

***NATIONAL WEATHER SERVICE INSTRUCTION 10-806  
JULY 30, 2003***

***Operations & Services  
Aviation Weather Services, NWSPD 10-8***

***WORLD AREA FORECAST SYSTEM***

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**NOTICE:** This publication is available at: <http://www.nws.noaa.gov/directives/>.

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SIGNED

7/16/03

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Gregory A. Mandt

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Date

Director, Office of Climate, Water, and Weather Services

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**1. Purpose.** This instruction describes the World Area Forecast System (WAFS), and operational procedures and services provided by the Washington World Area Forecast Center (WAFC) in support of WAFS.

**2. General.** The WAFS was established by the International Civil Aviation Organization (ICAO) Communications/Meteorology (COM/MET) Divisional Meeting held conjointly with the seventh session of the World Meteorological Organization (WMO) Commission for Aeronautical Meteorology (CAeM) in Montreal, in 1982.

The Federal Aviation Administration (FAA) is the meteorological authority, as defined by ICAO, for the United States, and has agreed the United States will provide a WAFC within the WAFS framework. The FAA has designated the National Weather Service (NWS) as its meteorological provider and in 1997, the NWS established the Washington WAFC.

**3. World Area Forecast System and World Area Forecast Centers.** The WAFS is a worldwide system which uses two World Area Forecast Centers to provide aeronautical meteorological en-route forecasts in uniform and standardized formats. The Washington WAFS is one of these two meteorological centers - the other center is the London WAFS. Washington and London WAFSs prepare and disseminate significant weather and upper-air forecasts in digital form on a global basis directly to forecast centers. Further, they also transmit directly to States by appropriate means as part of the Aeronautical Fixed Service (AFS). The WAFSs have agreed to provide:

- a. Grid point, digital form global forecasts for all required levels in standard format, containing upper level winds and temperatures, tropopause heights and maximum wind speed, directions, and height; and
- b. Global forecasts of significant weather information.

The Washington WAFS is composed of three centers: the National Centers for Environmental Prediction's (NCEP) Aviation Weather Center (AWC) in Kansas City, Missouri; the NCEP Central Operations (NCO) in Camp Springs, Maryland; and the Telecommunications Operations Center (TOC) at NWS Headquarters in Silver Spring, Maryland. The Washington WAFS issues significant weather (SIGWX) and wind/temperature forecasts in both pictorial (T4 facsimile) and gridded formats. Consistent with recommendations of ICAO, the National Weather Service also utilizes the Gridded Binary Format (GRIB) to represent gridded data, and the Binary Universal Form for the Representation of Meteorological Data (BUFR) to represent SIGWX data. These formats are described in NWSI 10-811, International Products.

To achieve WAFS' objectives, worldwide satellite communications are provided by three INTELSAT satellites. The United States operates two of these satellites - one each over the Atlantic and Pacific Oceans (see Appendix B for coverage) - to distribute WAFS Washington products from western Europe and West Africa westward to eastern Asia and Australia. These U.S. broadcasts are known as the International Satellite Communication System (ISCS). The London WAFS provides the remainder of global coverage with their Satellite Distribution System (SADIS), the third INTELSAT satellite.

Additionally, the Washington WAFS coordinates with its WMO Regional Specialized Meteorological Center (RSMC) for Volcanic Ash and Radioactive Releases, located within the NCO, to relay information about accidental releases of radioactive materials into the atmosphere, and provide transport model information to support environmental emergency response. The WAFSs also maintain contact with volcanic ash advisory centers for exchange of information on volcanic activity in order to coordinate the inclusion of information on volcanic eruptions in significant weather forecasts (Section 4.4 and 4.4.1 of this directive).

In addition to providing WAFS forecast information, the WAFS satellite broadcasts also include aeronautical operational meteorological data (OPMET). This allows the three satellite broadcasts to provide a cost effective means to achieve global exchange of this critical information.

As a supplement to WAFC service, Weather Forecast Offices (WFO) in Honolulu and Guam provide route forecasts as described in Appendix D of this directive.

