European and North
Atlantic Office

WORKING DRAFT of the

MET Strategy in supporting the Global ATM Operational Concept for the EUR Region

Prepared by the EANPG COG Meteorological/Air Traffic Management Task Force (MET/ATM TF)

May 2011

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DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
0.0	Dec. 2001	Invalidated parts of document as they have been provided by the authors and missing chapters	All
0.1	April 2002		
0.2	June 2002	Modified as a result of 6th meeting of METATM	All
0.3	Nov. 2002	Modified as a result of the METG/12 actions	All
0.4	Nov. 2002	Modified during ad-hoc meeting	All
0.5	April 2003	Modified during the METATM Drafting Group Meeting	All
0.6	June 2003	Modified as a result of the 7th meeting of METATM	All
0.7	November 2003	Modified as a result of the 8th meeting of METATM	All
0.8	March 2004	Modified as a result of the 9th meeting of METATM	All
0.9	June 2004	Modified as a result of the 10th meeting of METATM	All
1.0	July 2004	The second modification as a result of the 10th meeting of METATM	All
1.1	August 2004	The third modification as a result of a review by correspondence before METG/14	All
1.2	June 2009	Modified to reflect emerging developments in the ECAC region: - Single European Sky - Single European Sky ATM Research (SESAR)	All
1.3	September 2009	Document status change to ***WORKING DRAFT*** as a result of the 1st meeting of the MET/ATM Task Force.	Foreword
1.4	May 2011	Amendment to Section 2 – Future ATM to include PBN and CDM, inclusion of aerodrome requirements for MET and revision to Appendix 1	Section 2 Pages 8-9

TABLE OF CONTENTS

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FOREWORD

The forecast continued growth in air traffic volumes in Europe will increase demands on finite airspace and airport capacities. It will impose constraints on the ability of Air Navigation Service providers and airlines to accommodate growth whilst simultaneously improving safety and efficiency. Consequently the ICAO European Region (EUR) Air Traffic Management system (ATM) must evolve significantly to meet this expected growth.

The ICAO tenth Air Navigation Conference endorsed the CNS/ATM concept. This was further developed by the eleventh Air Navigation Conference in 2003, which endorsed the global ATM Operational Concept. The Global ATM Operational Concept should be the global framework and be used as guidance for the further development of ICAO ATM related provisions.

The importance of timely, accurate and easily available information, including meteorological information, for decision support is emphasized in the Global ATM Operational Concept.

In the follow-up to the tenth Air Navigation Conference, the ICAO Council re-emphasised the important role of regions and States with regard to the planning, implementation and transition to the Global ATM system.

In response, the Meteorology Group (METG) of the European (EUR) Air Navigation Planning Group (EANPG) was given the task in 1999 to monitor the activities in the CNS/ATM field, with particular focus on the development of the relevant parts of the EUR Air Navigation Plan (ANP). The METG subsequently established a project team (PT/METATM) to draft a strategy for the evolution of Aviation Meteorology (MET) in the EUR CNS/ATM Region for the period to 2015 and beyond.

The EANPG identified that a regular monitoring of activities in the European CNS/ATM domain is key for the development of the aeronautical meteorological service provision in support of the Global ATM Operational Concept and its planning instantition, the Global ATM Plan. Consequently, the METG replaced the METATM with the METATMG tasked to maintain the strategy for the evolution of MET in the EUR CNS/ATM concept and to report on significant developments in general.

This version of the strategy is an update of the original version and reflects minor changes with respect to evolved supporting material. Furthermore, it reflects experiences gained within emerged legislative frameworks set up in the context of Single European Sky and its technical Research and Development (R&D) component, SESAR.

To reflect the great importance of weather information integration into the future ATM System better and to ensure a framework of shared roles and responsibilities between the MET and ATM community, the EANPG COG determined that the METATMG should be disbanded in view of the establishment of a Meteorological/Air Traffic Management Task Force (MET/ATM TF). The MET/ATM TF reports directly to the EANPG COG.

The MET/ATM TF is comprised of MET and ATM experts assisted by the ICAO Secretariat,Eurocontrol and the European Commission. The information provided in this document is based on the relevant ICAO and Eurocontrol documents and the national practices, experiences and developments in EUR and other Regions.

The first meeting of the MET/ATM TF (August 2009) determined that it would be advantageous to place the latest version of the MET Strategy document on the ICAO EUR/NAT website, provided that it was clearly marked as a ***working draft***. This would

ensure greater visibility of the MET Strategy within the ATM community, in order to better identify key issues facing MET integration into ATM, ATM user expectations, etc.

EXECUTIVE SUMMARY

The future European Air Traffic Management (ATM) system will continue to be subject to the same vagaries of weather phenomena that affect air transport today. Historically, aviation weather services have mainly addressed safety issues. Now within the context of the future ATM system, the considerable impact of weather on safety, capacity and efficiency and its potential to mitigate some of the environment impact of aviation must be considered as well.

Aeronautical Meteorology (MET) is faced with great challenges in the provision of information to satisfy the needs of ATM on a scale not previously encountered and in a timely way. The response must be proactive. The agreed developments must be linked to clearly identified and validated improvements and to time-scales within which they will be delivered.

As the future ATM system evolves, the demands on MET will require improved or new systems, information and products to support it. It is essential that a strategic plan, a roadmap for change, is established to ensure a harmonised and cost effective European approach to interoperability.

The aim for the strategic plan is to provide guidelines to "ensure the provision of timely, accurate, and complete availability of tailored aeronautical meteorological information within the framework of system-wide information management for all phases of flight". To achieve this aim, the following strategic objectives have been identified:

- Define the scope, content, quality and timeliness of MET information to support the key enabling objectives of ATM in a cost-effective manner;
- Define standards to ensure:
    - harmonisation of an (the) open exchange model of MET data formatted for ATM use;
    - harmonisation of MET systems supporting ATM;
    - accessibility of MET information during all phases of flight.
- Improve the quality of MET information to respond to the ATM (safety) requirements through the application of a Quality Management system and safe and secure processes;
- Further improve the provision and use of MET information within the ATM system;
- Resolve institutional, organisational, regulatory, financial and intellectual property issues associated with the provision of MET information to ATM;
- Encourage the further integration of MET within the ATM system
- Improve the contribution of MET to the mitigation of the environmental impact of air traffic.

1. INTRODUCTION

1.1 Background

1.1.1. The future Air Traffic Management (ATM) system will continue to be subject to the same vagaries of weather phenomena that affect air transport today. Consequently, detailed knowledge about the past, current and future state of the atmosphere, provided as aviation meteorology (MET), is required to enable the objectives of the ICAO Global ATM Concept and its regional instantiations, the Single European Sky ATM Research programme (SESAR) and the Next Generation Air Transportation System NextGen) in the USA to be met.

