic volume), whose average non-linear coefficient was 1.09. The non-linear coefficient of the route from Chongqing Jiangbei to Shanghai Hongqiao were the lowest, at about 1.01, following from Hangzhou Xiaoshan to Kunming Changshui, from Kunming Changshui to Nanjing Lukou and from Beijing Daxing to Guangzhou Baiyun at 1.02, and that of the route from Xi'an Xianyang to Shenzhen Baoan was the highest, at about 1.28.

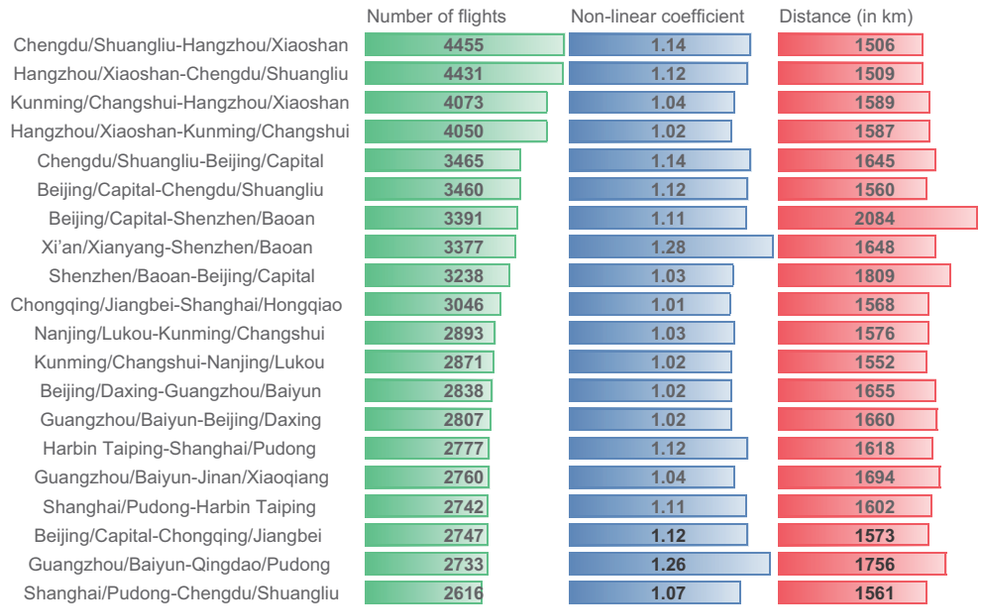


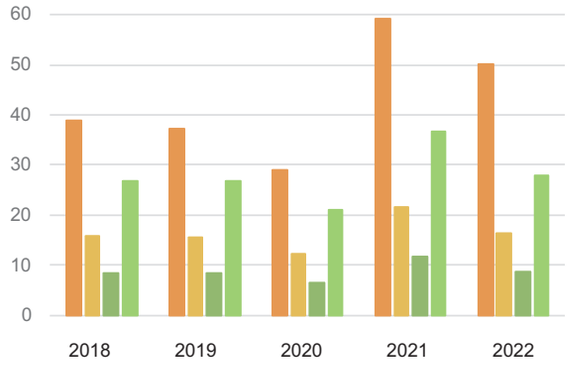
Figure 11 Non-linear coefficient of the busiest flight routes between city pairs with a flight distance of over 1500 km

(3) Vertical flight efficiency

An analysis was made of the top 10 route segments highest in average daily traffic flow at various flight levels from 6 000 to 15 500 meters, using the traffic data from the peak day (Feb.16, 2022). It can be seen that route segment A599 had the largest traffic flow at the three flight levels of 8400, 8900 and 10100 meters, accounting respectively for 28.07%, 20.72% and 15.66% of the total traffic at all of the flight levels from 6 000 to 15 500 m. For other heavy-traffic route segments, there was a concentration of flights at the flight levels of 6 600, 6 900 and 8 400 meters.

5. Temporary routes

The use of temporary routes in 2022 showed a slight downward trend compared with that of the previous year with all indicators reaching the relative high levels for five years. A total of 500,700 flights used temporary routes, shortening the flight distance by 16.35 million km, saving 88,300 tons of fuel consumption and reducing carbon dioxide emissions by 278,100 tons, a respective y-o-y decrease of 15.28, 24.50, 24.53 and 24.42 percentage points (Figure 12).



