International Civil Aviation Organization

The Eighth Meeting of the APANPIRG ATM Sub-Group

Video Teleconference, 23 – 27 November 2020

Agenda Item 7: AOP, MET, AIM, SAR

METEOROLOGY ISSUES RELEVANT TO ATM

(Presented by the Secretariat)

SUMMARY

This paper presents an overview of meteorology (MET) issues relevant to ATM arising from the work programme of the Meteorology Sub-group (MET SG) and its contributory bodies.

1. INTRODUCTION

1.1 The Meteorology Sub-group (MET SG) supports the Asia/Pacific (APAC) Air Navigation Planning and Implementation Regional Group (APANPIRG) in carrying out its work programme to support the APAC States/Administrations' planning and implementation of required MET service for international air navigation.

1.2 In turn, the MET SG divides its work programme into the following contributory bodies, focused on specific technical areas: Meteorological Information Exchange Working Group (MET/IE WG), Meteorological Services Working Group (MET/S WG), Meteorological Requirements Working Group (MET/R WG) and the Volcanic Ash Exercises Steering Group (APAC VOLCEX/SG).

1.3 This paper highlights some of the main issues being considered by the MET SG and its contributory bodies, which might be of interest to or require further coordination or consideration by the ATM SG.

2. DISCUSSION

APAC Seamless ANS Plan

2.1 Under the terms of reference, the objectives of the MET SG include facilitating the implementation (by States) of aeronautical meteorological systems and services as identified, *inter alia*, in the APAC Seamless ANS Plan elements.

Regional Guidance for Tailored Meteorological Information and Services to Support ATM Operations

2.2 In order to assist States in developing and implementing tailored meteorological information and services to support effective air traffic management (and specifically to support follow-up action on Conclusion ATM/SG/5-2), APANPIRG/29 (Sep 2018) approved the *Asia/Pacific Regional Guidance for Tailored Meteorological Information and Services to Support Air Traffic Management Operations* (located at the ICAO Asia and Pacific Office website) as a reference for States and Organizations concerned [Conclusion APANPIRG/29/25: APAC Regional Guidance for MET Information Supporting ATM].

2.3 Based on the new developments and examples from Hong Kong, China, Singapore and Republic of Korea, MET SG/24 (November 2020) is expected to approve updates to the *Asia/Pacific Regional Guidance for Tailored Meteorological Information and Services to Support Air Traffic Management Operations* for publishing on the ICAO website (see **Attachment 1**).

IWXXM implementation

2.4 The SARPs introduced by ICAO to Annex 3, which require meteorological information (including METAR/SPECI, TAF, SIGMET, AIRMET and volcanic ash, tropical cyclone and space weather advisory information) to be disseminated in IWXXM GML form were designed to foster the future SWIM environment, which will include meteorological, aeronautical and flight information, amongst others.

2.5 Although some APAC States are progressing well towards full compliance with the Annex 3 SARPs for IWXXM, a recent survey of States indicated that probably no more than half of APAC States have implemented or planned the implementation of dissemination of METAR/SPECI and TAF in IWXXM GML form.

2.6 To support States, the ICAO APAC Office recently hosted a Webinar on the implementation of IWXXM (https://www.icao.int/APAC/Meetings/Pages/2020-IWXXM-Webinar-.aspx).

Space Weather

2.7 In accordance with Annex 3, the space weather information service to support international air navigation was implemented on 7 November 2019.

2.8 A Meteorology Panel (METP) coordination group is tasked on the initial coordination and governance of the space weather information service. This includes facilitating the coordination between the designated space weather centres.

2.9 The MET SG is coordinating the preparation of updates to the Regional OPMET Bulletin Exchange Scheme to facilitate the exchange of space weather service information in the APAC Region.

APANPIRG Air Navigation Deficiencies

2.10 The current list of APANPIRG air navigation deficiencies in the MET field (APANPIRG/30 refers) contains fourteen (14) open deficiencies related to facilities and services in nine (9) Asia/Pacific States, as summarized in **Table 1**, below.

Table 1: Summary of APANPIRG air navigation deficiencies in the MET field

MET facilities and services	Asia/Pacific States	Def. ID	Status
Aerodrome meteorological observations or reports	Kiribati Nauru Solomon Islands	AP-MET-02 AP-MET-21 AP-MET-01	open open open
Meteorological watch office (MWO) or SIGMET information	Democratic Peoples' Republic of Korea Nauru Nepal Papua New Guinea Papua New Guinea Solomon Islands	AP-MET-16 AP-MET-24 AP-MET-14 AP-MET-08 AP-MET-22 AP-MET-23	open open open open open open
Volcanic ash/activity information	Papua New Guinea Tonga	AP-MET-04 AP-MET-17	open open
WAFS forecasts and/or flight briefings	Kiribati Nauru Solomon Islands	AP-MET-18 AP-MET-19 AP-MET-20	open open open

SIGMET coordination

2.11 A number of States/Administrations in the APAC Region are participating in international projects to support the issuance of coordinated, harmonized SIGMET information across international boundaries. These activities provide benefits to both the suppliers and users of SIGMET information.

Survey of State Meteorological Information Supporting Air Traffic Management

2.12 In order to inform ICAO (and States) of the provision of current and future meteorological (MET) information services by States specifically to support Air Traffic Management (ATM), in particular Air Traffic Flow Management (ATFM), MET SG/24 (November 2020) will consider approving the terms of reference for a survey of State Meteorological Information Supporting Air Traffic Management for circulation to States in early 2021 (see **Attachment 2**).

APAC User Requirements for SWIM-based MET Information Services Supporting ATFM

2.13 MET SG/24 (November 2020) will consider supporting further development on the proposed *APAC User Requirements for SWIM-based MET Information Services Supporting ATFM*. The work would specifically consider the needs of ATFM in the APAC Region and aim to facilitate the development of future SWIM-based MET information services.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper

…….

Attachment

DRAFT as of 2nd November 2020

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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

Second Edition, XX 20xx

Adopted by MET SG/xx in xx 20xx

RECORD OF AMENDMENTS AND CORRIGENDA

Amendments			
No.	Date of issue	Date entered	Entered by

Corrigenda			
No.	Date of issue	Date entered	Entered by

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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 guide 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 guide

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

[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.

operations. Recognizing the importance, various States have continued to evolve their 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

[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.

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 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.

2.2. 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. 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
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

Appendix 1 Specific Implementation Examples

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 Taking the opportunity of the replacement of CAD's Air Traffic Management System (ATMS), closer integration of tailored MET information with ATMS was realized to support ATC in tactical decision making. These include 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) 1hr forecast for the assessment of the significant convection over HKFIR at 3 km height.

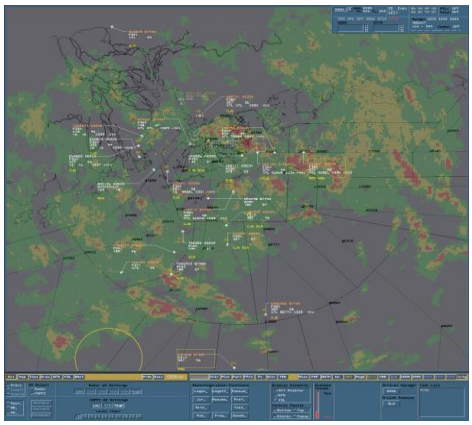


Figure 1 ATC console display showing aircraft positions overlaid on a CAPPI imagery

1.1.2 On the ATC console of the new 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.

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 points 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.

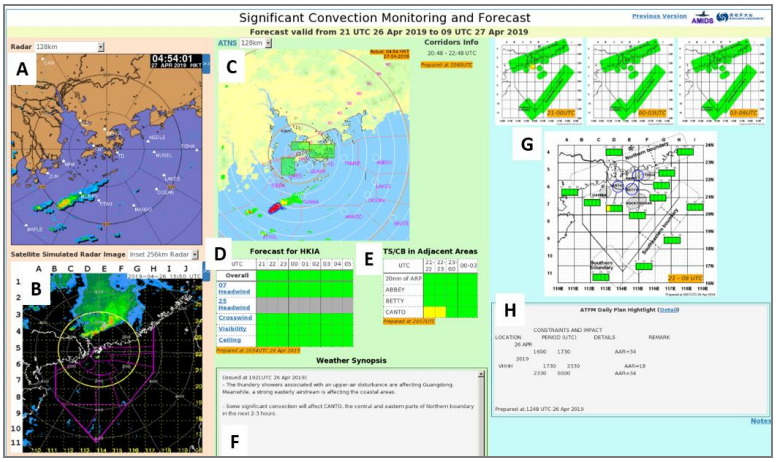


Figure 2. Integrated display of the MSTA: A) Choice of actual radar at different ranges and lightning overlays; B) Radar blended with satellite simulated radar image developed using Artificial Neural Network technology; C) 2hr convection nowcast for arrival/departure corridors by ATNS; D) 9hr performance-based 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.1.5 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.

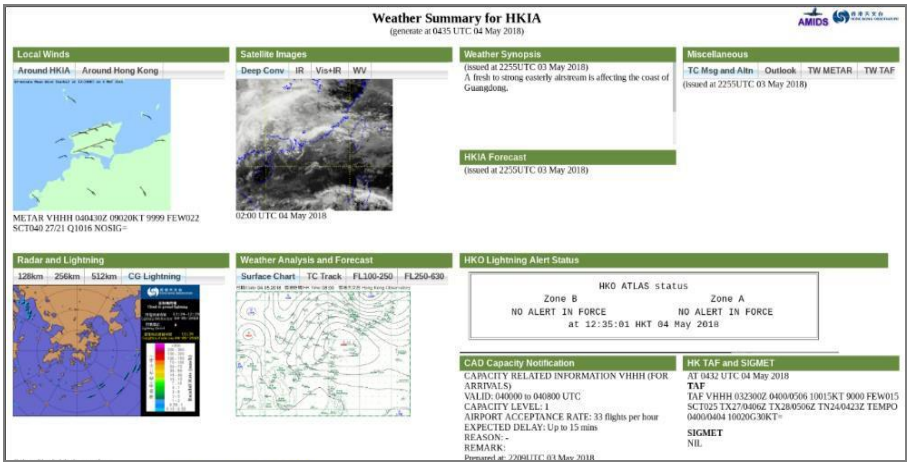


Figure 3. HKO Weather Summary for HKIA

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.

