International Civil Aviation Organization

FIFTEENTH MEETING OF THE COMMUNICATIONS/NAVIGATION/SURVEILLANCE AND METEOROLOGY SUB-GROUP OF (CNS/MET SG/15) APANPIRG

Bangkok, Thailand 25 – 29 July 2011

Agenda Item 14: Regional MET support to ATM

SUMMARY OF ICAO/WMO APAC MET/ATM SEMINAR AND TF/2 MEETING

(Presented by the Secretariat)

SUMMARY

This paper provides a summary of the ICAO/WMO APAC MET/ATM Seminar and TF/2 Meeting held in Fukuoka, Japan form 24-26 and 27-28 January 2011.

This paper relates to

Strategic Objectives:
A. Safety
C. Sustainability

Global Plan Initiatives:
GPI-18 Aeronautical information
GPI-19 Meteorological Systems

1. Introduction

1.1 The ICAO/WMO APAC MET/ATM Seminar was held in Fukuoka, Japan from 24-26 January 2011. The seminar was a prerogative of the APANPIRG via Conclusion 19/53, which was reinstated with APANPIRG 21/50 to include WMO as a partner in the seminar. The objective of the seminar was for States to exchange information on MET developments for ATM. Outcomes of the seminar discussions were considered in more detail at the MET/ATM TF/2 meeting held in Fukuoka, Japan from 27-28 January 2011.

1.2 The seminar was attended by 76 experts from 14 States, 2 Special Administrative Regions, IATA, IFALPA, IFATCA, WMO and ICAO. The MET/ATM TF/2 Meeting was attended by 43 experts from 11 States, 1 Special Administrative Region, IFATCA, WMO and ICAO.

2. Discussion

2.1 An executive summary of the seminar and TF/2 meeting is provided in the **Attachment 1** which includes information on State arrangements between MET and ATM,

Meteorological impacts on ATM such as volcanic ash, tropical cyclone, inter tropical convergence zone, and dust storms, use of meteorological information by ATM, ATM developments requiring additional/new MET information such as Meteorological Services in the Terminal Area (MSTA), and the future delivery method of MET data. The full report of the seminar may be accessed at http://www.icao.or.th/meetings/2011/METATM_Seminar/METATM_Seminar-rpt.pdf. The full report of the TF/2 meeting may be accessed at:
http://www.icao.or.th/meetings/2011/METATM_TF2/METATM_TF2rpt.pdf.

2.2 Note that Appendix C to the TF/2 meeting report contains proposed changes to the Terms of Reference (TORs) of the MET/ATM Task Force, which is provided in the **Attachment 2**. The meeting may contribute to these proposed changes which include adding membership States of Singapore and the Russian Federation and monitoring collaborative decision making in other regions with view of future applications in the APAC region. Given the above, the meeting is invited to consider the adoption of the following Decision.

Decision 15/x – MET/ATM TF TORs

That, Singapore and the Russian Federation be included in the APAC MET/ATM TF membership and add the monitoring of collaborative decision making for the possible future applications in the APAC Region and reflect these proposals in the MET/ATM TF TORs.

2.3 Note that Appendix D to the TF/2 meeting report contains six action items that the meeting should review and is provided in the **Attachment 3**.

2.4 Note that Appendix E to the TF/2 meeting report is input to the MSTA expert team that was expected to be shared with other regions by WMO. WMO or members of the WMO Expert Team may speak to developments in this Appendix which is reproduced in the **Attachment 4** to this paper.

3. Action required by the Meeting

3.1 The meeting is invited to:

a) note the information in this paper;

b) review and update, if necessary, the proposed TORs, and consider adopting the related Decision;

c) review and update, if necessary, the actions from the TF/2 meeting; and

d) update the group on other responses from regions to APAC input to MSTA questions.

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ICAO/WMO APAC MET/ATM Seminar and TF/2 meeting – Executive Summary
Fukuoka, Japan
24-26 and 27-28 January 2011

Annex 3, *Meteorological Provisions for International Civil Aviation*; provides standards and recommended practices on services for flight planning and tactical decision-making. Air traffic in some places, particularly North America and Europe, require additional meteorological products and services to those in Annex 3 for strategic planning by Air Traffic Management (ATM). The Asia and Pacific Regions currently have significant growth, which is forecasted to continue such that enhanced MET services and products are required to meet the needs of ATM in optimizing traffic flow. The ICAO/WMO APAC MET/ATM Seminar held in Fukuoka, Japan from 24-26 January 2011 (APANPIRG Conclusions 19/53 and 21/50 refer) allowed States to discuss their progress on MET products and services that better serve ATM. In addition, some issues were further considered by the APAC MET/ATM TF/2 meeting which resulted in six action items.

