PROGRESS ACTIVITY REPORT OF THE SIXTEENTH SESSION OF THE COMMISSION FOR AERONAUTICAL METEOROLOGY (CAeM-16)

(unedited and in official WMO languages when available)
MATERIAL ARRANGEMENTS FOR THE SESSION

Venue

At the kind invitation of the Government of the United Kingdom of Great Britain and Northern Ireland, the sixteenth session of the Commission for Aeronautical Meteorology (CAeM-16) will be held in Exeter from 24 to 27 July 2018, at the University of Exeter, Stocker Rd, Exeter, EX4 4PY. The opening ceremony will be held at 9.30 a.m. on 24 July 2018 in the Great Hall.

The Technical Conference (TECO) will be held at the same venue on 23 July 2018. The tentative work plan can be found on the session website: meetings.wmo.int/CAeM-16/.

Working languages

During the session, simultaneous interpretation in the six WMO official languages (Arabic, Chinese, English, French, Russian and Spanish) will be provided in the main conference room. Additional meeting rooms without interpretation facilities will also be available.

The TECO meeting will be in English only.

Documents

Delegations wishing to submit documents before the session are invited to send them to the WMO Secretariat, as soon as possible, but not later than 60 days before the opening of the session, in accordance with the provisions of Regulation 190(b) of the WMO General Regulations to allow time for translation. According to Regulation 189 of the WMO General Regulations, session documents should be distributed as soon as possible and preferably not later than 45 days before the opening of the session. Any document presented by a delegation should be submitted in the name of the Member of the Organization and not by an individual person.

Processes and documents workflow

The presentation of session documents and organization of the work of the session will differ this year from the practice of previous sessions, as explained at the CAeM-16 website. See CAeM-16/INF 1(2).

Distribution of documents

Documents will be posted before and during the session on the session website, in line with WMO greening efforts to promote paper-smart meetings. Therefore, participants are kindly invited to bring internet-enabled portable computers capable of handling Microsoft Word 2010 and Adobe PDF formats so that they can work in paper-smart mode during the session.

Provisional abridged report

Approved documents showing amendments in all languages will be posted as soon as possible after the session on the CAeM-16 website in the folder “Provisional Report (approved documents)”. 
Registration of participants

Online pre-registration is required for all participants to the session. In view of their official status with WMO, Permanent Representatives of WMO Members (PRs) have been given access to an online Event Registration System allowing the pre-registration of their respective delegations.

More information concerning online pre-registration will be provided in due course on the CAeM-16 session web site (meetings.wmo.int/CAeM-16/).

A conference information and registration desk will be set up close to the meeting rooms to facilitate the registration of participants and provision of general information.

Registration for TECO and sixteenth session of the Commission for Aeronautical Meteorology (CAeM-16) will take place at the conference information and registration desk at the University of Exeter and start on 22 July 2018, from 4 p.m. to 6 p.m. It will continue throughout TECO and the session. At the time of registration, participants will receive identification badges, which should be worn throughout the session.

Credentials

Pursuant to Regulation 21 of the General Regulations, prior to a session of a constituent body other than the Executive Council, each Member should, if possible, communicate to the Secretary-General the names of the persons composing the delegation to that body, indicating which of these shall be regarded as its principal delegate. In addition, a letter giving these particulars and signed by, or on behalf of, an appropriate governmental authority of the Member shall be sent to the Secretary-General or handed to his representative at the session. This letter shall be regarded as appropriate credentials for the participation of the individuals named therein in all activities of the constituent body.

Representatives of international organizations invited as observers to the session should provide in advance, or bring to the session, a letter of representation signed by the appropriate authority from their organization.

List of participants

A provisional list of participants will be uploaded on the session website shortly after the beginning of the meeting. This list will be updated on a daily basis.

Internet facilities

Wireless Internet connection (Wi-Fi) will be available in the main conference room and across the University Campus. The access is free once registered as a guest user.

Entry requirements

All participants who require a valid visa for admission to the United Kingdom of Great Britain and Northern Ireland should make their application for visas in accordance with the information set out at https://www.gov.uk/browse/visas-immigration. Applications must be made as soon as possible (but maximum 3 months before departure). Please inform us through registration@wmo.int, if an individual invitation letter is required for your visa application.

Time needed to obtain a visa may vary from case to case. It is strongly recommended that delegates inform themselves on the relevant appointment system and procedures as early as possible, to ensure that the visa may be issued in a timely manner. Delegates can find this information on relevant national government websites.
In cases where no diplomatic relations exist between a Member and the UK, or where a Member considers that some difficulties may be experienced in obtaining visas, delegates can submit a visa request directly to the Secretary-General of the World Meteorological Organization, in accordance with Annex I of the General Regulations of the Organization, who will in turn submit it to the UK for advice or assistance.

Such requests must contain all the necessary details: name, surname, date and place of birth, father's name, nationality, passport number, date and place of issue, expiry date, profession, place where the visa is to be issued, and duration of stay in UK. Requests should be received by the Secretary-General as far in advance of the meeting as possible.

Additional information regarding UK representation abroad may be found through the following link: [https://www.gov.uk/world/embassies](https://www.gov.uk/world/embassies).

**Transportation**

Exeter is easy to reach from Bristol airport and London by both bus and train. Details on transport to and from the University of Exeter Streatham Campus are available from: [https://www.exeter.ac.uk/visit/directions/streatham/](https://www.exeter.ac.uk/visit/directions/streatham/)

**Currency**

The local currency is the Pound Sterling (GBP).

The average exchange rate is as follows:

- 1 Euro = 0.89 GBP
- 1 USD = 0.72 GBP

**Health requirements/medical services**

Up-to-date information on international travel and health requirements are provided by the World Health Organization (WHO) at the following websites:

- [http://www.who.int/ith/en/](http://www.who.int/ith/en/)

It is strongly recommended that you take out personal medical insurance for the duration of the trip.

**Electricity and mobile phone connection**

Power systems are generally 230 volts and 50 Hz. The UK uses a three-pin plug and an adaptor will most likely be necessary.

Participants are advised to bring their own plug adapters to plug into UK power sockets. Information on the appropriate plugs may be found on the Internet (for example, at: [https://www.power-plugs-sockets.com/](https://www.power-plugs-sockets.com/)).

**Use of mobile telephones**

Participants are kindly reminded that, as a courtesy to their colleagues, their mobile telephones should be muted on entry to the conference room. Participants are requested to hold phone conversations outside of the conference rooms.
Local climate in July

Climate data during July in Exeter is listed below:
- Mean temperature: 17°C
- Mean maximum temperature: 22°C
- Mean minimum temperature: 12°C
- Mean relative humidity: 78%
- Mean precipitation: 46mm
- Mean number of days with precipitation ≥1 mm: 8 days
- Mean duration of sunshine: 6 h/day

Updated weather information can be found on the Met Office website (https://www.metoffice.gov.uk/).

Hotel reservation

Participants are advised that the University of Exeter has provided a discount code (LOYAL18) for booking bed and breakfast accommodation in Holland Halls. The bed and breakfast rate is £51.85 per night. This accommodation is a 5-10 min walk from the conference room. Holland Hall accommodation can be booked via https://bookings.eventexeter.com/.

As Exeter is a popular holiday destination in the summer months, hotels in the city can get booked early. https://www.visitexeter.com/places-to-stay lists recommended other accommodation options in the city centre area.
DOCUMENT PROCESSING FOR THE SIXTEENTH SESSION OF THE COMMISSION FOR AERONAUTICAL METEOROLOGY

Document types for the sixteenth session of the Commission for Aeronautical Meteorology

(1) The sixteenth session of the Commission for Aeronautical Meteorology (CAeM-16) will use two types of document:

- **Doc.** (documents) whose contents are listed below; these will appear in the final report;

- **INF.** (information) papers, which provide additional information relevant to the resolutions/decisions/recommendations adopted at the meeting; these will appear only in Part II of the report.

(2) The first type of document (**Doc.**) will consist of up to three parts, and every document will contain at least one resolution and/or one decision and/or one recommendation:

(a) **Resolutions** (optional) are decisions of CAeM that concern only the internal activities of the Commission, such as actions to carry out its part of the strategic programme of the Organization, the establishment and terms of reference of a working group or the designation of a rapporteur, in line with General Regulation 182(b);

(b) **Decisions** (optional) place on record instructions/directives to the Management Group from CAeM, Congress or EC resolutions or decisions, or provide records of CAeM opinions/observations on a specific topic, procedural decisions and other decisions pertaining to the internal matters of CAeM, in line with General Regulation 182(c);

The decision justification is additional information that is essential to support the decision being made. This should be short and should refer, as far as possible, to pre-existing documents. This part of the document will appear in the final report immediately after the corresponding decision;

(c) **Recommendations to Congress or the Executive Council** (optional) are decisions of CAeM requiring financial support or implementation by Members, proposals for Secretariat action or requiring coordination with other WMO bodies or with bodies outside the Organization, in line with General Regulation 182(a).

Document processing

(3) The first version (DRAFT 1) of documents will be published on the CAeM-16 website (meetings.wmo.int/CAeM-16/), and members of the Commission will be invited to send suggestions for improving the document to the Secretariat (caem16.plenary@wmo.int). These proposals will be assessed and the second draft (DRAFT 2) will be posted on the CAeM-16 website. Only the pre-session version of these documents will be available in all six WMO official languages.
(4) Information documents will be posted on the CAeM-16 website, but are not intended for amendment or discussion. These will normally be available in English only.

(5) During the session, the chairperson for an agenda item will lead the discussion on the documents for that item. Within a document, each decision will be discussed separately. In many cases each component of that decision, such as related annexes, will be discussed individually. Following current practice, component parts of a document may be approved by the session while other components may still need additional debate. Documents amended during the session will be posted successively as DRAFT 2, DRAFT 3, and so forth, and the final approved version will be marked APPROVED.

(6) Discussion of the document may end in two ways. The complete document may be approved, in which case any agreed changes to the document will be included and the approved version will be published on the CAeM-16 website in the PROVISIONAL REPORT (Approved documents) folder. Alternatively, the chairperson of the session may decide that no further progress can be made with the document at that time, in which case changes to the document will be included in the next draft, and the modified document will be published on the CAeM-16 website in the DRAFTS FOR DISCUSSION folder. This will be published as the next draft in the sequence (DRAFT 2, DRAFT 3, and so forth), whereas the previous draft will be moved to the SESSION ARCHIVE folder.

(7) Versions of documents created during the session will be available in English only, on the understanding that the revised texts will be read out clearly, with interpretation in all WMO official languages.

**Post-session publication**

(8) Approved documents from the session will be translated into all six WMO official languages and placed on the CAeM-16 website in the PROVISIONAL REPORT (Approved documents) folder.

(9) The approved documents, the agenda and the list of participants will be combined to form the abridged report of the session, which will be edited and published in the six WMO official languages. A second part of the report, consisting of information documents will also be published, in English only.
REPORT BY THE PRESIDENT OF THE COMMISSION

(Presented by Mr C.M. Shun, President of the CAeM)

Progress of the Commission during the intersessional period

The achievements of the Commission for Aeronautical Meteorology since its fifteenth session (CAeM-15) held on 15-16 July 2014 jointly with the ICAO Meteorology Divisional Meeting in Montreal, Canada can be highlighted as follows:

(a) The seventeenth World Meteorological Congress (Cg-17) in 2015 reconfirmed Aeronautical Meteorology as one of the WMO strategic priorities of the WMO Strategic Plan for the financial period 2016-2019. Aeronautical meteorology was first recognized as one of the WMO strategic priorities by Cg-16 (2011) for the financial period 2012-2015 which helped improve some of the longstanding resource difficulties faced by the Commission in the past;

(b) Very significant progress has been made by Members in the implementation of quality management systems (QMS) for aeronautical meteorological service provision and competency assessment for aeronautical meteorological personnel (AMP). In particular, from the CAeM global survey on aeronautical meteorological service provision conducted between November 2016 and February 2017 (see sub-paragraph (e) below), in a majority of States and Territories the aeronautical meteorological service providers (AMSPs) have fully (68%) or partially (14%) implemented QMS, whereas almost 70% of States and Territories have established a national competency programme for AMP;

(c) Highly successful organization and delivery of the 2017 WMO Aeronautical Meteorology Scientific Conference (AeroMetSci-2017) held in Toulouse, France on 6-10 November 2017 (https://www.wmo.int/aemp/AeroMetSci-2017), with excellent feedback received from over 200 participants, which was the second such event dedicated to WMO in the history of WMO, the first one being held in London, United Kingdom in March 1968. The 2017 conference opened new and promising ways for a fruitful information exchange between scientists, operational actors and end-user communities. The conference also highlighted the need for a mechanism for enhancing the sharing and use of aircraft data, in particular turbulence data, for the improvement of science and operations;

(d) Successful organization and delivery of the Special Dialogue on the Future of Aeronautical Meteorological Services at EC-69 (2017) engaging national and private AMSPs and aviation industry representing airlines and pilots with Decision 42 (EC-69) calling for the development of a methodology and the conducting of a sensitivity analysis of various scenarios of future meteorological service delivery for aviation, including different degrees of engagement of private sector providers, to assess possible impacts both on the national meteorological and hydrological services (NMHSs) as AMSPs and on the resulting service quality levels; such analytical information to inform WMO planning of aviation-related activities in the future, with first results of such analytics expected to be available in time for Cg-18 in 2019. Regional conferences were organized or are being planned to increase the awareness of Members to the changes in aeronautical MET services arising from the ICAO Global Air Navigation Plan (GANP) and its aviation system block upgrades (ASBU).
methodology, for example the WMO RA VI European Conference on MET for Aviation (ECMA) held in October 2015 and the WMO RA I African Conference on MET for Aviation (ACMA) under consideration;

(e) Conducting and coordination of a highly successful CAeM global survey on aeronautical meteorological service provision between November 2016 and February 2017 with an unprecedented response rate from WMO Members exceeding 90%. A publication detailing the outcomes of the survey and an analysis of the findings was compiled and published as AeM SERIES No. 1. Further details about the global survey is available in CAeM-16/INF. 3(8);

(f) Production of and updates to relevant standards, publications and guidance material were achieved, including updates to the WMO-No. 49, Technical Regulations, Volume II, Meteorological Service for International Air Navigation, ensuring its necessary alignment with Amendment 77 (2016) to ICAO Annex 3, a new version of the WMO Guide to the Implementation of Quality Management Systems for National Meteorological and Hydrological Services and Other Relevant Service Providers (WMO-No. 1100), a new WMO Guide to Competency (WMO-No. 1205), an upgraded CAeM moodle website, and a new CAeM Newsletter issued biannually (latest issue here).

Current and foreseen issues facing aeronautical meteorological service provision

While noting the above achievements of the Commission in the past four years, the following issues facing aeronautical meteorological service provision by WMO Members are to be highlighted, mostly stemming from the ambitious work plan driven by the above-mentioned ICAO GANP and ASBU methodology, as well as the evolving needs of the aviation industry and advancement of technologies:

(a) Ever-increasing aviation user demands for new and/or enhanced aeronautical meteorological services, globally harmonized services, seamless and more effective air traffic management in response to the rapid increase in air traffic in many parts of the world, as well as the more rapid (2-year) amendment cycle of ICAO Annex 3;

(b) Trends for regionalization and globalization of aeronautical meteorological services, especially the ongoing deliberations on the most appropriate international system for provision of phenomena-based hazardous meteorological information to address long-standing SIGMET deficiencies;

(c) Technological drivers such as the implementation of the ICAO system-wide information management (SWIM) system including the development of the new aeronautical meteorological code IWXXM, availability of technologies to uplink weather information to the cockpit of aircraft-in-flight, availability of nowcasting techniques for high-impact weather, etc. mean that timely upgrades will need to be pursued which could be challenging to the developing world. In this connection, it is noted that how the available nowcasting techniques could be applied in air traffic management is being demonstrated by the CAeM/CAS Aviation Research Demonstration Project (AvRDP);

(d) The role of the private sector in public-private partnership (PPP) within the ‘Global Weather Enterprise’ and the challenges and opportunities this presents for NMHSs of WMO Members;

(e) Lack of effective cost-recovery mechanism for aeronautical meteorological services in some WMO Member counties and the need to develop new mechanism(s) to support increased regionalization of service provision;
Maintenance and updating of QMS and Aeronautical Meteorological Personnel (AMP) competency assessment frameworks.

**Strategic and operational planning relevant to the Commission**

All of the CAeM Expert Team (ET) work plans have been uploaded to the WMO AeMP website (Direct links: ET-ASC, ET-CCP, ET-ETC, ET-GOV and ET-ISA) and that these have been maintained by the Secretariat taking into account the outcomes of the periodic ET meetings. The availability of these up-to-date work plans, complemented by the availability of final reports of meetings/events on the AeMP website, represents a clear demonstration of the work of the Commission. In respect of the preparation of a CAeM Operating Plan for 2020-2023, the CAeM-related inputs in terms of concrete priority tasks, related objectives and KPIs, will be provided once the final structures and content of the WMO Strategic Plan (SP) and Operating Plan (OP) are known. With reference to the already agreed general structure of the WMO SP for 2020-2023, where the SP was structured around five Long-Term Goals (LTG) with several Strategic Objectives (SO) assigned to each LTG, it is noted that the main sector-oriented service activities were included under LTG 1 – “Better serve societal needs” while the respective AeM-related strategic objective was SO 1.4 – “Weather-integrated decision-making”.

In addition to consideration of the CAeM Operating Plan, as a follow-up of Resolution 3 (Cg-17), the Decision 43 (EC-68) had, inter alia, requested the president of CAeM to prepare, in coordination with the Secretary-General, regional associations and technical commissions, a draft Long-Term Plan for the Aeronautical Meteorology Programme (LTP-AeMP) aligned with the ICAO GANP and ASBU methodology for consideration at EC-69 in 2017. In this connection, a methodology for the draft LTP-AeMP was prepared and endorsed by EC-69. Based on this methodology, the Secretariat in consultation with the CAeM MG has further developed a strawman and a strategy for the development and maintenance of the LTP-AeMP for 2019-2033 for consideration during the session (see CAeM-16/Doc. 6.3 and CAeM-16/INF. 6.3).

**WMO reform considerations relevant to the Commission**

The president has been involved in the ongoing discussions on the WMO reform and was invited to participate in relevant meetings, especially the annual PTC and Joint PRA/PTC meetings and a session of the EC Working Group on Strategic and Operational Planning (WG-SOP) during which WMO restructuring was discussed. The president presented a SWOT (strengths, weaknesses, opportunities, threats) analysis for CAeM and provided his views on various restructuring options at PTC-2017. While various options of reducing the number of technical commissions (TCs) had been discussed, with the possibility of the existing service-oriented TCs such as CAeM continuing in the form of non-intergovernmental Standing Committees (e.g. SC-AeM) under a consolidated Commission for Applications and Services, there was not yet a consensus at the time of preparation of documents for CAeM-16. It was expected that a consolidated proposal would be further deliberated by EC-70 (June 2018) and socialized with Members prior to consideration and approval of a preferred option by Cg-18 in 2019.

As the working arrangements between ICAO and WMO are also being reviewed and updated (see CAeM-15/INF. 5.1), it is envisaged that stronger ties will be established between the future CAeM or its successor (e.g. SC-AeM) and the ICAO Meteorology Panel (METP). International coordination and cooperation on aeronautical meteorology between WMO and ICAO would be further enhanced and the restructuring would see obvious benefits. The activities with the AeMP are also expected to continue to play a pivotal role in WMO as demonstrated through leadership in promoting QMS, the competency assessment framework, compliance culture, PPP, etc. within the Organization.
While the internal structure of the future CAeM or its successor has yet to be established, it would be based on the CAeM structure to be discussed at and agreed during the CAeM-16 session. Furthermore, regardless of whether WMO reform will happen in the near-term or far-term, a transition plan from the existing structure to any new structure will be of paramount importance to ensure continuity in activities.

**Closing remarks**

In concluding this report, since the CAeM-16 session represents the completion of the incumbent president’s term of office, heartfelt appreciation is expressed for the excellent support by all members of the CAeM and the CAeM Management Group including the Secretariat of both WMO and ICAO. The significant progress made by the Commission during the past eight years of tenure as president would not have been possible without this support.

Even though uncertainties on the future WMO restructuring are expected to exist for some time, it is hoped that the core values of strong scientific expertise, professionalism, close user engagement and partnership, agility, pro-activeness and inclusiveness will guide the Commission (or its successor), allowing aeronautical meteorological services worldwide to reach new heights in the decades to come.
REPORT BY THE EXPERT TEAM ON AVIATION, SCIENCE AND CLIMATE

(Presented by Herbert Puempel and Matt Strahan, ET-ASC co-chairs)

Terms of reference and composition

The CAeM Expert Team on Aviation, Science and Climate (ET-ASC) was established at CAeM-15 (2014) with the following terms of reference:

(a) To coordinate the response to science related requests in support of the development of new and evolving service delivery concepts and related observing system requirements, in collaboration with the relevant WMO bodies and programmes;

(b) To coordinate the response to science related requests for advice to support the development of new and evolving aviation now-casting and very short-range forecasting concepts in collaboration with the relevant WMO bodies and programmes;

(c) To provide expert representation to the ICAO CAEP and coordination of responses to science related requests for advice relating to the impacts of climate change and variability on aviation, including seasonal and inter-annual changes, in collaboration with GFCS and relevant WMO bodies and programmes; and to make WMO Members aware of emerging opportunities for related services;

(d) To develop and maintain a repository of relevant research activities in collaboration with the relevant organizations and bodies;

(e) To report regularly on progress to the president of CAeM.

In April 2018, the composition of ET-ASC was as follows:

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<tr>
<th>Co-chairs:</th>
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<tr>
<td>Herbert PUEMPEL (Austria)</td>
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<td>Matt STRAHAN (USA)</td>
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<th>Core members:</th>
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<tr>
<td>Piers BUCHANAN (UK)</td>
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<tr>
<td>Cory DAVIS (New Zealand)</td>
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<tr>
<td>Anna IVANOVA (Russian Federation)</td>
</tr>
<tr>
<td>Ping Wah LI (Hong Kong, China)</td>
</tr>
<tr>
<td>Pascal WAHINA (Tanzania)</td>
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Work programme progress/activity report

Since the CAeM-15 session in 2014, ET-ASC has been strongly engaged in:

(a) The preparation and conducting of a European Conference on Meteorology for Aviation (ECMA) held in Vienna, Austria, in October 2015;

(b) The aviation-centric workshop during WSN-16 on Nowcasting and Very Short Range Forecasting for Aviation held in Hong Kong, China, in July 2016;

(c) Preparing a first set of scientific answers to the questions posed by Airbus on the challenges of future climates for airframe and engine manufacturers.

In addition, ET-ASC in close cooperation with the CAeM Expert Team on Information and Services for Aviation (ET-ISA) was central to the planning, preparing and conducting of a joint CAeM/CAS/CBS Aeronautical Meteorology Scientific Conference in November 2017 (AeroMetSci-2017) in Toulouse, France on the underpinning scientific research and development to support the current and future needs of aviation.

During the intersessional period, ET-ASC convened two meetings conjoint with ET-ISA in March/April 2015 (report available here) and May 2017 (report available here).

ET-ASC considers that the most urgent task and achievement of the team over the intersessional period has probably been the remarkable increase of awareness of aviation stakeholders of the importance and challenges of providing fit-for-purpose, consistent and scalable aeronautical meteorological services in a changing climate reflected by new risk scenarios, in particular the impact that a more volatile climate may have on aerodrome design and operations. For example, the planning and design of a new aerodrome may, to some extent, be based upon dated climatological tables and aerodrome reference temperatures that are unrepresentative given the current pace of climate change.

The focus of the team’s efforts can, therefore, be summarized as follows:

Climate change related activities

(a) Review of the climatological tables in WMO-No. 49, Technical Regulations, Volume II: A preliminary study conducted by Anna Ivanov (ET-ETC core member) and a similar effort by the Austrocontrol MET department have indicated that in some regions and some topographic situations significant changes of the aerodrome reference temperature are already observed. As a consequence, ICAO should be consulted on proposals for missing specifications (e.g. reference period, variation in addition to the current maximum-based formulation) as a potential blueprint for future studies to be conducted by aeronautical meteorological service providers of WMO Members.

(b) Essential contributions to the ICAO Committee on Aviation Environmental Protection (CAEP), in particular, a draft White Paper contribution for the CAEP Steering Committee delivered to the ICAO secretariat early 2016, as well as a contribution to the CAEP yearbook, and presentations to a CAEP Scientific Conference held in Washington DC, United States, in 2015 were also provided.
**Aeronautical Meteorology Scientific Conference activities**

Preparation and conducting of the 2017 WMO Aeronautical Meteorology Scientific Conference at Météo-France in Toulouse, France from 6 to 10 November 2017 (AeroMetSci-2017) in collaboration with other expert teams including ET-ISA, based on the coordination between the ET-ASC and ET-ISA as effected by a conjoint meeting held in May 2017.

A Scientific Committee was established for AeroMetSci-2017, drawing on the particular expertise of CAeM and CAS expert teams and invited experts from scientific research and development (R&D) institutes as well as from aeronautical meteorological service providers of WMO Members. The Scientific Committee was co-chaired by Ping-Wah Li of Hong Kong Observatory (ET-ASC core member) and Herbert Puempel (ET-ASC co-chair) and well supported by others in the expert team.

The conference was structured in three main thematic sessions as follows:

(a) New developments in R&D for aeronautical meteorology, including techniques of nowcasting, short range forecasting and addressing specific aviation hazards. It had also considered the verification and validation of such predictions;

(b) Aspects of service delivery, i.e. how common situational awareness can be maintained in an increasingly data-rich environment with a variety of different access and human-machine interface systems; and

(c) The emerging evidence of climate change and variability impacting all aspects of aviation, from safety and regularity to the economic viability of specific operations.