1.1.2. Over the last 5 years both Eurocontrol's Performance Review Commission (PRC) and Eurocontrol's Central Flow Management Unit (CFMU) in their annual reports record that on average, in Europe 35 to 50 percent of ATFM delays at airports are attributable to "bad weather", mainly meaning poor visibility, low clouds and strong winds. The financial lost related to these delays is conservatively estimated at 1 billion Euro per year. Additionally, it has been noticed that there is an increasingly tendency for en-route phenomena increasingly degrade the overall performance of the ATM system.

1.1.3. Historically, aviation weather services have mainly addressed safety issues. Now within the context of the future ATM system, the considerable impact of weather on safety, capacity and efficiency and its potential to mitigate some of the environmental impact of aviation must be considered as well. In more detail, MET is an important key element for the short and medium term trajectory prediction which is central to SESAR and NextGen concepts. MET will be used either in planning the business trajectory or in changing the trajectory in the short term to accommodate several factors including the avoidance of weather hazards.

1.1.4 The PRC and Eurocontrol's advisory group on CFMU operations, the Operations Coordination Group (OCG) specifically addressed the importance of improved integration of weather information into the ATM decision making process to mitigate the adverse effects of "bad weather". Moreover, the EU Single European Sky initiative, its ATM Research Programme (SESAR) and the published European ATM Target Concept clearly identify meteorological information as a key enabler of the future ATM system.

1.1.5 This is a clear move away from the provision of meteorological information in support of hazard prevention and mitigation of adverse weather only towards the full integration of meteorological information in support of Performance Based Air Navigation (PBN) as envisaged by the Global ATM Operational Concept, the Global ATM Plan and Regional planning and implementation initiatives such as SESAR.

1.1.6 Within the context of SESAR and the European ATM Master Plan, the future ATM system will be fully reliant on the automation of precision time keeping. The impact of weather on capacity, efficiency and the environment will be key conditioning factors and must be an integral part of the system operations.

1.1.6 The meteorological community is faced with great challenges in the provision of information to satisfy the needs of ATM in a timely, economic way, and on a scale not previously encountered. The response must be proactive and the agreed developments. They should be supported by business cases and associated with clearly identified improvements and time-scales within which they will be delivered. And they must be fully in line with regional application activities such as SESAR.

1.1.7. For the short term period, MET will be potentially available based on ICAO and national requirements. Close coordination in the implementation of and training in the use of

MET will suffice at first. However to meet the ambitions of the ICAO Global ATM Concept and SESAR and NextGen the transversal use of MET in the decision making process throughout at phases of flight will become essential.

1.1.8. This will require improvements to the existing meteorological services, the development of new products and services and the introduction of concepts such as the "level of uncertainty" and the "level of confidence" associated with MET, to be used in decision making processes. This new attribute representing the "level of uncertainty/confidence" might be considered the 5th dimension associated to the weather depiction, in addition to the spatial and time coordinates, represented in the 4D Weather Cube concept and will be a significant change of philosophy in approaching the weather depiction, based on the most advanced globally available digital tools. This foreseen evolution requires an approach to Information Management which will ensure the timely, accurate, and complete availability of MET information within the concept of system-wide information management (SWIM) for all phases of flight.

1.1.9. In a generic sense, these developments lead to changes in:

a. Definitions of scope, content, quality and timeliness of MET to support the key enabling objectives of the ATM system in a safe and cost-effective manner mitigating as far as possible the environmental impact of air traffic;

b. Standards for MET Information provision to ensure:

- Harmonisation of the open exchange of MET, formatted for ATM use;
- Harmonisation of MET systems interfaces supporting ATM;
- Accessibility of MET during all phases of flight;
- Affordability through the use of advanced MET equipment with uniform capabilities and performance applicable to the Single European Sky (SES) area

c. Arrangements to resolve institutional, organisational, regulatory, financial and intellectual property issues associated with the provision of MET to ATM.

1.2 Why a MET Strategy for Europe?

1.2.1 Traditionally, the ATM connection with MET was essentially limited to ensure a link between the MET services and the flight crews in support of pre-flight briefing and the provision of Flight Information Services as regulated by Annex 11. Yet meteorological conditions represent one of the most important elements of the physical environment for the execution of a flight. Inclusion of meteorological information is essential for the determination of the ground based aspects of a flight, represented in the notion of the environmentally sustainable 4-dimensional trajectory and supporting Collaborative Decision Making (CDM) processes.

1.2.2 SESAR and NextGen and the MET Strategies of other ICAO Regions have identified that accurate and timely meteorological information fully integrated in the system to support all phases of flight, is seen as key for the ATM management. Such information shall be used to improve safety and to determine the optimum route/trajectory for an individual flight or series of flights in all planning and execution phases of flight. In consequence MET must be considered to be an integral element in the development of a new, medium and long term strategy for ATM.

1.2.3 As the future ATM system evolves, the demands put on MET will increase the need for improved or new systems and information services to satisfy them. It is essential that this strategic plan first published in August 2004 is maintained and evolves to ensure a harmonised European approach to interoperability. This approach will be based on the existing capabilities within the international meteorological community for the provision of high quality meteorological information that can better support the ICAO Global ATM Operational Concept.

1.2.4 The MET Strategy for Europe, with its subsequent updates, provides regular opportunities to make an objective evaluation of the current capabilities of the MET technology in Europe, as compared with other parts of the world. They will contribute significantly to the development of a Global MET Strategy with its strong foundation based on the required standards and good practices established in the ICAO Annexes.

1.3 Scope

1.3.1 The geographical scope of the MET Strategy is the ICAO European (EUR) Region. Nevertheless, in writing this strategy, due regard has been given to the global nature of MET and ATM interoperability in general and to the SESAR and NextGen concepts.

1.3.2 Whilst the ICAO Operational Concept is divided into seven interdependent concept components, the main focus of the MET Strategy is on five of these components: Airport Operations, Airspace Management and Airspace User Operations, Conflict Management, Demand and Capacity Balancing and ATM Service Delivery Management. Improved safety is, of course, an overriding concern. Nevertheless, within the current scope of the concept components of Airspace Organisation & Management and Security, meteorological information is not seen as essential and therefore they have not been addressed within this Strategy.

1.3.3 It is recognised that the needs of various sectors of ATM differ from one another and that an evolutionary portfolio of service levels (from simple to complex) should meet specific needs. Consequential recommendations for amendments to the EUR ANP/FASID and ICAO Annexes may be necessary.

1.3.4 The needs for all user groups should be addressed for all phases of flight activity: from planning (up to 6 months or more ahead of the date of flight), through execution, to post flight activities such as post-operations analysis (Figure 1 refers).

