Air Traffic Management Bureau, CAAC

Report of Civil Aviation Airspace Development in China 2019

Air Traffic Management Bureau, CAAC

September 2020

Foreword

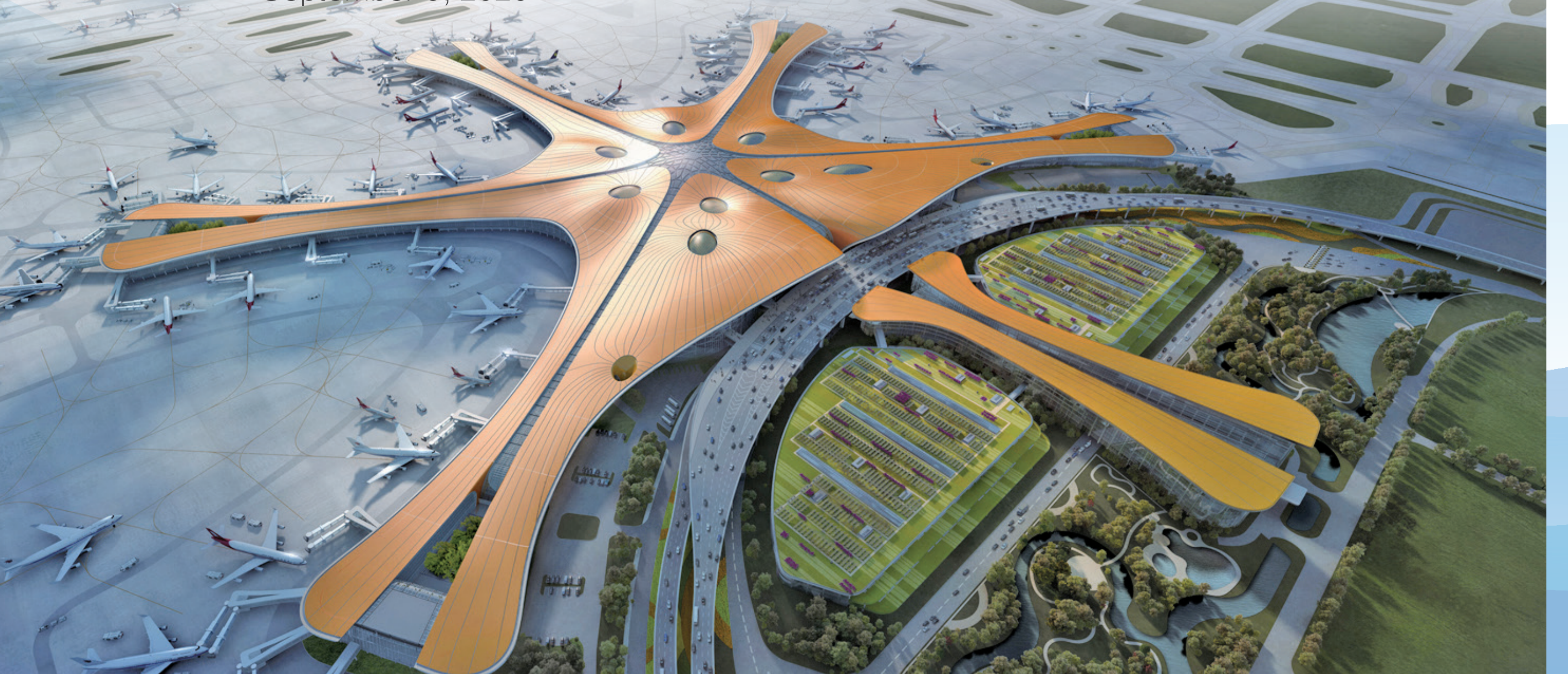
With the continuous development of China's civil aviation industry, there is an ever increasing demand for air traffic flow and the use of airspace resources. At present, the use of airspace and its operation and development has become the focus of attention for a wide range of airspace users. In light of this, the Air Traffic Management Bureau (ATMB) of CAAC has conducted a comprehensive collation and analysis of the annual data on civil aviation airspace development, in order to assist relevant departments or industry professionals in understanding China's civil aviation airspace development. This report, which consists of five parts, not only describes the use of civil aviation airspace in 2019 using objective and detailed data, but also analyzes the operation of civil aviation airspace in the same year, covering such essential elements as airports, waypoints, route segments, temporary routes, control sectors and high density terminal areas. In addition, it compares the Chinese and foreign indicators, and elaborates on the annual development trend and future prospects for airspace work.

In 2019, ATMB provided air traffic control (ATC) service to a total of 42.181 million movements (tower, APP, ACC), covering all kinds of flight activities, and the flight regularity rate reached 81.65%, the highest since 2010. Throughout the year, ATMB united as one and made every effort to overcome difficulties. It provided full support for the smooth opening of Daxing International Airport, and in the meantime, put into service the northern section of the high capacity Beijing-Guangzhou air corridor, bringing an end to the largest airspace adjustment in the history of civil aviation. ATMB contributed to the implementation of the national "Belt and Road Initiative" by transforming many trunk routes in the northwest part of China (Gansu, Qinghai and Ningxia) into parallel routes, with the transformation scale being the biggest over the past decade. It steadily promoted the application of new airspace technologies, piloted the first ever successful use of "point merge" technology at Shanghai Pudong International Airport, and conducted Continuous Descent Operation/Continuous Climb Operation (CDO/CCO) on a regular basis at Guangzhou Baiyun International Airport and Kunming Changshui International Airport.

We are very grateful to the international aviation community for its long-term support and help, and through information sharing and mutual exchanges, we can perform better. It's our hope that this report can provide useful information or reference for aviation stakeholders and prepare you for your future development. This year, the global aviation industry has been confronted with great difficulties due to the COVID-19 pandemic with no precedent. ATMB will continue to face the challenges and tackle tough issues head-on, with a view to contribute to the recovery of international civil aviation and making progress towards the strategic goal of building a safer and more efficient airspace environment for all airspace users.

Sincerely,

Che Jinjun
Director General
Air Traffic Management Bureau, CAAC
September 9, 2020



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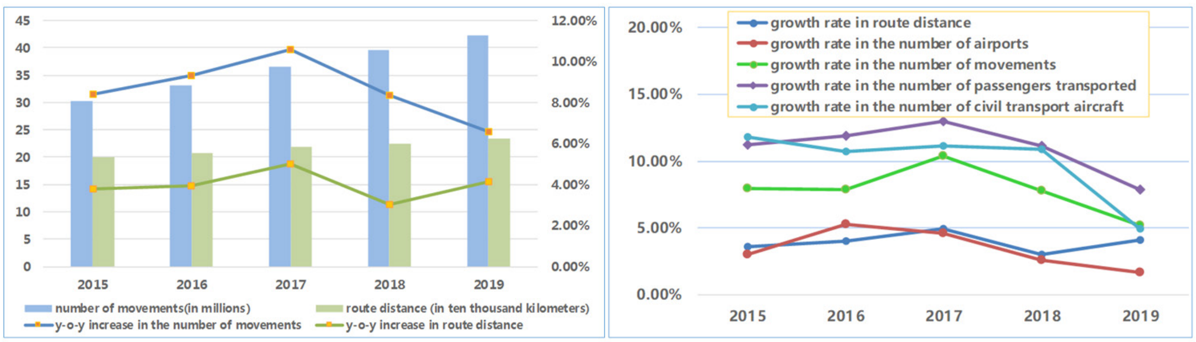
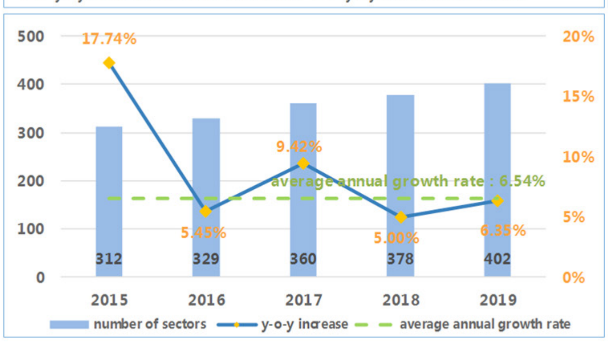
I. General

