**REVIEW OF THE METEOROLOGICAL COMPONENTS**

**OF THE ICAO GANP AND ASBU METHODOLOGY**

*(Submitted by the ET-ASC and ET-ISA Co-Chairs)*

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| **Summary and Purpose of Document**This document addresses:* a review of the fifth edition (2016) of the GANP and expectations for the sixth edition (2019);
* the existing and foreseen information- and service-related requirements, including MET in future SWIM; and
* the existing and foreseen science and research requirements; and

with a view to assisting ET-ASC and ET-ISA establish and maintain appropriate work plans and priorities. |

**ACTION PROPOSED**

The meeting is invited to:

1. note the information contained in this paper; and
2. consider the implications of the latest and next edition of the GANP, and related SWIM developments, on:
	1. the existing and foreseen work of ET-ISA and ET-ASC; and
	2. the coordination mechanisms between the two expert teams.

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1. **EXECUTIVE SUMMARY** (to be included in the final report)

1.1 The meeting appreciated that ICAO was continuing to maintain and update its Global Air Navigation Plan (GANP) (ICAO Doc 9750) on a triennial basis and that the fifth edition of the GANP, published in 2016, retained the aviation system block upgrades (ASBU) methodology where aeronautical meteorology (MET) was a key enabler to the future globally interoperable, harmonized air traffic management system. The meeting noted that, in general, the 2016 GANP represented a minor update (mainly a reorganization of the ASBU blocks into non-overlapping six-year time increments) while the next edition (sixth edition, 2019 GANP) was expected to represent a more comprehensive update.

1.2 The meeting acknowledged the important, intrinsic link between the strategy for air transport modernization set forth in the GANP and the existing and foreseen requirements for meteorological information and services and associated underpinning science and research activities.

1.3 In the context of existing and foreseen information- and service-related requirements, including MET in future system-wide information management (SWIM), the meeting acknowledged the progress that had been achieved over the past decade or so, particularly through successive expert teams of the CAeM charged with gathering and analysing users’ needs in order to develop innovative solutions (MET products and services of NMHSs) that support operations, especially in the terminal area.

1.4 Appreciating the users appetite for seamless meteorological information in space and time, with no inconsistency across boundaries, the meeting noted that there were efforts underway, through the development of the next edition of the GANP, to identify those key feature areas (including with respect to meteorology) that need to be improved in order to achieve a full implementation of the global ATM operational concept. This will require improved specificity of MET observations, nowcast, forecast information with high or very high temporal and spatial resolutions, the introduction of probabilistic information that will allow users to address (un)predictability or (un)certainty of MET in new ATM operating methods, and a user-oriented translation into the impact of adverse weather. The meeting appreciated that information, including MET information, will need to be organized and provided by solutions that support system-wide interoperability, secured seamless information access and the exchange and full integration of information into decision support or aid systems and that the need for more interoperability was (is), of course, directly linked to the transition to the SWIM environment.

1.5 In the context of existing and foreseen science and research requirements, the meeting considered aspects that included the blending of nowcasting and high-resolution modelling as well as predictability, probability and seamless prediction. It was noted that blending automated nowcasting techniques with high-resolution model forecasts at very short intervals had shown some recent early promise but that complex topography and distinctive boundaries between land use and surface types would demand further efforts before the results of such merging or blending techniques could be made available to the wider user community (unfiltered) through SWIM. With respect to seamless prediction,
it was noted that there was progress but that challenges remain in providing a ‘seamless’ service, not least due to the distinct methods and techniques applied, while recognising that maintaining a consistent, coherent suite of information (through SWIM) was crucial. Given the ‘Big Data’ scenario and the variety of users within the ‘user community’, each with their own specific use cases, the choice of the ‘best’ (i.e. most appropriate, fit for purpose) source of information would be a vital element of the decision support systems, depending on whether there was a safety, efficiency or other such user need. The massive increase of available information in a data-rich (hyper-rich) environment with increasingly short decision time horizons will require the integration of MET outputs/data into mostly automated decision-making processes while maintain some form of a consistent, coherent human interpretation.