	2018	2019	2020	2021	2022
Flights using temporary routes (in 10000)	39	37.3	28.97	59.1	50.07
Shortening flight distance (in million km)	15.74	15.7	12.32	21.66	16.35
Saving fuel consumption (in 10000 tons)	8.5	8.48	6.65	11.7	8.83
Reducing carbon emissions (in 10000 tons)	26.8	26.7	20.96	36.8	27.81

Figure 12 Changes in relevant indicators for temporary routes during 2018-2022

The top 10 temporary routes highest in average daily traffic flow were mainly in east, central-south China (Figure 13), with a daily average of 69 flights and 19 hours.

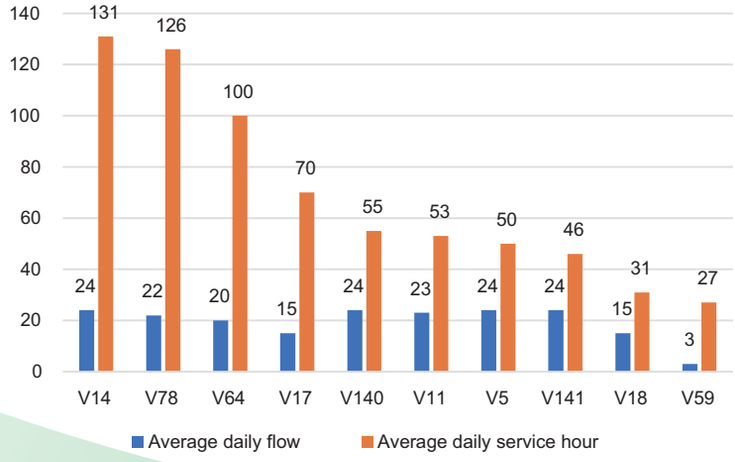
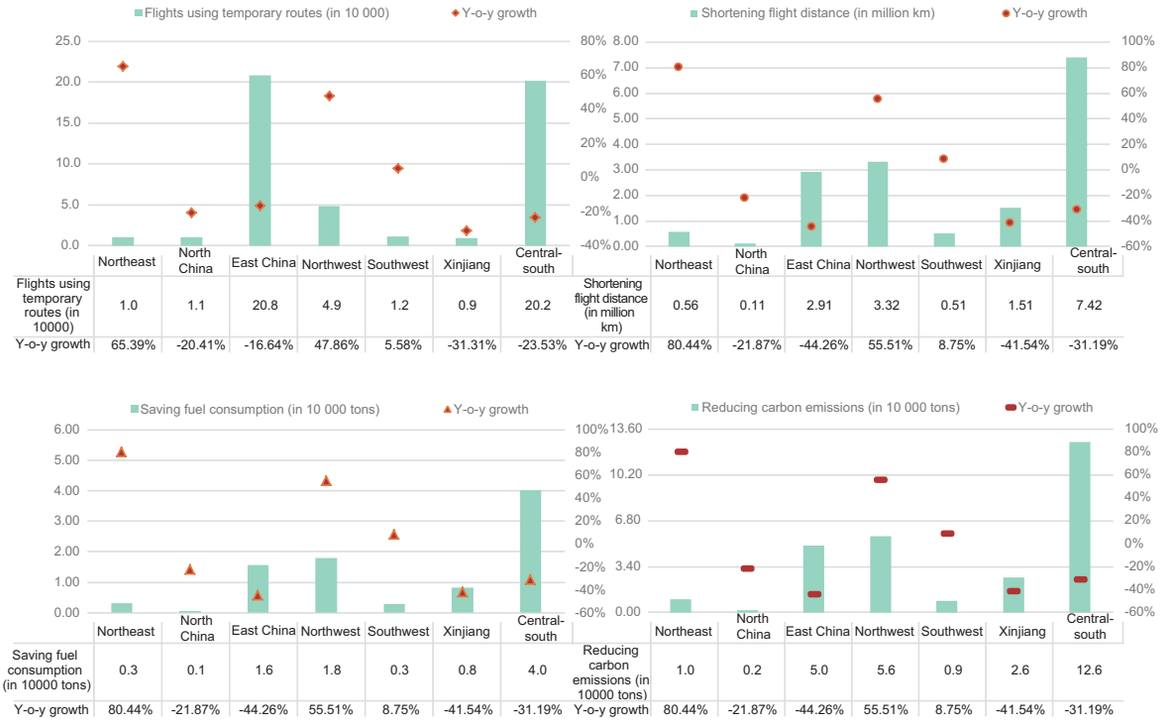