The first session benefitted from contributions by scientists from leading organizations and institutes, and wrap-up panel discussions provided summaries of the relevant outcomes of the presentations.

The second session on service delivery highlighted the strong need for further development of streamlined, coherent and focused information for all relevant stakeholders, including the need for communicating objectively measured and unambiguously predicted reliability and achievable accuracy of forecasts and warnings. The role of system-wide information management (SWIM)-based information systems and the need to support different user communities in their selection of fit-for-purpose data and products was noted.

The third session on the impact of climate change and variability on aviation addressed the all-important question of how well regional and even local impacts are objectively predictable, how the potentially large uncertainty of the occurrence and severity of high-impact (extreme) weather events could be quantified, where possible reduced and communicated in a way that would permit aviation stakeholders to optimize their risk management.

The conference attracted more than 200 participants. Feedback proved that the conference had been an outright success and potentially opened new and promising ways of a fruitful information exchange between scientists, operational actors and end-user communities going forward. It further transpired that it may be quite important to establish a solid consultation process between the different stakeholders on the merits and expected benefits of scientific methodologies as well as the use and securing of non-standard meteorological data (aircraft-based, ground-based/aerodrome-specific, remote sensing). The time-honoured ICAO process of defining the industry requirements for meteorological service for international air navigation may have to become the “last mile” of a much more open, collaborative and scientifically sound analysis of existing issues, scientific and technological capabilities and return-on-investment considerations. The need for governance (or, at least, a general agreement) on the use of aircraft data for the improvement of science and operations appeared urgently needed to avoid a potentially futile and resource-consuming competitive approach to data generation and use.
**Aviation Research Demonstration Project (AvRDP)**

With the support from members of ET-ASC and their networks, it was possible to make a contribution to the AvRDP Meeting held in Hong Kong, China in July 2016, providing an outlook on how climate change is expected to become a ‘game-changer’ in many observing and forecasting systems and problems. PW Li (ET-ASC core member) forms the main link to the AvRDP and ET-ASC has been ready to provide support for the work of this project where appropriate.

The co-operation of ET-ASC with the AvRDP has demonstrated the urgent need to further develop meaningful, user-oriented validation methods that would allow not only information and guidance for decision-support of the wider aviation community but also include quantified estimates of the situation-dependent, achievable accuracy and reliability of the guidance and data. Modern decision-support systems are perfectly capable of using the input of variable accuracy, provided this accuracy can be estimated beforehand, to allow the attribution of an appropriate weight to any information used in a complex process. This issue should figure prominently in the work programme of future expert teams or individuals serving in a similar capacity to the ET-ASC.

**Support to industry**

Building on existing contacts to Airbus and other interested OEMs (original equipment manufacturers), ET-ASC has explored ways on how WMO Members should act in the light of merging commercial opportunities for aeronautical meteorological service providers and research institutions. In a similar way, presentations given to the World ATM Congress in Madrid, Spain in Madrid 2018 and articles provided to ATM service providers (European Interfab Coordination, DFS and others) have laid the groundwork for enhanced delivery of relevant consulting activities by WMO Members.

Considerations for future work

In conclusion, it may be worthwhile to consider the need for an organization of future CAeM activities in the field of science, especially the transition from research into operations, and climate change in future working structures – both within the existing CAeM and any future technical commission arrangement.

The cooperation with ICAO, a very process-oriented and pragmatic partner organization, will put the onus of keeping track of scientific developments, environmental challenges such as climate change and variability, and a long-term perspective firmly in the WMO domain. While it will remain a core responsibility for WMO to work closely with ICAO bodies (such as the METP and CAEP) and to deliver tangible results in areas of technical development such as the SWIM concept and globally interoperable data and services, it will be up to teams or individuals such as the ET-ASC to ensure a high-level, open view and open mind on the wider challenges and directions of science to provide the necessary foresight for steering developments of meteorology in a direction that will support the aviation needs of the future in a collaborative manner, with all its knowns and unknowns in terms of technology, vagaries of nature and society.
REPORT BY THE EXPERT TEAM ON COMMUNICATION, COORDINATION AND PARTNERSHIP

(Presented by Gaborekwe Khambule and Marina Petrova, Co-Chairs of ET-CCP)

Terms of reference and composition

The CAeM Expert Team on Communication, Coordination and Partnership (ET-CCP) was established at CAeM-15 (2014) with the following terms of reference:

(a) To promote and maintain effective two-way communication mechanisms on matters relating to aeronautical meteorology with Members through the regional associations to determine regional priorities, promote awareness of developments, opportunities and challenges, and to coordinate appropriate responses to requests for advice and guidance;

(b) To establish an effective mechanism for monitoring and evaluation (M&E) of the CAeM work programme in the regions as an integral part of the WMO M&E system;

(c) To provide support to the Secretariat in developing and updating the relevant Aeronautical Meteorology Programme database entries e.g. Country Profile database;

(d) To promote WMO gender and equality policies within CAeM;

(e) To report regularly on progress to the president of CAeM.

In April 2018, the composition of ET-CCP was as follows:

<table>
<thead>
<tr>
<th>Co-chairs:</th>
<th>Gaborekwe KHAMBULE (South Africa)</th>
<th>Marina PETROVA (Russian Federation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core members:</td>
<td>Kaspar BUCHER-STUDER (Switzerland)</td>
<td>Boon Leung CHoy (Hong Kong, China)</td>
</tr>
<tr>
<td></td>
<td>Ishiyaku IBRAHIM (Nigeria)</td>
<td>Truusje Soetinie WARSODIKROMO (Suriname)</td>
</tr>
<tr>
<td></td>
<td>Lora WILSON (USA)</td>
<td>Kar Lin YAP (Singapore)</td>
</tr>
</tbody>
</table>

Work programme progress/activity report

Interactions within ET-CCP

During the intersessional period (2014-2018), ET-CCP dealt with the implementation process currently underway amongst WMO Members in meeting the International Civil Aviation Organization (ICAO) Global Air Navigation Plan (GAPN) and aviation system block upgrades (ASBU) strategies and requirements, to enable the Commission’s timely response to identified gaps and challenges, weaknesses and successes. Updates to the list of successes and weaknesses became a natural resource for assessing root problems and defining the ways for closing the gaps.
Teleconferences and email communication amongst the team served as a focus for dynamic communication and sharing of reviews of implementation processes in the Regions. On the whole, seven teleconferences were held, resulting in detailed reports for the CAeM Management Group on the involvement in the regional/sub-regional projects, participation in the regional/sub-regional expert teams/groups, collection of best practice examples, provision of advice, consultation and guidance at the MET related meetings, workshops and conferences.

**Coordination with CAeM Management Group (MG)**

The CAeM MG streamlined the team’s activities, setting essential tasks and providing guidance, and in particular, the ET-CCP was advised to make contact with regional working groups/task teams to monitor the progress of Members in regional planning and coordinate assistance for Members in need. ET-CCP enabled the MG to address common meteorological challenges of regional concern and provide guaranteed support for the organization of region-wide events, such as ECMA-2015, ACMA-2018 (under consideration), RA II RECO-2017, etc., aimed to raise awareness of the ICAO GANP and ASBU developments and their impact on aeronautical meteorological service delivery.

**Status of tasks in the work plan**

Guided by the CAeM MG, the work plan of ET-CCP has been regularly updated with realistic targets and deliverables taking into consideration of the resources available and the latest plan has been displayed on the WMO website since 31 July 2017.

A CAeM MG meeting in November 2016 (CAeM-MG-2016) encouraged ET-CCP to play an essential role in relation to the following CAeM initiatives: (a) the conduct of the 2016/17 CAeM global survey on aeronautical meteorological service provision; and (b) the issuance of regular information bulletins – Newsletters – to inform the MET community of the CAeM activities.

A CAeM MG meeting in January 2018 (CAeM-MG-2018) identified new tasks for ET-CCP, arising from the previously compiled initial implementation plan, to guide the team on further actions required to progress to higher implementation level over the short term.

**CAeM ET-CCP/1 Meeting**

Within the period under review, ET-CCP convened one face-to-face meeting in St. Petersburg, Russian Federation from 16 to 18 May 2016 to address a range of communication and outreach issues and to update its work plan (report available here). It was agreed that coordination and collaboration with other CAeM Expert Teams (ETs) was vital in order to ensure that the performance meets the targets. To this end, it was proposed to check the feasibility of using social enterprise networks such as Yammer, since such platforms could provide tools for analyzing the feedback and identifying ‘hot topics’. To improve outreach as regards CAeM developments, the team approached for the first time the need to issue regular CAeM Newsletters. The participation of a co-chair of the WMO CAeM Expert Team on Governance (ET-GOV) in the ET-CCP/1 meeting helped gain synergies between the two expert teams.

**Communication and outreach**

**Network of aviation experts**

Synergies between ET-CCP and ET-GOV evolved over time into successful attempts to establish an extended network of aeronautical meteorology (MET) focal points in the Members throughout the WMO Regions, which at a later stage would ensure the responses to CAeM surveys. It was recognized that officially designated MET focal points from WMO Members implemented the relevant tasks only to some extent. To further improve on effectiveness and
responsiveness, the team considered new approaches to engage additional MET experts and
identifying available aeronautical working groups in RAs which could provide the needed
support. Once established, the network proved to be reliable and resilient in two-way
communication with Members during the conducting of two CAeM surveys – a 2016-2017
CAeM global survey on aeronautical meteorological service provision and a 2018 CAeM
Newsletter satisfaction survey. The list of experts in MET is kept constantly updated.

2016-2017 CAeM global survey on aeronautical meteorological service provision

A CAeM global survey was conducted by ET-GOV in close coordination with ET-CCP between
November 2016 and February 2017, aiming to provide a global landscape for better strategic
planning and guidance material for Members. To achieve a more rapid response (or to make it
simple to use), the survey provided access to an online questionnaire. The team made every
effort to encourage the Members throughout the WMO Regions to respond
to the survey invitation with complete questionnaires, assisting with advice, instructions and updates. The survey yielded an exceptionally high response, with 92% of WMO Members responding by February 2017. This response rate was achieved, in great part, due to the outreach efforts of the team. Special focus by the team was also placed on the distribution of the outcomes of the global survey to Members. Information on the outcomes of the CAeM global survey is available in CAeM-16/INF. 3(8).

CAeM Newsletters

The issuance of biannual CAeM Newsletters is a direct way of getting through to the MET
community with comments and descriptions of the recent and planned events and highlights of
the most urgent issues. The team identifies wide-ranging topics for Newsletters on which there
is agreement, as the basis of the newsletter articles, thereby encouraging, accommodating and
informing of new and emerging trends in the provision of meteorological services for aviation.
Constant dialogue with the MG is essential to ensure that the topics to be highlighted in the
newsletters are vital and responsive to the Commission’s priorities. To date, four Newsletters
have been made available for the CAeM community: 6 October 2016, 13 February 2017,
5 September 2017 and 26 February 2018. It is anticipated that the next issue of the Newsletter - Newsletter-2/2018 - will include MET commitments and latest developments to appear in September 2018. The team is tasked not only to enable issuing, but also to promulgate these Newsletter issues within the WMO and the broader MET community.

CAeM 2018 Newsletter satisfaction survey

Currently, the periodic CAeM Newsletters are disseminated to approximately 900 recipients
within the WMO and broader MET community. To learn from the reading audiences what they
value or need from the Commission, as well as to decide what level of Newsletter improvement
is appropriate for the future, the CAeM-MG at its January 2018 meeting requested ET-CCP to
conduct a short ‘satisfaction survey’ in English. Responding to a limited set of questions,
newsletter recipients were asked about the special features of the newsletters, i.e. the format,
the content, the frequency of issuance, etc., to define the overall level of satisfaction with and
suggestions for improvement to the newsletters.

On 5 February 2018, the first CAeM Newsletter satisfaction survey (online questionnaire) was
developed, comprising 10 questions and an ‘additional comments’ box. The survey was
launched on 26 February 2018 to coincide with CAeM Newsletter-1/2018 and ran until
31 March 2018. The survey yielded 185 responses. ET-CCP intends to analyze the findings of
the survey and to make proposals regarding future newsletters to the CAeM-MG for
consideration.
**Cooperation with other CAeM Expert Teams**

Contacts with ET-ISA were strengthened to distribute to the CAeM community, and further to WMO Members, the information on the publication of the ICAO IWXXM 2.0RC1 in April 2016 for timely feedback before the release of the final version of IWXXM 2.1 in August 2016. Preparations for the issuance of the CAeM Newsletters intensify through contacts within all of the CAeM ETs.

**Other coordination and cooperation**

**Regional Associations**

Liaison with regional/sub-regional aviation task teams/subgroups, which are instrumental in the communication and outreach with regard to the CAeM activities, was enhanced through involvement and participation of ET-CCP experts in various meetings and aviation meteorology-related events. ET-CCP also facilitates national dialogue between the NMHSs, CAAs and other aviation stakeholders to build an inclusive and equitable partnership.

**ICAO Meteorology Panel (METP)**

The ET-CCP maintained communication with the ICAO METP through the members of the METP working groups (e.g. WG-MIE and WG-MOG) who are also core experts of the ET-CCP, to enable timely contributions to the work streams and receive sufficient information.

**Considerations for future work**

Targeted coordination will be essential in the forthcoming intersessional period, linked to different MET communities in order to elevate MET awareness and promote more intensive exchange of best practice examples. CAeM Newsletters may, for example, form the bulk of future communication, coordination and partnership outreach, aiming to cover the challenge in the Regions for adequate MET information resources and enable CAeM to maintain its relevance to the MET community.

While the form of the team may change going forward, keeping the essence of the team’s work ambitions to stimulate, encourage, coordinate and otherwise facilitate discussions in support of the future CAeM priorities should be noted.

The use of social platforms between the ET-CCP (or its future form) and the broader MET expert community would enhance internal communication amongst the CAeM ETs and external communication with other organizations, regional and sub-regional focal points for a continuous exchange of expertise and information.

Near term activities should include dealing with the CAeM global survey outcomes, contributing to the development of the communication strategy and supporting materials, as well as to the methodologies and techniques to be used in future for similar outreach with the MET community.

Areas for future work may also include addressing public-private partnership in the provision of aeronautical meteorological services and, in keeping with Resolution 5 (CAeM-XIII), further encouraging the participation of women and overall gender balance in the work of the Commission (or its successor).
REPORT BY THE EXPERT TEAM ON EDUCATION, TRAINING AND COMPETENCY

(Presented by Chris Webster and Kathy-Ann Caesar, ET-ETC co-chairs)

Terms of reference and composition

The CAeM Expert Team on Education, Training and Competency (ET-ETC) was established at CAeM-15 (2014) with the following terms of reference:

(a) To provide guidance on the implementation of WMO standards and recommended practices related to the competency and qualifications of aeronautical meteorological personnel (AMP);

(b) To facilitate efficient methods of education and training in aeronautical meteorology by making education and training resources available online;

(c) To encourage the sharing of education and training resources as well as best practices;

(d) To look for cost-effective training opportunities and to seek in-kind contributions to make these available in WMO official languages;

(e) To coordinate with the WMO EC Panel of Experts on Education and Training in developing and updating WMO provisions on competency and qualifications of AMP for inclusion in the WMO Technical Regulations and related guides;

(f) To contribute to developing appropriate guidelines and other relevant material meeting aeronautical users training needs on aeronautical meteorology;

(g) To address emerging training and education needs for enhanced meteorological services stemming from the ICAO Global Air Navigation Plan (GANP) and Aviation System Block Upgrades (ASBU);

(h) To report regularly on progress to the president of CAeM.

In April 2018, the composition of ET-ETC was as follows:

<table>
<thead>
<tr>
<th>Co-chairs:</th>
<th>Kathy-Ann CAESAR (British Caribbean Territories)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chris WEBSTER (New Zealand)</td>
</tr>
<tr>
<td>Core members:</td>
<td>Paul BUGEAC (Romania)</td>
</tr>
<tr>
<td></td>
<td>Michael GRAF (USA)</td>
</tr>
<tr>
<td></td>
<td>Andrea HENDERSON (Australia)</td>
</tr>
<tr>
<td></td>
<td>Jan Hendrick STANDER (South Africa)</td>
</tr>
<tr>
<td></td>
<td>Raf WINDMOLDERS (Belgium)</td>
</tr>
</tbody>
</table>
Work programme progress/activity report

Introduction

During the 2014 to 2018 intersessional period, the focus of ET-ETC has gradually broadened from competency-related matters to more general education and training issues. This change became more apparent in the lead-up to the 2016 qualification deadline for aeronautical meteorological forecasters (AMF).

Taking into account the current intersessional period and the final months of the previous period, ET-ETC has seen the passing of two very significant milestones in respect of aeronautical meteorological personnel (AMP) competency and qualification standards.

(a) Firstly, on 1 December 2013, the aeronautical meteorological observers (AMO) and aeronautical meteorological forecasters (AMF) competency standards came into force.

(b) Secondly, on 1 December 2016, the AMF qualification standard came into force.

A key role of ET-ETC during this period was to guide, coordinate and encourage all organizations in the aeronautical meteorology community in their efforts to comply with these WMO standards.

In view of the CAeM’s pioneering work in this regard, experts from other technical areas have sought and received advice from CAeM on how they could implement comparable systems.

Other ET-ETC activities have focussed on the delivery of supporting materials, providing expert advice and analysing survey results:

(a) Within the limited available resources, the ET-ETC has updated existing support materials (e.g. the CAeM Moodle website) and led the development of new guidance documents (e.g. the WMO Guide to Competency).

(b) Early in the intersessional period, ET-ETC developed a consistent process for dealing with requests from NMHSs and similar agencies for expert advice and reviews of AMP educational documentation. Some of these requests arose through the WMO regional association mechanism. Kathy-Ann Caesar took on responsibility for the initial handling of these enquiries.

(c) Results of the CAeM global survey related to qualifications and competency have received preliminary analysis.

During the intersessional period, ET-ETC convened one meeting conjoint with the CAeM Expert Team on Governance (ET-GOV) in November/December 2015 (report available here).

The Team

In September 2014, two months after the ET-ETC was established in Montreal, the CAeM family was saddened to learn of the passing of nominated co-chair Cynthia Abelman.

The vacant position was filled by Michael Pat Murphy (United States), who had to step down in January 2016 and was replaced by Robert Rutledge (United States). Mr Rutledge subsequently had to step down and was replaced in January 2017 by core ET-ETC member Ms Kathy-Ann Caesar (British Caribbean Territories).

In addition to the core members, the team appreciated the invited expertise of Ms Queenie C.C. Lam (Hong Kong, China) throughout the period.
ET-ETC has contained an enthusiastic group of experts with a variety of experiences and specializations. The combination of backgrounds has enriched the quality of the team and greatly enhanced its outputs.

**WMO Guide to Competency**

A *WMO Guide to Competency* was published in February 2018. The ET-ETC collaborated with the WMO Education and Training (ETR) Office to produce this document, under the leadership of Andrea Henderson of the Australian Bureau of Meteorology (core member of ET-ETC).

The Guide meets a great demand within the international community. It includes general material on defining and writing competencies, implementing competency frameworks that meet organizational needs, assessing for competencies, competency-based training and QMS-compliance.

The Guide will interface with a new Compendium of WMO Competency Frameworks, planned for publication in late 2018. This supplementary publication will contain a variety of examples of competencies developed in a WMO context, e.g. for aviation, marine, and climate services.

**Advice on Competency**

Although the deadline for implementation of competency standards for AMP passed in 2013, many AMSPs have continued to require assistance with implementing the standards. Thus, assisting Members in implementing the WMO AMP competency standards was an important task for ET-ETC during the intersessional period. Such assistance was provided through training workshops, provision of up-to-date guidance on the implementation of standards, and maintaining the E&T website (available here) and the AMP Competency Training Mapping Database (available here).

In 2016, core member Paul Bugeac developed a peer-reviewed guide to implementing Competency Management Systems as part of an overarching QMS. This document was made available via the CAeM Moodle website (available here).

**AMF Qualification Requirements**

ET-ETC has played an important role in supporting Members and training institutes to achieve compliance with the AMF qualification requirements that became a standard practice as of 1 December 2016. There were some concerns that the demonstration of compliance with the qualification standards would be a challenge for many Members, and requests for further implementation guidance were sent by several regional associations.

In August 2015, the team shared with ETR focal points and WMO Regional Training Centres (RTCs) an example of good practice in WMO RA I (Africa). The Tanzania Meteorological Agency had followed the recommended process by obtaining BIP-M compliance statements from their feeder universities.

Chris Webster and Jannie Stander led the development of a flow-chart, in collaboration with the WMO ETR Office, on how organisations could achieve the BIP-M deadline. This flow-chart was translated from English into four additional official WMO languages, and in January 2016 was widely distributed to all Members of WMO via the RTC and ETR focal point networks. It remains available on the CAeM Moodle website (available here).

To further raise the profile of this standard and of other guidance resources including FAQs, in February 2016 the ET-ETC compiled a list of participants at past AMP workshops (covering every regional association) and forwarded to them a useful and practical information sheet on this issue.
Education, training and competency websites

Under the supervision of core ET-ETC member Raf Windmolders, the CAeM Moodle website has been progressively upgraded and new materials added, with continued technical support kindly provided by the UK Met Office. A review of the currency of the material and (where necessary) consequential updating of the material on the website is ongoing, led by Andrea Henderson and Michael Graf.

Additionally, CAeM had developed a Competency Assessment Toolkit (CAT) in the previous intersessional period to assist with the introduction of the competency frameworks that were new at the time. In 2017, the ET-ETC reviewed and updated this CAT (available here) with the kind assistance of Hong Kong Observatory.

Considerations for future work

WMO Global Campus

The Executive Council Panel of Experts on Education and Training has been addressing the establishment of a WMO Global Campus. This initiative is intended to assist WMO Regional Training Centres and WMO-affiliated Training Institutions in working together more collaboratively to help meet the growing range and depth of education and training demands of WMO Members. Establishment of the WMO Global Campus will be of significant benefit to the aeronautical meteorology community.

A new WMOLearn Events Calendar – a product of the WMO Global Campus – is now available online at: https://learningevents.wmo.int/. The WMOLearn Events Calendar is a global searchable calendar of learning opportunities. Users can browse upcoming events or search the calendar by topic, location, institution, language, or WMO competency framework, for example. The Events Calendar is intended to offer training providers a global audience for announcements of their courses, workshops, or other learning opportunities. The calendar is also accessible from the WMOLearn portal at http://learn.wmo.int/.

CAeM-16 should consider how to support this important initiative.

For more information on the WMO Global Campus, see Meteworld November 2014 and Frequently Asked Questions.

Analysis of CAeM Global Survey

The ET-ETC has undertaken preliminary analysis of the 2016-2017 CAeM global survey on Aeronautical Meteorological Service Provision pertaining to qualifications and competency. Further analysis, particularly related to regional breakdowns of the results, will help determine where the implementation gaps are, thus enabling the targeting of those areas in most need of assistance.
REPORT BY THE EXPERT TEAM ON GOVERNANCE

Terms of reference and composition

The CAeM Expert Team on Governance (ET-GOV) was established at CAeM-15 (2014) with the following terms of reference:

(a) To work in coordination with the ICAO METP to review/update/consolidate existing service delivery guidance material e.g. WMO-No. 732, 904 and 1001 in collaboration with the appropriate CAeM ETs and WMO bodies;

(b) To work in coordination with the ICAO METP on developing governance and cost-recovery guidance material to support the development of provisions for regional service provision, including Regional Hazardous Weather Advisory Centres;

(c) To contribute to the development of WMO data policies in relation to SWIM, in consultation with the ICAO METP and relevant WMO bodies;

(d) To collect and share best practices in relation to competency of aviation MET service oversight personnel and provide inputs to ICAO in developing guidance material;

(e) To collect and share best practices of roles and responsibilities of meteorological authority and meteorological service provider and provide inputs to ICAO in developing guidance material;

(f) To coordinate on the evolution of the WMO regulatory material on aeronautical MET in line with ICAO plans for restructuring Annex 3;

(g) To report regularly on progress to the president of CAeM.

In April 2018, the composition of ET-GOV was as follows:

Co-chairs: Kent JOHNSON (Canada)  
Jan SONDIJ (Netherlands)

Core members: Yuki KATO (Japan)  
Peter LECHNER (New Zealand)  
Jaakko NUOTTOKARI (Finland)  
Claudia RIBERO (Argentina)  
Zhongfeng ZHANG (China)
**Work programme progress/activity report**

During the 2014 to 2018 intersessional period, ET-GOV convened one conjoint meeting with the CAeM Expert Team on Education, Training and Competency (ET-ETC) in November/December 2015 (report available here). In addition, one of the ET-GOV co-chairs participated in a meeting of the CAeM Expert Team on Communication, Coordination and Partnership (ET-CCP) in May 2016 (report available here).

ET-GOV made progress in several areas during the intersessional period, most notably the CAeM global survey on aeronautical meteorological service provision.

A final report on the outcomes of the 2016/17 CAeM global survey on aeronautical meteorological service provision was published in November 2017 (AeM SERIES No. 1). Details are included in CAeM-16/INF. 3(9). The response rate of more than 90% of WMO Members was unprecedented for WMO member surveys. This response rate was a result of an excellent coordination between ET-GOV and ET-CCP at the preparatory stage and during the conducting of the survey.

The CAeM-15 Session, held conjointly with the ICAO Meteorology Divisional Meeting in 2014, established a number of objectives with joint responsibility between WMO and ICAO. For some of these it was expected that the leadership would originate with the ICAO Meteorology Panel (METP) established by ICAO in 2015. Issues such as oversight and cost-recovery proved to be very complex. In some cases, accurate information was not readily available, even from countries that had responded to the global survey.

