International Civil Aviation Organization

WORKING PAPER

ICAO Asia and Pacific (APAC)
Twenty-Sixth Meeting of the Meteorology Sub-Group
(MET SG/26)

Online, 1 to 5 August 2022

Agenda Item 4: Regional guidance material

UPDATES OF REGIONAL GUIDANCE FOR TAILORED METEOROLOGICAL INFORMATION AND SERVICES TO SUPPORT AIR TRAFFIC MANAGEMENT OPERATIONS

(Presented by MET/R WG Ad Hoc Group – Australia, China, Hong Kong, China, Japan (rapporteur), Republic of Korea, Singapore, Thailand, Vietnam and IATA)

SUMMARY

This paper proposes updates on the *Asia/Pacific Regional Guidance for Tailored Meteorological Information and Services to Support Air Traffic Management Operations* to enhance its contents related to improvement process of the meteorological information and services including post operational analysis of tailored meteorological information effect on ATM decisions. The draft of the updates has been developed by the ad hoc group and discussed during the MET/R WG/11.

1. INTRODUCTION

1.1 The *Asia/Pacific Regional Guidance for tailored Meteorological Information and Services to Support Air Traffic Management (ATM) Operations* is aimed at fostering States' implementation and enhancement of meteorological information and services for ATM (hereinafter referred to as *tailored MET services*) in the Region. It captures necessary processes from preparatory to operational phases. The stepwise (process-wise) structure of the Guidance is expected to allow each State to refer to suitable chapters, sections or subsections depending on its status of implementation of tailored MET services to support ATM, including commencement, implementation or improvement. Furthermore, it provides details of operational service practices with specific examples and operational scenarios in its Appendices.

1.2 This Guidance is maintained by the ad hoc group of the MET/R WG consisting of Australia, China, Hong Kong, China, Japan (rapporteur), Republic of Korea, Singapore, Thailand, Vietnam and IATA, and available on the ICAO Asia and Pacific (APAC) Electronic Documents (eDocuments) website (https://www.icao.int/APAC/Pages/eDocs.aspx). States are encouraged to share their related activities and provide specific examples and/or operational scenarios to enhance the Guidance and its appendices. The maintenance procedures and means of publication of the Guidance are provided in the *Note for Appendix 1 and 2* of the Guidance.

2. DISCUSSION

2.1 At the MET/ATM Webinar held in July 2021, the mechanism to analyse the effect of tailored MET services on ATM decisions and flight operations was discussed. In consideration of the discussion, at MET/R WG/10 subsequently held after the Webinar, the ad hoc group was tasked as follows:

MILESTONES	By date	Responsibility	Status
Deliverable 4: Draft regional guidance material for tailored MET information supporting ATM operations			
4.9 Consider expanding the Guidance document to define a framework to capture post operational analysis on the impact of tailored met information on ATM decisions	Next MET/R WG meeting	Ad hoc group	To begin

2.2 Although there have been already some related descriptions under Section 2.2 of the Guidance, the ad hoc group considered that it would be beneficial to focus more on the post operational analysis as an improvement process of tailored MET services, in view of the experiences in supporting ATM operations by providing tailored MET services in the Region.

2.3 In order to include more detailed description of the post operational analysis framework, process or method in the Guidance document, the ad hoc group is planning to collect States' experiences to explore common procedures. The group is also considering to expand Appendix 1 of the Guidance, which currently provides member States' examples of tailored MET services, to include their experience on the post operational analysis.

2.4 In May 2022, the MET/R WG/11 has decided to expand the maximum number of pages for each State's example in Appendix 1 of the Guidance from four to five to allow the States to include additional information on the post operational analysis. Besides, the meeting supported the adoption of Hong Kong, China's updated implementation example, describing the latest developments on its ATM-tailored MET information and includes a description of the post-operational analysis and continuous service improvement (MET/R WG/11 WP/05). The meeting also reached a consensus on some other minor changes, and tasked the ad hoc group with preparing the final draft of the updates for MET SG/26's approval. In addition, the meeting invited the WG members to provide their example on post-operational analysis by 30 November 2022. [**Decision MET/R WG/11/01**]

2.5 MET/R WG/11 supported the following Draft Decision for further consideration by MET SG/26.

Draft Decision MET/R WG/11/02: ***Update the Regional Guidance for Tailored Meteorological Information and Services to Support ATM Operations***

That, the MET SG approves the proposed updates to the *Asia/Pacific Regional Guidance for Tailored Meteorological Information and Services to Support Air Traffic Management Operations*.

2.6 The modification of the Guidance (excluding its appendices) is prepared as the Attachment A of this paper. Updated Hong Kong, China's example including their post-operational analysis and continuous service improvement is prepared as the Attachment B.

2.7 Noting the discussion above, it is recommended that the MET SG adopt the following Decision:

<table>
<tr><td colspan="3">Decision MET SG/26-XX – Update the Regional Guidance for Tailored Meteorological Information and Services to Support ATM Operations</td></tr>
<tr><td colspan="2">What: That, the MET SG approves the proposed updates to the Asia/Pacific Regional Guidance for Tailored Meteorological Information and Services to Support Air Traffic Management Operations.</td><td>Expected impact:
☐ Political / Global
☐ Inter-regional
☐ Economic
☐ Environmental
☒ Ops/Technical</td></tr>
<tr><td>Why: To provide States with up to date guidance material and make the updated version available on the ICAO APAC eDocuments website</td><td colspan="2">Follow-up: ☐Required from States</td></tr>
<tr><td>When: As soon as practicable</td><td colspan="2">Status: Adopted by Subgroup</td></tr>
<tr><td colspan="3">Who: ☐Sub groups ☐APAC States ☒ICAO APAC RO ☐ICAO HQ ☐Other:</td></tr>
</table>

2.8 The ad hoc group plans the subsequent schedule for updating the Guidance as shown in the Appendix of this paper.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) adopt the Decision in paragraph 2.7.

