



ASSEMBLY — 40TH SESSION

TECHNICAL COMMISSION

Agenda Item 30: Other issues to be considered by the Technical Commission

ACTIVITIES IN AERONAUTICAL METEOROLOGY IN SUPPORT OF ICAO AND THE
MODERNIZATION OF THE AIR TRANSPORT SYSTEM

(Presented by the World Meteorological Organization (WMO))

EXECUTIVE SUMMARY

This information paper illustrates why, where and how the World Meteorological Organization (WMO) and its Members are working with aviation partners, including the International Civil Aviation Organization (ICAO), 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) and its aviation system block upgrades (ASBU) methodology.

This information 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. In addition this paper provides information concerning an ongoing reform of WMO constituent bodies and the development of a WMO long-term plan for aeronautical meteorology.

<i>Strategic Objectives:</i>	This information paper relates to the Safety, Air Navigation Capacity and Efficiency and Environmental Protection Strategic Objectives.
<i>Financial implications:</i>	None.
<i>References:</i>	ICAO Annex 3 — Meteorological Service for International Air Navigation (reproduced within WMO Technical Regulations (WMO-No. 49), Volume II) ICAO Doc 7475, <i>Working Arrangements between the International Civil Aviation Organization and the World Meteorological Organization</i> (reproduced within WMO Basic Documents No. 3 (WMO-No. 60), Chapter II) ICAO Doc 9750, <i>Global Air Navigation Plan (GANP)</i> Second ICAO Global Air Navigation Industry Symposium (GANIS/2) ICAO Doc 10045, <i>Report of the ICAO Meteorology (MET) Divisional Meeting (2014)</i> ICAO Doc 10115, <i>Report of the Thirteenth Air Navigation Conference (AN-Conf/13)</i> WMO-No. 1139, Report of the Fifteenth Session of the WMO Commission for Aeronautical Meteorology (CAeM-15) WMO-No. 1222, Report of the Sixteenth Session of the WMO Commission for Aeronautical Meteorology (CAeM-16) Eighteenth World Meteorological Congress (of WMO) (Cg-18) WMO AeM SERIES No. 5, Long-term plan for aeronautical meteorology

WMO aeronautical meteorology programme website, https://www.wmo.int/aemp/ IATA Safety Report 2019
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1. INTRODUCTION

1.1 The International Civil Aviation Organization (ICAO) and the World Meteorological Organization (WMO) have had a long and mutually productive history of formal coordination, collaboration and cooperation 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, dedicate resources on ensuring that the established aeronautical requirements are based upon high-quality, authoritative scientific and technical advice and the latest ‘state-of-the-art’ meteorological capabilities. This relationship between ICAO and WMO is a highly symbiotic one, for example: the two organizations periodically convene joint sessions of their respective technical bodies; Annex 3 to the Convention on International Civil Aviation, *Meteorological Service for International Air Navigation* is reproduced by WMO as Technical Regulations (WMO-No. 49), Volume II; and the two organizations have complementary technical guidance material and undertake complementary capacity development activities to promote implementation.

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 organizations through their extant working arrangements (ICAO 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 and its aviation system block upgrades (ASBU) methodology.

1.3 This information paper illustrates why, where and how the WMO and its Members are working with aviation partners, including ICAO, 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 GANP/ASBU. This information 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 in July 2014 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 aviation industry is rightly demanding improvements in aeronautical meteorological service provision – both the eradication of existing (in some areas, long-standing) deficiencies and the introduction of new and more consistent 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 is also involved (as an observer) in

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 193 Members (187 Member States and 6 Territories). More information on WMO is [available here](#).

the Airport Economics Panel/Air Navigation Services Economics Panel (AEP/ANSEP) and, in the past, has contributed to ICAO's Committee on Aviation Environmental Protection (CAEP)².

2.2 As evidenced by the 2018 Safety Report of the International Air Transport Association (IATA) published in April 2019, weather/meteorological conditions continue to pose a major threat and in some instances the highest threat to flight safety. Despite continual advances in observing and forecasting practices, weather/meteorological conditions – or rather, the intended or unintended penetration by aircraft into adverse conditions such as thunderstorms and strong gusty winds or wind shear – continue to be 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. Indeed, it could be concluded from the 2018 Safety Report of IATA that this threat has increased over recent years, perhaps partly due to changing weather patterns (e.g. more intense, more frequent convective activity in some regions) and perhaps partly due to operational pressures. This is a situation that deserves increased attention by ICAO, its States and its partners if the threats posed by adverse weather/meteorological conditions and a changing climate scenario are to be mitigated or otherwise reduced

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 edition (2019) of the GANP (ICAO Doc 9750).

2.4 In this connection, through its technical commissions³, 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) and other service providers 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 specific context of WMO's Commission for Aeronautical Meteorology (CAeM), the priorities of the Commission were established at its Sixteenth Session (CAeM-16) held in July 2018 across 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;

² ICAO withdrew WMO's observer status in the CAEP in 2012.

