



ICAO

*International Civil Aviation Organization*

**INFORMATION PAPER**

**Twenty-fifth Meeting of the Meteorology Sub-group  
(MET SG/25)**

Online, 18 – 22 October 2021

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**Agenda Item 5:** Research, development and other initiatives

**THE NEXT GENERATION OF THE WORLD AREA FORECAST SYSTEM (WAFS)**

(Presented by WAFC Washington)

**SUMMARY**

This paper describes the next generation of the World Area Forecast System (WAFS) forecasts for international air navigation.

**1. INTRODUCTION**

1.1 Since 2017 the two World Area Forecast Centres have been planning the next generation of the World Area Forecast System (WAFS) forecasts for international air navigation. This work has been conducted under the Meteorology Panel's Working Group on Meteorological Operations Group (METP-WG/MOG).

**2. DISCUSSION**

2.1 Major changes and improvements are coming for the WAFS grid point forecasts, WAFS Significant Weather (SIGWX) forecasts, and the WAFS delivery system in November 2023. These changes are described in the attachment to this paper (separate file). The group is invited to review and share the attachment as appropriate.

**3. ACTION BY THE MEETING**

3.1 Note the information contained in this paper.

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# The next generation of the World Area Forecast System (WAFS)

## Introduction

This document describes the next generation of the World Area Forecast System (WAFS) forecasts for international air navigation, provided by the World Area Forecast Centres (WAFS), in support of the International Civil Aviation Organization's (ICAO) Global Air Navigation Plan (GANP) and associated Aviation System Block Upgrades (ASBU).

Specifically, this document describes the next generation of WAFS grid point forecasts, WAFS Significant Weather (SIGWX) forecasts, and WAFS delivery system, i.e. Secure Aviation Data Information Service (SADIS) and the WAFS Internet File Service (WIFS).

This document is intended as information for other Panels and bodies within ICAO and users of WAFS information.

## Next generation WAFS grid point forecasts

Major changes and improvements are coming for the WAFS grid point forecasts in late 2023. These include a significant increase in the horizontal, vertical and temporal resolutions of the forecasts, including forecasts out to 5 days (120 hours), as well as the introduction of probabilistic forecasts.

### ***Grid point forecast resolution***

#### **Horizontal resolution**

Next generation WAFS grid point forecasts will have a horizontal resolution of 0.25 degrees latitude and longitude. Whilst the cumulonimbus, icing and turbulence fields were upgraded in November 2020 to this resolution, this will be an increase from the current 1.25 degree latitude and longitude horizontal resolution for the other WAFS fields.

#### **Vertical resolution**

The vertical resolution of the next generation grid point forecasts will increase and be provided at every 1,000 foot flight levels (FL).

Wind and temperature forecasts will begin at FL050 and continue through FL600. Other elements will have different vertical ranges, but all will have the same 1,000 foot vertical resolution. For example, humidity will range from FL050 through FL180, icing severity will range from FL050 through FL300, and turbulence severity will range from FL100 through FL450.

Current WAFS grid point forecasts are only provided for select FLs.

#### **Temporal resolution**

The temporal resolution of the next generation grid point forecasts will increase as follows:

- 1-hour intervals for forecasts valid from 6-hours through 24-hours
- 3-hour intervals for forecasts valid from 27-hours through 48-hours
- 6-hour intervals for forecasts valid from 54-hours through 120 hours.

*Note: Grid point forecasts of turbulence, icing, and cumulonimbus clouds will be provided through 48-hours.*

Current WAFS grid point forecasts have a temporal resolution of 3-hour intervals from 6-hours through 36-hours.

The new WAFS grid point forecasts will continue to be published 4-times a day.

### ***Probabilistic forecasts***

Probabilistic forecasts for cumulonimbus cloud, icing and turbulence are also being developed and will become part of the next generation WAFS grid point forecasts.

The traditional approach to weather forecasting is known as deterministic, with only one forecast outcome. Whilst this can provide good advice, deterministic forecasting may not provide the users with a full understanding of the possible range of outcomes, or the risks of encountering specific phenomena.