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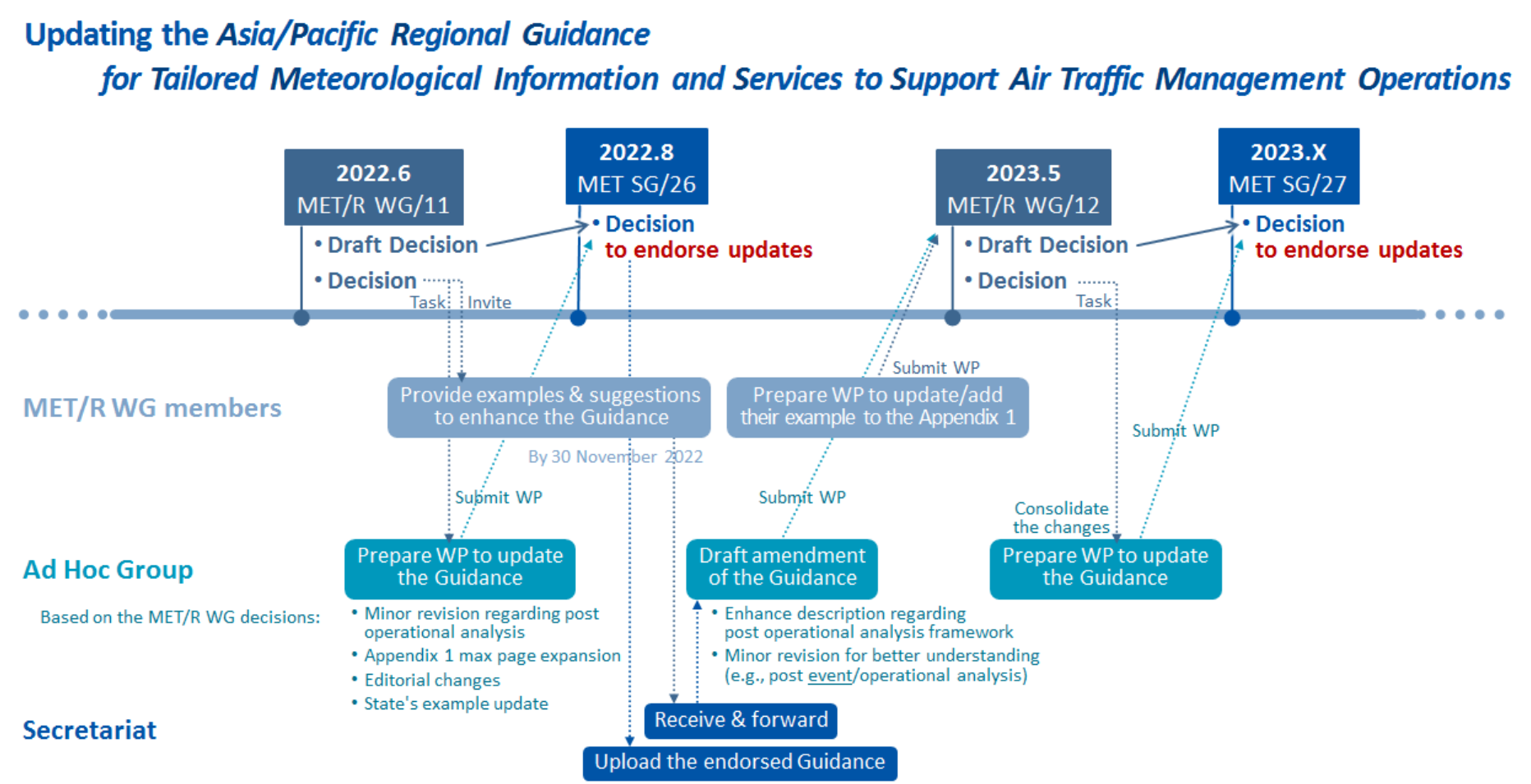
APPENDIX


Updating the Asia/Pacific Regional Guidance
for Tailored Meteorological Information and Services to Support Air Traffic Management Operations
2022.6
MET/R WG/11
• Draft Decision
• Decision
2022.8
MET SG/26
• Decision
to endorse updates
2023.5
MET/R WG/12
• Draft Decision
• Decision
2023.X
MET SG/27
• Decision
to endorse updates
Task
Invite
Task
MET/R WG members
Provide examples & suggestions to enhance the Guidance
By 30 November 2022
Prepare WP to update/add their example to the Appendix 1
Submit WP
Submit WP
Submit WP
Consolidate the changes
Ad Hoc Group
Based on the MET/R WG decisions:
Prepare WP to update the Guidance
• Minor revision regarding post operational analysis
• Appendix 1 max page expansion
• Editorial changes
• State's example update
Draft amendment of the Guidance
• Enhance description regarding post operational analysis framework
• Minor revision for better understanding (e.g., post event/operational analysis)
Prepare WP to update the Guidance
Secretariat
Receive & forward
Upload the endorsed Guidance

Attachment A

INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA/PACIFIC REGIONAL GUIDANCE FOR TAILORED METEOROLOGICAL INFORMATION AND SERVICES TO SUPPORT AIR TRAFFIC MANAGEMENT OPERATIONS

~~Second~~ Third Edition, ~~October 2021~~ XX 20xx

[Adopted by MET SG/~~25~~xx, Conclusion MET SG/~~25~~xx-~~10~~xx: Update to Regional Guidance for
Tailored Meteorological Information and Services to Support ATM Operations]

RECORD OF AMENDMENTS AND CORRIGENDA

Amendments			
No.	Date of issue	Date entered	Entered by

Corrigenda			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

1. Introduction

1.1 Purpose and overview of the guidance

1.1.1 This guidance aims to foster States' implementation and enhancement of meteorological (MET) information and services for air traffic management (ATM)[1] within Asia/Pacific (APAC) region.

1.1.2 The guidance captures most of the necessary processes from preparatory to operational phases. Furthermore, it provides detailed operational services, with specific examples and an operational scenario on ATM-tailored MET information and services. Information in this guidance can also be used to facilitate further improvement by the States who have already implemented ATM-tailored MET services.

1.1.3 A stepwise (process-wise) structure of the guidance is expected to allow each State to refer to chapters, sections or subsections useful for the commencement, implementation or improvement of its MET information and services to support effective ATM.