The seminar was attended by 76 experts from 14 States, 2 Special Administrative Regions, IATA, IFALPA, IFATCA, WMO and ICAO. The task force meeting was attended by 43 experts from 11 States, 1 Special Administrative Region, IFATCA, WMO and ICAO. The full reports of each can be found at the following website http://www.bangkok.icao.int/meetings/meetins.html. A brief summary of items discussed and resulting six actions are provided here within.

State arrangements between MET and ATM

Many States at the seminar have arrangements between MET and ATM. The host State, Japan, detailed steps in developing a MET service for ATM called the Air Traffic Meteorology Centre (ATMetC) located at the Air Traffic Management Centre (ATMC). These steps may be useful for emerging States that plan to provide such services in the future. The Republic of Korea noted that due to constraints in resources, visits to the nearby Area Control Centre (ACC) are conducted to provide briefings of weather impacts on ATM for each shift. The Russian Federation provides a mechanism for former Soviet Union States to improve MET services for aviation in the form of a working group. Most States with MET services for ATM provide briefings catered to ATM, in addition to teleconferences and mutual training (ATM for MET, MET for ATM) as described by Hong Kong China. The United States described the use of the Central Weather Service Unit at the En-route Centres in serving ATM needs in addition to products being used for strategic planning (greater than 4 hours in advance) at the Central Flow Control Unit. Collaborative decision making includes the airline operators which has proven successful in that they often cancel flights in advance resulting in less ATM workload to manage a particular weather event. Decision support tools include when aircraft are expected to be in convective weather, based on forecasts of convection overlaid on historic air traffic data at one hour intervals. Capacity impacts are forecasted using a combination of airport/terminal/en-route impacts due to weather, which allows for a prediction of how many flights should be cancelled to reduce delays to an acceptable level. Furthermore, operators are provided with choices (cancellation, delay, reroutes) which allow the operator to make the decision that best suits them. When an operator chooses a cancellation or delay, that time slot becomes available for another operator to use. Lastly, the seminar noted that the knowledge of other States air traffic impacts due to weather also assists neighboring States or States where operations are numerous to the other State in ATM planning.

Given the importance of collaborative decision-making, the MET/ATM TF/2 meeting agreed that terms of reference of the task force include "study the successful involvement of MET in the development of CDM in other regions with a view to future application in ASIA/PAC" (TF/2 meeting **Action 2/1 refers**).

Meteorological impacts on ATM

Various types of weather have significant impact on all phases of flight (en-route, terminal and aerodrome).

Volcanic Ash

States discussed various volcanic ash impacts on en-route and aerodrome operations. Japan noted the disruption to trans-Pacific flights that utilize one of the five Northern Pacific (NOPAC) routes as a result of the volcanic eruption of Mt. Sarychev in the Russian Federation on June 12, 2009. Many flights were en-route several hours before turning back to their point of origin and due to the operators not having the same information as the Japan Civil Aviation Bureau (JCAB) and city-pair restrictions. This has been partly resolved by sharing of information, but city-pair restrictions are only done on a case by case basis with an investigation on relaxing this constraint in such events before the aircraft departs. The use of Pacific Organized Track System (PACOTS), which are optimized routes determined by Japan and the United States each day based on the jet-stream. These routes are typically south of the volcanic ash cloud, however, adjustments to tracks based on new information are not currently made. Improvements being considered at the Informal Pacific ATC Coordination Group (IPACG) include coordination between the Russian Federation and Japan in terms of alternate routes. Another improvement is having accurate volcanic ash information for users. The Russian Federation has designated the Institute of Volcanic Geology and Geochemistry of FED Russian Academy of Sciences (IVGG FED RAS) as the State Volcano Observatory to continuously monitor active volcanoes in the Russian Far East, which includes the Sakhalin and Kuril Islands.