## ***Grid point forecasts of meteorological phenomena***

Next generation WAFS grid point forecasts will be provided for the following:

- Upper wind (including detail of the maximum wind)
- Upper air-temperature
- Upper air-humidity
- Tropopause height and temperature
- Turbulence severity
- Icing severity
- Cumulonimbus cloud extent, base and top height

The above are the same phenomena as provided by today's WAFS grid point forecasts with two exceptions. Turbulence severity replaces turbulence potential and in-cloud turbulence potential, and icing severity replaces icing potential.

New algorithms will be used to calculate the turbulence and icing severity forecasts. The new turbulence algorithm is a multi-diagnostic algorithm that includes turbulence indicators that were not in the previous WAFS algorithm. The turbulence forecast will be in the ICAO standard of Eddy Dissipation Rate (EDR).

The icing algorithm contains improved cloud physics that result in better performance scores. The icing forecast will be in categorical (none, light, moderate, severe) severity types.

## **Next generation WAFS SIGWX forecasts**

Major changes and improvements are coming for the WAFS SIGWX forecasts. These include a significant increase in the available forecasts, and the move to the ICAO Meteorological Information Exchange Model (IWXXM) format, for use in the System-Wide Information Management (SWIM) system thereby enabling greater sharing of this information with other users and systems.

### ***Additional valid times***

The WAFCs will produce next generation SIGWX forecasts for T+6, T+9, T+12, T+15, T+18, T+21, T+24, T+27, T+30, T+33, T+36, T+39, T+42, T+45 and T+48 hour valid times.

For decades, WAFS SIGWX forecasts were only a 24-hour forecast, i.e., the weather shown on a SIGWX forecast only represented the expected weather 24-hours in the future, which is referred to as a T+24 hour SIGWX forecast.

A key requirement for the next generation WAFS SIGWX provision was to provide data for more than just the T+24 hour valid time. Short-haul flight planning require data for the T+6 to T+18 timeframe, while ultra-long-haul flight planning requires data beyond T+24 hours.

## ***Increased vertical and horizontal domain***

Next generation WAFS SIGWX forecasts will be broadly consistent with today's WAFS SIGWX forecasts today however they will not be split into "high-level" (FL250 to FL630) and "medium-level" (FL100 to FL450) data sets as much of the data is simply duplicated. Next generation SIGWX will have a vertical range from FL100 to FL600.

Current SIGWX medium-level forecasts are only provided for four select regions of globe. Next generation SIGWX expands the domain to a global coverage down to FL100. The WAFCs will retire the existing medium-level SIGWX charts (4 areas), which only cover part of the globe, in late 2023.

## ***Format***

The WAFCs currently provide WAFS SIGWX forecasts for the graphical elements as objects in BUFR code and PNG formats. Next generation WAFS SIGWX will provide these objects in IWXXM format.

### **IWXXM format**

Next generation SIGWX will be in IWXXM format, which will be the new standard with ICAO. The WAFCs plan to provide example forecasts in the IWXXM form in November 2021. The new multiple time-step SIGWX forecasts, in IWXXM format only, are planned to be operational by later 2023.

### **BUFR format**

SIGWX forecasts are currently provided in BUFR Edition 3 format, which has not been supported by WMO since 2012. The WAFCs chose not to transition to BUFR Edition 4 and instead await the implementation of the IWXXM format in order that States and software providers would not need to make two sets of changes.

The WAFCs plan to cease production of SIGWX forecasts in BUFR format in late 2025.

### **PNG format**

The majority of users will be able to utilize IWXXM formatted SIGWX forecasts but there will be some that may require SIGWX forecasts in PNG format for flight documentation for a few years. The WAFCs plan to continue producing a T+24 hour SIGWX forecast that covers the current 13 SIGWX high level chart areas in PNG format until 2028.

## Next generation WAFS delivery system

The increases to the horizontal, vertical and temporal data resolutions means that a complete download of one run of WAFS grid point forecast data set will increase from 28MB to approximately 6.5GB, which is an increase of 230 percent. In order to deliver these new, much larger, data sets the WAFCs are developing the next generation of SADIS and the WIFS.

It is planned that the new system will be a cloud-hosted service, which will deliver key benefits such as the ability to scale dynamically according to demand. This will result in fast, reliable data downloads without any slowdown at peak periods. Cloud hosting also increases operational availability as the system is hosted on an extensive underlying network of servers, so should one server fail the system will seamlessly migrate to another.