Figure 13 Regional top 10 temporary routes with highest average daily traffic flow

Figure 14 shows the use of temporary routes in different regions. East and central-south China made optimal use of temporary routes, and northeast region saw the biggest increase in indicators compared with that of the previous year.



	Northeast	North China	East China	Northwest	Southwest	Xinjiang	Central-south
Flights using temporary routes (in 10000)	1.0	1.1	20.8	4.9	1.2	0.9	20.2
Y-o-y growth	65.39%	-20.41%	-16.64%	47.86%	5.58%	-31.31%	-23.53%
Shortening flight distance (in million km)	0.56	0.11	2.91	3.32	0.51	1.51	7.42
Y-o-y growth	80.44%	-21.87%	-44.26%	55.51%	8.75%	-41.54%	-31.19%
Saving fuel consumption (in 10000 tons)	0.3	0.1	1.6	1.8	0.3	0.8	4.0
Y-o-y growth	80.44%	-21.87%	-44.26%	55.51%	8.75%	-41.54%	-31.19%
Reducing carbon emissions (in 10000 tons)	1.0	0.2	5.0	5.6	0.9	2.6	12.6
Y-o-y growth	80.44%	-21.87%	-44.26%	55.51%	8.75%	-41.54%	-31.19%

Figure 14 Use of temporary routes in 2022

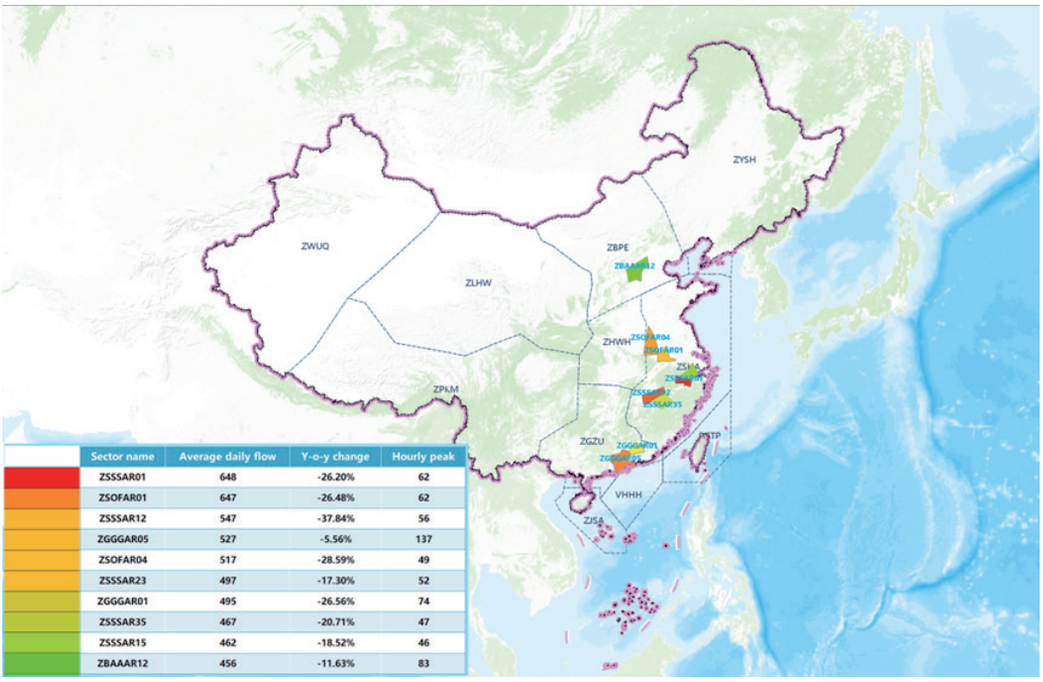
6. Busy area sectors

In 2022, 90% of the top 10 regional sectors with the highest average daily traffic were located in east and central-south China (Figure 15). Despite the impact of COVID-19, 100% of these 10 sectors saw a decrease in their traffic flow volume. The three sectors with the largest decrease in traffic volume were sector No. 12 in Shanghai (-37.84%), sector No. 4 in Hefei (-28.59%) and sector No. 01 in Guangzhou (-26.56%).

