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COMMITTEE A

Agenda Item 2: Enabling the global air navigation system

2.3: Future provision of aeronautical meteorological service

ENABLING THE FUTURE GLOBAL AIR NAVIGATION SYSTEM THROUGH THE PROVISION OF HIGH-QUALITY, FIT-FOR-PURPOSE, COST-EFFECTIVE METEOROLOGICAL AND CLIMATOLOGICAL INFORMATION AND SERVICES

(Presented by the World Meteorological Organization (WMO))

EXECUTIVE SUMMARY

This paper illustrates why, where and how the World Meteorological Organization (WMO) and its Members are working on a daily basis to improve and, where needed, transform the meteorological service provided to aviation users worldwide consistent with and as an enabler to the modernization of the air transport system conveyed in the ICAO Global Air Navigation Plan (GANP, Doc 9750) and its aviation system block upgrades (ASBU) methodology.

This paper gives examples of the relevance of meteorological information and services to aviation operations and alludes to the potential impacts of climate change and variability on aviation operations.

1. INTRODUCTION

1.1 ICAO and the World Meteorological Organization (WMO) have had a long and productive history of formal coordination and collaboration dating from the formative years of the organizations in the 1940s and 1950s. While ICAO is the entity responsible for establishing the aeronautical requirements for meteorological service for international air navigation, WMO is the entity responsible for establishing the standardized meteorological technical methods and practices necessary to fulfil the aeronautical requirements¹. The two organizations, and their respective States/Members, expend considerable resources on ensuring that the established aeronautical requirements are based upon sound scientific and technical advice and the latest 'state-of-the-art' meteorological capabilities. This relationship between ICAO and WMO is highly symbiotic one.

¹ WMO is a specialized agency of the United Nations with headquarters in Geneva, Switzerland, dedicated to international cooperation and coordination on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces, and the resulting distribution of water resources. WMO has 191 Members (185 Member States and 6 Territories). More information on WMO is [available here](#).

1.2 In July 2014, ICAO held a Meteorology Divisional Meeting (MET/14) conjointly with the fifteenth session of the WMO Commission for Aeronautical Meteorology (CAeM-15). In the spirit of the ongoing coordination and collaboration between the two organization through their extant working arrangements (The *Working Arrangements between the International Civil Aviation Organization and the World Meteorological Organization* (Doc 7475) and WMO-No. 60 refer), the conjoint meeting set the tone for the modernization of meteorological service for international air navigation over the coming years, fully aligned with the rolling 15-year plan for the modernization of the air transport system as conveyed in the ICAO Global Air Navigation Plan (GANP, Doc 9750) and its aviation system block upgrades (ASBU) methodology.

1.3 This paper illustrates why, where and how WMO and its Members are working on a daily basis to improve and, where needed, transform the meteorological service provided to aviation users worldwide consistent with and as an enabler to ICAO's GANP and ASBU methodology. This paper gives examples of the relevance of meteorological information and services to aviation operations and alludes to the potential impacts of climate change and variability on aviation operations.

2. DISCUSSION

2.1 As evidenced by the outcomes of MET/14 and the subsequent work of the ICAO Meteorology Panel (METP) and its working groups, as well as the half-day session on aeronautical meteorology held during the [second ICAO Global Air Navigation Industry Symposium](#) (GANIS/2 in December 2017), the industry is rightly demanding improvements in aeronautical meteorological service provision – both the eradication of existing (often long-standing) deficiencies and the introduction of new information and services – that will ensure that, by the 2030s, the aviation system (a system of systems) is safer, more efficient, more secure, more economic and more environmentally responsible than it is today. WMO is an integral, committed partner in ensuring that ICAO and the broader aviation community fulfil this vision. WMO is not only an active contributor to (member of) the aforementioned METP and its working groups but has also contributed in past years to ICAO's Committee on Aviation Environmental Protection (CAEP).