**4. World Area Forecast Center Information.** The information provided on WAFC broadcasts is defined in ICAO Annex 3, Meteorological Service for International Air Navigation, Chapter 3. This information is divided into four classes:

- a. Grid point information in GRIB format;
- b. Facsimile information in T4 format;
- c. SIGWX data information in BUFR format; and
- d. OPMET information in character-oriented format.

The required areas, flight levels and forecast times are established by Regional Air Navigation (RAN) agreements, and listed in the applicable regional ICAO Air Navigation Plan (ANP).

**4.1 Grid Point Data (GRIB).** Global upper winds, upper-air temperatures, tropopause heights, humidity, and maximum wind speed, direction and height are generated and distributed by both WAFCs. Each WAFC provides backup for the other, ensuring routine product distribution in case of one center's failure. Data is generated on a grid and coded in binary format using GRIB code (WMO FM 92-IX Ext. GRIB) for efficient distribution. Users receiving this data must have a data processing system which can read, decode, and manipulate this data for the user's specific purpose.

WAFS products in GRIB format are presented as a series of bulletins. Each bulletin contains a grid point field of one parameter at a single level, as a continuous bit stream of a sequence of bytes (1 byte = 8 bits), and within a communications envelope. Part I - Technical description of the document titled "Technical Description of Gridded Binary (GRIB Code) Data on a 'Thinned' Grid from WAFCs Washington and London" describes the precise details of the data format.

WAFS digital grid point data are on a grid  $1.25^{\circ}$  latitude x  $1.25^{\circ}$  longitude, where the points are approximately 140 kilometers (KM) apart over the whole globe. The globe is divided into eight segments, four each in the Northern and Southern Hemispheres. Each segment is  $90^{\circ}$  in length, starting either side of the  $30^{\circ}$  W meridian and covering from the Equator to each Pole. Decoding software available from WAFC Washington enables the information to be interpolated and presented on a regular latitude/longitude grid.

The gridded forecasts of upper-air winds and temperatures, direction, speed and height of maximum winds and tropopause heights are prepared four times daily and should be valid for 6, 12, 18, 24, 30 and 36 hours after the synoptic data time (0000, 0600, 1200, and 1800 UTC). They should be available for transmission in the above order as soon as technically feasible, but no later than six hours after the standard time of observation.

**4.2 Facsimile Charts (T4).** Facsimile charts in T4 format are produced for upper level wind and temperature forecasts at selected flight levels, and for SIGWX forecasts. These charts are issued for maximum areas of coverage described in Appendix A, and can be copied for briefing and flight documentation purposes as specified in ICAO Annex 3, Chapter 9.

**4.2.1 Upper Level Wind/Temperature Charts.** Upper level wind/temperature charts depict wind speed, in knots, and direction, in degrees, at specified grid points as wind arrows with barbs for speed. The temperature, in Celsius, is shown alongside the grid points.

Wind/temperature facsimile charts distributed by ISCS are created from high resolution GRIB data, but for clarity are presented on a lower resolution  $2.5^{\circ} \times 2.5^{\circ}$  latitude/longitude grid.

The required flight levels for each chart area are specified in the ICAO regional air navigation agreements.

**4.2.2 Significant Weather T4 Charts.** Information on significant weather phenomena is supplied in chart form by Washington WAFC for WAFS broadcast. These charts are issued in Mercator and Polar Stereographic projections. All SIGWX forecasts are 24-hours, prepared four (4) times daily based on 0000, 0600, 1200, and 1800 UTC observed data, and issued approximately 13 hours prior to valid time. SIGWX information issued for high altitudes, FL250 to FL630, and mid altitudes, FL100 to FL450, will show, as appropriate to flight:

- a. Thunderstorms;
- b. Tropical Cyclones;
- c. Severe squall lines;
- d. Moderate or severe turbulence (in cloud or clear air, implied during convection);
- e. Moderate or severe icing;
- f. Clouds associated with a. to e.;
- g. Widespread sandstorm/dust storm;
- h. Surface position of well-defined convergence zones; e.g., the ITCZ;.
- i. Surface positions, speed and direction of movement of frontal systems when associated with convection;
- j. Tropopause heights;
- k. Jet streams;

