

**Doc 10003**  
**AN/503**



# Manual on the Digital Exchange of Aeronautical Meteorological Information

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Approved by the Secretary General  
and published under his authority

First Edition — 2014

International Civil Aviation Organization

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Published in separate English, Arabic, Chinese, French, Russian  
and Spanish editions by the  
INTERNATIONAL CIVIL AVIATION ORGANIZATION  
999 University Street, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents  
and booksellers, please go to the ICAO website at [www.icao.int](http://www.icao.int)

**Doc 10003, *Manual on the Digital Exchange of Aeronautical  
Meteorological Information***  
Order Number: 10003  
ISBN 978-92-9249-572-5

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## AMENDMENTS

Amendments are announced in the supplements to the *Publications Catalogue*; the Catalogue and its supplements are available on the ICAO website at [www.icao.int](http://www.icao.int). The space below is provided to keep a record of such amendments.

## RECORD OF AMENDMENTS AND CORRIGENDA

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## FOREWORD

This first edition of the *Manual on the Digital Exchange of Aeronautical Meteorological Information* is published in response to the introduction of the exchange of aeronautical meteorological information in a digital form as part of Amendment 76 to Annex 3 — *Meteorological Service for International Air Navigation*, applicable 14 November 2013. As of this date, aerodrome routine and special meteorological reports (METAR and SPECI, including trend forecasts (TREND)), aerodrome forecasts (TAF) and information concerning en-route weather phenomena which may affect the safety of aircraft operations (SIGMET), may be exchanged in a digital form by States that are in a position to do so.

In the case of METAR, SPECI and TAF, their digital exchange is in addition to their current required exchange in the METAR, SPECI and TAF code forms, respectively, prescribed by the World Meteorological Organization. In the case of SIGMET, their digital exchange is in addition to their current required exchange in abbreviated plain language.

Where States are in a position to exchange METAR, SPECI, TAF and SIGMET in a digital form, Annex 3 requires that the information be formatted in accordance with a globally interoperable information exchange model, use extensible markup language (XML)/geography markup language (GML), and be accompanied by the appropriate metadata. This manual is intended to assist States in each of these three respects.

The availability of aeronautical meteorological information in a globally interoperable digital format is seen as a key enabler for future global air traffic management within a system-wide information management (SWIM) environment. Consequently, the enabling of the digital exchange of METAR, SPECI, TAF and SIGMET can be viewed as the first step towards the transition of all required aeronautical meteorological information to a digital form and its integration into a SWIM environment. Future amendments to Annex 3 are therefore expected to enhance and expand the digital exchange provisions introduced as part of Amendment 76. This manual will, consequently, be subject to periodic review and amendment to ensure necessary alignment with the evolving Annex 3 provisions in this regard.

The content of the manual was developed over a period of two years primarily through the input of the ICAO Meteorological Aeronautical Requirements and Information Exchange Project Team (MARIE-PT). Expertise from airline and pilot representative organizations and regional programmes for air transport modernization, and detailed technical expertise from the World Meteorological Organization and elsewhere was utilized. The manual was peer-reviewed by various domain experts.

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## LIST OF ABBREVIATIONS AND ACRONYMS

|         |                                                                                                                         |
|---------|-------------------------------------------------------------------------------------------------------------------------|
| AIM     | Aeronautical information management                                                                                     |
| AIXM    | Aeronautical information exchange model                                                                                 |
| ANSP    | Air navigation service provider                                                                                         |
| ATM*    | Air traffic management                                                                                                  |
| CDM     | Collaborative decision making                                                                                           |
| FIXM    | Flight information exchange model                                                                                       |
| GML     | Geography markup language                                                                                               |
| ISO     | International Organization for Standardization                                                                          |
| IWXXM   | ICAO meteorological information exchange model                                                                          |
| METAR*  | Aerodrome routine meteorological report (in meteorological code)                                                        |
| METCE   | Modèle pour l'Échange des Informations sur le Temps, le Climat et l'Eau (of the World Meteorological Organization, WMO) |
| NOP     | Network operations plan                                                                                                 |
| OGC     | Open Geospatial Consortium                                                                                              |
| OPM     | Observable property model                                                                                               |
| SAF     | Simple aeronautical features                                                                                            |
| SIGMET* | Information concerning en-route weather phenomena which may affect the safety of aircraft operations                    |
| SPECI*  | Aerodrome special meteorological report (in meteorological code)                                                        |
| SWIM    | System-wide information management                                                                                      |
| TAF*    | Aerodrome forecast (in meteorological code)                                                                             |
| TREND*  | Trend forecast                                                                                                          |
| UML     | Unified modelling language                                                                                              |
| W3C     | World Wide Web Consortium                                                                                               |
| WMO     | World Meteorological Organization                                                                                       |
| WXXM    | Weather information exchange model                                                                                      |
| XML     | Extensible markup language                                                                                              |
| XSD     | XML schema definitions                                                                                                  |

