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TECHNICAL COMMISSION

Agenda Item 24 : Aviation Safety and Air Navigation Priority Initiatives

INCREASING AVIATION RESILIENCE TO HAZARDOUS METEOROLOGICAL EVENTS

(Presented by Denmark on behalf of the European Union and its Member States[1], the other Member States[2] of the European Civil Aviation Conference and by EUROCONTROL, and co-sponsored by Singapore and IFALPA)

REVISION NO. 1

EXECUTIVE SUMMARY

Enhancing knowledge of increasingly frequent hazardous meteorological events, assessing their impact on aviation, and coordinating actions within the aviation community are essential to mitigating risks and strengthening system resilience. To this end, reinforcing a global strategy and vision would be highly valuable.

Action: The Assembly is invited to:

a) request ICAO to promote the enhancement of resilience for en-route, terminal area operations and infrastructure against the impacts of Hazardous Meteorological Events, such as increased severe turbulence, airborne icing, and severe convective storms which are exacerbated by climate change, by ensuring a holistic approach on the matter across different ICAO groups and bodies;
b) request ICAO to encourage States, organizations (e.g., IATA), and industry to share meteorological information from aircraft such as routine aircraft observations and reports, for free, especially those containing quantitative turbulence information and leveraging modern technologies, such as ADS-B version 3.0 to enhance atmospheric modelling, forecasting and nowcasting, and support a further improvement in the safety of all airspace users;
c) request ICAO to undertake a review of relevant Standards and Recommended Practices (SARPs) and guidance material to take into account the impact of frequent and hazardous weather phenomena on the safety of the flight progress and air traffic operations;
d) request ICAO to review and, where appropriate, update or develop guidance on adapting existing airport infrastructure to the impacts of short-term hazardous meteorological events and long-term impacts of climate change on infrastructure; and
e) request ICAO to promote the development or revision of State-level adaptation plans taking into consideration hazardous or disruptive effects of severe weather on both aviation operations and infrastructure.

[1] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden

[2] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Republic of Moldova, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland, Türkiye, Ukraine and the United Kingdom

Strategic Goals:	This working paper relates to the Strategic Goals *Every Flight is Safe and Secure; and Aviation Delivers Seamless, Accessible and Reliable Mobility for all.*
Financial implications:	The activities referred to in this paper will be undertaken with the resources available in the Regular Programme Budget and/or from extra-budgetary contributions.
References:	N/A

1. INTRODUCTION

1.1 The increasing occurrence of hazardous meteorological events (HME) poses significant challenges to aviation safety, operational efficiency, and to the long-term sustainability of the aviation sector. To mitigate these risks and enhance resilience, it is essential to leverage cutting-edge technologies that enable real-time data sharing and collection, advanced forecasting, and improved situational awareness. Better integration of forecasting and nowcasting with data reported by aircraft can deliver more accurate, timely, and actionable meteorological insights to the aviation sector.

1.2 HME such as severe turbulence, airborne icing, severe convective storms, extreme temperatures, floods, etc. are known safety and operational risks for aviation. The Intergovernmental Panel on Climate Change has stated that climate change will likely cause an increase in the number, frequency and extent of such events. For example, in the years to come it may be expected that there will be more extreme rainfall in large parts of the world, together with extremes of weather and natural disasters such as heat waves, floods, hurricanes and cyclones. It is fully expected that the safety and operational risks associated with an increased frequency of hazardous weather events will be exacerbated by climate change.

1.3 One of the key areas where technological advancements can bring immediate benefit is the detection and prediction of atmospheric hazards, particularly turbulence and convective storms. Accurate, real-time monitoring and forecasting of turbulence are critical for flight safety, fuel efficiency, and minimizing air traffic management (ATM) disruptions. The implementation of real-time airborne turbulence observation data sharing, utilizing modern technologies would significantly enhance the accuracy of atmospheric modelling and improve hazard mitigation strategies.

1.4 Furthermore, addressing these challenges requires a cohesive approach from ICAO to deliver appropriate guidance aimed at improving existing materials, enhancing resilience in en-route and terminal area operations, and adapting airport infrastructure to mitigate the impact of HME.

2. DISCUSSION

2.1 Analysis of HME potentially exacerbated by climate change

2.1.1 In recent years, the aviation industry has faced several severe meteorological events that have posed significant risks to flight operations. Examples include:

a) a notable incident related to Singapore Airlines Flight SQ321[3] in May 2024, encountering extreme turbulence over the Indian Ocean, leading to emergency landing, with injuries and one fatality;

b) a Qatar Airways flight from Doha to Dublin in May 2024, experiencing severe turbulence over Türkiye, injuring 12 passengers and crew, 8 of whom were hospitalized on arrival;

[3] *https://www.reuters.com/world/asia-pacific/singapore-turbulence-flight-investigation-finds-sharp-altitude-drop-caused-2024-05-29/*

c) the heaviest flooding at Dubai Airport in 75 years in April 2024, causing cancellation of over 1 200 flights and major disruptions;

d) the closure of Porto Alegre (Brazil) airport in May 2024 for several months due to flooding[4] caused by extreme rainfall had significant lost connectivity and economic and operational consequences; and

e) the "*DANA"*[5] (*high-altitude isolated depression*) in Valencia in October 2024, a severe weather system which produced powerful rain clouds and catastrophic flash floods, killed at least 200 people, and resulted in significant impacts to air traffic and the nearest airports.