Figure 16 shows the average flight time, maximum instantaneous number of flights[4], average instantaneous number of flight[5] and route network density.

4 The maximum instantaneous number of flights refers to the maximum number of aircraft that fly in a sector in an instantaneous time period during a statistical period (for example, the national traffic flow peak day in 2022). Here, the instantaneous time period is 1 minute.

5 The average instantaneous number of flights refers to the average number of aircraft that fly in a sector in an instantaneous time period during a statistical period (for example, the national traffic flow peak day in 2022). Here, the instantaneous time period is 1 minute.



	Sector name	Average daily flow	Y-o-y change	Hourly peak
	ZSSSAR01	648	-26.20%	62
	ZSOFAR01	647	-26.48%	62
	ZSSSAR12	547	-37.84%	56
	ZGGGAR05	527	-5.56%	137
	ZSOFAR04	517	-28.59%	49
	ZSSSAR23	497	-17.30%	52
	ZGGGAR01	495	-26.56%	74
	ZSSSAR35	467	-20.71%	47
	ZSSSAR15	462	-18.52%	46
	ZBAAAR12	456	-11.63%	83

Figure 15 Top 10 sectors in average daily traffic of regions

— As far as average flight time was concerned, Guangzhou NO. 12 sector featured the longest average flight time (13.320 minutes), followed by Chengdu NO.21 (12.840minutes), while Shanghai NO.23 featured the shortest (7.285 minutes). The variance[6] of the top 10 sectors in average flight time was 4.236, meaning big differences in this indicator.

— As far as maximum instantaneous number of flights was concerned, the sectors handling a high concentration of flights in a narrow time-frame mainly included Guangzhou 12 which handled 21 flights, followed by Shanghai NO.12 and Chengdu NO.21 which both handled 19 flights. Guangzhou NO. 05 and NO. 31 were the least ones handling 15 flights in an instantaneous manner. The variance of maximum instantaneous number of flights was 3.8778, indicating big differences.

— As far as average instantaneous number of flights was concerned, Guangzhou NO. 12 and Shanghai NO. 12 ranked first, which both handled 9 flights. The variance of average instantaneous number of flights was 1.5111, indicating little differences.

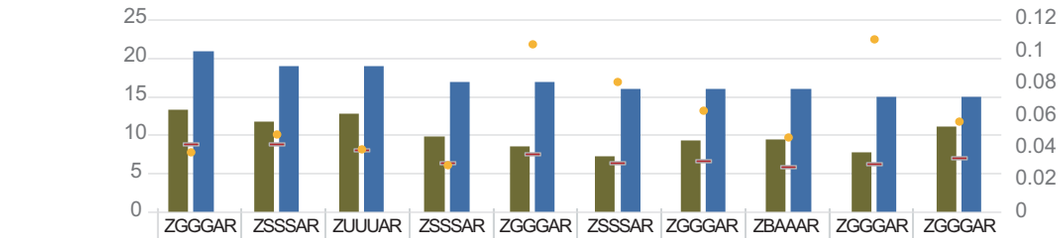
— As far as route network density was concerned, Guangzhou sector NO. 05 ranked first at 0.108, followed by Guangzhou NO.15 (0.105), while Shanghai NO. 35 ranked bottom on the

6 Variance is a measure of deviations between statistical indicators of each sector and the equivalent average indicators of the 10 sectors. It indicates variability among indicators of the sectors.

list at 0.030. The variance of route network density was 0.0008, showing little difference in this indicator.

As it can be seen from the analysis, Guangzhou NO.12 featured congested air routes such as R343. Although the route network density was relatively reasonable (0.038), due to its heavy traffic flow, this sector featured a large maximum and average instantaneous numbers of flights (21 and 9 flights respectively). In addition to the frequent changes in flight altitude within the sector, it was also necessary to coordinate and resolve crossing and convergence conflicts at the same altitude, resulting in heavier worklord of ATC service.

