Analysis and Discussion on Meteorological Support Services for the Navigation Ceremony of Langzhong Airport

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Abstract By analyzing the successful case of meteorological support services for the navigation ceremony of Langzhong Airport, the practice experience, existing problems and future improvement directions of aviation meteorological support services were analyzed and summarized to provide reference for the airport and its subsequent aviation meteorological support services in the future.

Key words Meteorological services; Meteorological support; Aviation meteorology; Analysis and discussion

DOI 10.19547/j.issn2152 - 3940.2025.01.007

In recent years, with the rapid development of the civil aviation industry, civil aviation units such as air traffic control, airlines and airports have more content, high-quality requirements and personalized forms for meteorological services[1]. In the *Outline for the High-quality Development of Meteorology* (2022 - 2035), it is mentioned that meteorological departments should provide meteorological support services with high quality, characteristics, diversification and high social attention, so aviation meteorological support services will become an indispensable part of meteorological support services in the future. Aviation meteorological conditions have a great impact on flight safety, and discomfort meteorological factors are one of the important causes of aviation safety accidents[2]. Langzhong Airport opened to traffic on December 17, 2023. According to the requirements of the superior, Langzhong Meteorological Bureau set up a meteorological support service team, and forecast the weather trend in the early period and the weather phenomena and meteorological elements during the navigation by analyzing various meteorological data, so as to ensure the successful completion of the navigation ceremony. In this paper, the experience and practice of aviation meteorological support service were analyzed to accumulate more experience for meteorological departments in aviation meteorological support services.

1 Overview of meteorological support services for navigation ceremony and weather situation

1.1 Overview of meteorological support services At 10:00 on December 17, 2023, a passenger plane landed successfully at Langzhong Airport, marking the success of the official navigation of Langzhong Airport and aviation meteorological support services. Langzhong Meteorological Bureau provides multi-stage meteorological support services in various stages according to demands.

In the preparatory stage, Langzhong Meteorological Bureau set up a meteorological support service team to conduct field visits and investigations at the airport, collect and sort out the climatic data in the same period and recent years, and clarify the service mode and the main meteorological factors affecting the take-off and landing of passenger aircraft at Langzhong Airport.

In the support stage, the meteorological service team provided forecast services of local sky conditions, pressure, wind direction and speed, temperature drop, rainfall (snow), visibility and ground ice and other weather phenomena, and on the day of navigation, meteorological support services were provided by means of numerical forecasting, meteorological observation stations, radar and satellites.

In the end stage, Langzhong Meteorological Bureau conducted technical exchanges with the airport and other relevant support units, resumed the service process, and summarized the experience of large-scale activities.

1.2 Actual situation of the weather process In early December, the cold air split by the polar air mass accumulated and broke out over the Lake Baikal. In middle December, the cold air crossed the Qinling Mountains from the Hexi Corridor in the northwest. It moved southwards and affected Langzhong City from December 14 to 17. During the period, the maximum temperature drop of Langzhong National Basic Observation Station was 9.0 ℃, and the minimum temperature was 1.7 ℃; the maximum wind speed was 12.5 m/s (force 6), and the main wind was northerly. From December 14 to 16, the weak warm and humid air from the south moved northwards, so that scattered light rain and sleet appeared, and the accumulated precipitation during the process was 0.4 mm. From the night of December 16 to 17, northerly air flow continued to weaken, and weak southerly wind dominated Langzhong City, while the sky condition was mainly cloudy for a short time; low cloud was 800 m high, and cloud cover was 70% - 90%; average wind speed was 4.3 m/s, and the maximum change

Received: November 8, 2024 Accepted: January 24, 2025

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in wind direction was 75°; air pressure was 1 010 – 1 020 hPa, and there was no precipitation, visual obstruction, ground ice and other weather phenomena.