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 5, Left). Another one displays arrival and departure rates and any traffic interruption messages from ATIS and NOTAM (Figure 5, Right). These two pages heighten common situation awareness and enhance the communications between MET and ATM office particularly during weather briefings (para. 1.6 below).

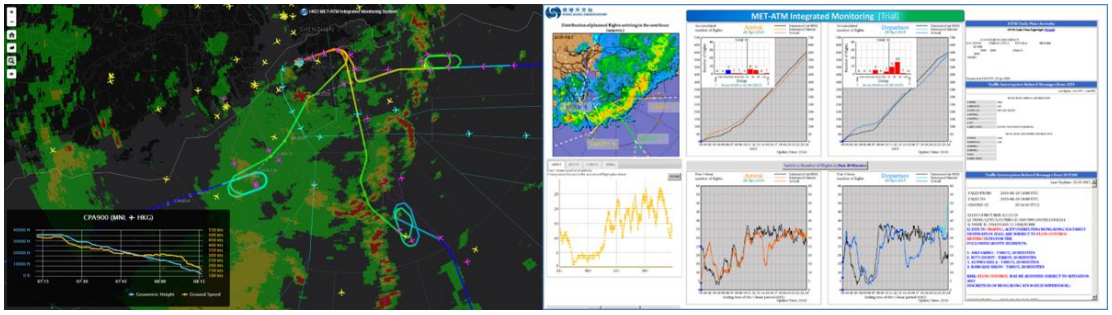


Figure 5. MET-ATM Integrated Displays showing arrival flights forced into holding patterns

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 and advisory information, as well as 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 6).

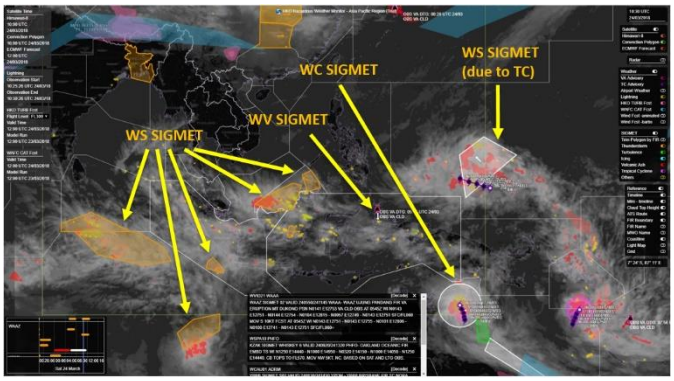


Figure 6. HKO Regional SIGMET Monitoring Page.

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 briefing mainly makes 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.

1.7.2 In preparation for adverse weather such as the approach of tropical cyclone (TC), additional weather briefings are conducted for the whole 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 b) are sent to CAD's ATS Data Management System (ATSDMS).

2.2 The rest of the products, including MSTA and miscellaneous tailored products are provided via the web-based Aviation Meteorological Information Dissemination System.

3. Other useful information

3.1 Regular high level meetings with CAD and the Airport Authority Hong Kong are held on an annual basis. Regular working level meetings with ATC are held generally a few times every year.

3.2 A Verification System has been set up for verification of both the ICAO Annex 3 and MSTA products.

Japan

1. ATM-tailored MET information and Services

1.1 ATMetC

The Japan Civil Aviation Bureau (JCAB) established the Air Traffic Management Center (ATMC) in Fukuoka in 2005 as a core organization for ATM in Fukuoka FIR. In line with ICAO's global concept for ATM, ATMC facilitates safe and efficient flight operation through ATM close cooperation with Airspace Management (ASM), Air Traffic Flow Management (ATFM) and oceanic ATM. At the same time as ATMC began operation, the Japan Meteorological Agency (JMA) established the Air Traffic Meteorology Center (ATMetC) to provide meteorological information and services in support of ATMC. ATMetC forecasters work in the same operation room as ATM officers to directly provide weather information and briefings tailored to ATM officers' needs. MET information and services specifically tailored for ATM requirements are as follows.

1.1.1 Air Traffic Meteorological Forecast (ATMet Category Forecast) (Figure 1)

- Target areas: major aerodromes and ATC sectors
- Contents: the potential for meteorological impact on air traffic flow with four color-coded categories (red, yellow, blue and white)
- Issuance time: every hour except from 14 to 16 UTC (midnight)
- Forecast time: up to 6 hours

1.1.2 Briefing sheet (Figure 2)

- Target: Strong wind for Tokyo (RJTT) and Heavy snow for New Chitose (RJCC)
- Contents: the probability of occurrence of impact on air traffic flow with four color-coded categories
- Issuance time: when significant weather is forecasted within 12 to 15 hours
- Forecast time: up to 16 hours

1.1.3 CDM conference

- Target areas: Fukuoka FIR and neighbor FIRs
- Providing methods: TV teleconference system
- Regular conference: 0620 and 2345 UTC
- Extra conference: As necessary (except midnight)

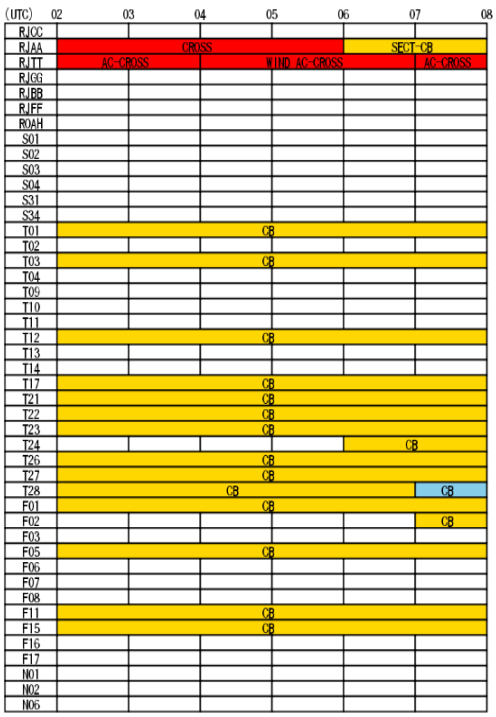


Figure 1 ATMet Category Forecast

1.1.4 Briefing (regular/extra)

- Target areas: Fukuoka FIR
- Providing methods: Face to face or information-sharing terminal at ATM officer's desk
- Regular briefings: 0130, 0445, 0550, 0915, 1200, 1945, 2000, 2220, 2315 UTC
- Extra briefings: As necessary (24 hours)

1.2 TMAT

To deal with increasing air traffic demands in Tokyo metropolitan area, JCAB organized the Traffic Management Units (TMUs) in 2011 as a branch of ATMC and they were placed at Tokyo international airport and Tokyo Area Control Center in order to conduct tactical and flexible ATFM in and around the Tokyo metropolitan area. JMA organized Tokyo Metropolitan Area Team (TMAT) at Tokyo international airport in 2014 as a branch of ATMetC to provide TMUs with meteorological information and detailed briefings focused on significant weather which affects air traffic flow in and around the Tokyo metropolitan area, including the approach control area of Tokyo / Narita international airport and its neighboring area.

1.2.1 ATM CIEL (Figure 3)

- Target areas: Tokyo/Narita international airport, Tokyo approach control area and ATC sectors around Tokyo metropolitan area
- Contents: Level of expected impact of significant weather on ATM
  - ✧ High : Need to reduce capacity value (CAPA) significantly
  - ✧ Medium : Need to reduce CAPA
  - ✧ Slight : Need to reduce CAPA slightly
  - ✧ None : Not need to reduce CAPA
- Issuance time: every hour except from 14 to 16 UTC
- Forecast time : up to 6 hours (temporal resolution: 10 minutes to 1 hour)
- Targeted weather phenomena:
  - ✧ Tokyo/Narita international airport: Thunderstorm, Visibility, Ceiling, Wind, etc.
  - ✧ In and around the Tokyo approach control area: CBs, Convective clouds and Wind

1.2.2 Wx Bulletin (Figure 4)

- Target areas: Tokyo/Narita international airport, Tokyo approach control area and ATC sectors around Tokyo metropolitan area
- Contents: Brief comments on phenomena expected to affect air traffic flow, and appropriate images to explain weather conditions and forecast
- Issuance time: 00 and 06 UTC

- Forecast time: up to 6 hours

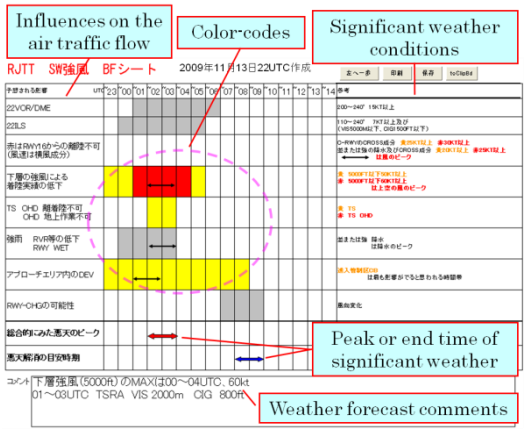


Figure 2 SIGWX Briefing sheet

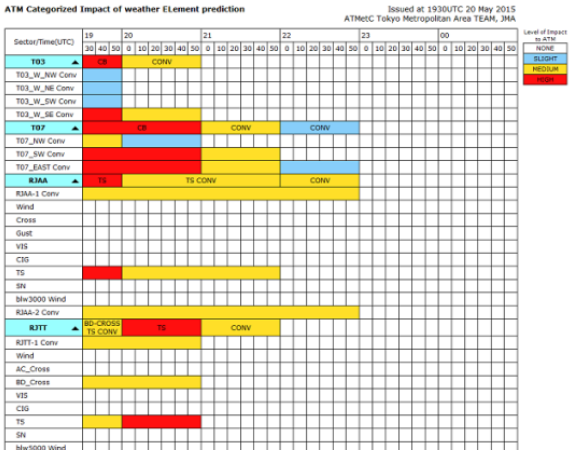


Figure 3 ATM CIEL

1.2.3 Briefing (regular/extra)

- Providing methods: Video conference, telephone and online chat
- Regular briefings: 0500, 1130, 2030 and 2250 UTC (four times/day)
- Extra briefings: As necessary (24 hours)
- Target areas: Responsibility area of Tokyo ACC and Tokyo approach control area

2. Means of Provision

2.1 ATMetS2

JMA established dedicated information distribution system, called ATMetS (“2” means second generation system). Terminals for the system are located at each ATM officer's desk.