Shanghai NO. 12 registered relativley long average flight time (11.850 minutes), partly due to its long and narrow sector configuration. Because of the huge overflight traffic flow volume, the maximum and average instantaneous number of flights were relatively large (19 and 9 flights respectively), particularly with heavier monitoring workload.



	ZGGGAR 12	ZSSSAR 12	ZUUUAR 21	ZSSSAR 35	ZGGGAR 15	ZSSSAR 23	ZGGGAR 01	ZBAAAR 23	ZGGGAR 05	ZGGGAR 31
Average flight time	13.320	11.850	12.840	9.849	8.627	7.285	9.320	9.475	7.856	11.111
Maximum number of instantaneous operations	21	19	19	17	17	16	16	16	15	15
Average number of instantaneous operations	9	9	8	6	8	6	7	6	6	7
Route network density	0.038	0.049	0.039	0.030	0.105	0.082	0.064	0.047	0.108	0.057

Figure 16 Relevant airspace indicators for some busy sectors

In general, some sectors in busy regions were under huge operation pressure. Based on actual situations, sector configuration can be scientifically redesigned and established, and operation patterns can be optimized in a coordinated manner to balance the workload among all sectors, adapt to the traffic flow volume and ATC services and build more efficient and high-quality sectors.

7. Busy approach (terminal) control areas

The top 10 approach/terminal control areas providing ATC support to the largest number of flights in 2022 are shown in Figure 17. Guangzhou, Shanghai and Chengdu approach

control areas ranked in the top 3, providing ATC support to 481554, 462010 and 357084 flights respectively, representing y-o-y drops of 25.71%, 39.52% and 25.20% respectively. In particular, Guangzhou and Shanghai approach control area were particularly congested as they still managed to provide ATC support to 2164 and 2483 flights during the peak day despite COVID-19, an decrease of 19.34 and 20.80 percentage points compared with that of the previous year.

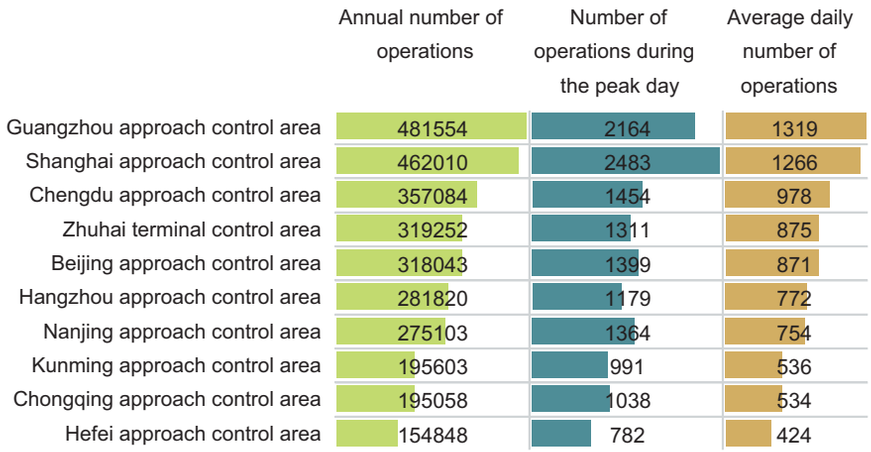
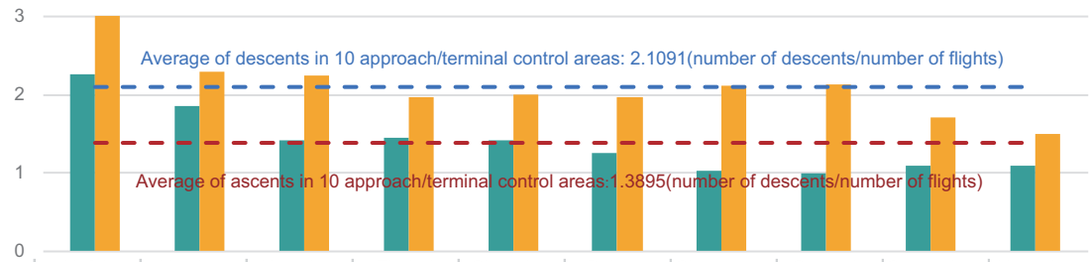