Fig. 1

Phases of Flight activity embraced by this Strategy

1.3.5 In addition to this classification, a more detailed operational view and classification of the requirements for ramp, surface departures, departure, dispersion, cruise, collection, approach and surface arrival, as suggested by the Global ATM Operational Concept, will only be applied when seen relevant for the purpose of this Strategy.

1.3.6 This MET Strategy identifies the means by which current meteorological information and system capabilities can be fully exploited to deliver the right information to the right place and at the right time as envisaged in the ATM Master Plan. Moreover, it outlines areas for potential R&D activities to support the newly developed concepts such as 4-D trajectory operations.

1.3.7 , The MET Strategy is harmonised with the Global ATM Operational Concept and identifies the MET strategic objectives up to and beyond 2025.

The MET Strategy describes the Meteorological Information Services that will be required to operate the regional component of the global air traffic system up to and beyond 2025. Furthermore, it addresses what is needed to increase user flexibility and maximize operating efficiencies in order to increase system capacity and improve safety levels in the future air traffic management system by using meteorological information

1.4 MET Strategy Development Methodology

1.4.1 Context

This MET Strategy is a dynamic and living document**.** As it evolves it will refine the required deliverables and the associated target dates, together with the entities that are responsible for their definition and/or implementation.

In the development of the MET Strategy, due consideration was given to:

a. Differences between the MET organisations of EUR States – The ICAO EUR Region is a heterogeneous area with regard to the level of sophistication, the level of performance of the MET services dedicated to the ATM and the economic resources made available by each State to sustain the transition to an enhanced navigation infrastructure. The evolution of the MET technology in parallel with the implementation of the SWIM infrastructure will provide economies of scale for all European States. This shall be enabled through access or transition to the same systems and with similar performances. Though acknowledging the global regulatory role of ICAO, in Europe it seems to be necessary to establish a central coordination body for all the MET activities in the aviation domain. The national MET organisations will retain their clearly defined responsibilities for the provision of the basic data at the required level of quality required by the present and future ATM environment.

b. The economic impact of Weather on aviation - A comprehensive baseline which quantifies the economic impact of adverse weather during various phases of flight, particularly on capacity and efficiency is not available. Nevertheless there is activity in this field (an analysis of airport delays attributed to adverse weather was undertaken by the Performance Review Commission of Eurocontrol (PRC) which is in the process of improving the analysis methodology to be applied [ATMAP-project]). Business case decisions on appropriate investments in the development or enhancement of aviation weather systems will be possible only if reliable economic data and pertinent analysis of the baseline costs implications of weather in the ATM systems is made available.

c. Potential of the current MET capabilities – The current capabilities of MET systems and the results of advanced research in the domain are not fully exploited in the EUR Region. Considerable progress has been made by the scientific community in developing a better understanding of the meteorological factors that affect aviation. As a result, MET service providers have made significant investments in computing technology, and better products and services have been introduced. The European ATM community could greatly benefit in the short term and at relatively low cost through an improved dialogue and co-ordination between the MET providers and the users of their services. The exploitation of the great potential offered by the down-linking of in-flight meteorological data, the use of output of the numeric weather predictions (NWP) and advanced MET detection techniques are only some examples of the opportunities available to ATM.

d. Cost/benefits of weather technology - Despite the significant progress achieved, weather still remains difficult to predict with a high degree of certainty. Supporting technology is expensive to develop and implement. Small gains may be achieved at high costs and therefore new investments should only be undertaken when justified by tangible benefits to the users.

e. Role of the Industry – Equipment manufacturers will play a major role in developing suitable ATC, Avionics, MET and other related equipment and facilities of the future ATM environment. Uncoordinated planning has resulted in a lack of harmonisation of current systems. The consequence is a multiplicity of choices and the absence of a commonly agreed way forward. As a result, Industry has had little incentive to invest in harmonised technology and product development in a timely way. Gaining the confidence and the support from the Industry *vis-a-vis* the agreed way forward is essential for the development of the future MET system and in consequence any require European Community Standards and Implementing Rules; therefore, appropriate objectives, which address Industry involvement, should be identified.

f. Role of the human factor – The extensive use of the expert systems envisaged within the future ATM infrastructure does not exclude the human from the decision making loop. The increasing role of meteorological information in the net-centric information environment, also known as system wide information management (SWIM) has to be reflected through appropriate arrangements between all the actors involved. Only then will true information sharing and CDM will be possible. The need for a new staff profile to reflect the evolving role of the meteorologist within the ATM environment is clearly needed**.**

1.4.2 Process description

The introduction of a new ATM system for the EUR Region will require the full support and commitment of all the aviation stakeholders. A successful evolution will only be achieved through the collaborative efforts of the many members of the aviation community and in an environment in which diverse interests are taken care of and equitably balanced. This is the

prime objective of the EC SESAR Programme and is instantiated in the ATM Target Concept and Master Plan which was developed by and with all stakeholder groups involved.

While it is possible to identify the characteristics of the future ATM system, characteristics such as trajectory based operations, minimising segregation, flexibility, user preferred routing and collaborative planning, a number of uncertainties inherent in longer-term planning still remain. Furthermore, the ATM System needs to be able to facilitate and accommodate the evolving demand of all airspace users, safely, efficiently, and with high performance in all Key Performance Areas while respecting the obligations that fall on each ATM stakeholder. It is recognised that choices from various development paths to follow shall be made on business case analysis. To facilitate any future decisional process, the following principles should be considered:

a. Evaluate current MET systems and identify existing shortcomings.

b. Ensure that any proposed strategic objective supporting the EUR ATM System is in line with the ICAO Global Air Navigation Plan and the European ATM Master Plan and meets performance criteria, including economic, of the full range of ATM requirements.

c. Check that the proposed MET developments are in tune with the appropriate developments in ATM systems in terms of technical and operational requirements, implementation schedule and will contribute to the expected benefits.

d. Choose an evolutionary implementation for the new developments proposed in MET. An incremental approach will allow the accumulation of essential and timely experience of the new systems and confidence will be established in the way forward.

e. Establish priorities in terms of time scales, paying due attention to:

   - identified constraints and user requirements, and

   - systems and areas of applicability in which immediate benefits could be provided or where early implementation may be most likely.

2 FUTURE ATM

2.1 Drivers for Change

2.1.1 ATM , like so many other business environments is "driven by safety and by commercial, economic and efficiency expectations". While there are Standards in place for global interoperability, many States' systems have evolved to levels that are able to sustain their individual requirements though they now struggle or fail to meet the ever-growing user expectations of global harmonisation and interoperability.

