

# FURTHER RESEARCH OF THERMAL CONVECTION TO CHINA FOR SOARING FLIGHT

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## ABSTRACT

In this paper, thermal states are analyzed and compared in three regions—Jiayuguan, Datong and Anyung of China, using 10 years surface and aerological data. It is concluded that Jiayuguan is ranked first in the summer half year, then Datong of Shanxi province, but the latter is the first in May. The last satisfactory is Anyung of Henan which, however, may be a good place for training.

More important, this method of evaluation of thermal inten-

sity using synoptic scale information is verified in practice. The statistical sample, however, must cover 10 years at least.

## 1. INTRODUCTION

The author has concluded (1) that the Hexi Corridor is a good place for sailplanes. Although Jiayuguan in the Hexi Corridor had been selected an important soaring base, and even if new records of China was constantly established at Jiayuguan during 1986-1988, it cannot be ruled out that this may be due to the

3 year period only. Therefore, we must investigate the position of Jiayuguan compared with Datong and Anyang, which were established in the 1950's.

## 2. METHOD AND DATA

The method used in (1) and similar meteorological data corresponding to the period (1971-1980) were applied.

Statistical and comparative methods are applied in this paper.

## 3. ANALYSIS

This is divided into two parts: the meteorological conditions and the thermal factors. All information in the tables were averaged for the period of 1971-1980. Standard time of Beijing is used.

(1) Contrasted analysis of meteorological conditions.

A. It is common knowledge that the energy source of thermal updrafts comes from solar radiation; its extent can be represented to a good degree by sunshine duration in practice and percentage of possible sunshine. These are shown respectively in Tables 1 and 2.

TABLE 1. MEAN SUNSHINE IN PRACTICE (UNIT: HOUR)

	March	April	May	June	July	Aug	Sept
Jiayuguan	241.2	243.7	298.2	294.5	281.2	280.3	252.1
Tatong	231.0	239.4	290.9	257.5	242.7	242.8	234.6
Auyang	191.0	216.9	271.6	251.1	203.5	205.2	202.6

TABLE 2. MEAN PERCENTAGE OF SUNSHINE (UNIT: %)

	March	April	May	June	July	Aug	Sept
Jiayuguan	66.3	66.4	66.5	66.4	62.1	66.5	68.0
Tatong	63.0	61.0	65.0	63.0	54.0	57.0	63.0
Auyang	51.7	55.7	62.5	57.8	46.4	49.5	54.6

Jiayuguan in both respects is better than Datong and Anyang. It is seen that Jiayuguan not only has abundant radiation, but also has better regularity, especially in the summer. In terms of radiation, therefore, Jiayuguan is the first of the three for thermals.

B. Moisture and cloudiness have an important influence on the radiation intensity at the surface and the lapse rate of temperature. They are illustrated in Tables 3 and 4. Here, the moisture is presented as difference between the dry-bulb (T) and dew-point temperature (Td).

TABLE 3. MEAN (T-Td) AT 14:00 HOURS (UNIT: DEGREES C)

	March	April	May	June	July	Aug	Sept
Jiayuguan	21.0	21.9	22.1	19.5	17.3	17.0	16.7
Tatong	16.3	19.1	21.9	17.5	12.4	11.3	13.2
Anyang	14.4	13.0	15.1	14.8	7.7	7.6	11.0

Jiayuguan is very dry compared with the other two places. Datong is very similar to it in May only. This difference is larger in the summer, because in Datong and Anyang it is the rainy season.

TABLE 4. MEAN CLOUD AMOUNT AT 14:00 HOURS

	March	April	May	June	July	Aug	Sept
Jiayuguan	6.0	5.7	5.9	6.2	5.9	5.0	5.0
Tatong	5.7	6.3	6.4	6.9	7.6	6.3	5.7
Anyang	6.5	5.9	5.7	6.3	7.3	6.6	5.8

TABLE 5. MEAN LOW CLOUD AMOUNT AT 14:00 HOURS

	March	April	May	June	July	Aug	Sept
Jiayuguan	0.3	0.7	0.8	1.8	1.9	1.3	1.9
Tatong	2.2	2.2	2.8	3.4	3.5	3.6	2.4
Anyang	1.5	1.4	1.2	2.0	3.7	3.5	1.7

It looks as if there is no large difference in the total amount, but what also matters is cloud form. In the summer, the composition at Datong and Anyang is mainly the Cb and Sc, but at Jiayuguan is Cu hum and Cb. Thus, it can be seen that the cloud for good development of thermals favors Jiayuguan.