\* Abbreviations included in the *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC, Doc 8400)

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# Chapter 1

## BACKGROUND

### 1.1 THE EVOLVING GLOBAL AIR TRANSPORT SYSTEM

1.1.1 The *Global Air Traffic Management Operational Concept* (Doc 9854) describes the manner in which the air traffic management (ATM) system will deliver services and benefits to airspace users by 2025-2030 and is in line with the recommendations of the Twelfth Air Navigation Conference (Montreal, 19–30 November 2012). It also details how ATM will act directly on the flight trajectory of a manned or an unmanned vehicle during all phases of flight, and the interaction of that flight trajectory with any hazard. Its scope describes the services that will be required to operate the global ATM system up to and beyond 2028.

1.1.2 This operational concept and the *Global Air Navigation Plan* (Doc 9750) address what is needed to increase user flexibility and maximize operating efficiencies in order to increase system capacity and improve safety levels in the future ATM system.

1.1.3 The guiding principle is that the ATM system is based on the provision of services. The service-based framework described in the operational concept considers all resources (including airspace, aerodromes, aircraft and humans) to be part of the ATM system. The primary functions of the ATM system will enable flight from an aerodrome into airspace and its subsequent landing, safely separated from hazards, within capacity limits, making optimum use of all system resources. The description of the operational concept components is based on realistic expectations of human capabilities and the ATM infrastructure at any particular time in the evolution of the ATM system described by this operational concept. It is independent of reference to any specific technology.

1.1.4 It is evident that the future ATM system will be founded on knowledge-based collaborative decision making (CDM). Effective CDM requires the intelligent use of the characteristics of uncertainty that are associated with the meteorological information provided. This form of risk management will enable decision makers to make executive choices according to their own objectively determined thresholds for action.

1.1.5 The system will be a network-based operation formed by four main components:

- a) a robustly networked ATM system which improves information sharing;
- b) a sharing of information which will enhance the quality of information and provide shared situational awareness;
- c) collaboration and self-synchronization enabled by shared situational awareness; and
- d) enhanced sustainability and speed of decision-making.

Collectively these will dramatically increase the efficiency of the ATM system.

## 1.2 NET-CENTRIC OPERATIONS

1.2.1 The concept of common (collaborative) information sharing has been under development for a decade or more. It was borne from a clear recognition that future ATM will be managed on a “network-centric” (net-centric) basis, with each aerodrome and each aircraft being considered as a node interlinked with all others within the system. Considerable investment is being made to develop the means to implement CDM at aerodromes and from a flow-management perspective, as first steps towards system-wide efficiency. Substantial progress has been made with the individual stakeholders at an aerodrome identified and the information needs and flows mapped. Site-specific trials are yielding positive results and CDM is being progressively rolled-out on a global basis.

1.2.2 Nevertheless, it is clearly recognized that individual (national) airspaces and aerodromes cannot continue to be regarded as singular and isolated components of ATM. Each will serve as a node interlinked with all others within the system. A transition to a service-centric approach within a global business framework is clearly required. ATM must be managed on a net-centric basis, and aerodrome and network CDM and the transition to a “time-ordered” system will be practical representations of this concept.