Figure 17 Top 10 busy approach/terminal control areas in 2022

The data of the peak day (Feb.16) was used to conduct the following analysis of relevant indicators associated with the above-mentioned approach/terminal control areas. In terms of the average number of aircraft ascents and descents, Hefei approach control area featured high at 2.26 and 3.13 respectively, 1.53 and 1.40 times as high as the average of the 10 control areas, followed by Nanjing approach control area at 1.85 and 2.30, 1.25 and 1.03 times as high as the average of the 10 control areas (Figure 18).



	Hefei approach control	Nanjing approach control	Kunming approach control	Zhuhai terminal control	Shanghai approach control	Beijing approach control	Chongqing approach control	Chengdu approach control	Guangzhou approach control	Hangzhou approach control
Average of ascent	2.2638	1.8547	1.4268	1.4604	1.4132	1.2628	1.0231	0.9941	1.0969	1.0993
Average of descent	3.1271	2.3011	2.2426	1.9810	2.0054	1.9734	2.1157	2.1394	1.7066	1.4991
Total	5.3909	4.1557	3.6693	3.4414	3.4187	3.2362	3.1388	3.1335	2.8035	2.5983

Figure 18 Average of ascents and descents in approach/terminal control areas during the peak day

IV. Review of Civil Airspace Development and Major Work in 2022

1. General airspace development in 2022

In 2022, despite the unprecedented difficulties caused by the New Coronavirus epidemic and many other development bottlenecks superimposed on each other, the civil aviation ATM system has stood the test in adversity, and the development trend of China's civil aviation airspace is relatively stable on the whole. Over the past years, the ATM system has always been based on the development needs and practical problems in terms of airspace, seeking progress while maintaining stability, taking multiple measures simultaneously, focusing on resource allocation, capacity expansion and efficiency optimization, tapping potential to optimize the "stock" of airspace, striving to promote the expansion of airspace "increment", taking the construction of air corridors as the main line, organically combining the structural adjustment of airspace in busy areas and terminal areas, and continuously optimizing the layout of the trunk route network. We actively improved the efficiency of airspace utilization and operation, solidly completed all airspace tasks, and injected momentum into the steady recovery and development of the industry.

2. High-quality airspace development

In 2022, the civil aviation ATM system rose to challenges and united as one in forging ahead to push the high-quality airspace development to a new level.

（1）Innovation — Exploring new areas for quality and efficiency improvement

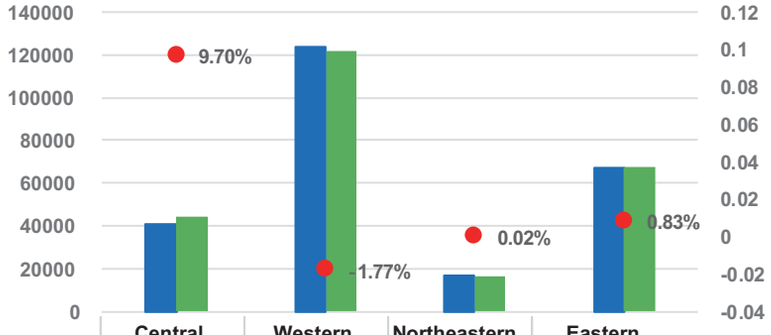
Continuous efforts were made in the development of unidirectional trunk route network. Following the principle of developing airspace plans with unidirectional cyclical air corridors, the ATM system coordinated the airspace development plan and changes in route network. By the end of 2022, seven large capacity air corridors, i.e., Beijing-Kunming, Guangzhou-Lanzhou, Shanghai-Lanzhou, Shanghai-Harbin, China-South Korea, Shanghai-Chengdu and Beijing-Guangzhou were put into operation one by one, as well as two groups of parallel routes from Lanzhou to Urumqi and from Chengdu to Lhasa were successfully put into operation, with the

unidirectional operation implementation rate hitting 78.52%.