2.2 MetAir

JMA has developed aviation weather information provision system, called MetAir. Users can obtain forecast products for airspace and aerodrome in a real time basis. Airlines can receive MET products through MetAir.

2.3 **Web chat system** (Figure 5)

As prompt decision making is required for ATM within terminal area, speedy and appropriate information sharing is necessary. Especially for weather briefing services, TMAT coordinates with TMUs whenever needed using online chat tool developed by JMA which enables quick information provision, in addition to video conference and telephone. As text information remains in the chat tool, TMU officers can reaffirm the contents of briefings at any time. Also, graphical information can be posted on the tool. This function helps TMU officers to easily understand the weather condition which is sometimes difficult to grasp only by the explanation on the telephone.

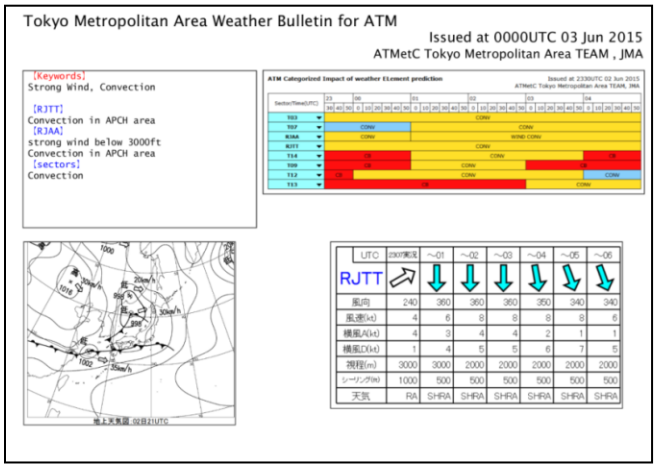


Figure 4 WX Bulletin

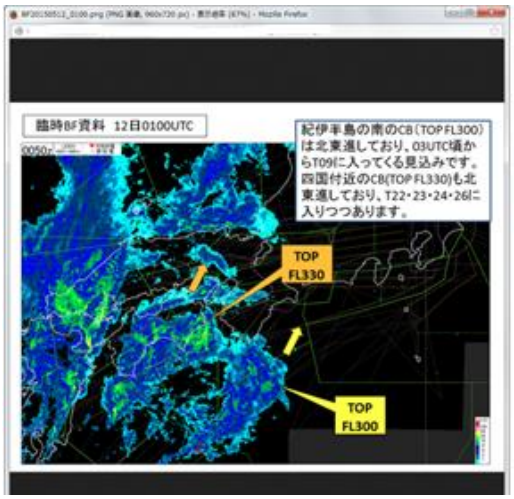


Figure 5 Graphical info on online chat

3. Other

3.1 Verification

ATMet category forecast criteria are weather conditions (or sometimes a combination thereof) defined through verification processes carried out by ATMetC in coordination with ATMC. This process involves three main steps:

a) Investigation of impacts on ATM in previous significant cases;

b) Confirmation of operational rules and conditions with reference to aircraft operation manuals and flight operations manuals; and

c) Checking of the latest requirements from ATM officers, such as high-priority airways and altitude, and important air navigation facilities (waypoints or typical holding areas).

Each criterion is verified by calculating the Weather Impact Ratio (WXIR), which is the ratio of the frequency of cases in which a weather condition has influenced air traffic flow to all cases of the weather condition concerned.

WXIR = (Number of occurrence of air traffic controls) / (Number of occurrence of WX conditions)

Meteorological services provided to support ATM need to be flexibly applicable to the various operational variables of such management, including ATC procedures, airways and aircraft types, which are also developed in parallel. It is therefore highly important to ensure close and continuous coordination with ATM officers in order to revise criteria appropriately based on the results of verification using WXIR in consideration of operational requirements. Through such continuous improvement, the gap between ATM operational requirements and MET capability can finally be closed (Figure 6).

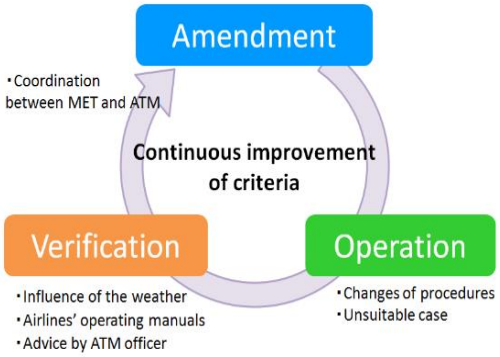


Figure 6 Continuous improvement of criteria

Singapore

1. ATM-tailored MET information and services

Meteorological and Air Traffic Management (MET/ATM) Collaboration in Singapore

The provision of air navigation services in the Singapore Flight Information Region (FIR) is undertaken by the Civil Aviation Authority of Singapore (CAAS), and Meteorological Service Singapore (MSS) is the aeronautical meteorological service provider. CAAS and MSS collaborated to develop ATM-tailored MET information and services aimed at enhancing the safety, efficiency and orderly flow of air traffic. The following lists some examples of MET information and services implemented in Singapore.

1.1 Weather briefing for ATC

MSS provides daily MET weather briefings through teleconference to air traffic controllers at the start of the morning and afternoon shifts of ATC units. Aided by visuals from a dedicated weather information portal which provides an integrated view of meteorological information in graphical and tabular formats (Figures 1), operational meteorologists brief the air traffic controllers on the weather conditions that can be expected around Singapore and the surrounding region. Timely updates are also provided by operational meteorologists through a direct communication line (dedicated hotline) should there be any change in the weather conditions.

1.2 Weather Window Products

Given that thunderstorms are common weather hazards in the deep tropics, MSS has been delivering categorical forecast on the occurrence of thunderstorms over critical watch areas. The watch areas are determined in consultation with the CAAS ATS units to align with their operational requirements. The enhanced categorical forecast (called the 'Weather Window') augments the standard Annex 3 products and provides information on the forecast of not only the occurrence of thunderstorms, but also their areal extent. The forecast is valid for 24 hours and is updated every 3 hours or on an ad-hoc basis when changes to the weather situation warrants it. The temporal resolution is higher in the shorter forecast range to provide more detailed information of a possible rapid development of adverse weather (considering the dynamic nature of tropical weather systems). The temporal resolution becomes coarser at longer forecast range to reflect the lower predictability of tropical convective-scale weather. The weather window is presented in colour-coded, tabular format for easy interpretation and is used for air traffic flow management planning.

1.3 Improvements to SIGMET Information

Apart from the weather window products, MSS has been leading the coordination with MET Watch Offices (MWOs) of neighbouring States under the Operational SIGMET Coordination (OSC) for Southeast Asia initiative on the issuance of harmonised cross-FIR SIGMETs to airspace users, air traffic controllers and planners.

1.4 Nowcasting for convective weather

Tropical weather systems tend to be dominated by thunderstorms that are localized and short-lived and have significant impact on air traffic operations. Given the nature of our local weather systems, there is limited predictability, and forecasts tend to be short range. This poses difficulties for ATM. To address these challenges, MSS in collaboration with the UK Met Office has developed a convective-scale Numerical Weather Prediction (NWP) model – SINGV to better predict convective-scale weather in the tropics. In addition, Singapore is developing capabilities in nowcasting model, leveraging on techniques such as machine learning with radar and satellite data. This is a tropical convective-scale NWP/Nowcasting system that is continuously being fine-tuned to provide improved weather forecasts to support ATM decision making.

2. Means of Provision

2.1. Analysis by Operational Meteorologist

While outputs from numerical weather predictions are used to provide a first-cut forecast of the weather situation, these numerical predictions have limitations in predicting convective weather in the tropics. Local knowledge and expertise of operational meteorologists are essential and continue to be integrated in the provision of MET information and services to the users.

2.2 ATC Weather Information Portal

A dedicated web portal (ATC web portal) has been developed for the provision of more MET information in support of ATM decision-making. The web portal is an integrated platform that allow users to view the current observations and weather window forecast products to enhanced situational awareness for ATC, and to aid users in pre-tactical air traffic flow management planning. In addition, for ease of visualization that may not be best served by a tabular format of weather window, thunderstorm areas are also presented on geospatial maps. Weather briefings using this web portal allows the operational meteorologists and the users to establish a common understanding of the weather situation and to discuss on any possible adverse weather that may affect operations.