1.2 Development of the regional implementation guidance

1.2.1 ICAO APAC Meteorological Requirements Task Force (MET/R TF) 4th meeting, held in July 2015 in Tokyo, noted that so-called 'ATM-tailored' MET information, when provided to support international air navigation, is still required to comply with the Annex 3 - *Meteorological Service for International Air Navigation*, 'General Provisions'. However, the detailed technical specifications for the information has not yet been specified in Annex 3. The meeting also noted that specific regional guidance material is necessary to assist States in developing and implementing tailored meteorological information and services to support effective ATM and agreed to develop the regional guidance material.

1.2.2 An ad-hoc group consisting of Australia, China, Hong Kong, China, Japan (rapporteur), New Zealand, Republic of Korea, Singapore, Thailand and Vietnam was tasked to develop a regional guidance material for tailored meteorological information to support ATM operations.

1.2.3 Detailed historical background of efforts for implementation and enhancement of MET information and services for ATM in APAC Region is described in section 1.4.

1.3 Importance of ATM-tailored MET information and services

1.3.1 With unprecedented growth in air traffic movements in the Asia/Pacific Region, ATM is paramount for the continued assurance of safe, efficient and timely aircraft operations. Recognizing the importance, various States have continued to evolve their

[1] *Note. ATM is defined in PANS-ATM (Doc 4444) as follows;*
The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management – safely, economically and efficiently – through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.

ATM systems and procedures to meet the growing demand and to maintain safety as the priority. Additionally, neighbouring States are increasingly collaborating on activities such as Air Traffic Flow Management (ATFM[2]), which are enhanced by the incorporation of dedicated support from MET services.

1.3.2 Information sharing and collaborative decision-making (CDM) by relevant stakeholders are indispensable for the successful provision of effective and efficient ATM. Aircraft operations are influenced by atmospheric conditions and meteorological phenomena, and so adverse conditions can have a significant impact on ATFM planning and provision.

1.3.3 In APAC, we experience diverse weather features on a daily basis as the region is influenced by climates varying from tropic to sub-polar and is further complicated by geography including both broad land masses and wide oceanic areas. It is therefore critical that the region's ATM, and particularly ATFM operations are supported by tailored MET information and services to ensure safe, efficient and orderly aircraft operations.

1.4 Historical backgrounds

1.4.1 Since ICAO endorsed the *Global Air Traffic Management Operational Concept* (GATMOC, Doc 9854) in 1996, States have worked on the enhancement of ATM. In the APAC Region, since the late 1990s, ATM (and ATFM) has evolved significantly in many States. Subsequently, tailored MET information and services has been recognised as critical information for the effective provision of ATM and subsequently has been incorporated as part of the strategic and tactical ATM operations of those States. For example, in Japan, the Air Traffic Meteorology Center (ATMetC) of the Japan Meteorological Agency (JMA) was established in February 2006, as a specialized MET service provider for the Air Traffic Management Center (ATMC) of the Japan Civil Aviation Bureau (JCAB).

1.4.2 In 2001, the ICAO APANPIRG Communications/Navigation/Surveillance and Meteorology Sub-Group (CNS/MET SG) formed the MET/ATM Task Force (TF) to facilitate regional implementation of meteorological services in support of ATM. The first Regional MET/ATM Seminar was held at the ICAO Regional Office in Bangkok, Thailand, in February 2006. In order to enhance regional implementation, in 2009, APANPIRG agreed to call for the 1st meeting of the MET/ATM TF to plan the 2nd Regional MET/ATM Seminar and TF Meeting in the 2010 timeframe. In February 2011, the Seminar and the 2nd meeting of the TF were held in Fukuoka, Japan, where experts from MET, ATM and other international organizations in the APAC region gathered to discuss their plans and best practices on the development and implementation of meteorological services in support of ATM. The meeting also included a technical tour to the ATMetC to provide an example of the collaborative work undertaken between MET

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[2] *Note. ATFM is defined in PANS-ATM (Doc 4444) as follows:*

A service established with the objective of contributing to a safe, orderly and expeditious flow of air traffic by ensuring that ATC capacity is utilized to the maximum extent possible, and that the traffic volume is compatible with the capacities declared by the appropriate ATS authority.

and ATM organisations. Subsequent TF meetings, and later the MET/R Working Group, successor to the MET/ATM TF, continued the important work of developing regional guidance to assist Asia/Pacific States with implementation or improvement of MET information and services to support ATM.

2. Implementation procedures

2.1 Preparatory phase (processes toward implementation)

2.1.1 Communication channel establishment

2.1.1.1 The most important step in the implementation of ATM-tailored MET information and services is to establish a good communication channel for mutual collaboration between MET and ATM organizations through periodic meetings, tours to each operation room and so on. To develop and facilitate an implementation plan, it would be useful to exchange views and information and build mutual understanding of each other's services, through regular consultations and meetings with clear focus.

2.1.1.2 In addition, consultation with collaborative decision-making (CDM) stakeholders from the initial stage will be desirable for smoother and better planning. This will further assist in the implementation process, given that CDM is an essential element in the ATM operational concept and concerned parties including airspace users[3], such as major airlines, are encouraged to participate in CDM.

2.1.2 Service Identification

2.1.2.1 Understanding ATM and aircraft operations

ATM operations vary in each State depending on its technical capabilities and characteristics of their responsible airspace. Better understanding of the State's ATM system is necessary to determine the scope of MET information and services to support ATM. This aspect will assist in understanding the local ATM requirements and determining the most appropriate process.

Additionally, procedures for aircraft operations adopted by airlines are also important in defining ATM-tailored MET information and services. The safety and efficiency of aircraft operations are fundamentally dependent on weather conditions. For example, each aircraft has maximum crosswind threshold values for take-off and landing. Adverse weather conditions may force aircraft to fly irregular flight routes and conduct unusual operations, which could result in significant diversion from the normal and planned distribution of air traffic. In this context, understanding aircraft operational procedures is helpful in designing a *fit-for-purpose* MET information and services.

[3] *Note. Airspace users is defined in Global Air Traffic Management Operational Concept (GATMOC) (Doc 9854) as follows;*
The term airspace users mainly refers to the organizations operating aircraft, and their pilots.