2.2 As evidenced by the annual [Safety Reports of the International Air Transport Association \(IATA\)](#), the weather or meteorological conditions continue to be a major threat (and in some instances the highest threat) to flight operations. Indeed, according to the IATA Safety Report 2017 issued in April 2018, “*Between 2013 and 2017, [...] the top three threats were weather, aircraft malfunction and wind/wind shear/gusts*”. Weather conditions – or rather, the intended or unintended penetration by aircraft of certain weather conditions – are consistently a contributory factor in aviation incidents and accidents such as loss-of-control in-flight (LOC-I), controlled flight into terrain (CFIT) and runway/taxiway excursions. This is a situation that warrants continued attention.

2.3 As aviation continues to grow – projected doubling in air traffic volume every 15 years – and as the impacts of climate change and variability on aviation operations become more evident – for example through the increased frequency and/or intensity of extreme weather events such as tropical cyclones, heat waves and droughts or other aviation-relevant changes in the operating environment such as the intensity and location of the jetstream at cruise levels or the incidence of severe flooding at aerodromes – the importance that needs to be placed by the entire community on the establishment and maintenance of high-quality, fit-for-purpose and cost-effective meteorological and climatological information and services for aviation operations cannot be emphasized enough. It demands a collaborative, community response. These sentiments appear consistent with the vision put forward by ICAO in the [proposed sixth \(2019\) edition of the GANP](#) (ICAO Doc 9750).

2.4 In this connection, through the Commission for Aeronautical Meteorology (CAeM) and other concerned technical commissions², regional associations, as well as their subsidiary structures (expert teams, etc.) and associated programmes, WMO continues to build the capacity and capability of national meteorological and hydrological services (NMHS) worldwide that serve the needs of the aviation community and wider society. WMO facilitates, for example, the maintenance and expansion of atmospheric, oceanographic and land-based observational networks, promotes the free and unrestricted exchange of basic meteorological data, and conducts capacity development and research to optimize the production of weather-, climate- and water-related services worldwide. These aspects are the embodiment of WMO within the United Nations system.

2.5 In the context of the CAeM specifically, the priorities of the Commission are currently encapsulated in the following five thematic areas (where sub-bullets illustrate of the nature of the work):

- a) education, training and competency of aeronautical meteorological personnel
 - education and training curricula;
 - qualification requirements; and
 - competency assessment frameworks and best practice;
- b) aeronautical meteorological information service and governance
 - information and data exchange policies, quality management system standards and cost recovery principles;
 - integration of meteorological information into air traffic management; and
 - service delivery development and best practice;
- c) aeronautical meteorological hazards prediction
 - innovation through scientific research and technological advancement;
 - transition from research into operations; and
 - probabilistic and impact-based forecasting in support of aviation operations;
- d) impacts of climate change and variability on aviation
 - impacts on jet streams and en-route hazards;
 - impacts on airport operations; and
 - impacts on airspace management/optimization and airframe design;
- e) communication and outreach
 - newsletters and other such outreach for members, regional associations, stakeholders and partners;
 - feedback mechanisms; and
 - focal point identification and coordination.

2.6 Activities by a CAeM community of expertise across these thematic areas as well by other technical commissions are ensuring WMO's contribution to the modernization of the aviation system. Examples of ongoing initiatives include the following (non-exhaustive and in no particular order):

² From an aviation perspective notably the Commission for Atmospheric Science (CAS), Commission for Basic Systems (CBS), and Commission for Instruments and Methods of Observation (CIMO).

a) Aviation Research and Development Project (AvRDP)

AvRDP is an international effort, initiated by WMO in 2014, to develop, demonstrate and quantify the benefits of end-to-end nowcasting (i.e. 0 to 6 hours forecasting) for the terminal area focussed on high impact weather. Phenomena with high impact include deep convection and thunderstorms, cloud base and visibility, surface wind, wind shear, upper-air and low-level turbulence, wake vortex, in-flight icing, winter weather, surface and airframe icing, tropical cyclones, volcanic ash clouds and gases, releases of radioactive material into the atmosphere and space weather.