Indonesia informed the seminar of the significant air traffic impacts, which included 400 cancelled flights at Jogjakarta Airport due to the eruption of Mount Merapi on Java Island that began on October 26, 2010. The impact of ash was probably reduced due to the ATS contingency plan in place (est. 2007), which involves collaboration between the civil aviation authority, MET authority, air navigation service provider, and the military. Further developments include bilateral ATM coordination for volcanic ash events between Indonesia and Singapore (TF/2 meeting **Action 2/4**). Specifically, a plan to develop contingency routes and FIR to FIR coordination in case of volcanic ash events is expected. A working paper on this subject will be submitted to the METWARN/I TF/1 meeting of the APANPIRG in March 2011.

Indonesia CAA and operators desire volcanic ash maps that contain thresholds of ash concentration. The seminar was briefed that volcanic ash thresholds are being investigated by the International Volcanic Ash Task Force (IVATF) airworthiness sub group which plans to use information provided by engine manufacturers. In addition, the IVATF ATM sub group is investigating a template on regional contingency plans for volcanic ash. This outcome would affect the development of the APAC regional contingency plan for volcanic ash. In the meantime, points of contact for operational purposes during a volcanic ash event have been provided by 13 States and one Special Administrative Region and posted on the APAC website (APANPIRG D21/9 refers). States who have not provided this information will be reminded by the APAC RO (TF/2 meeting **Action 2/3 refers**) for updating by 1 April 2011.

Other improvements of volcanic ash information services were provided to the seminar, such as the stakeholder meeting outcome conducted by the Federation Aviation Administration of the United States to improve volcanic ash information from the Volcanic Ash Advisory Centres (VAACs) Anchorage and Washington.

Tropical Cyclone

As volcanic ash events impact mainly en-route and aerodrome operations in the cases described, a tropical cyclone event in Japan on 7 and 8 October affected airport capacity at the Tokyo International Airport mainly due to operational requirements related to wind and visibility. The forecast for significant reduction in airport capacity was accurate and assisted in limiting the number of in air holds, saving costs to the airlines.

Intertropical Convergence Zone

Accurate convective forecasts in graphical and tabular form for air traffic focal points such as holding areas assists planning for the Hong Kong China ATM in determining proactive measures to avoid significant diversions caused by convective weather. Furthermore, ATM utilizes different flight levels in the Hong Kong FIR to avoid aircraft conflicts with the anticipation of deviations. These meteorological products are useful to air traffic planning for several months of the year when the Intertropical Convergence Zone results in large areas of significant convection.

Dust Storms

Airport arrival rates (AAR) were significantly reduced due to low visibility operations at Sydney International Airport as a large part of eastern Australia was affected by dust storms from 21-27 September 2009. The forecast for high winds provided anticipation of AAR reductions, but low visibility was not forecasted in time to assist AAR planning. The seminar noted that clarification on criteria and reporting of dust storms is being developed by the World Meteorological Organization (WMO) Sand and Dust Storm (SDS) Warning Advisory Assessment System (WAS) in conjunction with ICAO at the global study groups (AMOFSG and METWSG). Australia has taken an initiative in training and improved forecasting documentation guidance in the Bureau of Meteorology's Aeronautical Forecasters Handbook.

Use of Meteorological information by ATM

The seminar noted the 1,000 feet vertical spacing where Reduced Vertical Minimum Spacing (RVSM) is utilized is increased to 2,000 feet vertical spacing when severe turbulence is reported as per the RVSM Manual. WMO noted that the theoretical altimeter errors associated with vertical motion in situations such as turbulence and gravity waves should be investigated further. As a result, the MET/ATM TF/2 meeting invited WMO to request the ICAO Separation and Airspace Safety Panel (SASP) to investigate these theoretical errors, which could be done by comparing GPS readings with altimeter readings (TF/2 meeting **Action 2/5 refers**).

IFATCA noted their input could have been of use at the global study groups (AMOFSG, METWSG) when developing standards and guidance material related to visibility reporting and spatial area of TAF and METAR to name examples. IFATCA was invited to request membership of the global study groups to request membership. IFATCA also noted the importance of ATC to be involved in the development of ATM products since ATC is a tactical phase, while ATM is a strategic phase and a link is needed in the timeline of 0-4 hours in the operational planning phase. In addition, ATC desires products that are in graphic or tabular form whereas the strategic phase may have different product representation.