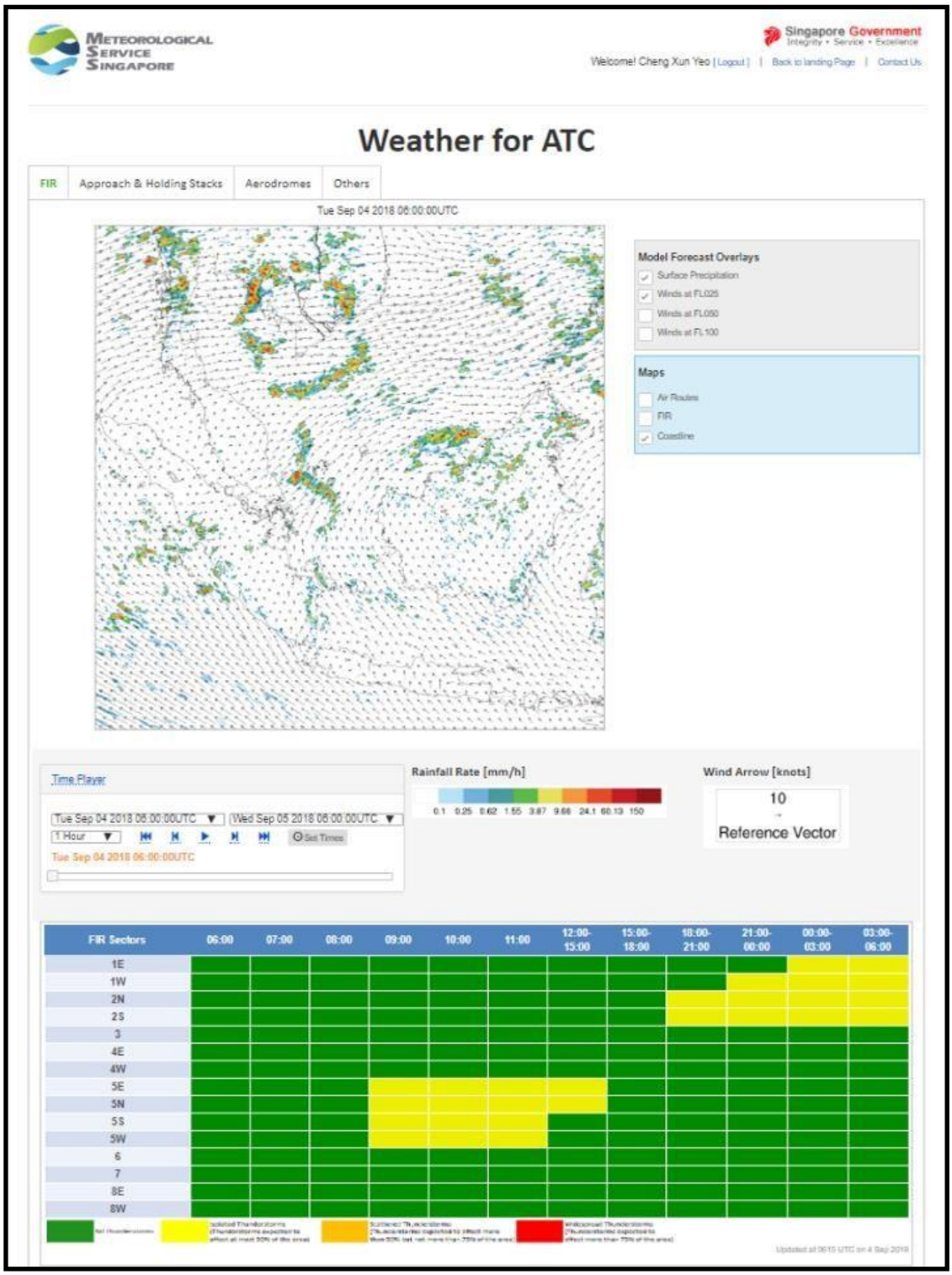


Figure 1a: Dedicated Web Portal for ATC showing Categorical Forecast of Thunderstorms.

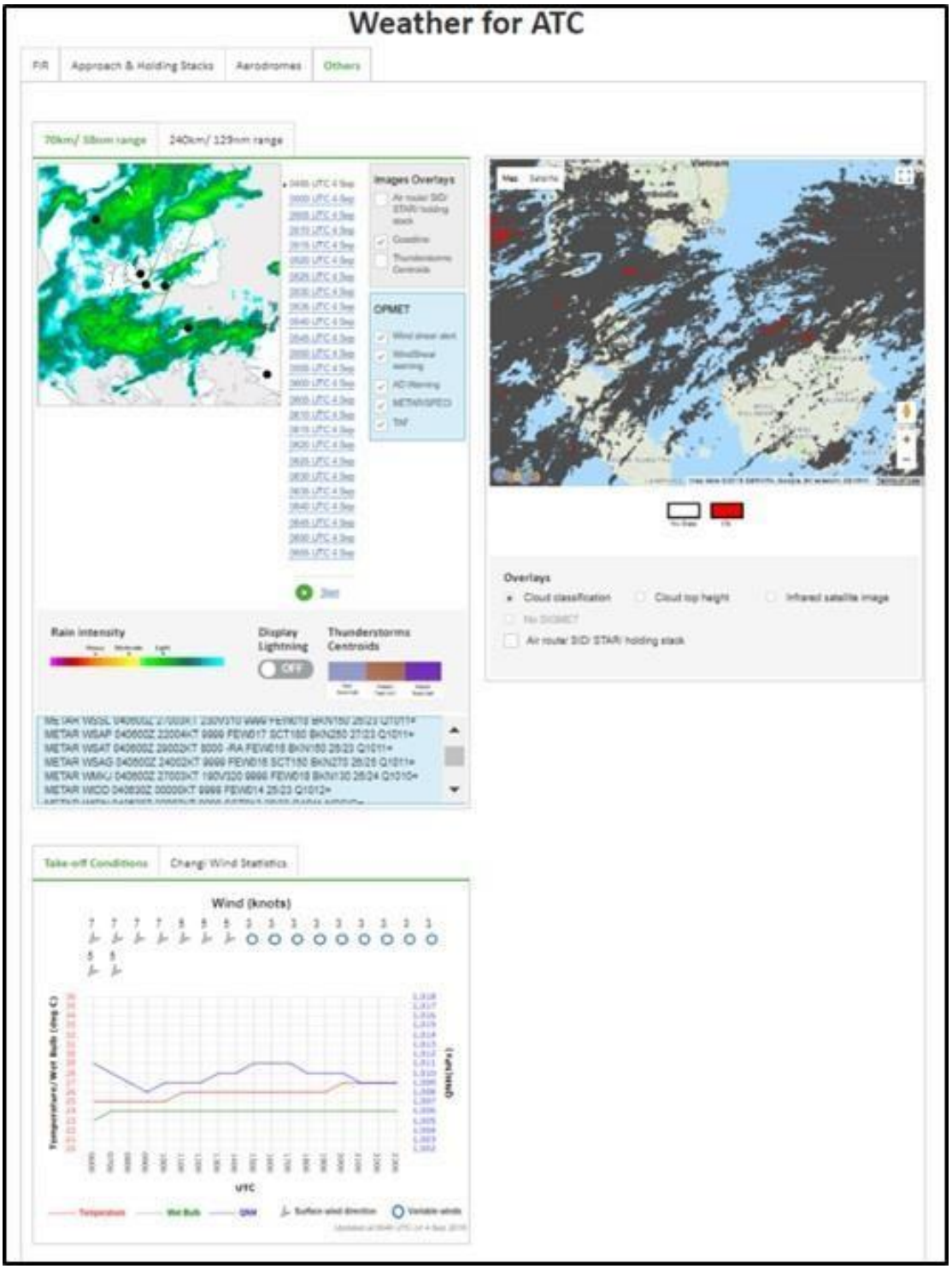


Figure 2b: Dedicated Web Portal for ATC showing observations including satellite and radar images, OPMET and AD warning information.

2.3. Direct Communication Line

A direct communication line has been established to facilitate exchange of information in a timely manner. This enables the operational meteorologists and ATC officers to

readily react to changes in weather situation.

Republic of Korea

1. ATM-tailored MET Information and Services

To improve the safety of air-navigation and efficiency of ATFM, the Ministry of Land, Infrastructure and Transport (MOLIT) of Korea has been operating the Air Traffic Command Center (ATCC) in Daegu since July 2017. The Korea Aviation Meteorological Office (AMO) works with the Korean Air Force 24 hours a day at the ATCC, to frequently provide MET information on major airports in and out of Korea as well as expected weather phenomena within Incheon FIR. AMO also participates in CDM conferences to support stakeholders' ATFM-related decisions.

1.1 CDM Conference

The ATCC regularly holds a CDM teleconference once a day (0700UTC). At the conference, AMO provides a weather briefing to CDM members. If significant weather conditions are expected to affect aircraft operations, AMO also joins a CDM teleconference to provide briefing services.

1.2 Weather Analysis

AMO issues a weather analysis twice a day (0000/0700UTC) for ATCC stakeholders. The analysis is distributed through the ATFM System and includes the following (Fig 1):

- Target: Major airports, Incheon and Nearby FIRs
- Issuance time: 0000/07000UTC
- Content: Summary of meteorological phenomena expected to affect ATFM within about 24 hours (TAF, SIGMET information, satellite images, radar images, numerical model-predicted weather charts, WINTEM, turbulence, volcanic ash information, etc.)

  In particular, when a significant phenomenon that may cause the ATFM restriction is expected in the neighboring FIR, the analysis also includes COMS satellite images and radar images provided by the Korea Meteorological Administration (KMA), and overseas SIGMET information.