The new system will enable users to download only the data they are interested in (for example covering a particular area, or selection of vertical levels) and will be interoperable with other SWIM systems.

The WAFCs plan to host test servers for the next generation WAFS products and IWXXM formatted OPMET data for demonstration and testing. This will enable users and workstation providers to prepare and adapt their systems in advance of these new data sets becoming available on the next generation SADIS and WIFS system in late 2023.

## Implementation of the next generation WAFS

Next generation WAFS information will be implemented in phases.

### ***Phase 1 – completed 5 November 2020***

- Partial implementation of next generation grid point forecasts
  - Increase the horizontal resolution of the hazard grid point forecasts to 0.25 degrees
  - Introduction of new turbulence and icing severity forecasts
  - Retirement of the in-cloud turbulence forecast products.

### ***Phase 2 – planned for late 2023***

- Implementation of the next generation WAFS (SADIS/WIFS) dissemination system
- Implementation of next generation WAFS SIGWX forecasts

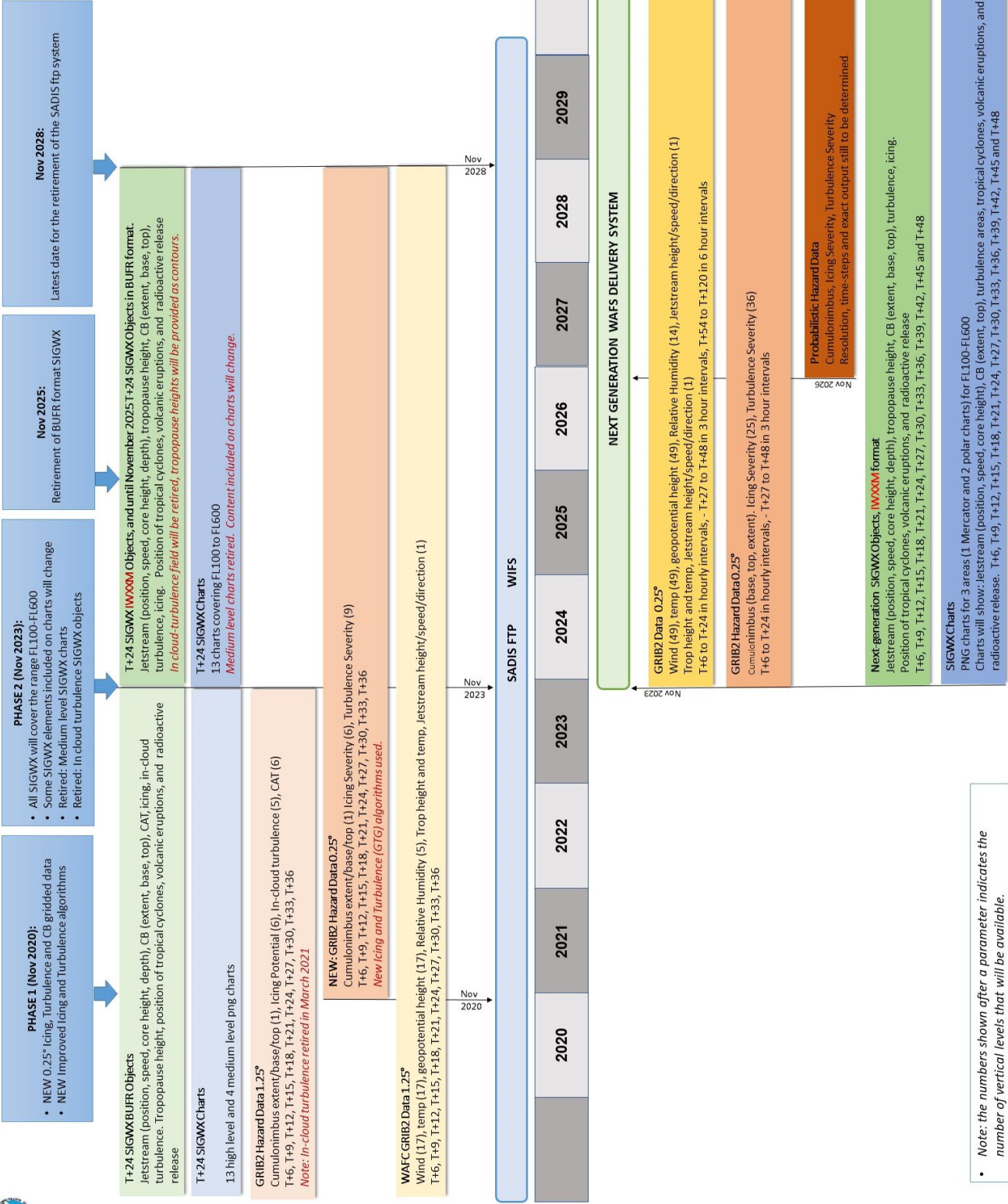
- Cease production of existing “medium level” SIGWX charts
- Continued partial implementation of next generation WAFS grid point forecasts
  - Implement increased horizontal resolution of the remaining grid point forecasts (e.g. wind, temperature)
  - Implement increased vertical resolution of the grid point forecasts to 1,000 foot flight levels
  - Implement additional forecast time steps
  - Implement probability forecasts of cumulonimbus clouds, icing severity and turbulence severity in demonstration mode
  - Cease production of Icing Potential and Clear Air Turbulence Potential data sets.

