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Agenda Item 6: Turbulence Information**ANALYSIS OF AIRCRAFT TURBULENCE CHARACTERISTICS IN CHINA
BASED ON AIRBORNE DATA**

(Presented by China)

SUMMARY

This paper presents the characteristics of aircraft turbulence based on airborne data in China. We analyzed 427956 ACARS turbulence reports from 2015 to 2023 and found that the peaks of aircraft turbulence was in spring and summer, daytime (10–21h), and below the altitude of 7880 meters. Moderate turbulence accounted for 94.4%, while severe turbulence increased above the altitude of 10000 meters and at wind speeds ≥ 25 m/s. Narrow-body aircraft contribute 91.7% of severe reports.

1. INTRODUCTION

1.1 Under the background of climate change, the aircraft turbulence over China has shown a trend of increasing which has a great affect on aviation safety. In order to know the characteristics of aircraft turbulence in this region more objectively and quantitatively, we collected 427956 ACARS-downloaded messages about turbulence from 1334 aircraft from 2015 to 2023, combined with aircraft models, to analyze the temporal and spatial distribution, intensity characteristics, and wind conditions during turbulence encounters in the Chinese mainland region.

1.2 In this paper, the gravitational acceleration G of the aircraft is selected as the criterion for determining the severity of aircraft turbulence. An acceleration of 0.5 (inclusive) to 1.0 is regarded as moderate turbulence, while an acceleration of 1.0 (inclusive) or above is considered severe turbulence. The following analysis times are all based on Beijing time.

2. DISCUSSION

2.1 From 2015 to 2023, due to the fluctuations in flights under the background of the COVID-19 pandemic, the number of aircraft turbulence reports received in the Chinese mainland showed significant inter-annual variations. Before the pandemic (2015-2019), with the continuous growth of flights, the number of turbulence reports increased year by year, reaching a peak in 2019, with over 60000 reports received; during the pandemic (2019-2022), the number of turbulence reports decreased year by year, reaching the lowest point in 2022, only half of that in 2019; after the pandemic (2023), with the recovery of flights, the number of turbulence reports soared.

2.2 The annual changes in the number of aircraft turbulence reports showed that there were significant annual variations in aircraft turbulence in the Chinese mainland. Aircraft turbulence was mainly concentrated in spring and summer (from March to August), with July being the most frequent.

The cumulative number of turbulence reports received in July reached 45976, accounting for 12.45% of the total reports; May followed, with 41571 turbulence reports, accounting for 11.26% of the total. In autumn and winter (from October to the following January), the number of turbulence reports reported by aircraft decreased significantly, and the number of turbulence reports received in each month (except October) were less than 20000.

2.3 Aircraft turbulence in the Chinese mainland showed a distinct diurnal variation. 72.84% of the turbulence reports were concentrated between 10 and 21 o'clock, with the peak occurring at 13 o'clock. From 21 o'clock to 04 o'clock the next day, due to the combined effect of a decrease in the number of flights during the day and a stable atmospheric layer, the frequency of turbulence reports gradually decreased hour by hour. Among them, 04 o'clock had the lowest number, with only 3131 reports, which was less than one-tenth of the number of turbulence reports received during the peak period.

2.4 The horizontal regional distribution of the number of aircraft turbulence reports from 2015 to 2023 showed that the turbulence reports were mostly located in areas with dense flights. The turbulence in the Chinese mainland mainly concentrated in the central-south, southwest, east-central, and north regions. The turbulence reports received in these four major regions accounted for 77.79% of all reports. Among them, the central-south region had the most, with a cumulative total of 86777 turbulence reports, accounting for 20.28% of all reports. The northwest, northeast, and Xinjiang regions received only one-third of the turbulence reports compared to the first four regions.

2.5 The vertical distribution of aircraft turbulence reports showed that the highest reported height was 12802 meters, while the lowest was 500 meters. Among them, 311293 moderate turbulence reports were concentrated below 7880 meters, accounting for 77.1% of all moderate turbulence reports. Especially, there were the most reports below 900 meters, with a total of 136008 turbulence reports received. Additionally, 5868 severe turbulence reports were located above 10000 meters, accounting for 24.56% of all severe turbulence reports. This phenomenon indicated that although there were fewer turbulence occurring above 10000 meters, the proportion of severe turbulence is higher.

2.6 The transmission of turbulence reports from aircraft also indicated that the frequency of high-altitude turbulence experienced by aircraft showed significant seasonal variations. The reported turbulence altitudes were slightly higher in winter and spring (from November to April of the following year) compared to summer and autumn (from May to October). Among them, the average altitude in January was the highest, approximately 4700 meters, while in October it was the lowest, approximately 3017 meters.

2.7 Among the total 4279560 turbulence reports, there were 404060 moderate turbulence reports, accounting for 94.42% of all reports; and there were 23896 severe turbulence reports, accounting for 5.58% of all turbulence reports. And 54.23% of the moderate turbulence reports occurred under an environmental wind speed of 1-10 m/s, while 36.29% of the severe turbulence incidents took place under a wind speed of 25 m/s or higher.

2.8 Reports showed that the severe turbulence involving narrow-body aircraft occurred 21922 times, accounting for 91.74% of all severe turbulence.

3. ACTION BY THE MEETING

3.1 The meeting is invited to note the information contained in this paper.