The ICAO Global Air Navigation Plan (GANP) clearly describes a more regionalized approach to aeronautical meteorological service provision. Many Members have expressed significant concerns about what this approach means for them and it could even be argued that the majority of WMO Members do not favour a more regionalized approach at all. Given these competing demands it has therefore been very difficult for the ET-GOV to make any progress on the institutional issues relating to increased regionalization.

In terms of governance and cost recovery models for regionalised service delivery, the ET-GOV co-chairs have contributed to the ICAO METP Working Group on Meteorological Cost Recovery Guidance and Governance (WG-MCRGG) discussions. In particular, one of the ET-GOV co-chairs attended the first meeting of ICAO METP WG-MCRGG which took place following the joint ET-GOV / ET-ETC meeting held in Wellington in November/December 2015. The second ICAO METP MCRGG meeting took place at WMO in Geneva in July 2016 and was attended by both co-chairs of ET-GOV.

The ET-GOV made significant progress to consolidate WMO-No. 731, *Guide to Meteorological Observing and Information Distribution Systems for Aviation Weather Services* and WMO-No. 732, *Guide to Practices for Meteorological Offices Serving Aviation*. A review of WMO-No. 731 is almost finished and shows that most of the information contained in this document is available in other WMO sources. It is the intention to move the relevant information that is not captured in other WMO publications from WMO-No. 731 to other existing WMO documents and declare WMO-No. 731 obsolete. An outline for the revised WMO-No. 732 has been prepared. The intention is that WMO-No. 732 will act as a reference document for aeronautical meteorology service providers containing references to all existing WMO and ICAO publications. Given the required effort to update WMO-No. 732 it is anticipated that the new version will be ready for publication in 2019.

In respect of a review and update of WMO-No. 904, *Guide to aeronautical meteorological services cost recovery: principles and guidance*, ET-GOV has determined that the document (last updated in 2007) continues to provide guidance of relevance to aeronautical meteorological service providers but that a future update (or updates) will be required, for example, in respect of emerging regional service provision arrangements under consideration with the ICAO Meteorology Panel (METP) and its working groups.
**Considerations for future work**

ICAO, specifically the ICAO METP, has a primary responsibility for topics such as cost-recovery, oversight and regionalization. Governance issues such as these tend to be multi-jurisdictional which increases the level of complexity. During the intersessional period, ET-GOV was not able to make significant progress on these multi-jurisdictional activities. On the other hand, ET-GOV was highly successful in activities which were primarily within the domain and authority of the WMO. It is recommended that any future team responsible for governance issues focuses first and foremost on activities that are within the domain of the WMO. For other activities, with shared accountability, the future team would provide support and advice to the relevant body, such as the ICAO METP. The possibility of establishing joint ICAO and WMO teams to consider issues with shared accountability will also be considered between the two organizations (see CAeM-16/Doc. 5 and CAeM-16/INF. 5(1)).

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REPORT BY THE EXPERT TEAM ON INFORMATION AND SERVICES FOR AVIATION

(Presented by Stéphanie Desbios and Jun Ryuzaki, ET-ISA co-chairs)

Terms of reference and composition

The CAeM Expert Team on Information and Services for Aviation (ET-ISA) was established at CAeM-15 (2014) with the following terms of reference:

(a) To work closely with ICAO and other partners in developing relevant background material, methodology and implementation guidance on the MET components of the Aviation System Block Upgrades (ASBU) based on identified user requirements [WP A];

(b) To contribute to the development of new or enhanced MET information and services in close collaboration with ICAO [WP B];

(c) To develop relevant performance metrics and validation methodologies for new or enhanced MET information and services [WP C];

(d) To contribute to the development of SWIM MET data standards and policies; to promote the implementation of MET information exchange under SWIM by Members [WP D];

(e) To report regularly on progress to the president of CAeM [WP E].

In April 2018, the composition of ET-ISA was as follows:

<table>
<thead>
<tr>
<th>Co-chairs:</th>
<th>Stéphanie DESBIOS (France)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jun RYUZAKI (Japan)</td>
</tr>
<tr>
<td>Core members:</td>
<td>Michael BERECHREE (Australia)</td>
</tr>
<tr>
<td></td>
<td>Bart NICOLAÎ (Belgium)</td>
</tr>
<tr>
<td></td>
<td>Pak Wai CHAN (Hong Kong, China)</td>
</tr>
<tr>
<td></td>
<td>Albert MOLOTO (South Africa)</td>
</tr>
<tr>
<td></td>
<td>Cecilia MINER (USA)</td>
</tr>
</tbody>
</table>
Work programme progress/activity report

After the CAeM Management Group meeting in May 2015, the ET-ISA work programme was structured around five work packages (WP A to E), each corresponding to a term of reference. Each work package included tasks and related activities. In total and as of 12 April 2018, 28 activities were conducted by the ET-ISA in the four-year intersessional period.

During the intersessional period (2014-2018), ET-ISA convened two meetings conjoint with the CAeM Expert Team on Aviation, Science and Climate (ET-ASC) in March/April 2015 (report available here) and May 2017 (report available here). The terms of reference of the ET-ISA especially (a), (b) and (d) show clearly that coordination and collaboration with the ICAO Meteorology Panel (METP) working groups have been the main drivers of the team’s work during the intersessional period since CAeM-15. After the METP established its working structure in April 2015, ET-ISA experts, as members/advisors, contributed to the work and reported on progress of those working groups to the CAeM Management Group through regular reports and to the wider CAeM community through communication means such as the biannual CAeM Newsletters.

The development of the meteorological components (‘Advanced MET’ or AMET) of the ICAO Global Air Navigation Plan (GANP) and its Aviation System Block Upgrade (ASBU) methodology is in the remit of the ICAO METP Working Group on Meteorological Requirements and Integration (WG-MRI), as well as under the scope of the ICAO ASBU Panel Project Team (ASBU-PPT) in charge of the update of the ASBU framework for the next edition (2019) of the GANP. ET-ISA members that are advisors within the WG-MRI have contributed to the elaboration of functional and performance requirements of MET information and services to support selected ASBU Block 1 AMET modules (WP A). Documentation on existing and future capabilities for MET services in support of Air Traffic Management (ATM), with a focus on the terminal area, was also updated by ET-ISA during the first months of the intersessional period (WP B).

In 2016, one of the ET-ISA co-chairs was nominated as one of the three ICAO METP experts in the ICAO ASBU PPT referenced above. Contributions to the work of this team consisted in gathering comments from ET-ISA experts on existing B0 and B1 AMET modules (also called threads), and on newly created B2, B3 and B4 modules. The description improvement on terminal area aspects of B1 AMET module, which ET-ISA contributed to, was also taken into account by the ASBU PPT MET experts. B2 and B3 A-MET modules highlight the full transition to a data-centric environment in the System Wide Information Management (SWIM) context as well as an increased use of probabilistic MET information that will better enable aviation users to perform their risk assessments. The AMET module descriptions have recently been made available under the ICAO ASBU online database at https://www4.icao.int/gangway/ASBU and will be considered at the ICAO 13th Air Navigation Conference (AN-Conf/13) in October 2018. This activity linked to the ICAO ASBU PPT’s work was added to the ET-ISA work plan in early 2017 (WP B).

Members of ET-ISA have been involved in the METP working groups to develop concepts of operation (ConOps) for enhanced aeronautical MET services and the relevant documentation, i.e. for the world area forecast system (WAFS), space weather information service, regional hazardous weather advisory system, and release of radioactive material (WP A). Within the METP working group on meteorological information and service delivery (WG-MISD), one of the ET-ISA co-chairs successfully led work to develop guidance for the improvement of SIGMET harmonization, which will be included in a future update of ICAO Doc 8896 – Manual on Aeronautical Meteorological Practice. Several ET-ISA members also supported the CAeM Management Group in providing comments on the White Paper on Aviation Meteorology Information Delivery in 2030 drafted by the ICAO METP Working Group on Meteorological Cost Recovery Guidance and Governance (WG-MCRGG).
In November 2017, WMO successfully held its Aeronautical Meteorology Scientific Conference (AeroMetSci-2017) in Toulouse, France. The conference was attended by more than 200 participants from around the world, including experts from atmospheric research institutes, meteorological service providers, airlines, pilots and other aviation and meteorology representatives. Co-chairs of ET-ISA were involved in the Organizing Committee and also in the event itself as ‘master of ceremonies’ or session co-chairs and panel moderator. The co-chairs of ET-ISA worked closely with the CAeM Expert Team on Aviation, Science and Climate (ET-ASC), the CAeM/CAS Scientific Committee for AeroMetSci-2017 and others concerned in the organizing and conducting of the conference. The conference concluded with a series of recommendations and a statement which will guide the direction of scientific research activities over the next 15 years to meet the needs of the global aviation industry and to address issues related to climate change. Information on the outcomes of AeroMetSci-2017 is provided in CAeM-16/INF. 3(9).

ET-ISA continued the work started in 2013 to gather information on progress in the large ATM modernization programmes such as NextGen (United States of America), SESAR (Europe), CARATS (Japan) and more recently CMATS (Australia), for further understanding on how MET information will be utilized in the future ATM environment (WP B). Relevant information to raise awareness of the CAeM community on these large ATM modernization programmes and on the new services for the terminal area will be made available on the WMO AeMP website (under ‘Implementation Areas).

Furthermore, ET-ISA experts, mainly through one of the co-chairs and a core member, contributed to global and regional discussions concerning information exchange in the future SWIM environment (WP D). ET-ISA experts were involved in several WMO and ICAO groups on MET information exchange under SWIM (definition of the SWIM, guidance for the implementation of exchange of OPMET data) and on the interrelation between SWIM and the WMO Information System (WIS). Communication about SWIM and IWXXM (ICAO meteorological information exchange model) implementation was conducted through two CAeM Newsletter articles in 2017 and 2018 and the development of the short guiding text (available here) regarding the distinction between MET products and MET information services. Finally, with regard to performance metrics and validation methodologies (WP C) for new or enhanced MET information and services, ET-ISA coordinated with ET-ASC on the elaboration of a high/strategic level document on this topic for future distribution. An emphasis was put on aviation users’ perspective that must be carefully taken into account in the verification/validation methodology to assess the service performance according to those users’ requirements. This document will be made available on the WMO AeMP website (under ET-ASC). It should also be noted that this topic is also under consideration by the joint CAeM/CAS Aviation Research Demonstration Project (AvRDP) (more information available here) and coordination with the AvRDP project group will continue in the next intersessional period. Information on AvRDP is also provided in CAeM-16/INF. 4(3).

**Considerations for future work**

As the national and regional ATM modernization programmes progress with their developments, for example in the context of the second part of the SESAR programme called SESAR2020, new initiatives for enhanced MET services to support ATM, especially in the terminal area, will appear. A continuing priority, therefore, will be for the CAeM (or its successor) to continue monitoring and suitably engaged in the activities under such ATM modernization programmes in order to identify requirements stemming from them and to facilitate the transition of research into operations in further developing aeronautical meteorological services collaboratively.

The ICAO GANP/ASBU methodology currently extends to the year 2030 and beyond. Relevant background material, methodology and implementation guidance on the ASBU MET components, based on identified user requirements, will still be required by the aeronautical meteorology community, especially in the near term (2019) when the B1 AMET module starts. In particular,
responding to GANP and ASBU requirements for the integration of the MET information into the ATM decision-making processes in support of trajectory-based operations (TBO) should continue as a priority activity.

The SWIM environment will offer a set of new standards for information exchange and for services. Due consideration will need to be given to the further development of the IWXXM. In addition, a future focus should be put on the service concept, in the sense that MET information will no longer be ‘disseminated’ but where ‘services should be provided’ which allow aviation users to access MET data and retrieve necessary fit-for-purpose information in the relevant forms. Initial consideration was given by ET-ISA towards the end of the current intersessional period on the interrelation between SWIM and the WIS. It is foreseen that this topic will need to be further developed jointly by the CAeM and by relevant CBS groups (or successor bodies).
VOLCANIC ASH ISSUES

Volcanic ash advisory centre best practices

During the intersessional period (2014-2018), WMO has continued to play an active role in supporting the nine volcanic ash advisory centres (VAACs) in their efforts to improve their operational processes and practices to achieve service delivery harmonization – not only amongst the VAACs but also with other concerned parties such as State volcano observatories and meteorological watch offices – in the context of the requirements within the International Airways Volcano Watch (IAVW).

These service-improvement efforts have been channelled through the conducting of periodic (typically annual) VAAC "Best Practice" workshops. Since the CAeM-15 session in July 2014, three VAAC BP workshops have been held as follows:

(a) 5 to 8 May 2015, London, United Kingdom;
(b) 25 to 27 April 2016, Buenos Aires, Argentina; and
(c) 7 to 9 June 2017, Tokyo, Japan.

The reports of these meetings are available here: https://www.wmo.int/aemp/Final-Reports

Each of these workshops has served as an opportunity for the VAACs to share experiences and lessons learned, in particular from the operational response to recent eruptions in respective areas of responsibility, and to discuss the roles, responsibilities and programmatic coordination of volcanic ash issues across concerned WMO and ICAO expert groups.

A majority of the VAAC managers/representatives involved in the VAAC BP workshops are also State-nominated expert members on the ICAO Meteorology Panel (METP) Working Group on Meteorological Operations Groups (WG-MOG) addressing the IAVW.

In view of this and in order to make optimal use of the available resources, the VAAC BP workshops held in 2016 and 2017 were timed to immediately precede the ICAO METP WG-MOG/2 and WG-MOG/5 meetings addressing the IAVW. Convening the VAAC BP workshops and WG-MOG (IAVW) meetings in this way has facilitated a direct transition of the outcomes of the workshops into the ICAO standards-making processes.

The recent VAAC BP workshops have addressed the following key issues of relevance to the operation of the IAVW (in no particular order):

(a) VAAC operational responsibilities, handovers and backup arrangements;
(b) VAAC collaboration and information sharing for improved situational awareness;
(c) Trial of T+0 volcanic ash advisory information confidence;
(d) Trial of T+24 volcanic ash advisory information in graphical form (VAG);
(e) VAA and VAG consistency;
Discernible volcanic ash and aircraft reports;

Forecast verification and VAAC key performance indicators (KPIs);

Volcanic observatory notice to aviation (VONA);

Volcano eruption source parameters (ESP);

Volcanic ash atmospheric transport dispersion modelling (ATDM);

Re-suspended volcanic ash clouds;

Volcanic sulphur dioxide (SO$_2$);

Jet engine impacts of encounters with volcanic ash and gases; and

The ICAO meteorological information exchange model (IWXXM) for volcanic ash advisory information;

The VAAC BP workshops have served as an excellent outlet for VAAC managers and other representatives to discuss these and other issues of direct relevance to the operation of each VAAC in support of the IAVW. A number of the foregoing key issues remain, and will continue to remain, ongoing for the foreseeable future as the state of the underpinning science progresses and as technology continues to advance allowing the volcanic advisory operations of the VAACs to further improve in line with aviation users’ needs and expectations.

Appreciating the tremendous pace of scientific and technological advancement, at the most recent VAAC BP workshop held in June 2017 there was a recognition that there could be a mutual benefit of convening the next or other future VAAC BP workshop in concert with a meeting of the WMO/IUGG Volcanic Ash Scientific Advisory Group (VASAG) – see below – particularly in the context of promoting the pull-through from scientific research into VAAC operations. In this regard, MetService of New Zealand has kindly offered to host a conjoint VAAC BP workshop and VASAG meeting in Wellington in November 2018. It is expected that this conjoint meeting will precede a meeting of the ICAO METP WG-MOG (IAVW) in Wellington.

WMO/IUGG Volcanic Ash Scientific Advisory Group

A WMO and International Union of Geophysics and Geodesy (IUGG) Volcanic Ash Scientific Advisory Group (VASAG) was established by the WMO Executive Council in June 2010 and fully supported by the Secretary-General of the IUGG. The terms of reference of the VASAG were last reviewed and updated by the Executive Council in June 2015$^1$.

The objective of the WMO/IUGG VASAG is to provide scientific advice combining expertise in the field of atmospheric sciences and volcanology, to support informed decisions by ICAO and other aviation stakeholders concerned with the volcanic ash hazard to aviation.

Since the CAeM-15 session in July 2014, three VASAG meetings have been held as follows:

(a) 11 and 12 December 2014, San Francisco, CA, United States of America (VASAG/5);
(b) 22 and 23 October 2015, Anchorage, AK, United States of America (VASAG/6); and
(c) 21 to 23 August 2017, Vancouver, WA, United States of America (VASAG/7).

$^1$ The Annex to paragraph 2.26 of the general summary of the EC-67 report (WMO-No. 1158) refers.
The reports of these meetings are available here: [https://www.wmo.int/aemp/Final-Reports](https://www.wmo.int/aemp/Final-Reports)

Each of these meetings has served to provide a single, authoritative source of scientific expertise in the field of volcanic ash affecting civil aviation, with an emphasis both on meteorological (remote sensing and in-situ observations, transport and dispersion modelling) as well as geophysical/volcanological issues such as eruption source parameters, ash characteristics, ash fallout and aggregation. Outcomes of the VASAG have directly fed into the ICAO METP WG-MOG (IAVW) outlined above.

Where practicable and necessary, and to make optimal use of the available resources, the VASAG meetings have been timed to coincide with an International Workshop on Volcanic Ash (IWVA) convened by WMO in coordination with ICAO. For example, the VASAG/6 meeting in October 2015 immediately followed IWVA/7 in Anchorage.

The recent VASAG meetings have addressed the following key issues of relevance to the scientific and technological developments in support of the IAVW (in no particular order):

(a) Advanced numerical modelling techniques of ash dispersal dynamics;
(b) Model inter-comparisons of plume dynamics;
(c) Satellite inter-comparison of volcanic ash cloud and gases and multi-sensor integrated approaches;
(d) The next-generation of geostationary satellites with volcanic ash cloud applications;
(e) Use of probabilistic methods for ash detection;
(f) Hyperspectral infrared measurements to detect high-level dispersed ash;
(g) Multispectral approaches to the retrieval of ash cloud properties;
(h) Automated data assimilation and inverse modelling techniques;
(i) Advancement of a global eruption source parameter database and source term characterization;
(j) Advancement of remote sensing techniques and in-situ observations;
(k) Application of infrasound technologies;
(l) Quantitative volcanic ash information and long-range forecasts;
(m) Aircraft encounters database; and
(n) Aviation colour codes and the volcano observatory notice to aviation (VONA).

A number of the foregoing key issues remain and will continue to remain, ongoing for the foreseeable future as the state of the underpinning science progresses and as technology continues to advance allowing volcanic advisory operations of the VAACs to further improve in line with aviation users’ needs and expectations.

As eluded to above, there will be a conjoint VAAC BP workshop and VASAG meeting in Wellington in November 2018 to address matters of mutual interest.
WMO in coordination with ICAO have periodically convened international workshops on volcanic ash. The workshops serve to bring together around 100 world-leading scientists involved in volcano monitoring and volcanic ash cloud observation and forecasting with a view to advancing science and technology in support of the IAVW.

The most recent workshop (IWVA/7) was convened in Anchorage, AK, United States of America in October 2015. The workshop addressed the improvement of the scientific aspects of the IAVW including:

(a) the understanding and use of ground-based volcanic monitoring;
(b) the detecting, analysing and tracking of volcanic ash clouds; and
(c) the forecasting of volcanic ash cloud dispersion.

The report on IWVA/7 and previous such workshops are available here: https://www.wmo.int/aemp/Final-Reports

The next IWVA is likely to take place in 2019 or 2020.
SPACE WEATHER ISSUES

CAeM/CBS Inter-Programme Team on Space Weather Information, Systems and Services

Decision 33 of EC-68 in 2016 approved a four-year plan for WMO activities related to space weather and requested the CAeM and Commission for Basic Systems (CBS) to establish an Inter-Programme Team on Space Weather Information, Systems and Services (IPT-SWeISS).

IPT-SWeISS is responsible for coordinating space weather activities within WMO programmes, to maintain a linkage with constituent bodies and partner organizations (such as ICAO) and to provide guidance to WMO Members.

Prior to the establishment of IPT-SWeISS, an Inter-Programme Coordination Team on Space Weather (ICTSW) had worked on space weather issues in WMO since 2010, also under the auspices of CBS and CAeM. The achievements of ICTSW illustrated the broad field of activity – including aviation – that could benefit from WMO involvement in space weather, demonstrated the capability of WMO to effectively facilitate a breakthrough in this area, and played a recognized role in the international space weather community.

The main tasks of IPT-SWeISS can be summarized as follows:

(a) Integration of space weather observations;
(b) Standardization and enhancement of space weather data exchange and delivery;
(c) Coordinating the development of space weather best practices for end-products and services;
(d) Encouraging dialogue between research and operational space weather communities;
(e) Organization of capacity building, training and outreach activities; and
(f) Provision of guidance to WMO Members and programmes on space weather matters.

To address the foregoing, at the first meeting of the IPT-SWeISS held from 21 to 23 June 2017 in Geneva, the inter-programme team established the following standing task teams:

(a) Task team on space weather basic systems (TT-SYS);
(b) Task team on space weather science (TT-SCI); and
(c) Task team on space weather applications (TT-APP).

In addition, in recognition of the establishment, by ICAO, of a global framework for an operational space weather information service for aviation in the 2018 timeframe, IPT-SWeISS also established an ad hoc Task Team on Aviation (TT-AVI).
IPT-SWeISS ad hoc Task Team on Aviation

One of the key components in the realization of an operational, global space weather information service for aviation before the end of 2018 was the conducting, by WMO at ICAO’s request, of site assessments and audits of prospective space weather information providers.

Following ICAO consultation with its Contracting States, in October 2017 WMO was officially requested by ICAO to undertake the site assessment and audit of 10 (ten) prospective space weather information providers before the end of March 2018. This figure however later reduced to 9 (nine) in December 2017 due to the withdrawal of one prospective provider.

Between August and December 2017, following its establishment at IPT-SWeISS/1, the main task of TT-AVI was to undertake the development of suitable audit procedures and reporting templates, working methodology and schedule. This activity was undertaken with the assistance of the CBS OPAG-ISS Expert Team on Centre Audit/Certification (ET-CAC) and the WMO Secretariat.

Between August and December 2017, self-assessments submitted by the prospective providers were reviewed by the experts in order to determine the suitability for an audit to proceed.

During November and December 2017, experts from TT-AVI and ET-CAC undertook the site assessment and audit of the 9 (nine) prospective space weather information providers. Each site assessment entailed two experts – one space weather expert from TT-AVI and one audit expert from ET-CAC – and generally lasted two days. The experts conducted one or (maximum) two audits each. Travel and subsistence associated with the site assessments and audits by the WMO audit teams were borne by the receiving State/provider.

Following each site assessment, a post-audit report was completed by the WMO audit team. These post-audit reports outlined the compliance of the prospective providers against a set of (ICAO defined) criteria and formed the basis of a WMO final report which was considered and endorsed at the third meeting of the ICAO Meteorology Panel (METP/3) on 26 and 27 April 2018 in Montreal.

The presidents of CBS and CAeM, as well as the co-chairs of IPT-SWeISS and ET-CAC, were kept informed of the foregoing developments throughout.

Next steps

With the completion of and reporting on the site assessment and audit of prospective space weather information providers, the main task of TT-AVI was completed on schedule. IPT-SWeISS will determine the continuance, or otherwise, of the ad hoc TT-AVI at its next meeting (IPT-SWeISS/2) scheduled for 21 to 23 May 2018 in Tokyo. The IPT-SWeISS/2 meeting will also give consideration to the next iteration of the four-year plan for WMO activities related to space weather to cover the period 2020 to 2023.

The ICAO Annex 3 – "Meteorological Service for International Air Navigation" provisions concerning space weather were adopted by the ICAO Council in March 2018 and will be applicable in November 2018 as part of Amendment 78.

Taking into account, as necessary, the WMO final report on the site assessments and audits of prospective space weather information providers, it is wholly the responsibility of ICAO to determine which prospective space weather information providers will be designated to provide the space weather information service for aviation. ICAO is expected to make this designation later in the third or fourth quarter of 2018, prior to the applicability date of Amendment 78 to Annex 3.
OUTCOMES OF THE 2016-2017 CAeM GLOBAL SURVEY ON AERONAUTICAL METEOROLOGICAL SERVICE PROVISION

Executive summary

Introduction

A global survey of aeronautical meteorological service provision was conducted by the Commission for Aeronautical Meteorology (CAeM) between November 2016 and February 2017.

The primary objective of the survey was to establish a comprehensive, consolidated global view on the existing institutional arrangements for the provision of meteorological services to international air navigation, particularly at a national level, taking into account the supporting ICAO and WMO regulatory frameworks.

More than 90% of WMO Members responded to the CAeM survey. The outcomes of the survey were collated on a global and regional basis and comprised more than 50 questions.

The success of the survey was ensured through excellent collaboration between the CAeM Expert Team on Governance (ET-GOV) and Expert Team on Communication, Coordination and Partnerships (ET-CCP).

MWO, AMO and AMS functions

One of the main focuses of the survey was on the ICAO/WMO service provision functions of meteorological watch office (MWO), aerodrome meteorological office (AMO) and aeronautical meteorological station (AMS).

Globally, there are approximately 230 MWOs and at least 600 AMOs and 1,250 AMSs serving international civil aviation. In addition, aeronautical meteorological services are being provided to approximately 2,500 domestic airports worldwide.

There is a large variety of arrangements and conditions within and between States and Territories, as well as across regions, for the provision of aeronautical meteorological service. The maturity of aeronautical meteorological service providers (AMSP) varies significantly across the WMO Members.