- l. Information on location of volcanic eruptions which are producing ash clouds of significance to aircraft operations, including those producing only steam. This is depicted with a volcanic eruption symbol at the location of the volcano and, at the side of the chart, the volcanic eruption symbol, the name of the volcano, latitude/longitude, the date and time of first eruption, if known, and a reminder to users reference should be made to Significant Meteorological Advisories (SIGMET) and Notices to Airmen (NOTAM) or Notices to Airmen for Volcanic Ash (ASHTAM) issued for the area concerned; and
- m. Information on location of an accidental release of radioactive materials into the atmosphere, of significance to aircraft operations, comprising; the radioactivity symbol at the site of the accident, and at the side of the chart, the radioactivity symbol, latitude/longitude of the site of the accident, date and time of the accident and a reminder to users to check NOTAM for the area concerned.

**4.2.3 Significant Weather BUFR Files.** BUFR is a standard binary format approved by the WMO for efficient storage of meteorological features, and includes all information needed to describe the SIGWX features. To produce a BUFR file, two elements are needed: a raw data file and a set of tables containing descriptors. When raw data is encoded, each data value is attached to a descriptor defining what the data represents. The decoding process reads the BUFR file, looks up the descriptor in the relevant table, and writes out the information in the proper format. Binary BUFR files contain a set of tables with descriptors. Descriptors must be decoded from a set of common tables on the local machine in order to understand what the values represent. To this end, BUFR messages are very small and machine independent. They can be understood and decoded by any BUFR decoder having the latest tables available.

SIGWX data in BUFR format is independent of the background or projection. Only the information describing the feature is encoded. For example, a CLOUD area is a list of points with the height of bases and tops, and cloud type and amount attributes attached. There are no rules on how the cloud area should be drawn, or how the attributes are displayed. On SIGWX charts this is shown as a box, sometimes with an arrow to the area but this information is determined by the graphical display program.

BUFR does not provide information on how to visually represent data. However, ICAO Annex 3 includes guidance on how meteorological features should be depicted on charts. SIGWX BUFR messages prepared by AWC use the following WMO headers:

<b>BUFR FEATURES</b>	<b>COMMON NAME</b>	<b>WMO HEADER</b>
Jet streams	JETS	JUWE96 KKCI
Clear Air Turbulence	CAT	JUCE00 KKCI
Cumulonimbus	CLOUD	JUBE99 KKCI
Tropopause	TROP	JUTE97 KKCI
Frontal Systems	FRONTS	JUFE00 KKCI
Tropical Cyclones, Sandstorms and Volcanoes	V_T_S	JUVE00 KKCI

**4.3 Operational Meteorological (OPMET) Information in Character-Oriented Format.**

OPMET information includes METARs, TAFs, SIGMET information and special AIREPs. Volcanic ash and tropical cyclone advisory messages will also be included on the broadcast.

When METARs or TAFs are intended for distribution in bulletin form, a WMO abbreviated header is added to the first line of message text to facilitate data compilation into appropriate bulletins. The WMO abbreviated header is described in document WMO No. 386 - Manual on the Global Telecommunication System.

**4.4 Regional Specialized Meteorological Center (RSMC) for Volcanic Ash and**

**Radioactive Releases.** The ICAO has recognized releases of radioactive materials and toxic chemicals pose a serious threat to aircraft operations in the atmosphere and at airports. The Air Navigation Commission instructed the Secretariat to develop necessary arrangements and procedures for monitoring, and provision of warnings to aircraft, of radioactive materials and toxic chemicals in the atmosphere. This is done with the assistance of the Volcanic Ash Warnings Study Group, strengthened by the addition of the International Atomic Energy Agency (IAEA). ICAO recognized many States have national emergency plans and procedures for radioactive materials and toxic chemical clouds, i.e., the U.S. has the Federal Radiological Emergency Response Plan. Therefore ICAO was especially concerned to ensure aircraft (especially in flight) were not neglected in emergency procedures. The foregoing task is complex and of sensitive nature, and has not yet been completed. Section 4.4.1 provides an interim solution pending development of further international arrangements and procedures.