2.1.2.2 Past Events and Case Studies

Investigation of MET-related impacts on air traffic flow is essential to determine what kind of MET information and services are required to effectively support ATM. One practical approach, in cooperation with airlines, is to compare operational records (including causes of delay, if available) with past weather data.

Once ATFM is implemented, focus could be on more direct ways to use the flow management records in the ATFM process in addition to the aircraft operations records for the comparison with past MET data.

2.1.2.3 Service proposal (Proposal from MET organization)

Through the process mentioned in 2.1.2.1 and 2.1.2.2, it is expected to obtain better understanding of the ATM processes based on aircraft operational procedures and possible weather impact on air traffic flow. The next step would be to develop a draft plan for MET information and services in support of ATM and to provide a proposal to the ATM organization. The proposed plan could be conceptual process with specific explanation and prototypes of MET information or services, should be sought on the proposal.

2.1.2.4 Service development (Requirements from ATM organization)

With the feedback from the ATM organization described in 2.1.2.3, the MET and ATM organisations could modify and make necessary changes to the proposed plan. This will ensure that both parties (MET and ATM) are aware of the requirements and limitations and are able to adopt a practical plan for the region.

This would be an iterative process, until the proposed plan for MET information and services becomes matured.

2.1.2.5 Service definition

Once the proposed plan is mature, the provision of MET information and services in support of ATM can be formalized. The plan should also describe how the ATM tailored MET products will be utilised in conjunction with the other MET products, are made available to the airspace users in a timely fashion so that all stakeholders are in possession of the same information at the same time. It may be that bespoke MET information solutions, tailored to the specific ATM service provider, are also made available to the airspace users as part of CDM arrangements.

2.1.3 System development

The next step is to develop a system and associated software applications necessary to provide ATM-tailored information and services defined in section 2.1.2.5.

2.1.4 Trial run of the system and service

It is essential to conduct a trial of the system and procedures to test secure delivery of the defined MET information and services. If any issues are identified through the trial, they should be resolved through close consultation with the stakeholders concerned (mainly the ATM organizations), before the service becomes operational. In addition, the trial process will assist in determining the system reliability. The outcomes of the trial and lessons learnt should be well documented to assist with future requirements.

2.1.5 Service provision agreement

In parallel with the system development, to ensure that continuous provision of the defined MET information and services is maintained, it is important to formalize a written agreement (or to amend an existing agreement, if applicable) between the MET and ATM organizations. The Agreement should include the MET and ATM capabilities, and outline the operational processes, the working relationship and the communication channels. When such an agreement is later implemented with airlines or other stakeholders, existing agreements should also be amended accordingly.

2.2 Operational phase (processes for continuous improvement)

2.2.1 Operational trial

Before MET information and services are provided operationally, an operational trial should be conducted so that forecasters and ATM officers can familiarize themselves with the provision and usage of the new information and services. The trial period should be set based on agreement between the parties concerned. A post implementation of the operational trial should be conducted to ensure lessons learned from the process are documented and improvements are made prior to implementation.

2.2.2 Provision of MET information and services

MET information and services developed according to the process described in 2.1 are provided to ATM officers in accordance with the service provision agreement between the MET and ATM organizations.

2.2.3 Verification and evaluation

After the implementation of ATM-tailored MET information and services, it is required ~~(i)~~ to regularly verify and evaluate its quality to ensure that it practically supports ATM ~~and (ii) to improve MET information and services~~. Also, when a meteorological condition has a significant impact on ATM, it is also recommended that stakeholders conduct a post-event analysis to identify lessons learnt.

2.2.4 Continuous improvement

Regular evaluation meetings between relevant parties such as airspace users, ATM and MET organizations are one of the basic approaches to continuously improve the implemented information and services. These meetings should draw from the results of verification and evaluation as well as lessons learnt from significant events, to identify changes and innovations to continually improve MET information and services.~~When a meteorological condition has a significant impact on ATM, it is also recommended that stakeholders conduct a post-event analysis to identify lessons learnt and subsequent improvements.~~

3. MET information and services in support of ATM

In this chapter, some examples of MET information and services that are effective for supporting ATM operations are discussed. As it will require budget, resources, technology, and time to introduce relevant MET information and services, some of which may not be defined in ICAO Annex 3, it is worthwhile to consider implementing them in a stepwise manner, depending on the situation in each State.

Examples of MET information and services for ATM in some States are described in Appendix 1. In addition, operational scenarios of MET/ATM collaboration, such as how MET information and services are provided to ATM officers, are described in Appendix 2.

3.1 Participation of MET organizations in CDM

3.1.1 CDM is an approach where relevant stakeholders share necessary information in order to make decisions collaboratively to enable enhanced ATM operations. This process involves a collaboration of stakeholders to generate products suitable for better pre-tactical traffic management strategies and optimised use of available capacity. The expected role of a MET organization in CDM is for aviation forecasters with an understanding of the effects of meteorology on ATM to provide necessary meteorological information at and around relevant aerodromes and air routes in a timely manner.

3.1.2 To achieve effective CDM, aviation forecasters should have a basic understanding of ATM and Air Traffic Control (ATC) procedures, such as, inter alia, runway weather minima and aircraft operating criteria so that they would be able to foresee aviation impacting weather and provide appropriate briefings to ATM and ATC in a timely manner.

3.1.3 Where an event or phenomena has a significant impact on normal air traffic flows (e.g.: mass deviation of aircraft), it is vital to ensure that common situational awareness is maintained at all times among affected stakeholders. Rapid identification of the possible cause of such a situation (e.g. adverse meteorological conditions, runway closure) allows both ATM and MET organizations to take immediate action in a collaborative manner to mitigate the impact.

3.2 Weather briefing in support of ATM

3.2.1 Direct weather briefings for ATM officers is an effective method to share current and expected weather assessments in and around major aerodromes and air routes, including any expected impacts on aircraft operation and air traffic flow.

3.2.2 Regular weather briefings in support of ATM may be provided several times per day. Depending on rostered shift arrangements in ATC centres, MET briefings may be scheduled for groups of controllers just prior to commencing their operational duty.