In a majority (approximately 60%) of States and Territories, the MWO, AMO and AMS functions are provided by national meteorological and hydrological services (NMHS). Air traffic services (ATS) organizations are the second largest provider (between 15 and 25%) with 25% performing the MWO function, while military entities, airport authorities and commercial meteorological service providers complete the portfolio of AMSPs. The largest variety of entities providing ICAO/WMO functions is noticed for AMS service provision. In 20% of States and Territories, the AMS service provision is made up of a combination of these entities.

1 The numbers for AMO and AMS do not include the offices and stations of the 18 Members that did not respond.
Twenty-five percent of Members have no responsibility to maintain a continuous meteorological watch over a flight information region and, therefore, do not have an MWO. Of those Members with the responsibility to maintain a continuous meteorological watch over a flight information region (or regions), 64% of Members are responsible for one MWO, and 5% of Members for two MWOs.

In total, over 80% of States and Territories have less than five AMOs. There are three States however with more than fifty AMOs, and in total there are approximately 600 AMOs in place.

While precise data on number of AMOs existing in the past is not readily available, it is considered that the number of AMOs existing today has reduced over the years as more and more AMO functions are performed from a regional or centralized location. In other words, AMO are no longer always physically located at an aerodrome.

Three quarters of Members have between one and five AMSs while 12% have between six and ten AMSs. The remainder varies between 21 and 50 AMSs. It is worthwhile to note that three Members respectively have responsibility for providing 67, 71 and 153 AMSs.

Almost 50% of Members indicated that there are plans to migrate to fully automated aerodrome observations, which is already the case for 3% of Members. Almost 40% of Members indicated that there are no plans to migrate to fully automated aerodrome observations. The differences in this regard between regional associations are significant.

The reasons for not migrating fully to automated aerodrome observations vary significantly between States and Territories and across regions and includes quality issues, lack of funding or negative business cases as well as States and Territories that opt for a hybrid approach.

In a majority (70%) of States and Territories, the meteorological observational data of the AMS is made available free of charge to the NMHS. In 6% of cases a charge is involved for the NMHS and in 5% of States and Territories, the observation data is not being made available to the NMHS at all. Seventeen Members (9%) indicated that there are issues regarding the sharing and provision of the meteorological observation data in their State or Territory.

**Regulatory frameworks**

The ICAO and WMO regulatory provisions are strongly reflected in the national legal/regulatory frameworks of States and Territories. In almost 80% of Members, the MWO, AMO and AMS functions are assigned through a formal designation to service providers.

The notion of ‘meteorological authority’ is not applied uniformly by all responding States and Territories. Many AMSPs no longer perform the role of regulator, which was a common case in the past for many NMHSs serving as AMSPs. In more than 70% of Members functional separation between regulation, service provision and oversight already exists.

Twenty-five percent of Members were of the opinion that the entity providing oversight does not possess adequate expertise in aeronautical meteorology. Several Members identified oversight deficiencies ranging from having no oversight at all to a need for more guidance and assistance.

**Quality management systems (QMS) implementation**

In a majority of States and Territories, the AMSPs have fully (68%) or partially (14%) implemented QMS. This is a significant improvement compared to previous years. However, at the same time, more than 30% of Members face a regulatory risk because of lack of a QMS or only a partially implemented QMS. The main reasons for such non-compliance have been stated as lack of funding and/or human resources, or low priority given by the government.
Of the AMSPs that have fully implemented a QMS, only one in every eight is certified to the ISO 9001:2015 QMS standard. Recognizing a need to transition from ISO 9001:2008 to ISO 9001:2015 by September 2018, and in view of the lack of implementation of QMS in a number of States and Territories, it is concluded that a considerable effort is still required from Members to implement QMS and/or transition to the ISO 9001:2015 standard.

**Competency and qualification of aeronautical meteorological personnel**

WMO introduced standards for competency assessment of aeronautical meteorological personnel (applicable since 1 December 2013) and qualification standards for aeronautical meteorological forecasters (applicable on 1 December 2016). Almost 70% of States and Territories have established a national competency programme for aeronautical meteorological personnel. The frequency of the competency (re)assessment ranges typically between one and five years.

In approximately 50% of States and Territories, the AMSPs fully comply with WMO requirements for the competency assessment for aeronautical meteorological observers and forecasters as well as the qualification standards for aeronautical meteorological forecasters. Thirty percent of Members indicate that this is in progress, 10% have not started and for 10% the situation is not known due to non-response. As such, many Members face a regulatory risk because of non-compliance with the competency assessment and qualification standards.

**Funding mechanisms including cost recovery**

In approximately 40% of States and Territories the aeronautical meteorological service provision is wholly funded by the government budget, and in 20% the service provision is fully funded via cost recovery mechanisms. For 30% of States and Territories, the funding mechanism is made up of combinations of government funding, cost recovery and commercial revenues. Cost recovery for aeronautical meteorological service provision is applied in half of the States and Territories.

Cost allocation and cost recovery for the provision of aeronautical meteorological service is an issue for a number of Members. Best practices are identified as Members having a cost allocation system and a cost recovery mechanism in place. The aeronautical meteorological service provision is fully funded from either government budget or cost recovered via en-route and terminal charges. If required, a fair share of the core infrastructure costs can be allocated to the costs of the aeronautical meteorological service provision via the core cost mechanism.

**Technical capacity/capability**

Almost 90% of MWO AMSPs provide WS SIGMET in combination with or without other SIGMET types or AIRMET. For 11% of Members, this is unknown, or the Members do not have an MWO responsibility, and therefore, do not issue SIGMETs. Regional differences exist as for example some regions do not provide AIRMET, and in other regions, tropical cyclones do not occur and as such WC SIGMETs are not provided. One third of Members conduct cross-border coordination for SIGMET production with MWOs in neighbouring FIRs.

Almost 80% of AMO AMSPs utilize NWP output and nowcasting products (fully or to some extent) in the forecasting process, including warnings, while a minority of approximately 10% of AMSPs do not.

Almost two-thirds of Members conduct forecast verification for either TAF, AIRMET, SIGMET or aerodrome warnings, and based on the response to the survey, this figure is expected to go up to 80% by 2019.
At the time of the survey only around one-third of Members use aircraft based observations from AMDAR, ADS and or SSR Mode S in the aeronautical meteorological forecast production process.

**Challenges in service provision**

New or emerging challenges amongst Members include meeting emerging technological standards such as IWXXM and to fulfil ATM user needs for improved meteorological data and services.

The top 10 priority challenges indicated by Members were: migration to XML, qualification of AMF, QMS implementation/maintenance, maintenance and calibration of observing equipment, automation of aerodrome observation, meeting demands for advanced products and services, cost-recovery implementation, competency assessment, SIGMET quality, and advanced MET information and services for terminal area.

Several Members identified other challenges such as competition from other providers (private sector, commercial providers or regionalization) on aeronautical meteorological service provision. Especially in Europe, there is the challenge to comply with the cost reduction targets of the Single European Sky, and at the same time comply with regulations and to contribute to increased safety and capacity by improving meteorological services for air traffic management.

**Survey report**

A full, detailed final report on the outcomes of the 2016-2017 CAeM Global Survey on Aeronautical Meteorological Service Provision was prepared by the CAeM Expert Team on Governance (ET-GOV) and published by WMO in November 2017 as AeM SERIES No. 1 (English only).

**Follow-up/Next steps**

The above-mentioned final report on the outcomes of the global survey together with the strategic outcomes of a special dialogue on the future of aeronautical meteorological services (EC 69, Geneva, 2017) provide a comprehensive global and regional landscape of aeronautical meteorological service provision in 2017.

Based on these outcomes, WMO (in collaboration with ICAO) should continue to assist Members in addressing aeronautical meteorological service provision deficiencies, monitor compliance with QMS, competency and qualification standards on an ongoing basis, and continue to provide guidance and capacity development support to those Members most in need of assistance.

The outcomes of the global survey will be considered by EC-70 (June 2018) with a view to establishing appropriate and necessary next steps in line with the foregoing.

Executive summary

A WMO Aeronautical Meteorology Scientific Conference of 2017 (AeroMetSci-2017) was held at the Centre International de Conférences de Météo-France in Toulouse, France from 6 to 10 November 2017. The conference was attended by more than 200 participants represented by all six WMO Regions.

The conference involved the Commission for Aeronautical Meteorology (CAeM), Commission for Atmospheric Sciences (CAS) and Commission for Basic Systems (CBS) and was in response to Decision 44 (EC-68).

The objective of the conference was to provide a forum for representatives of the scientific research community (including research institutes, universities and other academia), aeronautical meteorological service providers (public and private sector), aviation users and industry to discuss the need for and strategic direction of meteorological scientific and technological advancement in support of current and future air transport needs. This was the first such international conference convened by WMO dedicated to aeronautical meteorology science and technology since March 1968.

The conference provided an overview on the current state-of-the-art and the foreseen advances in meteorological science and technology, and the expectations for faster transfer of these advances into operations in the form of fit-for-purpose services for aviation end-users. The conference was a blend of keynote presentations, oral and poster technical presentations and panel discussions addressing the following leading topics:

(a) **Science underpinning meteorological observations, forecasts, advisories and warnings** comprising ice crystal icing and airframe icing research, turbulence research, significant convection research, wake vortex detection and prediction research, fog and low visibility research, space weather research, atmospheric aerosols and volcanic ash research as well as advances in observing methods and the use of observations, seamless nowcast and numerical weather prediction, probabilistic forecast and statistical methods;

(b) **Integration, use cases, fitness for purpose and service delivery** comprising in-cockpit and on-board meteorological capabilities, terminal area and impact-based forecast, collaborative decision-making, air traffic flow management, network management, trajectory-based operations, flight planning and user-preferred routing;

(c) **Impacts of climate change and variability on aviation operations and associated science requirements** comprising jet stream position, intensity and related phenomena, extreme weather events at airports and changes to established scenarios, and the re-evaluation of airframe/avionics resilience standards and certification.

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1 The proceedings of the WMO Scientific and Technical Conference on Aeronautical Meteorology of March 1968, London, United Kingdom are published as WMO-No. 227 (available here).
At the conclusion of the Conference, a set of recommendations and a statement were formulated to better inform the planning of meteorological scientific research activities over the next 15 years consistent with aviation users’ needs and expectations.

Conference programme

The conference programme was arranged as follows:

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<td>Re-evaluation of airframe/avionics resilience standards and certification</td>
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Recommendations and statement

The conference formulated the following recommendations and statement:

**Recommendation 1**

In the context of science underpinning aeronautical meteorological (MET) observations, forecasts, advisories and warnings, the conference *recommended* that:

(a) Research activities demand improved access to data, especially aircraft-based observations to support validation, verification and calibration as part of a continuous improvement drive;

(b) Research efforts should be conducted in collaboration with users to ensure their needs are addressed;

(c) The transition from research to operations following validation should be accelerated and well communicated;

(d) Conveying uncertainty is required to inform risk management, but remains a challenge that needs further research and guidance; and

(e) MET hazards and their impacts on aviation should be more clearly defined and articulated.

**Recommendation 2**

In the context of integration, use cases, fitness for purpose and service delivery, the conference *recommended* that:

(a) Close collaboration within and across MET and air traffic management (ATM) communities should be actively encouraged as a prerequisite of impact assessment and an enabler to future global interoperability and harmonization;

(b) Establishing ATM users’ requirements should be a prerequisite for tailored, fit-for-purpose MET solutions;

(c) MET information must be translatable into ATM impacts to enable full integration in the strategic planning, pre-tactical and tactical decision-making phases;

(d) Probabilistic methodologies with proper verification and calibration should be applied to better convey to users where and to what extent inherent forecast uncertainties exist;

(e) Blending MET parameters through ensemble approaches that yield a higher quality, more usable forecast should be further pursued but with an acknowledgement of the potential masking of extremes;

(f) Machine-learning such as artificial intelligence could be pursued to optimize MET support to ATM in the era of ‘Big Data’;

(g) Design of systems for delivering harmonized MET information to pilots and other stakeholders should further consider the need for standardization and collaborative decision-making (CDM);

(h) An increasingly automated ATM operating environment will require supporting MET educational programmes for end-users; and

(i) The research-to-operations process for prioritized MET products and services reaching maturity should be expedited.
**Recommendation 3**

In the context of climate change and variability on aviation and associated science requirements, the conference *recommended* that:

(a) The potential impacts of climate change and variability on aviation operations on the ground and in the air downscaled to the local level must be well researched and communicated;

(b) The mitigation of extreme weather events and the adaptation to a changing climate demands a multidisciplinary effort involving both the physical and the social sciences. Furthermore, all stakeholders in meteorology and aviation must work together, including through WMO and ICAO, to build consensus on robust, sustainable global solutions;

(c) Responding to climate variability will require a high degree of flexibility on the aviation users’ side. While the incidence of high-impact extreme weather events are expected to increase, they will be infrequent relative to the norm. The foreseen continued growth of aviation worldwide in a changing climate scenario may present new challenges as demand for airspace capacity increases;

(d) Improved availability of and access to high-quality in-situ observations of meteorological parameters, including water vapour, is a key enabler to improving climate prediction model capabilities. The preservation of such data is essential for validating and calibrating climate predictions; and

(e) A changing climate scenario may render some of today’s aerodrome, airspace and airframe design and operation standards inadequate in the years or decades to come. Using past climatological records alone as an indicator of future climate at an airport, say, may be insufficient given the (current) rate at which the world’s climate is changing (warming).

**Statement**

The conference *stated* that:

(a) There is a tremendous amount of ongoing cross-disciplinary research in the field of aeronautical meteorology (MET). This collaborative scientific excellence should be leveraged to enable the future global air traffic management (ATM) system;

(b) The role of MET as a key enabler to aviation’s vision for a globally interoperable, harmonized ATM system of the future that is safer, more efficient and more environmentally responsible will only be realized through the accelerated transition of scientific research and technological advancement into operations based on aviation users’ needs, new and improved community partnerships, trust, transparency and openness; and

(c) As the potential impacts of climate change and variability on aviation operations become better understood, the research community should continue to advance relevant science and communicate in a style that is well understood by the user.
Conference proceedings, website and satisfaction survey

Proceedings of the conference, in the form of a WMO publication, are available as AeM SERIES No. 2. The conference proceedings include the addresses given during the opening of the conference, the summaries of panel discussions, the recommendations and statement of the conference, copies of all the keynote presentations, technical oral presentations and technical poster presentations and other relevant information.

In addition, the WMO Aeronautical Meteorology Programme (AeMP) website (available here) provides all materials associated with the conference.

Immediately following the conference, the 200+ participants were consulted via an online survey to gather their feedback on the planning and preparation, conducting and scope of the conference, together this suggestions for future such events. The satisfaction survey yielded a response rate of more than 50%. Overall, the feedback was overwhelmingly positive. The results of the satisfaction survey are available here. More than 90% of respondents indicated that if WMO were to conduct a similar conference in the future they would recommend this conference to others. And, more than 90% of respondents indicated that a similar conference should be conducted by WMO within five years (not later than 2022). On a scale of 1 to 5 (where 1 is poor and 5 is excellent), respondents gave the conference a weighted average score of 4 (very good).

Follow-up/Next steps

The outcomes of the conference will be considered by EC-70 (June 2018) with a view to establishing appropriate and necessary next steps in line with the above-mentioned recommendations and statement.
WORLD WEATHER WATCH

WMO Integrated Observing System (WIGOS) including Aircraft Meteorological Data Relay (AMDAR) and other instruments and methods of observation

**AMDAR**

In late 2016, the International Air Transport Association (IATA) secretariat approached WMO to inform that, at the behest of its member airlines, it had undertaken a study on the operation of the WMO Aircraft Meteorological Data Relay (AMDAR) programme and had made the following recommendations:

(a) IATA to work with WMO to expand the AMDAR programme across the globe and establish a more equitable cost-recovery mechanism for the participating airlines; and

(b) IATA to set up a global turbulence database with real-time data transmission to airlines during flight operations.

During an initial meeting between representatives of the secretariats of WMO and IATA, held in Geneva, Switzerland on 12 December 2016, it was agreed that there appeared to be significant advantages and mutual benefits, to their respective members, if a formal collaboration on the future operation of the AMDAR programme were to be established.

Based on further collaboration with IATA and discussion and consideration of the matter by the Management Groups of the Commission for Basic Systems (CBS) and Commission for Instruments and Methods of Observation (CIMO) as well as the CBS Expert Team on Aircraft-Based Observing Systems (ET-ABO), a Decision 60 (EC-69) was formulated to establish a Working Arrangement between IATA and WMO on the Operation of the AMDAR Programme. Under the Working Arrangement the two organizations would work together to develop the terms of reference and concept of operations, based on which a future collaboration on AMDAR might be defined and later approved by a subsequent decision of the Executive Council and Congress. The Working Arrangement was formally established in July 2017. Since then, the ET-ABO has been working with IATA to develop the Concept of Operations for the IATA-WMO Collaborative AMDAR Programme, for which an initial draft was developed in December 2017 and considered by Regional Association VI (Europe) at its Seventeenth Session (RA VI-17, February 2018).

**Key Aspects of the IATA-WMO Collaboration on AMDAR Impacting RA VI (Europe)**

Under the Concept of Operations for the IATA-WMO Collaborative AMDAR Programme (IWCAP) the following are the key aspects:

(a) Each Regional Association (RA) would be responsible for establishing and maintaining regional requirements for AMDAR observations, primarily based on national member requirements and resourcing to pay for observations and support for the programme operation;
(b) IATA and WMO would develop a cost framework for supporting the operation and development of IWCAP to meet national and regional requirements for observations;

(c) IATA and WMO would jointly manage funds to support the IWCAP and reimburse airline partners for the costs of the programme development and provision of observations on the WMO Information System (WIS); and

(d) RAs would operate and maintain Regional Data Processing Centres and support planning activities and data and quality management operations through the establishment of regional working groups.

Given the successful operation of the EUMETNET/E-AMDAR programme on a regional collaborative basis, Decision 3.2(5)/1 (RA VI-17) was formulated in which RA VI endorsed the developing IATA-WMO Collaboration on AMDAR and decided that, subject to IATA and WMO entering into a formal collaboration on AMDAR based on a decision by Cg-18 in 2019, RA VI will compile its requirements for AMDAR observations by July 2018, with a view to beginning development of the WMO Region VI AMDAR Programme under the IATA-WMO Collaboration in January 2019 and potentially beginning operation of the programme in January 2020.

The Executive Council was requested by CBS to consider the decision to re-establish the Task Team on the IATA-WMO Collaboration on AMDAR under EC to be responsible for the finalization of the proposed Concept of Operations, the proposed Terms of Reference of the collaboration, and the draft Implementation Plan for Establishment of the IATA-WMO Collaborative AMDAR Programme, potentially beginning operation in January 2020.

**RRR and SoG-Aero**

A Rolling Review of Requirements (RRR) process, initiated by WMO in the early 2000s and progressing under the auspices of CBS, is addressing a number of WMO application areas, including aeronautical meteorology, with a view to compiling a consistent set of observational user requirements agreed to by a community of experts working operationally in each application area. The RRR process accommodates an OSCAR tool (including observing system requirements, space-based and surface-based observing system capabilities), a gap analysis between requirements and capabilities as well as impact studies, and statements of guidance (SoGs) for each application area. The RRR process is feeding an Implementation Plan for the Evolution of the Global Observing System (IP-EGOS) – responding to the vision of the GOS in 2025 – as well as the vision for the observing system components of the WMO Integrated Global Observing System (WIGOS) in 2040.

In respect of aeronautical meteorology, through a CBS Inter-Programme Expert Team on Observing System Design and Evolution (IPET-OSDE), a Point of Contact (Mr Jitze van der Meulen) has been coordinating with CAeM/Management Group in respect of reviewing and updating the Statement of Guidance for Aeronautical Meteorology (SoG-Aero). The latest SoG-Aero (together with SoGs for the other application areas) is available at: http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html#SoG

**Instruments and methods of observation**

At the November 2016 and January 2018 meetings of the CAeM Management Group, there was an acknowledgement of a need for improved coordination and collaboration between CAeM and the Commission for Instruments and Methods of Observation (CIMO) in the context of meteorological observations supporting international air navigation. For example, guidance on meteorological observations at aerodromes and (increasingly) in the terminal area could be improved or developed, including in the context of automated observing systems, and that there needs to be a way to direct periodic aviation-specific enquiries on instruments and

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1 Observing Systems Capability Analysis and Review tool.
methods of observation to persons with the necessary level of expertise to respond. The CAeM-MG-2016 acknowledged that addressing these issues should form part of the CAeM's future priorities.

Global Telecommunications System (GTS), WMO Information System (WIS) and interoperability with ICAO SWIM

CBS has continued to support the development and implementation of the IWXXM (ICAO Meteorological Information Exchange Model) as a data format for reporting aeronautical meteorological information in XML/GML2. Information on the standard and its development are available at https://wis.wmo.int/page=TT-AvXML and the technical maintenance of the code can be accessed at https://github.com/wmo-im/iwxxm. WMO Executive Council at its seventieth session (EC-70) in June 2018, will consider a CBS recommendation to include the maintenance of IWXMM under WMO fast-track process, thus facilitating its operational support.

Following the endorsement of a strategy for the future development of WIS - Resolution 8 (EC-69) – WMO has been moving forward with the design and implementation of the next generation of WIS. WIS 2.0 will be a collaborative system of systems using Web-architecture and open standards to provide simple, timely and seamless sharing of trusted weather, water and climate data and information through services.

WMO Inter-commission Task Team on WIS (ITT-WIS), that included representation by CAeM, noted that in parallel with the development of WIS 2.0, ICAO is developing its system-wide information management (SWIM) environment that will include meteorological information as one component. The two systems will be provided with information by NMHS and there will be a requirement for them to be compatible and for information to flow between the two systems. ITT-WIS recommended that the WIS 2.0 implementation plan should include a register of partner systems, such as SWIM, with which WIS 2.0 must interact closely.

Data management and data representation, including the ICAO meteorological information exchange model (IWXXM)

In preparation for the SWIM environment and at the request of ICAO, for the past several years WMO has been developing the IWXXM referenced above. The IWXXM is the data model chosen for representing aeronautical meteorological information in SWIM and the technical specifications of IWXXM are included in the WMO Manual on Codes (WMO-No. 306), Volume I.3, Part D – Representation Derived from Data Models. The agreed format for the operational exchange of information in the SWIM environment, including meteorological information, is XML/GML.

Traditional WMO data representations for aeronautical meteorological information such as GRIB and BUFR (used for WAFS upper-air and significant weather forecasts respectively) and traditional alphanumeric code forms such as METAR and TAF are expected to be phased out over time as the new, contemporary, non-proprietary data representations become the primary (and eventually only) required format. However, the traditional data representations will continue in the foreseeable future in parallel with the contemporary data representations during the transition from old to new.

Following on from previous releases, Release 2.1.1 of IWXXM was approved for use from May 2018. This release has enabled Members to produce reports that are compliant with Amendment 77 to ICAO Annex 3/WMO-No. 49, Technical Regulations, Volume II (applicable November 2016) and has overcome identified problems with the validation of a small number of messages experienced by some users of IWXXM 2.1.0

2 eXtensible Markup Language (XML)/Geography Markup Language (GML)
Amendment 78 to ICAO Annex 3/WMO-No. 49, Volume II (applicable November 2018) requires an update to IWXXM to support the introduction of space weather advisory information. This will be implemented through a new major release, IWXXM 3.0, that is (at time of writing) under development by the WMO CBS Task Team on Aviation XML (TT-AvXML) and expected to be approved by May 2019 through the CBS fast-track amendment procedure. In addition to the new functionality to support the issuance of the space weather advisory information, the structure of IWXXM will be modified in order to reduce the complexity of the meteorological messages/reports. The XML encoding for IWXXM 3.x will be significantly restructured compared to the XML encoding for IWXXM 2.x. The structure will be simplified and the dependence on ISO 19156 (Geographic information – Observations and measurements) will be removed. XML parsing components of software written to read IWXXM 2.1.1 XML messages will have to be rewritten to obtain comparable information from IWXXM 3.x messages. The two encodings will be incompatible.

Release IWXXM 3.0 and previous releases are designed to implement the content rules of meteorological messages/reports expressed in ICAO Annex 3/WMO-No. 49, Volume II. At the May 2018 meeting of TT-AvXML it was agreed that the frequency of major updates to IWXXM should be reduced. Unless Amendment 79 to Annex 3 (applicable November 2020) introduces changes to the OPMET information that requires changes to IWXXM, these components will remain unchanged between IWXXM 3.0 and 3.1. TT-AvXML will attempt to introduce new components to IWXXM resulting from ICAO Annex 3/WMO-No. 49, Volume II amendments in a way that increases flexibility without altering the encoding of existing components. This will reduce the risk of future releases needing to be major releases that break backwards compatibility. Although software updates will still be needed to ensure IT security and compatibility with the operating environment, the frequency of updates to the software needed to adapt to changes in IWXXM will be reduced. This should enable updates to software reading and writing IWXXM reports to be incremental, adding new functionality to existing capabilities as required.

**Global data-processing forecasting system (GDPFS)**

The GDPFS Programme is evolving through the realization of Resolution 11 of the Seventeenth session of the World Meteorological Congress (Cg-17) of June 2015. Resolution 11 (Cg-17) called for the gradual move to integrated and Seamless Data-Processing and Forecasting System. A Steering Group has been established to guide its implementation. Significant progress has been made in the development of the Implementation Plan following the Sixty-ninth Session of the WMO Executive Council (EC-69) in 2017 which requested that an implementation plan be tabled for consideration by the seventieth Executive Council (EC-70) in June 2018; Draft plan was discussed at the CBS Management Group (CBS-MG), following discussion at CBS TECO in March 2018. CBS-MG recommended that the final IP be discussed by Cg-18 after obtaining guidance from EC-70 on the draft plan.