ATM developments requiring additional/new MET information

The seminar noted that future MET requirements for ATM will likely have high level enabling clauses in Annex 3 with more dynamic information in a WMO/ICAO Manual (TF/2 meeting action **2/6 refers**). These new requirements should assist in maximizing the benefits of performance based

navigation (PBN). The World Area Forecast System in its current form does not meet the demands of PBN due to the coarse spatial and temporal resolutions. Some locations utilize greater spatial and temporal resolutions of upper level wind to assist in arrival metering and sequencing, such as Hong Kong China.

Meteorological Services in the Terminal Area (MSTA)

To close the gap between current Annex 3 provisions and ATM needs, the Meteorological Services in the Terminal Area (MSTA) initiative is being developed by WMO in collaboration with ICAO. The prototype MSTA is expected to assist ICAO in developing requirements on MET products and services (forecasts and probabilities of convection, winds, low ceiling/visibility, winter weather and dust/sand storms) for a wider terminal area not currently prescribed in Annex 3. These services are subject to endorsement at the ICAO MET/AIM Divisional Meeting / WMO CAeM XV Session in 2014. User input is provided to WMO, which is linked to an ICAO user group in the development of requirements. User input at the regional level was provided at the task force meeting, which addressed the following points: **development of probabilistic forecasts, verification and validation of forecast accuracy, translating weather products to user impacts and standards and guidance material for MSTA**. The seminar consensus to these points will be incorporated in the AMOFSG ad-hoc group and WMO encouraged sharing its feedback at forthcoming MET/ATM meetings in other ICAO regions (TF/2 meeting **Action 2/6** refers).

Future data delivery

The delivery of weather information to ATM and other AT sectors will change from alphanumeric code to extensible markup language (subject to endorsement by the ICAO MET/AIM Divisional Meeting / WMO CAeM XV Session in 2014). The reason for the change is to enable automated systems, reduce coding errors and improve quality control.

Other

One subject only raised in the MET/ATM TF/2 meeting was the review of the Air Traffic Flow Management (ATFM) Survey 2010. Several States noted the MET information provided was incomplete, misleading or missing. As a result, the meeting requested the survey be checked for validation by those States as described in **Action 2/2**.

Next MET/ATM event

The meeting agreed that the CNS/MET SG/15 meeting will have the most insight in determining the time frame of the next MET/ATM event, which may not be required each year, but should be tied in with global developments such as Annex 3 amendments and WMO meetings.

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ICAO APANPIRG CNS/MET
Meteorology and Air Traffic Management TASK FORCE (MET/ATM TF)

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2. DESCRIPTION	
Objective	Improve efficiency of ATM and airlines by providing tailored regional MET products needed to optimize flight routes in all weather conditions
Benefits	Increase efficiency – save time and fuel as well as reduce carbon emissions
Terms of Reference	Under guidance from ICAO Secretariat: a) Evaluate the current and future requirements for MET in support of ATM ~~(includes ATFM)~~ in the ASIA/PAC Region and update Regional Air Navigation Plan accordingly and provide guidance material to assist States to develop MET services to meet these requirements; b) Assess aviation meteorological services, systems and architecture in the region and how they can integrate weather information into decision support tools; c) Investigate sub-regional exchange of MET information and associated agreements that facilitate ATM operations particularly over busy routes that overlap different FIRs; d) Promote coordination between MET and ATM communities in the ASIA/PAC Region to enhance the level of understanding of MET requirements and capabilities in support of ATM; e) To study the successful involvement of MET in the development of CDM in other regions with a view to future application in ASIA/PAC f) Monitor global policy associated with source data and delivery of MET products for ATM; g) Coordinate with METWARN/I TF on framework for contingency plan for specific phenomenon including volcanic ash, radioactive cloud, tropical cyclone and Tsunami with reference to developments made by the IAVW, IVATF and WMO IUGG scientific advisory group ~~steering committee~~; h) Report to the CNS/MET Sub-group of APANPIRG for further co-ordination through the ICAO Secretariat with other relevant bodies (ATM/AIS/SAR Sub-group).
Work Program	See section 6