By the end of 2019, there were 992 airways and air routes in China, covering a distance of 234,509 km in total, a net increase of 9275 km over the previous year. Route density was about 0.023 km per sq km of airspace, and the traffic density was about 0.56 flights per sq km of airspace. There were 237 airports of various types, a y-o-y increase of 4. There were 16,996 city pairs and 11,345 flight routes, and the non-linear coefficient of flight routes between city pairs averaged about 1.14. There were a total of 47 entry and exit points, allowing efficient connection with neighboring countries and regions (Figure 1).





Flight Information Regions(FIRs)	11
Total Area of FIRs(million sq km)	1081
Airports	237
Total Number of Airways and Air Routes	992
Total Mileage of Airways and Air Routes(km)	234509
Entry/Exit points	47
Upper Control Areas	15
Lower Control Areas	28
Approach/Terminal Control Areas	44
Average Non-Linear Coefficient of flight routes between city pairs	1.14

Figure 1 Overview of Chinese civil aviation airspace in 2019

There are 11 FIRs in China (including those in Taipei and Hong Kong), covering a total area of about 10.81 million square kilometers. By the end of 2019, there were 15 upper control areas, 28 low altitude control areas and 44 approach (terminal) control areas. A total of 402 area and approach /terminal control sectors were approved.

In 2019, ATC towers across China provided service for 10.766 million movements (excluding those of aviation school training flights), a y-o-y increase of 7.60%. The ATMB provided service for a total of 42.181 million movements in the whole year, a y-o-y increase of 6.6%. The 45 airports at which the ATMB provided ATC services saw about 8.127 million movements, accounting for 75.49% of the national total, a y-o-y increase of 2.57%.

II. Static Airspace Organization

1. Airports

In 2019, China witnessed an addition of 4 transport airports, bringing the total number of transport airports in the country to 237, including 70 international airports and 167 domestic airports. A total of 226 airports, accounting for 95.36%, have announced their PBN procedure design, with the remaining 11 airports yet to publish their PBN procedure design.

At present, all of the 45 airports at which ATMB provides ATC service have completed their PBN procedure design. Among them, 44 have implemented PBN procedures, and 37 have partially or fully separated the arrival and departure routes.

By the end of 2019, 237 transport airports across the country had a total of 260 runways, a y-o-y increase of 2.77%. There were 2 airports with 4 runways, 3 airports with 3 runways and 11 airports with 2 runways, accounting for 0.84%, 1.27% and 4.64% of the total number of airports, respectively.

2. Waypoints

By the end of 2019, there were 527 waypoints where 3 or more routes converge and intersect, accounting for 28.81% of the total number of waypoints (Figure 2).

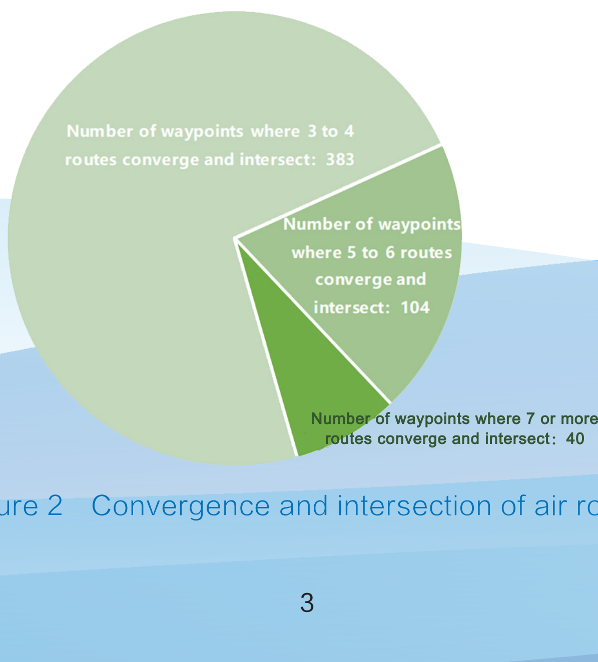


Figure 2　Convergence and intersection of air routes

3. Airways and air routes

By the end of 2019, there were 992 airways and air routes nationwide, covering a total distance of 234,509 km if the overlap distance was deducted. Among them, there were 743 permanent routes, covering a distance of 183,966 km, accounting for 78.45% of the total; 249 temporary routes spanning 50,543 km, accounting for 21.55% of the total.

Compared with the figure in 2018, the total distance of airways and air routes saw a net increase of about 9275 km in 2019, a y-o-y increase of 4.12% (Figure 3). To be more specific, there was a net increase of 34 permanent routes, covering a total distance of 4193 km, and a net increase of 35 temporary routes, totaling 5082 km.

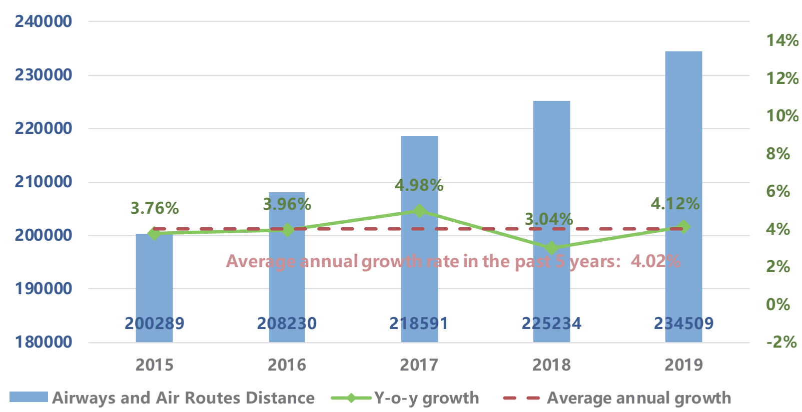


Figure 3 Changes in airways and air routes distance during 2015-2019

Overall, China witnessed a relatively slow growth in the total distance of routes, with an average annual growth rate of about 4.02% in the past five years. Under the current airspace management system, ATMB acts in compliance with national social and economic development strategies, focuses on further adjusting the systematic structure layout, promotes the steadily sustainable expansion of available airspace, and aims for more efficient, intensive and safer allocation and use of airspace resources. A series of achievements have been made in a phased manner. First, five large-capacity air corridors including Beijing-Kunming and Guangzhou-Lanzhou air orridors have been completed and put into service one by one, further optimizing the layout of the network of trunk routes. Second, air routes are opening more to the international world. Third, there was a significant increase in the total distance of departure/arrival routes, with a five-year average annual growth rate of 8.27%, the highest among all kinds of routes. Fourth, the distance of temporary routes has maintained a relatively rapid growth rate, with a five-year average annual growth rate of 7.20%.