The ATM system intensified its efforts to popularize the application of Continuous Descent Operation (CDO), Continuous Climb Operation (CCO), Point Merge System (PMS) and Established on RNP-AR APCH (EoR) in busy airports and control areas with the aim of easing the burden of ATC service and making airspace operation more efficient. In the past year, we comprehensively summarized the implementation results and experience of existing cases of CDO/CCO operation, guided or promoted the application of PMS at Dalian, Beijing Capital and Guangzhou airports, and continued to carry out the application researches of EoR in north and northwest China, laying a solid foundation for further implementation of related work.

(2) Coordination — Pursuing balanced development for intensive and high efficiency

In 2022, the central, western, northeastern and eastern regions achieved more balance between airspace development and airport construction. The distances of air routes reached 44470, 121849, 16461 and 67383 km respectively by the end of 2022, accounting for 17.78%, 48.71%, 6.58% and 26.94% of the national total and representing respective y-o-y increases of 9.70, -1.77, 0.02 and 0.83 percentage points. In particular, the central regions saw average annual growth rates of 9.70%, a continuously steady growth in air route resources, and a gradually improved and rationalized route network structure (Figure 19).



Unit in km	Central region	Western region	Northeastern region	Eastern region
2021	40538	124047	16457	66827
2022	44470	121849	16461	67383
Y-o-y growth rate	9.70%	-1.77%	0.02%	0.83%

Figure 19 Growth of air route distances in some regions in 2022

(3) Opening up — Connecting the world for larger development scale

We have opened up our national airspace resources wider to the world for the whole year. Nationwide, there were a total of 73 airports serving international flights, with 518 international routes totaling 147382 km with increase of 386 km from the 2021 level, enabling China's route network to connect with more countries. Meanwhile, advancement was made in improving the flexibility of entry and exit points. By the end of 2021, the number of entry and exit points connecting different countries reached 15[7], allowing smooth and efficient entry and exit and further connecting the world.

3. Overview of major airspace work in 2022

(1) Promoting in-depth optimization of airspace organization and improvement of airspace utilization efficiency

First, the Beijing-Guangzhou large capacity air corridor has been successfully implemented. On May 19th, the Beijing-Guangzhou large capacity air corridor (southern part) was officially put into operation and further improved the overall operation efficiency of the airspace, which involved the adjustment of 19 air routes, covering a total distance of 2,313 kilometers, and the improvement of arrival and departure procedures relating to 13 airports. Approximately 5,000 domestic flight routes between city pairs were adjusted, effectively reducing the congestion along the Beijing-Guangzhou large capacity air corridor and minimizing conflicts in terms of intersecting air routes. For energy conservation and emission reduction, it is estimated that about 125 kilometers per one-way trip from Beijing Capital to Hong Kong, Shenzhen, Zhuhai and Macao would be saved, resulting in an annual reduction of around 17,000 tons of fuel consumption and 54,000 tons of carbon emissions. The implementation of the southern part indicates the successful establishment of the "air traffic artery" spanning over 2,000 kilometers from north to south across China, which was of great significance for enhancing the operational environment of civil aviation airspace and restructuring the backbone network layout.

Despite the gradual increase in traffic flow volume after the implementation of Beijing-Guangzhou large capacity air corridor which operated in a "two routes operating southward and two routes operating northward, and unidirectional loop" pattern, the overall distribution of traffic has become more balanced, workload of ATC service in sectors has become more

7 15 entry and exit points are ARGUK, ASSAD, GOPTO, KAMUD, SADLI (AKARA-Fukue corridor), MAGIT, MORIT, NIXAL, POLHO, RULAD, SAGAG, SARIN, SIMLI, TAMOT and TEBAK.

scientifically reasonable, and airspace operations have become more efficient and smooth.

Second, proactive efforts have been made to optimize the airspace organization of the approach control areas at Guangzhou, Wuhan, and Changsha airports. Based on a deep integration of airspace user demands, the approach control areas, arrival and departure routes, and flight procedures of the above three airports have been optimized and adjusted. This not only ensured effective connections between the approach control areas and major air routes, but also improved the safety and operational efficiency of regional airspace, contributing to increased airport capacity.