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 *<Additional text to be developed based on the discussions>*

1. **DISCUSSION**

**2.1 Review of the fifth edition (2016) of the GANP and expectations for the sixth edition (2019)**

2.1.1 In 2016, the Council and the Assembly of ICAO respectively adopted and endorsed a new fifth edition (2016) of the Global Air Navigation Plan (GANP) (ICAO Doc 9750), [available here](file:///%5C%5CINTERNAL.WMO.INT%5CUserData%5CRedirected%5CBVuitteney-Gelman%5CDocuments%5CDOCUMENTS%5CICAO%5CDoc.%209750-5th%20edition%5C9750_5ed_en.pdf). The 2016-2030 GANP has retained the aviation system block upgrades (ASBU) methodology – first introduced at part of the fourth edition of the GANP in 2013 – although the blocks themselves have now been organized into non-overlapping six-year time increments[[1]](#footnote-1). Four performance improvements areas[[2]](#footnote-2) of the ABSU methodology have also been retained (unchanged).

2.1.2 The GANP continues to represent a rolling, 15-year strategic methodology which leverages existing technologies and anticipates future developments based on States/industry agreed operational objectives. The ASBU methodology within the GANP is intended to enable aviation to realise global harmonization, increase capacity and improve environmental efficiency that modern air traffic growth demands in every region of the world. Through the GANP, ICAO is focussing its efforts at present on the development and implementation of performance-based navigation (PBN), continuous climb operations (CCO), continuous descent operations (CDO) and air traffic flow management (ATFM).

2.1.3 Aeronautical meteorology (MET) remains a key enabler to the realization of a globally interoperable, harmonized air traffic management (ATM) system, in particular through the information management domain/system-wide information management (SWIM). MET modules are a thread within the globally interoperable systems and data performance improvement area of the ASBU methodology, and are reflected mainly in the Communications and Information Management technology roadmaps within Appendix 5 of the GANP. Dependencies between modules – within and across performance improvement areas as well as across time block increments – are illustrated at Appendix 6 of the GANP. The MET modules have dependencies with several other modules, including but not limited to those addressing SWIM and digital ATM.

2.1.4 The GANP continues to offer a long-term vision for air transport modernization that will assist ICAO, States, industry and others to ensure continuity and harmonization among their modernization programmes. To find a balance between consolidation and keeping pace with new developments, the next edition of the GANP (sixth edition, 2019) is expected to undergo a more comprehensive update aligned with the six-year block periods referenced above.

2.1.5 At present, as preparation for the next edition of the GANP, ICAO is conducting a so-called ‘ASBU framework review’ as the technical part of the whole GANP reviewing activity. With this aim, ICAO has established an ASBU Panel Project Team (ASBU-PPT) to undertake this reviewing activity involving experts from many ICAO panels, including the Meteorology Panel (METP). Three METP experts, including one of the ET-ISA co-chairs, are contributing to this work.

2.1.6 As the next edition of the GANP would be published in 2019, the ASBU-PPT has been requested to focus mainly on Blocks 0 and 1 (2013-2018 and 2019-2024 respectively) and to provide detailed description of threads for these two blocks, whereas Block 2 (2025-2030) and beyond would simply be outlined. Since October 2016, the ASBU-PPT has held several teleconferences to review work progress. Modules such as AMET, SWIM, ACDM, TBO and others have been classified as ***operational* *threads*** or as ***information threads*** that may support the previous ones. AMET is one of the information threads for which the description editing activity intensified in February 2017 when it was requested that operational threads (e.g. CDO) should identify their dependencies with other threads as well as enablers to support their implementation. The ICAO Secretariat in charge of this activity then requested each thread leader to coordinate with MET experts to assist in identifying dependencies on MET of the thread elements.

2.1.7 During an ASBU-PPT face-to-face meeting, held in ICAO HQ during the first week of May 2017, almost all operational threads were reviewed in order to advance and, if possible, finalize the description of the thread (detailed elements), to identify the dependencies on other threads (such as meteorology) and the enablers, and to draft the performance analysis part, as included in the template of each thread description.