4. Control areas and control sectors

By the end of 2019, there were 15 high-altitude ACCs , 28 medium and low altitude ACCs , 42 Approach Control Centres, and 2 Terminal Control Centres.

In 2019, there were 402 control sectors in China, including 256 area control sectors and 146 approach/terminal control sectors. In the whole year, 15 area control sectors and 9 approach control sectors were newly established, a respective y-o-y increase of 6.22% and 6.57%.

From 2015 to 2019, the number of sectors grew at an average annual growth rate of about 8.56 per cent. It grew by 6.54% year-on-year in 2019, slightly lower than the average annual growth rate.

5. FIRs

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

III. Analysis of Airspace Operation

1. Airports

In 2019, the total airport tower operations were 10.766 million movements, a y-o-y increase of 7.60%. Major airports[1] handled 8.127 million movements; accounting for 75.49 percent of the total airport operations volume, with their average daily number of movements staying at 498, a y-o-y increase of 1.01%. Beijing Capital International Airport, Shanghai Pudong International Airport, Guangzhou Baiyun International Airport, Shenzhen Baoan International Airport and Chengdu Shuangliu International Airport were the top five in the annual number of movements, accounting for 7.31%, 6.29%, 6.04%, 4.55% and 4.54% of the total handled by major airports, respectively. With the exception of Beijing Capital International Airport, the other four airports showed a steady growth in the average daily traffic (Figure 4).

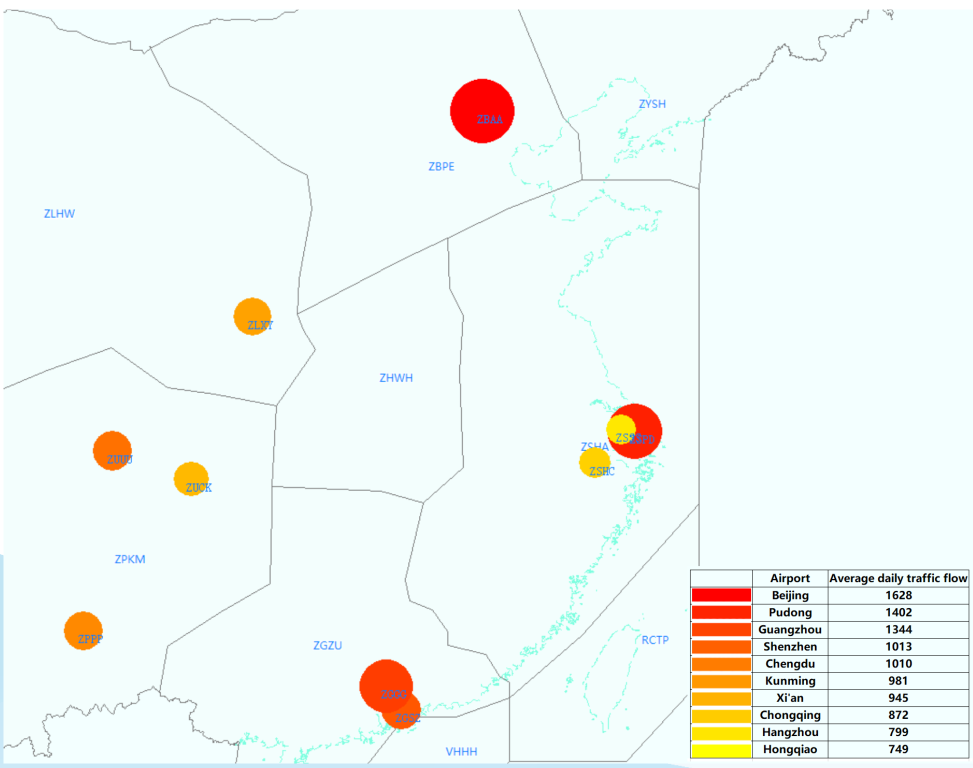


Figure 4 Top 10 airports in average daily traffic

1 Major airports refer to the 45 airports at which the ATMB provides control services.

An analysis of the daily flow time-varying coefficient[2] at the top five airports was made using the traffic data of the peak day (August 3, 2019). As it can be seen from Figure 5, on the whole, most airports are in heavy-duty operation from 08:00 to 21:00 with low volatility in terms of traffic flow. There are two troughs during 12:00-14:00 and 17:00-19:00. In addition, the peak hours in terms of arriving and departing traffic are similarly distributed among all of the airports; traffic handled during the peak hours usually does not exceed the average hourly traffic by more than 30%; and the difference between the number of movements during the peak hour and the average hourly movements tends to be the same for all of the airports.

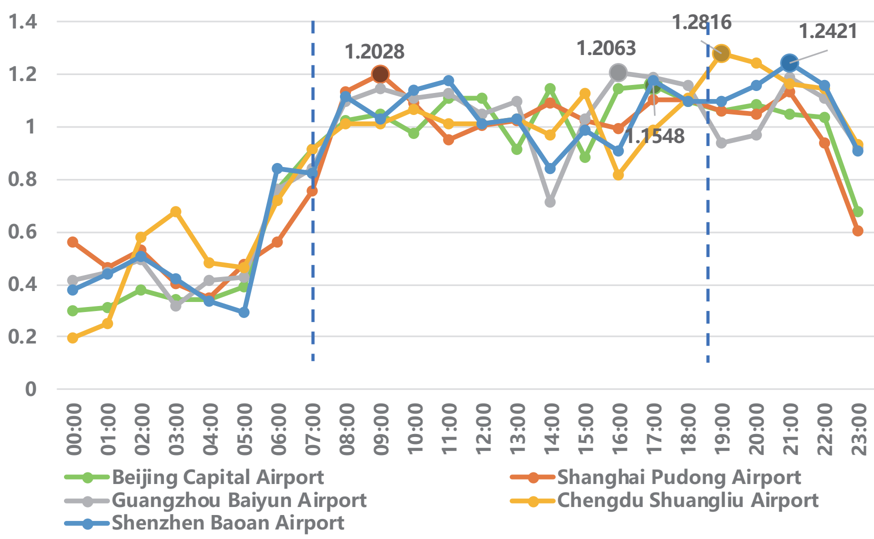


Figure 5 Peak day daily flow time-varying coefficient of the top five airports

The five airports with the relatively large year-on-year increases in the number of movements were Yinchuan Hedong, Hulunbuir Hailar, Xining Caojiabao, Lanzhou Zhongchuan and Wuhan Tianhe airports, which saw respective y-o-y increases of 11.53%, 10.90%, 10.57%, 8.35% and 8.00%, higher than the average growth rate of 4.33% for the major airports. In terms of movements handled during the peak days and the peak hours, Beijing Capital (1830 for the peak day/104 for the peak hour), Shanghai Pudong (1527/99) and Guangzhou Baiyun (1491/90) ranked top three, showing how busy China's three major composite hubs are (Figure 6).