2.1.2 Such events, exemplify the growing contribution and impact of extreme weather on safety and network efficiency. If these HME will be exacerbated by climate change - increasing in intensity, duration or frequency - there is a need to adapt the operations and infrastructure to reduce the operational and safety impacts. These HME emphasise the need to reduce exposure through enhanced monitoring, forecasting, operational preparedness, infrastructure adaptation, and greater reliance on weather information in the decision-making process for all the involved actors to mitigate risks. At the European level, several aviation Climate Change initiatives from European Aviation Safety Agency (EASA), EUROCONTROL and Airports Council International (ACI)-Europe, are assessing trends and adaptation measures/strategies, providing peer support and developing guidance to support stakeholders.

2.1.3 The ICAO Climate Adaptation Synthesis[6] (2018) identifies eight significant climate effects: sea level rise (floods), storm intensity, temperature changes, precipitation shifts, icing conditions, wind changes, desertification, and biodiversity shifts, each requiring tailored adaptation and resilient measures with varying time frame impact and regional differences.

2.1.4 Adaptation efforts should expand across local, national, regional, and international levels, incorporating contingency planning, infrastructure reinforcement, operational adjustments, and training programmes.

2.2 Need for enhanced sharing of the real-time airborne observation data

2.2.1 The ICAO Meteorology Panel (METP) is advancing the hazardous weather information service (HWIS) to improve global access to harmonized hazardous weather information for commercial aviation. This service aims to boost safety and efficiency by enabling operators to avoid hazardous conditions, leveraging tools like nowcast modelling, satellite data, and radar within a 0–6-hour (or greater) timeframe.

2.2.2 Recent advancements include the provision of higher-resolution World Area Forecast System (WAFS) gridded and significant weather forecasts and the pending introduction of probabilistic data for turbulence and other hazards to be provided by world area forecast centre (WAFC) London and Washington. Real-time airborne observation data, as well as the International Air Transport Association (IATA) turbulence aware data should strongly aid SIGMET preparation and as well future HWIS by meteorological service providers and enhance forecast verification and forecasting accuracy. This in-flight observation information supports the further development of forecast methodologies, enabling the analysis of possible operational consequences in advance and providing more reliable information for flight preparation. Stronger collaboration and standardized mechanisms for collecting and sharing

[4] *https://www.reuters.com/world/americas/brazils-porto-alegre-airport-resume-operations-after-major-floods-2024-08-09/*
[5] *https://www.reuters.com/business/environment/spains-deadly-dana-weather-phenomenon-its-links-climate-change-2024-10-30/*
[6] *https://www.icao.int/environmental-protection/Documents/Climate%20Adaptation%20Synthesis%20with%20Cover_20200221.pdf*

aircraft-derived observation data via air-ground data link, including ADS-B version 3.0, would further improve weather prediction models. This could improve safety of operations, aircraft routing and mitigation of go-arounds and reduce crosswinds impacts. To date, however, this data is not available without a commercial service.

2.3 ICAO coordination for alignment of improved messages

2.3.1 Within ICAO, different groups and bodies address hazardous weather and climate change impacts (e.g. METP on HWIS and WAFS developments, Aerodrome Design and Operations Panel (ADOP) on Pavement classifications and Committee on Aviation Environmental Protection (CAEP) on Climate Change Adaptation), ICAO must ensure a cohesive, cross-organizational response to align objectives, streamline mitigation efforts, and prioritize initiatives across bureaus within ICAO so that common objectives are aligned, and messages coordinated, and appropriate priority is given to these initiatives.

2.3.2 A more structured coordination within ICAO would enhance clarity, ensuring key ICAO messages are consistent and comprehensible across stakeholders. Strengthening collaboration and synchronizing work programmes among these groups will foster coherent strategies, facilitate informed decision-making, and reinforce ICAO's leadership in addressing aviation's climate-related challenges.

2.4 Need for improved guidance material to address extreme weather events

2.4.1 **Enhancing resilience to extreme weather events in aviation.** Aviation stakeholders must have the necessary knowledge, expertise and information at hand to anticipate, mitigate, and respond effectively to hazardous weather conditions in a collaborative way. For this purpose, it is crucial to strengthen ICAO's specific guidance on training and situational awareness programs in order to include scenarios related to HME. It will enhance the industry's resilience against evolving climate-driven hazards.

2.4.2 Guidance on managing extreme weather events specifically for infrastructure

2.4.2.1 At the Fourteenth Air Navigation Conference (AN-Conf/14), several recommendations were made, one of which was directed to the ADOP (Recommendation 2.1/1 (c) and (g)). While the topic has started to be discussed within the ADOP, it is not yet concretely included in their work programme.

2.4.2.2 During the Conference, the floods in Porto Alegre were highlighted as an example. Additionally, Europe is once again battling extreme weather events, including floods in Slovenia, wildfires in Portugal and Greece, heavy flash floods, heat waves, snowstorm Filomena, the DANA in Spain, and landslides in Norway.

2.4.2.3 Avoiding or reducing exposure to the hazardous or disruptive effect of severe weather to protect airport ground equipment and infrastructure is crucial. There is a need to increase the capability of ground safety equipment and infrastructure to withstand the effects of these severe weather events, so that continuous safe operation can be ensured. Furthermore, runway and airside pavements must withstand extreme temperatures and drainage capacity should be improved. An increasing number of airports are carrying out climate change risk assessments to identify impacts to which they may be vulnerable, and then developing adaptation plans to address the risks.

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