3.2.3 Where unexpected weather phenomena may affect aircraft operation and/or air traffic flow, or the actual weather deviates significantly from that forecast, a special briefing should be provided by aviation forecasters. Special briefings can be either proposed by aviation forecasters or requested by ATM officers.

3.3 ATM-tailored meteorological information

3.3.1 Impact-based weather information

3.3.1.1 Tailored MET information that shows possible impact on air traffic flow (e.g. when and where the weather phenomenon affects air traffic flow) can be useful to support the management of air traffic capacity in each ATC sector and execution of air traffic flow controls.

3.3.1.2 Information that is relevant to the impact to air traffic flow will be extremely valuable; for example, a probabilistic forecast of impact to ATFM may provide a quantitative estimate of reduction in air traffic capacity. To develop such *impact-based* information, consensus among stakeholders has to be developed regarding relationships between specific meteorological conditions and their possible impacts on air traffic flow.

3.3.2 Information for common situational awareness

3.3.2.1 It would be helpful for ATM representatives and other relevant stakeholders to understand the background of relevant meteorological conditions (e.g. occurrence process and characteristics), as well as the associated forecast confidence, which would facilitate risk assessment to enable more effective and efficient ATM operations. It is desirable to provide relevant graphical information which can explain meteorological conditions effectively, such as pressure distribution charts, weather radar and satellite imagery, and/or weather advisories with simple associated descriptions.

3.4 Information and products developed for other use

3.4.1 Existing meteorological information may also be useful to support ATM. Some examples are listed below.

- OPMET information
- Volcanic ash advisory (VAA) and tropical cyclone advisory (TCA)
- WAFS products (Wind and Temperature (WINTEM) chart, SIGWX chart and gridded global forecast of wind, temperature, cumulonimbus clouds, icing and turbulence)

- Real-time observational data at congested aerodromes
- Weather radar imagery
- Specific phenomena based information, such as Thunderstorm and lightning information
- Satellite imagery and derived products
- Nowcasting products
- Numerical weather prediction data and derived products
- Earthquake and tsunami information
- Space weather

3.5 Means of provision

3.5.1 Dedicated information sharing system

3.5.1.1 To facilitate CDM, information sharing among all relevant stakeholders in MET and ATM is necessary, to ensure common situational awareness is maintained. In order to support ATM operations, a system should be acquired or developed which enables ATM officers to utilize MET information at any time. Similarly, aviation forecasters need an environment through which they can look at ATM-related information to provide appropriate MET information. It is thus required that dedicated systems for information sharing between MET and ATM organizations be established, so that ATC officers and aviation forecasters can effectively exchange information operationally.

3.5.2 Means of communication

3.5.2.2 Listed below are some examples of how ATM stakeholders can communicate and share necessary information.

- The aeronautical fixed service (i.e. AFTN/AMHS)
- Hotline (direct phone line)
- Web-chatting system
- Telephone or video conference system
- Use of common CDM software/application
- Joint use of an operation room
- Information sharing web-portal

4. Future progress in MET/ATM services

4.1 Global Air Navigation Plan (GANP)

4.1.1 In 2014, the 38th Session of the ICAO Assembly amended the Global Air Navigation Plan (GANP) and formulated the Aviation Systems Block Upgrades (ASBUs), the implementation plan of the GANP, as proposed by the twelfth ICAO Air Navigation

Conference (AN-Conf/12). The ICAO Meteorology Panel (METP) was established in September 2014 is tasked with providing standard and recommended practices for MET information and services in support of ATM for the terminal area and in line with the aviation system block upgrades (ASBU).

4.1.2 In the future, States in a position to do so would be required to provide ATM-tailored MET services based on globally consistent requirements. Since this global standardization is being welcomed among users such as airlines and pilots, the States in the APAC Region may adapt their systems accordingly when such standards are available.

4.2 Future integration of MET information into ATM decision-making

4.2.1 The ICAO Air Traffic Management Requirements and Performance Panel (ATMRPP), in coordination with the METP and other panels concerned, has discussed future integration of MET information into ATM decision-making system, along with the Global Air Traffic Management Operational Concept (GATMOC) (ICAO Doc 9854). The "Concept for the integration of Meteorological information for ATM" has been developed by the ATMRPP and other bodies concerned. It provides guidance on methods and procedures to interpret MET information as it relates to possible constraints on air traffic flow. It supports estimation of the potential impact of the meteorological condition to ATM and provides ATM officers with possible actions to be taken, e.g. selecting the safest routes while minimising diversions.

4.3 Next generation air transportation system developments

4.3.1 To deal with growing air traffic congestion, some States or Regions have been planning the development of next generation air transportation systems. These include NextGen (United States), SESAR (Europe) and CARATS (Japan). It is important for MET organizations to make the best effort to improve their capability in the provision of MET information and services to meet such future requirements and facilitate the development of a new generation air transportation system.

References

- International Civil Aviation Organization (ICAO) Annex 3 - Meteorological Service for International Air Navigation
- Global Air Traffic Management Operational Concept (Doc 9854)
- Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services (Doc 9377)
- Air Traffic Management (Doc 4444)
- GANP Portal (https://www4.icao.int/ganpportal/)

Acronyms

AN-Conf	Air Navigation Conference
APAC	Asia and Pacific region
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
ASBU	Aviation System Block Upgrades
ATC	Air traffic control
ATFM	Air traffic flow management
ATM	Air traffic management
~~ATMC~~	~~Air Traffic Management Center~~
~~ATMetC~~	~~Air Traffic Meteorology Center~~
ATMRPP	Air Traffic Management Requirements and Performance Panel
CARATS	Collaborative Actions for Renovation of Air Traffic Systems
CDM	Collaborative Decision Making
GANP	Global Air Navigation Plan
GATMOC	Global ATM Operational Concept
ICAO	International Civil Aviation Organization
~~JCAB~~	~~Japan Civil Aviation Bureau~~
~~JMA~~	~~Japan Meteorological Agency~~
MET	Meteorological services for air navigation
MET/ATM TF	Meteorology/Air Traffic Management Task Force
METP	Meteorology Panel
MET/R WG	Meteorological Requirements Working Group
NextGen	Next Generation Air Transportation System
OPMET	Operational Meteorological/Meteorology
SESAR	Single European Sky ATM Research
SIGWX	Significant Weather
TCA	Tropical Cyclone Advisory
VAA	Volcanic Ash Advisory
WAFS	World Area Forecast System
WINTEM	Wind and Temperature