(2) Contrasted analysis of thermal factors

Important also are sensible heat, lapse rate, convective condensation level and thermal lift index. They have close relations with thermal draft.

A. Sensible heat strength SH is determined by the following equation:

$$SH = C_p P \quad C_d V (T_s - T_a)$$

where  $C_p P$  and  $C_d$  are separately constant under some conditions,  $V$  is the speed of surface wind,  $(T_s - T_a)$  is the temperature difference between surface and air. Obviously, sensible heat is

mainly determined by  $V$ , and  $(T_s - T_a)$ , and is in direct ratio with them. Here, sensible heat is represented only by  $V$  and  $(T_s - T_a)$  because differences of  $C_d$  for surface quality in the three regions is small.

The  $(T_s - T_a)$  is shown on Table 6.

TABLE 6. MEAN  $(T_s - T_a)$  AT 14:00 HOURS (UNIT: °C)

	March	April	May	June	July	Aug	Sept
Jiayuguan	16.2	20.6	22.5	23.4	20.7	19.6	17.5
Tatong	11.8	15.6	17.6	17.5	14.7	13.5	11.5
Anyang	12.0	14.0	18.0	17.1	12.2	11.9	10.7

It is a fact that  $(T_s - T_a)$  of the Jiayuguan is larger than 19 degrees C except in March and September, but at Datong and Anyang 18 degrees C is reached only for one month. In addition, Jiayuguan has higher wind speed and sensible heat. For the latter it is better even than the Tibetan Plateau, which was called a good heating source in the atmosphere [2].

Sensible heat is what produces convection after solar radiation has reached the surface. Thus, convection at Jiayuguan certainly exceeds that of the other two regions by a big margin.

B. Lapse rate is often used to indicate the development of thermal convection. Table 7 gives lapse rate at 2000 hours. Jiayuguan is located about 18 degrees west of Beijing and its sunshine is comparatively long, over 12 hours. Soaring can progress up to 2100 hours in summer.

TABLE 7. MEAN LAPSE RATE BELOW 500 hpa AT 20:00 HOURS

	March	April	May	June	July	Aug	Sept
Jiayuguan	0.65	0.77	0.82	0.77	0.77	0.77	0.72
Tatong	0.63	0.71	0.74	0.70	0.64	0.61	0.63
Anyang	0.57	0.62	0.65	0.67	0.58	0.56	0.58

For mean lapse rate above 0.7 degrees C/100m, Jiayuguan has the largest period of the three regions. Graph #1 gives experimental relationship between lift rate of glider and lapse rate. For example, when the mean lapse rate is 0.77 degrees C/100m, the mean lift of the glider is 2.8 m/s, but maximum and minimum lift speeds are respectively 5.7 m/s and 1.9 m/s. Some gliders, however, can obtain larger lift speed for the same lapse rate, depending to a large extent on the skill of the pilot in finding the thermals.

Anyang is poorer; it approaches only average lapse rates.

C. The convective condensation level is an indication how high the glider can climb. Mean convective condensation levels are shown in Table 8.

TABLE 8. MEAN CONVECTIVE CONDENSATION LEVEL (UNIT:m)

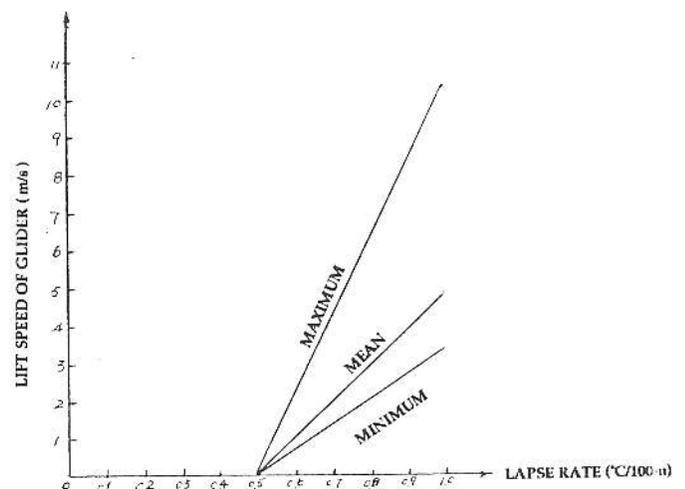
	March	April	May	June	July	Aug	Sept
Jiayuguan	2250	2763	2575	2150	1925	2100	2925
Tatong	2038	2388	2738	2188	1550	1413	1650
Anyang	1800	1625	1888	1850	936	950	1375