2.1.8 Information threads, such as meteorology, were also reviewed in such a way that relevant information threads' elements possessing dependencies with operational threads be easily identified. In this objective, METP experts conducted an intensive restructuring and rewording activity of the AMET thread template. The last edition of this template is now including the following elements as follows:

In Block 0:

* Meteorological observations products (AMET-B0/1)
* Meteorological forecast products (AMET-B0/2)
* Meteorological advisory and warning products (AMET-B0/3)
* Climatological and historical meteorological products (AMET-B0/4)
* Dissemination of meteorological products (AMET-B0/5)

In Block 1:

* Meteorological observations information (AMET-B1/1)
* Meteorological forecast information (AMET-B1/2)
* Climatological and historical meteorological information (AMET-B1/3)
* Meteorological information in SWIM (AMET-B1/4)

Through these two lists of elements, METP experts intend to highlight the foreseen transition from a product-centric environment to an information-centric environment, as well as the migration to the SWIM. In each element's description, detailed MET products and information requirements are listed. Each other operational thread would then be allowed to identify the MET requirements their implementation is dependent on. As a next step, the METP experts involved in ASBU-PPT still have to conduct the performance analysis for the AMET thread, following guidance to be provided by the ICAO Secretariat.

**2.2 Existing and foreseen information- and service-related requirements, including MET in future SWIM (ET-ISA focus)**

2.2.1 Since 2007, the Commission for Aeronautical Meteorology (CAeM) has been conducting an initiative towards the identification of aviation users’ needs in the terminal area around aerodromes and the definition of new products and services in support of Air Traffic Management (ATM), with a focus on those terminal areas with the highest density of air traffic. This activity was grounded on two factors that were noted:

* Firstly, the provisions of the meteorological service for the international air navigation held a gap between provisions for the enroute phases of flights (e.g. WAFS) and those to support airport operations (e.g. TAF), and
* Secondly, several innovative MET products and services to support operations in the terminal area were under development or even already in use in NMHSs of several WMO Members. There was no doubt that these services satisfied national users and that they still do; however, a real need for standardization and consequently for translation of ‘needs’ into ICAO requirements was identified.

2.2.2 The successive CAeM expert teams in charge of this initiative gathered and analysed the users’ needs standing ‘behind’ these innovative solutions for a MET service in the terminal area. The main characteristics emerging from this analysis were:

* high to very high temporal and spatial resolution for observations and forecasts (e.g. 0.1° or few km spatially; 5 to 15 minutes temporally),
* new parameters or phenomena considered (e.g. wind shear),
* first step in translation of adverse weather into impact based on operational thresholds (e.g. forecast of wind speed over the value that triggers break in ground handling,
* forecast of wind along approach paths,
* nowcasting of convective activity over stack areas with severity levels defined according to impact on operations),
* introduction of probabilistic information,
* service covering larger time ranges (from +5 minutes up to several days) but seamless in time, etc.

2.2.3 In the meantime, large programmes for ATM modernization such as CARATS in Eastern Asia, NextGen in the USA and SESAR in Europe emerged and emphasized again some of these fundamental characteristics from which requirements for MET services in support to ATM would be derived. First, users request seamless MET information in time and in space, with no inconsistency at air controlled sector borders. The implementation of new concepts defined within these large programmes and introduced in the Global ATM Operational Concept (ICAO Doc 9854) requires MET observation, nowcast and forecast information with high to very high temporal and spatial resolutions, the introduction of probabilistic information that would allow to address predictability or uncertainty in new ATM operating methods, and a user-oriented translation into impact of adverse weather. The activity currently conducted by ICAO Panels in preparation of the next edition of the Global Air Navigation Plan (GANP, ICAO Doc 9750) aims at identifying what key feature areas need to be improved in order to achieve a full implementation of GATMOC concepts. These key feature areas include meteorology that is seen as an enabler for a successful implementation of operational concepts (see paragraph 2.1). Recently, the ICAO Panels conducted an exercise consisting in establishing dependencies between meteorology and other key feature areas, dependencies that would at a later stage be derived in terms of detailed MET requirements. It is foreseen that those derived requirements will match those already identified and will bring further details into the process so that consolidated MET information and services requirements could be defined.