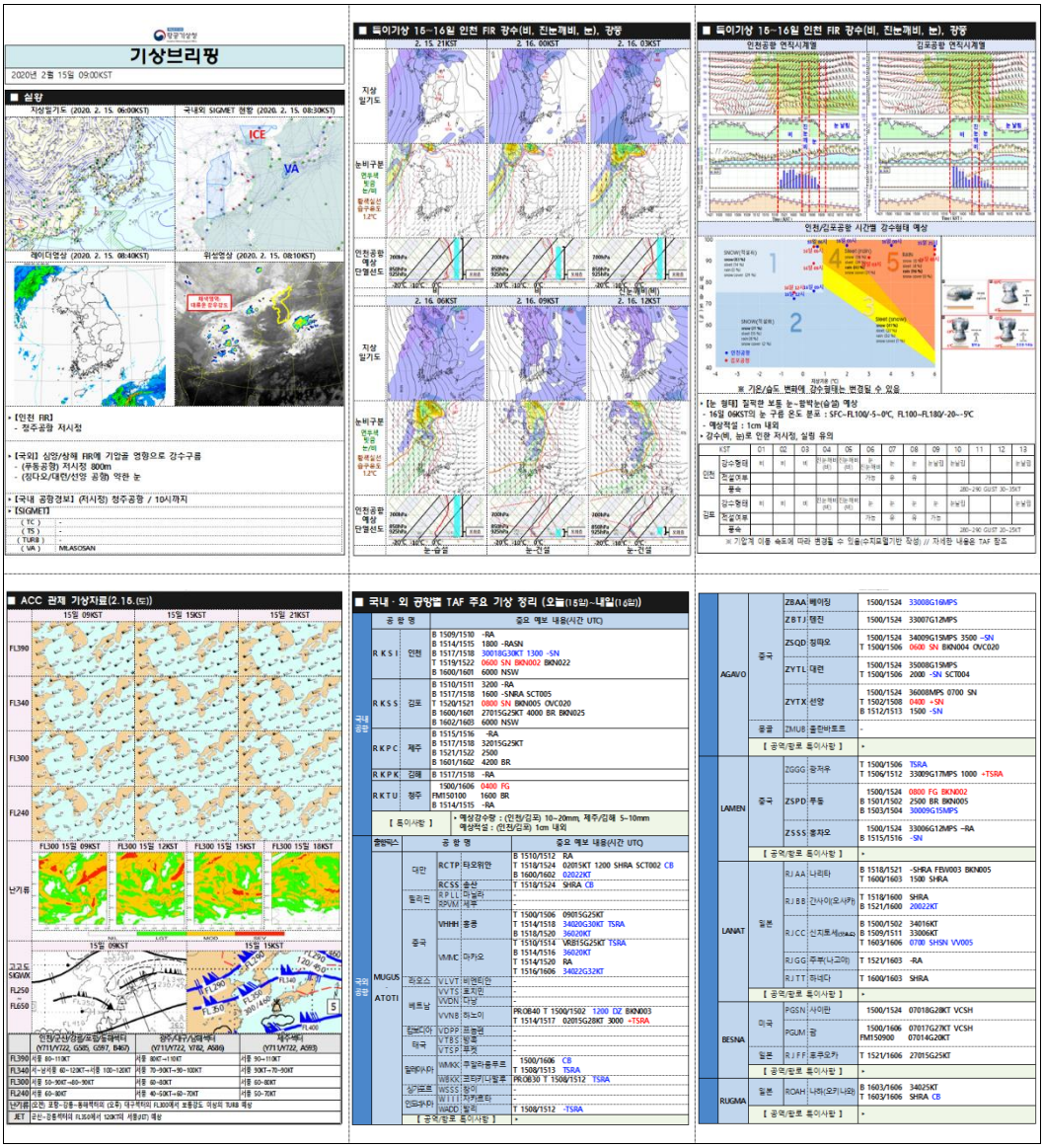


Fig 1. Weather analysis provided by AMO (twice a day), which includes i) real-time weather conditions, ii) significant weather forecasts in and out of Korea, and iii) weather charts for forecasting period.

1.3 Special MET Information

1.3.1 Typhoons

If a typhoon is expected to affect the Incheon FIR, the expected typhoon path up to five days ahead will be provided based on the typhoon information released by the KMA's National Typhoon Center. In particular, forecasters analyze numerical prediction models and cases of typhoons that followed a similar path to provide forecasts for major airports (Incheon, Gimpo, Jeju and Gimhae airports) and air routes (Fig 2).

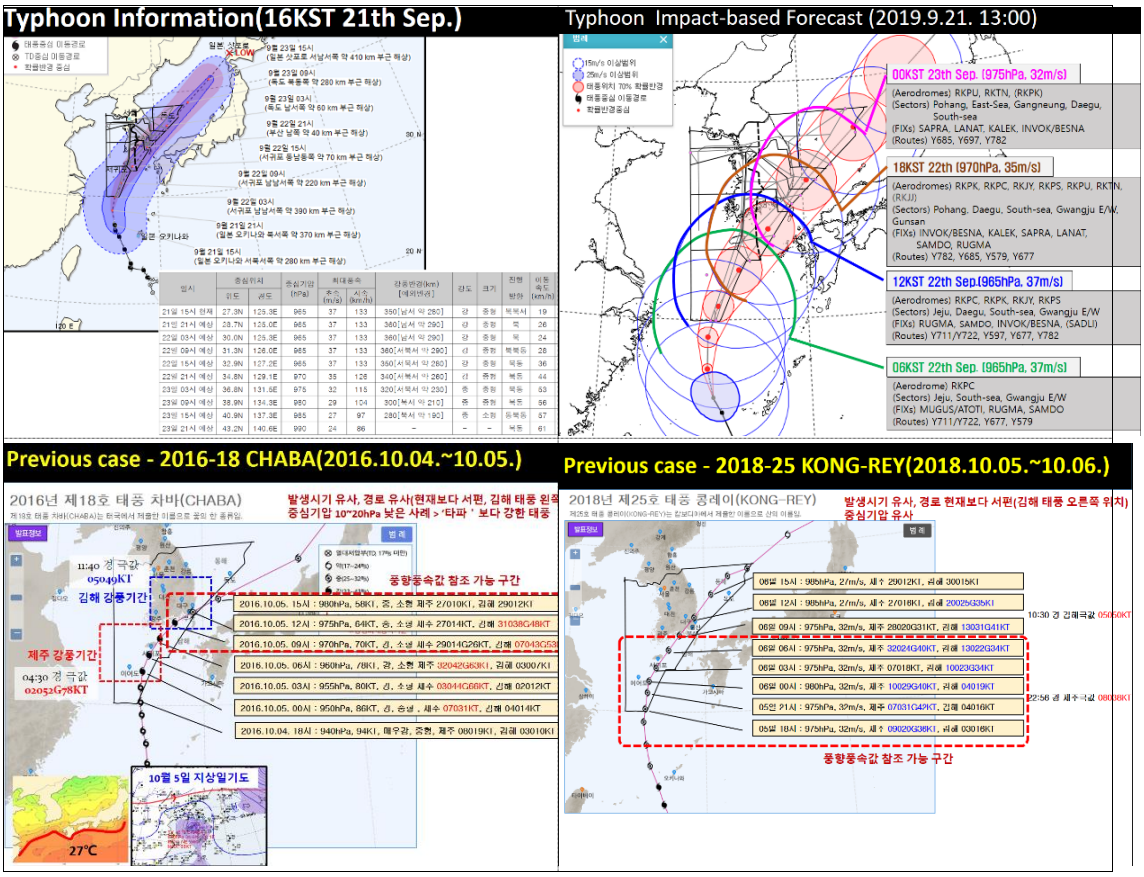


Fig 2. Typhoon forecast information: expected typhoon paths, typhoon impact areas, previous cases, etc.

1.3.2 Volcanic Ash

An analysis of the VAACs' forecasts for volcanic ash and low/medium-level winds is provided to give information on the volcanic ash dispersion paths and flight level (Fig 3).

1.3.3. MET Information Service on Holiday Seasons

The number of flights in Korea usually increases dramatically during holidays and summer vacations. AMO provides MET information for major airports about a week before the holiday seasons, and this information is used for ATM operators' flight planning and decision-making (Fig 4).

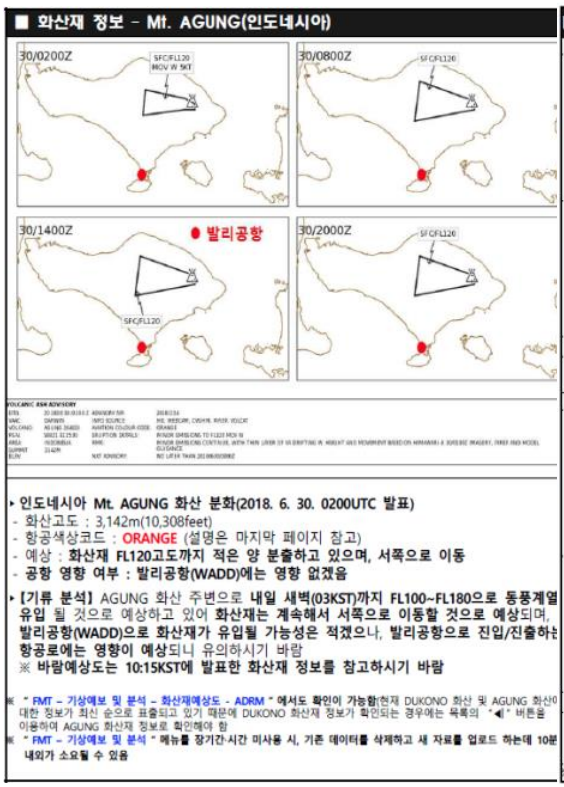


Fig 3. Volcanic ash information (expected ash routes, air flow forecasts)