Note for Appendix 1 and 2

- The example from each State for Appendix 1 should ~~be up to four pages,~~ follow~~ing~~ the format below:
  1. ATM-tailored MET information and services
     - ✧ MET information and/or services for ATM, excluding OPMET information
     - ✧ One section for each MET information or service
       e.g. Dedicated MET information, Participation in CDM, Briefing for ATM officers.
  2. Means of Provision
     - ✧ Means of MET information provision for ATM officers, such as dedicated information provision system
  3. Other useful information (if any)
     - ✧ Collaboration with ATM officers for MET information and/or services improvement~~–~~ (e.g. regular meeting, collaborative post event analysis)
     - ✧ Verification of MET information described in ~~chapter~~ "1. ATM-tailored MET information and services".
     - ✧ Implementation history of ATM-tailored MET information and services, including how long it took to implement such information and services.
- Each State's example for Appendix 1 should be up to four (4) pages. Five (5) pages are allowed in the cases that the post-operational analysis is included in the contents.
  - ✧ To avoid increasing the pages, states are encouraged to provide general and/or essential information. States may include links to WPs/IPs and/or their public website in their examples to show supplemental or advanced information.
- The operational scenario from each State for Appendix 2 should be up to four (4) pages.
- Maintenance procedure
  - ✧ States, who wish to add or update their own examples or operational scenarios, would need to submit WPs describing the drafts of examples to MET/R WG for discussions and/or adoption.
  - ✧ The ad hoc group of the MET/R WG is to consolidate the changes and seek MET SG's endorsement for updating the guidance.

- Means of publication
  - ✧ Each example and operational scenario of Appendix 1 and 2 is published on the

ICAO APAC website (APAC eDocuments) with separated PDF files considering the user's accessibility to the information.

Hong Kong, China

1. ATM-tailored MET information and services

Under the agreement between the Hong Kong Observatory (HKO) and Civil Aviation Department (CAD), HKO provides a suite of ATM-tailored MET information and services in support of international air navigation.

1.1 Tactical Decision Products

1.1.1 To facilitate tactical decision making of the air traffic controllers (ATC), tailored MET information is ingested into CAD's Air Traffic Management System (ATMS). The MET information includes: a) 10 layers of Constant Altitude Plan Position Indicator (CAPPI) imageries from 1 km to 10 km with range 256 km of the two Doppler weather radars in Hong Kong; and b) 1 layer of the HKO Aviation Thunderstorm Nowcasting System (ATNS) 1 hour nowcast for the assessment of the significant convection over HKFIR at 3 km height.

1.1.2 On the ATC console of the ATMS, either weather radar imagery of a specific height or an ATNS forecast can be chosen to be overlaid with the aircraft indicators (Figure 1). Further details can be found in the presentation included in Joint Session ATFM/SG/7 and MET/R WG/6.

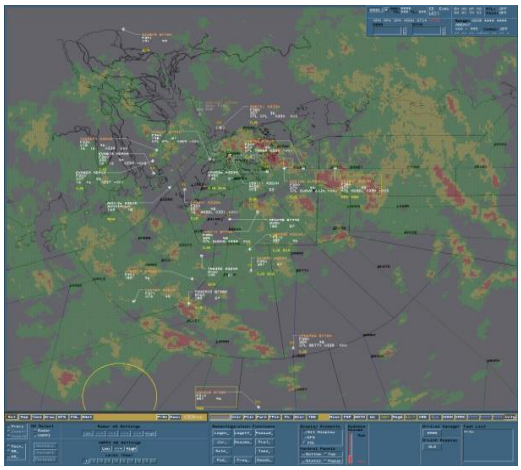

Figure 1. ATC console display showing aircraft positions overlaid on a CAPPI imagery

1.2 Meteorological Services for Terminal Area (MSTA) Products

1.2.1 The Hong Kong Air Traffic Flow Management Unit (ATFMU) of CAD regularly assesses the capacity of the Hong Kong International Airport (HKIA), which depends on both the runway and airspace capacity, in the next few hours. In collaboration with CAD, HKO has been providing tailored MSTA, grouped under the product named Significant Convection Monitoring and Forecast (Figure 2), to support ATFM operation since 2010. These are briefly summarized in the following paragraphs. Further details can be found in MET/R TF/3 WP07.

1.2.2 The suite of MSTA products to support runway capacity estimation includes amongst others, ATNS to automatically forecast the future location of weather cells that may block the intended flight path or significant waypoints in the airspace. While forecasts of products D, E, and G in Figure 2 are generated automatically, they could be adjusted manually by Aviation Forecasters.

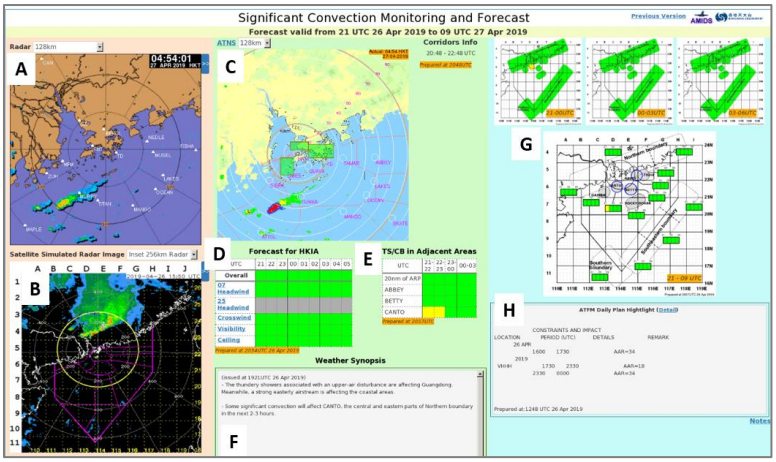

Figure 2. Integrated display of the MSTA: A) Choice of actual radar at different ranges and lightning overlays; B) Radar blended with satellite simulated radar image developed using Artificial Neural Network technology; C) 2hr convection nowcast for arrival/departure corridors by ATNS; D) 9hr performance-based weather forecast for the aerodrome; E) 6hr convection forecast around HKIA and major waypoints; F) weather synopsis around HKIA and the major waypoints; G) 12hr significant convection forecast time series for key ATC areas based on blended NWP and nowcasting outputs; and H) ATFM Daily Plan.