2.1.2 Currently, a range of factors, including cost, efficiency, safety and national interests are driving the change in the ATM system. However, the catalyst for change must be ATM user expectations, within a framework of safety case, cost/benefit analysis and business case.

2.1.3 The success of the future ATM system will be reliant on effective planning and management to deliver to the airspace user the (near as possible) optimum business trajectory whilst ensuring flexibility. Flow and capacity management enabled by high precision time-keeping, trajectory based operations and short/medium term conflict detection and resolution will be a significant means of ensuring flight punctuality and efficiency.

2.1.4 Based on forecast traffic volumes and orientations, and on weather forecasts, Air Traffic Flow Management (ATFM) will originate and control the daily Network Operations Plan and will apply any refinements to accommodate real-time events. The need to adapt the original plan may also result from forecast significant weather phenomena that are monitored on a continuous basis.

2.1.5 Increasingly ATM will become a truly “time-ordered system” in which events will be driven by required time of arrival (RTA) at specific points or for landing. The RTA will dictate both planning and operations alike and the use of statistical MET will be used to refine aircraft schedules and probabilistic forecasts employed to maximise short notice cargo yields.

2.1.6 A key change will be the evolution of the interface between the airlines, flight-crews and the ATM network in determining the optimum flight profiles. The Airline Operations Centres (AOC) will examine the requirements for a flight and the current and predicted air situation, such as weather, airspace structure, en-route capacity, airport capacity and environmental considerations so as to select the optimum flight profile. The collected real-time weather data will be collated and analysed to assess, in conjunction with user charges, the cost-benefit of alternative routes and aircraft may be re-planned whilst in flight.

2.1.7 The development of air and ground-based automated systems, in association with new procedures and working arrangements in ATM such as 4D trajectory management and performance-based navigation (PBN), will permit the dynamic management of airspace and the tactical routing of aircraft to provide significant operational benefits (safety, economy, flexibility, improved regularity, and environmental impact mitigation) to users. PBN represents a significant shift from the conventional use of terrestrial radio navigation beacons, fixed way-points and structured routes to the exploitation of an aircraft’s on-board capability to fly the optimum trajectory with high accuracy.

2.1.8 Certain weather situations (e.g. poor visibility conditions, strong winds, thunderstorms) and weather induced runway contamination can restrict airport capacity. Each airport is affected by local weather conditions which impact on their individual actual capacity at any moment in time. Although new systems to operate during some adverse weather conditions such as advanced surface movement guidance and synthetic vision are expected to become available, the key to mitigation and minimisation of disruption will remain mainly in the intelligent use of increasingly accurate forecasting of weather events. Improvements are also needed in the terminal area short-term forecasting. (e.g. departure and approach wind profiles to maximise

runway throughput by incorporation of such data into algorithms to provide time-based separation reduced wake-vortex separation minima tools for controller use). In addition, the wider use of MET information by a more informed and aware industry will allow aerodromes, operators and other supporting services to plan for and mitigate against weather impacts. This includes areas such as winter weather runway clearance, de-icing planning and refueling activities in the proximity of thunderstorms

2.1.9 The key to the future is interoperability within the ATM environment enabled by advanced communications systems, standard interfaces and by standard information exchange models that support the required seamless, transparent and open exchange of Meteorological Information. This Weather Information Exchange model (WXXM) will support the exchange of weather information in digital format(s) through terrestrial, airborne and satellite data links.

2.1.10 The establishment of common situational awareness between MET providers and other partners of the ATM system will improve traffic predictability and operational flexibility. When combined with the introduction of compatible exchange models across all domains of ATM, it will greatly enhance the network-wide adoption of Collaborative Decision Making (CDM) and assist with the introduction of associated decision support tools. MET as a primary influence on ATM operations will be fully integrated into the decision making process for the first time.

2.2 Key changes

2.2.1 This strategy outlines a range of conceptual changes that will evolve through the planning horizon. Key to the philosophy adopted within the MET strategy (the same as the one adopted within the Global ATM Operational Concept) is the notion of global utilisation, management and interchange of information. This will enable in an evolutionary way, significant changes in the roles of all participants within the ATM system, to facilitate enhancements in safety, economy and efficiency across the system and environmentally sustainable. This philosophy should be supported by evolution to a holistic, cooperative and collaborative decision-making environment, where the diverging expectations and interests of all members of the ATM community are balanced to achieve equity, access and system efficiency.

Proactive versus reactive

2.2.2 A major factor in decision making is the accuracy, timeliness and completeness of the information on which the decisions are based. Currently, a reactive rather than proactive approach to decision making is the norm, as the perceived level of associated risk is considerably lower than in the proactive alternative. To change this norm, it is clear that a significantly higher degree of understanding and cooperation between the user and supplier communities is required in order to identify the key data attributes required to assure a high degree of confidence in the information and a platform for decision making.

Improved means for forecast

2.2.3 Improved means to forecast and report windshear, low level turbulence, wake vortex, low visibility procedure conditions, winter conditions, severe weather phenomena and similar occurrences are required in addition to the traditional requirements for MET as specified in Annex 3.

Better utilisation of already available data

2.2.4 Advances in observation and forecasting techniques have raised the levels of accuracy of the predicted information, but the use of these products by the ATM community continues to be low. The reasons for this underutilisation are far from clear. There is circumstantial evidence that a lack of awareness is a significant cause contributing to this situation. To correct this, a

major effort is required from the MET service providers in order to improve the level of understanding and confidence within the ATM community and substantial effort has already been expended and continues to be expended within the SESAR construct.

2.2.5 Nevertheless, it is recognised that action by the MET community alone is insufficient to enable change. An engaged and continued dialogue between ATM and MET to ensure better understanding of needs and capabilities is required. Therefore the early identification of the key MET data attributes and associated quality requirements (accuracy, timeliness, level of confidence, etc.) to support the various decision making entities within the ATM system (ATS, ATFM, AOP, AOC, etc.) is essential to provide a foundation for future investments for the development of MET; an objective of SESAR.

Need for harmonisation

2.2.6 Statistics demonstrate that effective implementation of the critical elements of a safety oversight system and other ICAO provisions are essential to ensure aviation safety. In response to widespread concerns about the adequacy of aviation safety oversight around the world, ICAO launched the Universal Safety Oversight Audit Programme (USOAP). The 2nd cycle of safety oversight audits commenced in January 2005 and will continue until December 2010. Following the USOAP audits it was found that the majority of EUR States were in compliance with the Standards stated in Annexes 3 and 11 in respect of MET serving the aviation needs. It also found that implementation varies significantly between the EUR States. Some States have found it necessary to require and arrange for the provision of MET services and products for ATM in addition to those specified in Annexes 3 and 11. It would appear that some of the MET provisions for ATS in Annexes 3 and 11 should be reviewed and that new categories of services and products dedicated to ATM may be required at the national, regional, and global levels. The need for a harmonised EUR approach to define up-to-date services and products is clearly evident, while the requirements to reflect local conditions should also be addressed. Whilst services are often developed to meet specific local requirements, these should be standardised across the ICAO EUR Region as far as is practicable, to ensure that irrespective of where the MET information is accessed, there is a consistent approach to its presentation.