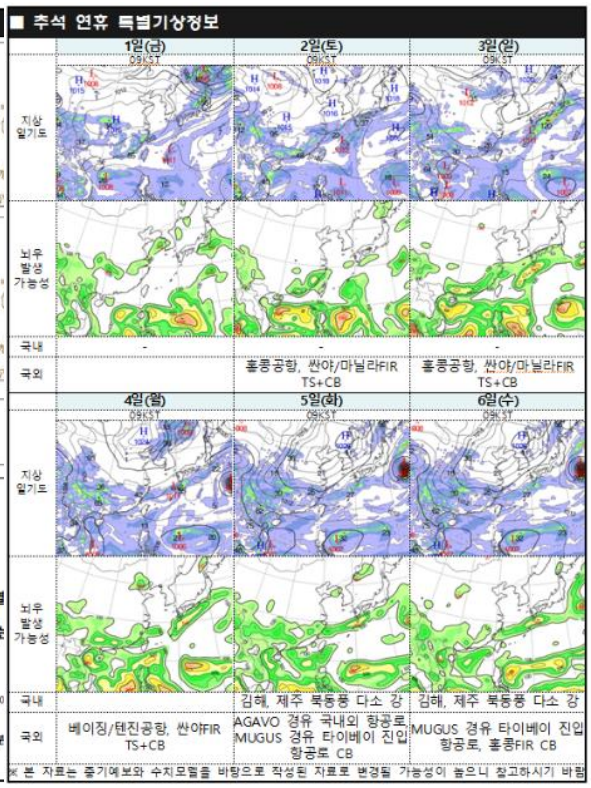


Fig 4. MET information service on holiday seasons

1.4 Weather Briefing for ATC

AMO provides weather briefings once or twice a day for controllers in Daegu and Incheon ACC. The briefing includes descriptions and forecasts for weather events expected during their work time and is provided to the controllers at the time of their shift changes.

2. Means of Provision

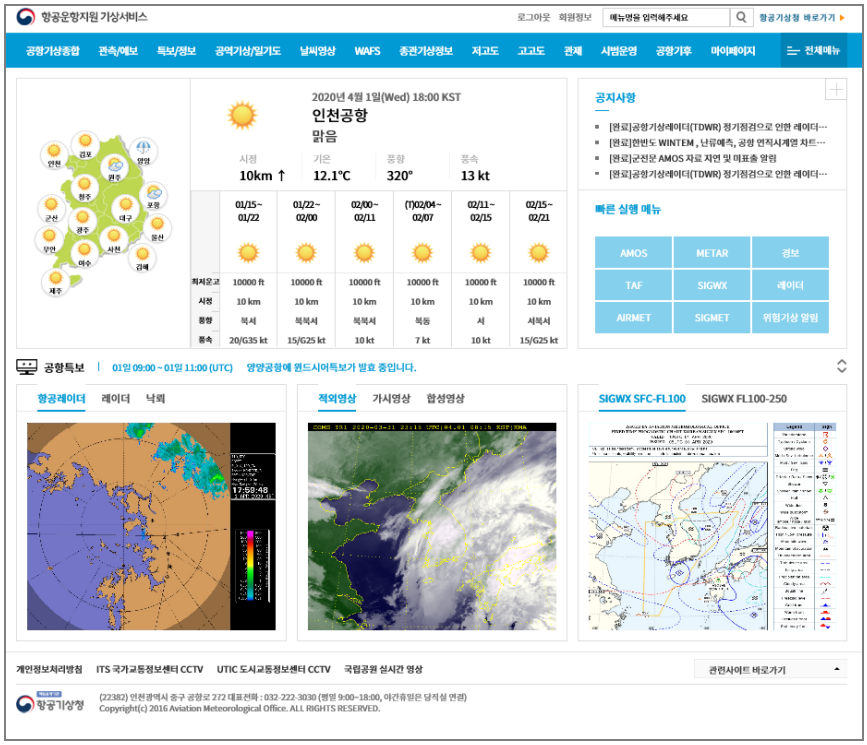
2.1 Flow Management Terminal (FMT) System

Weather information, such as radar images, satellite images, TAF and METAR, is being provided in real-time through the FMT system operated by MOLIT.

2.2 AMO Website

All MET information issued by AMO is provided on its website. In particular, TAF bulletin boards are provided to help visitors see significant weather forecasts for each airport at a glance (Fig 5).

(a)



(b)

Fig 5. (a) AMO website (https://global.amo.go.kr) and (b) TAF bulletin board

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Appendix 2 Operational Scenario – Case of MET/ATM Collaboration –

Scenario 1:

CBs affected air traffic flow around approach control area of Tokyo International Airport (18 August, 2015)

1. Overview

A developing squall line was moving eastward along the coast of Tokai and Kanto Region of Japan. It caused many deviations from the planned air-routes and holdings in and around the terminal area, for aircraft approaching from west to Tokyo International Airport (RJTT). The Air Traffic Management Center (ATMC) reduced air traffic capacity (CAPA) in the affected ATC sectors, such as sector T09 and T14, and executed air traffic flow controls for aircraft flying in / heading to the air space. In addition, because some westbound aircraft departed from RJTT were forced to enter into neighboring sectors, such as sector T12 and T13, to avoid developed CBs of the squall line, ATMC finally conducted capacity reduction and flow controls for those ATC sectors to prevent possible conflicts between eastbound and westbound aircraft within those sectors (See Fig. 1 and Fig. 2).

This case shows how MET forecasters and ATM officers collaboratively dealt with this adverse weather condition described above, which occurred around a congestive international airport.

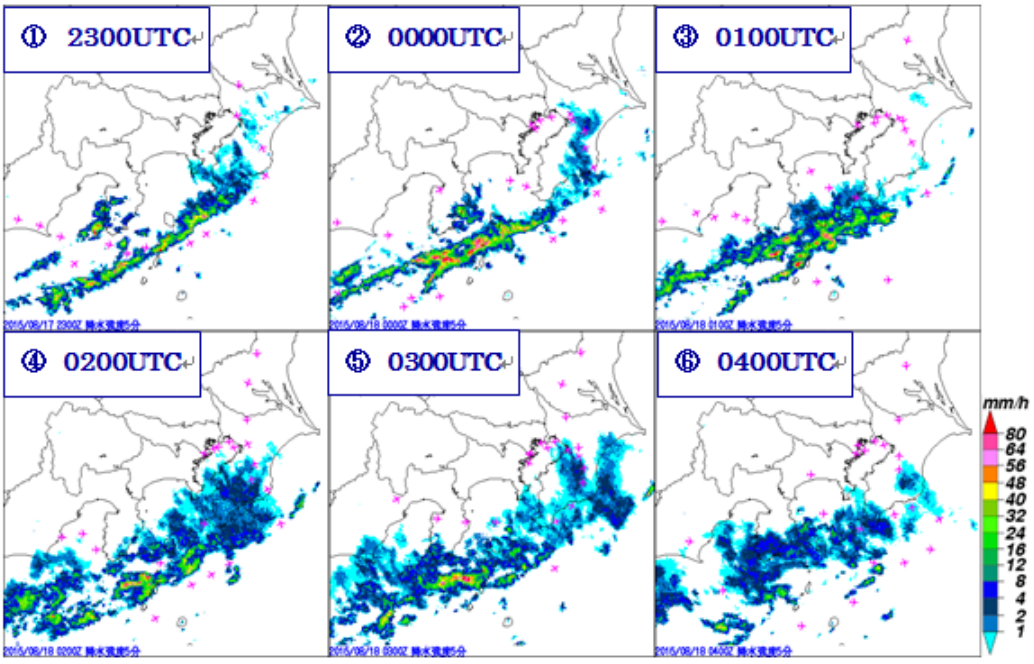

Figure 1 Radar echo intensity from 23:00 UTC 17th August to 04:00 UTC 18th August. Airplane-shaped marks indicate aircraft positions.

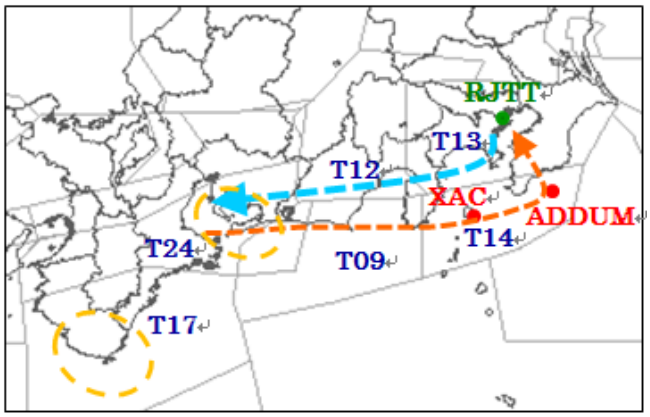

Figure 2 Name of ATC sectors (blue text) and reporting points (red text)

- Yellow circle: Holding area for aircraft flying to RJTT
- Orange arrow: Regular air-routes for aircraft approaching from western Japan to RJTT
- Light blue arrow: Regular air-routes for aircraft flying from RJTT to western Japan

2. MET/ATM collaboration

Described below is the collaborative actions taken by MET forecasters and ATM officers in this case (MET: Air Traffic Meteorology Center, Japan Meteorological Agency (ATMetC/JMA), ATM: Air Traffic Management Center, Japan Civil Aviation Bureau (ATMC/JCAB))

17th August 2015

20:00 UTC Special briefing was provided by MET

MET: "Echo top height of the CB clouds would reach more than FL460 in sector T09."

MET: "CB clouds will approach sector T14 around 21 UTC and then Tokyo Approach Control Area (ACA) around 22 UTC."