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

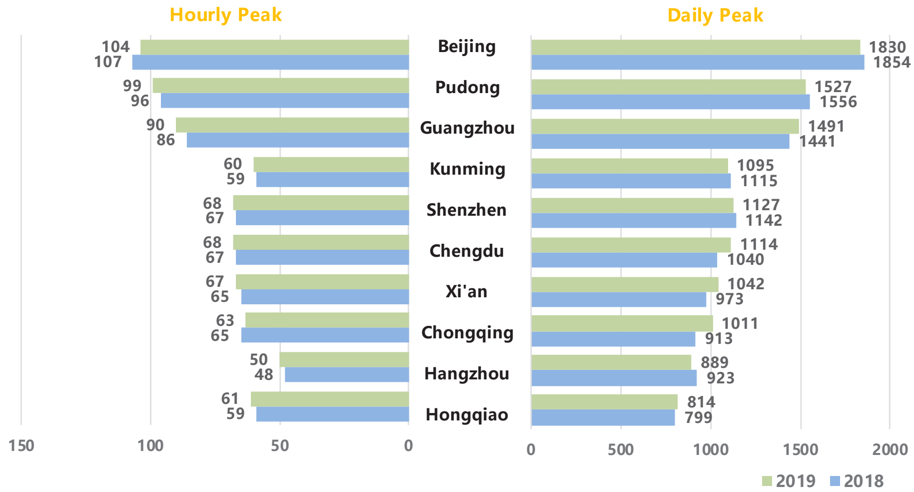


Figure 6　Hourly /daily peak operations of top 10 airports in recent 2 years

2. Heavy-traffic waypoints

The top 10 waypoints seeing the highest average daily traffic flow pasing through in 2019 are shown in Figure 7. HFE (Luogang VOR), LKO (Longkou VOR), PAVTU, TOL (Tonglu VOR) and OBLIK ranked in the top five, all of which saw an average of more than 1 000 flights passing through each day and were where several high density air routes converged. The traffic passing through these waypoints remained high all the year round, and the surrounding airspace environment was complex (Figure 7).

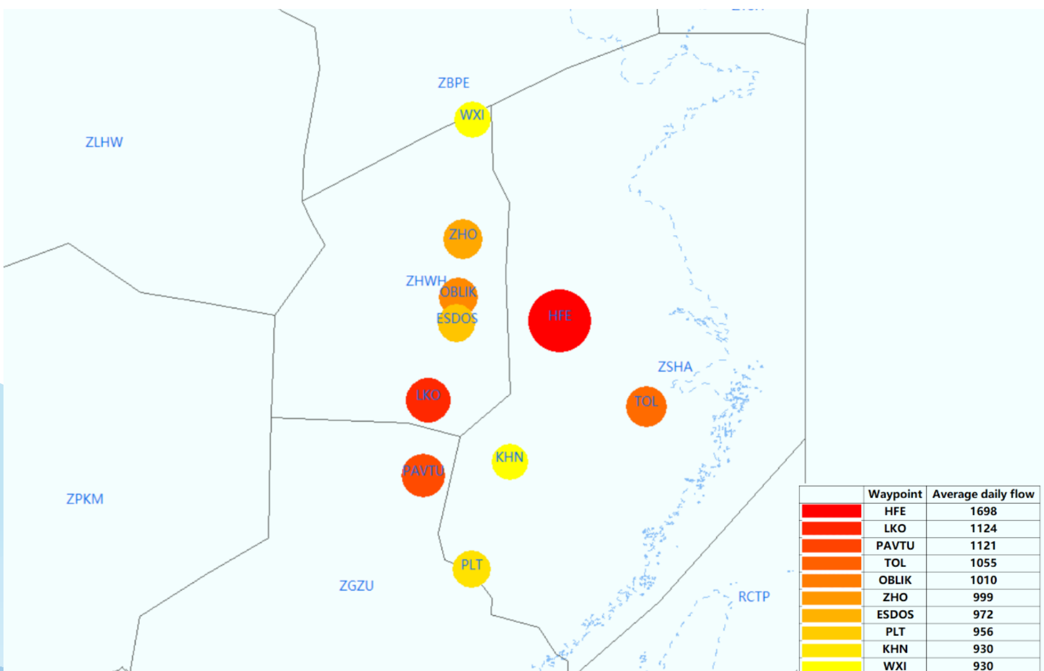


Figure 7　Top 10 ACC waypoints in average daily flow

The five waypoints with the largest increase in average daily traffic were DST(Dongshan VOR), HFE, MADUK, ESDOS and TOL, which saw a respective y-o-y increase of 14.04%, 10.84%, 10.33%, 7.88% and 7.65% (Figure 8). Detailed description of these waypoints is as follows:

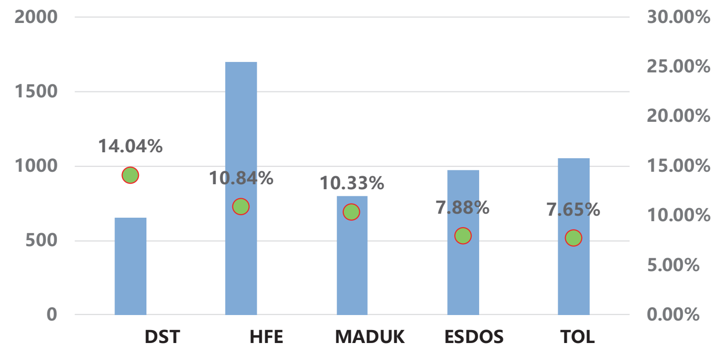
— TOL is where six routes converge, including route A470, A599 and W508. Due to the surging number of flights to and from southwest and central and south parts of China, and the rapid increase in the number of airports in Hangzhou, Nanjing and other locations, this point saw a significant increase in terms of the traffic passing through.

— DST located in Wenzhou and featuring complex airspace organization, is where 8 routes converge, including route B221, R596 and W117. The increase in traffic can be attributed to two main factors: the seasonal change in the number of flights; and the huge increase in the number of flights between the northeast part of China and areas in and beyond east part of China, as well as from the central and west part of China and Zhejiang to Taipei.

— Both HFE and MADUK are where the trunk route R343 and other routes converge. The significant increases in traffic passing through these two points can be attributed to two main factors: the increase in the number of flights between East China and areas in and beyond the northwest part of China; and the rapid increase in the number of small and medium-sized airports in Jiangsu.

— ESDOS is where A461 and W118 converge in the Wuhan area. In particular, after the airspace program for Daxing Interanational Airport was put into effect, traffic from the two airports in Beijing converged at this waypoint before going further to central and south prat of China. And given the continuous increase in traffic on the Beijing-Guangzhou route, traffic passing through the point saw a steady increase.

An analysis revealed that the heavy-duty waypoints were mainly located on the trunk routes such as A461, A470, A599, B221 and R343, and the increase in traffic flow passing through one waypoint could easily lead to a flow increase at the subsequent waypoints, meaning that the operation of trunk route network was facing an ever increasing pressure.



	DST	HFE	MADUK	ESDOS	TOL
The average daily flow at this waypoint	650	1698	801	972	1055
Year-on-year growth rate	14.04%	10.84%	10.33%	7.88%	7.65%
The number of routes intersecting and converging at this waypoint	8	8	3	1	6

Figure 8　Indicators for the top tive waypoints with the largest increase in average daily traffic

3. High density traffic entry and exit points

In 2019, China witnessed a total of 1,468,110 inbound and outbound flights, a y-o-y decrease of 12.74%. Figure 9 shows the traffic passing through the top 10 entry and exit points with the largest traffic in the past three years. As it can be seen from the Figure, over the past three years, the traffic flow passing through SIKOU (Hong Kong) has shown a steady upward trend; whereas the flow passing through LAMEN-SADLI (China -Japan) has shown a downward trend on a yearly basis. Some entry and exit points, such as AGAVO (China - South Korea) and POLHO (China - Mongolia) have shown obvious fluctuations in flow in the past three years.