Through Resolution 6 (Cg-XVI), Congress agreed that the revised Manual on the Global Data-processing and Forecasting System (WMO-No. 485) is the single source of technical regulations for all operational data-processing and forecasting systems operated by WMO Members, including its designated centres.

Also through Resolution 18 (EC-69), EC approved the publication of the revised Manual on the GDPFS (WMO-No. 485) including the addition of new types of centres. The Manual was effectively published on 16 February 2018.

In support of transition arrangements, in particular, that existing Regional Specialized Meteorological Centres (RSMCs) once they mapped themselves onto new types of centres "will retain their status until the eighteenth session of the World Meteorological Congress (Cg-18), in 2019; and to retain status after Cg-18, they need to demonstrate compliance by Cg-18", it is planned to audit the centres for full compliance in advance of Cg-18, following the procedures that will be developed by the ICT-DPFS Task Team (TT) on audit.
Note: At EC-69, five additional World Meteorological Centres (WMCs) were designated bringing the total number to eight. Designation of DWD Centre in Offenbach as a WMC has been recommended to EC-70 (June 2018) for approval. The list of all currently designated centres can be found in Part III of the Manual on GDPFS (see above link).

The new Manual on GDPFS offers the opportunity to designate new types of Centres, in particular, the following which are closely related to aviation: Offenbach (Germany) and Tokyo (Japan) were designated as RSMC for Nowcasting. Designation of Hong Kong (China) as RSMC for Nowcasting has been recommended to EC-70 (June 2018) for approval.

**Emergency response activities**

Environmental emergencies can be caused by a broad range of events with various temporal and spatial scales involving the release of hazardous substances into the environment. Emergencies response activities addressed under the auspices of the CBS are no-longer just limited to nuclear emergencies but are now extended to include non-nuclear emergencies as well. As per the 2017 update to the Manual on the Global Data-processing and Forecasting System, Annex IV to the WMO Technical Regulations (WMO-No. 485), the scope of non-nuclear emergency response activities includes:

(a) Smoke from large fires;

(b) Volcanic eruptions (excluding those service arrangements covered by the volcano watch services for international air navigation); and

(c) Large chemical releases.

Designation criteria for Regional Specialized Meteorological Centres (RSMCs) conducting non-nuclear emergency response was developed by an Expert Team on Emergency Response Activities (ET-ERA) and integrated in the new Manual on the GDPFS.

Applications from Germany (Offenbach) as RSMC for nuclear Emergency Response Activities (ERA) (currently only backtracking) and the applications from France and Germany for designation of their centres (Toulouse and Offenbach) as RSMCs for non-nuclear ERA were reviewed by ET-ERA and have been recommended to EC-70 (June 2018) for designation.
GLOBAL ATMOSPHERE WATCH

Volcanic ash and other related aerosols

Volcanic aerosol is a specific kind of the atmospheric particles that are important for aviation safety and climate modelling.

Volcanic eruptions past and present (e.g. Eyjafjallajökull, 2010) have demonstrated a need for better knowledge of volcanic ash dispersion in the atmosphere to ensure safety and efficiency of air traffic operations, both in the air and on the ground. Timely notification of the extent and movement of volcanic ash in atmosphere are components of the critical information that aviation users demand.

The success in implementation of Paris Agreement on climate change depends, to certain extent, on improved knowledge of the climate system. Estimates of aerosol impacts on climate are largely uncertain. Volcanic aerosol is one of the sources of sulphur in the upper troposphere and may have a cooling effect on climate that needs quantification.

Current activities of the WMO Global Atmosphere Watch (GAW) Programme are focusing on recent advances in monitoring and modelling volcanic ash and other related aerosols.

Other potentially hazardous aerosols impacting aviation include sand and dust storms in desert and arid regions. Observations and forecasting of dust storms, for example, is the focus of the WMO Sand and Dust Storm - Warning Advisory and Assessment System (SDS-WAS), a joint project of GAW and the World Weather Research Programme (WWRP).

The GAW Programme and SDS-WAS Project collaborate closely on volcanic and desert dust aerosols with the International Civil Aviation Organization (ICAO), the International Union of Geodesy and Geophysics (IUGG) and other partners, exploring ongoing progress on Lidar instruments, the GALION alerting system, a new initiative on inter-comparison of volcanic ash forecasting products, and other support to the International Airways Volcano Watch (IAVW).

Use of LIDAR (light detection and ranging) techniques for volcanic aerosol observations

Ground-based LIDAR techniques represent a powerful method for monitoring the dispersion of a volcanic cloud in the atmosphere. Lidar instruments use ultraviolet, visible or near-infrared light to image aerosols. They can be used at different locations: close to the source for monitoring mainly the volcanic plume height, or a long distance away to provide data on the atmospheric dispersion of the volcanic cloud. Lidar observations can be much more powerful if coordinated across monitoring networks. Lidar monitoring networks are fundamental to study aerosols on a large spatial scale including the processes of their transport and transformation. Coordinated lidar ground-based observations are valuable when integrated with satellite data to show the evolution of the event over space and time.

Nowadays, there are different lidar techniques for the investigation of aerosol properties spanning from the simplest elastic backscatter lidar, to complex and advanced lidars such as the multi-wavelength Raman lidar and High Spectral Resolution Lidar (HSRL). All of them are suitable for monitoring the spatial and temporal distribution of volcanic-emitted particles up to the upper troposphere / lower stratosphere region. They can characterize these particles from a dynamical, and in some cases microphysical, point of view.
GALION observations of volcanic particles

One of the objectives of the GAW Programme is to study the four-dimensional (space and time) distribution of aerosols. The mission of the GAW Atmospheric LIdar Observation Network (GALION) is to organize the observational capability for the four-dimensional distribution of key aerosol parameters on a global scale (GAW Report No. 178, WMO TD-No. 1443).

GALION provides the vertical component of this distribution through advanced laser remote sensing from a network of globally distributed ground-based stations. GALION is a federated network of existing regional lidar networks that contribute data to GAW. Because explosive volcanic eruptions are sudden and unforecastable events that can affect the upper troposphere and lower stratosphere region at the global scale, an alerting system has been set up for this kind of events within GALION.

Inter-comparison of satellite-based volcanic ash products

High-quality, quantitative volcanic ash-cloud products are needed to meet the evolving needs of users, especially those in aviation. Quantitative satellite remote sensing of volcanic ash clouds has evolved significantly over the last decade with the advent of new sensors and techniques. Models that forecast the dispersion and transport of volcanic ash clouds have also evolved – and satellite products have been shown to improve forecasts.

In order to document the state of satellite-based volcanic ash cloud retrieval science and improve international coordination on research and operational activities related to satellite remote sensing of volcanic ash, a product ‘inter-comparison initiative’ has been created by the IUGG and WMO. The inter-comparison activity was subsequently formalized through the creation of a pilot project under the WMO Sustained, Coordinated Processing of Environmental Satellite Data for Nowcasting (SCOPE-Nowcasting) initiative.

The goal of the WMO SCOPE-Nowcasting initiative, which is led by the WMO Space Programme, is to demonstrate continuous and sustained provision of consistent, well-characterized satellite products for nowcasting and severe-weather risk reduction. The first phase of the SCOPE-Nowcasting, which was completed in 2015, aimed to document the strengths and limitations of satellite algorithms that detect and characterize volcanic ash clouds. The primary objective of the second phase of the inter-comparison activity, which will be completed in 2018, is to better characterize and understand product differences.

GAW products and services

Society can and is impacted by long-term and short-term changes to atmospheric composition. Volcanic ash and gas emissions are a great example of where there are both immediate impacts (for example on aviation) and longer-term impacts (including climate forcing). In recognition of this, the GAW Programme identified the need for increased support for the development and expanded use of services and research activities concerning the forecasting of atmospheric composition. As part of this activity the GAW Scientific Advisory Group (SAG) on Modelling Applications (SAG-APPs) was established in 2016.

The main objective of the SAG-APPs is to further develop a portfolio of modelling products and services related to atmospheric composition and, more specifically, to demonstrate the usefulness of exchanging chemical observational data in near-real-time in support of monitoring and forecasting applications, such as that for volcanic eruptions which are key areas of interest and challenge.

To this end the SAG-APPs is coordinating with existing groups, such as the WMO-IUGG Volcanic Ash Scientific Advisory Group (VASAG) on volcanic forecasting to identify possible demonstration projects and knowledge exchange opportunities. Information on the ongoing activities of the WMO-IUGG VASAG is provided in CAeM-16/INF. 3(6).
Aviation Research Demonstration Project (AvRDP)

On August 2012, in a joint meeting of two working groups (i.e. Nowcasting Research and Mesoscale Weather Forecasting Research) of WMO World Weather Research Programme (WWRP) proposed to set up an Aviation Research and Development Project (AvRDP). The AvRDP aimed to demonstrate the capability of nowcasting and mesoscale modelling techniques in support of the development of the next generation aviation initiative, aviation system block upgrades (ASBU) under the Global Aviation Navigation Plan (GANP) endorsed by ICAO in 2013.

In the ASBU roadmap, aeronautical meteorological services are required to provide enhanced services to be implemented over the next 15 years and beyond. A key concept in the ASBU roadmap is trajectory-based operations (TBO) which will seamlessly integrate high-resolution, rapidly-updated observation, nowcast and forecast information along the entire flight trajectory, from take-off, ascending, en-route, descent and landing phases, into the air traffic management (ATM) system.

The meteorological elements covered in TBO includes, amongst others, convection and thunderstorms, ceiling and visibility, wind, wind shear, upper-air and low-level turbulence, inflight icing, winter weather, surface icing and airframe icing, tropical cyclones, wake vortex, volcanic ash, radiative cloud and space weather. AvRDP is providing a more thorough assessment of the above-mentioned meteorological capabilities at selected airports with different climatology and air transport density. AvRDP aims to further demonstrate the benefits of enhanced end-to-end nowcasting services for the terminal area focused on high impact weather services to the aviation community in support of the ASBU initiative.

The AvRDP was endorsed at the Seventh Session of WWRP Scientific Steering Committee (SSC) (November 2014) and a kick-off meeting of the project was held in Shanghai, China (June 2015) to discuss and finalize the project’s implementation plan. Phase I of the project commenced in mid-2015 with five airports participating namely: Charles de Gaulle (CDG), Hong Kong Airport (HKG), Johannesburg (JNB), Shanghai (SHA) and Toronto Pearson (YYZ). Canada’s Iqaluit Airport (YFB) joined the project during its Second Intensive Observing Period for winter weather (November 2016-March 2017). The implementation of Phase I (2015-2017) focused on nowcasting research covered 0- to 6-hour nowcasts, MET products verification and a training workshop. Phase II (2016-2018) activities concentrated on MET-ATM translation and validation.

Encouraged by the continuing success of the AvRDP, the WMO Executive Council at its 68th Session in 2016 (EC-68) endorsed the upgrade of AvRDP to a WMO Inter-Commission Aviation Research Project which expanded the project’s scope. EC-68 requested the presidents of WMO Commission for Atmospheric Sciences (CAS), Commission for Aeronautical Meteorology (CAeM) and Commission for Basic Systems (CBS) to prepare a coordinated roadmap for the project in support of future operational solutions for ATM. It also endorsed the organization of the WMO Aeronautical Meteorology Scientific Conference (AeroMetSci-2017) (Toulouse, November 2017) which provided an overview of the current state-of-the-art and foreseen advances in meteorological science and technology needed to underpin the changing global aviation industry, in line with the ICAO GANP and its ASBU methodology. The event also identified aviation research needs and plan the research focus of the above-mentioned project.
At the third meeting of the AvRDP (Toulouse, November 2017) three more airports joined the project, namely: Pulkovo (LED), Singapore (SIN) and New Delhi (DEL). Plans are underway to organize a training workshop in 2018 which will focus on MET-ATM integration. The projects’ SSC has scheduled a telecon in mid-August 2018 to discuss preparation of the roadmap for the Inter-Commission Aviation Research Project to be presented at the 18th WMO Congress in 2019.


A report on the outcomes of the 2017 WMO Aeronautical Meteorology Scientific Conference (AeroMetSci-2017) held from 6 to 10 November 2017 in Toulouse, France is provided in [CAeM-16/INF. 3(9)](#). The conference was a cross-commission effort undertaken by the CAeM, CAS and CBS.

**Other research developments of relevance to aviation**

Three WWRP core projects could significantly contribute to aviation:

(a) The Polar Prediction Project is working on improving knowledge and predictive tools in remote regions such as Polar Regions which is of interest to several new and established flight routing;

(b) The High-Impact Weather Project is focusing on a set of hazards which have strong impacts, especially for landing and take-off; and

(c) The Sub-seasonal to seasonal project is targeting monthly prediction which could play a relevant role in planning flights weeks ahead.
OTHER WMO PROGRAMMES

Tropical cyclone developments of relevance to aviation

SIGMET information is issued by Meteorological Watch Offices (MWO) about the occurrence or expected occurrence of specified en route phenomena which may affect the safety of aircraft operations. SIGMETs are of highest priority among other types of meteorological information provided to aviation users, supporting pre-flight planning and in-flight re-planning. Provisions concerning the issuance and dissemination of SIGMET information are contained in ICAO Annex 3 to the Convention on International Civil Aviation, *Meteorological Service for International Air Navigation* which is reproduced by WMO as Technical Regulations (WMO-No. 49), Volume II. Specialized tropical cyclone advisory information is required to support MWOs in the preparation of SIGMET information related to tropical cyclones.

To encourage implementation, there was a recommendation in Africa, for example, for establishing an agreement at the national level for coordination between civil aviation and meteorological authorities, which would be communicated by joint letters signed by both secretary generals of WMO and ICAO:

“... The main purpose of Meteorological Watch Offices (MWOs) is to issue SIGMETs including Tropical Cyclone SIGMETs which are based on information received from TCAC, La Réunion. It was noted, however, that some MWOs do not have AFTN terminals. Such MWOs are therefore not able to perform their duties effectively included participating in the annual AFI SIGMET Tests. Consequently, the meeting recommends improved coordination between NMHS and associated Civil Aviation authorities to enhance service delivery. This should include ICAO sending mails directly to aeronautical meteorological service providers on matters that require direct attention of the provider and copied to the concerned civil aviation authority."

Within the aforementioned ICAO and WMO provisions, tropical cyclone advisory centres (TCACs) are designated to provide tropical cyclone advisories to MWOs, the world area forecast centres (WAFCs) and international OPMET data banks (e.g. Pretoria and Dakar). Close coordination has been established between the MWO and its responsible TCAC. The ICAO Meteorology Divisional Meeting in 2002 formulated Recommendation 1/12(b), *Implementation of SIGMET requirements*, which call, *inter alia*, for the relevant (ICAO) planning and implementation regional groups (PIRGs) to conduct periodic tests of the issuance and reception of SIGMET messages, in order to maintain the international tropical cyclone watch system as being ‘ready-for-action’.

The various tropical cyclone RSMCs/TCWCs\(^1\) have progressed toward producing text and graphical products to the designated TCACs. Given different relationships and differing capabilities between these centres across the WMO Regions, the pace of implementation has varied. At the minimum, all centres are producing text-based tropical cyclone advisory information for the TCAC and a number of the centres are producing graphically-based products as well. The recently emerging requirement for TCAC products in the XML/GML formats has been noted.

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\(^1\) Regional specialized meteorological centres (RSMCs) and tropical cyclone warning centres (TCWCs)
It has been recommended by WMO Tropical Cyclone Meetings (TCM) that the Tropical Cyclone Programme of WMO (TCP) should coordinate, through the relevant WMO technical commission, to work with ICAO to ensure that the aeronautical users’ requirements for tropical cyclone information is discussed among the WMO Permanent Representatives of the TCACs/RSMCs/TCWCs to ensure regional coordination and that the implementation plans meet ICAO’s regulatory requirements. Additionally, in order to improve coordination, ICAO representation should be offered at the various WMO Regional Association tropical cyclone meetings.

**Education and training developments of relevance to aviation**

**Competency and qualification**

The WMO competency standards for aeronautical meteorological observers (AMO) and aeronautical meteorological forecasters (AMF) were the first WMO competency framework to be approved in 2013 and included in WMO-No. 49, *Technical Regulations*, Volume I, *General Standards and Recommended Practices*. Since then, four additional frameworks have been implemented by WMO, with several additional frameworks under development. This has prompted the publication of the *WMO Guide to Competency* (WMO-No. 1205) in early 2018. This Guide covers competency assessment practices, competency documentation, and competency-based training. In addition, it discusses the process of developing or adapting a competency framework. Experts of the CAeM Expert Team on Education, Training and Competency were instrumental in the development of this Guide.

The qualification requirement that an AMF has successfully completed the relevant parts of the Basic Instruction Package for Meteorologists (BIP-M) was introduced by WMO as a recommended practice in 2013 and elevated to a Standard in 2016. ([WMO-No. 49, Technical Regulations, Volume I, General Meteorological Standards and Recommended Practices, Part V, Personnel providing aeronautical meteorological services, section 1.2.1.1 refers.](https://www.wmo.int/pages/technical-regulations/no-49/))


In support of the need for education and training institutions to demonstrate compliance of their curriculum to the BIP-M and the BIP-MT (Basic Instruction Package for Meteorological Technicians), the WMO Education and Training (ETR) Office has made available a BIP-M and BIP-MT Compliance Mapping tool via URL: [https://training.wmo.int](https://training.wmo.int). This tool aids institutions in mapping the learning outcomes of its curriculum to that of the BIP-M or BIP-MT, considering which courses address them, and how they are assessed.

The WMO ETR Office will be requesting that EC-70 (June 2018) approve a review plan for the BIP-M and BIP-MT to consider any needs for updating based on scientific advances and changing roles of operational weather forecasters and changing service delivery requirements. If approved, the review would begin later in 2018.

**WMO Global Campus**

The WMO Global Campus initiative has implemented a new global, searchable calendar of events at URL: [https://learningevents.wmo.int](https://learningevents.wmo.int). It is recommended that all training providers register an account to enable them to submit their events as an additional way to promote their activities. In addition, the initiative is in the process of developing a searchable learning resources library to become a part of the existing WMO e-Library at [https://library.wmo.int](https://library.wmo.int). All aeronautical meteorology training resources can be made more accessible to Members through this too. Additional goals of the initiative include investigating competency-based training certificate systems and developing a database of experts.
Additional priorities of the WMO ETR Office include promotion of management training for National Meteorological and Hydrological Services (NMHSs) to remain effective in a complex and rapidly changing environment. The goals will include integrating management development into the activities of WMO Regional Training Centres (RTCs) and other training institutions to meet needs of developing NMHSs, development of management training curricula and resources and promotion of management related activities.

Additionally, the WMO ETR Office will aid the development of a volunteers’ programme, as well as promote the creation of new learning resources for all priority areas, supporting effective training delivery, introducing up-to-date science into curricula, and increasing collaboration with universities and the private sector.
COOPERATION WITH THE INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

This information paper provides an overview of the latest developments in respect of the cooperation between WMO and the International Civil Aviation Organization (ICAO) in the provision of meteorological service for international air navigation.

Developments since the ICAO Meteorology Divisional Meeting of July 2014 held conjointly with the WMO CAeM-15 session

The ICAO Meteorology Divisional Meeting (MET/14) was held from 7 to 18 July 2014 in Montreal, Canada. The meeting was held conjointly with the fifteenth session of the WMO Commission for Aeronautical Meteorology (CAeM-15). The report of MET/14 was published by ICAO as Doc 10045. The MET/14 formulated 29 recommendations which were subsequently endorsed by the ICAO Council. Many of the MET/14 recommendations were to be undertaken by ICAO in close coordination with WMO.

One month after MET/14 (August 2014), ICAO undertook a restructuring of its Air Navigation Bureau (ANB) resulting in the dissolution of the Meteorology (MET) Section. The MET Section was, at the time, a direct conduit with the AEM Division of WMO. As a result of the restructuring, the responsibility for handling MET issues within the ICAO secretariat transferred to a (new) Airport Operations and Interoperability (AOI) Section1.

Six months after METP/14 (January 2015), ICAO undertook a restructuring of its Air Navigation Commission (ANC) panels resulting in the dissolution of all existing MET operations groups, study groups and other groups2 and the establishment of a new Meteorology Panel (METP). The tasks to be undertaken by METP concerned the maintenance and development of the provisions governing meteorological service for international air navigation and, in particular, to advance selected recommendations of MET/14.

The METP held its first meeting (METP/1) in Montreal, Canada, from 20 to 24 April 2015. The meeting elected a chair and vice-chair, established a working structure in the form of a METP management group (MG), working groups (WG) and associated WG rapporteurs. METP/1 also formulated tasking corresponding to METP job cards with clear deliverables and deadlines. The current working structure of METP comprises five working groups (see below).

Since its establishment, the METP has so far convened on three occasions – METP/1 held from 20 to 24 April 2015, METP/2 held from 17 to 21 October 2016 and METP/3 held from 26 and 27 April 2018. The fourth meeting of the METP (METP/4) is scheduled to take place from 10 to 14 September 2018. To progress work during the intersessional periods, the METP MG and WGs have convened on multiple occasions, with the latest suite of meetings taking place in May 2018.

1 Later renamed Airport Operations and Infrastructure (AOI) Section.
2 World Area Forecast System Operations group (WAFSOPSG), International Airways Volcano Watch Operations Group (IAVWOPSG), Satellite Distribution System Operations Group (SADISOPSG), Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG), Meteorological Warnings Study Group (METWSG) and the Meteorological Aeronautical Requirements and Information Exchange Project Team (MARIE-PT).
An additional development since the METP/14 has been a change to the frequency of amendments to ICAO Annex 3 – *Meteorological Service to International Air Navigation* provisions which has had a direct impact on the frequency of amendments to WMO-No. 49, *Technical Regulations*, Volume II. Specifically, Annex 3 has moved from a 3-year amendment cycle to a 2-year amendment cycle. This transition first occurred with the publication of the 19th Edition of Annex 3 in July 2016 (comprising Amendment 77). The 20th Edition of Annex 3 will be published in July 2018 (comprising Amendment 78) and it is anticipated that future editions/amendments will occur in 2020, 2022 and so on. ICAO has transitioned to a 2-year amendment cycle for all Annexes to the Convention on International Civil Aviation which pertain to international air navigation and aviation safety. The ICAO Council, at its discretion, may adjust this amendment cycle, particularly where there may be need to amend ICAO provisions to address an urgent safety concern resulting in an ‘off-cycle’ amendment.

**ICAO Meteorology Panel and its working groups**

As indicated above, the ICAO Meteorology Panel (METP) has established five working groups (WG). The WGs are as follows together with a high-level outline of their existing work streams:

<table>
<thead>
<tr>
<th>METP Working Group</th>
<th>Existing work streams (as at April 2018)</th>
</tr>
</thead>
</table>
| Working Group on Meteorological Requirements and Integration (WG-MRI) | • MET for ATM requirements  
• GANP update  
• PANS-MET development  |
| Working Group on Meteorological Information and Service Development (WG-MISD) | • Release of radioactive material  
• Regional hazardous weather advisory centre concept  
• Space weather  
• Volcanic sulphur dioxide  |
| Working Group on Meteorological Information Exchange (WG-MIE) | • IWXXM requirements  
• MET-SWIM Plan and Roadmap  
• IWXXM documentation  
• Support and coordination related to the foregoing  |
| Working Group on Meteorological Operations Groups (WG-MOG) | • Secure aviation data information system (SADIS) and WAFS internet file service (WIFS)  
• World area forecast system (WAFS)  
• International airways volcano watch (IAVW)  |
| Working Group on Meteorological Cost Recovery Guidance and Governance (WG-MCRGG) | • White Paper on aviation meteorology information delivery in 2030  
• Other issues relating to the cost recovery and governance of meteorological service for international air navigation, including the notion of ‘meteorological authority’  |

WMO is represented in the METP and each of its working groups by the secretariat in an expert capacity. When necessary, the WMO secretariat is assisted by members of CAeM expert teams or other WMO groups.

A number of existing members of the CAeM expert teams and other WMO groups are also, in an ICAO capacity, members (or advisors to members) of the METP and its working groups nominated by their State.

There will be a need to ensure WMO sustains its contribution to the activities of the ICAO METP and its working groups during the next intersessional period.
ICAO Committee on Aviation Environmental Protection

As alluded to in the report of the CAeM Expert Team on Aviation, Science and Climate (ET-ASC) (see CAeM-16/INF. 3(1)), during the intersessional period WMO/CAeM experts have contributed to the activities of the ICAO Committee on Aviation Environmental Protection (CAEP), in particular in connection with the development of a draft White Paper contribution for the CAEP Steering Committee in 2016, as well as a contribution to a CAEP yearbook. Presentations to a CAEP Scientific Conference held in Washington DC, United States, in 2015 were also provided.

There will be a need to ensure a continuation of engagement between WMO and the ICAO CAEP and its working groups during the next intersessional period.

(Re)Introduction of a PANS-MET

As indicated in the foregoing, the ICAO METP WG-MRI is undertaking the development of a Procedures for Air Navigation Services – Meteorology (PANS-MET). This is linked to Recommendation 5/2 of MET/14 and, subsequently, to Job Card METP.005.01 of the METP.

The (re)introduction, by ICAO, of a PANS-MET in the 2020 to 2022 timeframe\(^3\) will result in a major reorganization of the Annex 3 provisions. Much of the content of Part II – Appendices and Attachments will be transferred to the PANS-MET (with associated amendments to prevailing provisions) while Part I – Core SARPs will be amended to accommodate the replacement of references to Part II by the PANS-MET.