3. COMMUNICATION STRATEGIES				
Description	**Target Audience**	**Delivery Method**	**Frequency / Date**	**Responsibility**
Work Plan	Task Force Members	Document via email	As required but reviewed at least quarterly	Chair
General correspondence	Task Force Members	Email	As required	Task Force Members
Task Force Meeting	Task Team Members	Meeting	As required, supplemented by teleconference	Chair
Status & Milestone Reports	ICAO Secretariat and Task Team Members	Report via email	At least half-yearly	Chair
Task Force Report	CNS/MET SG	Working Paper	Yearly	Chair

4. PERFORMANCE FRAMEWORK FORM (PFF)				
Tasks	**Time Frame**	**Responsibility**	**Status**	**Milestone**
Task 1: Conduct MET/ATM meeting in 2009 to determine actions needed to obtain regional MET requirements to support ATM	2009	MET/ATM TF	complete	1
Task 2: Conduct survey on regional ATM requirements for MET information	2010-2011	MET/ATM TF	To commence after MET/ATM meeting	1
Task 3: Conduct MET seminar in coordination with WMO in 2011 to further develop list of possible regional MET requirements to support ATM	Jan 2011	MET/ATM TF	planning	1
Task 4: Assess aviation meteorological services, systems and architecture in the region and how they can integrate weather information into decision support tools	2010-2015	MET/ATM TF	In progress	2
Task 5: Investigate sub-regional exchange of MET information and associated agreements that facilitate ATM operations particularly over busy routes that overlap different FIRs	2010-2015	MET/ATM TF	In progress	3
Task 6: Facilitate implementation of Meteorological Services for the Terminal Area (under development by WMO)	2010-2015+	MET/ATM TF	future	4
Task 7: Monitor global policy associated with source data and delivery of MET products for ATM	2010-2015	MET/ATM TF	future	5

5. MILESTONES			
Milestone	**Accountability**	**Dates**	**Status**
Milestone 1: Determine regional MET requirements for ATM	**MET/ATM TF**		**To begin**
Milestone 2: Develop methods to use weather information in decision support tools	**MET/ATM TF**		**To begin**
Milestone 3: Develop sub-regional exchange of MET information to facilitate ATM operations in busy routes	**MET/ATM TF**		**To begin**
Milestone 4: Develop regional implementation plan for the Meteorological Services for the Terminal Area	**MET/ATM TF**		**future**
Milestone 5: Monitor global policies associated with source data and delivery of MET products for ATM	**MET/ATM TF**		**To begin**

6. WORK PLAN				
Activity / Milestone	**Accountability**	**Predecessors**	**Date**	**Status**
Activity 1: Develop regional MET requirements for ATM				
Activity 1.1: Conduct MET/ATM meetings (TF meetings, Seminars) to contribute in developing MET requirements for ATM	MET/ATM TF	-	Jan 11 (at least every 18 months)	In progress
Activity 1.2: Analyse existing surveys (e.g. ATFM survey) and develop new surveys, when necessary, to determine regional ATM requirements for MET	MET/ATM TF	-		To begin
Activity 1.3: Recommend regional MET requirements for ATM to CNS/MET SG and AMOFSG (through direct membership) meetings	MET/ATM TF	-	Annual (AMOFS G – 18 months)	To begin
Milestone 1: Determine regional MET requirements for ATM				
Activity 2: Developing methods to use weather information in decision support tools				
Activity 2.1:	MET/ATM TF	-		To begin
Activity 2.2:		-		
Activity 2.3:		-		
Milestone 2: Develop methods to use weather information in decision support tools				
Activity 3: Developing sub-regional exchange of MET information to facilitate ATM operations				
Activity 3.1: States develop agreements on the exchange of MET information that provides benefits to ATM operations on sub-regional level	States	-		To begin
Activity 3.2: States report developments to MET/ATM TF and CNS/MET SG meetings	States/ MET/ATM TF	3.1		To begin
Milestone 3: Develop sub-regional exchange of MET information to facilitate ATM operations in busy routes				To begin
Activity 4: Developing regional implementation plan for MSTA				
Activity 4.1: Monitor developments of MSTA (pending approval at conjoint ICAO/WMO Divisional meeting 2014)	MET/ATM TF	-		In progress
Activity 4.2: Monitor Annex 3 developments (requirements for MSTA)	MET/ATM TF	4.1		future
Activity 4.3: Develop regional implementation plan for MSTA	MET/ATM TF	4.2		future
Activity 4.4: Monitor regional implementation of MSTA	MET/ATM TF	4.3		future
Activity 4.5: Report implementation progress to CNS/MET SG	MET/ATM TF	4.4		future
Milestone 4: Develop regional implementation plan for Meteorological Services for the Terminal Area				**future**

