



METEOROLOGY PANEL



Meteorology Panel (METP)

Working Group on Meteorological Operations Group (WG-MOG)

World Area Forecast System (WAFS) Work Stream

Twelfth Meeting

(METP/WG-MOG/12-WAFS)

WebEx, 23 to 24 March 2020

MEETING REPORT

INTERNATIONAL CIVIL AVIATION ORGANIZATION

LIST OF WG-MOG/12 – WAFS ACTIONS

Action 12/01 — Terms of Reference

That;

- a) the METP-WG/MOG12 meeting accepts the proposed updates to the Terms of Reference as shown in Appendix C; and
- b) the ICAO Secretariat puts the finalised Terms of Reference document onto the ICAO public website (replacing the previous copy).

Action 12/02 – Turbulence type forecasts

That, IATA is invited to include the WAFCs in their investigations of whether turbulence type forecasts (initially MTW or CAT, and potentially in future CIT) are useful for aviation, bearing in mind the limitations of verifying these forecast types. IATA is invited to report back to the next MOG/WAFS meeting.

Action 12/03 – Depiction of flight level of tropopause on WAFS SIGWX forecasts

That, the WG-MOG Rapporteur, be invited to submit the proposed amendment to ICAO Annex 3 – *Meteorological Service for International Air Navigation* regarding the depiction of the flight level of tropopause on world area forecast system (WAFS) significant weather (SIGWX) forecasts, as given at Appendix D and at **Appendix F** to this report, as part of a consolidated package of WAFS-related Amendment 80 proposals.

Action 12/04 – Tropical cyclone inclusion on SIGWX charts in time for Amendment 80

That the METP/MOG informs METP/5 on the following proposed changes pertaining to the inclusion of tropical cyclone (TC) positions on the WAFS SIGWX forecasts for Amendment 80;

1. TC positions will be plotted on forecasts valid between 6-hours and 24-hours at 6-hour intervals
2. The 6-hour forecast position will be used for SIGWX forecasts valid at 9-hours, the 12-hour forecast position will be used for forecasts valid at 15-hours, and the 18-hour forecast position will be used for forecasts valid at 21-hours.
3. The SIGWX chart legend will be updated to state when TC position information is not available or a time-steps three hours earlier is used.

Action 12/05 – Tropical cyclone (TC) information beyond T+24 hours

Given that the WAFCs are not in a position to include TC forecast position information for forecasts between 27-hours and 48 hours, the ICAO Secretariat is invited to:

- a) undertake a formal consultation with IATA, IFALPA, CANSO and IFATCA panel members to identify their requirements for longer range tropical cyclone advisory information;
- b) in conjunction with WMO, investigate whether the TCACs will be in a position to provide the extra TC information, and a timescale on which the new forecast information could be produced;
- c) provide guidance on what form this forecast information should be supplied in, who should propose these changes for Annex 3 and other associated documentation; and
- d) report back on progress to the next MOG/WAFS meeting.

Action 12/06 – Tropical Cyclone Advisory forecast position guidance

That WAFC Washington be invited to work with RSMC/TCACs Miami and Honolulu to request that their advisories are produced using the main synoptic hours in time for Amendment 80.

Action 12/07 – TCAC designation and areas of coverage in the Atlantic Ocean

That, the ICAO Secretariat be requested to:

- a) consult respectively with the ICAO European and North Atlantic Office and the ICAO South American Office to ascertain the status of tropical cyclone advisory centre (TCAC) designation and TCAC areas of coverage in the far eastern part of the North Atlantic and the western part of the South Atlantic; and
- b) provide a report on the outcomes of a) to the next MOG/WAFS meeting.

Note. — The report should include, to the extent possible, information on the mechanisms used (or intended to be used) to enable the provision of tropical cyclone advisory information by ICAO-designated TCACs, including amendments to ICAO regional air navigation plans.

Action 12/08 – Tropical Cyclone Job Card

That the ICAO Secretariat, in conjunction with the Rapporteur prepare a paper for METP/5 which highlights to the Air Navigation Commission the need for a tropical cyclone job card, given the number of issues that have been identified regarding the provision of tropical cyclone advisory information.

Action 12/09 – Format of future WAFS data sets

That, the WAFS Provider States prepare, on behalf of the WG-MOG Rapporteur, a working paper for METP/5 to inform the METP of the requirement to be able to offer WAFS data sets in other formats (in addition to GRIB) in order to meet the requirements set out in the Global Air Navigation Plan.

Action 12/10 – Proposal Amendment 80 to Annex 3 - *Meteorological Service for International Air Navigation for the WAFS and the associated changes for Doc 8896*

That, an ad hoc group consisting of Karen, Larry, Greg, Stéphanie, Graham, Oleh, Raul and Klaus, and co-led by Karen and Larry;

- a) continue to mature the draft provisions pertaining to the WAFS for Amendment 80 (included as Appendix F) and to prepare a paper for METP/5
- b) further develop the changes needed in Doc 8896 - *Manual of Aeronautical Meteorological Practice*, that relate to the Annex 3 Amendment 80 proposal and ensure that the limitations and processing applied to SIGWX charts in line with Decisions 12/01 and 12/02 are properly explained.
- c) review the WAFS CONOPS to ensure the document reflects the changes that are being proposed for Amendment 80.
- d) report back to the next MOG/WAFS meeting

Action 12/11 – Doc 8896 changes relating to Amendment 79 of Annex 3

That, the WG-MOG/WAFS accept the proposed amendments to Doc 8896 (included as Appendix G) considering any agreed changes during the meeting, and that Larry Burch and Karen Shorey, on behalf of the WG-MOG Rapporteur, work with the rapporteurs of the other working groups, or their representatives, to prepare a consolidated working paper presenting all the proposed amendments to Doc 8896 that relate to Amendment 79 of Annex 3 and provide these to the ICAO secretariat as soon as possible.

Action 12/12 — Job Card 10 update

That, the WG-MOG Rapporteur present the proposed updates to Job Card 10, as shown in Appendix H, to METP/5 for consideration.

Action 12/13 – Enhanced WAFS Verification Statistics

That, the WAFCs be invited to consult further with the user community (including drawing on the expertise of the WMO expert team on meteorological hazard science) and IATA to determine the best way to present enhanced verification scores such as those provided the WAFS management report (MOG12/SN20), and to report back to the next meeting.

Action 12/14 – Probabilistic forecasts

That IATA will investigate the requirements for probabilistic forecasts with their members, supported by the WAFCs who will provide examples of what is technically feasible, and report back at the next MOG/WAFS meeting

LIST OF WG-MOG/12 – WAFS DECISIONS

Decision 12/01 – Amendment 80 proposals for SIGWX forecasts

The METP/MOG agrees that as part of Amendment 80 WAFS SIGWX forecasts will;

a) be comprised of the elements and products as detailed in the table below;

WAFS SWH SIGWX FORECASTS	
<ul style="list-style-type: none"> ● Global coverage of all parameters, and extending from FL100 to FL600. ● Forecast timesteps: 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 and T+48 ● Forecasts produced: 4x daily 	
<p>All Timesteps</p> <ul style="list-style-type: none"> ● IWWXM format ● PNG format ‘ground truth’ charts: <ul style="list-style-type: none"> ● 1x Mercator covering 180W to 180E and 60N to 45S ● 1x Northern Polar Stereographic extending out to 30N ● 1x Southern Polar Stereographic extending out to 30S 	<p>In addition to the provision for all timesteps – the following will also be produced for the SIGWX forecast valid at 24-hours</p> <ul style="list-style-type: none"> ● SWH BUFR files will be produced until Nov 2024. ● PNG format SWH charts (black and white) covering areas A, B, B1, C, D, E, F, G, H, I, J, K, L, and M <p><i>Note: the BUFR files will differ from the IWXXM provision in the following way: they will not contain tropopause height or icing information</i></p>
SIGWX parameters	
Jet Stream	Position and speed, jet core height and jet depth will be forecast, and marked on charts using current conventions and styles
Cumulonimbus (CB) cloud	Areas of OCNL or FRQ CB cloud will be forecast. CB base and top information will be contained within the digital data, but only CB top information will be plotted on WAFS produced SWH charts. Areas of CB cloud will be marked on charts within scalloped areas
Turbulence	Areas of moderate (MOD) or severe (SEV) turbulence, and the base and top of the hazard will be forecast (Note: this field encompasses both clear air turbulence and orographic turbulence types). Areas of turbulence will be marked on charts using current conventions and styles
Icing	Areas of MOD or SEV icing, and the base and top of the hazard, will be forecast and contained within the digital file, but will <u>not</u> be plotted on WAFS produced charts.
Tropopause Height	5000ft interval contours will be forecast Tropopause height contours will be marked by a thin dashed line and a three-digit number which indicates the flight level
Tropical Cyclones	Included on forecasts up to and including 24-hours if a Tropical Cyclone Advisory has been issued for it. For forecasts charts valid at 9-hours, 15-hours and 21-hours the tropical cyclone position for three hours earlier will be used.
Volcanic Eruptions	Marked if a volcanic ash advisory has been issued
Radioactive Release	Marked if a radioactive release has been reported
Sand/dust storms	Marked if a heavy sand or dust storm has been reported in a SIGMET

b) use the blended hazard data sets for CB cloud , icing and turbulence, and each WAFS will use their own data in the production of jet stream and tropopause height information

c) not carry out backups

Decision 12/02 – SIGWX chart legend

That the METP/MOG agrees that as part of Amendment 80 WAFS SIGWX chart legends will take the form shown in **Appendix E** and will;

- a) state “T+XX VALID AT <HH> UTC ON <DD> <MMM> <YYYY> to describe the validity of the forecast
- b) have an additional legend that states “TC POSITION FOR 3-HOURS EARLIER IS SHOWN” on the T+9, T+15 and T+24 timesteps;
- c) say “TC INFORMATION IS NOT AVAILABLE FOR THIS TIMESTEP” for timesteps between T+27 and T+48; and,
- d) say “TC/VA PROCESSING ERROR” if the processing of the input IWXXM files has failed in some way

1. **AGENDA ITEM 1: OPENING OF THE MEETING**

1.1 The twelfth meeting of the METP MET Operations Group (MOG/12) for matters pertaining to the World Area Forecast System (WAFS) was originally scheduled to take place at the UK Met Office in Exeter, UK, however due to the global pandemic of Coronavirus this had to be cancelled. For this reason, the meeting took place over WebEx from 23 to 24 March 2020. Mr. Colin Hord, Policy Lead MET and AIM, United Kingdom CAA, and Rapporteur of WG-MOG, chaired the meeting. Mr. Hord was assisted by Mr. Raul Romero, Technical Officer, Meteorology, ICAO Headquarters.

1.2 Mr. Hord opened the meeting at 1130 hours UTC. He welcomed all those present and appreciated the effort that many of the participants had made to take part in the meeting remotely noting the different time zones that the meeting would be taking place in. The meeting agreed a number of protocols when using WebEx to enable the meeting to run smoothly and to enable everyone to take part.

2. **AGENDA ITEM 2: INTRODUCTION**

2.1 Referenced study notes (SN) and information papers (IP) are available on the ICAO METP MOG public website, under: <https://portal.icao.int/METP/MOG/Pages/MOG-Meetings.aspx>.

2.2 The Agenda for the meeting, presented in MOG/12/IP/02, was adopted without change.

2.3 The list of participants is contained in **Appendix A**.

3. **AGENDA ITEM 3: MATTERS RELATING TO WAFS**

3.1 **Status of outstanding WG-MOG (WAFS) Actions**

3.1.1 The meeting noted the status of outstanding actions relating to WAFS, which was provided to the meeting in Appendix A to MOG/12/IP/02 (Rev1) by the Rapporteur. After a review the meeting was pleased to note the outstanding actions were satisfactorily addressed. It was noted that a number of papers will be presented during the course of the meeting that will address the specific actions. A summary of the actions from MOG/9 is included in **Appendix B**.

3.1.2 **WAFS Management Report**

3.1.2.1 The World Area Forecast Centres (WAFCs) presented the WAFS Management Report, which covered the period from March 2019 through February 2020. The meeting was pleased to note that the WAFS Provider States continue to provide a valuable and reliable service to the aviation community, as evidenced by the availability, timeliness and verification statistics provided in the Management Report.

3.1.2.2 Both WAFCs have a Quality Management System. WAFS London, as a function of the Met Office, is ISO 9001:2015 and ISO 14001:2015 compliant. Twice per year, SGS (certification partners) visit the Met Office to monitor its compliance. Both the ISO 9001:2015 and the ISO 14001:2015 certificates are valid until 13 August 2020.

3.1.2.3 WAFS Washington, as a function of the National Weather Service's Aviation Weather Center in Kansas City, is ISO 9001:2015 compliant. The certificate is valid until December 28, 2021.

3.1.2.4 The meeting heard that there were some issues with the service continuity, WAFS London reported that there has been one interruption to WAFS London's capability to provide upper air gridded hazard forecasts (CB cloud, Icing and Turbulence) during the period. On 10 January 2020 the 00Z run was affected by a server problem which prevented the creation of the data sets, and as a result a fall back (contingency) data set was issued. There were a few occasions where network problems at

WAFc Washington prevented WAFc London from obtaining WAFc Washington's hazard grids for blending. This resulted in WAFc Washington being able to issue blended hazard grids, while WAFc London had to issue unblended hazard grids. It was noted that there were three unscheduled backups during the period due to operational difficulties at WAFc London on 23 June 2019 (06 UTC run), 29 December 2019 (18 UTC run) and 19 January 2020 (06 UTC run).

3.1.2.5 The meeting heard that the WAFS model verification is now available on the respective WAFcs websites, verification statistics for the last year are shown in Appendix C of the Management Report. The meeting noted a continued improvement in the accuracy of the data being provided by the WAFcs. It was noted that due to the COVID-19 related reduction in aircraft flying at the current time, and a consequential dramatic decline in the number of aircraft-based observations in some regions, there may be an impact on the verification scores. A similar effect was seen following the Eyjafjallajökull volcanic eruption in 2010 when there was reduced flying during that event. It was noted that verification schemes that are currently used will need to be reviewed to ensure that they provide comparative results when used with the higher resolution data.

3.1.2.6 There was discussion on the WAFS performance indicator tables in Appendix A of the Management Report. Timeliness is measured against a number of thresholds: a 6-hour target for WAFS gridded data sets (as per ICAO Annex 3), but additional thresholds are also measured that relate more closely to the times that the data is normally delivered (for example a 4 hour 20 minute threshold for gridded wind and temperature). It was noted that changes being introduced for Amendment 79 to ICAO Annex 3 will change the delivery time thresholds. These will be incorporated into the next WAFS Management report, and a clearer distinction will be made between those targets that relate to Annex 3, and those set locally.

3.2 Other operational matters

3.2.1 Interaction with other METP groups and issues arising from METP/4

3.2.1.1 The meeting reviewed IP/03 – *Interaction with MIE* which detailed how MOG is working with MIE to develop SIGWX related IWXXM requirements, guidance and documentation, along with the MET SWIM Plan. This schema will assist the provision of high level SIGWX datasets but could also be used by service providers who will be creating low level SIGWX datasets.

3.2.2 Review of MOG Terms of Reference in relation to WAFS

3.2.2.1 The meeting reviewed the Terms of Reference (ToR) for the MOG (SN/01 – *Terms of Reference*). The paper highlighted the need to change task list to actions and to add a reference to job cards. During the meeting it was noted the reference to Space Weather and Regional Hazardous Weather Centres would need to change since Space Weather centres will be added to the MOG remit shortly.

Action 12/01 — Terms of Reference

That;

- a) the METP-WG/MOG12 meeting accepts the proposed updates to the Terms of Reference as shown in **Appendix C**; and
- b) the ICAO Secretariat puts the finalised Terms of Reference document onto the ICAO public website (replacing the previous copy).

3.3 **Work required in support of WAFS Developments**

3.3.1 **Matters relating to gridded WAFS products**

3.3.1.1 IP/04 – *WAFS Gridded Data Set Provision from November 2020* by the WAFS Provider States, presented a summary of the WAFS gridded data sets that the WAFS Providers intend to deliver from November 2020 in line with the proposed Amendment 79 update to ICAO Annex 3. It was highlighted that from this date it is anticipated that not only will forecasts be more accurate they will contain additional information including Icing Severity and Turbulence Severity, these parameters along with the Cumulonimbus (CB) cloud datasets will be provided at a horizontal resolution of 0.25 degrees. It was noted the Turbulence Severity will be provided as an Eddy Dissipation Rate (EDR) (Annex 3 has been updated with regards to the references to EDR as part of the Amendment 79) which is independent of aircraft size. The comparison figures in the paper were not for a particular aircraft but are provided as a comparison to the existing scheme. Regarding the Icing Severity it was noted that the information will be provided as 0 Trace, 1 Slight, 2 Moderate and 3 Severe.

3.3.1.2 SN/02 – *WAFS turbulence type forecasts gridded data set provision from Nov 2020* by the WAFS Provider States discussed the provision of turbulence information, while the user community had requested an indication of the type of turbulence the WAFCs had noted during their development of Turbulence Severity they use an algorithm called Graphical Turbulence Guidance (GTG). This algorithm can sometimes differentiate between forecasts of clear-air turbulence (CAT) and mountain wave (MTW) turbulence but does not forecast convection-induced turbulence (CIT), which is perhaps the most important type of turbulence to diagnose.

In this regard the meeting noted the following action:

Action 12/02 – Turbulence type forecasts

That, IATA is invited to include the WAFCs in their investigations of whether turbulence type forecasts (initially MTW or CAT, and potentially in future CIT) are useful for aviation, bearing in mind the limitations of verifying these forecast types. IATA is invited to report back to the next MOG/WAFS meeting.

3.3.1.3 IP/05 – *WAFS gridded data sets from Nov 2022¹* provided a summary of the WAFS gridded data sets that the WAFS Providers intend to deliver from November 2022. It was understood that there are some airlines that will shortly be in a position to make use of the higher resolution information. The UK Met Office commissioned a study that had shown there are significant fuel savings that can be made when using the higher resolution data which is important in the context of climate change.