## 1.3 CONSEQUENCES FOR METEOROLOGICAL SERVICES

1.3.1 The global ATM system will continue to be subject to the same vagaries of weather phenomena that affect air transport today. The additional and significant volume of air traffic predicted for the coming years will render the system significantly more sensitive to disruption and the consequential increased costs associated with it. Historically, aeronautical meteorological services have mainly addressed safety issues. Now, within the context of the evolving ATM system, the considerable impact of weather on capacity and efficiency and the potential to mitigate some of the environmental impacts of aviation must be given greater consideration while continuing to operate safely.

1.3.2 The importance of timely, accurate and easily available meteorological information for decision support is emphasized in Doc 9854. As such it is recognized that the success of the ATM system will be reliant on effective planning and management to deliver to the airspace user the (near as possible) optimum business trajectory while ensuring flexibility. Flow and capacity management enabled by high-precision time-based metering (e.g. consistently achieving the required time of arrival, four-dimensional (4D)-trajectory management and short/medium-term conflict detection and resolution) will be significant means of ensuring flight punctuality, efficiency and maintaining system throughput. This will be a key component in the effective management of congested airspace and aerodromes.

1.3.3 Furthermore, based on forecast traffic volumes and their orientations, and weather forecasts, air traffic flow management will originate and control the daily plan (e.g. network operations plan (NOP), story book) 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.

1.3.4 A key change needed is the evolution of the interfaces between the airlines, flight crews and ATM network in determining the optimum profiles for a flight. The airline operations centres will examine the requirements for a flight and the current and predicted environment in which to operate (e.g. as meteorological conditions, airspace structure, en-route capacity, aerodrome capacity and environmental considerations) so as to select the optimum flight trajectory. Meteorological information will be collated and analysed in order to assess, in conjunction with aircraft performance data and user charges, the cost benefit of modified flight profiles or alternative routes, and aircraft may be re-planned while in flight.

1.3.5 The development of air- and ground-based automated systems, in association with new procedures and working arrangements in ATM (e.g. 4D trajectory management<sup>1</sup>), is required to support future operations. It is expected that these will permit the dynamic management of airspace allowing the tactical routing of aircraft to provide significant operational benefits (safety, economy, flexibility, improved regularity and environmental-impact mitigation) to users.

1.3.6 Certain meteorological conditions (e.g. low visibility, strong winds, thunderstorms) and weather-induced runway contamination (e.g. snow, volcanic ash) can and do restrict aerodrome and airspace capacity. Each aerodrome, and to some extent, each sector of airspace is affected by local meteorological conditions which impact on their individual actual capacity at any moment in time. New equipment to support aircraft operations during hazardous meteorological conditions (e.g. advanced surface movement guidance and control systems, synthetic vision), are becoming increasingly available. Nevertheless, the key to mitigation and minimization of disruption will rely primarily on the intelligent use of increasingly accurate forecasting of meteorological conditions. This will be especially important for large, congested hub aerodromes and their associated airspace.

1.3.7 Improvements are also foreseen in terminal area short-term forecasting (e.g. departure and approach wind profiles) to maximize runway throughput. This will be achieved by the incorporation of such data into algorithms to provide tools for use by controllers to improve aerodrome throughput by delivering time-based separation rather than the inefficient distance-based separation of today, and a reduction of wake-vortex separation when conditions so exist. Furthermore, terminal area short-term forecasting will support continuous descent operations in general.

1.3.8 Figure 1-1 provides a graphical representation of the different stages in the 4D-trajectory evolution linked to the various stages of planning and where the integration of meteorological information could be envisaged.

1.3.9 The key to efficient operation of the ATM system is interoperability within the ATM environment. This will be enabled by advanced communications systems, standard interfaces and by standard information exchange models that support the required seamless, transparent and open digital exchange of meteorological information.

1.3.10 An important consideration in this respect is to ensure global interoperability not only from a meteorological information perspective but also on interlinks with other identified relevant data domains. ATM systems, such as controller decision support tools, will not only use meteorological information but will fuse this information with other relevant information, such as aeronautical information and flight information, to support knowledge-based decision-making. Figure 1-2 provides a graphical representation of the different identified data domains and user communities.

1. 4D trajectory management is the process that captures the overall traffic situation in the NOP and controls the development of the business or mission trajectories in four dimensions (latitude, longitude, flight level and time). Specifically, 4D trajectory management is the process by which the business trajectory of the aircraft is established, agreed, updated and revised. This is achieved through collaborative decision making processes between the operator, ATM, and other stakeholders where applicable, except in time-critical situations when only the flight crew and controller are involved.