Activity 5: Monitoring global policies associated with source data and delivery of MET products for ATM				
Activity 5.1: monitor global policies associated with source data and delivery of MET products for ATM	MET/ATM TF	-		To begin
Activity 5.2: report results to MET/ATM TF and CNS/MET SG meetings	MET/ATM TF	5.1		future
Milestone 5: Monitor global policies associated with source data and delivery of MET products for ATM				

FOLLOW-UP OF APAC MET/ATM TF/2
ACTION AGREED

Status on 26 April 2011
√ = completed

No.	Title/Action	Follow-up action (target/completion dates in brackets)
2/1	**Proposed updates to TORs** That, the Secretariat will draft a working paper with the proposed changes to the TORs • membership to include Singapore and Russian Federation • removal of ATFM in (a) since it is covered in ATM • include new TOR "study the successful involvement of MET in the development of CDM in other regions with a view to future application in ASIA/PAC" • include IAVW in section (f) (now g) • modify WMO reference to WMO IVGG scientific advisory group in section (f) (now g) • the inclusion of ATM/AIS/SAR/SG in section (g) to be coordinated with the Secretariat (now h) for further consideration by the CNS/MET SG/15 meeting	Secretatariat WP for CNS/MET SG/15 √ **(paper drafted)**
2/2	**Check the validity of the ATFM survey by States for more accurate depiction of MET elements used for ATFM** That, States check the validity of the ATFM survey to obtain more accurate contributions from MET for ATFM. Update survey and draft WP for ATM/AIS/SAR/SG/22 and CNS/MET SG/15 meetings	Secretariat Email original survey to TF members of the following States: Brunei Darussalam, China, Malaysia and United States √ **(email – 2 Feb 2011)** Collect responses **(Malaysia and United States returned)** Secretariat Update survey results for consideration by ATM/AIS/SAR/SG/22 and

		CNS/MET SG/15 (30 April 2011) **(paper drafted, waiting on other returns)**
2/3	**Operational point of contact for volcanic ash events** That, the Secretariat remind States to provide an operational point of contact in case of a volcanic ash event (APANPIRG Decision 21/9 refers)	Secretariat State letter (reminder) √ **(2 Feb 2011)** States to respond to SL Secretariat update website √ **(25 April 2011)**
2/4	**Bilateral ATM coordination for volcanic ash events** That, ATM of Indonesia and Singapore prepare a working paper for the METWARN/I TF/1 meeting on a plan to develop contingency routes and FIR to FIR coordination in case of volcanic ash events	States: Indonesia and Singapore WP √ **(23 Mar 2011 – WP/13)**
2/5	**Altimeter reading study when vertical motion is present** That, WMO considers requesting ICAO Separation and Airspace Safety Panel (SASP) to investigate theoretical errors associated with altimeter readings when vertical motion is present (in such situations as turbulence and gravity waves). This could be done by operators in comparing GPS readings with altimeter readings.	WMO letter (1 May 2011)
2/6	**APAC ATM input to MSTA questions for further development for AMOGSG** That, the feedback from the APAC MET/ATM TF/2 meeting to MSTA Expert Team be incorporated in the AMOFSG ad-hoc group and WMO be encouraged to share its feedback at forthcoming MET-ATM meetings in other ICAO regions.	WMO input to ad-hoc study group Study note (1 June 2011)

APAC MET/ATM TF /2 meeting input to WMO Expert Team on Meteorological Services in the Terminal Area (MSTA)

Question 1 - Probabilistic forecasts

All the elements that can result in impacts on capacity and traffic at the terminal and en-route may be useful presented in a probabilistic forecast, e.g. rain, snow, thunderstorm, fog, ceiling and visibility, freezing precipitation, wind, sea breeze, smoke, haze and wind shear (terminal) and thunderstorm, cumulonimbus, convection, icing and turbulence (en-route).