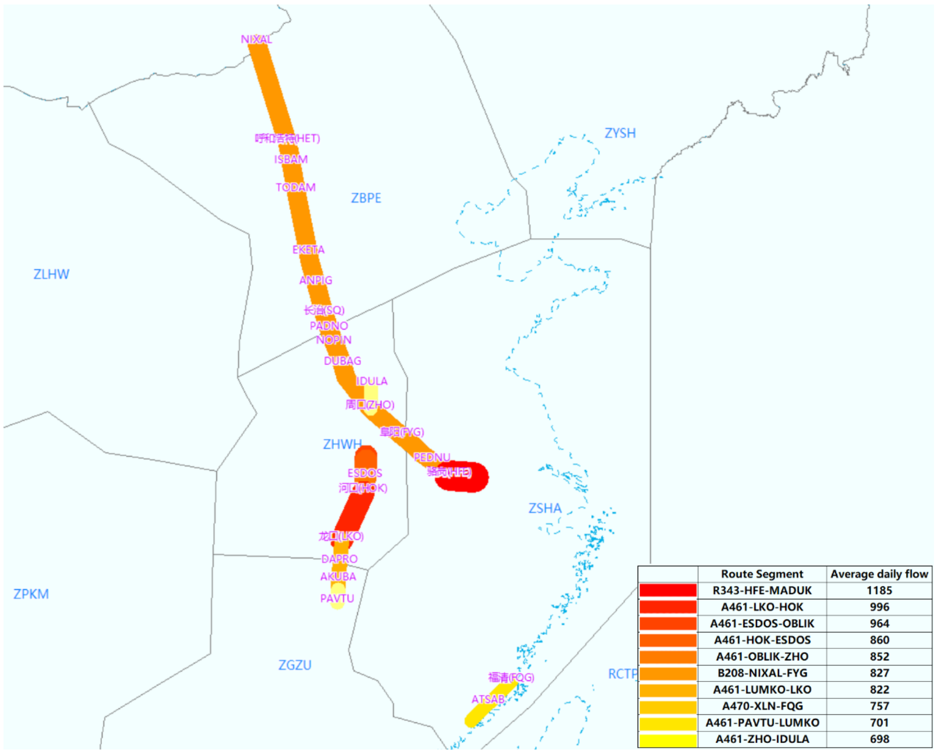
Ranking	Entry and Exit point	2017	2018	2019
1	LAMEN-SADLI (China-Japan)	196874	188332	186180
2	AGAVO (China-South Korea)	108848	166504	129762
3	LINSO (China-Myanmar)	89591	84677	85493
4	SIKOU (Hong Kong)	76826	78727	80079
5	BUNTA (China-Vietnam)	64725	52246	52246
6	POLHO (China-Mongolia)	52411	104187	51150
7	BEKOL (Hong Kong)	47441	47064	49702
8	SAGAG (China-Laos)	46236	43308	43900
9	SULEM (Taibei)	50088	36490	43130
10	ASSAD (China-Vietnam)	54329	52738	43028

Figure 9　Traffic flow passing through the top 10 entry and exit points in recent 3 years

4. High density route segments and route operation efficiency

1) Traffic volume

In 2019, the top 10 route segments with the largest average daily traffic flow were mainly located on such trunk routes such as A461, A470, A593 and R343, with a daily average of 770 flights passing through these segments. The segment B208-NIXAL-FYG (Fuyang VOR) saw the most significant increase in flow, increasing by 117.63% (Figure 10).



	Route Segment	Average daily flow
	R343-HFE-MADUK	1185
	A461-LKO-HOK	996
	A461-ESDOS-OBLIK	964
	A461-HOK-ESDOS	860
	A461-OBLIK-ZHO	852
	B208-NIXAL-FYG	827
	A461-LUMKO-LKO	822
	A470-XLN-FQG	757
	A461-PAVTU-LUMKO	701
	A461-ZHO-IDULA	698

Figure 10　Top 10 route segments in average daily traffic

The segment of A461 starts from WXI (Weixian VOR) and ends on PAVTU, in the central and south part of China, accounting for about 60% of the total length of the entire route. It maintains high density operation throughout the year, and has 16 flights per kilometer on average, one of the most congested in the country. As far as airspace organization is concerned, the route segment, running south-north and covering a large area, connects with many east-west trunk routes and has a total of 6 high density points where three or more routes converge (each with a daily average of 700+ flights passing through), thus becoming one of the trunk segments featuring the most complex airspace organization. In 2020, ATMB will practically promote to build the air corridors between Beijing and Guangzhou, which will optimize the overall layout of route network and making traffic flow faster, safer and smoother.

2) Horizontal flight efficiency

In 2019, the average non-linear coefficient of domestic routes between city pairs was about 1.14, meaning, on average, each flight actually flew a distance approximately 14% longer than on the optimal route. Figure 11 shows the top 10 busiest routes between city pairs with flight distance exceeding 1500 km (in a descending order in terms of how busy they are), whose average non-linear coefficient was 1.12, slightly better than the national average of 1.14.

Ranking	City pair	Number of Flights	Non-linear coefficient
1	Beijing Capital-Shenzhen Baoan	12267	1.15
2	Shenzhen Baoan-Beijing Capital	12025	1.03
3	Beijing Capital-Chengdu Shuangliu	11920	1.18
4	Chengdu Shuangliu-Beijing Capital	11875	1.19
5	Beijing Capital-Guangzhou Baiyun	11354	1.11
6	Guangzhou Baiyun-Beijing Capital	11307	1.02
7	Beijing Capital-Chongqing Jiangbei	8534	1.19
8	Chengdu Shuangliu-Shanghai Pudong	6725	1.07
9	Shanghai Pudong-Chengdu Shuangliu	6692	1.11
10	Beijing Capital-Kunming Changshui	6651	1.17

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

3) Vertical flight efficiency

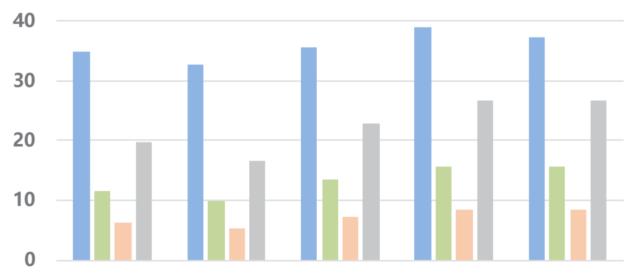
Based on the traffic data from the peak day (August 3, 2019), the A461 route segment carried the largest traffic flow at the flight levels of 6900, 7500 and 8400 meters, accounting for 9.02%, 10.36% and 9.98% of the total traffic at all available flight levels, respectively.

Other high density segments also mainly carried the largest traffic flow at the flight levels of 6900, 7500 and 8400 meters.

5. Temporary routes

The use of temporary routes in 2019 was roughly the same as that in 2018. A total of 373,000 flights flew temporary routes, shortening the flight distance by 15.7 million kilometers, saving 84,800 tons of fuel and cutting carbon dioxide emissions by 267,000 tons, a respective y-o-y drop of 4.36, 0.25, 0.24 and 0.37 percentage points.