2.3 High Level requirements

2.3.1 High level ATM requirements from MET

2.3.1.1 **Full compliance** with the ICAO Standards and, as far as possible, with ICAO recommendations.

Note: The ICAO Standards are the core of community and national regulation for the 30 Single European Sky States[1] of the EUR Regions and prescribed by the so-called Service Provision Regulation. The current and foreseen SES regulations will act as the legislative component of the future ATM System in an EC context and are mandatory and directly applicable to the 30 States.

2.3.1.2 **Harmonisation** of MET within the entire EUR Region, through common regulation, procedures and services.

2.3.1..3 **Availability** of timely, accurate, complete, up-to-date and tailored MET information to the aviation community; this requirement will be achieved through:

[1] The 27 States of the European Community (EC) plus Iceland, Norway and Switzerland who have signed cooperation agreements with the EC

a) appropriate tools and means for generation, distribution, integration and display of MET information. It should be recognised that the responsibility for these four steps in making MET information available could be completely separated from a service provision perspective;

b) provision of appropriate MET facilities at airports, including improved instruments for local weather observation, data processing and communication;

c) high quality MET information in the calculation of flight trajectories for the pre-flight and in flight phases ;

d) better local weather and wake vortex forecasting;

e) development and implementation of a common, platform independent means to exchange MET information between expert and non-expert systems, and

f) provision of efficient means to access, understand, and use MET information from a user perspective.

2.3.1.4 **Integration** and interoperability of ATS, ATFM, airports, AIS, MET, AOCs and aircraft into an interactive system to provide complete, relevant and timely information, enabling an effective management decision process. This requirement will be achieved through the establishment of a virtual information pool, an essential component of the System-Wide Management of Information (SWIM). This will provide a harmonised access for airspace users to information such as AIS, MET, etc. The means to facilitate interoperability shall be provided through the adoption of a common data exchange model to facilitate platform independent inter system communication and machine readability of forecast and real-time MET data to ground-based and airborne applications, the latter through datalink.

2.3.1.5 **Efficiency** of MET within the entire EUR Region through:

a) a more customer-oriented approach in providing the MET services and products to the ATM community;

b) better use of the national and international infrastructure in provision of MET services and products to avoid duplication;

c) increased automation and rationalisation, and;

d) a coordinated and harmonised approach in defining, managing and executing the required R&D.

2.3.1.6 **Quality Assurance** of the MET information, through:

a) establishment and implementation of a recognised Quality Management Systems for MET. The ISO 9000 series certification is recommended by Annex 3 and the Service Provision Regulation for the SES States;

Note: Whilst a Safety Management System for MET is not required by Annex 3, the SES Service Provision Regulation requires a rudimentary level of Safety Management in place for MET Service Provision. This could be achieved by expanding the Quality Management System with some principal components of a full fletched Safety Management System.

b) development of harmonised (EUR) key performance indicators (KPI's) for the provision of MET.

2.3.1.7 MET will evolve to satisfy the present and future needs of ATM. The spatial resolution for real-time and forecast data, the levels of accuracy for each specific MET parameter of importance (real-time and forecast) and the extent, duration and level of intensity of severe weather phenomena affecting flight operations will be determined. The information will be provided in a format suitable for ingestion into ATM system(s), particularly into automated support tools. Important to recognise is that since MET information will become an integral part of building the 4D business trajectory, the requirements with respect to integrity, availability, and confidence level of the MET information could significantly change with today' requirement. Today, MET information resides almost completely in the domain between flight planning and almost near real time decision making. In the foreseen system, this will be expanded to the domain of immediately decision making with its own set of requirements for the provision and use of the information and linked requirements for Quality and Safety Management.

3 STRATEGIC AIM AND OBJECTIVES

3.1 Vision Statement

"To ensure the timely, accurate and complete availability of aeronautical meteorological information within the framework of system-wide information management required for building the best suitable 4D flight trajectory ".

3.2 Strategic objectives

Objective 1:
Define the scope, content, quality and timeliness of MET information to support the key enabling objectives of ATM in a cost effective manner.

Currently, the scope of the meteorological products provided to the aviation community is dominated by the requirements of pilots and airline operators for pre-flight briefing material and in-flight warnings. In general, most ICAO Annex 3 requirements (in terms of products and services) are currently aimed at providing pilots with briefing information and warnings for safe and cost effective flights. Although future ATM systems will continue to make use of this information, there will be requirements from other parts of the ATM system for more specialised information for all the phases of flight activity (as indicated in figure 1).

The current CNS/ATM concept for the EUR Region and the SESAR Master Plan identifies only high level requirements for aeronautical meteorological information: to improve efficiency and to promote safety. They require that timely, accurate, complete, and up to date aeronautical meteorological information have to be available to meet users' needs. Nevertheless, these needs are expected to be explicitly listed in the relevant Work Packages of the SESAR programme.

Objective 2:
Define standards to ensure:
- **harmonisation of open exchange models of MET data for ATM use;**
- **harmonisation of MET systems supporting ATM;**
- **accessibility of MET information during all phases of flight.**

Interoperability is essential for the efficient operation and management of the emerging and future ATM system. A key element of this is the exchange of aeronautical information (MET,

AIS, etc), in system independent and open architecture format(s). In the ECAC AIM Domain, extensive work has been undertaken in the development of an Aeronautical Information Exchange Model (AIXM), which together with the adoption of Extensible Markup Language (XML) and its geospatial derivate GML, has provided a conceptual means to provide a follow-on to the traditional Notice to Airmen (NOTAM) for the provision of change information. This concept, known as the digital NOTAM, has the capability of providing the means to change a single data bit or a data string in a database in the air or on the ground in near-real time, regardless of system or platform as long as the information is provided in a common exchange model.

It is recognised that the meteorological community has developed and currently uses highly efficient information formats to provide system-to-system exchange, but these may not be suitable to fit within the ATM concept. Consideration is being given to the provision of a suitable means of open system information exchange, ranging from modification of existing data exchange formats to the development of a new exchange model suitable for the transmission of MET information to ATM (air and ground) systems; the Weather Information Exchange Model (WXXM).

Objective 3:
Improve the quality of MET information to respond to the ATM (safety) requirements through the application of Quality Management processes.