At the present time, WMO-No. 49, Technical Regulations, Volume II is effectively a duplicate of ICAO Annex 3. ICAO Annex 3 addresses Contracting States while WMO-No. 49, Volume II addresses Members. But, apart from this, the two publications are essentially identical in respect of Parts I and II content.

It is worthwhile to note here that WMO-No. 49, Volume II currently contains two further parts beyond the foregoing – namely Part III addressing aeronautical climatology and Part IV addressing the format and preparation of flight documentation.

The reorganization of the ICAO Annex 3 provisions and the introduction of a PANS-MET will have significant ramifications on WMO-No. 49, Technical Regulations, Volume II as well as all associated WMO (and ICAO) guidance material.

Working arrangements between ICAO and WMO

WMO and ICAO have had formal working arrangements dating back to the 1950s. The working arrangements – ICAO Doc 7475 and WMO-No. 60, Chapter 2 refer – were last updated in 1963. In response to Recommendation 4/1 of MET/14, the ICAO and WMO Secretariat are in the process of reviewing and updating the working arrangements.

The update to the working arrangements will likely represent a major revision in structure but only minor changes in the overall intent of the working arrangements. For instance, the fundamental premise that ICAO is the entity responsible for establishing the aeronautical requirement for meteorological service for international air navigation and WMO is the entity responsible for establishing the technical methods and practices to fulfil the aeronautical requirement will be retained.

\(^3\) A PANS-MET existed until the mid-1970s when Annex 3 was completely revised (and retitled) to incorporate the PANS-MET specifications and became Annex 3 – Meteorological Service for International Air Navigation, Parts I and II that has existed through to today.
The update to the working arrangements is expected to pave the way for greater efficiency and effectiveness of the two Organizations in the field of aeronautical meteorology, potentially manifesting in the form, where necessary, of joint technical bodies/working structures, joint publications and joint capacity building activities beyond any such arrangements that exist today.

**Bilateral meeting between ICAO and WMO secretary generals**

On 28 April 2017, Dr Fang Liu, ICAO Secretary General and Professor Petteri Taalas, WMO Secretary-General convened a short bilateral meeting at WMO headquarters in Geneva, Switzerland. The bilateral meeting was an opportunity for the heads of each organization to discuss matters of common interest, particularly in the context of strengthening cooperation in the field of aeronautical meteorology.

More information on the outcomes of the bilateral meeting is available here. A joint circular letter on the occasion of the bilateral meeting is available here: English, French, Spanish, Russian and Arabic.
COOPERATION WITH OTHER INTERNATIONAL ORGANIZATIONS WITH WHOM WMO HAS AGREEMENTS OR WORKING ARRANGEMENTS

Cooperation with the International Air Transport Association (IATA)

Since the CAeM-15 session in July 2014, WMO primary engagement with the International Air Transport Association (IATA) has been through the respective membership of the ICAO Meteorology Panel (METP)\(^1\). IATA representatives have also attended several of the WMO VAAC Best Practice workshops and the 7th WMO International Workshop on Volcanic Ash (IWVA/7 held in 2015)\(^2\) as well as the 2015 RA VI European Conference on Meteorology for Aviation (ECMA-2015) and the 2017 WMO Aeronautical Meteorology Scientific Conference (AeroMetSci-2017)\(^3\). In addition, there have been several other areas where WMO and IATA cooperation during the intersession period has taken place as follows:

**IATA and WMO collaboration on aircraft-based observations**

On 7 July 2017, Professor Petteri Taalas, Secretary-General of WMO and Alexandre de Juniac, Director General of IATA held talks concerning the establishment of a new working arrangement between the two organizations on the operation and further development of the Aircraft Meteorological Data Relay (AMDR) system. AMDAR is a critical component of the WMO Integrated Global Observing System (WIGOS), utilizing on-board aircraft sensors, computers and communication systems to collect, process and transmit meteorological data to ground stations via satellite or radio links for quality control and assimilation into numerical weather prediction models and other applications.

Further information on the IATA-WMO collaboration on AMDAR is provided in CAeM-16/INF. 4(1).

**IATA Flight Operations Support Task Force (FOSTF)**

The IATA Flight Operations Support Task Force (FOSTF) convenes typically once or twice per year, offering airline representatives (IATA Members), air navigation service providers and others concerned the opportunity to discuss a range of aeronautical meteorology-specific matters, particularly those being addressed by the ICAO METP, in order to help IATA formulate position statements for METP and other groups. WMO is represented in the FOSTF by the WMO Secretariat and has attended several meetings over the intersessional period.

**IATA Accident Classification Technical Group (ACTG)**

The IATA Accident Classification Technical Group (ACTG) convenes typically once or twice per year and is tasked with reviewing and analysing aviation accidents, identifying contributing factors, determining trends and areas of concern relating to operational safety, and developing prevention strategies. Safety reports issued by IATA on an annual basis\(^4\) demonstrate that meteorology/weather conditions continue to be a significant threat and factor in aviation incidents and accidents, on the ground and in the air – for example, runway excursions, loss of

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1. The activities of the ICAO METP and its working groups are outlined in CAeM-16/INF. 5(1).
2. The WMO VAAC Best Practice workshops are outlined in CAeM-16/INF. 3(6).
3. The 2017 WMO Aeronautical Meteorology Scientific Conference is outlined in CAeM-16/INF. 3(9).
control in-flight (LOC-I) and controlled flight into terrain (CFIT). Improved WMO dialogue with IATA in this context is intended to better quantify these threats and factors with a view to seeking opportunities to further improve aeronautical meteorological service provision and, of course, aviation’s safety performance. WMO is represented in the ACTG by the WMO Secretariat and expects to attend future meetings.

**Cooperation with the International Federation of Airline Pilots’ Associations (IFALPA)**

Similar to the foregoing remarks concerning IATA, WMO primary engagement with the International Federation of Airline Pilots’ Associations (IFALPA) has been through the respective membership of the ICAO METP. IFALPA representatives have also attended several of the WMO VAAC Best Practice workshops, the 2015 RA VI European Conference on Meteorology for Aviation (ECMA-2015) and the AeroMetSci-2017 conference referenced above. In addition, IFALPA representatives have provided advice to regional SIGMET coordination activities such as the Pilot Project on SIGMET Coordination in Southeast Asia in 2016/17.

**Cooperation with the Agency for Air Safety in Africa and Madagascar (ASECNA)**

During the intersessional period, WMO primary engagement with the Agency for Air Safety in Africa and Madagascar (ASECNA) has been in the context of the convening of an African Conference on Aeronautical Meteorology (ACMA). The call for such a regional event arose from Resolution 2 of RA I-16 (held in Praia, Cabo Verde in February 2015) concerning the future development of meteorological service provision to civil aviation in RA I (Africa).

Initially, an ACMA event organized by WMO in collaboration with ASECNA was scheduled to take place in Libreville, Gabon in November 2016. However, owing to circumstances beyond the control of the host country and supporting organizations, the event was postponed at short notice. At the time of writing, the WMO Offices for Africa and Least Developed Countries (AFLDC) continues to work with RA I Members and ASECNA to determine a suitable hosting venue and timing of a rescheduled ACMA event.

**Cooperation with the International Union of Geophysics and Geodesy (IUGG)**

Through a WMO/IUGG Volcanic Ash Scientific Advisory Group (VASAG), WMO and the IUGG continue to cooperate in respect of volcanic eruptions and volcanic ash and gases in the atmosphere that may impact international air navigation. The VASAG was established in the aftermath of the volcanic eruptions in Iceland in 2010. An overview of the recent and ongoing activities of the VASAG is provided in CAeM-16/INF. 3(6).

**Cooperation with the International Atomic Energy Agency (IAEA)**

WMO and the IAEA continue to cooperate in respect of the release of radioactive material into the atmosphere that may impact international civil aviation. This interaction is primarily through a WMO CBS Expert Team on Emergency Response Activities (ET-ETA) and WMO involvement (along with the International Civil Aviation Organization (ICAO) and other concerned stakeholders) in an IAEA Interagency Committee on Radiological and Nuclear Emergencies (IACRNE).

WMO cooperation with IAEA has supported discussions within the ICAO Meteorology Panel Working Group on Meteorological Information and Service Development (WG-MISD) addressing the release of radioactive material (RRM) work stream – including SIGMET for radioactive clouds – and has also supported the development of a 2017 update to the IAEA Emergency Preparedness and Response Joint Radiation Plan of the International Organizations (EPR-JPLAN).
WMO STRATEGIC PLAN AND OPERATING PLAN (2020-2023)

References

A. EC-70/Doc. 16.2(1) – WMO Strategic Plan 2020-2023
B. EC-70/Doc. 16.2(2) – Draft Budget 2020-2023
C. EC-70/INF. 16.2(3) – Draft Operating Plan 2020-2023

Background

The WMO strategic planning process for the next WMO financial period (2020 to 2023) and beyond is based on and comprises three interlinked key components, namely:

(1) The WMO Strategic Plan, which provides a high-level vision and overarching priorities of the future direction of WMO, articulated in long-term goals and strategic objectives with focused implementation areas for the financial period 2020–2023 and related monitoring indicators,

(2) The WMO Operating Plan, which presents outcomes in the form of benefits to Members, outputs, activities and related performance indicators to address the global societal needs and achieve the strategic objectives,

(3) The WMO Results-based Budget, which identifies resources for implementing the Strategic Plan, including functioning of constituent bodies, the Secretariat and activities.

During the next WMO financial period, the activities of the Commission for Aeronautical Meteorology (CAeM) (or its successor) should be aligned with the Strategic Plan, Operating Plan and Results-based Budget.

WMO Strategic Plan

The WMO Strategic Plan provides a high-level vision and overarching priorities of the future direction of WMO. The Plan (see illustration at Figure 1) sets out long-term goals for 2030 horizon and strategic objectives focused on addressing the most pressing developments and needs during the 2020-2023 planning cycle of the Organization. The Plan articulates expected outcomes expressing clear benefits to Members. As these goals and objectives are translated into detailed plans, resources will be focused in accordance with three overarching priorities:

(1) Enhancing preparedness and reducing losses of life and property from hydrometeorological extremes;

(2) Supporting climate-smart decision making to build resilience and adaptation to climate risk;

(3) Enhancing socioeconomic value of weather, climate, hydrological and related environmental services.
In fulfilling its mandate, WMO recognizes that, above all, the principles of striving to ensure that “no Member State or Territory should be left behind” and to sustain the public trust and confidence in the science underpinnings and the authoritative voice of the Organization and its Members. As WMO works to translate its vision into results, the Organization will be guided by the following values:

1. Accountability for results and transparency,
2. Collaboration and partnership, and
3. Inclusiveness and diversity.

**Aeronautical meteorological service delivery in the WMO Strategic Plan 2020-2023**

The activities to be undertaken by WMO through the aeronautical meteorology programme are captured under Long-Term Goal 1 (LTG-1) - Better serve societal needs: delivering authoritative, accessible, user-oriented and fit-for-purpose information and services. More specifically, aeronautical meteorology is captured under Strategic Objective 1.4 (SO 1.4) within LTG-1 - Enhance the value and innovate the provision of decision-supporting weather information and services.

SO 1.4 encompasses weather-informed decision-making for all modes of transport (aviation, marine, land), energy, agriculture, health, tourism, urban and other sectors will be raised to new levels, resulting in substantial productivity gains and positive environmental impacts.
Service delivery approaches will be innovated to build Members’ capacity to provide modern, fit for purpose and high quality services.

The focus of SO 1.4 in the 2020-2023 timeframe includes:

- Enhance and increase weather services by uptake of modern technology in service delivery and quality management principles.
- Design and implement new weather and water prediction services for the specific needs of megacities and other urban areas.
- Provide NMHSs with further guidance and assistance in the assessment and enhancement of socioeconomic benefits of their services.
- Establish principles and guidance for successful public-private engagement, and facilitate a continuous dialogue between players and stakeholders based on collaboration and mutual reinforcement.
- Develop and adopt international standards, quality control mechanisms and recommended practices in a holistic manner for all service areas based on best national practices.

The WMO Strategic Plan and the outcomes of the CAeM-16 session will more clearly define the specific aeronautical meteorology tasks to be undertaken aligned with these objectives, as part of the WMO Operating Plan (see next).

**WMO Operating Plan**

The WMO Operating Plan presents outcomes in the form of benefits to Members, outputs, activities and related performance indicators to address the global societal needs and achieve the strategic objectives. The Operating Plan is based upon the sixteen Strategic Objectives (SOs) defined in the Strategic Plan.

The Operating Plan entails a cascading flow of elements as follows:
An illustration of the WMO Operating Plan 2020-2023 is given in Figure 2 below.

**Figure 2. Illustration of the WMO Operating Plan 2020-2023**

With respect to performance indicators, the number of Members with QMS, socioeconomic benefit analyses, cooperation between NMHSs and private/academic actors, use of web applications and social media in service delivery will be monitored.

Within SO 1.4, outputs and milestones have been developed. Some of these outputs and milestones are common to all service delivery elements and some specific to aviation. Those applicable to all service delivery elements include increased compliance with technical regulations, monitoring against the WMO Strategy for Service Delivery, WMO Competency Frameworks, Quality Management Framework, and enhanced awareness of the benefits of meteorological services on key application and/or user segments.

Noting that the Commission (or its successor) will progress work in the context of the following priority themes during the eighteenth financial period (2020-2023) (See CAeM-16/Doc. 8):

1. Education, training and competency of aeronautical meteorological personnel (AMP),
2. Aeronautical meteorological information service development and governance,
3. Aeronautical meteorological hazards prediction,
4. Impacts of climate change and variability on aviation, and
5. Communication and outreach,

the milestones and outputs specific to aeronautical meteorological services for the WMO Operating Plan 2020-2023 will be strengthened and finalized in advance of Congress in 2019 and it is envisaged that the following ongoing activities will also be sustained:

- Updated WMO technical regulations, manuals, guides and publications addressing aeronautical meteorology.
• Strengthened cooperation, coordination and collaboration with ICAO and other relevant aviation stakeholders in the establishment and maintenance of standards in meteorological service for international air navigation.

• Organization of regional awareness events on the impact of the ICAO Global Air Navigation Plan (GANP) and its Aviation System Block Upgrade (ASBU) methodology on aeronautical meteorological service provision.

**WMO Results-based Budget**

The WMO Strategic Plan will guide the decisions and activities of WMO in helping to realize its 2030 vision, and will serve as the focus for the upcoming financial period 2020–2023, bringing the greatest benefits to Members. The Strategic Plan takes into account strategic, operational, financial, compliance and reputational risks for the Organization and its Members as outlined in key drivers.

The integrated WMO Operating Plan 2020-2023 presents time-bound programme activities and projects, result-oriented budgets and success. The Operating Plan forms the basis for resource allocation, and defines the risks and performance matrices against which to assess progress to achieve expected outcomes through the WMO Monitoring and Evaluation System.

Accordingly, the WMO Results-based Budget is a necessary, integral component of the strategic planning process of the Organization.
1. Background and Rationale

The sixteenth of the Commission for Aeronautical Meteorology (CAeM-16) will be hosted by the United Kingdom, at the University of Exeter from 24 to 27 July 2018. It will be preceded by a Technical Conference (TECO) on 23 July 2018 at the same venue.

The 2018 TECO will chart the course of aeronautical meteorology, from its beginnings at the dawn of manned flight to the wide range of regulated and non-regulated (commercial) products and services provided today to the increasingly data-rich, service-oriented architecture of the future and what this all means for the aeronautical meteorological community going forward.


2. Objective and Theme

The objective of the Conference will be to raise the awareness of the TECO delegates to several critical issues that are likely to impact on the aeronautical meteorological community over the coming years and how WMO would address those issues in partnership with ICAO and other relevant stakeholders. TECO delegates will be encouraged to participate actively in the debates aimed to help inform subsequent discussions and decisions at the CAeM-16 Session.

The theme of the Conference is:

"The future is now: Meteorology enabling aviation decision support"

3. Expected Outcome and Outputs

The expected outcome of the Conference will be an enhanced awareness of current and foreseen challenges and opportunities relating to meteorological service for international air navigation and an increased understanding between the meteorological service provider and aviation user communities resulting from the highly interactive, participative and collaborative format of the TECO.

The direct output of the Conference will be a summary report highlighting key messages and recommendations for consideration by the CAeM-16 Session that immediately follows.
4. **Stakeholders and Partners**

The Conference will harness partnerships that already exist at a national, regional and global level within the meteorology and aviation communities, including both public and private enterprise, and will help foster new partnerships.

The Conference is expected to attract the following stakeholders and partners:

(a) National Meteorological and Hydrological Services (NMHS) of WMO Members, in particular those providing meteorological service for international air navigation;

(b) Other designated aeronautical meteorological service providers,

(c) Participants from the private sector engaged in the provision of value added meteorological services to aviation;

(d) Representatives of international organizations such as ICAO, IATA and IFALPA; and

(e) Other aviation industry users and stakeholders.

5. **Format and Responsibility**

The Conference will comprise a blend of keynote and other oral presentations, panel discussions including interactive question/answer sessions with audience participation, and wrap-up summaries.

The following aspects of the Conference are planned:

(a) *Historical context* – providing an outline of how far aeronautical meteorology has come over past years/decades, where it is ‘today’ and where it is foreseen to need to be ‘tomorrow’, including the anticipated role of WMO and CAeM;

(b) *Users’ perspective* – ensuring that users’ current and foreseen capabilities, needs and expectations are conveyed to the aeronautical meteorology community, thereby encouraging researcher-provider-user awareness and alignment going forwards;

(c) *Innovation showcase* – providing an outlet for public and private enterprise to showcase existing and emerging use-cases in aeronautical meteorology, thereby helping inform the community of what is already possible and what may be possible in the future; and

(d) *Action-oriented recommendations* – identifying the needs and priorities of WMO Members and the industry, expressed by TECO delegates to optimize input to the follow-on CAeM-16 Session.

An organizing committee chaired by the president of the CAeM, compromising (as a minimum) members of the CAeM Management Group and a rapporteur, will assist WMO in the preparation, conduct and follow-up of the Conference. This assistance will include the development of the conference programme, list of speakers and a report to CAeM-16.

6. **Provisional Programme**

The provisional programme of the Conference is available via the following URL:

http://meetings.wmo.int/CAeM-16/SitePages/TECO.aspx
7. Organizing Committee Composition

The organizing committee (OC) of the Conference comprises the following experts*:

<table>
<thead>
<tr>
<th>OC chairperson:</th>
<th>Chi-Ming SHUN (President of CAeM)</th>
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<tbody>
<tr>
<td>OC co-leads:</td>
<td>Kent JOHNSON (ET-GOV co-chair)</td>
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<td>Matt STRAHAN (ET-ASC co-chair)</td>
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<tr>
<td>OC members:</td>
<td>Ian LISK (Vice-President of CAeM)</td>
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<td></td>
<td>Herbert PUEMPEL (ET-ASC co-chair)</td>
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<td></td>
<td>Gaborekwe KHAMBULE (ET-CCP co-chair)</td>
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<td></td>
<td>Marina PETROVA (ET-CCP co-chair)</td>
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<tr>
<td></td>
<td>Chris WEBSTER (ET-ETC co-chair)</td>
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<tr>
<td></td>
<td>Kathy-Ann CAESAR (ET-ETC co-chair)</td>
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<td></td>
<td>Jan SONDIJ (ET-GOV co-chair)</td>
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<td></td>
<td>Stéphanie DESBIOS (ET-ISA co-chair)</td>
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<td></td>
<td>Jun RYUZAKI (ET-ISA co-chair)</td>
</tr>
<tr>
<td>WMO secretariat:</td>
<td>Greg BROCK (Acting Chief, AEM Division)</td>
</tr>
<tr>
<td></td>
<td>Dimitar IVANOV (Executive Assistant to the Secretary-General)</td>
</tr>
</tbody>
</table>

* Other experts will be invited to participate in the OC as necessary.
LONG-TERM PLAN FOR THE AERONAUTICAL METEOROLOGY PROGRAMME (LTP-AeMP) (2019-2033)

References

1) Abridged final report with resolutions of the seventeenth World Meteorological Congress (Cg-17), 25 May to 12 June 2015, Geneva, Switzerland (WMO-No. 1157).

2) Abridged final report with resolutions and decisions of the sixty-eighth session of the Executive Council (EC-68), 15 to 24 June 2016, Geneva, Switzerland (WMO-No. 1168).

3) Abridged final report with resolutions and decisions of the sixty-ninth session of the Executive Council (EC-69), 10 to 17 May 2017, Geneva, Switzerland (WMO-No. 1196).


5) ICAO Global Air Traffic Management Operational Concept (GATMOC) (ICAO Doc 9854).


Background

Resolution 3 (Cg-17) – Aeronautical Meteorology Programme, requested, inter alia, the Secretary-General to apply, in coordination with the president of the Commission for Aeronautical Meteorology, a longer-term planning approach to the Aeronautical Meteorology Programme consistent with the International Civil Aviation Organization (ICAO) Global Air Navigation Plan (GANP) and its Aviation System Block Upgrades (ASBU) methodology and timeline (2013-2028), with special consideration on building capacity of subregions and Members with long-standing deficiencies in their service provision to civil aviation.

Further, Resolution 66 (Cg-17) – WMO support to evolving aeronautical meteorological services, was a recognition that future developments at a global, regional and national level should be fully aligned with the ICAO GANP and its ASBU methodology.

Decision 43 (EC-68) – Action Plan – meteorological services for aviation, requested, inter alia, the development of a draft long-term plan for the WMO Aeronautical Meteorology Programme (LTP-AeMP) aligned with the ICAO GANP and its ASBU methodology for consideration by the Executive Council at its sixty-ninth session (2017).

Decision 42 (EC-69) – Future of Aeronautical Meteorological Services, noted, inter alia, the development of a draft LTP-AeMP as contained in EC-69/INF. 6.2(2).

The draft LTP-AeMP noted by EC-69 essentially proposed a methodology for step-wise performance improvements to the observing and forecasting of microscale, toposcale, mesoscale, large-scale and planetary scale meteorological phenomena over the coming 15 years and beyond in support of aviation operations at the aerodrome, in the terminal area and in en-route airspace (see figures below).
Typical aviation operations performed and their interest area
(Source: Figure 3 of EC-69/INF. 6.2(2))

Illustration of the temporal and spatial relationship between meteorological phenomena and aviation interest area
(Source: Figure 4 of EC-69/INF. 6.2(2))
Similar to the modular approach applied within the GANP/ASBUs, the foundation of the draft LTP-AeMP was centred on several (four) performance improvement areas (viz. microscale, toposcale, mesoscale, large-scale and planetary scale), several (four) blocks of time (Block 0 to Block 3), and multiple modules (dependent or independent) which could, as and where necessary, readily be mapped to corresponding modules within the GANP (see sample below).

More refined structure for AeMP long-term plan
(Source: Figure 5 of EC-69/INF. 6.2(2))

At the CAeM Management Group meeting in January 2018 (CAeM-MG-2018), the MG considered how to handle the development of the LTP-AeMP in the context of WMO strategic and operating plans (SP and OP) as well as the evolution of ICAO GANP and its ASBU methodology. The MG was also mindful of the outcomes of the EC-69 Special Dialogue on the Future of Aeronautical Meteorological Services and the 2017 WMO Aeronautical Meteorology Scientific Conference (AeroMetSci-2017).

The MG was of the view that much effort was still required before a LTP-AeMP would be sufficiently mature for consideration by CAeM, Executive Council and/or Congress in the 2018 to 2019 timeframe. Moreover, the MG questioned whether the draft LTP-AeMP structure submitted to EC-69, which had taken inspiration from the ICAO GANP/ASBU, might be too extensive for CAeM/AeMP purposes. The MG proposed a re-evaluation of the entire proposed structure of the LTP as well as a strategy that would ensure its maintenance owing to the fact that the LTP would be a ‘living document’, under constant review and periodic update. In addition, the MG recognized that the WMO SP and OP for 2020-2023 as well as a foreseen major update to the ICAO GANP (2019-2033), both of which were (at the time) a ‘work in progress’, would be significant influencing factors on the scope and content of the LTP-AeMP for the 2019 to 2033 period. The MG also remarked that the LTP-AeMP should not only address prospective advances in meteorological science over the coming 15 years and beyond but also technological advances which will also drive aeronautical meteorological service provision.
As a consequence, CAeM-MG-2018 requested the preparation of a ‘straw man’ and a strategy for the development and maintenance of the LTP-AeMP for 2019 to 2033. The MG recognized that the LTP-AeMP should (would) be a consideration of the CAeM-16 session.

Straw man

The following straw man is intended to present a simplified draft proposed structure for the LTP-AeMP in order to stimulate discussion which will ultimately lead to a new and improved proposal (or proposals). Under each main heading, a brief illustration of the content is provided in italics to aid understanding [and approximate number of pages in square parenthesis].