3.3.1.4 The meeting discussed SN/04 – *Vertical Resolution & Vertical Level Attributes of The Proposed Next Generation World Area Forecast System (WAFS)*, by Clemens Weidemann, which noted that currently a list of different units is used to indicate vertical levels within WAFS gridded data. The paper proposes to use the upcoming changes to next generation WAFS to unify the data structure and designating absolute pressure [Pa] as the only vertical attribute as it may be used universally and related to derived indications. However, after discussion it was noted that many of the units used for height had been used by the aviation industry for many years (such as flight levels, feet, metres and geopotential metres) and that having to change would probably result in significant costs. It was suggested that when new parameters were introduced that a review of the units that were used should be undertaken.

¹ Note: This paper was written before the changes to the applicability date of Amendment 80 was published by ICAO

3.3.2 **Matters relating to Significant Weather provision**

3.3.2.1 SN/07 – *Depiction Of Flight Level Of Tropopause on WAFS SIGWX Forecasts* by Greg Brock (WMO) which updated the meeting on actions undertaken by WMO, with the assistance of the WAFCs, in response to Action 9/9 concerning the depiction of flight level of tropopause on WAFS significant weather forecasts. It was agreed that a new model SIGWX chart should be provided in Appendix 1 of Annex 3 whereby the new chart would need to depict the flight level of the tropopause as contours (i.e. as a dotted line with contour intervals appropriate to the chart size). In this regard the following action was agreed.

Action 12/03 – Depiction of flight level of tropopause on WAFS SIGWX forecasts

That, the WG-MOG Rapporteur, be invited to submit the proposed amendment to ICAO Annex 3 – *Meteorological Service for International Air Navigation* regarding the depiction of the flight level of tropopause on world area forecast system (WAFS) significant weather (SIGWX) forecasts, as given at **Appendix D** and at **Appendix F** to this report, as part of a consolidated package of WAFS-related Amendment 80 proposals.

3.3.2.2 SN/08 – *Plotting Tropical Cyclones on Next Generation WAFS SIGWX Charts* reported on the findings of an ad-hoc group formed at METP-WG/MOG9 to resolve issues pertaining to the inclusion of tropical cyclone information on WAFS SIGWX charts. Discussions with the TCACs had taken place and it was found that while the majority of TCACs could provide the information needed by the WAFCs there was a concern that could be discrepancies between the marked TC position (based on the TC advisory information) and any associated CB cloud (based on WAFS forecast information). The IATA and IFALPA representatives in the ad-hoc group accepted that given these potential differences were inevitable, stated that in their view this position mismatch is less than ideal but airline operators and flight crew, for example, understand that uncertainties can grow and divergence in numerical weather prediction. It was noted that the additional timesteps that will be introduced for Amendment 80 will mean that additional obligations will be needed to be developed for the TCACs, it was for this reason that at this time the WAFCs felt that no radical changes to the Tropical Cyclone Advisory could be proposed at the present time, and further investigatory work is required before progress can be made towards getting a regulated source of TC information for all the time-steps that are required. A proposal for plotting tropical cyclones on WAFS SIGWX charts based on the information that is currently available has been determined and is set out in the action below.

3.3.2.2.1 The meeting agreed to the following:

Action 12/04 – Tropical cyclone inclusion on SIGWX charts for Amendment 80

That the METP/MOG informs METP/5 on the following proposed changes pertaining to the inclusion of tropical cyclone (TC) positions on the WAFS SIGWX forecasts for Amendment 80;

1. TC positions will be plotted on forecasts valid between 6-hours and 24-hours at 6-hour intervals
2. The 6-hour forecast position will be used for SIGWX forecasts valid at 9-hours, the 12-hour forecast position will be used for forecasts valid at 15-hours, and the 18-hour forecast position will be used for forecasts valid at 21-hours.
3. The SIGWX chart legend will be updated to state when TC position information is not available or a time-steps three hours earlier is used.

Action 12/05 – Tropical cyclone (TC) information beyond T+24 hours

Given that the WAFCs are not in a position to include TC forecast position information for forecasts between 27-hours and 48 hours, the ICAO Secretariat is invited to:

- a) undertake a formal consultation with IATA, IFALPA, CANSO and IFATCA panel members to identify their requirements for longer range tropical cyclone advisory information;
- b) in conjunction with WMO, investigate whether the TCACs will be in a position to provide the extra TC information, and a timescale on which the new forecast information could be produced;
- c) provide guidance on what form this forecast information should be supplied in, who should propose these changes for Annex 3 and other associated documentation; and
- d) report back on progress to the next MOG/WAFS meeting.

3.3.2.3 SN/09 – *Alignment of Tropical Cyclone Forecast Times* provided an update on the findings of the ad-hoc working group set up to resolve the issues relating to lack of standardisation in the forecast position times in issued tropical cyclone advisories that will impact on the production of the next generation WAFS SIGWX forecasts. The ad-hoc group noted variation internationally between the times at which the bulletins containing tropical cyclone advisory (TCA) information are issued. With this in mind, it was agreed to propose a note to Annex 3, Appendix 2, Section 5 and Table A2-2 that advises that main synoptic hours are used, additionally the example provided in Annex 3, Appendix 2, Example A2-2 is proposed to be updated to use main synoptic hours. (See **Appendix F**). It was noted that RSMC/TCAC Miami and Honolulu provide TCAs at non-synoptic hours, WAFC Washington will work closely with these two centres, as a consequence the following action was agreed.

Action 12/06 – Tropical Cyclone Advisory forecast position guidance

That WAFC Washington be invited to work with RSMC/TCAC Miami and Honolulu to request that their advisories are produced using the main synoptic hours in time for Amendment 80.

3.3.2.3.1 SN/10 – *Tropical Cyclone Advisory Centre Areas of Coverage* provided a report on the consultation undertaken by WMO with tropical cyclone advisory centres (TCACs) as well as ICAO regional offices regarding the suitability of existing TCAC areas of coverage given the potential development of tropical cyclones in the far eastern part of the North Atlantic and the western part of the South Atlantic following the action from the previous MOG (WAFS). It was found that TCAC Miami's responsibility did not extend south of the equator in the Atlantic Ocean. For the far eastern part of the North Atlantic it was found that the ICAO EUR ANP did not require the issuance of TCA information by a TCAC. This was duly discussed at ICAO EASPG METG/29 in September 2019 where it was agreed to set up an ad-hoc group to progress this matter. In the western part of the South Atlantic noting that the TCAC Miami's area of coverage did not extend south of the equator it was also found that no other TCAC covered the South Atlantic. The ICAO EASPG are now discussing how best to progress this matter especially as the incidence of tropical cyclones in this region is rare but not non-existent. It was noted that following the ICAO SAM MP/3 meeting it was agreed to submit a proposal to the GREPECAS to modify the ICAO CAR/SAM regional air navigation plan. It was noted that tropical cyclone-related issues such as these did not appear on the MOG (WAFS) job card and that a recommendation should be made to the next METP meeting to include the need for a job card related to the provision of tropical cyclone information. In light of the discussion the meeting agreed to the following actions:

Action 12/07 – TCAC designation and areas of coverage in the Atlantic Ocean

That, the ICAO Secretariat be requested to:

- a) consult respectively with the ICAO European and North Atlantic Office and the ICAO South American Office to ascertain the status of tropical cyclone advisory centre (TCAC) designation and TCAC areas of coverage in the far eastern part of the North Atlantic and the western part of the South Atlantic; and
- b) provide a report on the outcomes of a) to the next MOG/WAFS meeting.

Note. — The report should include, to the extent possible, information on the mechanisms used (or intended to be used) to enable the provision of tropical cyclone advisory information by ICAO-designated TCACs, including amendments to ICAO regional air navigation plans.

Action 12/08 – Tropical Cyclone Job Card

That the ICAO Secretariat, in conjunction with the Rapporteur prepare a paper for METP/5 which highlights to the Air Navigation Commission the need for a tropical cyclone job card, given the number of issues that have been identified regarding the provision of tropical cyclone advisory information.

3.3.2.3.2 SN/11 WAFS SIGWX Provision from November 2022² (Amendment 80) provided an overview of the planned changes to the World Area Forecast System's (WAFS) significant weather (SIGWX) forecasts that will be required for Amendment 80 to Annex 3. The meeting noted that Amendment 80 will bring in a single consolidated SIGWX data set that will encompass the range FL100 to FL600. This will allow greater flexibility for users as operators and flight planning companies will be able to provide bespoke charts based on the digital dataset. Three "ground truth" charts will be produced; these are not designed for flight briefing or documentation but for users to ensure the information on the charts is being provided correctly. A colour scheme was proposed and agreed at METP-WG/MOG 09 (Action 9/10). The meeting agreed which high level SIGWX charts (in png format) will be provided on SADIS and WIFS until retirement in 2028. Moreover, it was agreed that high level SIGWX BUFR files T+24 will be produced until November 2024 but will no longer contain tropopause spot height information.

3.3.2.3.3 At the previous MOG (WAFS) meeting there was an action for IATA and IFALPA to review the requirement for the height of CB cloud base information on WAFS SIGWX forecasts. As there was no feedback received it was agreed to remove this information from the SIGWX charts, however the CB cloud base information will be included within the digital dataset.

3.3.2.3.4 As the new Graphical Turbulence Guidance gridded data set will be used to generate the turbulence objects it was agreed that the plotting of Clear Air Turbulence will become simply Turbulence and will be depicted by bold dashed contours. A change to the legend will also be undertaken for WAFS SIGWX.

3.3.2.3.5 The meeting agreed to a revision of the chart legend which is shown in **Appendix E**.

3.3.2.3.6 The production of SIGWX charts will be an automated process, and as a consequence collaboration with various partners will no longer be necessary. For this reason, the SIGWX chatroom operated by WAFC Washington will cease. It was noted that both WAFCs will not be issuing SIGWX corrections through administrative messages, but both WAFCs will still welcome feedback on the SIGWX forecasts for use in post event analysis and verification activities. The procedure to follow will be updated and included in Doc 8896.

² Note: This paper was written before the changes to the applicability date of Amendment 80 was published by ICAO

3.3.2.3.7 As part of Amendment 80 the backup arrangements will also be amended. Both WAFCs will routinely produce all SIGWX forecast data sets, and publish these on SADIS and WIFS, therefore if all systems are working correctly both forecasts will be identical. For this reason, quarterly back up testing activities will cease as both WAFCs will produce the same products routinely.

3.3.2.3.8 The WAFCs noted that it was their intention to create a sample set of the new SIGWX data that could be used by operators and flight planning companies to evaluate the new datasets in their systems.

3.3.2.3.9 A summary of the changes that are being proposed are included in the decision agreed below.

Decision 12/01 – Amendment 80 proposals for SIGWX forecasts

The METP/MOG agrees that as part of Amendment 80 WAFC SIGWX forecasts will;

b) be comprised of the elements and products as detailed in the table below;

WAFC SWH SIGWX FORECASTS	
<ul style="list-style-type: none"> ● Global coverage of all parameters, and extending from FL100 to FL600. ● Forecast timesteps: 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 and T+48 ● Forecasts produced: 4x daily 	
<p>All Timesteps</p> <ul style="list-style-type: none"> ● IWWXM format ● PNG format ‘ground truth’ charts: <ul style="list-style-type: none"> ● 1x Mercator covering 180W to 180E and 60N to 45S ● 1x Northern Polar Stereographic extending out to 30N ● 1x Southern Polar Stereographic extending out to 30S 	<p>In addition to the provision for all timesteps – the following will also be produced for the SIGWX forecast valid at 24-hours</p> <ul style="list-style-type: none"> ● SWH BUFR files will be produced until Nov 2024. ● PNG format SWH charts (black and white) covering areas A, B, B1, C, D, E, F, G, H, I, J, K, L, and M <p><i>Note: the BUFR files will differ from the IWXXM provision in the following way: they will not contain tropopause height or icing information</i></p>
SIGWX parameters	
Jet Stream	Position and speed, jet core height and jet depth will be forecast, and marked on charts using current conventions and styles
Cumulonimbus (CB) cloud	Areas of OCNL or FRQ CB cloud will be forecast. CB base and top information will be contained within the digital data, but only CB top information will be plotted on WAFC produced SWH charts. Areas of CB cloud will be marked on charts within scalloped areas
Turbulence	Areas of moderate (MOD) or severe (SEV) turbulence, and the base and top of the hazard will be forecast (Note: this field encompasses both clear air turbulence and orographic turbulence types). Areas of turbulence will be marked on charts using current conventions and styles
Icing	Areas of MOD or SEV icing, and the base and top of the hazard, will be forecast and contained within the digital file, but will <u>not</u> be plotted on WAFC produced charts.
Tropopause Height	5000ft interval contours will be forecast Tropopause height contours will be marked by a thin dashed line and a three-digit number which indicates the flight level
Tropical Cyclones	Included on forecasts up to and including 24-hours if a Tropical Cyclone Advisory has been issued for it. For forecasts charts valid at 9-hours, 15-hours and 21-hours the tropical cyclone

	position for three hours earlier will be used.
Volcanic Eruptions	Marked if a volcanic ash advisory has been issued
Radioactive Release	Marked if a radioactive release has been reported
Sand/dust storms	Marked if a heavy sand or dust storm has been reported in a SIGMET

b) use the blended hazard data sets for CB cloud , icing and turbulence, and each WAFC will use their own data in the production of jet stream and tropopause height information

c) not carry out backups

Decision 12/02 – SIGWX chart legend

That the METP/MOG agrees that as part of Amendment 80 WAFS SIGWX chart legends will take the form shown in **Appendix E** and will;

- e) state “T+XX VALID AT <HH> UTC ON <DD> <MMM> <YYYY> to describe the validity of the forecast
- f) have an additional legend that states “TC POSITION FOR 3-HOURS EARLIER IS SHOWN” on the T+9, T+15 and T+24 timesteps;
- g) say “TC INFORMATION IS NOT AVAILABLE FOR THIS TIMESTEP” for timesteps between T+27 and T+48; and,
- h) say “TC/VA PROCESSING ERROR” if the processing of the input IWXXM files has failed in some way

3.3.2.3.10 IP/06 *Changes To WAFC Washington PNG Charts from Nov 2020 (Amendment 79)* notified the meeting of proposed changes to the PNG charts that are produced by WAFC Washington, specifically to cease inclusion of the height of the bases of cumulonimbus clouds and to include tropopause height information as contours. The meeting discussed the matter and it was noted that, at present, Annex 3 Appendix 1 Sheet of Notations used in flight documentation details that tropopause level should be shown as a value within a rectangle not a contour. It was noted that due process should be undertaken before changes of this nature were made. It was also noted that this would introduce an inconsistency between the two sets of WAFS SIGWX charts issued by the WAFCs. As this was an IP there was no action, however in light of the discussion WAFC Washington will review this proposal further.

3.3.3 Matters relating to WAFS Documentation

3.3.3.1 SN/12 *Using Non-WMO Code Forms for WAFS Data* outlined the requirement for the use of non-WMO code forms in order to deliver the next generation of WAFS data sets in a way that meets the requirements set out in the GANP. As the WAFCs are introducing higher resolution data sets which will be substantially larger than at present, they believe that there may be better ways of delivering this data to users. The WAFCs identified an issue that relates to the format of data files in GRIB code format, the standard that is currently supported by ICAO. It was noted that GRIB code form does not have the flexibility needed to support users who wish to extract smaller datasets for specific areas or to support dynamically optimised flight trajectory planning. For this reason, the WAFCs have been considering the use of more contemporary open-source data formats that are suited for the advanced functionality that is desired (e.g. NetCDF2, GeoJSON3). A proposal to amend Annex 3 was discussed however it was noted that it was not appropriate to remove the references to WMO GRIB at this time. It was noted that the WAFS Concept of Operation (ConOps) had not been updated for a while and it may be worth considering a review to ensure requirements such as data formats are captured. The meeting agreed to the following action:

Action 12/09 – Format of future WAFS data sets

That, the WAFS Provider States prepare, on behalf of the WG-MOG Rapporteur, a working paper for METP/5 to inform the METP of the requirement to be able to offer WAFS data sets in other formats (in addition to GRIB) in order to meet the requirements set out in the Global Air Navigation Plan.

3.3.3.1.1 SN/14 *Draft Provisions for World Area Forecast System (WAFS) Information* provided draft amendments to Annex 3 – Meteorological Service for International Air Navigation intended for Amendment 80 relating to WAFS information. This paper was a summary of various actions from the previous meeting all of which required proposals to amend Annex 3. The meeting discussed two specific topics one related to how tropopause height is shown on SIGWX charts and in the associated object database, this topic is discussed more fully at SN/07 (see 3.3.3.1.5)

3.3.3.1.2 The other topic concerned a the need to establish a minimum set of visualized WAFS forecasts (charts) for flight documentation, a proposal to Annex 3 and looked to remove the word “minimum” from Annex 3 Appendix 8 paragraph 4.2.2.1 and make some other changes which reflected the proposals to the various changes that had been discussed to flight documentation. The meeting felt that while they were in agreement with the spirit of the proposed Annex 3 change the word minimum (or a suitable synonym) should be retained.

3.3.3.1.3 The meeting also discussed which horizontal resolution of WAFS gridded forecasts should be used as standard for flight documentation i.e. 1.25 degree or 0.25 degree. The meeting felt that 0.25 degree should be the resolution used as part of the standard, with a retirement clause added for 1.25 degree resolution, the wording would be agreed in the ad-hoc team which was set up to review to ensure the wording was consistent across all the areas of Annex 3 that are proposed to change. The ad-hoc group would also consider how best to present the material in Annex 3 so ensuring that any Standards do not contain large amounts of technical details. **Appendix F** contains the proposed changes that were presented and agreed in principle at the meeting which will be used by the ad-hoc group as the basis for their discussions. The meeting agreed the following action:

Action 12/10 – Proposal Amendment 80 to Annex 3 - Meteorological Service for International Air Navigation for the WAFS and the associated changes for Doc 8896

That, an ad hoc group consisting of Karen, Larry, Greg, Stéphanie, Graham, Oleh, Raul and Klaus, and co-led by Karen and Larry;

- a) continue to mature the draft provisions pertaining to the WAFS for Amendment 80 (included as **Appendix F**) and to prepare a paper for METP/5
- b) further develop the changes needed in Doc 8896 - *Manual of Aeronautical Meteorological Practice*, that relate to the Annex 3 Amendment 80 proposal and ensure that the limitations and processing applied to SIGWX charts in line with Decisions 12/01 and 12/02 are properly explained.
- c) review the WAFS CONOPS to ensure the document reflects the changes that are being proposed for Amendment 80.
- d) report back to the next MOG/WAFS meeting

3.3.3.1.3.1 SN/15 *Doc 8896 Changes Relating to Amendment 79 Of Annex 3* was presented to the meeting, it contained a consolidated set of changes required for Doc 8896 in respect of the changes being made to the WAFS data provision from November 2020. Raul Romero, ICAO Secretariat, requested that the information contained in the Appendix to this paper was provided to him as soon as possible so that it can be included in the latest update. The meeting agreed the following action:

Action 12/11 – Doc 8896 changes relating to Amendment 79 of Annex 3

That, the WG-MOG/WAFS accept the proposed amendments to Doc 8896 (included as **Appendix G**) considering any agreed changes during the meeting, and that Larry and Karen, on behalf of the WG-MOG Rapporteur, work with the rapporteurs of the other working groups, or their representatives, to prepare a consolidated update presenting all the proposed amendments to Doc 8896 that relate to Amendment 79 of Annex 3 and provide these to the ICAO secretariat as soon as possible.