2.2.4 With the expected growth in aviation demand, economic pressures and attention to environmental impact, the ATM system will be increasingly reliant on accurate and timely information. Such information must be organized and provided by solutions that support system-wide interoperability, secured seamless information access and exchange and full integration of information into decision-support or aid systems. This applies to meteorological (MET) information. Aeronautical MET service providers have to fully engage in this transition from a product-centric environment (e.g. OPMET data in traditional alpha-numerical codes) to an information-centric environment that will allow the exchange of accurate, fit-for-purpose and timely MET information and its integration into ATM decision-support or aid systems. The ICAO document edited collaboratively by the ATM Requirements and Performance Panel (ATMRPP) and the MET Panel working group for MET Requirements and Integration (WG-MRI) with inputs from the CAeM, as the Concept for Integration of MET Information for ATM provides a detailed approach for this integration, taking into account ATM concepts, and impact translation of MET information allowing a better integration into ATM systems.

2.2.5 Integration of MET information into any air navigation system could also be seen as the positive outcome of all initiatives and efforts towards more interoperability. The need for more interoperability is directly linked to the transition to the SWIM environment. The current and globally known definition of SWIM is:

*SWIM consists of standards, infrastructure and governance enabling the management of the ATM-related information and its exchange between qualified parties, via interoperable services.*

In the MET domain, transitioning to the SWIM means applying the existing exchange model for meteorological information (i.e. IWXX), and its related format schemes (XML/GML) and defining, developing and implementing the delivery services that would allow users to access this meteorological information relevant for their operations and to integrate it into their decision-support systems. The governance of this exchange of MET information would also need to be defined. From all these efforts towards more interoperability and integration of MET information into the air navigation system as a whole, service-related requirements would be derived that all MET service provides would have to fulfil in the future SWIM environment.

**2.3 Existing and foreseen science and research requirements (ET-ASC focus)**

 ***“Blending” of nowcasting and high-resolution modelling***

2.3.1 The latest conference of the Aviation Research Demonstration Project (AvRDP) held in July 2016 in Hong Kong, China demonstrated the current state of the art in “blending” automated nowcasting techniques with high-resolution model forecasts run at very short intervals. While there are already some promising outcomes based on analysing the early stages of the model forecasts from an ensemble run with respect to extrapolation-based nowcast techniques, it appears that in complex topography and near distinctive boundaries between land-use and surface types significant further efforts will be required before the results of such merging or blending techniques could be made available to a wider user community through an “unfiltered” SWIM-type information system. These systems have distinctive advantages in terms of availability, transparency and applicability of data and information, but are built on the philosophy of “let the buyer beware”, i.e. they may require additional services in terms of scenario- and use-case dependent suitability for complex ATM planning horizons.

***Predictability, Probability and seamless prediction***

2.3.2 A central characteristic of future and emerging ATM systems will be use of SWIM by a multitude of users and use cases, whereby information for any 4-dimensional volume of airspace may be required simultaneously by different actors with significantly different time horizons, granularity requirements and impact translations of errors, time-and space related inconsistencies between different data and information sources. Progress and challenges in providing a seamless service from methodologically distinct techniques , maintaining coherent information, will be crucial for the success of MET for ATM information systems.

2.3.3 For different user communities, individual users and their specific use cases, the ‘Big Data’ approach favoured by some designers of SWIM systems will make the choice of the ‘best’ (the most appropriate) safety- and efficiency-increasing and risk-minimizing source of information a vital element of decision support systems. This will require the development of Impact-related performance measures, creating a new definition of “SMART” measures that are scientifically sound, meaningful to specific users, based on automated production with real-time availability, and technique-independent.

2.3.4 The massive increase of available data and information in a data-rich (hyper-rich) environment with increasingly short decision times for users will require the integration of outputs/data into mostly automated decision-making processes while maintaining human interpretation possible and coherent. This will depend on the ability of such systems to remain transparent in the weighting, prioritizing and ranking of the information sources used in the final decision recommendation to the humans finally responsible for the safety and efficiency of the activities.

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1. namely 2013-2018 for Block 0, 2019-2024 for Block 1, 2025-2030 for Block 3, and 2031 onwards for Block 3 [↑](#footnote-ref-1)
2. namely airport operations, globally interoperable systems and data, optimum capacity and flexible flights, and efficient flight paths [↑](#footnote-ref-2)