End users (e.g. ATM) would make use of probability forecasts of various criteria being met which are known to cause significant impact and result in contingencies, actions and decisions being made, e.g. high intensity precipitation, visibility and/or ceiling reaching certain thresholds, strong wind and crosswind or tailwind exceeding user-defined/aircraft type limits.

The probability forecasts would be useful if they targeted the cumulative constraints of those elements above such as visibility/ceiling, convection, freezing precipitation and wind. For example, each weather element would be represented as a probability of meeting the user/situation/purpose criteria.

Multiple possibilities for the probabilistic forecasts of cumulative constraints may be developed to meet user specific and purpose specific needs. For example, the probability of the duration of a thunderstorm at an aerodrome lasting 45 minutes may be used to decide on contingency procedures. A simplistic representation of this concept is illustrated below where the probability of the event (rows) and the terminal demand (columns) are used in a risk matrix/decision support tool to determine the level of contingency required (red = divert, yellow = hold, green = no contingency).

	LOW	MEDIUM	HIGH
HIGH			
MEDIUM			
LOW			

Use of probabilistic forecasts in risk matrices as described above may be developed to meet user needs in a format/framework similar to the Meteorological Category Forecast used by the JMA ATMetC described by Japan, however it's noted that the Meteorological Category Forecast is designed for deterministic forecasts.

The idea above relates to human use of MET information to support ATM decision making, however probabilistic forecasts may be developed to populate automated decision support tools.

It was suggested that graphical probabilistic forecasts may also be useful, such as those developed in some states to predict the strike probability of tropical cyclones. Such information could be useful for short-term probabilistic forecasts of convection impacting flight corridors and holding areas, etc.

User requirements were noted as the key factor for determining what elements, or more precisely what constraints would be provided in probabilistic format.

The scientific and technological constraints on probabilistic forecasting techniques would place limits on the scope covered by probabilistic forecasts, e.g. Hong Kong China reported that Graphical Convective Forecast techniques have limited skill out to 30-60 minutes only.

In order to ensure the probabilistic forecasts are used appropriately and meet the desired purpose it was suggested that high impact events could be analysed on a case-by-case basis as described in the CDM process presented by USA.

For users to have confidence in adapting probabilistic forecasts, it is envisaged that probabilistic forecast systems would incorporate real-time verification and validation functions to ensure the forecasts are reliable and calibrated.

Question 2 - Verification and Validation

Air Traffic Services have the thankless task of making rational, concrete decisions based on information input that is partly or largely subject to a degree of uncertainty.

For this reason, and to reduce stress in ATM staff, decision support tools are being developed that help to turn probabilistic information with varying degrees of uncertainty into binary, yes/no type decisions.

Such decision support tools, and to some extent the direct use of probabilistic information by ATM staff, requires reliable information on the degree of accuracy and reliability of the input information. This information can be derived from verification and validation processes. In terms of verification, the classic verification measures focus on measures such as mean absolute error, standard deviation and bias of continuously varying parameters such as temperature, pressure or wind (in direction and speed).

These measures are difficult to interpret by human users in a decision making process, unless they can be expressed in terms that are closely related to the user process. As an example, the errors in low-level wind forecasts could be expressed as cumulative position or timing errors of aircraft positions in a continuous descent leading to a turning-in point for final approach. Such a measure can easily be compared to separation requirements and thus have a direct bearing on operational procedures.

For parameters used in deciding operating categories and procedures such as ceiling height or visibility, verification needs to address the issue of critical thresholds. Here the ability of the forecasting system to correctly predict the parameter in the given categories can be measured by performance indicators such as Probability of detection, false alarm rate or measures of success composed of these two.

Again, interpretation of these measures in terms of direct operational usefulness is difficult for non-experts, and do not easily translate into operational impacts.

The workshop participants favoured a time-success diagram that can be constructed based on past performance of the system. Users need to provide a “tolerance limit” that defines what can be considered acceptable (e.g. the location of a thunderstorm has to be within a 5 or 10 mile radius from the forecast position, the onset or cessation of a phenomenon such a freezing rain has to be predicted within 10, 20 or 30 minutes), and based on these definitions of a “hit”, a diagram can be constructed that allows to determine the likely lead time (warning time before onset) for any desired threshold of success. As different user communities (tTWR controller, APCH, Supervisor, ATFM) work to very different time horizons in their decision making process, they can be provided with the expected success rate at the required time horizon, or, if a minimum success rate is defined (say 75% of all cases of below IFR conditions need to be predicted), the available lead time (say 3 hours) can be read from the diagram.