3.3.3.1.3.2 SN/16 *Doc 8896 Changes Relating to Amendment 80 of Annex 3* was presented to the meeting, it provided an insight to the likely changes that will be needed to Doc 8896 when the proposed changes to WAFS provision are introduced as part of Amendment 80. Noting that there was an increasing likelihood that Amendment 80 would be delayed from November 2022 to November 2023 it was agreed there was likely to be more time to work on this activity and that it could be represented at the next MOG (WAFS) . As a consequence, there was no action agreed.

3.4 Review of Job Cards

3.4.1 SN/17 *METP Job Card 10* was presented and detailed some key changes including the tasks that relate to Amendment 79 of Annex 3 are now complete, which have been reoriented to turn them into tasks for Amendment 80 and a new task to related to the development of probabilistic data sets has been added. To this end the following action was agreed.

Action 12/12 – Job Card 10 update

That, the WG-MOG Rapporteur present the proposed updates to Job Card 10, as shown in **Appendix H**, to METP/5 for consideration.

3.4.2 SN/18 *MOG/WAFS Connectivity Diagram* detailed some work that had been carried out for the Meteorology Panel’s Management Group’s Cross Working Group Progress (CWGP) meeting in November 2019, which had requested that each METP working group develop a living connectivity diagram or document that describes the linkages between the working group and external groups, the ASBUs, internal and external to ICAO, so that this information is maintained on the METP secure web site pages. The diagram that was shown to the CWGP meeting was presented, and it was noted that some additional information is needed to be added from the IAVW workstream of the MOG. The Rapporteur agreed to share the diagram with Paula Acethorp the IAVW workstream lead so any additional connections can be added before it is uploaded to the METP website.

3.5 Science capabilities

3.5.1 Modelling developments and new capabilities

3.5.1.1 Several presentations were given by the WAFC London, which included an update on turbulence and convection forecasting and a demonstration of the new SIGWX object generation. A presentation on probabilistic forecasting was given by Dr Piers Buchanan which showed some of the ways in which probabilistic information could be presented to users. It was noted that the WAFCs are now at the stage where engagement with the end users is required before probabilistic WAFC forecast offering can be determined.

3.5.1.2 Cameron Lethlean presented IP/7 *Supercooled Liquid Water Clouds And Evaluation Of Icing Forecasts Using Aircraft Observations (SOCRATES)*.

3.5.1.3 The meeting expressed gratitude to the presenters for their presentations. The presentations will be posted on the WG-MOG Public webpage as appropriate. During the discussions it was agreed to raise the following actions:

Action 12/13 – Enhanced WAFS Verification Statistics

That, the WAFCs be invited to consult further with the user community (including drawing on the expertise of the WMO expert team on meteorological hazard science) and IATA to determine the best way to present enhanced verification scores such as those provided the WAFS management report (MOG12/SN20), and to report back to the next meeting.

Action 12/14 – Probabilistic forecasts

That IATA will investigate the requirements for probabilistic forecasts with their members, supported by the WAFCs who will provide examples of what is technically feasible, and report back at the next MOG/WAFS meeting

4. AGENDA ITEM 5: TIMETABLE AND FUTURE MEETINGS OF WG-MOG (WAFS)

4.1 The next meeting of the WG-MOG (WAFS) will be held at the facilities of the UK Met Office in Exeter, UK during the week of 12 to 15 April 2021.

5. AGENDA ITEM 6: AOB RELATING TO WG-MOG (WAFS)

5.1 None.

6. AGENDA ITEM 7: CLOSURE OF THE MEETING

6.1 The Meeting was closed at 22.00 UTC hours by Mr. Colin Hord, Rapporteur of the METP WG-MOG. He thanked all delegates for their contributions which had made this a successful online meeting. He also informed the meeting about his retirement at the end of April. In this regard Mr. Raul Romero expressed, on behalf of ICAO, the appreciation of the organization for the excellent work done by Mr. Hord in during the last five years as Rapporteur of the METP WG MOG and previously as contributing expert to the Aeronautical MET Programme. The sentiments of ICAO were shared by the Members and Advisors participating at the meeting who also thanked Mr. Hord for his work and wished him well in his retirement.

APPENDIX A

List of participants

NAME	STATE or ORGANIZATION
Lethlean, Cameron	Australia
Dumas, Karine	Canada
Desbios, Stéphanie	France
Clemens Weidemann	Germany
Osterberg, Kari	Finland
Hord, Colin	United Kingdom
Dutton, Jonathan	United Kingdom and WAFC London
Shorey, Karen	United Kingdom and WAFC London
Buchanan, Piers	United Kingdom and WAFC London
Murphy, Michael (Pat)	United States
Strahan, Matt	United States and WAFC Washington
Burch, Larry	United States
Pettigrew, Brian	United States
Diori, Saley	ASECNA
Rennie, Graham	IATA
Shulimov, Oleh	IATA
Oehl, Thorsten	IATA
Szalasny, Slawomir	IATA
Romero, Raul	ICAO
Sievers, Klaus	IFALPA
Brock, Greg	WMO

APPENDIX B – Actions from the last MOG Meeting

Item	Status
<p>Action 9/1 – Enhancements to the WAFCs’s verification programmes That the WAFCs review their verification programmes and consider the feasibility to enhance the provision of statistics, including the feasibility to provide statistics from additional regional areas, and statistics for wind (such as errors in wind speed over a specific values or errors in wind direction at low wind speeds) and report back to the next WG-MOG (WAFS) meeting.</p>	A paper (SN18) will be presented at MOG 12 on this topic.
<p>Action 9/2 – MOG Terms of Reference in relation to WAFS That, a) the Rapporteur of the WG-MOG update the MOG Terms of Reference (ToR) to include the development of SARPs for inclusion into Annex 3 – <i>Meteorological Service for International Air Navigation</i>, as well as support the METP in the maintenance of the WAFS related Job Card; and b) provide the updated ToR to the Secretary for posting on the WG-MOG Public webpage.</p>	Complete
<p>Action 9/3 – Enhanced WAFS Information That, the a) Rapporteur provide the 4-page high-level summary (Appendix C [to the MOG/9 report]) on the enhanced WAFS information to the METP rapporteurs for onward dissemination to members of their WGs; b) Secretariat be invited to share the 4-page high-level summary on the enhanced WAFS information within ICAO and with others concerned, as appropriate; and c) WAFCs consider the feasibility of staffing an exhibition booth at the upcoming fortieth ICAO Assembly (A40) in September/October 2019 as a means to increase awareness of the forthcoming enhancement to the WAFS information.</p>	Complete. The WAFCs attended the ICAO Innovation fair on the 22/23 September 2019 in Montreal.
<p>Action 9/4 – Draft provisions for WAFS information intended for Amendment 80 to Annex 3 - <i>Meteorological Service for International Air Navigation</i> and related guidance material in ICAO Doc 8896 - <i>Manual of Aeronautical Meteorological Practice</i> That, the WAFCs, a) finalize the proposed amendments to Annex 3 (Amendment 80), pertaining to the WAFS (Appendix E); b) in support of a), prepare proposed consequential amendments to guidance material in Doc 8896; and c) deliver to the next WG-MOG (WAFS) meeting for review prior to METP/5 (September 2020) consideration.</p>	SN14 and 16 will be presented at MOG 12 on with final proposals for Annex 3 Amendment 80 and Doc 8896.
<p>Action 9/5 – Further investigation of the need for cumulonimbus cloud (CB) height of cloud base information on WAFS SIGWX forecasts That, all members of the MOG/WAFS, especially members from IATA and IFALPA, a) investigate through their membership or users, the need for CB height of cloud base information on the WAFS SIGWX forecast, taking into account that the inclusion of CB cloud bases may result in more clutter and less readability with the other information on the SIGWX forecasts; b) report results on a) to the WAFCs (Karen Shorey and Matt Strahan) by 1 November 2019; and c) subject to the outcome of a) and b), the WAFCs to use the results to make appropriate updates to the proposed SARPs for Amendment 80 to Annex 3 (Action 9/4).</p>	No feedback was received from IATA or IFALPA, therefore CB base information will be removed from the examples being prepared for the Annex 3 Amendment 80 update.

<p>Action 9/6 – Guidance material on new WAFS SIGWX information in IWXXM form That, the WAFCs a) develop stand-alone guidance material on the use of enhanced WAFS SIGWX information in IWXXM form; and b) report progress to the next WG-MOG (WAFS) meeting.</p>	<p>A progress update on IWXXM SIGWX will be prepared for MOG12, however it is too early to have guidance material prepared for users.</p>
<p>Action 9/7 – Tropical cyclone depiction on the SIGWX forecasts and provisions relating to the forecast times within the tropical cyclone advisory (TCA) That, an ad-hoc group, consisting of Cameron, Greg, Karen (lead), Klaus, Larry, Matt and Stéphanie, a) resolve the issues discussed at WG-MOG/9 (WAFS) pertaining to the enhancement of tropical cyclone advisory (TCA) information on the enhanced WAFS SIGWX forecasts, taking into account any ramifications on the TCA message in IWXXM form; b) that Greg verify the use, amongst tropical cyclone advisory centres (TCAC), of the four synoptic times of 00, 06, 12, and 18 UTC for the forecasts in the TCA; c) pending the outcome of b), prepare draft guidance material to be incorporated ICAO Doc-8896 – <i>Manual of Aeronautical Meteorological Practice</i> to encourage TCACs to adjust their forecast times within the TCAs, when appropriate, to the four synoptic times of 00, 06, 12, and 18 UTC; d) prepare a draft amendment to Example A2-2 – <i>Advisory message for tropical cyclones</i> of Annex 3 – <i>Meteorological Service for International Air Navigation</i> to reflect the TCA forecast times aligned with the four synoptic times of 00, 06, 12, and 18 UTC, and; e) report progress to the next WG-MOG (WAFS) meeting.</p>	<p>SN8, SN9 and SN11 will be presented at MOG 12 on these topics.</p>
<p>Action 9/8 – Tropical cyclone advisory coverage areas That, WMO be invited to: a) consult with the tropical cyclone advisory centres (TCAC), through the WMO Tropical Cyclone Programme, regarding the suitability of the existing areas of responsibility given the potential development of tropical cyclones in the far-eastern North Atlantic and South Atlantic Oceans; and b) report progress to the next WG-MOG (WAFS) meeting.</p>	<p>SN10 will be presented at MOG 12 on this topic.</p>
<p>Action 9/9 – Provisions for tropopause height information on WAFS SIGWX forecasts within Annex 3 and related guidance material in Doc 8896 That, in response to Decision 9/2, WMO with the assistance of the WAFCs, a) prepare proposed amendment to the Model Charts used in Appendix 1 of Annex 3 concerning tropopause height information on WAFS SIGWX forecasts for inclusion as part of Amendment 80 (November 2022), as well as related guidance material for inclusion in Doc 8896; and b) deliver to the next WG-MOG (WAFS) meeting for review prior to METP/5 (September 2020) considerations</p>	<p>SN7 will be presented at MOG 12 on this topic.</p>

<p>Action 9/10 — WAFS SIGWX Charts in Colour That the METP-WG/MOG requests the WAFCs make available, where feasible, from November 2022, WAFS SIGWX charts on SADIS/WIFS, using the graphical and colour conventions as described below:</p> <table border="1" data-bbox="209 322 975 723"> <thead> <tr> <th>Parameter</th> <th>Convention</th> </tr> </thead> <tbody> <tr> <td>Land Areas</td> <td>White</td> </tr> <tr> <td>Ocean/Sea Areas</td> <td>Pale Blue</td> </tr> <tr> <td>Jet Stream</td> <td>Black Arrow, fletches and height information</td> </tr> <tr> <td>Turbulence Areas</td> <td>Black Dashed line, with two tone shading or hatching (to differentiate between MOD and MOD/SEV TURB). Colour scheme to be determined by the next MOG-WAFS meeting in 2020.</td> </tr> <tr> <td>Cumulonimbus Cloud Areas</td> <td>Red scalloped areas</td> </tr> <tr> <td>Tropopause Height</td> <td>Blue dotted contours</td> </tr> </tbody> </table> <p><i>Note: Black and white SIGWX charts will continue to be shown in Annex 3 and Doc 8896.</i></p>	Parameter	Convention	Land Areas	White	Ocean/Sea Areas	Pale Blue	Jet Stream	Black Arrow, fletches and height information	Turbulence Areas	Black Dashed line, with two tone shading or hatching (to differentiate between MOD and MOD/SEV TURB). Colour scheme to be determined by the next MOG-WAFS meeting in 2020.	Cumulonimbus Cloud Areas	Red scalloped areas	Tropopause Height	Blue dotted contours	<p>Included within plans for the next generation WAFS work.</p>
Parameter	Convention														
Land Areas	White														
Ocean/Sea Areas	Pale Blue														
Jet Stream	Black Arrow, fletches and height information														
Turbulence Areas	Black Dashed line, with two tone shading or hatching (to differentiate between MOD and MOD/SEV TURB). Colour scheme to be determined by the next MOG-WAFS meeting in 2020.														
Cumulonimbus Cloud Areas	Red scalloped areas														
Tropopause Height	Blue dotted contours														
<p>Action 9/11 – Remit of the METP for issues pertaining to SIGMET information That, the WG-MOG Rapporteur write to the Chair of the METP concerning the lack of a remit in the METP job cards addressing issues pertaining to the provision of SIGMET information.</p>	<p>The handling of “orphan” topics such as SIGMET was discussed at the MET-P cross working group meeting in Daytona Beach, USA in November 2019.</p>														
<p>Decision 9/1 — Updated table of flight levels for WAFS grid point forecasts intended for Amendment 80 to Annex 3 – <i>Meteorological Service for International Air Navigation</i> That, the updated table of flight levels, Appendix D [to the MOG9 report], be accepted by the METP-WG/MOG/9.</p>	<p>This will be incorporated into the proposals for Amendment 80 to Annex 3.</p>														
<p>Decision 9/2 – Tropopause Height depiction on SIGWX Charts That the METP-WG/MOG/9 agrees that from November 2022, tropopause height information should be: a) provided in the form of contours (rather than spot values) based on the WAFS gridded data and represented by a dotted line with contour intervals appropriate to the chart size; and b) removed from the T+24 hour BUFR format SIGWX data.</p>	<p>This will be incorporated into the proposals for Amendment 80 to Annex 3.</p>														

APPENDIX C – Terms of Reference

- New text is shaded in grey
- Deleted text is shown with ~~red-strikeout~~

METP Meteorological Operations Group (MOG) Terms of Reference

The aim of the MET Operations Group is to ensure that the following systems meet the agreed user requirements:

- WAFS
- SADIS / WIFS
- IAVW

~~In the longer term it is considered that Space Weather and Regional Hazardous Weather Centres will be added to the remit of the working group.~~ It is expected that Space Weather will be added to the remit of the working group in the short term, whilst Regional Hazardous Weather Centres will be added in the medium term.

The MET Operations group should:

- Establish Key Performance Indicators for the provision of services based on the performance requirements in coordination with other METP WGs and final agreement by the METP
- Define the continuity / availability of services based on the performance requirements, in coordination with the other METP WGs and final agreement by the METP.
- Arrange for the reporting of KPIs from each provider State (e.g. verification and timeliness metrics)
- Receive reports from each provider State on the management of their system(s)
- Set out, review and maintain the back-up arrangements and include relevant details in management reports
- Ensure that coordination and harmonisation takes place between WAFCs, VAACs, and SADIS / WIFS providers
- Monitor, assess and provide advice on potential scientific and technological developments to meet the current, future and evolving performance requirements to the METP in coordination with WMO.
- Assess the financial and technical implications of proposed developments to services and their implementation.
- Ensure that developments have measurable success criteria for implementation
- Establish the times scales, pre-operational tests and implementation of services
- Maintain and, when required, create guidance material on the implementation and provision of services.
- Identify any weaknesses in the current service provision and coordinate updates to the requirements with other Working Groups of the METP
- Ensure that the necessary remedial actions are in place when necessary to overcome identified deficiencies.
- Where necessary assist the Secretariat in the coordination of the arrangements between the various international organizations
- Propose changes to the job cards when required
- Maintain an up to date ~~task-list~~ set of actions

Following each meeting provide a report and make it available on the METP website

APPENDIX D – Depiction of flight level of tropopause

PROPOSED AMENDMENT TO ICAO ANNEX 3, METEOROLOGICAL SERVICE FOR INTERNATIONAL AIR NAVIGATION, REGARDING THE DEPICTION OF THE FLIGHT LEVEL OF TROPOPAUSE

Excerpt based on the Twentieth Edition (2019) of Annex 3, where:

- New text is shaded in grey
- Deleted text is shown with ~~red-strikeout~~

PART II

APPENDICES AND ATTACHMENTS

APPENDIX 1. FLIGHT DOCUMENTATION —

MODEL CHARTS AND FORMS

(See Chapter 9 of this Annex.)

...