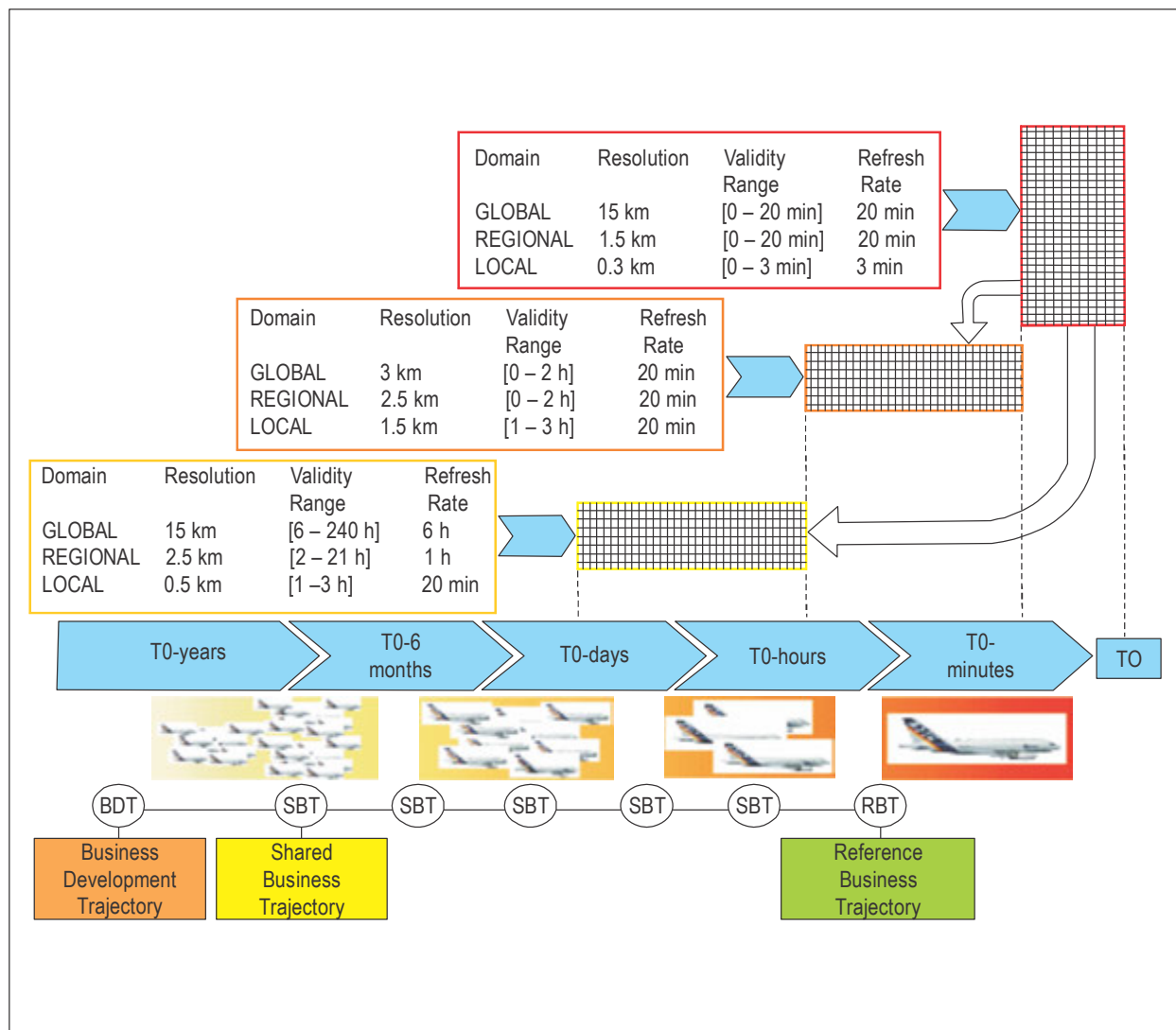


Figure 1-1. MET-ATM perspective