When it comes to wind shifts affecting runway selection, TWR, APCh and ATFM would be able to find the achievable accuracy at the typical time horizon they have to work to quite easily.

Thus, decision support models looking at a typical cost-loss situation can be objectively optimized based on this information, while in the case of human decision making, the knowledge of the expected accuracy and reliable of the input data will rationalize the process, reduce stress and improve performance of the staff in question.

Question 3 - MET products translated to user impacts

After discussing various options, the workshop participants favoured the following mechanism to translate MET products from MSTA to user impacts.

(a) *what and how to provide MSTA*

Framework should contain:
(1) weather element which are critical to operation, and
(2) criteria/scenario which corresponds to "impact" (as determined and agreed between MET and users).

For (1), it is noted that the detailed scenario/criteria would be dependent upon user group and time frame based on different operations such as tactical and strategic operation.

(b) *weather elements that need to be dealt with at higher priority*
wind, convection, winter weather (icing, snow), low visibility and cloud ceiling which are considered to have more impact to ATM operation in general.

(c) Interface between MET and ATM
MET will provide forecast on whether the weather element meets the "criteria/threshold/scenario" and ATM will estimate the impact to ATM operation (e.g. capacity changes). Human aspects (e.g. actions to be done based on such information) should also be taken into consideration. IFATCA and certain ATM users indicated that the MSTA service would be useful to ATM to raise their awareness and to facilitate their decision-making and planning purposes. Both MET and ATM need to work jointly to determine the "scenario/criteria" which correlates to impact.

(d) visualization
To facilitate CDM, it is proposed to have similar layout for stakeholders, including possible components such as categorization of impact into different levels, with potential combination of tabular, graphical, textual, or gridded format as determined by MET Authority and user.

The participants generally supported the proposal of the above MSTA concept. It allows flexibility to suit different users' operational need and is not a one-side-fits-all process. It also raises the awareness of MET to put more focus and raise their awareness on forecasting weather elements meeting certain criteria at the area coverage that are of interest to ATM.

Question 4 - Residence of provisions

(Question) In the MSTA proposal to be considered by the ICAO/WMO Conjoint Meeting in 2014, it has been suggested that the Core SARPs (i.e. Standards and/or Recommended Practices) be restricted to basic info, with the details put into Manuals/Guides?

All 4 groups concurred that the provision of MSTA should be included in Annex3, as general enabling clauses with agreements between MET and ATM, considering the fact that Annexes are high-level documents which identically shouldn't have so many details. For example, air traffic services (ATS) has been regulated by Annex11, however, details of ATS are written in manuals such as Doc 4444, PANS_ATM, Doc 7030.

Groups also agreed that the detail specification of the MSTA, such as verification method, forms with examples, airspace density criteria for terminal area, should be documented in manuals or guidance materials. Development of manuals and guidance materials should reflect user feedback from ATM, PILOTS, and Airline Operators that define the functional and performance requirements.

Besides those comments, there was an interesting suggestion raised by a member. It said that the MSTA will consist of various kinds of services, such as observation, forecasting, and also delivery of the services, and such whole services shouldn't suitable to be written in a single section in Annex3. This suggestion should be considered by the ET-MSTA carefully, in order to develop future regulations and guidance materials appropriately as much as possible.

(Question) Which aspects should go into each section; e.g. Model Charts and Forms, desirable accuracy of forecasts, and/or guidance material?

Throughout the question time, there were many aspects to be included into each documents suggested, as shown in Table 1. Although almost of all materials were already covered by section 1, except "use of probabilistic forecast". Because probabilistic forecast is a state-of-the-art technology, it is more suitable for guidance materials than Annex3.

	Annex3	Guidance
Conceptual	- desirable accuracy - Aerodrome Density Criteria -boundary/hight - WX phenoma -Agreement btn MET/ATM -Forms(text, graphic)	-Model Charts -Forms (example) -Verification method -boundary/hight (detail figure) -Users Feedback (From ATM, PILOTS, OPERATERS) -Methodology -Use of Probabilistic Forecast

Fig.1
Question 4-2 : aspects which should be included in each document

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