It can be seen that Datong is nearly as good as Jiayuguan before July, and very poor, owing to high moisture.

D. The thermal lift index indicates direction and intensity of vertical motion. Negative values indicate ascent, and the ascending velocity is directly proportional to the value.

TABLE 9. MEAN THERMAL LIFT INDEX AT 1500 M. HEIGHT

	March	April	May	June	July	Aug	Sept
Jiayuguan	-1.5	-4.0	-2.5	-2.5	-2.0	-1.0	-1.0
Tatong	-1.1	-3.0	-4.1	-2.7	-1.4	-0.4	-0.9
Anyang	1.7	1.1	1.1	0.8	3.0	2.9	1.7



Graph 1. Relation between lapse rate and lift speeds of glider. This graph is made by Sang Xingling of the Anyung Soaring School.

Jiayuguan and Datong have completely ascending motion at the height 1500m. during the summer half of the year, but Datong shows some difference with practice, because the air is considered to be dry in the graphical solution. In fact, Jiayuguan conditions approach dry air more closely than Datong. But the absolute value at Datong is very large in May. Unquestionably, Anyang is still very poor.

#### 4. Discussion

According to the analysis above, we have no choice but to acknowledge that Jiayuguan is first of the three regions. It is also to be expected from the geographical factors in Table 10.

TABLE 10. GEOGRAPHICAL FEATURES

	Latitude	Longitude	Elevation	Surface Character
Jiayuguan	39°00'N	98°15'E	1500 m.	Sand and Gravel
Datong	38°40'N	113°20'E	1040 m.	Poor Sandy Soil
Anyang	35°50'N	114°10'E	120 m.	Amble Soil

Jiayuguan is located at higher latitude than the other regions and its global radiation is 140-150 k.cal./cm.2 year [3] while we must remember that the distribution of the global radiation has a tendency to increase towards the northwest in China.[4] In addition, sand and gravel have small heat capacity, so that the surface rapidly emits heat and produces vigorous sensible heat after absorbing solar radiation, especially in summer.

For example, soaring records in China were shattered again and again during the period 1986-1988 at Jiayuguan. As for 500 km. out-and-return flight, it was completed for the first time in China in five hours in a single seater. Pilot Mr. Qi said that 100 km. triangle could be completed after finishing the 500 km.; the two-seater also returned successfully at 8:00 p.m. In the day the lapse rate of Jiayuguan is equal to 0.7 degrees C per 100m. at 8:00 a.m. Good ordinary thermals are roughly 300m. in diameter giving net climb rate of around 3-4 m/s, and a height of about 2000-3000m is reached in soaring courses.

Datong would be the second choice during the summer, but it might be considered first during May; the condensation level and lift index of Datong are larger than Jiayuguan in May, while the other elements approach those of Jiayuguan. In addition, Jiayuguan often has gales and dust devils in the spring. therefore, Datong is more advantageous for soaring than Jiayuguan in May. For example, Chinese Soaring Championships were held satisfactorily here in May for the last 10 years.

As to Anyang, it has two unfavorable conditions, namely the west instability in the summer and the subsidence inversion under 1500m. in the spring, because it is located at the lee side of the Taihang mountain. Thus, its thermals are so weak that it can be used only for training and not contests. Contests attempted here have been unsatisfactory, due to the weak thermals.

The conclusions using the statistical data 1971-1980 agree with practice. However, it will be better if more data are used.

You are welcome to Jiayuguan, and will enjoy the magnificent views of a we-inspiring cumulus floating in the blue sky and see dust devils like trees. You will enjoy the soaring so much as to forget to return home.

#### REFERENCES:

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