1.2.3 All the above products/systems use three levels of colour code to indicate the impact to air traffic, viz GREEN for mild or no impact, AMBER for medium impact and RED for significant impact. Though the actual criteria for defining the colour codes vary across different forecast products, the simple three levels of colour code are adopted uniformly in all the products described above. The Significant Convection Monitoring and Forecast also includes the latest ATFM Daily Plan issued by ATFMU after taking into account the above significant convection nowcast and forecast information as well as consultation by Aviation Forecaster via regular and ad hoc weather briefings (para.1.7 below).

1.3 Arrival Management and other Miscellaneous tailored Products

1.3.1 25 layers of gridded upper wind and temperature forecasts over HKFIR at a resolution of 0.2 degrees at hourly interval for up to 24 hours are provided to ATMS for trajectory prediction of individual aircraft and a system for aircraft arrival sequencing.

1.3.2 Apart from the above products, other major tailored products include a) Weather Summary for HKIA which includes, inter alia, local winds, radar, satellite, lightning information and lightning alert for the airport, weather synopsis, aerodrome forecast with possible alternative scenario, TAFs of nearby airports, SIGMET for the HKFIR, TC track, weather analysis and forecast charts (Figure 3); b) HKIA Local Routine/Special Report and c) MET page showing the latest observation, data from the Automatic Meteorological Observing System, windshear alerts, forecast of HKIA and neighbouring aerodrome.

1.4 Lightning Nowcast Products

1.4.1 For the protection of ground personnel from being injured by lightning strikes, HKO has developed the Airport Thunderstorm and Lightning Alerting System (ATLAS), a nowcasting system for detecting and nowcasting lightning activities over HKIA. The system generates RED or AMBER alerts based on either detection or forecast of cloud-to-ground lightning activities (CG). When CG is detected within 10 km or forecast to be within 5 km from the ARP, AMBER alert will be issued. When CG is detected or forecast to be within 1 km boundary of the alert zones (respectively encompass the Chek Lap Kok Island, and the majority of passenger and cargo apron), RED alert will be issued for the corresponding zone.

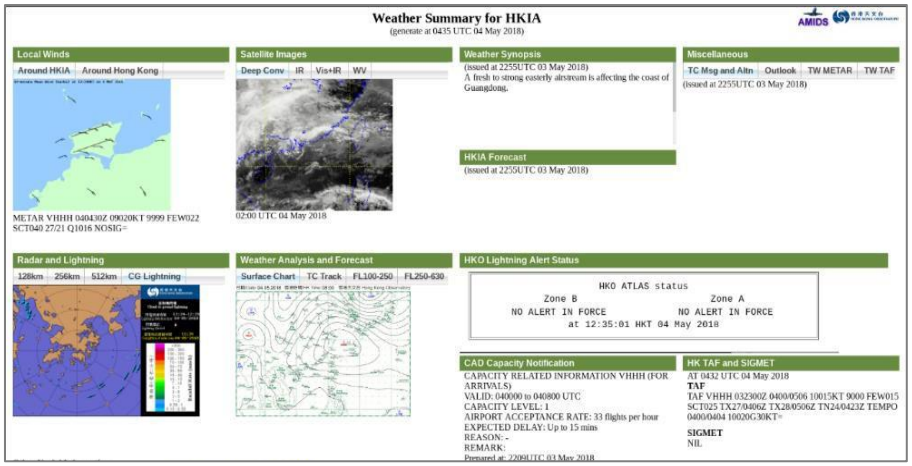

Figure 3. HKO Weather Summary for HKIA

1.5 Integrated monitoring system for MET-ATM

1.5.1 HKO has developed two integrated monitoring pages for aviation forecasters to appreciate the weather impact on air traffic. One displays the real time aircraft positions together with weather radar (Figure 4, Left). Another one displays arrival and departure rates and any traffic interruption messages from ATIS and NOTAM (Figure 4, Right). These two pages heighten common situation awareness and enhance the communications between MET and ATM office particularly during weather briefings (para. 1.7 below).

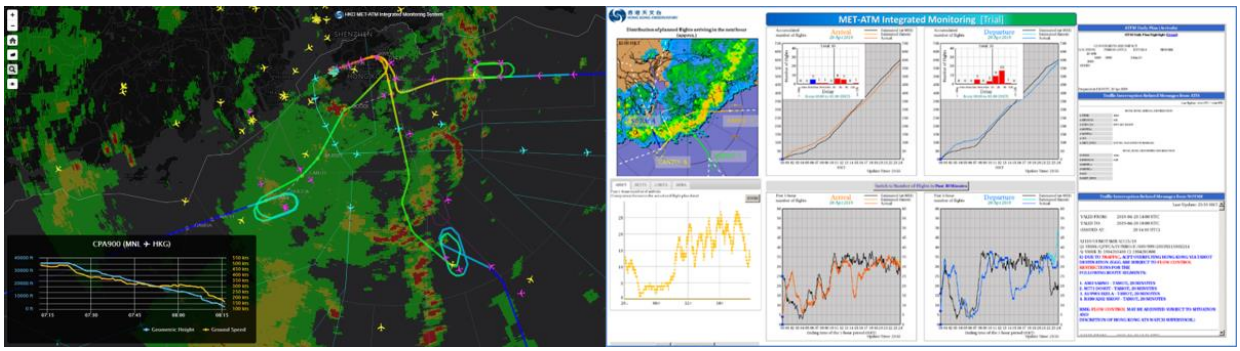

Figure 4. MET-ATM Integrated Displays showing arrival flights forced into holding patterns due to convective activities (Left) and the arrival/departure rates (Right).