Last but not least, the advancement of improving the flexible use of entry and exit points has been made. To meet the demand from the International Air Transport Association (IATA) and foreign airlines to increase the flexibility of entry and exit points, two new entry and exit points, LINSO and TELOK, were added. The relevant plans have been approved and are expected to be formally implemented in 2023. LINSO and its corresponding flight routes are available for flexible use by flights operating between China, Japan, South Korea, and the Middle East, further enhancing safety and promoting energy conservation as well as emission reduction. TELOK and its corresponding flight routes are available for flexible use by flights operating between China and Europe or North America, helping to alleviate operation pressure in busy areas.

(2) Systematically promoting the researches and application of new technologies and striving to consolidate the foundation for high-quality development

First, we continued to promote Continuous Descent/Continuous Climb Operations (CDO/CCO). We conducted in-depth researches on the implementation of airport operations, and systematically summarized the effectiveness and related experiences of CDO/CCO implementation at operating airports. According to statistics, in 2022, CDO/CCO operations were implemented at Shanghai Pudong, Xi'an, Urumqi, Guangzhou, Chengdu, Chongqing, Kunming, Changchun, Guilin, and Dalian airports. These ten airports executed a total of 2,339 CDO/CCO flights (1,087 CDO flights and 1,252 CCO flights) throughout the year, resulting in a cumulative reduction of 365.87 tons of fuel consumption and a decrease of 1,132.15 tons of carbon emission.

Second, we extensively promoted the application of Point Merge System (PMS). Issue plans for PMS application and promotion within 2022 and during the 14th Five-Year Plan period. We provided guidance to Dalian airport and advanced implementation at Beijing Capital airport and Guangzhou area in terms of PMS.

V. Outlook of Civil Aviation Airspace Work in 2023

The year 2023 represents a critical year for the development of civil aviation during the 14th Five-Year Plan period. The main tasks in terms of airspace management will focus on meeting the new requirements for further development, which will concentrate on actively implementing green development concept, continuously optimizing the structure of the backbone air route network, seientifically improving airspace utilization efficiency, and constantly strengthening airspace assessment and analysis. Comprehensive efforts will be made to promote high-quality development of civil avation airspace, with four main tasks to be accomplished:

First, we will solidly promote the consturction of large capacity air corridors. ATMB will accelerate the implementation of Shanghai-Kunming, Shanghai-Guangzhou and Beijing-Shanghai large capacity air corridors and actively carry out preliminary researches, plan design, simulation and evaluation on the above-mentioned air corridors to improve trunk route network and provide stronger aviation support.

Second, we will carry out in-depth optimization and adjustment of airspace organization. In line with the national strategy and the needs of regional economic development, ATMB will properly integrate the construction of large capacity air corridors and airspace development demands particularly based on regional operation characteristics, prioritize the capacity of airspace resources support in key areas, advance the optimization and adjustment of airspace organization in busy areas such as the Beijing-Tianjin-Hebei region, improve the overall safe and smooth operation, and create a high-quality operation environment for airspace users. We will also continue to straighten our flight routes, effectively reduce the non-linear coefficient of flight routes between city pairs to improve the flight efficiency and strive to achieve the national strategic goals of carbon peaking and carbon neutrality.

Third, we will gradually step up the researches, application and popularization of new technologies in an all-round way. ATMB will systematically summarize the experience and

problems of existing cases of CDO/CCO operation, and deeply explore the implementation plan of CDO/CCO normal operation in different regions; we will continue to track the progress of the application of PMS at Beijing Capital airport and Guangzhou area, steadily promote the application of PMS in Changsha, Kunming and Tianfu airports, and start PMS application researches at other 8 airports including Beijing Daxing and Shanghai Hongqiao airports; at the same time, conduct researches on EoR application in north and northwest China, including simulation verification as well as operational safety assessment of relevant airports in the above-mentioned regions.

Fourth, we will comprehensively strengthen airspace assessment and analysis capacity. Efforts will be made to scientifically focus on the intelligent ATC strategies, to continuously enhance major airspace planning and assessment for optimization and to soundly accelerate the improvement in terms of airspace statistics, analysis as well as the intelligence and digitization of airspace assessment to provide scientific, abundant and objective quantitative basis for the decision-making process in airspace management.

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