AvRDP is providing an assessment of the capabilities of aeronautical meteorological service providers for such phenomena at a select group of airports around the world with different climatologies and different air traffic densities. The airports involved in AvRDP are (at time of writing): Paris Charles de Gaulle (CDG), Hong Kong (HKG), Iqaluit (YFB), Johannesburg (JNB), New Delhi (DEL), Pulkovo (LED), Shanghai (SHA), Singapore (SIN) and Toronto Pearson (YYZ).

Following on from an initial phase of work focussing on the 0-6 hour nowcast and verification, a second phase of work is currently focussing on the translation of meteorological conditions into air traffic management impacts (MET-ATM translation) and validation.

More information on AvRDP is [available here](#).

b) Aircraft Meteorological Data Relay (AMDAR)

The Aircraft Meteorological Data Relay (AMDAR) programme was initiated by WMO in the late 1990s in coordination with aviation partners and has led to the development of the AMDAR observing system – a system which utilises predominantly existing aircraft on-board sensors, computers and communications systems to collect, process, format and transmit meteorological data to ground stations via satellite or radio links. Once on the ground, the data is relayed to NMHSs of WMO Members where it is processed, quality controlled and transmitted on the WMO Global Telecommunications System and then used by NMHSs for a range of meteorological applications including public weather forecasting, climate monitoring and prediction, early warning systems for weather hazards and, importantly, weather monitoring and prediction in support of aviation.

The AMDAR system currently produces in excess of 700,000 high-quality observations per day of air temperature and wind speed and direction, together with the required positional and temporal information and with an increasing number of water vapour/humidity and turbulence measurements being made.

The high-quality in-situ observational data obtained from aircraft-based observing systems such as AMDAR is crucial not only in the initialisation of numerical weather prediction models used for day-to-day forecasting applications, but is also serving as a key input to improving climate prediction model capabilities. The preservation of such observational data is also essential for validating and calibrating climate predictions.

At time of writing, WMO is working with the International Air Transport Association (IATA) to expand the AMDAR programme worldwide and to establish more equitable cost-recovery mechanism for the participating airlines. WMO is also assisting IATA in establishing a global turbulence database with real-time data transmission to airlines during flight operations.

More information on AMDAR is [available here](#).

c) Meteorological Information Exchange Model

Over the past several years and at the request of ICAO, WMO has been leading the development of the ICAO Meteorological Information Exchange Model (IWXXM). In preparation for information exchange within the system-wide information management (SWIM) environment of the future ATM operating environment, the IWXXM has been chosen as the data model to represent aeronautical meteorological information. The currently agreed (prescribed) format for the operational exchange of information in the SWIM environment, including meteorological information, is XML/GML³.

WMO is responsible for maintaining all of the technical specifications for IWXXM in line with the ICAO requirements, notably those contained in ICAO Annex 3 – Meteorological Service for International Air Navigation.

At time of writing, IWXXM version 3.0 is under development within WMO to support the applicability of Amendment 78 to ICAO Annex 3 — *Meteorological Service for International Air Navigation*. The IWXXM-related provisions in Amendment 78 have applicability in November 2019 and November 2020. IWXXM 3.0 will, for example, support the introduction of the space weather advisory information.

More information on IWXXM is [available here](#).

3. CONCLUSION

3.1 Trajectory-based operations (TBO), performance-based navigation (PBN), airport collaborative decision-making (A-CDM), network operations, wake turbulence mitigation and so on require high-quality, fit-for-purpose, cost-effective meteorological (and in some instances climatological) information and services that are available at the right time, for the right place, in the right format.

3.2 Through international frameworks, including those espoused by ICAO, WMO and its Members are committed to supporting the strategic, pre-tactical, tactical and post-operations needs of aviation users worldwide. Moreover, WMO and its Members are assisting the international community in the response to and the mitigation of the impacts of climate change and variability on aviation operations.

— END —

³ Extensible Markup Language (XML) and Geography Markup Language (GML) are open-industry standards.