The provision of meteorological products and services will remain highly scientific and technical. Nevertheless, the weather will remain impossible to predict with 100% confidence. Whilst numerous aviation met providers are present across Europe, there will be potential for varying levels of service and reliability. To minimise this variability and to ensure a high level of service and accuracy to ATM as possible, it will be necessary to ensure that appropriate safety and quality management systems (QMS) are in place. Annex 3 recommends QMS to be implemented. A roadmap should be established to ensure the implementation in the EUR region.

Objective 4:

Further improve the provision and use of MET information within the ATM system.

As SESAR and NextGen evolve, MET will have to respond adequately to the current and foreseen specific needs of ATM for tailored quality products, available at the right place and at the right time. Further improvement in the provision and use of meteorological information within the ATM system means optimum exploitation of the facilities offered by the current MET systems, at low costs and high benefits in terms of safety, regularity and efficiency, as well as initiatives to identify new capabilities for increasing the quality and cost/benefit of the meteorological information provider. The Strategy proposes ways and means for improving the provision through, perhaps, the universal adoption of the "4D Weather Cube" concept[2] and use of MET information within the ATM system, with priorities and emphases on those tasks with immediate benefits.

[2] A concept coined in the United States to describe a virtual repository of ALL authorised MET information, regardless of source, from which the end user can obtain required information

Extensive investment in the provision of global and local meteorological information and infrastructure to meet the needs of all user communities (government, defence, aviation, marine etc.) has resulted in the development of high performance numerical weather prediction models and observing systems (such as radar, satellite, and laser based systems such as LIDAR etc). One of the goals for ATM should be to leverage these general investments to meet clearly defined and validated user needs.

All investments should be measurable against the clearly defined criteria of improvements in safety, efficiency, capacity, cost-effectiveness, security, environmental mitigation, uniformity and harmonisation. Key areas of focus for development are considered to be: the development of high resolution models, enhancement of short term forecasting services, remote sensing techniques on ground and via satellite, site specific developments, increased use of data link to downlink aircraft acquired data, including humidity, and other areas as required.

Objective 5:
Resolve institutional, organisational, regulatory, financial and intellectual property issues associated with the provision of MET information to ATM

Different models exist for organising the MET structure for aviation in the EUR Region. The process of corporatizing of MET service providers is ongoing in some European states. Most importantly, the European Commission "Single Sky" regulation requires the separation of MET service provision and the regulatory functions and set common requirements for certification of air navigation service providers, including MET. This is imposing new approaches to institutional, organisational, financial and intellectual property issues and that is why, very early proposals for institutional arrangements need to be developed.

Objective 6:

Encourage the further integration of MET within the ATM system in order to optimise the use of information systems supporting ATM

The ATM system has a finite capacity, despite infrastructure and/or technical developments. However, it is recognised that inefficiencies in the system result in the loss of capacity. A critical enabler for the absorption of the predicted traffic growth is improved efficiency to exploit this unused potential. Tactical, short-term, medium term and strategic planning will all play their part. The key is the availability, amalgamation and intelligent use of aeronautical information in its broadest sense. MET has a critical role to play. Traditionally, it has been considered in relative isolation, but once incorporated into (collaborative) decision making algorithms, it will become a major influencing factor in the efficient, focussed and effective management of airspace and airport capacities.

Further improvements in MET facilities, applications, supporting infrastructure and quality of services are expected to lead to greater harmonisation, integration and rationalisation of existing or new support systems and services and to the further introduction of improved MET products tailored to user requirements.

Though the use of a MET expert system within the CDM will increase, the Meteorologist could continue to add cognitive value in the provision of appropriate information and this should be further developed in accordance with human factor principles.

Objective 7:

Further improve contribution to the mitigation of the environmental impact of air traffic

MET has a significant and proven effect on the environmental (ENV) performance and sustainability of ATM (fuel consumption, track miles, holding, diversion, etc.) and on the environmental impact of air transport in general. Instances of the latter include reduced local air quality and noise footprint shapes and dispersions in the vicinity of an airport, sub-optimal runway configurations, and growing instances of aircraft contrail induced persistent cirrus which is contributing significantly to global warming. Moreover, studies have shown that in addition to the cirrus effect, aviation has major impact on Climate change.

Together, the adverse effects of environmental impact and Climate change are likely to result in additional regulation which will impact capacity through the imposition of operational constraints, and the introduction of environmental charges which will increase air operator's costs. (Presently, there has been limited international study into the MET-ATM-ENV-Climate change paradigm, and such initiatives are clearly required).

4. GUIDELINES FOR EVOLUTION

It is recognised that the guidelines for the further evolution of a harmonized, responsive, and cost effective MET should be:

a) The exploitation of current capabilities and performance offered by numerical weather prediction in forecasting the weather, particularly adverse weather, to allow its impact to be managed in an effective way;

b) The effective use of available technologies (radar, satellite, wind profiler, data link, etc.) to improve safety margins, support increased capacity and enhance operating efficiency;

c) The improvement of MET facilities and applications, supporting infrastructure and quality of services required to support the rationalisation, integration and harmonisation of existing and new air navigation systems and services;

d) The introduction of new or improved MET products tailored to users' requirements to exploit capacity, particularly for Terminal airspace and airport use whilst minimising environmental impact;

e) The identification and implementation of new and/or innovative ways for the provision of meteorological information, enabled by emerging technologies. Priority should be given to the enhancement of less capable MET systems or their early replacement by new systems;

f) The definition of the nature, intent, content, format and presentation of MET information provided to the pilot, air traffic controller and other end-users and their associated systems;

g) The identification of human factors issues associated with the role of MET within the ATM system with specific focus on enabling Collaborative Decision Making and the associated staff training requirements;

h) The definition, agreement and introduction of specific key performance indicators (KPI's) for MET services and products, necessary for performance monitoring and the building of users' confidence.

5. EXPECTED BENEFITS

5.1 The provision of meteorological information will be an integrated function of the ATM system. The information will meet the ATM requirements in terms of content, format and timeliness.

5.2 The main benefits of the meteorological information for the ATM system identified by the ICAO Global ATM Operational Concept and fully supported by the regional application initiative SESAR, are:

a) improved accuracy and timeliness of meteorological information will be used to optimize the flight trajectory planning and prediction, thus improving safety, predictability and efficiency of the ATM system;

b) increased availability of shared meteorological information on board the aircraft will allow the preferred trajectory to be refined in real-time;

c) better identification, prediction and presentation of adverse weather will allow the management of its effects more efficiently, thereby improving safety and flexibility, for example, by providing accurate and timely information on the need for diversion or rerouting;

d) improved aerodrome reports and forecasts will facilitate the optimum use of available aerodrome capacity;

e) increased availability of meteorological information (air reports) from on board meteorological sensors will contribute to improve forecast meteorological information and the display of real-time information, and

f) meteorological information will contribute to minimizing the environmental impact of air traffic.