MODEL SWH WAFS Significant weather chart (high level)
Example. Polar stereographic projection (~~showing the jet stream vertical extent~~)
Example. Mercator projection

~~MODEL SWM Significant weather chart (medium level)~~

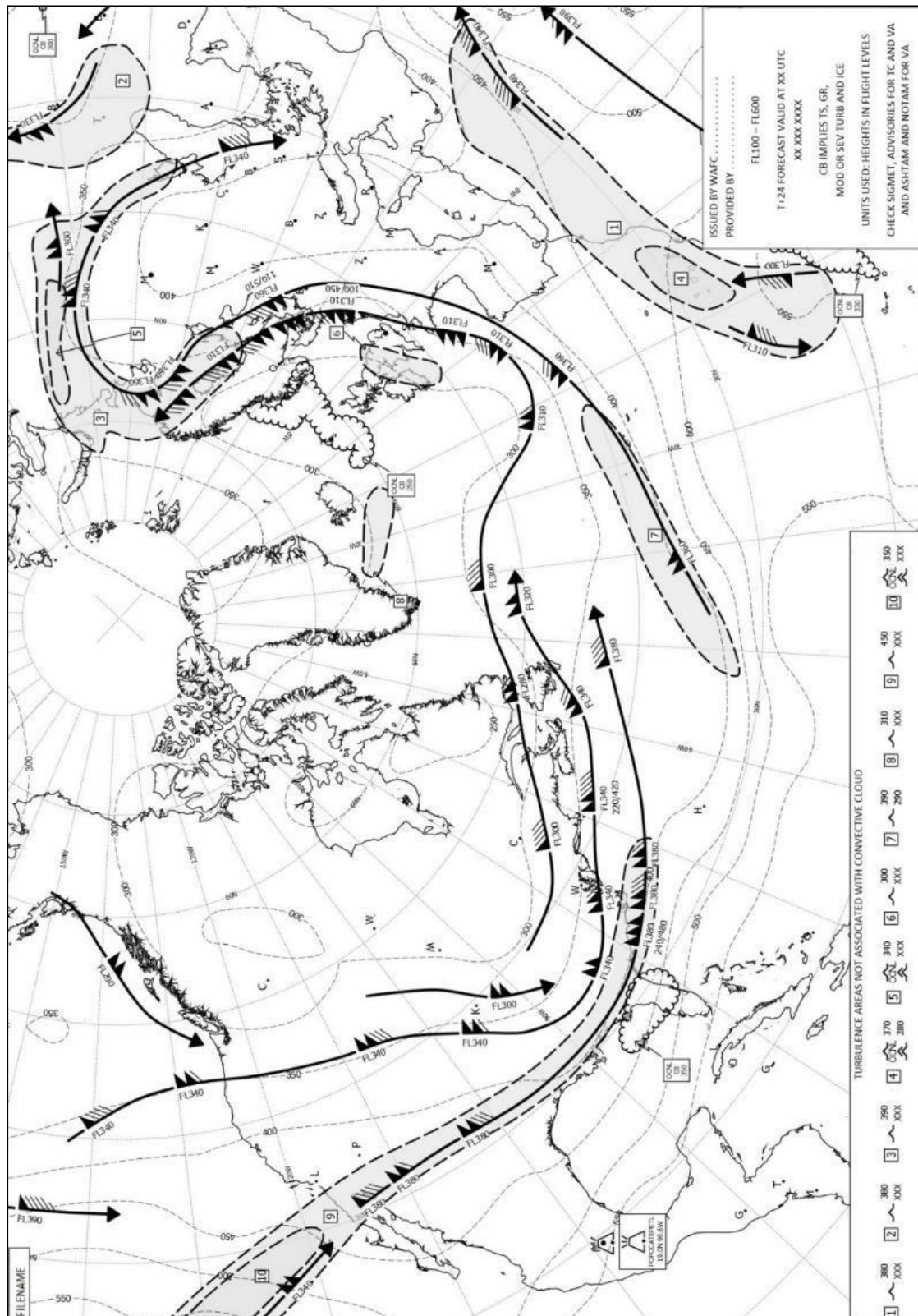
...

Editorial Note.— Replace the existing MODEL SWH and MODEL SWM examples in *toto* by the following new MODEL SWH examples, in Polar stereographic projection and Mercator projection respectively.

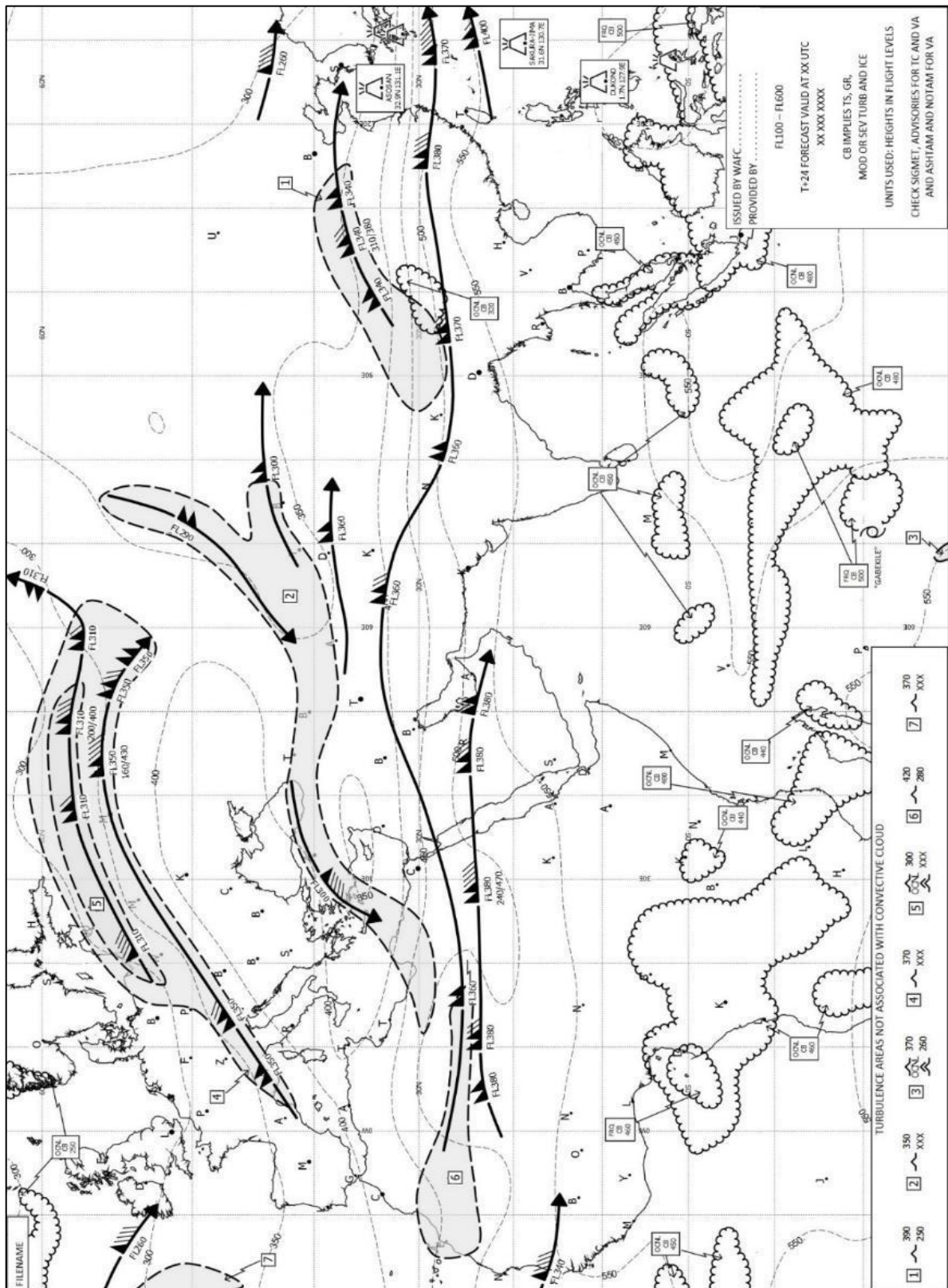
WAFS SIGNIFICANT WEATHER CHARTS (HIGH LEVEL)

MODEL SWH

Example. Polar stereographic projection ~~(showing the jet stream vertical extent)~~



Example. Mercator projection



APPENDIX E – SIGWX chart legend format

<p>ISSUED BY WAFC XXXX PROVIDED BY XXXX</p> <p>FIXED TIME PROGNOSTIC CHART ICAO AREA X SIGWX FL100-FL600</p> <p>T+XX FORECAST VALID AT <HH> UTC ON <DD> <MMM> <YYYY></p> <p>CB IMPLIES TS, GR MOD OR SEV TURB AND ICE</p> <p>UNITS USED: HEIGHTS IN FLIGHT LEVELS CHECK SIGMET, ADVISORIES FOR TC AND VA, AND ASHTAM AND NOTAM FOR VA</p> <p><ADDITIONAL STATEMENT></p>

The “Additional Statement” would be shown if appropriate and would read:

TC INFORMATION IS NOT PROVIDED FOR THIS VALIDITY TIME
VA PROCESSING ERROR
TC PROCESSING ERROR
or
TC POSITION FOR 3-HOURS EARLIER IS SHOWN

APPENDIX F – Amendment 80 changes

- New text is shaded in grey.
- Deleted text is shown with red ~~strikeout~~
- Areas needing further consideration, based on discussions at MOG/12, to be addressed by ad hoc group are in a yellow highlight

CHAPTER 3. GLOBAL SYSTEMS, SUPPORTING CENTRES AND METEOROLOGICAL OFFICES

...

3.2 World Area forecast centres

...

3.2.1 A Contracting State, having accepted the responsibility for providing a world area forecast centre (WAFC) within the framework of the WAFS, shall arrange for that centre:

a) to prepare gridded global forecasts of:

- 1) upper wind;
- 2) upper-air temperature and humidity;
- 3) geopotential altitude of flight levels;
- 4) flight level and temperature of tropopause;
- 5) direction, speed and flight level of maximum wind;
- 6) cumulonimbus clouds;
- 7) icing; and
- 8) turbulence;

b) to prepare global forecasts of significant weather (SIGWX) phenomena;

c) to issue the forecasts referred to in a) and b) in digital form to meteorological authorities and other users, as approved by the Contracting State on advice from the meteorological authority;

d) to receive information concerning the release of radioactive materials into the atmosphere from its associated World Meteorological Organization (WMO) regional specialized meteorological centre (RSMC) for the provision of transport model products for radiological environmental emergency response, in order to include the information in SIGWX forecasts; and

e) to receive information on volcanic activity from ~~establish and maintain contact with~~ volcanic ash advisory centres (VAACs) for the ~~exchange of information on volcanic activity in order to coordinate the~~ inclusion of information on volcanic eruptions in SIGWX forecasts.

3.2.2 In case of interruption of the operation of a WAFC, its functions shall be carried out by the other WAFC.

Note.—Back up procedures to be used in case of interruption of the operation of a WAFC are updated by the Meteorology Panel (METP) as necessary; the latest revision can be found on the ICAO METP website

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CHAPTER 9. SERVICE FOR OPERATORS AND FLIGHT CREW MEMBERS

...

9.1 General provisions

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9.1.6 ~~Charts~~ Visualizations generated from the digital forecasts provided by the WAFCs shall be made available, as required by operators, ~~for fixed areas of coverage as shown in Appendix 8, Figures A8-1, A8-2 and A8-3~~ for the valid times and coverage area applicable to the route of the flight.

9.1.7 When forecasts of upper wind and upper-air temperature listed under 9.1.3 a) 1) are supplied in chart form, they shall be fixed time prognostic charts for flight levels as specified in Appendix 2, ~~Table A2-3 or Table A2-4~~ 1.2.2 a). When forecasts of SIGWX phenomena listed under 9.1.3 a) 6) are supplied in ~~chart~~ visualized form, they shall be fixed time prognostic charts for an atmospheric layer limited by flight levels as specified in Appendix 2, ~~1.3.2~~ 1.3.1.4 and Appendix 5, 4.3.2.

9.1.8 The forecasts of upper wind and upper-air temperature and of SIGWX phenomena ~~above flight level 100 requested~~ for pre-flight planning and in-flight replanning by the operator shall be ~~made available~~ supplied as soon as technically feasible ~~they become available, but not later than 3 hours before departure~~. Other meteorological information requested for pre-flight planning and in-flight replanning by the operator shall be supplied as soon as is practicable.

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CHAPTER 11. REQUIREMENTS FOR AND USE OF COMMUNICATIONS

11.3 Use of aeronautical fixed service communications — world area forecast system products

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Recommendation.— World area forecast system products ~~in digital form~~ should be transmitted using ~~binary~~ digital data communications techniques. The method and channels used for the dissemination of the products should be as determined by regional air navigation agreement.

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APPENDIX 1. FLIGHT DOCUMENTATION — MODEL CHARTS AND FORMS

...

MODEL SWH - WAFS Significant weather chart (high level)
Example. Polar stereographic projection (showing the jet stream vertical extent)

~~MODEL SWM — Significant weather chart (medium level)~~

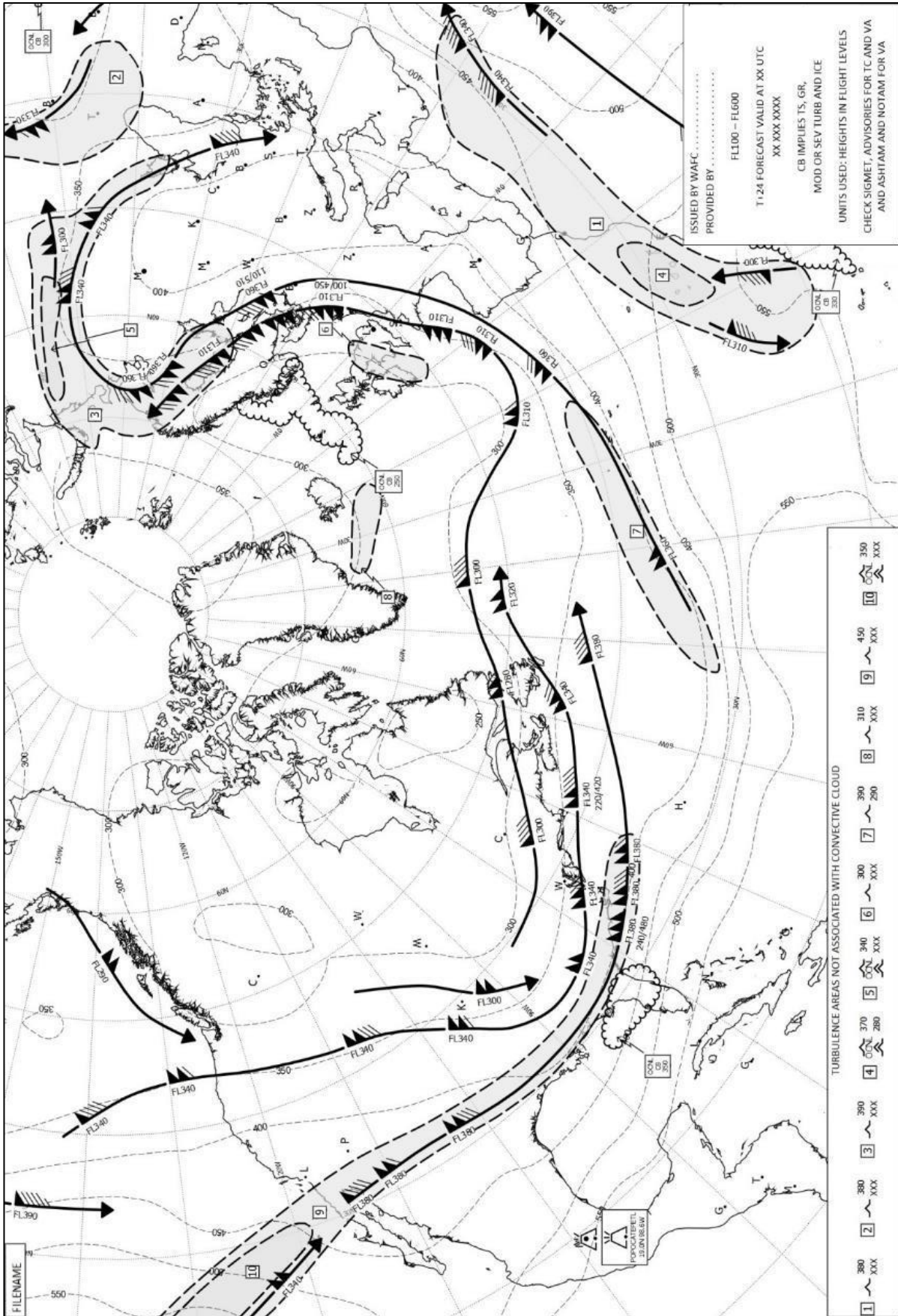
...

Replace the existing MODEL SWH and MODEL SWM examples in toto by the following new MODEL SWH examples, in polar stereographic projection and Mercator projection respectively.