20:40 UTC Latest status of air traffic was reported by ATM

ATM: "Deviations have occurred in sector T17 and T09, because of CB clouds. We are now watching the situation of these CB clouds carefully."

21:00 UTC Special briefing was provided by MET

MET: "The CBs in sector T09 will approach XAC (reporting point) around 22 UTC and then ADDUM (reporting point) around 23 UTC.

ATM: "When will the CBs go away from Tokyo ACA?"

MET: "It will be after 00 UTC of 18th."

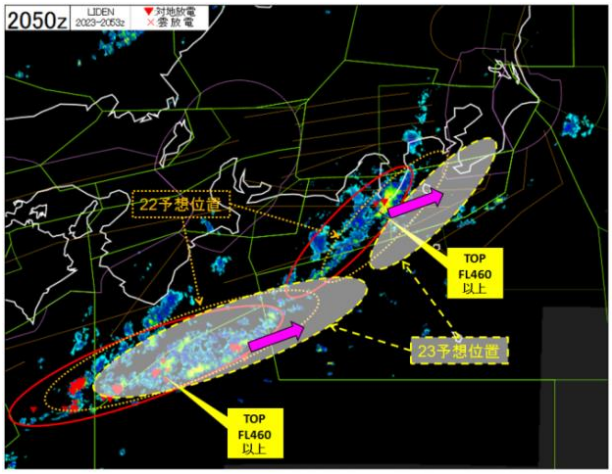

Figure 3 Material for non-regular briefing at 21:00 UTC on 17th August

21:20 UTC EDCT[1] was issued for flights heading to RJTT from west

22:00 UTC CAPA[2] was reduced to 93% in sector T09

22:10 UTC EDCT was issued for flights heading to RJTT through sector T09

23:08 UTC Special briefing was provided by MET

MET: "The CBs near XAC are now moving east and will approach ADDUM around 00 UTC."

MET: "The CBs newly developed around sector T09 will move to the eastward. Then it will be merged with CB cloud area of the east."

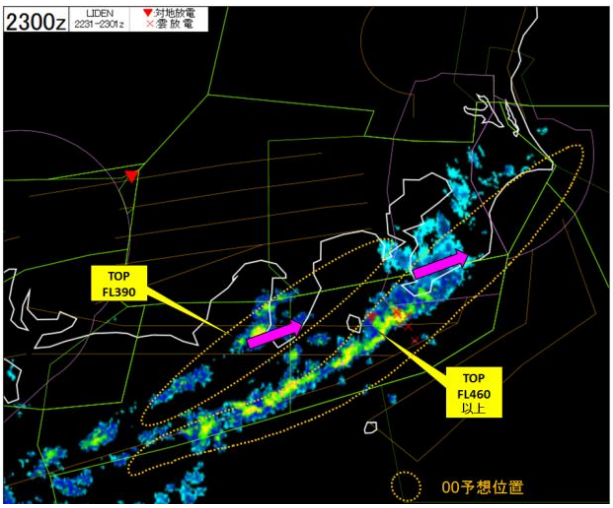

Figure 4 Material for non-regular briefing at 23:08 UTC on 17th August

23:10 UTC Entrance Interval was reduced for sector T09

23:30 UTC CAPA was reduced to 88% in sector T12, 89% in sector T13

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[1] *Expected Departure Clearance Time (EDCT)* is assigned for the flights to certain aerodrome or airspace when air traffic volume is expected to exceed the ATC capacity of the aerodrome of the airspace.

[2] *CAPA* is an acronym for the ATC capacity of an aerodrome or an ATC sector.

23:35 UTC Departure Interval was reduced for sector T12

23:40 UTC EDCT was cancelled for flights heading to RJTT through sector T09

18th August 2015

01:10 UTC Special briefing provided by MET

MET: "Developing CB area in T14 and T09 sectors will move to the northeast or the east-northeast and the peak of the development will continue until around 03 UTC."

MET: "A part of the CBs may spread to sector T12 and T13, but it would not be expected to spread largely to the north. CB clouds in T17 sector will move to the northeast or the east-northeast and spread into T09 sector around 09 UTC, but it will eventually weaken from around 06 UTC."

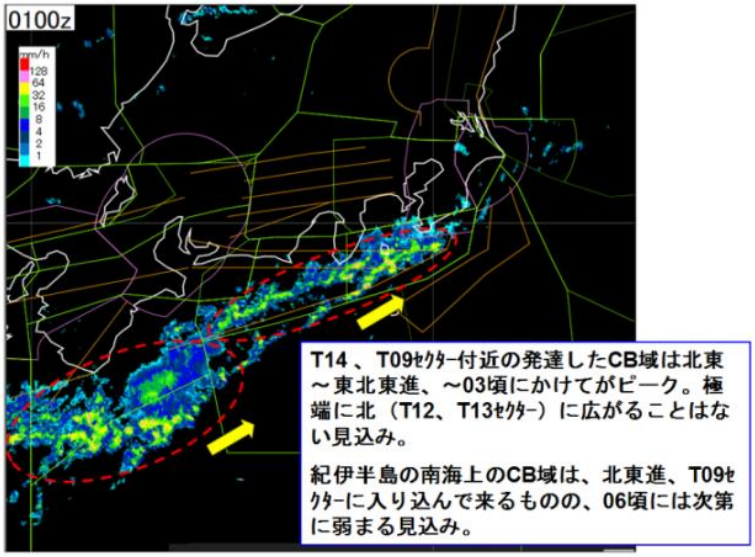

Figure 5 Material for non-regular briefing at 01:10 UTC on 18th August

02:00 UTC Entrance Interval was restored for T09 sector

06:00 UTC Departure Interval was restored for T12 sector

09:30 UTC EDCT was cancelled for flights heading to RJTT from west

3. Summary

In this case, ATM officers shared the latest situation of air traffic flow with MET forecasters and on the other hand, MET forecasters provided special briefings for ATMC with regard to prediction of CB clouds which affected ATC sectors, such as T09 and T14. Additionally, MET forecasters paid attention also to the situation of CB clouds developed in T12 sector, because a number of westbound aircraft departed from RJTT flew into T12 and T13 sectors and, as a result, significant conflicts between eastbound and westbound aircraft were anticipated in those sectors. Based on such interactions, ATMC officers

appropriately managed air traffic flow with frequent special briefings from MET forecasters.

This case shows how mutual coordination between MET forecasters and ATM officers will improve the efficiency and the safety of air traffic flow under adverse weather conditions.

INTRODUCTION

Purpose: This survey is intended to inform ICAO (and States) of the provision of current and future meteorological (MET) information services by States specifically to support Air Traffic Management (ATM), in particular Air Traffic Flow Management (ATFM).

The survey solicits input from the MET and ATM communities and Airspace Users in the Asia/Pacific Region (APAC) Region with the following terms of reference regarding the initiative and objective of the survey.

- To identify current and future meteorological requirements, in terms of the provision of MET information and communication methods, to support ATM;
- To identify the types and importance of MET information for ATM;
- To identify the gaps between the existing MET information services and the requirements of ATM community and Airspace Users;
- To identify challenges faced by States/Administrations regarding the provision of MET information to support ATM, in particular ATFM;
- To identify other guidance and education material required to support States/Administrations in implementing MET information to support ATFM.
- To remind States/Administrations of the existence of Asia Pacific Regional Guidance for Tailored Meteorological Information and Services to Support ATM Operations document.

Benefits: The survey results will assist ICAO APAC Regional Office to:

- Understand States/Administration current status and requirements of MET information to support ATM, in particular ATFM;
- Explore opportunities and enhance MET-ATM integration in APAC States/Administrations;
- Facilitate a coordinated approach for further improvement of MET services in support of ATM, especially ATFM in the APAC Region.
- Seek further input from States/Administrations on other guidance or education material required to assist the implementation of MET information service to support ATFM.

To collect input from BOTH the MET and ATM communities in the APAC Region, each State/Administration would be requested to provide at least **2 separate survey returns,** one from each of the MET and ATM communities.

State/Administrations are also encouraged to invite additional survey returns from their State-based Airspace Users such as airlines, for some of the specific questions indicated in the Questionnaire.

Please select all relevant responses (there may be more than one per question)

PART A – GOVERNANCE AND LEGISLATION (Questions for MET and ATM)

(1) Has your State/Administration enacted primary legislation and supporting regulations to ensure that the implementation of MET service is in accordance with ICAO Annex 3 - *Meteorological Service for International Air Navigation* and any applicable regional air navigation agreements?

a) No
b) Yes (please specify):
_____
_____
_____

(2) Does your State/Administration have a written agreement in place between the air traffic authority/service and the meteorological authority/service defining roles and responsibilities and the MET information to be provided in accordance with ICAO Annex 3 and ICAO Doc. 9377 – *Manual on Coordination between Air Traffic Services, Aeronautical information Services and Aeronautical Meteorological Services*?

a) No
b) Yes (please specify):
_____
_____
_____

PART B – IMPLEMENTATION OF AIR TRAFFIC FLOW MANAGEMENT (ATFM) – Questions for ATM only

(3) Has your State/Administration implemented ATFM?
a) Yes
b) No

(4) If Yes to Q3, please specify your State's level of implementation of ATFM and provide further details.
Note: Level of implementation defines the phase at which the States are in implementing their ATFM procedures and processes. For example, Level 1, 2 or 3 of Distributed Multi-Nodal ATFM Project or implementation phases of any other ATFM projects the States are involved in.