As shown in Figure 12, in the past five years, although the use of temporary routes showed a downward trend in 2016 compared with the previous year, it has improved since 2017 and maintained a relatively stable momentum from 2018 to 2019. Analysis revealed that the relevant indicators of temporary routes in 2019 were relatively ideal in general (Figure 12). In particular, a total of 13 new temporary routes were newly added in east part of China and central and south part of China, which further enriched the airspace resources available for civil aviation. On the whole, there has been a gradually growing enthusiasm for the use of shared military and civilian airspace, a steady additional shortening of the flight distance for each flight as a result of the use of temporary routes, significant efficiency improvement in the use of regional temporary routes.



	2015	2016	2017	2018	2019
Flights of Utilizing Temporary Routes(10-thousand flights)	34.9	32.6	35.5	39	37.3
Shortening Flight Distance(million km)	11.58	9.79	13.43	15.74	15.7
Saving Fuel (10-thousand ton)	6.25	5.3	7.2	8.5	8.48
Reducing Carbon Emissions (10-thousand ton)	19.7	16.6	22.8	26.8	26.7

Figure 12　Changes in relevant indicators for temporary routes during 2015–2019

6. Hign density area and approach control sectors

In 2019, among the top 10 control sectors with the highest average daily traffic, they were concentrated in east and central and south parts of China, and experienced an increase in traffic (Figure 13). According to the data, the three sectors with the largest increase in traffic were Hefei sector No.01 (+11.59%), Hefei sector No.04 (+11.22%) and Guangzhou sector No.02 (+5.13%).

Due to traffic congregation over HFE and traffic surge at many airports, especially the rapid increase in the number of flights from Fujian and Jiangxi to areas in and beyond North China via W127 and between Jiangsu, Zhejiang and

Shanghai and areas in and beyond the northwest part of China via B208, Hefei sectors No.01 and 04 saw a significant increase in traffic.

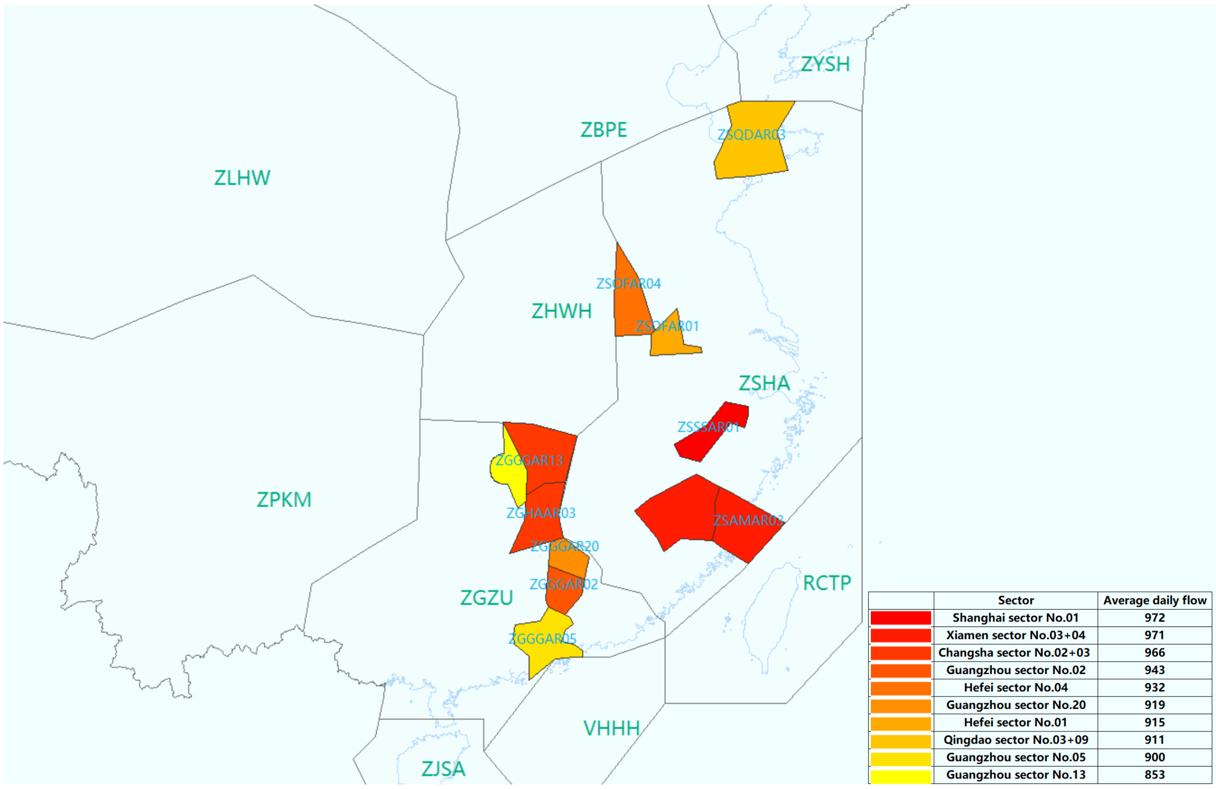
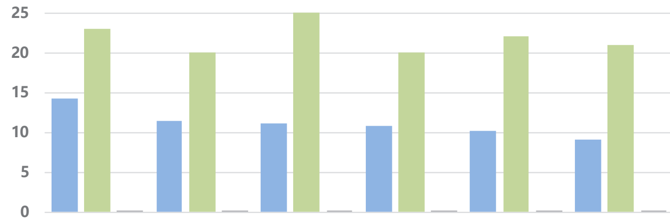


Figure 13 Top 10 sectors in average daily traffic

Figure 14 shows the average service time, maximum number of instantaneous flights and the number of waypoints where routes intersect in some high density sectors on the peak day (August 3, 2019). An analysis of relevant indicators shows that, Guangzhou sectors No.01 and 15 were among those that featured a large number of intersection points and instantaneous flights, relatively short average flight time, complex sector airspace organization, huge instantaneous pressure for ATC controllers and enormous difficulties in airspace adjustment. However, following adjustment, Chengdu sector No.08 was, relatively speaking, small in the number of intersection points, low in the maximum number of instantaneous operations, and long in average flight time, contributing to an moderate improvement in the overall airspace operating environment and making it less difficult to provide ATC service.



	Guangzhou sector No.13	Chengdu sector No.08	Wuhan sector No.02	Guangzhou sector No.01	Shanghai sector No.01	Guangzhou sector No.15
Average flight time	14.28	13.18	11.45	10.78	10.2	9.12
Maximum number of instantaneous operations	23	13	20	20	22	21
Route network density	0.03	0.04	0.04	0.05	0.10	0.03

Figure 14 Relevant indicators for some busy sectors on the peak day (August 3)

7. Busy approach (terminal) control areas

1) Traffic volume

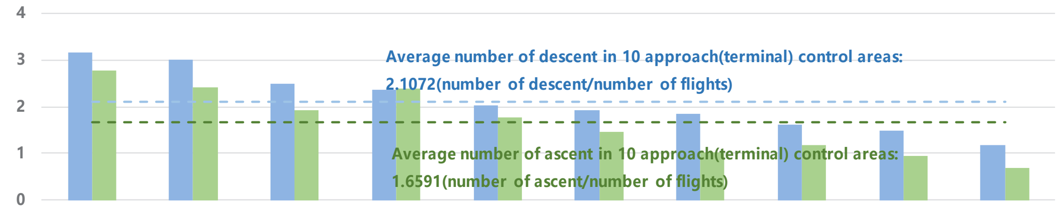
The top 10 approach control areas handling the largest number of flights in 2019 are shown in Figure 15. Shanghai, Guangzhou and Beijing approach control areas ranked in the top three, providing ATC support to 987,421, 812,523 and 675,488 operations respectively. In particular, Shanghai approach control area was particularly busy, handling nearly 3000 operations on the peak day.