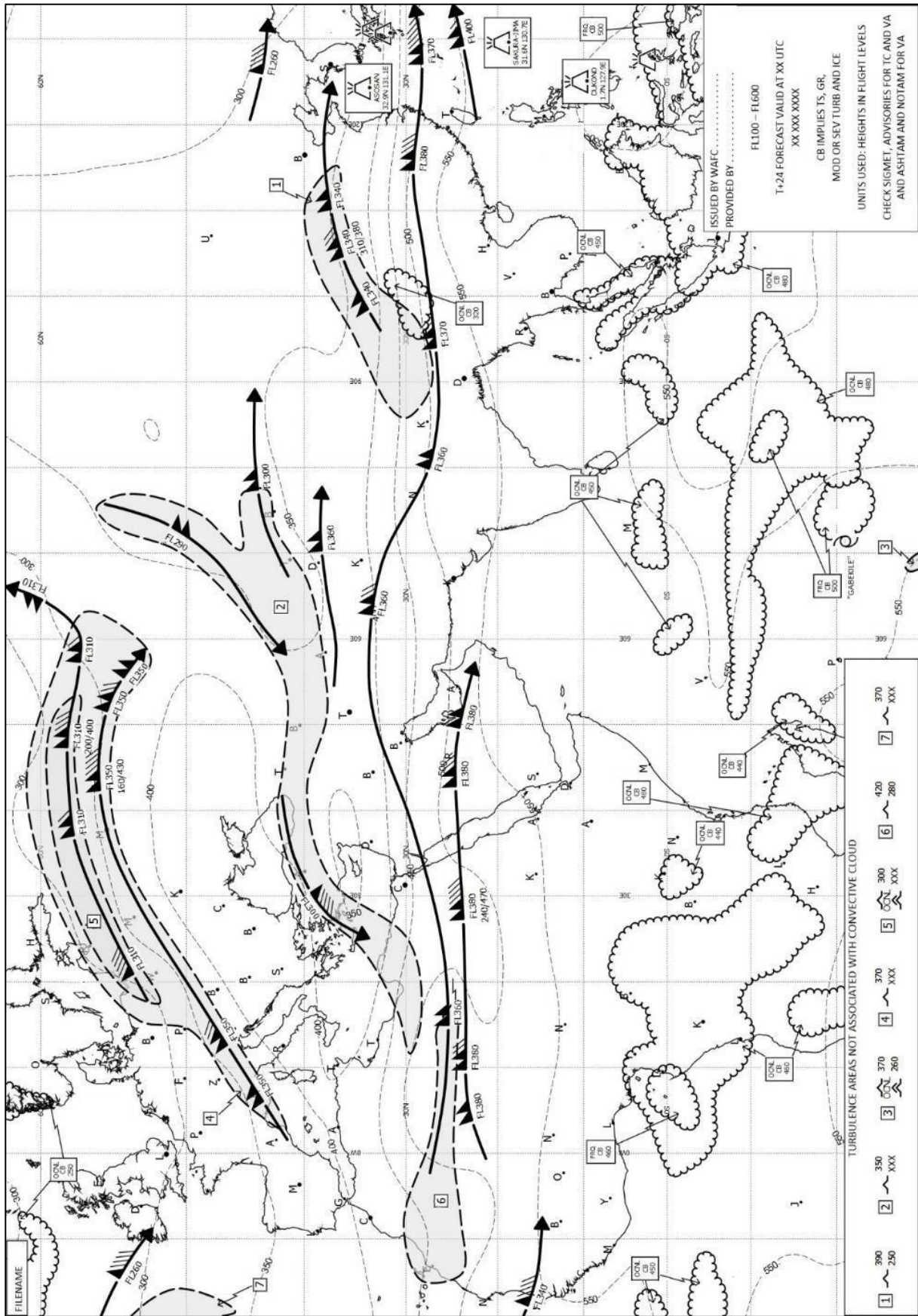
WAFS SIGNIFICANT WEATHER CHART (HIGH LEVEL)

MODEL SWH

Example. Polar stereographic projection (showing the jet stream-vertical extent)



Example. Mercator projection



Update the following sections in the existing MODEL SN as shown below.

MODEL SN

...

2. FRONTS AND CONVERGENCE ZONES AND OTHER SYMBOLS USED

	Cold front at the surface		Position, speed and level of maximum wind
	Warm front at the surface		Convergence line
	Occluded front at the surface		Freezing level
	Quasi-stationary front at the surface		Intertropical convergence zone
	Tropopause high		State of the sea
	Tropopause low		Sea-surface temperature
	Tropopause level		Widespread strong surface wind*
	Tropopause level contour		
<p>Wind arrows indicate the maximum wind in jet and the flight level at which it occurs. If the maximum wind speed is 60 m/s (120 kt) or more, the flight levels between which winds are greater than 40 m/s (80 kt) is placed below the maximum wind level. In the example, winds are greater than 40 m/s (80 kt) between FL 220 and FL 400.</p> <p>The heavy line delineating the jet axis begins/ends at the points where a wind speed of 40 m/s (80 kt) is forecast.</p> <p>++ Symbol used whenever the height of the jet axis changes by +/-3000 ft or the speed changes by +/-20 kt</p> <p>* This symbol refers to widespread surface wind speeds exceeding 15 m/s (30 kt).</p>			

...

3.3 Heights

Heights are indicated on SWH ~~and SWM~~ WAFS significant weather charts in flight levels (FL), top over base. When XXX is used, tops or bases are outside the layer of the atmosphere to which the chart applies. The height of the cloud base of cumulonimbus clouds are not shown on WAFS significant weather charts.

In SWL charts:

- Heights are indicated as altitudes above mean sea level;
- The abbreviation SFC is used to indicate ground level

4. DEPICTING OF LINES AND SYSTEMS ON SPECIFIC CHARTS

4.1 Models SWH ~~and SWM~~ – WAFS S significant weather charts (high and medium)

Scalloped line = demarcation of areas of cumulonimbus cloud significant

weather

- Heavy broken line = delineation of area of **CAT** moderate or severe turbulence not associated with convective cloud
- Heavy solid line interrupted by wind arrow and flight level = position of jet stream axis with indication of wind direction, speed in kt or m/s and height in flight levels. The vertical extent of the jet stream is indicated (in flight levels), e.g. FL 270 accompanied by 240/290 indicates that the jet extends from FL 240 to FL 290.
- ~~Flight levels inside small rectangles = height in flight levels of tropopause at spot locations, e.g. 340. Low and high points of the tropopause topography are indicated by the letters L or H, respectively, inside a pentagon with the height in flight levels. Display explicit FL for jet depths and tropopause height even if outside forecast bounds.~~
- Dashed line interrupted by a three-digit number = tropopause level contour where the number represents the flight level of the tropopause

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APPENDIX 2. TECHNICAL SPECIFICATIONS RELATED TO WORLD AREA FORECAST SYSTEM AND METEOROLOGICAL OFFICES

1. WORLD AREA FORECAST SYSTEM

...

1.2 Upper-air gridded forecasts

1.2.1 The forecasts of upper winds; upper-air temperature; and humidity; direction, speed and flight level of maximum wind; flight level and temperature of tropopause, areas of cumulonimbus clouds, icing, turbulence, and geopotential altitude of flight levels shall be prepared four times a day by a WAFC and shall be valid for fixed valid times in accordance with Table A2-1 and Table A2-2 ~~at 6, 9, 12, 15, 18, 21, 24, 27, 30, 33 and 36 hours~~ after the time (0000, 0600, 1200 and 1800 UTC) of the synoptic data on which the forecasts were based. Each forecast shall be ~~disseminated~~ made available as soon as technically feasible but not later than 5 hours after standard time of observation for the forecasts with a validity up to 36 hours.

Table A2-1. Fixed valid times for WAFS upper-air gridded forecasts with 0.25 degree horizontal resolution

Upper-air grid point forecasts	1-hourly intervals	3-hourly intervals	6-hourly intervals
Wind, temperature, geopotential altitude	6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24 hours	27, 30, 33, 36, 39, 42, 45 and 48 hours	54, 60, 66, 72, 78, 84, 90, 96, 102, 108, 114 and 120 hours
Flight level and temperature of tropopause			
Direction, speed and flight level of maximum wind			
Humidity			
Horizontal extent and flight levels of base and top of cumulonimbus clouds	6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24 hours	27, 30, 33, 36, 39, 42, 45 and 48 hours	Not provided
Icing	22, 23 and 24 hours		
Turbulence			

Table A2-2. Fixed valid times for WAFS upper-air gridded forecasts with 1.25 degree horizontal resolution

Upper-air grid point forecasts	3-hourly intervals
Wind, temperature, geopotential altitude	6, 9, 12, 15, 18, 24, 27, 30, 33 and 36 hours
Flight level and temperature of tropopause	
Direction, speed and flight level of maximum wind	
Humidity	

1.2.2 The grid point forecasts for the following parameters prepared by a WAFS shall comprise:

- a) wind and temperature data for flight levels ~~50 (850 hPa), 80 (750 hPa), 100 (700 hPa), 140 (600 hPa), 180 (500 hPa), 210 (450 hPa), 240 (400 hPa), 270 (350 hPa), 300 (300 hPa), 320 (275 hPa), 340 (250 hPa), 360 (225 hPa), 390 (200 hPa), 410 (175 hPa), 450 (150 hPa), 480 (125 hPa) and 530 (100 hPa)~~;
- b) flight level and temperature of tropopause;
- c) direction, speed and flight level of maximum wind;
- d) humidity data for flight levels ~~50 (850 hPa), 80 (750 hPa), 100 (700 hPa), 140 (600 hPa) and 180 (500 hPa)~~;
- e) horizontal extent and flight levels of base and top of cumulonimbus clouds;
- f) icing for layers centred at flight levels ~~60 (800 hPa), 100 (700 hPa), 140 (600 hPa), 180 (500 hPa), 240 (400 hPa) and 300 (300 hPa)~~;

Note.—Layers centred at a flight level referred to in f) have a depth of 100 hPa.

- g) turbulence for layers centred at flight levels ~~100 (700 hPa), 140 (600 hPa), 180 (500 hPa), 240 (400 hPa), 270 (350 hPa), 300 (300 hPa), 340 (250 hPa), 390 (200 hPa) and 450 (150 hPa)~~; and

Note 2.—Layers centred at a flight level referred to in g) have a depth of 100 hPa for flight levels below 240, then 50 hPa for flight levels 240 and above.

- h) geopotential altitude data for flight levels ~~50 (850 hPa), 80 (750 hPa), 100 (700 hPa), 140 (600 hPa), 180 (500 hPa), 210 (450 hPa), 240 (400 hPa), 270 (350 hPa), 300 (300 hPa), 320 (275 hPa), 340 (250 hPa), 360 (225 hPa), 390 (200 hPa), 410 (175 hPa), 450 (150 hPa), 480 (125 hPa) and 530 (100 hPa)~~.

Note.—The exact pressure levels (hPa) for a), d), f), g), and h) is provided in the Manual of Aeronautical Meteorological Practice (Doc 8896).

Note.— The details for the flight levels for a), d), f), g), and h) are provided in Table A2-3 and A2-4.

Table A2-3: Upper-air grid point forecasts with 0.25 degree horizontal resolution for the following flight levels.

Flight Level	Geopotential Altitude (FT)	ICAO Standard Atmosphere pressure level (hPa)	Wind	Temperature	Turbulence	Icing	Humidity
FL050	5000	843.1	X	X		X	X
FL060	6000	812.0	X	X		X	X
FL070	7000	781.9	X	X		X	X
FL080	8000	752.6	X	X		X	X
FL090	9000	724.3	X	X		X	X
FL100	10000	696.8	X	X	X	X	X
FL110	11000	670.2	X	X	X	X	X
FL120	12000	644.4	X	X	X	X	X
FL130	13000	619.4	X	X	X	X	X
FL140	14000	595.2	X	X	X	X	X
FL150	15000	571.8	X	X	X	X	X
FL160	16000	549.2	X	X	X	X	X
FL170	17000	527.2	X	X	X	X	X
FL180	18000	506.0	X	X	X	X	X
FL190	19000	485.5	X	X	X	X	
FL200	20000	465.6	X	X	X	X	
FL210	21000	446.5	X	X	X	X	
FL220	22000	427.9	X	X	X	X	
FL230	23000	410.0	X	X	X	X	
FL240	24000	392.7	X	X	X	X	
FL250	25000	376.0	X	X	X	X	
FL260	26000	359.9	X	X	X	X	
FL270	27000	344.3	X	X	X	X	
FL280	28000	329.3	X	X	X	X	
FL290	29000	314.9	X	X	X	X	
FL300	30000	300.9	X	X	X	X	
FL310	31000	287.4	X	X	X		
FL320	32000	274.5	X	X	X		
FL330	33000	262.0	X	X	X		
FL340	34000	250.0	X	X	X		
FL350	35000	238.4	X	X	X		
FL360	36000	227.3	X	X	X		
FL370	37000	216.6	X	X	X		
FL380	38000	206.5	X	X	X		
FL390	39000	196.8	X	X	X		
FL400	40000	187.5	X	X	X		

FL410	41000	178.7	X	X	X		
FL420	42000	170.4	X	X	X		
FL430	43000	162.4	X	X	X		
FL440	44000	154.7	X	X	X		
FL450	45000	147.5	X	X	X		
FL460	46000	140.6	X	X			
FL470	47000	134.0	X	X			
FL480	48000	127.7	X	X			
FL490	49000	121.7	X	X			
FL500	50000	116.0	X	X			
FL510	51000	110.5	X	X			
FL520	52000	105.3	X	X			
FL530	53000	100.4	X	X			
FL540	54000	95.7	X	X			
FL550	55000	91.2	X	X			
FL560	56000	87.0	X	X			
FL570	57000	82.8	X	X			
FL580	58000	79.0	X	X			
FL590	59000	75.2	X	X			
FL600	60000	71.7	X	X			

Table A2-4: Upper-air grid point forecasts with 1.25 degree horizontal resolution for the following flight levels.

Flight Level	Geopotential Altitude (FT)	ICAO Standard Atmosphere pressure level (hPa)	Wind	Temperature	Humidity
FL050	5000	843.1	X	X	X
FL080	8000	752.6	X	X	X
FL100	10000	696.8	X	X	X
FL140	14000	595.2	X	X	X
FL180	18000	506.0	X	X	X
FL210	21000	446.5	X	X	
FL240	24000	392.7	X	X	
FL270	27000	344.3	X	X	
FL300	30000	300.9	X	X	
FL320	32000	274.5	X	X	
FL340	34000	250.0	X	X	
FL360	36000	227.3	X	X	
FL390	39000	196.8	X	X	
FL410	41000	178.7	X	X	
FL450	45000	147.5	X	X	
FL480	48000	127.7	X	X	
FL530	53000	100.4	X	X	

1.2.3 The foregoing grid point forecasts shall be issued by a WAFC in an appropriate gridded binary code form using the GRIB code form prescribed by the World Meteorological Organization (WMO).

Note.—The GRIB code form is contained in the Manual on Codes (WMO No. 306), Volume I.2, Part B—Binary Codes.

1.2.4 The foregoing grid point forecasts a), b), c), d) and h) in Table A2-4, shall be prepared by a WAFC in a regular grid with a horizontal resolution of 1.25° of latitude and longitude.

1.2.5 The foregoing grid point forecasts, e), f) and g) in Table A2-3, shall be prepared by a WAFC in a regular grid with a horizontal resolution of 0.25° of latitude and longitude.

1.3 Significant weather (SIGWX) forecasts

1.3.1 General provisions

1.3.1.1 Forecasts of significant en-route weather phenomena shall be prepared as SIGWX forecasts four times a day by a WAFC and shall be valid for fixed valid times, as detailed in Table A2-5, at 24 hours after the time (0000, 0600, 1200 and 1800 UTC) of the synoptic data on which the forecasts were based. Each forecast shall be disseminated made available as soon as technically feasible but not later than 7 hours after standard time of observation under normal operations and not later than 9 hours after standard time of observation during backup operations.

~~1.3.1.2 SIGWX forecasts shall be issued in binary code form using the BUFR code form prescribed by WMO.~~

~~*Note.—The BUFR code form is contained in the Manual on Codes (WMO No. 306), Volume I.2, Part B—Binary Codes.*~~

~~1.3.1.3 **Recommendation.**—As of 4 November 2021, in addition to 1.3.1.2, SIGWX forecasts should be disseminated in IWXXM GML form.~~

1.3.1.2 SIGWX forecasts shall be made available in IWXXM form as detailed in Table A2-5.

Table A2-5: SIGWX forecast fixed valid times

Time	SIGWX forecast fixed valid times	
	IWXXM form	PNG form
T+6 hours	X	
T+9	X	
T+12	X	
T+15	X	
T+18	X	
T+21	X	
T+24	X	X
T+27	X	
T+30	X	
T+33	X	
T+36	X	
T+39	X	
T+42	X	
T+45	X	
T+48	X	

Note. 1.—Guidance on the implementation of IWXXM is provided in the Manual on the ICAO Meteorological Information Exchange Model (IWXXM) (Doc 10003).

Note 2. — Geography markup language (GML) is an encoding standard of the Open Geospatial Consortium (OGC).

1.3.1.3 **Recommendation.**— SIGWX forecasts should be made available PNG form in accordance with Table A2-5.

1.3.1.4 SIGWX forecasts shall be issued for flight levels between 100 and 600.

1.3.2 Types of SIGWX forecasts

~~SIGWX forecasts shall be issued as high-level SIGWX forecasts for flight levels between 250 and 630.~~

~~Note.— Medium level SIGWX forecasts for flight levels between 100 and 250 for limited geographical areas will continue to be issued until such time that flight documentation to be generated from the gridded forecasts of cumulonimbus clouds, icing and turbulence fully meets user requirements~~

1.3.3~~2~~ Items included in SIGWX forecasts

SIGWX forecasts shall include the following items:

- a) tropical cyclone provided that the maximum of the 10-minute mean surface wind speed is expected to reach or exceed 17 m/s (34 kt);
- ~~b) severe squall lines;~~
- b) moderate or severe turbulence (~~in cloud or clear air~~) not associated with convective cloud;
- ~~c~~d) moderate or severe icing;

Note.— Icing to be included in SIGWX in IWXXM form but not in SIGWX in PNG form.

- ~~d~~e) widespread sandstorm/duststorm;
- ~~e~~f) cumulonimbus clouds associated with thunderstorms ~~and with a) to e)~~;

~~Note.— Non convective cloud areas associated with in cloud moderate or severe turbulence and/or moderate or severe icing are to be included in the SIGWX forecasts.~~

- ~~f~~g) flight level of tropopause;
- ~~g~~h) jet streams;
- ~~h~~i) information on the location of volcanic eruptions that are producing ash clouds of significance to aircraft operations, comprising: volcanic eruption symbol at the location of the volcano and, in a separate text box on the chart, the volcanic eruption symbol, the name of the volcano (if known) and the latitude/longitude of the eruption. In addition, the legend of SIGWX charts should indicate “CHECK SIGMET, ADVISORIES FOR TC AND VA, AND ASHTAM AND NOTAM FOR VA”; and
- ~~i~~j) information on the location of a release of radioactive materials into the atmosphere of significance to aircraft operations, comprising: the radioactive materials in the atmosphere symbol at the location of the release and, in a separate text box on the chart, the radioactive materials in the atmosphere symbol, latitude/longitude of the site of the release, and (if known) the name of site of the radioactive source. In addition, the legend of SIGWX charts on which a release of radiation is indicated should contain “CHECK SIGMET AND NOTAM FOR RDOACT CLD”.

Note 1.—~~Medium-level SIGWX forecasts include all the items above.~~ Tropical cyclone information is included when provided by a tropical cyclone advisory centre.