(5) If No to Q3, is your State/Administrative intending to implement ATFM?
a) Yes
b) No

If yes, please specify the expected timeline and provide further details:

PART C- PROVISION OF MET INFORMATION

PART C1 - CURRENT PROVISION OF METEOLOGICAL INFORMATION (Questions for MET and ATM)

(6) **For ATM and MET:** Indicate below the provision of specific MET information/services in your State/Administration to support ATFM (select more than one options as necessary):

a) Local report, routine/special
b) Aerodrome meteorological report, routine/special (METAR/SPECI)
c) Volcanic activity report
d) Volcano Observatory Notice to Aviation (VONA)
e) Air-report, routine/special (ARP/ARS)
f) Aerodrome forecast (TAF)

g) Trend forecast (TREND)
h) Area forecast for low-level flights (GAMET)
i) Significant weather (SIGWX) forecast; low-level (flight levels below 100)
j) Significant weather (SIGWX) forecast; medium-level (flight levels between 100 and 250)
k) Significant weather (SIGWX) forecast; high-level (flight levels between 250 and 630)
l) Upper-air wind and temperature grid point forecasts
m) Volcanic ash advisory information (VAA)
n) Volcanic ash advisory information in graphical format (VAG)
o) Tropical cyclone advisory information (TCA)
p) Tropical cyclone advisory information in graphical format (TCG)
q) SIGMET information
r) AIRMET information
s) Aerodrome warning (AD WRNG)
t) Wind shear Warning (WS WRNG)
u) Wind shear alert
v) Aeronautical climatological information
w) Other MET information, e.g., tailored service (please specify):

_____
_____

(7) **For ATM only:** Does your State/Administration's ATM/ATFM system(s) utilize automated processing of gridded MET information (e.g. World Area Forecast System (WAFS) information) to support flight planning?

For MET only: What gridded MET information (e.g. World Area Forecast System (WAFS) information) is provided to your State's ATM to support flight planning.?

Parameter	WAFS as the information source (Yes / No)	Other sources (Yes / No) (If yes, please specify the source(s))
Wind		
Temperature		
Humidity		
Icing		
Turbulence		
Cumulonimbus cloud		
Other (please specify):		

PART C2 - FUTURE PROVISION OF METEOLOGICAL INFORMATION (Questions for MET, ATM and Airspace Users)

(8) **For ATM and Airspace Users:** Rate the types of aerodrome MET observation and forecast parameters considered useful to support ATM/ATFM operation and rate the impact of these parameters to ATM/ATFM operations. Please use the ratings as follows

- Ratings on usefulness: 5-Very useful / 4-Useful / 3-Less useful / 2-Not useful / 1-Not Applicable
- Ratings on impact: 5-Very high impact / 4- Relatively high impact / 3 – Relatively low impact / 2 – Very low impact / 1-Not Applicable

Aerodrome MET information	Ratings on usefulness	Ratings on impact
Wind speed and direction		
Headwind and crosswind		

Wind Shear		
Visibility		
Runway Visual Range (RVR)		
Temperature		
QNH		
Low clouds		
Fog/Mist		
Haze		
Smoke		
Frost		
Snow (including snowstorm)		
Hail		
Thunderstorm		
Dust (including Duststorm)		
Sand (including Sandstorm)		
Light precipitation (e.g. drizzle, light rain)		
Heavy precipitation (e.g. Heavy showers, rain, snow, etc)		
Volcanic ash		
Flooding / storm surge		
Tropical Cyclone		
Other (please specify):		

(9) **For ATM and Airspace User:** Rate the types of MET observation and forecast phenomena within your Flight Information Region (FIR) considered useful to support ATFM operation and rate the impact of these phenomena to ATM/ATFM operations.
Please use the ratings as follows

- Ratings on usefulness: 5-Very useful / 4-Useful / 3-Less useful / 2-Not useful / 1-Not Applicable
- Ratings on impact: 5-Very high impact / 4- Relatively high impact / 3 – Relatively low impact / 2 – Very low impact / 1-Not Applicable

Airspace (Enroute) MET information	**Ratings on usefulness**	**Ratings on impact**
Wind speed and direction		
Temperature		
Convective Cloud (such as Deep Convection or Towering Cumulus Cloud)		
Thunderstorms		
Duststorms		
Sandstorms		
Icing (moderate or severe)		
Turbulence (moderate or severe)		
Volcanic Ash		
Tropical Cyclone		
Other (please specify):		

(10) **For ATM and Airspace User:** Rate the importance of characteristic descriptions of MET phenomenon for an effective and efficient ATFM in your State/Administration. Please use the ratings as follows and specify the reasons.

(Ratings of importance: 5-Very important / 4-Important / 3-Less important / 2-Not important / 1-Not Applicable)

Characteristic descriptions of MET Information	**Ratings of importance**	**Reason(s)**
Time of issuance and validity		
Observed position, horizontal extent and vertical extent		
Forecast position, horizontal extent and vertical extent		
Observed movement / forecast movement		
Intensity (light, moderate and severe)		
Expected change in intensity (weakening, intensifying or no change)		
Frequency (isolated, scattered, occasional and frequent)		
Probability of occurrence		
Confidence/Uncertainty of forecast		
Other (Please specify):		

(11) **For ATM and MET:** Are there any established objective rules for automatic quantitative translation from MET constraints to ATFM impact (e.g. change in Airport Arrival Rate, Airport Departure Rate, Miles-in-Trail (MIT)/Minutes-in-Trail (MINIT), other flow control measures) developed or planned to be developed in your State/Administration? If yes, please provide implementation details otherwise, please provide additional information on the State's plan.

_____

_____

_____

(12) **For ATM and Airspace Users:** In relation to MET information, rate the importance of the following components for an effective and efficient ATFM in your State/Administration. Please provide your expectations from MET service providers for each component. Please use the ratings as follows and provide further details.
(Ratings of importance: 5-Very important / 4-Important / 3-Less important / 2-Not important / 1–Not Applicable)

Needs of ATFM operation	**Ratings of importance**	**Please provide further details**
Timeliness, such as forecast lead time and update frequency		
Quality of forecast, such as accuracy and reliability		
Provision of MET information as an information service, such as through secured web services, in SWIM environment ***Note:*** *SWIM information can be found at https://www.icao.int/APAC/Pages/swim.aspx*		
Integration of MET information, provided through information service in SWIM, with other information domain, such aeronautical		

information and flight information to enable a data-centric operational environment.		
SWIM-compliant meteorological information to be more readily exchanged with the aircraft to improve operational awareness and decision-making using air/ground data connectivity and aircraft on-board systems.		
Capability to translate MET constraint into ATFM impact is required for decision support tool.		
Optimized flight trajectory planning		
Information on the state of the runway as provided by the appropriate airport authority, such as runway deposits, the extent of runway contamination, the depth of deposit and the estimated surface friction.		
Other (please specify):		

(13) **For ATM and Airspace User:** Based on the response from Q8 to Q12, what the challenges that your organization may have encountered, if any, regarding the development, implementation and/or utilisation of enhanced MET services to better support ATFM operation?

_____
_____
_____

(14) **For MET only:** In reference to Q8 to Q12, what are the challenges your organization may have encountered (or may encounter), if any, regarding the development and implementation of enhanced MET services to better support ATFM operation?

_____
_____
_____

(15) **For ATM and MET:** What initiatives does your State/Administration currently undertake, or will undertake in future, to enhance MET service provision specifically in support of ATFM operations? Indicate the expected implementation timeline for these initiatives.

Future Initiatives	**Expected Timeline (2020-2021) / (2022-2023) / (2024-2025)**	**Brief Description of the Initiative**
Collaborative decision-making process, including MET information to support of ATFM operations.		
MET–ATM integration (Integration of forecast data supporting ATM (ATFM and Air Traffic Services (ATS)).		
MET for FF-ICE (Flight and Flow Information for		

Collaborative Environment – Reference ICAO Doc 9965) (link the brochure)		
Other (Please Specify):		

PART D – COMMUNICATION METHODS (Questions for MET, ATM and Airspace Users)

(16) **For ATM and MET:** By which mode does your State/Administration disseminate aeronautical MET information to ATS units, Airspace Users and other stakeholders (select more than one option as necessary)?

a. Aeronautical Fixed Telecommunications Network (AFTN)
b. ATS Message Handling System (AMHS)
c. Telephone
d. Facsimile
e. Internet
f. Web/video conferencing
g. System to system Interface, e.g. web-based technology.
h. Other (please specify): _____

(17) **For ATM and MET:** What is the most effective means of representing MET information in support of AFTM in your State/Administration? Please use the ratings below for your preference.
(Preference: 5-Most preferred / 4-Preferred / 3-Less preferred / 2-least preferred / 1- Not Applicable)

Form of MET information presentation	Preference
Text	
Chart / Graphical	
Animation / Video	
Briefing	
Other (please specify):	

(18) **For ATM, MET and Airspace Users:** What are the challenges that your State/Administration may have encountered, if any, for an effective collaboration and communication between ATM and MET while developing and implementing ATFM?
_____
_____
_____

PART E – EDUCATION (Questions for MET, ATM and Airspace Users)

A document titled *Asia Pacific Regional Guidance for Tailored Meteorological Information and Services to Support Air Traffic Management Operations* is now available on the ICAO APAC eDocuments web-page. <Put a link here once final version is made available>. The aim of the document is to foster States' implementation and enhancement of MET information and services for ATM within APAC region.

The guidance captures most of the necessary processes from preparatory to operational phases. 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. This guidance is expected to support State implementation of the Regional Framework for Collaborative ATFM.

(19) Was your State/Administration aware of this document?
a) No
b) Yes

(20) How do you think your State/Administration can benefit from the guidance in implementation or enhancement of MET information and services for ATM?

(21) What other guidance or education material required to support State/Administration in implementing or improving provisions of MET information and services to support effective ATFM?

Thank you for your time to complete this survey

Respondent Information

State/Administration: _____
Organization: _____
Name: _____
Post title: _____
Email: _____
Work nature: (ATM operation / MET service / Airspace User)