1.6 Regional SIGMET monitoring

1.6.1 To support Hong Kong ATFMU's participation in Distributed Multi-Nodal ATFM Network trial operation, HKO has developed an Integrated Monitoring webpage to show real-time en-route hazardous weather within the APAC region. Information provided includes SIGMET, advisory information, VONA, METAR, TAF, PIREP, global satellite imageries, radar reflectivity, lightning, numerical weather prediction data, significant convection and turbulence forecast, etc., for ATFMU's reference (Figure 5).

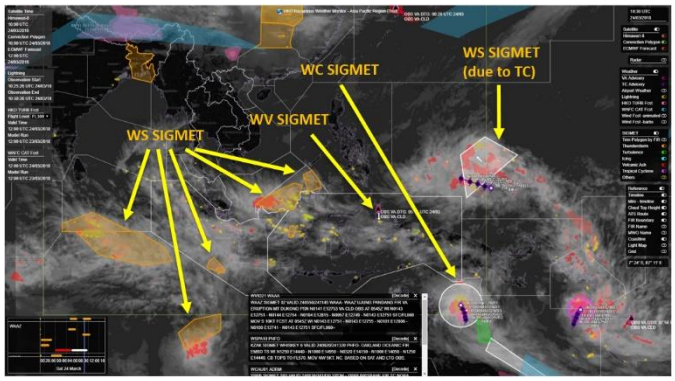

Figure 5. HKO Regional SIGMET Monitoring Page

1.7 Weather briefing

1.7.1 HKO provides MET weather briefings to ATFMU/ATC three times a day, once in the early morning, once at noon and once in the early evening, through teleconference. The briefings mainly make use of the MSTA products and the Weather Summary for HKIA discussed under 1.2 and 1.3.2 above. Timely updates are also provided through a hotline should there be any change in the weather conditions.

1.8 Special alerting service for high impact weather

1.8.1 To provide advance alerts to ATM, the Airport Authority and the local aviation stakeholders on the approach of tropical cyclone (TC), HKO provides a whole series of information and alerting services. After a TC is formed in the western North Pacific or the South China Sea (SCS), HKO will send an automatic email to the aviation community subscribers whenever the location or forecast movement track of the TC is updated. When the TC is about to enter the SCS, an alert will be sent to users' mobile phone via an instant messaging app on possible impact to HKIA or HKFIR. In case the TC is expected to move close to HK posing a risk to air traffic over HKIA, special weather briefings are conducted for the aviation community at HKIA to heighten common situation awareness and to support Collaborative Decision Making.

2. Means of Provision

2.1 The tactical decision products and the arrival management products discussed under para. 1.2 and 1.3.1 respectively are ingested directly into CAD's ATMS. Products under para. 1.3.2 are sent to CAD's ATS Data Management System (ATSDMS).

2.2 Most of the products, including Met information required by ICAO, MSTA and miscellaneous tailored products are provided via the web-based Aviation Meteorological Information Dissemination System (AMIDS) (Figure 6).

Figure 6. HKO AMIDS

2.3 To support the need for efficient communication with stakeholders especially during

high impact weather scenarios (e.g. approaching tropical cyclones), a WeatherChat WhatsApp group was set up in 2020 to update users with the latest assessment of high impact weather (e.g. high winds, extensive severe thunderstorms, prolonged significant windshear and severe turbulence, etc.) that might affect the aerodrome and HKFIR.

2.4 To update the stakeholders on the latest developments of aviation weather service, MET product guidance, non-local aviation meteorological hazards of general interests and other interesting meteorological topics, a "HK Aviation Weather Services Facebook" page was launched in 2021 to provide more casual but informative content to registered users.

3. Post operational analysis and continuous service improvement

3.1 Regular high-level meetings with CAD and the Airport Authority Hong Kong are conducted on an annual basis. Regular working level meetings with ATC are held generally a few times every year. These regular meetings review and evaluate the usefulness of the meteorological information provided, present the latest developments in aviation weather services and foster related discussions.

3.2 In relation to the special weather briefings for high impact weather (e.g. tropical cyclones) as mentioned in 1.8.1, a debriefing session would be arranged after the event to collect stakeholders' feedback and seek opportunities for further improvements (Figure 7).

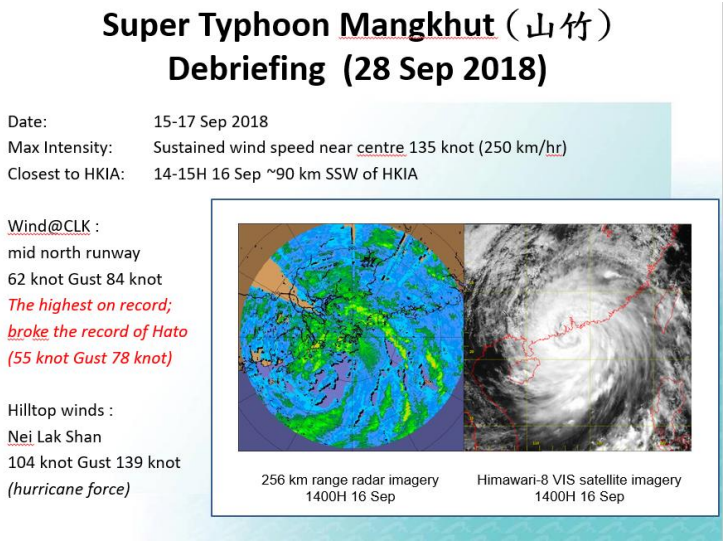

Figure 7. Debriefing slide on the record-breaking Super Typhoon Mangkhut that affected Hong Kong in September 2018

3.3 To continuously monitor the performance of tailored products, in which some are derived from ICAO Annex 3 products, HKO operates the Aviation Forecast Verification System (AFVS) to perform verification by objective means. The related ICAO Annex 3 products are verified against METAR/SPECI and satellite imageries. Further details on the verification algorithm can be found in MET SG/19 IP/26.

3.4 For tailored MSTA products mentioned in 1.2, an objective verification scheme was developed to verify the colour-coded impacts against radar imageries. Objective verification scores (e.g. probability of detection, false alarm ratio, critical success index, bias, etc.) are regularly generated to assess the performance of ATNS as well as improvement contribution by the aviation forecasters.