Note 2.— Items to be included in low-level SIGWX forecasts (i.e. flight levels below 100) are included in Appendix 5.

1.3.43 Criteria for including items in SIGWX forecasts

The following criteria shall be applied for SIGWX forecasts:

- ~~a) items a) to d) in 1.3.3 shall only be included if expected to occur between the lower and upper levels of the SIGWX forecast;~~
- ~~a)~~ b) the abbreviation “CB” shall only be included when it refers to the occurrence or expected occurrence of cumulonimbus clouds:
 - ~~1) affecting an area with a maximum spatial coverage of 50 per cent or more of the area concerned;~~
 - ~~2) along a line with little or no space between individual clouds; or~~
 - ~~3) embedded in cloud layers or concealed by haze;~~
- b) the inclusion of “CB” shall be understood to include all weather phenomena normally associated with cumulonimbus clouds, i.e. thunderstorm, moderate or severe icing, moderate or severe turbulence and hail;
- ~~c)~~ d) where a volcanic eruption or a release of radioactive materials into the atmosphere warrants the inclusion of the volcanic eruption symbol or the radioactive materials in the atmosphere symbol in SIGWX forecasts, the symbols shall be included on SIGWX forecasts irrespective of the height to which the ash column or radioactive material is reported or expected to reach; and
- ~~d)~~ e) in the case of co-incident or the partial overlapping of items a), ~~h)~~ i) and ~~i)~~ j) in 1.3.3, the highest priority shall be given to item ~~h)~~ i), followed by items ~~i)~~ j) and a). The item with the highest priority shall be placed at the location of the event, and an arrow shall be used to link the location of the other item(s) to its associated symbol or text box.

~~1.3.1.3 Recommendation.— As of 4 November 2021, in addition to 1.3.1.2, SIGWX forecasts should be disseminated in IWXXM GML form.~~

~~Note 1.— Guidance on the implementation of IWXXM is provided in the Manual on the ICAO Meteorological Information Exchange Model (IWXXM) (Doc 10003).~~

~~Note 2.— Geography markup language (GML) is an encoding standard of the Open Geospatial Consortium (OGC).~~

2. AERODROME METEOROLOGICAL OFFICES

2.1 Use of world area forecast system (WAFS) products

...

2.1.2 In order to ensure uniformity and standardization of flight documentation, the WAFS digital ~~GRIB, and BUFR~~ data received and, as of 4 November 2021, IWXXM data received, shall be decoded into standard WAFS visualizations ~~charts~~ in accordance with relevant provisions in this Annex, and the meteorological content and identification of the originator of the WAFS forecasts shall not be amended.

2.2 Notification of WAFC concerning significant discrepancies

Aerodrome meteorological offices using WAFS SIGWX ~~BUFR or as of 4 November 2021, IWXXM~~ data shall notify the WAFC concerned ~~immediately~~ if significant discrepancies are detected ~~or reported in respect of WAFS SIGWX forecasts concerning~~ between the SIGWX forecast and conditions reported by aircraft.:

- ~~a) icing, turbulence, cumulonimbus clouds that are obscured, frequent, embedded or occurring at a squall line, and sandstorms/duststorms; and~~
- ~~b) volcanic eruptions or a release of radioactive materials into the atmosphere, of significance to aircraft operations.~~

~~The WAFC receiving the message shall acknowledge its receipt to the originator, together with a brief comment on the report and any action taken, using the same means of communication employed by the originator.~~

Note.— Guidance on reporting significant discrepancies is provided in the Manual of Aeronautical Meteorological Practice (Doc 8896).

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Table A2-12. Template for advisory message for volcanic ash

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Table A2-23. Template for advisory message for tropical cyclone

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, included whenever applicable;
= = a double line indicates that the text following it should be placed on the subsequent line.

Note 1.— The ranges and resolutions for the numerical elements included in advisory messages for tropical cyclones are shown in Appendix 6, Table A6-4.

Note 2.— The explanations for the abbreviations can be found in the PANS-ABC (Doc 8400).

Note 3.— Inclusion of a colon after each element heading is mandatory.

Note 4.— The numbers 1 to 21 are included only for clarity and are not part of the advisory message, as shown in the examples.

<i>Element</i>	<i>Detailed content</i>	<i>Template(s)</i>	<i>Examples</i>
1	Identification of the type of message (M)	Type of message	TC ADVISORY
2	Status indicator (C) ¹	Indicator of test or exercise	STATUS: TEST or EXER
3	Time of origin (M)	Year, month, day and time in UTC of issue	DTG: nnnnnnnn/nnnnZ
4	Name of TCAC (M)	Name of TCAC (location indicator or full name)	TCAC: nnnn or nnnnnnnnnn
5	Name of tropical cyclone (M)	Name of tropical cyclone or "NN" for unnamed tropical cyclone	TC: nnnnnnnnnnn or NN
6	Advisory number (M)	Year in full and message number (separate sequence for each cyclone)	ADVISORY NR: nnnn/[n][n][n]
7	Observed position of the centre (M)	Day and time in UTC and position of the centre of the tropical cyclone (in degrees and minutes)	OBS PSN: nn/nnnnZ Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]
8	Observed CB cloud ³ (C)	Location of CB cloud (referring to latitude and longitude (in degrees and minutes) and vertical extent (flight level)	CB: WI nnnKM (or nnnNM) OF TC CENTRE or WI ⁴ Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn] – [Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]] and TOP [ABV or BLW] FLnnn
9	Direction and speed of movement (M)	Direction and speed of movement given in sixteen compass points and km/h (or kt), respectively, or stationary (< 2 km/h (1 kt))	MOV: N nnKMH (or KT) or NNE nnKMH (or KT) or NE nnKMH (or KT) or ENE nnKMH (or KT) or E nnKMH (or KT) or ESE nnKMH (or KT) or SE nnKMH (or KT) or SSE nnKMH (or KT) or S nnKMH (or KT) or SSW nnKMH (or KT) or SW nnKMH (or KT) or WSW nnKMH (or KT) or W nnKMH (or KT) or WNW nnKMH (or KT) or NW nnKMH (or KT) or NNW nnKMH (or KT) or STNR
10	Changes in intensity (M)	Changes of maximum surface wind speed at time of observation	INTST CHANGE INTSF or WKN or NC
11	Central pressure (M)	Central pressure (in hPa)	C: nnnHPA
12	Maximum surface wind (M)	Maximum surface wind near the centre (mean over 10 minutes, in m/s (or kt))	MAX WIND: nn[n]MPS (or nn[n]KT)
13	Forecast of centre position (+6 HR) ⁵ (M)	Day and time (in UTC) (6 hours from the "DTG" given in Item 3); Forecast position (in degrees and minutes) of the centre of the tropical cyclone	FCST PSN +6 nn/nnnnZ HR: Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]
14	Forecast of maximum surface wind (+6 HR) ⁵ (M)	Forecast of maximum surface wind (6 hours after the "DTG" given in Item 3)	FCST MAX nn[n]MPS (or nn[n]KT) WIND +6 HR: 22MPS

15	Forecast of centre position (+12 HR) ⁵ (M)	Day and time (in UTC) (12 hours from the "DTG" given in Item 3); Forecast position (in degrees and minutes) of the centre of the tropical cyclone	FCST PSN +12 HR: nn/nnnnZ Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]	FCST PSN +12 HR: 26/0400Z N2830 W07430
16	Forecast of maximum surface wind (+12 HR) ⁵ (M)	Forecast of maximum surface wind (12 hours after the "DTG" given in Item 3)	FCST MAX WIND +12 HR: MAX nn[n]MPS (or nn[n]KT)	FCST MAX WIND +12 HR: 22MPS
17	Forecast of centre position (+18 HR) ⁵ (M)	Day and time (in UTC) (18 hours from the "DTG" given in Item 3); Forecast position (in degrees and minutes) of the centre of the tropical cyclone	FCST PSN +18 HR: nn/nnnnZ Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]	FCST PSN +18 HR: 26/0600Z N2852 W07500
18	Forecast of maximum surface wind (+18 HR) ⁵ (M)	Forecast of maximum surface wind (18 hours after the "DTG" given in Item 3)	FCST MAX WIND +18 HR: MAX nn[n]MPS (or nn[n]KT)	FCST MAX WIND +18 HR: 21MPS
19	Forecast of centre position (+24 HR) ⁵ (M)	Day and time (in UTC) (24 hours from the "DTG" given in Item 3); Forecast position (in degrees and minutes) of the centre of the tropical cyclone	FCST PSN +24 HR: nn/nnnnZ Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]	FCST PSN +24 HR: 26/1200Z N2912 W07530
20	Forecast of maximum surface wind (+24 HR) ⁵ (M)	Forecast of maximum surface wind (24 hours after the "DTG" given in Item 3)	FCST MAX WIND +24 HR: MAX nn[n]MPS (or nn[n]KT)	FCST MAX WIND +24 HR: 20MPS
21	Remarks (M)	Remarks, as necessary	RMK: Free text up to 256 characters or NIL	RMK: NIL
22	Expected time of issuance of next advisory (M)	Expected year, month, day and time (in UTC) of issuance of next advisory	NXT MSG: [BFR] nnnnnnn/nnnnZ or NO MSG EXP	NXT MSG: 20040925/2000Z

Notes.—

1. Used only when the message issued to indicate that a test or an exercise is taking place. When the word "TEST" or the abbreviation "EXER" is included, the message may contain information that should not be used operationally or will otherwise end immediately after the word "TEST". [Applicable 7 November 2019]
2. Fictitious location.
3. In the case of CB clouds associated with a tropical cyclone covering more than one area within the area of responsibility, this element can be repeated, as necessary.
4. The number of coordinates should be kept to a minimum and should not normally exceed seven.
5. When practical, forecast times are at main synoptic hours, i.e., 00, 06, 12 and 18 UTC. When the time of origin is not at one of the main synoptic hours, the forecast times are to the nearest main synoptic hour.

Example A2-2. Advisory message for tropical cyclones

TC ADVISORY	
DTG:	20040925/ 1900 1200Z
TCAC:	YUFO*
TC:	GLORIA
ADVISORY NR:	2004/13
OBS PSN:	25/ 1800 1130Z N2706 W07306
CB:	WI 250NM OF TC CENTRE TOP FL500
MOV:	NW 20KMH
C:	965HPA
MAX WIND:	22MPS
FCST PSN + 6 HR:	25/ 2200 1800Z N2748 W07350
FCST MAX WIND + 6 HR:	22MPS
FCST PSN + 12 HR:	26/ 0400 0000Z N2830 W07430
FCST MAX WIND + 12 HR:	22MPS
FCST PSN + 18 HR:	26/ 1000 0600Z N2852 W07500
FCST MAX WIND + 18 HR:	21MPS
FCST PSN + 24 HR:	26/ 1600 1200Z N2912 W07530
FCST MAX WIND + 24 HR:	20MPS
RMK:	NIL
NXT MSG:	20040925/ 2000 1800Z

*Fictitious location

APPENDIX 8. TECHNICAL SPECIFICATIONS RELATED TO SERVICE FOR OPERATORS AND FLIGHT CREW MEMBERS

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2. SPECIFICATIONS RELATED TO INFORMATION FOR PRE-FLIGHT PLANNING AND IN-FLIGHT REPLANNING

...

2.2 Format of information on significant weather

~~2.2.1~~ Information on significant weather supplied by WAFCs for pre-flight planning and in-flight replanning shall be in the **BUFR** **IWXXM GML** code form.

~~Note.—The BUFR code form is contained in the Manual on Codes (WMO No. 306), Volume I.2, Part B—Binary Codes.~~

~~2.2.2 Recommendation.—As of 4 November 2021, in addition to 2.2.1, information on significant weather supplied by WAFCs for pre-flight and in-flight replanning should be in the **IWXXM GML** form.~~

Note. 1.— Guidance on the implementation IWXXM is provided in the Manual on the ICAO Meteorological Information Exchange Model (IWXXM) (Doc 10003).

Note 2. — Geography markup language (GML) is an encoding standard of the Open Geospatial Consortium (OGC).

...

4 SPECIFICATIONS RELATED TO FLIGHT DOCUMENTATION

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4.2 Charts in flight documentation

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4.2.2. Set of charts to be provided

4.2.2.1 The **minimum** number of **charts** visualised SIGWX, wind and temperature forecasts ~~for flights between flight level 250 and flight level 630 shall include a high level SIGWX chart (flight level 250 to flight level 630) and a forecast 250 hPa wind and temperature chart. The actual charts~~ provided for pre-flight and in-flight planning and for flight documentation shall be as agreed between meteorological authorities and users concerned.

Note. — Fixed area chart areas are shown Appendix 8, Figures A8-1, A8-2 and A8-3

4.2.2.2 Charts to be provided shall be generated from the digital forecasts provided by the WAFCs whenever these forecasts cover the intended flight path in respect of time, altitude and geographical extent, unless otherwise agreed between the meteorological authority and the operator concerned.

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Replace the figures A8-1, A8-2 and A8-3 in toto by the following new images.

...

Figure A8-1 - Fixed areas of coverage of WAFS forecasts valid for 24 hours in chart form — Mercator projection

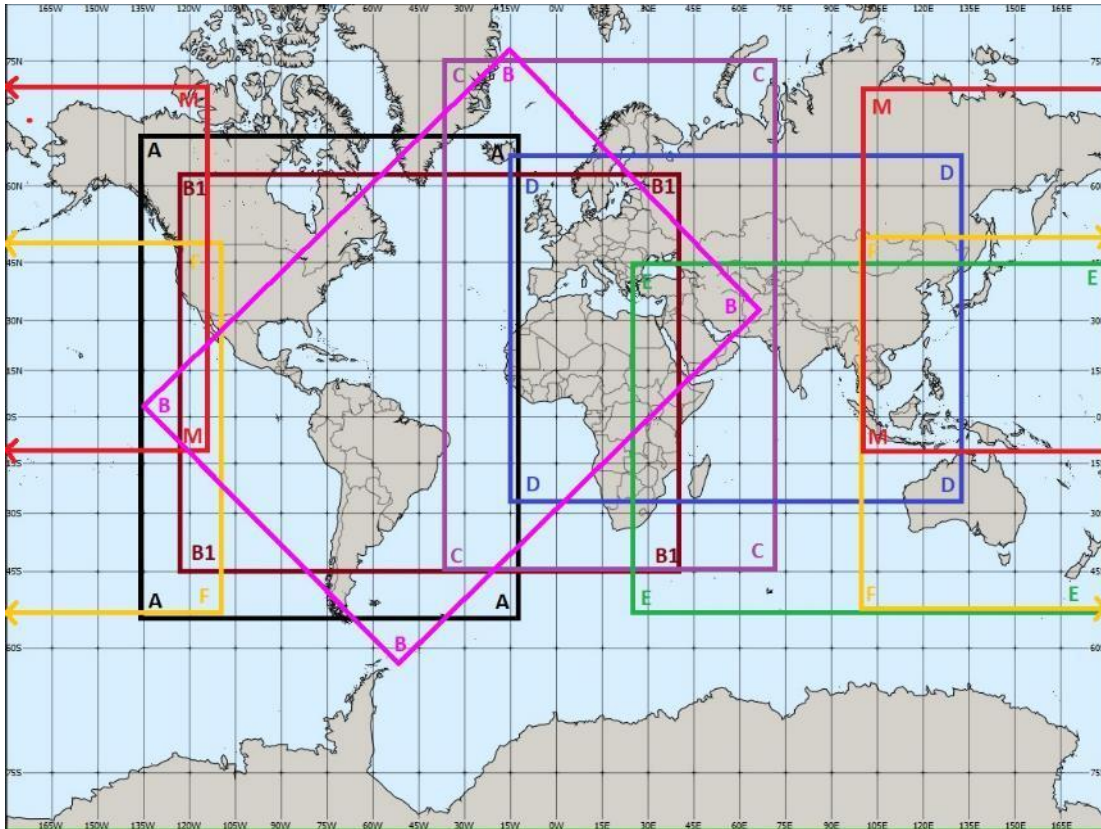


CHART	LATITUDE	LONGITUDE	CHART	LATITUDE	LONGITUDE
A	N6700	W13724	D	N6300	W01500
A	N6700	W01236	D	N6300	E13200
A	S5400	W01236	D	S2700	E13200
A	S5400	W13724	D	S2700	W01500
ASIA	N3600	E05300	E	N4455	E02446
ASIA	N3600	E10800	E	N4455	E18000
ASIA	0000	E10800	E	S5355	E18000
ASIA	0000	E05300	E	S5355	E02446
B	N0304	W13557	F	N5000	E10000
B	N7644	W01545	F	N5000	W11000
B	N3707	E06732	F	S5242	W11000
B	S6217	W05240	F	S5242	E10000
B1	N6242	W12500	M	N7000	E10000
B1	N6242	E04000	M	N7000	W11000
B1	S4530	E04000	M	S1000	W11000
B1	S4530	W12500	M	S1000	E10000
C	N7500	W03500	MID	N4400	E01700
C	N7500	E07000	MID	N4400	E07000

C	S4500	E07000	MID	N1000	E07000
C	S4500	W03500	MID	N1000	E01700

Figure A8-2 - Fixed areas of coverage of WAFS forecasts valid for 24 hours in chart form — Polar stereographic projection (northern hemisphere)