2 Process and characteristics of meteorological support services for the navigation ceremony

2.1 Process of meteorological support services In the early stage, according to SPECI standards provided by the airport, the meteorological factors affecting the takeoff and landing of aircraft were obtained, including crosswash wind direction changing ≥ 60°, average wind speed ≥5 m/s, wind gust ≥10 m/s, sudden changes in pressure, rainfall (snowfall), road ice, visibility ≤ 800 m, low cloud height ≤450 m, rapid changes in cloud cover, *etc.* Based on the data compiled by Langzhong National Basic Meteorological Observation Station in the past 30 years, meteorological elements and precipitation types in December were analyzed, and the climate trend was analyzed jointly with Nanchong Meteorological Bureau. It is concluded that from December 15 to 18, there was a gale process accompanied with rainfall and a drop in temperature.

From December 5 to 9, the analysis of the interim weather trend was carried out. According to the real weather charts of the ground and upper air and the situation field data of the EC forecast model, the cold air split by the polar air mass moved southwards and caused a gale accompanied with a drop in temperature during the navigation ceremony. Northerly winds and changes in wind direction were expected to produce crosswind to affect aircraft landing. There was a weak warm and humid air moving northwards in the middle and low levels, which would form a shear system. There was a precipitation process, which may cause ground ice or low visibility. The control of northerly wind was not conducive to the occurrence of haze, fog and other visual distance obstacles. The pressure slowly rose.

The short-term weather trend was analyzed on December 13. According to the charts of real weather on the ground and in the upper air, temperature was −48 ℃ in the center of the cold high pressure, and the isotherm gradient was dense. The −20 ℃ cold advection moved southwards from Hexi Corridor to the Qinling Mountains through the northwest path. According to the extrapolation method, it is expected that cold air would reach the city in the afternoon of December 14, and last until December 17. Based on relevant data, Langzhong Meteorological Bureau issued a yellow warning of a strong drop in temperature, and pointed out that the drop in temperature during the period was 8 – 10 ℃, while the lowest temperature declined to about 0 – 1 ℃. Intermittent light rain or sleet occurred from the night of December 14 to 16, and was accompanied by a force 5 – 7 northerly wind. The analysis of short-term weather trend has identified specific difficulties in meteorological support services, including the duration of cold air and strong wind, the precipitation type during the period of strong cooling, and whether causing ice on the ground.

Short-term weather forecast analysis was carried out from December 14 to 16. According to the situation field of EC forecast model and numerical forecast model, the wind speed of the system reached the maximum at night of December 15, and began to decrease during the day of December 16. By the night of December 16, the average wind force 10 m above the ground decreased to 2 – 3, and gust was less than 10 m/s. The main wind direction changed from north to south, which might be affected by crosswind. Under the influence of cold air flow, air pressure rose to about 1 020 hPa, and remained stable. Owing to the influence of the northward movement of weak warm humid air flow, light rain or sleet mainly appeared in the airport area from the night of December 15 to 16, and the precipitation stopped in the afternoon. The ground temperature increased slightly, and remained at 0 – 4 ℃, while cloud cover was 60% – 80%, which was not conducive to road icing. Due to the existence of northerly dry and cold air, the humidity in the lower layer of the atmosphere was 50% – 70%, and there was no condition for forming fog.

At 02:00 on December 17, the short-term tracking, monitoring and forecasting services were conducted. According to the monitoring data, average wind speed decreased to 4.3 m/s, and the minimum and average temperature were 1.7 and 3.8 ℃; there was light rain (0.4 mm), and there was no water on the airport runway, which was not conducive to ice on the ground. At 08:00, according to the data of the weather station and the on-site data of the airport, it was cloudy, and there was no precipitation; cloud height was 800 m, and cloud cover was 80%; temperature was 2.7 ℃, and average wind speed was 1.6 m/s; wind direction changed from north to south at night, and the meteorological conditions for the occurrence of crosswind also decreased. Then the ground, radar, satellite monitoring data and EC forecast model data were used to carry out hour-by-hour refined forecast at 09:00, 10:00 and 11:00. The influence of northerly airflow tended to end, and southerly airflow dominated. The sky condition was stable, and meteorological elements did not change dramatically. At the three times of the refined forecast, it was mainly cloudy for a short time, and cloud cover was 70% – 90%; pressure was 1 020 hPa, and there was no precipitation; there was a force 1 – 2 wind, and the wind was southerly; visibility was greater than 10 km, and temperature was 2 – 3 ℃. At 11:00, the navigation ceremony of Langzhong Airport was successfully concluded, and the aviation meteorological support service achieved good results.