	Annual number of operations	Number of operations during the peak day	Average daily number of operations
Shanghai	987421	2968	2705
Guangzhou	812523	2553	2226
Beijing	675488	1939	1851
Zhuhai	587884	1753	1611
Hangzhou	488851	1511	1339
Nanjing	484563	1553	1328
Chengdu	427997	1210	1173
Kunming	364475	1126	999
Xi'an	347960	1051	953
Chongqing	329436	1051	903

Figure 15 Top 10 busy approach /terminal control areas in 2019

2) Operation efficiency

The data of the peak day (August 3, 2019) was used to conduct the following analysis into the relevant indicators for the above approach (terminal) control areas. In terms of the numbers of ascent and descent per aircraft, the highest numbers were in Chongqing approach control area at 2.77 and 3.15 respectively, followed by Kunming approach control area at 2.41 and 3.00 respectively. Both were much higher than 1.66 and 2.11, the average numbers of ascent and descent in the 10 control areas (Figure 16).



	Chongqing approach control area	Kunming approach control area	Xi'an approach control area	Zhuhai terminal control area	Guangzhou approach control area	Nanjing approach control area	Chengdu approach control area	Hangzhou approach control area	Shanghai approach control area	Beijing approach control area
Average number of descent	3.15	3.00	2.48	2.35	2.03	1.92	1.85	1.61	1.50	1.18
Average number of ascent	2.77	2.41	1.92	2.40	1.78	1.46	1.03	1.18	0.95	0.69
Total	5.92	5.41	4.40	4.75	3.81	3.38	2.88	2.79	2.45	1.87

Figure 16 Average numbers of ascent and descent in approach /terminal control areas during the peak day (August 3)

In terms of the number of turns, Chongqing approach control area featured the largest number of turns per aircraft at 2.30 turns, followed by Hangzhou approach control area at 2.25 and Kunming approach control area at 2.15 (Figure 17).

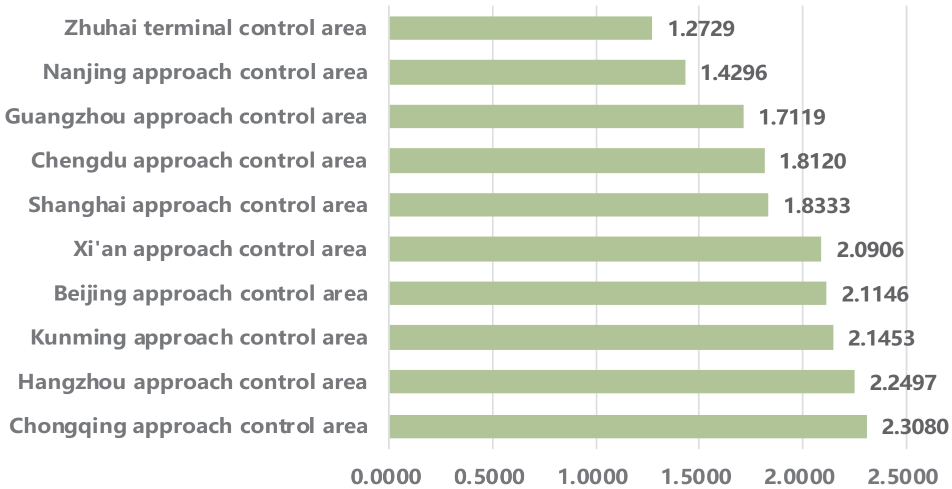


Figure 17 Average turns in approach /terminal control areas during the peak day (August 3)

IV. Specialized Airspace Related Work in 2019

1. Airspace optimization and adjustment for Beijing Daxing International Airport

In September, 2019, Beijing Daxing International Airport, which attracted worldwide attention, was officially put into operation. In October, new runways were put into service, and the adjustments to flight procedures, major airspace and routes came into force. This airspace adjustment program was designed following the concept of "unidirectionality", aiming to "efficiently consolidate airspace resources, and actively advance meticulous airspace management". The program transformed some trunk routes with the traffic of more than 500 flights into unidirectional parallel routes, resulting in airspace configuration featuring "separation of inbound and outbound traffic" on major routes. This airspace adjustment covered an area which is the largest in history. From the border between China and Mongolia in the north to the Guilin area control in the south, and from the west of Inner Mongolia in the west to the Dalian area control in the east, more than 200 air routes were adjusted, involving more than 5,300 flights. A total of 29 civil aviation airports across the country have adjusted their flight procedures synchronously. In particular, major changes have taken place in the airspace organization within the Beijing ACC as several groups of parallel routes, making unidirectional traffic flow smoother. Following its implementation, the overall plan has further improved the operational environment of the regional airspace, contributing significantly to balancing the distribution of traffic, optimizing the structure of congested nodes and improving flight operational efficiency.

2. Optimization of the airspace in Gansu, Qinghai and Ningxia in the northwest part of China

In order to further optimize the airspace organization in the northwest part of China and address inadequacies in airspace resources in the key areas covered by the "Belt and Road Initiative", the airspace adjustment plan for Gansu, Qinghai and Ningxia was formally implemented in July 2019. As a large-scale airspace adjustment in the west part of China in the past decade, this optimization plan aimed to transform some major air routes in Gansu, Qinghai and Ningxia airspace into bidirectional parallel routes, with a total of 13 routes newly established, including W217, W218 and V115, 14 routes adjusted, and 1,116 flight routes between city pairs newly added or adjusted, which facilitated the separation of the arriving and departing traffic at Lanzhou, Xining, Yinchuan and other airports in the west part of China and made the en-route and approach phases of flight significantly more efficient.

3. Wider application of new technologies

1) Continuous Climb Operations and Continuous Descent Operations (CCO/CDO)

Following the early-stage pilot operation, Guangzhou Baiyun International Airport and Kunming Changshui International Airport further applied on a regular basis CDO/CCO during evening hours in 2019. CDO/CCO was applied from 1:00 to 6:00 am at Guangzhou Airport, covering the Guangzhou approach control area. Based on, for example, the October data, it's known that the CDO/CCO was implemented at a rate of 84.4%. A total of 100 flights flew CDO/CCO in the whole month, saving a total of 6.3 tons of fuel and reducing emissions by 29 tons. Specifically, a total of 29 flights used CCO (in the direction of YIN), saving about 1.5 tons of fuel, with an average low-altitude level flight time less than 13 seconds; and a total of 71 flights used CDO (in the direction of ATAGA), saving about 4.8 tons of fuel, with an average low-altitude level flight time of 4.50 minutes, 2.37 minutes shorter than when CDO was applied on a non-regular basis(Figure 18).