³ From an aviation perspective notably the Commission for Aeronautical Meteorology (CAeM), Commission for Atmospheric Sciences (CAS), Commission for Basic Systems (CBS) and Commission for Instruments and Methods of Observation (CIMO). Note, following the Eighteenth World Meteorological Congress (Cg-18) convened by WMO in June 2019, the Organization has embarked on a reform of its constituent bodies, including the technical commissions referenced here.

- 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 enroute hazards such as turbulence;
 - 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 community of expertise across the foregoing thematic areas is ensuring WMO's contribution to the modernization of the aviation system as demanded by ICAO and other leading industry partners. Examples of ongoing initiatives include the following (non-exhaustive and in no particular order):

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. Airports involved in AvRDP have included 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).

At time of writing, WMO is undertaking a review of AvRDP, where progress has been made and where gaps exist in the meteorological science supporting air traffic management. A vision for future research activities will likely stem from this review.

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 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/GML⁴.

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.

At time of writing, IWXXM version 3.0 is under the final stages of development and approval within WMO to support the applicability of Amendment 78 to ICAO Annex 3. 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. **ADDITIONAL INFORMATION**

3.1 In June 2019, the Eighteenth World Meteorological Congress was convened by WMO in Geneva, Switzerland. Congress convenes at least once every four years. This year, Congress discussed matters including but not limited to:

- strategic plan, operating plan and results-based budget for the next WMO financial period (2020 to 2023 inclusive);

⁴ Extensible Markup Language (XML) and Geography Markup Language (GML) are open-industry standards.

- governance review including a reform of WMO's constituent bodies such as the Commission for Aeronautical Meteorology (CAeM);
- weather, climate, hydrological and related environmental services, including aeronautical meteorological services;
- earth system observations and predictions, including the WMO Integrated Global Observing System (WIGOS), WMO Information System (WIS) and WMO Global Data-processing and Forecasting System (GDPFS);
- earth system research;
- capacity development; and
- policy and other related matters

3.2 In respect of aeronautical meteorological services referenced above, Congress endorsed the recommendations emanating from the CAeM-16 session (referenced at 2.5 above) as well as a long-term plan for aeronautical meteorology. Additional information on the long-term plan is given AT 3.4 below.

3.3 In respect of the governance review referenced above, it is worthwhile to note that, following endorsement by Congress, WMO has now embarked on a major reform of its constituent bodies in the 2019-2020 timeframe. This reform will include but not be limited to a restructuring (consolidation and repurposing) of all existing technical commissions including CAeM, Commission for Basic Systems (CBS), Commission for Instruments and Methods of Observation (CIMO) and Commission for Atmospheric Sciences (CAS) as well as an alignment of the WMO secretariat with the new WMO constituent bodies structure. Along with all other eight intergovernmental technical commissions, the CAeM will be dissolved over the coming months (provisionally by early 2020). In its place, a new non-intergovernmental Standing Committee on Aeronautical Meteorology is expected to be established under a new (intergovernmental) Commission for Services and Applications. WMO constituent bodies reform is seen as opportunity for the Organization to forge closer, more efficient and more effective working arrangements with partner organizations including ICAO, in particular at the technical level.

3.4 As alluded to above, one of the outcomes of Congress included the endorsement of a long-term plan for aeronautical meteorology. The long-term plan, developed initially by the CAeM, provides a framework upon which aeronautical meteorological service providers of Members/States in particular, and the broader meteorology and aviation communities in general, can plan a progressive transformation from a conventional "product-centric" approach to a modern "information-centric" approach to service provision for aviation through to 2030 and beyond.

3.5 The long-term plan pays due regard to sector-wide air transport progress envisaged over the coming decade or more and is complementary to the ICAO GANP. This complementarity is necessary to ensure that as ICAO's vision for a globally interoperable, harmonized air traffic management system of the future becomes fully realized developments on the WMO side can and will occur in unison.

3.6 The long-term plan offers a vision and rolling strategy that will assist WMO, its Members and partners, including ICAO, ensure that aeronautical meteorological service provision evolves in a manner that harnesses scientific and technological advancement, both on the service providers' side and the aeronautical users' side. The long-term plan is published by WMO as AeM SERIES No. 5 [available here](#) in English only.

3.7 Additional information on the activities of WMO in the context of aeronautical meteorology and other online resources, including a Moodle education and training platform, are available at the following URL: <https://www.wmo.int/aemp/>

4. CONCLUSION

4.1 Trajectory-based operations, performance-based navigation, airport collaborative decision-making, 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.

4.2 Through international frameworks, WMO, its Members and their aeronautical meteorological service providers 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.

4.3 WMO is reforming the way in which it conducts its business as part of a constituent bodies reform, which is an opportunity to forge closer, more efficient and more effective working arrangements with partner organizations including ICAO. And, a new WMO long-term plan offers a vision and rolling strategy for the evolution aeronautical meteorological service provision consistent with the complementary plans of ICAO.

— END —