Welcome

Introductory remark from the WMO Secretary-General. [1 page]

Foreword

Introductory remark from the president of the Commission for Aeronautical Meteorology. [1 page]

Executive Summary

A concise summary to allow readers to become quickly acquainted with the content of the long-term plan with the key messages for Members. [2 pages]

The Aeronautical Meteorology Programme

An overview of the objective of the programme, the maintenance and management of the programme and the stakeholders involved, activities undertaken within the programme or contributing to the programme, and the benefits to be derived from developing and maintaining a long-term plan for the programme. [2 pages]

Drivers for change and the vision for the 2030s

An exploration of the key global issues and trends driving change within the aviation and meteorology sectors and the vision for aeronautical meteorological service provision in the 2030s. [4 pages]

Anticipating and responding to aviation users’ needs and expectations for enhanced meteorological service provision through scientific and technological advancement

A review of aviation users’ existing and foreseen needs and expectations for meteorological service consistent with ICAO Global Air Navigation Plan (GANP) and its Aviation System Block Upgrade (ASBU) methodology, and an assessment of the existing and foreseen scientific and technological advances in meteorological services considered necessary or desirable to fulfil the aeronautical requirements. Linkage here with the WMO strategic plan and activities undertaken by other WMO programmes or initiatives of relevance to the AeMP. [4 pages]

Performance improvement: The long-term plan for the AeMP

The identification of performance improvement areas to be addressed in aeronautical meteorological service provision in the near-, medium- and longer-term (5-, 10-, 15-year time horizon respectively).
Each performance improvement area identified will illustrate the opportunity envisaged and/or the challenge faced, the benefits to be derived from making positive progress (including cost-benefit), and the key enablers and international coordination required to be in place. The performance improvement areas will lead to the formulation of action plans and the identification of deliverables considered necessary or desirable to deliver the expected outcome(s). [4 pages per performance improvement area]

Guidance for Members

A review of existing and planned new/updated WMO guidance material and other relevant resources and information to support Members in developing their own long-term plan in aeronautical meteorological service provision. Concluding remarks with key messages for Members will also be provided. [4 pages]

Appendices

Appendices may be used to provide additional information of relevance to the long-term plan.

Strategy

Table 1 below provides a strategy for the establishment of the LTP-AeMP (2019-2033) while Table 2 below provides a strategy for the ongoing maintenance of the LTP-AeMP once established.

Note: Tables 1 and 2 below assume the current (2018) structure of WMO constituent bodies. Reference to a ‘task team’ is for illustration only.

Table 1. Strategy for the establishment of the LTP-AeMP (2019-2033)

<table>
<thead>
<tr>
<th>What</th>
<th>When</th>
<th>Who</th>
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<tbody>
<tr>
<td>Review of straw man and strategy</td>
<td>July 2018</td>
<td>CAeM-16</td>
</tr>
<tr>
<td>Establishment of task team (or similar)</td>
<td>September 2018</td>
<td>CAeM Management Group</td>
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<tr>
<td>Commencement of task team activities</td>
<td>October 2018</td>
<td>Task team</td>
</tr>
<tr>
<td>including development of first draft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(first edition, 2019-2033)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review of first draft (first edition)</td>
<td>December 2018</td>
<td>CAeM Management Group</td>
</tr>
<tr>
<td>Development of final draft (first edition)</td>
<td>Early January 2019</td>
<td>Task team</td>
</tr>
<tr>
<td>Review of final draft (first edition)</td>
<td>Late January 2019</td>
<td>CAeM Management Group</td>
</tr>
<tr>
<td>Submission of final draft (first edition)</td>
<td>February 2019</td>
<td>Secretariat</td>
</tr>
<tr>
<td>to Congress for endorsement</td>
<td></td>
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<tr>
<td>Endorsement of final draft (first edition)</td>
<td>May 2019</td>
<td>Congress (Cg-18)</td>
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<tr>
<td>Adjustments, if required, to final draft</td>
<td>Q3 2019</td>
<td>Task team in consultation</td>
</tr>
<tr>
<td>(first edition) based on outcomes of</td>
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<td>with CAeM Management Group</td>
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<td>Congress</td>
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<tr>
<td>Publication of first edition including</td>
<td>Q4 2019</td>
<td>Secretariat</td>
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<tr>
<td>online version and communicate to all</td>
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<td></td>
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<tr>
<td>Members</td>
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Table 2. Strategy for the ongoing maintenance of the LTP-AeMP

<table>
<thead>
<tr>
<th>What</th>
<th>When</th>
<th>Who</th>
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<tbody>
<tr>
<td>Commencement of development of first draft of second edition (2023-2037) taking into account latest developments</td>
<td>Q1 2020</td>
<td>Task team</td>
</tr>
<tr>
<td>Finalization of first draft (second edition)</td>
<td>Q1 2021</td>
<td>Task team</td>
</tr>
<tr>
<td>Review of first draft (second edition)</td>
<td>Q2 2021</td>
<td>CAeM Management Group</td>
</tr>
<tr>
<td>Development of final draft (second edition)</td>
<td>Q3 2021</td>
<td>Task team</td>
</tr>
<tr>
<td>Review of final draft (second edition)</td>
<td>Q4 2021</td>
<td>CAeM Management Group</td>
</tr>
<tr>
<td>Submission of final draft (second edition) to CAeM-17 for review and recommendation</td>
<td>Q1 2022</td>
<td>Secretariat</td>
</tr>
<tr>
<td>Review of and recommendation on final draft (second edition)</td>
<td>Q3 2022</td>
<td>CAeM-17</td>
</tr>
<tr>
<td>Adjustments, if required, to final draft (second edition) based on outcomes of CAeM-17</td>
<td>Q4 2022</td>
<td>Task team in consultation with CAeM Management Group</td>
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<tr>
<td>Submission of final draft (second edition) to Cg-19 for endorsement</td>
<td>Q1 2023</td>
<td>Secretariat</td>
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<tr>
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<td>Cg-19</td>
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<td>Q3 2023</td>
<td>Task team in consultation with CAeM Management Group</td>
</tr>
<tr>
<td>Publication of second edition including online version and communicate to all Members</td>
<td>Q4 2023</td>
<td>Secretariat</td>
</tr>
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</table>

Note: The foregoing activities in Table 2 would repeat every four years thereafter for subsequent editions. Table 2 would need to be amended to take account of any changes to WMO constituent bodies and subsidiary structures that may arise from the outcomes of the Eighteenth World Meteorological Congress (Cg-18) in 2019.
Abstract

In response to the Global Air Navigation Plan (GANP) and the associated Aviation System Block Upgrade (ASBU) methodology promulgated by the International Civil Aviation Organization (ICAO), new initiatives to fast-track science into applications and services to meet the increasing demand from users have been taken forward by aeronautical meteorological services and providers around the world. This information paper gives a brief summary of the identified opportunities for further advancement of aviation weather services from the perspective of an NMHS supporting a busy aviation hub.

Air Traffic Flow Management

The arrival capacity of an airport depends on both the runway condition and airspace utilization and weather impact is an important consideration in the Air Traffic Management (ATM) and Air Traffic Flow Management (ATFM) processes. Performance-based MET Services for Terminal Area (MSTA) products such as those in Figure 1 had been found to be very useful for ATFM. Such a product may provide: (a) nowcast system output on the future location of weather cells that may block the intended flight path or significant points in the airspace; (b) 1hr convection nowcast for arrival/departure corridors; (c) 6hr convection forecast for the aerodrome and major waypoints; and (d) 9hr performance-based weather forecast for the aerodrome; and (e) 12hr significant convection forecast time series for key areas in the Flight Information Region (FIR) based on blended NWP and nowcasting outputs. A simple three-level colour coding scheme could be adopted uniformly in all the forecast-nowcast products described above though the actual criteria for defining the colour codes may vary across different forecast products. The criteria for defining the colour codes should be determined collaboratively with the users supported by objective means such as correlating the radar reflectivity against the probability of flights conducting missed-approach, holding and slowdown.

To ensure that the product/service is fit for purpose and credible, there should be a good understanding of the users' needs and the weather impact. The Aviation Research and Development Project (AvRDP) aims to demonstrate the capability of nowcasting and mesoscale modelling techniques and more importantly to research on the translation of MET information into ATM impact products. Background information on AvRDP can be found in CAeM-16/INF. 4(3). A second training workshop on AvRDP to be held in Hong Kong, China on 8-10 October 2018 will focus on this important aspect.

Lightning risk mitigation

The apron being a rather open area, ground personnel are unavoidably exposed to the risk of injuries from lightning strikes. Thunderstorm nowcast systems which generate alerts based on either detection or forecast of cloud-to-ground lightning activities (CG) have been proven to be useful for protection of ground personnel. For very busy airports, one might need to consider multiple-level alerts, such as "wireless headset", "suspension of non-essential operation on the
apron” (AMBER), and “suspension of all operation on the apron” (RED) based on the proximity of the lightning to the apron area or sub-areas in order to minimize the impact of such alerts to airport operation.

**Airport Collaborative Decision Making (A-CDM)**

For common situation awareness, integrated or one-stop-shop displays to facilitate A-CDM would allow users to gain access to a multitude of related information quickly. An example of an A-CDM platform which integrates weather with other airport operation information to facilitate users to appreciate the potential impact of weather on their different phases of work is given in Figure 2. Close collaboration with the airport community would be necessary in designing the products to ensure that the information displayed would be directly relevant and understandable to the users.

**Weather briefing service**

Apart from integrated information system facilitating A-CDM, weather briefing by meteorologists (Figure 3) for major weather events such as tropical cyclone would be useful to support multi-party collaborative decision making and emergency response. As significant weather disruptions at other major airports in the region could also have a rippling effect due to rescheduling or diversion of a large number of flights, such weather briefings will take on more regional perspectives. For major airports with integrated airport centre or emergency centre to coordinate airport operations during significant disruptions, the stationing of meteorologists may be required to provide the necessary face-to-face consultation service and to provide continuous feed of the latest weather information so that the whole airport community could get prepared for possible weather disruptions.

**Take-off/Landing Phase of Flight**

**Building-wake monitoring using short-range LIDAR**

An airport requires a lot of infrastructures such as passenger terminal building and hangers to support its operation. There have been reports, however, of aircraft incidents caused by low-level wind effects due to disrupted airflow by such man-made structures in proximity to runways. Apart from Computer Fluid Dynamics (CFD) modelling or wind tunnel experiments to evaluate whether there would be undue low-level wind effect resulting from such developments, short-range LIDAR (SRL) has been demonstrated to be useful in monitoring and detecting such wind events by scanning at high spatial and temporal resolution over the approach path. An example of the airflow disturbance as measured by SRL is given in Figure 4. In conjunction with aircraft positioning capability offered by Automatic Dependent Surveillance–Broadcast (ADS-B) up to every second, evolution of fast-evolving turbulent structures traceable to individual pilot reports can be mapped out with impressive details. It is expected that such effort undertaken in close collaboration with the airport, airline, pilot and ATM users would lead to the development of real-time alerting of airflow disturbances caused by building wakes.

**Wake vortex detection**

Many airports around the world are taking steps to further increase runway capacity in reducing aircraft separation where technically feasible and safe. It has been found that the SRL is also capable in observing wake vortices left behind by arrival aircraft (see Figure 5). Automatic algorithms are capable of identifying and tracking wake vortex events which could be validated by ADS-B data. In order to facilitate wake vortex re-categorization for operational reduction of aircraft separation, local wake vortex characteristics under different environmental conditions will need to be established, e.g. based on measurement campaign utilizing SRLs installed at strategic locations relative to the runway approaches and departures.
Sub-kilometre scale aviation model

Despite rapid increase in spatial resolution offered by global prediction systems operated by major centres around the world, spatio-temporal behaviour of many aviation-impact weather phenomena are of the meso- or even micro-scale and are known to exhibit considerable variability in their occurrence, for example the timing of occurrence of land-sea breeze which would affect the runway to be used. As the runway length is normally only a few kilometres, the NWP model has to run at a very fine resolution for the purpose. Sub-kilometre scale model, at a resolution nested down to 200m near the airport, would be required in some cases (e.g. airports in the vicinity of complex terrain and/or coastal environment) to capture the intricate wind flow (Figure 6).

Meso-EPS

With the adoption of a safety management system, risk assessment is increasingly integrated into the operation of the airlines. For assessment of risk likelihood, there is increasing demand for probabilistic forecast. Leveraging the assimilation of ubiquitous remote-sensing observations and local meteorological data, regional ensemble prediction systems (EPSs) at the meso- or convective-scale resolutions could provide a good objective basis for estimation of the potential weather risk. An example of the use of mesoscale-EPS system in assessing the impact of Typhoon Nida is given in Figure 7.

En route Phase of Flight

Flight-specific meteorological service for flight crew

As more airlines go for e-Enabled1 aircraft to operate in paperless environment, there is an unprecedented opportunity to transform the legacy one-size-fits-all paper-based flight documentation into a customised flight-specific weather service based on the planned flight route, which is a huge breakthrough in terms of the mode of service delivery to support the future trajectory-based operation. With planned aircraft location and time from a detailed flight plan, 4-D weather conditions along the flight route will be collated from all kinds of weather information available (Figure 8). Example of these may include: (a) tailor-made information in the standard flight documentation taken into account operational considerations of the respective airline; (b) enhanced satellite imagery to indicate significant convective area; and (c) aircraft observations including AMDAR and/or PIREP.

Ice Crystal Icing identification

Over the last 20 years, the aviation industry has documented more than 100 incidents in which turbofans have lost power during high-altitude flights. The culprit is water droplets that were carried by strong updraft in deep convective clouds to high altitude and frozen into ice crystals which cannot be detected by on-board weather radar due to the very small size. Called ice-crystal icing (ICI) or high-altitude water content, this phenomenon has caused concern to many airline operators. Using artificial intelligence, split-window algorithm based on the multi-channel satellite data from Himawari-8 (H-8) could be used to identify regions of ICI (Figure 9). Advection method could then be used to nowcast or forecast the future location of ICI.

Satellite-based nowcast system blended with NWP

With the new generation of geostationary meteorological satellites, the update frequency of satellite data now rival that of ground-based weather radar and with a coverage over a much

1 As a minimum, an e-enabled ground system is designed to support the flow of electronic data between the aeroplane and ground IT-systems
larger area. Satellite-based nowcast (Figure 10) would thus come in handy to support the forecasting of en route hazardous weather for the whole FIR. For seamless forecast at different spatial and temporal scales, satellite-based nowcast could be blended with the radar-based nowcast system and NWP model, for example through the use of neural network to derive the satellite-based reflectivity which could then be blended with radar and NWP data, to provide seamless nowcast over a large area.

**SIGMET Coordination**

Aviation users have long raised concern about the lack of SIGMET in some areas and the inconsistency of SIGMET across FIR boundaries. While ICAO has established a working group to develop the future regional en route hazardous weather advisory system, considering that it would still take a few years for the system to be developed, a number of sub-regional SIGMET coordination efforts are on-going to address the inconsistency issue in the short-term. Coordination platforms such as the one in Figure 11 have been developed by some Members to support common situation awareness and to facilitate harmonization of SIGMETs issued by several Meteorological Watch Offices (MWOs). Further extension and integration of such sub-regional SIGMET coordination efforts are being explored.

**Looking ahead**

Members might like to note the many opportunities described above in meeting new and anticipated demands from the aviation sector, and consider the future role of WMO in supporting Members in their long-term planning in further advancing aeronautical meteorological services.
Figure 1  Integrated web display of the MSTA forecast suite including: (a) Choice of Real-time radar and lightning data picture or Aviation Thunderstorm Nowcasting System to automatically forecast the future location of weather cells that may block the intended flight path or significant points in the airspace; (b) Composite of latest radar and deep convection satellite image; (c) 1hr convection nowcast for arrival/departure corridors; (d) 9hr performance-based weather forecast for the aerodrome; (e) 6hr blended convection forecast around the airport and the major waypoints; (f) 12hr significant forecast time series for key ATC areas; and (g) Airport Capacity Notification issued by the ATFM unit to airports within the region.

Figure 2  An example of A-CDM display integrating meteorological information with other airport operation information.
Figure 3  Weather coordination briefing for the whole airport community in action during the approach of a tropical cyclone.

Figure 4  Assessing the impact of new constructions at the Hong Kong International Airport (HKIA) using CFD simulations (left); and (right) detection of building-induced turbulence using rapid-scanning SRL.

Figure 5  Four SRLs (red circle) placed at a strategic location for monitoring wake turbulence from arrival and departure flights (left); and complex wake vortices observed by the SRL (right).
Figure 6  (a) 4-hour simulation of sea breeze by sub-kilometre scale aviation model; (b) simulated LIDAR based on the 4-hour AVM forecast; (c) and (d) are respectively the actual aerodrome and LIDAR observations.

Figure 7  Mesoscale EPS simulation of Typhoon Nida. The picture at the lower right corner is the corresponding actual satellite image.
Figure 8  Screen capture of ‘MyFlightWx’ – a weather app supporting e-Enabled aircraft. The upper part is a virtual 3D globe for user control and presenting weather forecast in an intuitive way to pilots. The lower part is a vertical profile along the flight route which could highlight the potential weather hazards along the planned route.

Figure 9  ICI as detected by the channel difference algorithm based on Himawari-8 with the black dot representing the location of the ICI report (left); and (right) 15-hour forecast of ICI with the red dot representing the location of the ICI report.
Figure 10  6-hour significant convection nowcast in the Asian region.

Figure 11  Operational web SIGMET Coordination platform for SE Asia
WMO REGULATORY AND GUIDANCE MATERIAL

Introduction

The Commission for Aeronautical Meteorology (CAeM) is responsible, inter alia, for the international standardization of methods and techniques for the provision of aeronautical meteorological services. These international standards are the principal embodiment of WMO Technical Regulations (WMO-No. 49), Volume II – Meteorological Service for International Air Navigation, and Annex 3 to the Convention on International Civil Aviation (ICAO Annex 3).

The international standards within WMO-No. 49, Volume II and ICAO Annex 3 are supported by a number of WMO and ICAO publications, including those contained in other volumes of WMO-No. 49 and WMO manuals and guides.

The following is intended to provide an overview of the latest status of the WMO regulatory, guidance and other material of relevance to the CAeM.

In addition, proposals aimed at eliminating existing duplication or redundancy between WMO and ICAO publications addressing aeronautical meteorological service provision are given for consideration.

Technical Regulations (WMO-No. 49)

<table>
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### WMO Manuals

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<td>• Volume I.3, Part D – Representations derived from data models</td>
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<td>• Volume II - Regional Codes and National Coding Practices</td>
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<td>544</td>
<td>Manual on the Global Observing System, Annex V to the WMO General Regulations</td>
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<td>Amendment to general provisions, definitions and other provisions in Parts I and III</td>
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### WMO Guides

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<td>731</td>
<td>Guide to Meteorological Observing and Information Distribution Systems for Aviation Weather Services</td>
<td>2014 edition</td>
<td>CAeM ET-GOV charged with undertaking a review of WMO-Nos. 731 and 732 with a view to updating and consolidating the guidance material and eliminating obsolete material. Refer to CAeM-16/INF. 3(4)</td>
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<td>842</td>
<td>Guide to the provision of meteorological service for international helicopter operations</td>
<td>1996</td>
<td>CAeM-MG-2018 (January 2018) recommended to make WMO-No. 842 obsolete because all provisions relating to meteorological service to support international helicopter operations are already covered by ICAO Annex 3/WMO-No. 49, Volume II provisions and their associated guidance material</td>
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<tr>
<td>904</td>
<td>Guide to aeronautical meteorological services cost recovery: principles and guidance</td>
<td>2007 (2nd edition)</td>
<td>CAeM ET-GOV charged with undertaking a review of WMO-No. 904 with a view to updating or consolidating with other existing guidance material. Refer to CAeM-16/INF. 3(4)</td>
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<td>1061</td>
<td>Guide to the WMO Information System</td>
<td>2015 edition</td>
<td>To be used in conjunction with the Manual on the WMO Information System (WMO-No. 1060) referenced above</td>
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<td>1112</td>
<td>Guidelines on the role, operation and management of National Meteorological or Hydrometeorological Services</td>
<td>2013</td>
<td>Superseded by WMO-No. 1195 (see below)</td>
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<td>1195</td>
<td>Guidelines on the Role, Operation and Management of National Meteorological and Hydrological Services</td>
<td>2017 edition</td>
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<td>1205</td>
<td>Guide to Competency</td>
<td>2018 edition</td>
<td>New publication with input from CAeM ET-ETC.</td>
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<td></td>
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<td>Guidance on developing, implementing and/or maintaining competency-based training and assessment programmes based upon competency frameworks established in the WMO-No. 49, Technical Regulations, Volume I</td>
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**Other WMO publications**

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<td>770</td>
<td>Methods of interpreting numerical weather prediction output for aeronautical meteorology: by the CAeM Working Group on Advanced techniques applied to aeronautical meteorology</td>
<td>1992</td>
<td>CAeM-MG-2018 (January 2018) recommended to make WMO-No. 770 obsolete in view of the outdated nature of the information and the fact that methods of interpreting numerical weather prediction output are considered to be sufficiently covered in other existing WMO publications</td>
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Additional considerations

Within the WMO and ICAO regulatory frameworks for aeronautical meteorological service provision, there is currently a duplication between WMO No. 49, *Technical Regulations*, Volume II – Meteorological Service for International Air Navigation, and ICAO Annex 3. Parts I and II of these publications are essentially identical. Parts III and IV are reserved only for the WMO publication, where Part III addresses aeronautical climatology and Part IV addresses the format and preparation of flight documentation.

Arising from a bilateral meeting between the WMO Secretary-General and the ICAO Secretary General in April 2017 it was recommended that the two organizations seek opportunities to improve efficiency, including potentially eliminating WMO No. 49, Volume II.

At the CAeM Management Group meeting in January 2018 (CAeM-MG-2018 report available here), the MG noted that the ongoing duplication of key documents such as Technical Regulations, including disparate document controls, was not consistent with the principles of quality management and does not set a good example to international aeronautical meteorological service providers and the wider community.

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<td>Compendium on tropical meteorology for aviation purposes</td>
<td>2003</td>
<td>Information on tropical meteorology and the hazards that weather in the tropics might pose for aviation operations</td>
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<td>1038</td>
<td>Weather Forecasting for Soaring Flight</td>
<td>2009</td>
<td>Guidelines for meteorological forecasting in soaring flight and related activities</td>
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<td>TD 1390</td>
<td>Aviation Hazards</td>
<td>2007</td>
<td>2018 edition under preparation with input from CAeM ET-ETC</td>
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Aerodrome reports and forecasts: a user’s handbook to the codes


Compendium on tropical meteorology for aviation purposes

Information on tropical meteorology and the hazards that weather in the tropics might pose for aviation operations

Weather Forecasting for Soaring Flight

Guidelines for meteorological forecasting in soaring flight and related activities

Aviation Hazards

2018 edition under preparation with input from CAeM ET-ETC
WMO CONSTITUENT BODY REFORM AND ITS IMPLICATIONS ON THE COMMISSION

References

D. EC-70/Doc. 16.2(1) – WMO Strategic Plan 2020-2023
E. EC-70/Doc. 16.3(4) – Technical Commissions
F. EC-70/Doc. 16.3(6) – Transition Plan

Background

Over the past several years, as a follow-up to outcomes of the World Meteorological Congress and Executive Council on the continuous improvement of organizational process and practices, the World Meteorological Organization (WMO) has been engaged in a dialogue on the reform of its constituent bodies (so-called ‘WMO reform’), including the Executive Council, regional associations and technical commissions including the Commission for Aeronautical Meteorology (CAeM).

The forthcoming WMO Strategic Plan for the nineteenth financial period of the Organization (2020 to 2023) conveys a 2030 vision where all nations, especially the most vulnerable, are more resilient to the socioeconomic consequences of extreme weather, climate, water and other environmental events and underpin their sustainable development through the best possible services, whether over land, at sea or in the air.

At the same time, the United Nations 2030 Agenda for Sustainable Development, the Paris Agreement on Climate Change, and the Sendai Framework for Disaster Risk Reduction serve as the centrepieces for national and international policy making and action. As a consequence, their implementation will increasingly demand actionable, accessible and authoritative information and services on the changing states of the entire Earth System.\(^1\)

With the foregoing context, the role of WMO will remain to support the activities of its Member States and Territories in understanding the past, monitoring the present and predicting the future state and interactions of the atmosphere, the hydrosphere and other vital elements of our planet, enabling adequate and effective preparedness, adaptation and response to related natural extremes. This will require further enhancement of coordinated and interoperable networks and systems for data collection and processing, improvement of predictive skill through advanced science and computational technologies, and finally highly innovative approaches of service delivery that will ensure that accurate, fit-for-purpose information will reach its users on time for making their weather-, water- and climate-informed decisions.

To this end, the WMO reform is intended to reposition and in some cases repurpose constituent bodies and substructures such that the Organization can better serve the needs of its Members and the wider community for the foreseeable future.

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\(^1\) In this context, the Earth is being considered as an integrated system of atmosphere, ocean, cryosphere, hydrosphere, biosphere and geosphere, which informs policies and decisions based on a deeper understanding of the physical, chemical, biological and human interactions that determine the past, current and future states of the Earth.
Technical Commission Structure Discussion

At present, WMO comprises eight technical commissions\(^2\). A number of these technical commissions, including CAeM, have existed since the formative years of the Organization in the 1950s. On many occasions over the past 70 years, WMO and ICAO have convened conjoint CAeM sessions (WMO) and Meteorology Divisional Meetings (ICAO). The most recent conjoint meeting was in July 2014 in Montreal\(^3\).

At the seventieth session of the Executive Council (EC-70) held from 20 to 29 June 2018, the Council formulated a recommendation to go forward to the eighteenth World Meteorological Congress (Cg-18) (June 2019) whereby the technical commissions will be restructured through the establishment of a new technical commission structure along the lines of the following (see Figure 1 for a notional illustration):

A. Commission for Earth System Observation, Infrastructure and Information*  
B. Commission for Weather, Water, Climate, Water and related Environmental Services and Applications*  

* Working titles. The precise names of these technical commissions and the final number of technical commissions will be determined by Cg-18 (June 2019).

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Figure 1. Notional new technical commission structure for the nineteenth financial period (Illustration only. Subject to change)

\(^2\) Commission for Aeronautical Meteorology (CAeM), Commission for Agricultural Meteorology (CAgM), Commission for Atmospheric Sciences (CAS), Commission for Basic Systems (CBS), Commission for Climatology (CCl), Commission for Hydrology (CHy), Commission for Instruments and Methods of Observation (CIMO) and Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM).