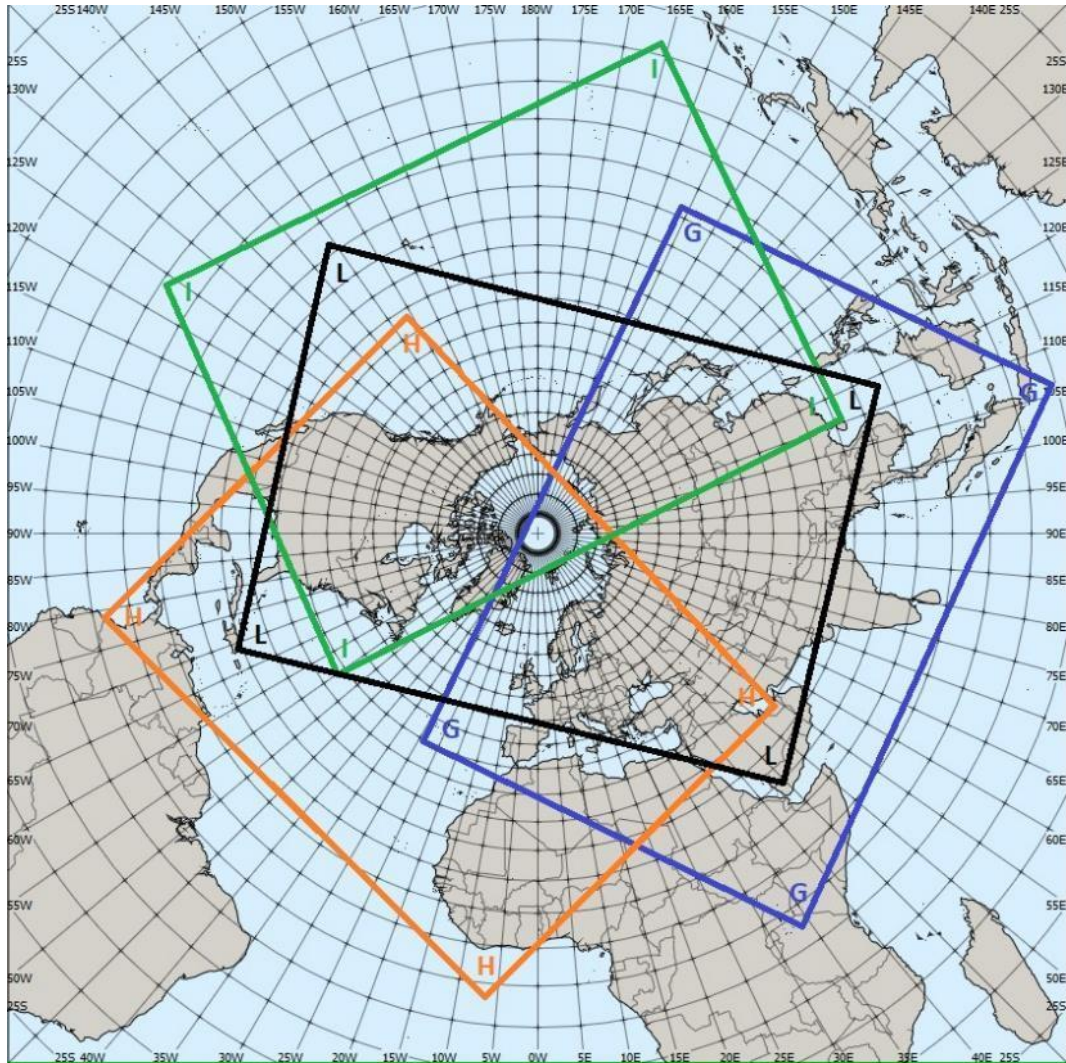


CHART	LATITUDE	LONGITUDE	CHART	LATITUDE	LONGITUDE
EUR	N4633	W05634	I	N1912	E11130
EUR	N5842	E06824	I	N3330	W06012
EUR	N2621	E03325	I	N0126	W12327
EUR	N2123	W02136	I	S0647	E16601
G	N3552	W02822	L	N1205	E11449
G	N1341	E15711	L	N1518	E04500
G	S0916	E10651	L	N2020	W06900
G	S0048	E03447	L	N1413	W14338
H	N3127	W14836	NAT	N4439	W10143
H	N2411	E05645	NAT	N5042	E06017
H	S0127	W00651	NAT	N1938	E00957
H	N0133	W07902	NAT	N1711	W05406

Figure A8-3 - Fixed areas of coverage of WAFS forecasts valid for 24 hours in chart form — Polar stereographic projection (southern hemisphere)

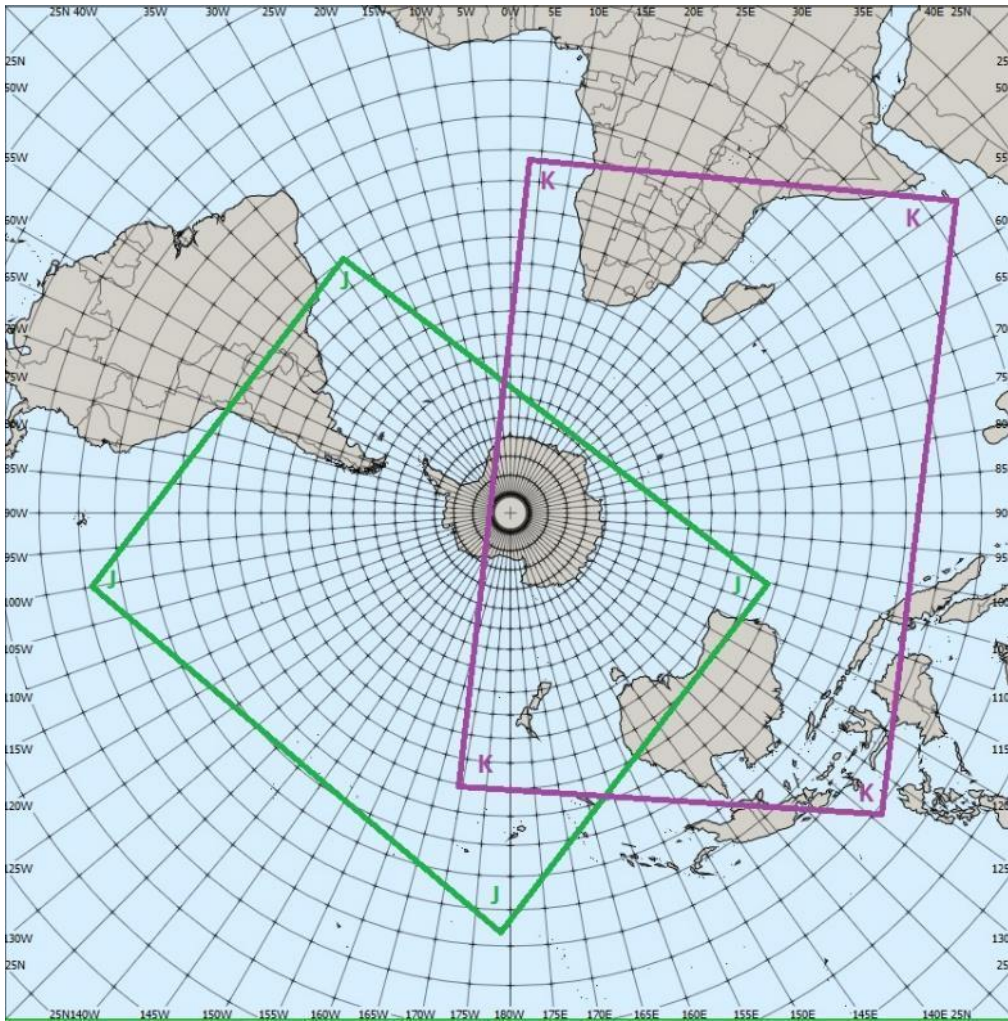


CHART	LATITUDE	LONGITUDE
J	S0318	W17812
J	N0037	W10032
J	S2000	W03400
J	S2806	E10717
K	N1255	E05549
K	N0642	E12905
K	S2744	W16841
K	S1105	E00317

APPENDIX G – Doc 8896 changes related to Annex 3 Amendment 79 (Nov 2020)

- New text is shaded in grey.
- Deleted text is shown with red ~~strikeout~~

Chapter 1. METEOROLOGICAL SERVICE FOR INTERNATIONAL AIR NAVIGATION

...

1.5 WORLD AREA FORECAST CENTRES (WAFCS)

The two WAFCS (ANP, Volume I, Part V) are components of the world area forecast system (WAFS), which is designed to supply aerodrome meteorological offices, meteorological authorities and other users with forecasts of global upper winds, upper-air temperatures, tropopause heights and temperatures, maximum winds, humidity, cumulonimbus clouds, icing, and ~~in-cloud and clear air~~ turbulence in the GRIB code form for direct input into meteorological and/or flight planning computers. The WAFS also supplies global forecasts of significant weather in the BUFR code form.

Note.— Further information on the WAFS is given in Appendix 1.

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Chapter 3. FORECASTS

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3.7.2 WAFS upper-air forecasts

3.7.2.1 Upper-air forecasts are received from WAFCS in gridded form and supplied to users in gridded or chart form. Wind and temperature data selected from the global forecasts should be depicted on the upper wind and upper-air temperature charts in a sufficiently dense latitude/longitude grid. On the charts, the wind direction is shown by arrows with a number of feathers or shaded pennants to indicate the wind speed, and temperatures are given in degrees Celsius as thus:



Note.— Negative temperatures are indicated without sign, but positive temperatures are shown with a preceding “+” sign.

Wind and temperature information is given for points on a grid sufficiently dense to provide meaningful information. On computer-drawn charts, wind arrows normally take precedence over temperatures, and temperatures take precedence over the chart background.

Note.— Examples of forecast charts of upper wind and upper-air temperatures are included in Annex 3, Appendix 1.

3.7.2.2 The forecasts of:

- a) upper wind;
- b) upper-air temperature;
- c) flight level and temperature of tropopause;
- d) direction, speed and flight level of maximum wind;
- e) geopotential altitude of flight levels; and
- f) upper-air humidity

prepared in binary code form at a horizontal resolution of 1.25° of latitude and longitude. The forecasts are produced four times daily by WAFCs and are valid for 6, 9, 12, 15, 18, 21, 24, 27, 30, 33 and 36 hours after the time (0000, 0600, 1200 and 1800 UTC) of the synoptic data on which they are based. The forecasts should be available for the transmission from WAFCs to users no later than ~~six~~ five hours after the respective standard time of observation. The upper wind and upper-air temperature forecasts are prepared for the following flight levels (which correspond to the fixed pressure levels indicated in brackets):

Flight Level	Geopotential altitude (ft)	ICAO Standard atmospheric pressure level (hPa)	Pressure levels (hPa) referenced in Annex 3, Appendix 2
FL 50	5 000	843.1	850
FL 60	6 000	812.0	800
FL 80	8 000	752.6	750
FL 100	10 000	696.8	700
FL 140	14 000	595.2	600
FL 180	18 000	506.0	500
FL 210	21 000	446.5	450
FL 240	24 000	392.7	400
FL 270	27 000	344.3	350
FL 300	30 000	300.9	300
FL 320	32 000	274.5	275
FL 340	34 000	250.0	250
FL 360	36 000	227.3	225
FL 390	39 000	196.8	200
FL 410	41 000	178.7	175
FL 450	45 000	147.5	150
FL 480	48 000	127.7	125
FL 530	53 000	100.4	100

Note.— Upper-air humidity forecasts are prepared only up to FL 180 (500 hPa).

~~3.7.2.3 The foregoing forecasts prepared by WAFCs consist of computer-processed meteorological data for grid points in a regular grid with a horizontal resolution of 1.25° of latitude and longitude. The data are prepared in a format suitable for automated use, i.e. in the WMO GRIB code form:~~

~~———— a) for transmission from one meteorological computer to another, e.g. an airline flight planning computer, an ATS computer, or the computer of a national meteorological service or an aerodrome meteorological office; and~~

~~b) for the extraction and production of the required wind and temperature information.~~

~~The forecasts are made available using two AFS Internet-based services.~~

~~Note.— The GRIB code form is contained in the Manual on Codes — International Codes (WMO-No. 306), Volume I.2, Part B — Binary Codes~~

~~3.7.2.43~~ In addition, forecasts of cumulonimbus (CB) clouds, icing, and ~~clear air and in-cloud~~ turbulence at a horizontal resolution of 0.25° of latitude and longitude are prepared in gridded format four times daily by WAFCS and are valid for 6, 9, 12, 15, 18, 21, 24, 27, 30, 33 and 36 hours after the time (0000, 0600, 1200 and 1800 UTC) of the synoptic data on which they are based.

~~3.7.2.54~~ The forecasts of CB clouds depict the horizontal extent and flight level of base and top of CB clouds. Forecasts of icing, ~~clear air turbulence~~ and ~~in-cloud~~ turbulence are prepared for layers centred at flight levels as shown in Table 3-5. The layers regarding icing ~~and in-cloud turbulence forecasts~~ have a depth of 100 hPa and the layers regarding ~~clear air~~ turbulence have a depth of 50 hPa.

~~3.7.2.65~~ The foregoing WAFS forecasts are provided by the WAFCS using two AFS Internet-based services; the Secure Aviation Data Information Service (SADIS) and the WAFS Internet File Service (WIFS). Data is provided in the form of upper-air gridded global datasets ~~for use in flight planning~~, and are provided in a format suitable for automated use, i.e in the WMO GRIB code form:

a) for transmission from one meteorological computer to another, e.g. an airline flight planning computer, an ATS computer, or the computer of a national meteorological service or an aerodrome meteorological office; and

b) for the extraction and production of the required wind and temperature information.

~~These datasets include wind, temperature, humidity, CB clouds, icing and turbulence. These data are provided in gridded format (i.e. WMO GRIB-2 code form) and are intended to be integrated directly into automatic flight planning systems.~~

~~Note.— The GRIB code form is contained in the Manual on Codes — International Codes (WMO-No. 306), Volume I.2, Part B — Binary Codes~~

~~3.7.2.6~~ The operator may use ~~WAFS these~~ data in their flight planning decisions, in accordance with their own business model and safety management systems. It is important to note that the WAFCS do not provide visualizations of upper-air gridded global forecasts in support of flight documentation requirements included in Annex 3, Chapter 9.

~~3.7.3 — WAFS forecasts of significant en-route weather phenomena~~

~~3.7.3.1~~ ~~SIGWX forecasts are prepared by WAFCS four times a day for fixed, valid times of 0000, 0600, 1200 and 1800 UTC in binary format, i.e. in the WMO BUFR code form and/or PNG chart form. The dissemination of SIGWX forecasts should be completed at least 15 hours before their validity time.~~

Table 3-5. Details of forecasts of icing, and ~~clear air and in-cloud~~ turbulence

<i>Layer centred at flight level (pressure in hPa in brackets)</i>	<i>Icing</i>	<i>Clear air Turbulence</i>	<i>In-cloud turbulence</i>
60 (800)	X	—	—
100 (700)	X	X	X
140 (600)	X	X	X
180 (500)	X	X	X
240 (400)	X	X	X
270 (350)	—	X	—
300 (300)	X	X	X
340 (250)	—	X	—
390 (200)	—	X	—
450 (150)	—	X	—

3.7.3 WAFS forecasts of significant en-route weather phenomena

3.7.3.1 SIGWX forecasts are prepared by WAFCs four times a day for fixed, valid times of 0000, 0600, 1200 and 1800 UTC in binary format, i.e. in the WMO BUFR code form and/or PNG chart form. The dissemination of SIGWX forecasts should be completed at least 15 hours before their validity time. In addition, from 4 November 2021, information on significant weather supplied by WAFCs for pre-flight and in-flight re-planning should also be in IWXXM form.

Note.— Guidance on the implementation of IWXXM is provided in the Manual on the ICAO Meteorological Information Exchange Model (IWXXM) (Doc 10003). Details related to the IWXXM coding are contained in Volume I.3, Part D — Representations derived from data models.

3.7.3.2 High-level and medium-level SIGWX forecasts concentrate on significant en-route weather phenomena of relevance to flights operating at medium and high levels, namely:

- a) tropical cyclone;

Note.— The maximum of the 10-minute surface wind speed must reach or exceed 17 m/s (34 kt).

- b) severe squall lines;
- c) moderate or severe turbulence (in cloud or clear air);
- d) moderate or severe icing;
- e) widespread sandstorm/duststorm;
- f) CB clouds associated with a) to e) above;
- g) flight level of tropopause;
- h) jet streams;

- i) information on the location of volcanic eruptions which are producing ash clouds of significance to aircraft operations, comprising volcanic eruption symbol at the location of the volcanic eruption, the name of the volcano (if known), and the latitude/longitude of the eruption. In addition, the legend of SIGWX charts should indicate “CHECK SIGMET, ADVISORIES FOR TC AND VA, AND ASHTAM AND NOTAM FOR VA”; and
- j) information on the location of a release of radioactive materials into the atmosphere of significance to aircraft operations, comprising the radioactive materials in the atmosphere symbol at the location of the release. Further details are to be given in a separate text box on the chart: the radioactive materials in the atmosphere symbol, the latitude/longitude of the site of the release; and (if known) the name of the site of the radioactive source. In addition, the legend of SIGWX charts on which a release of radiation is indicated should contain “CHECK SIGMET AND NOTAM FOR RDOACT CLD”.

3.7.3.3 The following criteria are used by the WAFCs when including items in the SIGWX forecasts:

- a) tropical cyclones, severe squall lines, moderate and severe turbulence, moderate and severe icing, sandstorm/duststorm and CB clouds are included if expected to occur between the lower and upper level of the SIGWX forecast;
- b) the abbreviation “CB” should be included only where it refers to the occurrence or expected occurrence of CB:
 - 1) affecting an area with a maximum spatial coverage of 50 per cent or more of the area concerned;
 - 2) along a line with little or no space between individual clouds; or
 - 3) embedded in cloud layers or concealed by haze.
- c) the inclusion of “CB” should be understood to include all weather phenomena normally associated with CB clouds, namely, thunderstorm, moderate or severe icing, moderate or severe turbulence, and hail;
- d) where a volcanic ash eruption or a release of radioactive material into the atmosphere warrants the inclusion of the volcanic activity symbol or the radioactivity symbol in SIGWX forecasts, the symbols should be included on both high-level and medium-level SIGWX forecasts, regardless of the flight levels to which the volcanic ash column or radioactive material is reported or expected to reach; and
- e) in the case of coincident or partial overlapping of items a), i) and j) in 3.7.3.2, the highest priority must be given to item i), followed by item j) and a). The item with the highest priority is to be placed at the location of the event, and an arrow used to link the location of the other item(s) to its associated symbol or text box.

3.7.3.4 WAFCs issue the following SIGWX forecasts:

- a) high-level SIGWX forecasts for flight levels between FL 250 and FL 630; and
- b) medium-level SIGWX forecasts for flight levels between FL 100 and FL 250 for limited geographical areas in accordance with regional air navigation agreement.

Note 1.— Examples of the form of presentation of high- and medium-level SIGWX forecasts are given in Annex 3, Appendix 1.

Note 2.— Medium-level SIGWX forecasts ~~are planned to be phased out as soon as flight documentation generated from the gridded forecasts of CB clouds, icing and turbulence fully meet user requirements~~ will be retired in November 2022, when a new high-level SIGWX dataset encompassing FL 100 to FL 600 is introduced..