### ***Phase 3 – planned for late 2026***

- Full implementation of next generation grid point forecasts
  - Implement probability forecasts of cumulonimbus clouds, icing severity and turbulence severity in operational mode
- Cease production of SIGWX forecasts in BUFR format

### ***Phase 4 – planned for late 2028***

- Cease production of SIGWX forecasts in PNG format



## Using next generation WAFS information

### *Next generation WAFS grid point forecasts*

Technological advances mean that there are now better ways of exposing data to users, in a way that can be customised to their particular requirements through “custom query” functions. In the future a user will be able to request “wind data, for FL300, FL310, FL320, FL330 and FL340 over a defined area, for T+9 and T+12” and receive this in a file containing only the information they require. Flight planning operations could request high resolution wind, temperature and hazard data that is relevant to the flight trajectory.

Next generation WAFS grid point probabilistic forecasts of turbulence and cumulonimbus clouds will enable operators and flight crew to select routes that avoid turbulence of specific levels of severity and cumulonimbus clouds based on their operational specifications. For example, Operator A has determined through its safety management system (SMS) that its aircraft model X-123 needs to find a trajectory around an area with a forecast of 70 percent probability of EDR greater than 0.30, while Operator B through its SMS will fly around a 50 percent probability of EDR greater than 0.30.

Next generation WAFS grid point wind forecasts with finer resolution and more accuracy will enable operators to select more fuel-efficient flight routes. Wind forecasts valid out to 5 days (120 hours) will allow operators to choose more fuel-efficient routes much earlier than with today’s 36-hour forecasts.

Next generation WAFS forecasts of turbulence will also help flight crews mitigate injuries should they encounter turbulence by proactively turning on seat belt signs, and by helping them decide how best to avoid turbulence.

Next generation WAFS icing forecasts will enable users to select routes that avoid icing per operation specific levels of severity. WAFS icing forecasts will be especially useful in Extended Diversion Time Operations (EDTO).

### *Next generation WAFS SIGWX forecasts*

Finally, after over a quarter of a century, WAFS SIGWX forecasts will be made available for more than just one time-step, i.e. T+24 hours. Next generation WAFS SIGWX forecasts, with 3-hourly time-steps from T+6 through T+48 hours, will provide flight crew and operators with SIGWX forecasts that can be used

for short-haul through ultra-long-haul flights as well as extended flight planning.

The increasing adoption of Electronic Flight Bags, and the increasing sophistication of commercial software/systems means that the true value of the next generation SIGWX forecasts can be realised. These systems will enable the following types of functionality and flexibility:

- Customisable and zoom-able map areas
- User defined colour schemes
- Facility for SIGWX data to be included as part of the SWIM environment
- The ability to toggle different SIGWX layers on and off
- The option to only show SIGWX layers relevant to the operating altitude
- The ability to add other flight specific information to the chart, e.g., flight path
- The ability to display WAFC gridded data and WAFC SIGWX data at the same time.
- The ability to quickly step through different time steps of chart

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