2.2 Characteristics of meteorological support services Langzhong Meteorological Bureau accurately predicted three days in advance the time period when the north gale would move southwards and weaken, wind direction and speed, pressure, precipitation and its type, visibility conditions, ice on the ground and other weather elements during the activity period. The forecast service conclusion of the whole process is basically consistent with the actual situation of weather, laying a foundation for the smooth development of the navigation ceremony.

The aviation meteorological service process happened in winter when the polar continental air mass is more active. Its weather

and climate characteristics are stable pressure with less sudden changes, small changes in wind direction and speed, low temperature, small temperature difference, no obvious precipitation. However, it is easy to produce fog when the weather is fine, wind is light and water vapor is abundant, and it is easy to produce haze and other weather phenomena with visual obstruction as water vapor conditions are poor. The southward movement of polar air mass, strong northerly gale with long duration, a large drop in temperature, and common relative humidity are not conducive to the generation of fog and haze. In the case of southerly warm and humid air, weak precipitation will be formed. For the aviation meteorological services, the force of gale, crosswind, precipitation (snow), visual obstruction phenomenon, and ground ice are the main influencing factors. According to the model test, the performance of situation field data of EC forecasting model and numerical forecasting model was stable and reliable. In general, it is conducive to the development of the aviation meteorological services.

3 Conclusion and discussion

Compared with other meteorological support services, aviation meteorological support services have high requirements on the demand for meteorological data, the duration of forecast cycle, the diversity of service products, the accuracy of forecast time and the division and coordination of personnel. It is necessary to clarify the specific requirements of aviation meteorological service objects, be familiar with the weather and climate characteristics of the local service period, carry out long-term tracking, monitoring and forecasting, and rationally use meteorological data.

In terms of complexity, safety and forecast accuracy, aviation meteorological support services are conducted better in winter than summer. In winter, the strength, track and region of the weather system are relatively stable, and the forecasting and warning time is longer. In summer, the weather phenomenon is sudden, and the timeliness of early warning is low. For the test results of each forecasting model, those of the situation field and numerical forecasting model are stable and reliable in winter, and severe weather forecast is weak or missing in summer.

Aviation meteorological support services require long-term establishment of climate trend, medium- or short-term, near and hourly meteorological support services. They periodically use 30-year meteorological consolidation data, surface and upper air weather charts, situation prediction models, numerical prediction models, and timely conduct ground and radar weather monitoring.

In practical applications, due to the complexity and uncertainty of meteorological conditions, it is difficult to make accurate forecasts. With the gradual improvement of users' requirements, the requirements for aviation weather forecasting are virtually increased[3]. Meteorological departments lack such comprehensive meteorological support service experience, which also raises meteorological service support to a new height, and the problems and challenges that need to be faced are more severe.

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the sowing time should be appropriately postponed. The rain concentration period is from May to June, with frequent rainstorms, which is easy to cause secondary geological disasters such as landslides, and water accumulation in the field. Special attention should be paid to strengthening prevention. From July to August, there will be short-term high temperature weather above 38 ℃ in the southern hilly area, so it should pay attention to prevention. According to the historical experience of planting lily, all regions should combine the climate and weather forecast of local meteorological stations to timely sow seeds, prevent the impact of adverse weather, and improve the yield and quality of *L. brownii* var. *viridulum*.

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