3.7.3.5 The SIGWX forecasts issued by the WAFCs are in support of the flight documentation requirements included in Annex 3, Chapter 9.

3.7.3.6 In order to assist WAFCs in improving their SIGWX forecasts, while under continuous review, it is an important responsibility of aerodrome meteorological offices receiving WAFS forecasts to notify the WAFCs concerned of significant discrepancies between SIGWX forecasts and observed conditions.

3.7.3.7 There are two options for aerodrome meteorological offices to assist in WAFS SIGWX forecast production:

- a) immediately prior to chart production, assist in finalizing the SIGWX forecasts through participation in a WAFS SIGWX chat room; and
- b) by providing feedback relating to discrepancies between issued SIGWX charts and observed or reported conditions.

3.7.3.8 The chat room is open half an hour prior to standard SIGWX chart issue times and participants can view or comment on a draft version of the chart prior to it being issued. To participate in the chat room, please contact wifs.admin@noaa.gov to arrange for a chat room user account.

3.7.3.9 To report discrepancies that occur with issued SIGWX charts, the notification by aerodrome meteorological offices should be based on the criteria given in Appendix 5 of this manual. Abbreviated plain language should be used in preparing the notification in accordance with the guidance material given in Appendix 5. E-mail should be used for transmission of notifications of discrepancies to the relevant WAFS. The WAFS, after receiving such a notification, should acknowledge receipt and make a brief comment including, if necessary, a proposal for follow-up action.

3.7.3.10 The WAFSs will only issue corrections to SIGWX forecasts resulting from errors in the originally issued forecast. The WAFSs will not, and are not required to, issue amendments that are a result of the atmosphere evolving differently to that originally expected. Table 3-6 highlights the distinction between errors (which require the issuance of a correction) and changes in the atmospheric conditions (which do not require the issuance of an amendment).

Table 3-6. Examples of errors (requiring a correction to WAFS SIGWX forecasts) and changes in the atmospheric conditions (not requiring an amendment to WAFS SIGWX forecasts)

<i>Errors requiring a correction by WAFSs</i>	<i>Changes not requiring an amendment by WAFSs</i>
A SIGWX forecast should have a jet stream height of FL340. The forecaster inadvertently indicates FL430.	A SIGWX forecast indicates a jet stream height of FL340; on subsequent evidence (numerical data, aircraft reports etc.) the jet stream height may be expected to be at FL370. On the basis of the original data, however, FL340 was an entirely reasonable forecast value.
A volcano symbol or tropical cyclone symbol was inadvertently omitted when there was information at the time of issuance for its inclusion.	After the issuance of a forecast, WAFS is made aware of a volcano that has recently erupted. This information could not possibly have been known by the forecasters at the time of issuance.

3.7.3.11 In the event of a correction being required, the WAFSs will re-issue a full set of their WAFS SIGWX forecasts, in all formats ~~i.e. all of the SIGWX BUFR files and all of the SIGWX PNG files~~, for the affected validity time. In addition to the re-issued forecasts, the WAFS issuing the corrected forecasts will also issue administrative messages. One administrative message will contain information describing the

nature of the correction while another administrative message will list all of the re-issued SIGWX files, as shown in Example 3-4.

3.7.3.12 The content of such corrections and related administrative messages shall be brought to the attention of users of the WAFS SIGWX forecast at the pre-flight planning stage. Where relevant to a particular flight, such correction information may, where practicable, be forwarded to aircraft in flight.

3.7.3.13 WAFS SIGWX forecasts remain subject to correction up until three hours before the fixed validity time of the affected forecast.

...

Chapter 4 - SIGMET INFORMATION, TROPICAL CYCLONE AND VOLCANIC ASH ADVISORY INFORMATION, AIRMET INFORMATION, AERODROME WARNINGS, WIND SHEAR WARNINGS AND ALERTS, AND SPACE WEATHER ADVISORY INFORMATION

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Example 4-2. Advisory messages for tropical cyclones and volcanic ash in text format

a) Tropical cyclone advisory

TC ADVISORY	
DTG:	20070925/ 1600Z 1200Z
TCAC:	YUSO
TC:	GLORIA
ADVISORY NR:	2007/12
OBS PSN:	25/ 1500Z 1130Z N2706 W07306
CB:	WI 450KM OF TC CENTRE TOP FL500
MOV:	NW 20KMH
C:	965HPA
MAX WIND:	23MPS
FCST PSN + 6 HR:	25/ 2200Z 1800Z N2748 W07350
FCST MAX WIND + 6 HR:	23MPS
FCST PSN + 12 HR:	26/ 0400Z 0000Z N2830 W07430
FCST MAX WIND + 12 HR:	23MPS
FCST PSN + 18 HR:	26/ 1000Z 0600Z N2852 W07500
FCST MAX WIND + 18 HR:	21MPS
FCST PSN + 24 HR:	26/ 1600Z 1200Z N2912 W07530
FCST MAX WIND + 24 HR:	20MPS
RMK:	NIL
NXT MSG:	20070925/ 2000Z 1800Z

Note1.— For the decode see Annex 3, Appendix 2, Table A2-2.

Note2.— Forecast positions should be provided for the main synoptic hours of 00, 06, 12 and 18 UTC

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Chapter 5 – METEOROLOGICAL SERVICE FOR OPERATORS AND FLIGHT CREW MEMBERS

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5.1.6 The meteorological information to be provided to operators and flight crew members includes the following information, as agreed between the meteorological authority and the operators concerned:

- a) forecasts of:
 - 1) upper wind and upper-air temperatures;
 - 2) upper-air humidity;
 - 3) geopotential altitude of flight levels;
 - 4) flight level and temperature of tropopause;
 - 5) direction, speed and flight level of maximum wind;
 - 6) CB clouds;
 - 7) icing;
 - 8) ~~clear air~~ turbulence; and
 - ~~9) in-cloud turbulence; and~~
 - 409) SIGWX phenomena;

Note 1.— Forecasts of upper-air humidity, geopotential altitude of flight levels, CB clouds, icing, and ~~clear air and in-cloud~~ turbulence are used only in automatic flight planning and need not be displayed. However, if necessary, forecasts of CB clouds, icing and turbulence may be visualized according to the specific thresholds relevant to user operations.

Note 2.— When supplied in chart form, forecasts of upper wind and upper-air temperature are fixed-time prognostic charts for flight levels as specified in 3.7.2.2.

Note 3.— When supplied in chart form, forecasts of SIGWX phenomena are fixed-time prognostic high-level (SWH) and medium-level (SWM) charts which are for an atmospheric layer limited by flight levels as specified in 3.7.3.4 and/or low-level (SWL) charts for flight levels below FL 100.

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Chapter 6 – DISSEMINATION OF OPMET INFORMATION

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6.3 DISSEMINATION OF OPMET INFORMATION ON THE INTERNET

Note.— Since the public Internet has become increasingly reliable for dissemination of data, it can be used to exchange non-time-critical OPMET information including WAFS forecasts subject to its availability and satisfactory operational performance. In this context, any OPMET information (including WAFS forecasts) used for flight planning can be considered non-time critical and therefore disseminated over the public Internet. Guidance on the use of the public Internet is available in the Guidelines on the Use of the Public Internet for Aeronautical Applications (Doc 9855).

6.3.1 A global set of OPMET information and world area forecast system (WAFS) forecasts are made available through the AFS Internet-based services (SADIS FTP and WIFS operated by WAFC London and WAFC Washington, respectively) to meteorological offices. Where the necessary arrangements have been made, the service may also be available to other users, such as ATS units and

operators. The WAFS forecasts are available ~~through the AFS Internet-based services are~~ in GRIB code form, and comprise of ~~comprising~~ forecasts of upper wind and upper-air temperature, humidity, tropopause heights and temperatures, maximum winds, CB clouds, icing, ~~in-cloud and clear-air~~ turbulence and geopotential altitude data, as well as SIGWX forecasts in the BUFR code form.

6.3.2 The reception of WAFS forecasts through the AFS Internet-based services provides excellent reliability and quality of information for relatively low cost. States that have not already done so are therefore encouraged to arrange for the access to the AFS Internet-based services. The procedures and conditions concerning authorized access to AFS Internet-based services are given in Appendix 1.

Note.— For details on the methods to be used in the various ICAO regions for the exchange of OPMET information, see the relevant air navigation plan (ANP), Volume II. Details on regional networks or systems for the exchange of OPMET information are published by ICAO regional offices on a regular basis.

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Appendix 1 – INFORMATION ON THE WORLD AREA FORECAST SYSTEM (WAFS) (See 1.5)

1. GENERAL DESCRIPTION

1.1 The world area forecast system (WAFS) brings to meteorological forecasting the concept of centralization, in designated centres, of forecasting activities for the pre-flight planning and en-route phases of flights. Its general aspects were initially developed by the Communications/Meteorology Divisional Meeting (1982), held conjointly with the Seventh Session of the World Meteorological Organization (WMO) Commission for Aeronautical Meteorology. A major review and development of the WAFS was conducted at the Meteorology Divisional Meeting (2002) held conjointly with the Twelfth Session of the WMO Commission for Aeronautical Meteorology.

1.2 The objective of the system is to provide meteorological offices, meteorological authorities and other users (e.g. pilots and operators) with global aeronautical meteorological en-route forecasts. This objective is achieved through a comprehensive, integrated, worldwide, uniform and cost-effective system which takes full advantage of evolving technologies. Currently, two world area forecast centres (WAFCs), i.e. WAFS London and WAFS Washington, issue global upper-air forecasts in the WMO GRIB Edition 2 code form and medium- and high-level SIGWX forecasts in the BUFR code form. In addition, the WAFCs issue, as a back-up, SIGWX forecasts in the PNG chart form which can also be used by States unable to generate charts from the BUFR data.

1.3 WAFS forecasts are made available by WAFS London and WAFS Washington on the AFS Internet-based services (Secure Aviation Data Information Service (SADIS) FTP and WAFS Internet file service (WIFS)), respectively).

~~*Note.— The 0° elevation angle contour is the theoretical extent of coverage, while the 5° elevation angle is considered to be the practical extent of coverage according to nominal design criteria.*~~

1.4 In addition to WAFS forecasts, a global set of alphanumeric operational meteorological (OPMET) information is made available on the AFS Internet-based services.

1.5 The WAFS is expected to develop to ensure that it continues to meet evolving aeronautical requirements in a cost-effective manner.

2. GUIDELINES FOR AUTHORIZED ACCESS TO THE WAFS INTERNET-BASED SERVICES

The guidelines below were originally developed by ICAO to assist States in arranging for access to the WAFS satellite broadcast. In 2.1 and 2.2 below, the guidelines have been updated to reflect the discontinuation of WAFS satellite broadcasts.

2.1 General

2.1.1 The WAFS Internet-based services constitute a sub-system of the ICAO AFS providing aeronautical information to States.

2.1.2 The aeronautical information made available by the WAFS Internet-based services includes primarily OPMET information and WAFS upper wind and upper-air temperature, humidity, tropopause heights and temperatures, maximum winds, cumulonimbus clouds, icing, ~~in-cloud and clear air~~ turbulence and significant weather forecasts in gridded and graphical formats, and alphanumeric messages.

2.1.3 Through the use of the Internet-based services, States may wish to meet their obligation under Article 28 of the Convention on International Civil Aviation regarding the supply to users of meteorological information for the provision of meteorological service to international air navigation.

2.1.4 Recovery by States of associated costs through charges to international civil aviation should be based on the principles contained in Article 15 of the *Convention on International Civil Aviation* and *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082).

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Appendix 9 – GUIDELINES FOR ACCESS TO AERONAUTICAL METEOROLOGICAL INFORMATION (See 6.1.4)

Note 1.— The “Guidelines for Access to Aeronautical Meteorological Information” were noted by the Council on 23 February 2004 (171/4).

Note 2.— The “Guidelines for Authorized Access to the World Area Forecast System (WAFS) Satellite Broadcast” noted by the Council on 5 July 1995 (145/24) provide additional guidance relevant to the subject matter (see Appendix 1, section 2).

1. GENERAL

1.1 Aeronautical meteorological information consists of operational meteorological (OPMET) information and the WAFS ~~upper wind, humidity and temperature~~ datasets and significant weather forecasts ~~and alphanumeric messages~~. The OPMET messages consist of tropical cyclone advisories, volcanic ash advisories, aerodrome routine meteorological reports (METAR), aerodrome special meteorological reports (SPECI), special air-reports (AIREP), aerodrome forecasts (TAF), GAMET area forecasts, and SIGMET and AIRMET information.

1.2 The telecommunication facilities used for the international exchange of OPMET information should be aeronautical fixed service (AFS), in accordance with Annex 3 — *Meteorological Service for International Air Navigation* and the regional air navigation plan (ANP), Part III — *Communications, Navigation and Surveillance* and Part V — *Meteorology*.

1.3 Through the use of the AFS to exchange OPMET information in accordance with the regional ANP, Part V — *Meteorology*, Contracting States will meet their obligation under Article 28 of the *Convention on International Civil Aviation* (Doc 7300) regarding the supply to users of aeronautical meteorological information for the provision of meteorological service to international air navigation.

1.4 Recovery by Contracting States of associated costs through charges on international civil aviation should be based on the principles contained in Article 15 of Doc 7300 and *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082).

Note.— Detailed guidance for determining the costs of aeronautical meteorological service is provided in the Manual on Air Navigation Services Economics (Doc 9161).

APPENDIX H – Job Card 10

Additions are shown in **highlighted** text, whilst deletions are shown with ~~strikethrough~~.

METP.010.03	Further development of the World Area Forecast System (WAFS)
Source	MET Divisional Meeting 2014 (Recommendations 2/2 and 2/3 a) and b)), METP/ 24
Problem Statement	The world area forecast system (WAFS) is a worldwide system established to provide aeronautical meteorological en-route forecasts in uniform standardized formats. The WAFS needs to be maintained and further developed, including the integration of the information provided into the future system wide information management (SWIM), in support of the aviation system block upgrade (ASBU) methodology.
Specific Details	<p>The WAFS provides global aeronautical meteorological en-route WAFS forecasts in digital form to meteorological authorities and other users on a global basis by two Provider States. The WAFS information is made available via the Secure Aviation Data Information Service (SADIS) and the WAFS Internet File Service (WIFS)).</p> <p>Following the recommendation by the MET Divisional Meeting (Recommendations 2/5, 2/5 and 2.12), the METP, in close coordination with WMO, continue to further develop the requirements for the WAFS consistent with the Global Air Navigation Plan (Doc 9750), including the integration of the information produced by the system into the future system wide information management (SWIM) environment.</p> <p>It was further recommended by the MET Divisional meeting (recommendation 2/4 b) iv)) that this includes the development of guidance for States concerning how their ICAO obligations may be met in the context of local, sub-regional, regional, multi-regional and global MET, including cost recovery and governance considerations.</p>
Expected Benefits	The resolution of WAFS gridded data sets will be increased vertically, horizontally and temporally, and SIGWX data will be provided for multiple time-steps in IWXXM format. This will assist aviation users in accurate flight planning, and will be delivered in a way which meets GANP and SWIM objectives. SIGWX forecast provision will be extended to cover multiple time-steps. Probabilistic data sets will enable users to make more informed operating and safety decisions.
Reference Documents	Annex 3 — Meteorological Service for International Air Navigation, Global Air Navigation Plan (Doc 9750), Manual of Aeronautical Meteorological Practice (DOC 8896), Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services (Doc 9377), Meteorology (MET) Divisional Meeting Report (Doc 10045) Agenda Item 2, Appendices A, B and F, Meteorology Panel (METP) deliverables (through its Working Groups), SADIS User Guide (Part 1 and Part 2), WIFS User Guide and guidance material available at the MOG Website.
Deliverable Expert Group	Meteorology Panel (METP)

ID	Document Affected	Description of Amendment proposal or Action	Supporting Expert Group	Status	Expected Dates		
					Delivery Date	Effective	Applicability
1708	Actions	Assist ICAO in the coordination of the arrangements between the Provider States comprising the WAFS and in ensuring that the global requirements for WAFS information are met.		On Schedule			Nov 2020
10096	Annex 3	Develop proposals for inclusion in Amendment 79 to Annex 3 to meet operational requirements in preparation for the operational implementation of the next generation of WAFC services.	FLTOSP ATMRPP	On Schedule	Q1 2018	Jul 2020	Nov 2020
9594	Electronic Air Navigation Plans (eANP)	Based on Annex 3 amendment, update of the eANPs as necessary		On Schedule	Q3 2018	Nov 2020	Nov 2020
9596	Manual of Aeronautical Meteorological Practice (Doc 8896)	Update guidance material to support the implementation of Annex 3 amendment		On Schedule	Q3 2018 2021	Nov 2020 Nov 2022	Nov 2020 Nov 2022
9597	Manual on Coordination between ATS, AIS and AMS (Doc 9377)	Update guidance material to support the implementation of Annex 3 amendment		On Schedule	Q3 2018 2021	Nov 2020 Nov 2022	Nov 2020 Nov 2022
9595	GANP (Doc 9750)	Review latest version of GANP to ensure that WAFC deliverables are on schedule		On Schedule	Q3 2018 2020	Nov 2020 Nov 2022	Nov 2020 Nov 2022
10098	Actions	Increase the horizontal, temporal and vertical resolution of WAFC gridded data in line with the GANP requirements. Deliver scientific improvements to the algorithms used into the production of hazard data sets.		On-schedule	Q4 2018 2022	Nov 2022	Nov 2022
10099	Actions	Develop the WAFC SIGWX data provision to provide multiple time-steps of data in SWIM compliant format		On-schedule	Q4 2018 2022	Nov 2022	Nov 2022
10097	Annex 3	Develop proposals for inclusion in Amendment 801 to Annex 3 regarding the development and provision of probabilistic forecasts to meet operational requirements of users the aviation industry in preparation for the operational implementation of the next generation of WAFC services.	FLTOSP ATMRPP	On Schedule	Q3 2020 2022	Jul 2022 Jul 2024	Nov 2022 Nov 2024
Status: Approved	Priority:	Initial Issue Date: 17 Jun 2015	Date Approved by ANC: 12 March 2019	Session / Meeting: 210-8			

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