\(^3\) Namely, ICAO MET/14 and WMO CAeM-15.
These new intergovernmental technical commissions will be supported by an optimal non-intergovernmental subsidiary structure as needed to implement the WMO Strategic Plan in 2020-2023 in the most efficient and effective manner. The technical commissions are intended to support the Strategic Plan, which aims to support the development of:

1. **An Earth System science approach to seamless prediction** from climate scales down to the mesoscale that is built upon the concept of the weather, water, climate linkage,

2. **An integrated approach to weather, water, and climate** linkages supporting Members’ effort to ultimately unify operational climate, weather and water prediction systems using a fully coupled Earth system model approach,

3. **A holistic, interdisciplinary approach to services and applications** with a strong focus on users and use cases, promoting impact-based approach and supporting common development of standards and methodologies for generic service attributes like quality, competence, fitness for purpose, accessibility, as well as innovation in service delivery (e.g., through social media),

The possible savings realized through the restructuring of the technical commissions could then be redirected to: (a) more frequent sessions (2-year cycle) of constituent bodies; (b) support the participation of experts from developing countries in constituent body sessions in an inclusive and transparent way; (c) provide more support to substructures of regional associations; and (d) optimize use of Members’ experts in a more efficient and coordinated way and other benefits.

At the time of writing, it is envisaged that WMO’s activities in support of aeronautical meteorological service provision will be conducted mainly within and under the technical commission addressing services and applications (B). The technical commission addressing observations, infrastructure and information (A) would, though, be a key collaborator in this regard. Insofar as subsidiary structures are concerned, it is envisaged that a non-intergovernmental Standing Committee on Aeronautical Meteorology (working title) will be established under B.

The establishment of a non-intergovernmental standing committee addressing aeronautical meteorology (“SC-AeM”) could be seen as an opportunity for WMO and ICAO to engage more efficiently and effectively at the technical working level, an outcome that would be consistent with the priorities agreed between the WMO Secretary-General and the ICAO Secretary General at their bilateral meeting in April 2017. The new technical commission sessions (and potentially parallel sessions of the standing committees during technical commission sessions) will take care of the items which need the decisions by the inter-governmental processes.

Ultimately, the future structures of the WMO constituent bodies in the nineteenth financial period (2020 to 2023) will be a decision of Congress in June 2019. In the meantime, work is ongoing to develop an effective and realistic ‘Transition Plan’, a plan that will include further consultation with WMO Members and other stakeholders.

If the proposals described above are endorsed by Congress, it is currently planned that the two technical commissions (A and B) would commence their work relatively soon after although the details of this will be informed by the development of the aforementioned Transition Plan for constituent body reform. The existing technical commissions will not be disbanded until the full establishment of the new commission structure, thereby ensuring the continuity of ongoing commission activities.

Finally, in accordance with final paragraph of Article 8 of the Convention, the president of each new commission and their vice-presidents will be elected by Congress, from amongst the current presidents and vice presidents of technical commissions, a one-time measure aimed at expediting the transition to the new structure of the technical commissions. Upon completion of the transition process, the existing technical commissions would be disbanded.
WORKING STRUCTURE OF THE COMMISSION, INCLUDING ESTABLISHMENT OF SUBSIDIARY BODIES

References

1. Abridged final report with resolutions and recommendations of the fifteenth session of the Commission for Aeronautical Meteorology (CAeM-16), 15 to 16 July 2014, Montreal, Canada (WMO-No. 1139).


Background

At the CAeM-15 session in July 2014, through Resolution 2 (CAeM-15) and in accordance with Regulation 33 of the WMO General Regulations, the Commission decided to establish the following CAeM subsidiary bodies: Expert Team on Aviation, Science and Climate; Expert Team on Communication, Coordination and Partnership; Expert Team on Education, Training and Competency; Expert Team on Governance; and Expert Team on Information and Services for Aviation. In addition, through Resolution 1 (CAeM-15), a CAeM Management Group was established.

The CAeM Management Group and five CAeM expert teams have remained the principle subsidiary bodies of the Commission during the intersessional period (2014 to 2018).

Recent CAeM Management Group considerations

In preparing for the CAeM-16 session in July 2018, the CAeM Management Group (MG), at its January 2018 meeting in Geneva, Switzerland, gave consideration to, inter alia, the restructuring of technical commissions and the future CAeM expert team needs and structures.

Restructuring of technical commissions

In the context of the restructuring of technical commissions (TC), the CAeM-MG-2018 realized that while there was, at that stage, still some uncertainty about the exact nature of the future TC structure, it was highly likely that the Aeronautical Meteorology Programme (AeMP) would continue to be handled as one of the application programmes of WMO through the WMO reform process. The MG discussed WMO reform matters at length, particularly in view of their direct bearing both on the continuance and evolution of CAeM as one of the constituent bodies of WMO, on the AeMP as a mature programme area of the Organization, as well as on the structures and composition of the Secretariat. A range of views were expressed by the MG, some addressing the challenges that would likely be faced by such reform, others addressing the opportunities that may arise as a result of the reform.

The challenges considered by the MG included the proposed transitioning from an intergovernmental arrangement to a non-intergovernmental arrangement and how to continue to ensure commitment from Members, a sufficient ‘community of expertise’ to support the programme, and balanced representation (i.e. between the developed world and the developing world, between the regions and by gender).
The opportunities considered by the MG included the potential to further improve how WMO coordinates and collaborates with the International Civil Aviation Organization (ICAO). For example, there may be opportunities for WMO to have an agile community of expertise in aeronautical meteorology (and other supporting scientific and technical areas) that would more readily, more efficiently and more effectively be able to provide advice into the ICAO regulatory process rather than via the traditional expert teams and other such groups that exist today. In addition, there may be opportunities, where needed and feasible on both sides, for WMO and ICAO to have joint working and/or management group structures.

The MG considered that regardless of whether the WMO reform would happen in the near-term or far-term, a transition plan from the existing structure to any new structure would be of paramount importance to ensure continuity in activities.

Future CAeM expert team needs and structures

In the context of future CAeM expert team needs and structures, the CAeM-MG-2018 recognized that the establishment of the future structure of CAeM subsidiary bodies would be guided by two main contributing factors: (1) the need to deliver the AEM-related objectives of the WMO strategic plan for 2020-2023; and (2) the final decision on the restructuring of WMO constituent bodies including the technical commissions. Since, at the time, both factors were not yet concluded, the MG accepted that it would have to deal with some uncertainties and assumptions.

The MG also accepted that another key influencing factor to be considered in the planning process was related to the longer-term tasks stemming from the evolution of the ICAO Global Air Navigation Plan (GANP) and its aviation system block upgrades (ASBU) methodology, of which ICAO’s next GANP would be endorsed in 2019 to cover the period until 2033. The MG recognized the need for WMO to support the evolution of the ICAO and WMO regulatory frameworks, and that this should stay as a foundation pillar of the AeMP.

Despite the prevailing uncertainty about the various plans and structures, and the assumptions to be made in this regard, the MG felt strongly that it should adopt a proactive approach to effecting changes within the Commission. This would help ensure a smoother transition in response to any future overarching organizational changes e.g. reconstituting of the CAeM from an intergovernmental technical commission to a non-intergovernmental standing committee.

The MG also recognized that the current CAeM composition of a management group and five expert teams, plus other working structures such as VAAC BP and VASAG, may not be a sustainable or efficient arrangement going forwards. Many of the WMO (PR-nominated) experts involved in the CAeM MG, ETs and other groups also served as ICAO (State-nominated) members or advisors on the ICAO METP and/or its working groups. The MG agreed that better coordinated and more agile arrangements should be pursued – both on the WMO side and the ICAO side. These future arrangements should ensure that WMO continues to provide expert scientific and technical advice to ICAO without overlapping the respective structures (for example, ET-ISA and WG-MISD as well as ET-GOV and WG-MCRGG which exist today possess a certain amount of overlap).

The MG speculated that a community of expertise (referenced above), if established, could retain a required level of expertise while also enabling a more efficient and more effective use of the resource than is perhaps the case today. However, he MG agreed that for those areas wholly under the responsibility of WMO – notably the competency and qualification, education and training of aeronautical meteorological personnel – retaining a dedicated WMO expert team, subject to availability of supporting resources, would be appropriate.
After thorough debate, the MG agreed that, as a basic principle, any future working structures of WMO in support of the AeMP should take into account of:

(a) Education, training and competency;
(b) Normative work – i.e. standards development and maintenance;
(c) Innovative applications – i.e. research to operations; and
(d) Emerging issues – e.g. climate change and variability impact on aviation.

Priority themes

Respecting the foregoing basic principles and in preparation for the CAeM-16 session, the MG agreed (through correspondence after CAeM-MG-2018) to the following priority themes to sustainably build WMO Members’ capacity in providing high-quality, for for-purpose, cost-effective aeronautical meteorological services in support of aviation’s demands for a globally interoperable, harmonized air traffic management system of the future. Areas of expertise broadly corresponding to the anticipated future needs of the Commission aligned with these priority themes are indicated in italics.

(1) Education, training and competency of Aeronautical Meteorological Personnel (AMP)
   (a) Education and training curricula
   (b) Qualification requirements
   (c) Competency assessment frameworks and best practice

(2) Aeronautical Meteorological Information Service Development and Governance
   (a) Information and data exchange policies, quality management system standards and cost recovery principles
   (b) Integration of meteorological information into air traffic management
   (c) Service delivery development and best practice

(3) Aeronautical Meteorological Hazards Prediction
   (a) Innovation through scientific research and technological advancement
   (b) Transition from research into operations
   (c) Probabilistic and impact-based forecasting in support of aviation operations

(4) Impacts of Climate Change and Variability on Aviation
   (a) Impacts on jet streams and en-route hazards
   (b) Impacts on airport operations
   (c) Impacts on airspace management/optimization and airframe design

(5) Communication and Outreach
   (a) Newsletters and other such outreach for Members, Regional Associations, Stakeholders and partners
   (b) Feedback mechanisms
   (c) Focal point identification and coordination
Nomination of experts for CAeM subsidiary bodies

Consistent with the foregoing and in order to facilitate the selection process of experts to be considered for members of the subsidiary bodies of the CAeM, Permanent Representatives of CAeM members were invited by the Secretary-General of WMO, through letter ref. 12960/2018/WDS/AN/CAeM-16 of 24 May 2018, to propose suitable experts to support the CAeM priority themes together with an indication of the level of commitment that could be undertaken by the nominated experts (lead expert 20 days per annum, core expert 15 days per annum, and ad hoc support expert 5-10 days per annum). It is worthwhile to note that coordination amongst the nominated experts will predominantly be via electronic communication (email and video/teleconferences). Face-to-face meetings will only be called on the basis of need and affordability and would normally only call for the attendance of lead and core nominated experts.

Proposal for working structure of the Commission following CAeM-16 including establishment of subsidiary bodies

Taking all of the foregoing into account, it is recommended that a CAeM MG should be re-established during the CAeM-16 session and that further subsidiary bodies of the Commission (for example, expert teams) may be established by CAeM-16 taking into account of the aforementioned priority themes and likely implications of WMO reform on the Commission.

Regarding the re-established CAeM MG, this should comprise, as members, the president of the Commission, vice-president of the Commission plus the minimum number of lead experts necessary to represent expertise, regional and gender balance. Proposed terms of reference of the CAeM MG are given in CAeM-16/Doc. 8.

Regarding subsidiary bodies of the Commission, taking into account of the aforementioned priority themes, viz. (a) Education, training and competency of Aeronautical Meteorological Personnel (AMP), (b) Aeronautical Meteorological Information Service Development and Governance, (c) Aeronautical Meteorological Hazards Prediction, (d) Impacts of Climate Change and Variability on Aviation, and (e) Communication and Outreach, the CAeM-16 may decide:

(1) to establish, during the session, the subsidiary bodies considered necessary;

(2) to task the CAeM MG to establish, after the session, the subsidiary bodies considered necessary; or

(3) to apply approaches (1) and (2) above in combination.

In addition to (1) to (3) above, the CAeM-16 may also wish to consider if certain priority theme(s) could be supported by just the lead expert(s) or by focal point(s) known to the aeronautical meteorology/CAeM community (for example, nominated experts supporting other technical commissions of relevance to the CAeM) rather than a subsidiary body comprising both lead and core experts.

Regardless of when the subsidiary bodies of the Commission are established, a fundamental aspect will be the availability of a community of expertise (i.e. an aeronautical meteorology experts network or “AEMnet”) that possesses an appropriate and necessary breadth of skill and competence to support the work of the Commission (or its successor) going forwards. Based on nomination by WMO Members, lead experts, core experts and ad hoc experts as well as other known focal points would form this so-called AEMnet. This concept can be illustrated as follows:
Taking into account the internal and external drivers, the CAeM MG will be responsible for identifying, defining and prioritizing tasks to be accomplished and outputs to be delivered by the Commission in support of the AeMP and other relevant WMO programmes, and will utilize the AEMnet to accomplish the tasks to the required format and within the timeframes prescribed.
REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION

The following tables provide a list of resolutions and recommendations adopted by the Commission for Aeronautical Meteorology (CAeM) prior to its sixteenth session (2018) and still in force together with suggested actions at CAeM-16.

In addition, and relating to one of the previous resolutions of the Commission (Resolution 5 of CAeM-XIII), a report on gender mainstreaming and the participation of women and men in the activities of the CAeM is given at the Annex.

References

(a) Abridged final report with resolutions and recommendations of the thirteenth session of the Commission for Aeronautical Meteorology (CAeM-XIII), 23 to 30 November 2006, Geneva Switzerland (WMO-No. 1018);

(b) Abridged final report with resolutions and recommendations of the fifteenth session of the Commission for Aeronautical Meteorology (CAeM-15), 15 to 16 July 2014, Montreal, Canada (WMO-No. 1139);

(c) Abridged final report with resolutions of the Seventeenth World Meteorological Congress (Cg-17), 25 May to 12 June 2015, Geneva, Switzerland (WMO-No. 1157);

(d) Abridged final report with resolutions and decisions of the Sixty-eighth session of the Executive Council (EC-68), 15 to 24 June 2016, Geneva, Switzerland (WMO-No. 1168).
1. **Previous resolutions of the Commission for Aeronautical Meteorology**

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<tr>
<th>Resolution No.</th>
<th>Title of the Resolution</th>
<th>Suggested actions at CAeM-16</th>
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<td>5 (CAeM-XIII)</td>
<td>Participation of women in the work of the Commission</td>
<td>X</td>
<td>To be replaced under CAeM-16/Doc. 9. Also refer to Gender Mainstreaming at the Annex to CAeM-16/INF. 9(1) hereunder.</td>
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<td>1 (CAeM-15)</td>
<td>Management Group of the Commission for Aeronautical Meteorology</td>
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<tr>
<td>2 (CAeM-15)</td>
<td>Establishment of subsidiary bodies of the Commission for Aeronautical Meteorology</td>
<td>X</td>
<td>To be replaced under CAeM-16/Doc. 8</td>
</tr>
<tr>
<td>3 (CAeM-15)</td>
<td>Review of previous resolutions and recommendations of the Commission for Aeronautical Meteorology</td>
<td>X</td>
<td>To be replaced under CAeM-16/Doc. 9</td>
</tr>
</tbody>
</table>

2. **Previous recommendations of the Commission for Aeronautical Meteorology**

<table>
<thead>
<tr>
<th>Recommendation No.</th>
<th>Title of the Recommendation</th>
<th>Suggested actions at CAeM-16</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (CAeM-15)</td>
<td>Terms of reference of the Commission for Aeronautical Meteorology</td>
<td>X</td>
<td>Adopted by Congress under Resolution 1 (Cg-17). To be replaced under CAeM-16/Doc. 8</td>
</tr>
<tr>
<td>2 (CAeM-15)</td>
<td>Long-term planning to support aeronautical meteorology as a WMO strategic priority</td>
<td>X</td>
<td>Noted by Congress under Annex to paragraph 2.5.58 of the general summary (Cg-17). To be replaced under CAeM-16/Doc. 6.1, 6.2 and/or 6.3</td>
</tr>
<tr>
<td>3 (CAeM-15)</td>
<td>Review of relevant resolutions of the Executive Council based on previous recommendations of the Commission for Aeronautical Meteorology</td>
<td>X</td>
<td>Requested by Congress under Resolution 1 (Cg-17) to be taken into account by the Executive Council. To be replaced under CAeM-16/Doc. 9</td>
</tr>
</tbody>
</table>

Annex: 1
ANNEX

GENDER MAINSTREAMING

As indicated at 1 above (Previous resolutions of the Commission for Aeronautical Meteorology), Resolution 5 (CAeM-XIII) addressed the participation of women in the work of the Commission. This resolution was kept in force by the Commission through CAeM-XIV in 2010 and CAeM-15 in 2014.

The Seventeenth World Meteorological Congress (Cg-17) in 2015 and the Sixty-eighth Executive Council (EC-68) in 2016 considered gender mainstreaming in WMO.

The following information presents statistics on the participation of women and men in the activities of CAeM (as at 1 May 2018) as well as the relevant outcomes of Cg-17 and EC-68.

A draft Resolution to replace Resolution 5 (CAeM-XIII) is provided in CAeM-16/Doc. 9.

I. Statistics on the Participation of Women and Men in CAeM Activities

Delegates to CAeM Meetings

Table 1 below presents the gender composition of delegates to the latest five CAeM sessions. Having started from a low baseline at 9%-12%, female representation soared to 22% in 2006, further reaching 25% at the latest CAeM session in 2014.

<table>
<thead>
<tr>
<th>CAeM Session</th>
<th>Women %</th>
<th>Men %</th>
</tr>
</thead>
<tbody>
<tr>
<td>XI (1999)</td>
<td>12%</td>
<td>88%</td>
</tr>
<tr>
<td>XII (2002)</td>
<td>9%</td>
<td>91%</td>
</tr>
<tr>
<td>XIII (2006)</td>
<td>22%</td>
<td>78%</td>
</tr>
<tr>
<td>XIV (2010)</td>
<td>26%</td>
<td>74%</td>
</tr>
<tr>
<td>XV (2014)</td>
<td>25%</td>
<td>75%</td>
</tr>
</tbody>
</table>

Figure 1 below compares the representation of women and men in delegations to sessions of the eight WMO Technical Commissions.

At 25%, the share of female delegates at CAeM-15 reflected the global average in 2012-2015.

In the current financial period (2016-2019), the highest proportion of women was registered at the latest sessions of CAgM (37%), JCOMM (37%) and CHy (36%).
The increase in the share of female delegates to CAeM sessions was accompanied by an equivalent increase in the proportion of female principal delegates. The latter soared from 10% in 1999 to 27% in 2010, then dropping to 23% at the latest session in 2014 (see Figure 2 below).

For comparison, the highest share of female principal delegates (36%) was registered at CAgM-17, followed by CHy-15 and JCOMM-5 at 34% and 33%, respectively.
CAEM Management Group

At 33%, female membership in the CAEM Management Group is above the average for technical commissions. Only CAGM has achieved parity on its Management Group (55% women, 45% men).

Table 2: Proportion of women and men on CAEM Management Group

<table>
<thead>
<tr>
<th>Women</th>
<th>Men</th>
<th>Total</th>
<th>Women %</th>
<th>Men %</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>8</td>
<td>12</td>
<td>33%</td>
<td>67%</td>
</tr>
</tbody>
</table>

Expert Teams

As evident from Figure 3 below, females represent 31% of the membership of CAEM and CCI expert teams, which is the highest among TCs.

Progress Report and Global Survey on Gender Mainstreaming in WMO

More statistical information, including on the gender balance among national meteorological and hydrological services (NMHS) staff, is available in the Progress Report on Implementation of the WMO Policy on Gender Mainstreaming (March 2015) and the Results of the 2013 Global Survey on Gender Mainstreaming in WMO.

II. WMO Policy on Gender Equality

The Seventeenth World Meteorological Congress (Cg-17) adopted Resolution 59 (Cg-17) on Gender Equality and Empowerment of Women which requests WMO technical commissions and regional associations:

(a) To develop action plans on implementation of the WMO Policy on Gender Equality within their areas of responsibility;

(b) To continue compiling statistics on the participation of men and women in their work;
(c) To take action on the outcomes and recommendations of the Conference on the Gender Dimensions of Weather and Climate Services;

(d) To report to the Executive Council and the World Meteorological Congress on progress.

Congress further urged Members to take the following actions, among others:

(a) To nominate more female candidates to other WMO constituent bodies and their working structures as well as to training events and for WMO fellowships;

(b) To nominate more female candidates to participate in the work of technical commissions as members of their management groups as well as members of relevant expert teams, working groups and programmes;

(c) To increase the representation of women in their delegations to WMO constituent body meetings;

(d) To respond to regular surveys on gender equality in WMO and in National Meteorological and Hydrological Services, and designate gender focal points.

As an annex to the Resolution, Congress adopted an updated WMO Policy on Gender Equality which outlines the following roles and responsibilities for technical commissions (paragraph 8.3):

“The technical commissions should be aware of and implement the WMO Gender Equality Policy within their area of responsibility. Efforts should be made to ensure that a minimum of at least 30 percent of the members of their working structures is female and that this percentage rises progressively within each financial period. The longer-term objective will be to reach parity between male and female members.”

Technical commissions are expected to report to the Executive Council on progress at least once during each financial cycle (paragraph 9.2).

EC-68 endorsed a WMO Gender Action Plan (Decision 77 (EC-68)) as well as agreed with the priority actions identified by the EC Advisory Panel of Experts on Gender Mainstreaming for 2016-2019 (marked in red). The document contains a range of actions intended for implementation by WMO constituent bodies, including technical commissions (see Column B of the WMO Gender Action Plan).

Priority actions for constituent bodies include:

(a) Make gender equality a permanent item on agendas and discuss at least once per financial period.

(b) Promote the active role of female delegates in constituent body sessions.

(c) Include a short gender analysis in Strategic Plan 2020-2023.

(d) Maintain the Key Outcomes and KPIs related to gender mainstreaming in OP 2020-2023.

(e) Conduct at least two Women’s Leadership Workshops on the margin of constituent body meetings.

(f) Update the WMO Capacity Development Strategy and Implementation Plan with a view to incorporating relevant aspects of the WMO Gender Equality Policy.

(g) Update the WMO Capacity Development Strategy and Implementation Plan with a view to making them more gender-sensitive.

(h) Report to the EC and Cg on progress at least once per financial period.
REVIEW OF RELEVANT RESOLUTIONS AND DECISIONS OF WMO GOVERNING BODIES RELATED TO THE COMMISSION

The following tables provide a list of resolutions and decisions adopted by the WMO governing bodies (Congress and Executive Council) based on previous recommendations of CAeM or of relevance to the CAeM and still valid.

References

A. Abridged final report with resolutions and decisions of the sixth-fifth session of the Executive Council (EC-65), 15 to 23 May 2013, Geneva, Switzerland (WMO-No. 1118).

B. Abridged final report with resolutions of the seventeenth World Meteorological Congress (Cg-17), 25 May to 12 June 2015, Geneva, Switzerland (WMO-No. 1157).

C. Abridged final report with resolutions and decisions of the sixth-eighth session of the Executive Council (EC-68), 15 to 24 June 2016, Geneva, Switzerland (WMO-No. 1168).

D. Abridged final report with resolutions and decisions of the sixth-ninth session of the Executive Council (EC-69), 10 to 17 May 2017, Geneva, Switzerland (WMO-No. 1196).
1. Previous resolutions of the World Meteorological Congress and Executive Council (in chronological order)

<table>
<thead>
<tr>
<th>Resolution No. (and session)</th>
<th>Title of the Resolution</th>
<th>Suggested actions at CAeM-16</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (EC-65)</td>
<td>Steps to be undertaken to achieve compliance with the regulations of the World Meteorological Organization and the International Civil Aviation Organization</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>1 (Cg-17)</td>
<td>Report of the fifteenth session of the Commission for Aeronautical Meteorology, including revised terms of reference of the Commission</td>
<td>X</td>
<td>Follow-up action complete.</td>
</tr>
<tr>
<td>3 (Cg-17)</td>
<td>Aeronautical Meteorology Programme</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>8 (Cg-17)</td>
<td>Amendment of competency and qualification provisions in the Technical Regulations (WMO-No. 49), Volume I</td>
<td>X</td>
<td>Follow-up action complete.</td>
</tr>
<tr>
<td>44 (Cg-17)</td>
<td>Aviation Research and Development Project</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>66 (Cg-17)</td>
<td>WMO support to evolving aeronautical meteorological services</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>14 (EC-69)</td>
<td>Amendment to the Technical Regulations (WMO-No. 49), Volume II – Meteorological Service for International Air Navigation</td>
<td>X</td>
<td>Follow-up action complete.</td>
</tr>
<tr>
<td>## (EC-70)</td>
<td>[Placeholder for any resolutions arising from EC-70 (20 to 29 June 2018) to be addressed by the CAeM]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Previous decisions of the Executive Council (in chronological order)

<table>
<thead>
<tr>
<th>Decision No. (and session)</th>
<th>Title of the Resolution</th>
<th>Suggested actions at CAeM-16</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 (EC-68)</td>
<td>Four-year plan for WMO activities related to space weather</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>42 (EC-68)</td>
<td>Implementation of the WMO Strategy for Service Delivery</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>43 (EC-68)</td>
<td>Action Plan – Meteorological services for aviation</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>44 (EC-68)</td>
<td>Intercommission Aviation Research Project</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>42 (EC-69)</td>
<td>Future of aeronautical meteorological services</td>
<td>X</td>
<td>Still relevant and valid.</td>
</tr>
<tr>
<td>## (EC-70)</td>
<td>[Placeholder for any decisions arising from EC-70 (20 to 29 June 2018) to be addressed by the CAeM]</td>
<td></td>
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</table>