5.3 Performance management will be an important part of the quality assurance of meteorological information.

6. WAY AHEAD

6.1 Future capabilities of MET services

6.1.1 Significant advances have been made over the last decade in atmospheric science, expert systems, and the computing power used by MET services. It is highly likely that the speed of technological advance will continue in, at least, the short term. Therefore, it is expected that those existing or foreseen requirements of ATM that presently can not be met will progressively be satisfied during the lifetime of this strategy.

6.1.2 The foreseen ATM oriented capabilities of MET are indicated in **Appendix 1.**

6.2 Roadmap for the way ahead

6.2.1 The attainment of the Strategic Objectives outlined in section 3 will be demanding. The cost, complexity and global nature of the foreseen evolution of MET requires a phased,

managed and harmonised approach. A roadmap for change is clearly required. Section 3 provides for the initial rationale of the strategic objectives that are required to "ensure the timely, accurate and complete availability of tailored aeronautical meteorological information within the framework of system-wide information management for all phases of flight".

6.2.2 In the EUR Region, a harmonised and managed approach to the identification and implementation of modified or new requirements, systems and processes developed under the auspices of SESAR or other regional programmes and organisations must be established. Implementation of requirements, the timescales associated with the implementation and the monitoring of the process could be based on the principles of Eurocontrol' European Single Sky ImPlementation (ESSIP) This process would provide a basis for the evolution of the provision of MET in the EUR CNS/ATM transition plan and also for the identification of needs to amend ICAO SARPS (mainly Annexes 3 & 11) and supporting WMO requirements.

6.2.3. Developing a roadmap for MET, this should be closely aligned with the overall roadmap developed in the context of the European ATM Master Plan (www.atmmasterplan.eu) and aligned with the Global Air Traffic Management Operational Concept.

Appendix 1

Foreseen expected ATM oriented capabilities of MET

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
Increased resolution of WAFS GRIB data			X	X	X			Horizontal resolution 40km 15 levels in the vertical Time interval 3 hrs Time period T+3 – T+48 Improved resolution of meteorological phenomena on a global scale e.g. jets, height of tropopause, areas of turbulence
Table Driven Code Format data and charts (e.g. XML, GML etc.)			X	X	X	X		Greater flexibility in creating route specific charts and route specific data time series
Increased resolution of global models			X	X	X	X		Horizontal resolution 10km 50 levels in the vertical

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
								Time interval 1 hr Time period T+0 – T+144 Better resolution of national-scale weather phenomena and improved accuracy of forecasts for next 5 days
Increased resolution of mesoscale models			X	X	X	X		Horizontal resolution 1km 70 levels in the vertical Time interval 15 mins Time period T+0 – T+48 Better resolution of regional and local-scale weather phenomena and improved accuracy
Improved ensemble modelling Probably developed by a consortium of European countries using distributed super computing facilities			X	X	X	X		Provision of probabilistic forecasts Horizontal resolution 10km 50 levels in the vertical Time interval 1hr Time period T+0 – T+336 Development of advanced statistical techniques to indicate confidence in a particular forecast outcome or a

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
								representation of the range of possible forecast outcomes.
Single site models using local forcing to modify either glodal or mesoscale model predicitions			X	X	X	X		50 levels in the vertical Time interval 15 mins Time period T+0 – T+120 More accurate representation of likely conditions at a particular geographic location, which can take account of local topography, land use etc.
Improved Nowcasting Use of high resolution observational data such as weather radar and satellite imagery for improved short term forecasts for airlines, airports, and ATC including: (a) movement and evolution of precipitating systems (b) convective activity (c) vertical profiles of winds in the terminal area (d) lightning risk (e) cloud (f) surface visibility			X	X	X	X		Horizontal resolution 1 km 50 levels in the vertical Time interval 5 mins Time period T+0 – T+6 Rapid update, short period forecasts for tactical planning

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
Meteosat Second Generation products Improved instrumentation on a geostationary satellite that includes Europe in its footprint			X	X	X	X		Improved measurements of remotely derived atmospheric profiles of temperature and humidity. Improved, cloud, wind speed, wind direction, and chemistry measurements
MetOp products Improved instrumentation on polar orbitng satellites that will cover Europe			X	X	X	X		Improved measurements of remotely derviced atmospheric profiles of temperature, humidity, wind speed, and wind direction.
Improved atmospheric profiles using GNSS techniques e.g. (a) total water column measurements with ground based receivers (b) profiles of refractivity using horizon occultation techniques using aircraft based receivers			X	X	X	X		Wider coverage of atmospheric profiles for input into numerical weather prediction models, which will increase the accuracy of their predictions
Improved volcanic eruption detection			X	X	X	X		Improved satellite imagery over Europe and improved algorithms for

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
								automatically analysing satellite pictures will lead to better automatic eruption detection.
Improved volcanic ash detection			X	X	X	X		Improved satellite imagery over Europe and improved algorithms for automatically analysing satellite pictures e.g. detecting SO_2 will lead to better detection of volcanic ash once the eruption has taken place.
Improved volcanic ash dispersion modelling			X	X	X	X		Improved dispersion modelling will enable more accurate prediction of where ash clouds will be advected to once an eruption has taken place.
High frequency automatic observations				X	X	X		Automatic Weather Stations provide high frequency observations. These can be displayed in the control tower at present but will become more widely available e.g. for uplinking to aircraft on approach to the airfield
Improved understanding of Climate Change and the effect of aircraft on Climate change	X	X						The Inter Governmental Panel on Climate Change is driving forward

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
								further research into climate change, including the affect of aircraft on the climate. This will lead to a better understanding of how climate will change in the future.
Easier access to climate statistics	X	X						More climate data bases will become available and easier to access. These data bases could include statistical analysis on such things as: (a) threshold wind speed/direction (b) RVR (c) CAT I, II, III frequencies (d) Mean cross/head wind (e) Mean cross wind when runway is dry/wet
Improved aircraft met measurements				X	X	X	X	More accurate in flight meaurements of temperature, humidity, pressure, turbulence, icing, wind speed and wind direction which can be used to

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
								provide near-real time information on actual weather conditions to Airline Operations Centres as well as to increase accuracy of initial starting conditions in forecasting process
Improved products for uplinking to the aircraft cockpit				X	X	X		Met products will become available for uplinking and display in the aircraft cockpit. These will include: (a) charts of Significant Weather e.g. short term predictions of CAT (b) high frequency ground based observations e.g weather radar, lightning observations (c) short term forecasts of wind