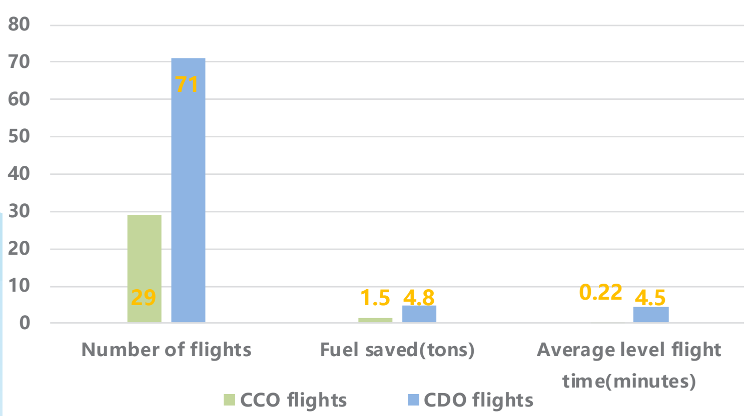


Figure 18 Regular application of CDO/CCO at Guangzhou airport

From July 7 to December 1, a total of 108 flights were operated at Kunming Airport using CDO/CCO, saving 33.34 tons of fuel in total, and cutting emissions by 104.3 tons. CDO/CCO was applied from 1:30 to 7:30 am, covering the Kunming area control and the approach control area. Specifically, 67 flights used CCO (in the direction of DADOL), saving about 29.3 tons of fuel in total and reducing emissions by about 91.7 tons, and 41 flights used CDO (in the direction of MEBNA), saving in total about 4.04 tons of fuel and reducing emissions by about 12.6 tons. Based on, for example, the October data, it's known that the average level flight time for flights using CCO was 4.76 min; and in the case of CDO it was 4.16 min, which was about 0.9 min shorter than when CDO was applied on a non-regular basis (Figure 19).

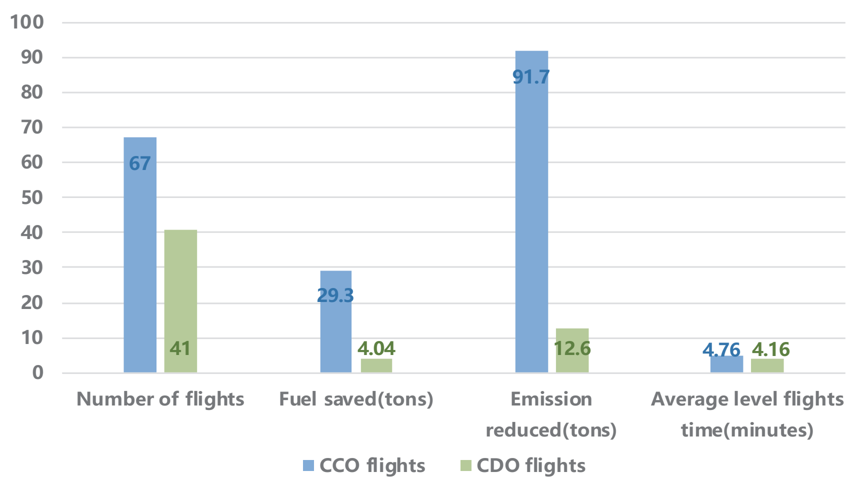


Figure 19　Regular application of CDO/CCO at Kunming airport

The results achieved from the application of CDO/CCO at the above two airports showed that CDO/CCO has played a significant role in, among others, saving energy and reducing emissions, cutting low-altitude flight time, and optimizing flight profile.

2) Implementation of Point Merge System (PMS) technology for the first time

Point Merge System (PMS) technology refers to an integrated application of PBN for the purpose of sequencing arrival flow. Through specialized airspace/program design based on the characteristics of ATC operation, this technology makes full use of the aircraft PBN capabilities to achieve efficient arrival flow sequencing and continuous descent operation. The application of PMS can cut the amount of air-ground communication during arrival, reduce the workload of ATC controllers, enhance pilots’ situational awareness, and accurately merge and maintain separation between the incoming traffic from different directions, so as to effectively improve the operational efficiency of aircraft in the terminal area. At present, the technology is in the initial stage of pilot application in China, and pilot application is encouraged in areas where conditions permit.

In December, 2019, the Point Merge System flight procedures were officially applied at Shanghai Pudong International Airport. This is the first time this new technology was applied in China, providing valuable hands-on experience for a wider domestic application of this technology in the future. “Point merge” technology performs significantly better than radar vector in terms of reducing the air-ground communication, enhancing pilots’ situational awareness and accurately maintaining the safe separation between the arrival flow, and can contribute greatly to a higher operation quality and efficiency of aircraft in a high density terminal area.

V. Civil Aviation Airspace Management Outlook 2020

In general, the major problems and bottlenecks China faces in its current airspace development include: 1. Airspace resources increase slowly. 2. Airspace organization needs furthrer improvement. There are lots of nodes where high density routes converge and intersect, the non-linear coefficients of flight routes are high, and the structure of the route network is to be further optimized. 3. Traffic distribution is uneven. On one hand, some of the trunk routes connecting major city pairs are overburdened with traffic and feature high concentration of traffic flow, often resulting in operation overload. On the other hand, other air routes (especially regional routes) carry less traffic and feature low traffic density.

In 2020, ATMB will focus our efforts on the following four areas:

1. Practically promote the construction of large-capacity air corridors by continuing to step up the implementation of the plan on the establishment of the Beijing-Guangzhou large-capacity air corridor. This corridor links and serves as an air traffic artery between the two world-class city clusters of Beijing-Tianjin-Hebei and the Greater Bay Area, and once fully operational, it will be of great significance in improving the structure of the north-south trunk route, optimizing the overall layout of route network and making traffic flow faster, safer and smoother.

2. Continue to optimize the airspace in high density locations, in an effort to enhance the overall operation efficiency of local route network and terminal areas. Chengdu Tianfu International Airport, scheduled to be put into operation in 2021, is another important construction project after Beijing Daxing International Airport. The corresponding adjustment to the airspace planning in Chengdu terminal area will result in significant change in the air route and terminal airspace organization of the whole southwest region, producing a far-reaching impact on the ATC activities in the region. To this end, we will proactively implement the airspace optimization and adjustment plan tailored for Tianfu International Airport, and focus

on a series of work, so as to lay a solid foundation for the smooth operation of Tianfu International Airport. In addition, we will continue to optimize the airspace in Hainan, and make every effort to ensure the smooth implementation of the plan to transform route G221 into a unidirectional parallel route.

3. Speed up the application of new technologies. We will further promote the pilot application of CCO/CDO at Urumqi, Xi'an, Changchun and other airports, carry out researches on Point Merge System (PMS), follow up closely bearing in mind specific application and relevant cases, conduct specialized researches, improve the operation efficiency at approach terminals, and constantly improve procedure design service quality.

4. Support the reforms on airspace management system, including strengthening the researches on airspace planning, proposing state-level concepts and principles guiding future airspace planning and operation, boosting the role of overall planning in guiding airspace management, developing an overall, coordinated and systematic plan to coordinate various tasks included in the 14th Five-year Plan, so as to nurture a more favorable environment for the development of civil aviation transport industry and of ATC operation system.

In 2020, the global civil aviation transportation industry, which suffered heavy losses due to the spread of COVID-19 worldwide, is facing a new situation with unprecedented challenges. ATMB will be fully committed to the recovery of air transportation and gradually transform the past model aimed at increasing development speed and scale to the sustainable pattern focusing on imporving quality and efficiency. Simultaneously, on the basis of technological innovation, ATMB will also endeavor to realize more refined, digital and intelligent civil airspace management in order to adapt to the requirements of development and changes under the new circumstances.

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