Expected Capabilities	Phases of Flight that will Benefit							Comments including benefits for ATM
	strategic planning	pretactical planning	tactical planning	departure	Inflight	Arrival	post-flight	
								on the approach and take off for automatic integration into the FMS (d) updates on enroute winds and optimum route

Appendix 2

Foreseen expected Lines of Action in MET Development

En route

Action item	**ICAO Doc 9854[3] Reference**	**Timeline from a technical MET perspective**
probabilistic weather forecasts in support of making greater use of congested/constrained en route airspace.	2.9.18.a and c	2011-2015
integration of meteorological information into Decision Making Support Systems in support of making greater use of congested/constrained en route airspace.	2.9.18.a and c	partially implemented-2015
increased accuracy and timeliness of meteorological information in support of dynamic modification of airspace sectors	2.9.18.a, c and e	2011-2018
meteorological information to prevent the formation of persistent contrails in serving the environmental impact of air transport.	2.9.18.a, c and f	2011-2016

Terminal

Action item	**ICAO Doc 9854 Reference**	**Timeline from a technical MET perspective**

[3] ICAO Global Air Traffic Management Operational Concept

Action item	ICAO Doc 9854 Reference	Timeline from a technical MET perspective
weather observations and very short-range terminal weather forecasts in support of dynamic terminal area configuration to mitigate the effects on capacity and safety and improved	2.9.18.a, b and c	2011-2018
weather forecasts in support of dynamic terminal area configuration to mitigate the effects on capacity and safety	2.9.18.a, b and c	2011-2018
forecast of hazardous weather phenomena including low level windshear and temperature inversions	2.9.18.a, b and c	Partially implemented-2016
weather information integrated into decision oriented tools in support of dynamic terminal area configuration to mitigate the effects on capacity and safety	2.9.18.a, b and c	partially implemented-2012

Airport

Action item	ICAO Doc 9854 Reference	Timeline from a technical MET perspective
weather observation and dissemination systems that enable airport utilization with ensured predictability and reliability of operations.	2.9.18.c, d and e	2011-2015
weather forecasts and dissemination systems that enable airport utilization with ensured predictability and reliability of operations	2.9.18.c, d and e	2011-2020
weather-dependant wake procedures in support of time-based separation	2.9.18.b, c, d and e	2011-2025
weather observations and weather forecasts of wind aloft for approach and departure flight operations and runway selection procedures.	2.9.18.c, d and e	2011-2018

Action item	ICAO Doc 9854 Reference	Timeline from a technical MET perspective
lightning observations and (short-range) forecast in support of efficient and safe ground operations	2.9.18.c, d and e	partially implemented-2016
weather forecast in support of snow removal and aerodrome pavement de-icing operations	2.9.18.c, d, e and f	partially implemented -2018
low visibility procedure conditions forecasts to optimise airport arrival and departure flow rates.	2.9.18.c, d and e	2011-2020
weather observations and weather forecasts in support of aircraft de-icing.	2.9.18.c, d, e and f	2011-2015
observed and forecasted meteorological parameters related to the braking action of the movement area of the airport will serve to reduce capacity loss safely.	2.9.18.c, d and e	2011-2020

General

Action item	ICAO Doc 9854 Reference	Timeline from a technical MET perspective
inclusion of climatology factors into long term planning through conditional climatology methods.	2.9.18.a	Partially implemented-2015
seasonal forecasts to define optimum routes to be used for schedule and airport/airspace strategic slot planning	2.9.18.a	2011-2016
observations and forecasts of volcanic ash and other severe contaminant releases for tracking and display purposes in support of air navigation safety.	2.9.18.a	2011-2015

Institutional

Action item	ICAO Doc 9854 Reference	Timeline
harmonisation of meteorological information (regulatory aspects) across all flight domains, including oceanic and international flights and continuity from pre-flight to post-flight operations in support of global application	2.9.17	2011-2019
institutional, legal, financial and liability issues related to MET service provision.	2.9.17	2011-2020

Appendix 3

Glossary and Definitions

A. Glossary

AIS	Aeronautical Information Services
ANP	Air Navigation Plan
AOC	Airline Operations Centre
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air Traffic Services
BUFR	Binary Universal Form for the Representation of Meteorological Data
CAT	Clear Air Turbulence
CDM	Collaborative Decision Making
CNS/ATM	Communication, Navigation, Surveillance/Air Traffic Management
EANPG	European Air Navigation Planning Group
EATMP	European Air Traffic Management Programme
ECAC	European Civil Aviation Conference
EUR	European Region / The European Region in ICAO term
EUROCONTROL	European Organisation for the Safety of Air Navigation
FASID	Facilities and Systems Implementation Document
FL	Flight level
FPL	Flight Plan Message (ICAO format)
GRIB	Gridded Binary data
HMI	Human-Machine Interface
ICAO	International Civil Aviation Organisation
IR	Infra-Red
KPI	Key Performance Indicators
LIDAR	Light Detection And Ranging
MET	Aeronautical Meteorology
METEOSAT	Meteorological Satellite
METG	Meteorology Group

NOTAM	Notices to Airmen
OCD	Operational Concept Document
PBN	Performance Based Navigation
PRC	EUROCONTROL Performance Review Commission
PT/METATM	Project Team / MET in the CNS/ ATM concept for the EUR Region
QMS	Quality Management System
RADAR	Radio Detection and Ranging
R&D	Research and Development
RTA	Required Time of Arrival
SARPS	(ICAO) Standards and Recommended Practices
SES	Single European Sky
SWIM	System Wide Information Management
WAFS	World Area Forecast System
WMO	World Meteorological Organization
XML	Extensible Markup Language

B. Definitions

Air traffic management (ATM):

The dynamic, integrated management of air traffic and airspace — safely, economically, and efficiently — through the provision of facilities and seamless services in collaboration with all parties.

Air traffic management system:

A system that provides ATM through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground and/or space-based communications, navigation and surveillance.

BUFR	Binary Universal Form for the Representation of Meteorological Data (a WMO standard for point data designed to convey meteorological data)
GRIB	The WMO format for the storage of weather information and theexchange of weather product messages in gridded binary form
Nowcasting	An observation-intensive approach to local, very short-term weather forecasting. In the strictest sense it applies to the detailed description of the current weather combined with forecasts for up to 2 hours ahead, these being obtained by simple extrapolations of the existing situation or by more sophisticated methods.

Note 1: ICAO definitions are used or else if stated otherwise.

Note 2: The ICAO definition contained in the Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444) for ATM and ATM systems are different from above definitions that are used in the ICAO ATM Operational Concept document.

Appendix 4

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– END –