**4.4.1 National And International Arrangements and Procedures for Radiological**

**Hazards to Aviation.** The Washington WAFC will place the standard radiological symbol on the SIGWX charts when radiological material has been accidentally released into the atmosphere. Location by common name, latitude/longitude and time of the release, if known, should accompany the symbol.

The NCO Senior Duty Meteorologist (SDM) will provide information concerning radiological releases, if known, to AWC by any means available. The Washington RSMC (WRSMC) participates in International WMO and IAEA Environmental Emergency Response (EER) programs for incidents involving atmospheric radiological releases only from nuclear power plants (NPP). The RSMC runs the HYSPLIT air transport and dispersion (ATD) model, which creates plume trajectory and ATD forecasts of radiological plume. When combined with other RSMCs, coverage of NPPs is nearly global. WRSMC HYSPLIT model output is available to the AWC and the IAEA. Only the IAEA has agreed to assist ICAO by providing any information it has concerning type and source of an atmospheric radiological release to aviation interests. The NCO SDM has access to the IAEA, but there are no robust reporting procedures or central radiological information clearing house in place which would ensure most radiological releases to the atmosphere from various sources would be reported to the NCO SDM and passed on to the AWC.

The National Federal Radiological Emergency Response Plan (FRERP) also requires WRSMC to run the HYSPLIT model for other Federal agencies. Under this national plan, the NCO SDM is also authorized to notify AWC in events of national interest, providing them with information

for placement of the radiological symbol. HYSPLIT ATD forecast runs use high resolution ETA models (up to 4 KM) which are available for the lower 48 states on a secure web site. For radiological events impacting Hawaii, Alaska, and U.S. territories, HYSPLIT ATD forecasts are run from the Global Forecast System model and output is sent by telephone fax to AWC. The NCO SDM also notifies AWC directly by phone.

**5. Areas of Responsibility.** The WAFS areas of responsibility assigned to the Washington WAFS are shown in Appendix A (Maximum Areas of Coverage), and have been decided by ICAO region air navigation agreement.

**6. Use of Approved Contractions.** All contractions and/or abbreviations used in WAFS forecasts prepared for international use will be taken from the Procedures for Air Navigation Services (PANS) - ICAO Abbreviations and Codes, Doc. 8400/5. All other words in the forecast should be spelled out.

**7. Backup.** WAFS service backup will be accomplished in accordance with NWS Instruction 10-2003. Backup capability of the WAFSs will be tested periodically.

**8. Broadcast Schedules.** Information broadcast on ISCS will be disseminated as soon as it becomes available at the uplink. Therefore, the system does not operate with a strict timetable. A complete list of ISCS broadcast content and bulletin numbers is provided at <http://www.nws.noaa.gov/tg/iscsdat.shtml>.

In accordance with ICAO Annex 3, forecast charts will be disseminated on the ISCS at least nine hours before the valid period begins, or as otherwise specified by regional air navigation agreement. OPMET information in alphanumeric format will be disseminated as soon as the messages are received. SIGMETs and special air reports are information of immediate concern to aircraft about to depart or in flight. These messages and volcanic ash and tropical cyclone advisory messages will be distributed without delay.

**9. Amendment Criteria.** Forecast amendments should be issued in accordance with the following criteria:

- a. Significant Weather: Changes to significant en-route weather phenomena and any new information concerning volcanic eruptions or the accidental release of radioactive materials into the atmosphere, of significance to aircraft operations; newly expected occurrence; or no longer expected.
- b. Aircraft Icing and Turbulence: Newly expected occurrence; error in expected position of phenomena; intensity increasing; intensity decreasing from severe to light or nil, or from moderate to nil.
- c. Jet Streams: Newly expected occurrence or disappearance; error in expected position greater than (GT) 400 KM; error in speed GT 20 %; or error in core height GT 3,000 feet.

- d. Wind: Change in direction of greater than or equal to (GTE) 30 degrees, provided wind speed is GTE 30 knots before and after the change; or change in speed GTE 20 knots.
- e. Temperature: Change of GT five (5) degrees Celsius.

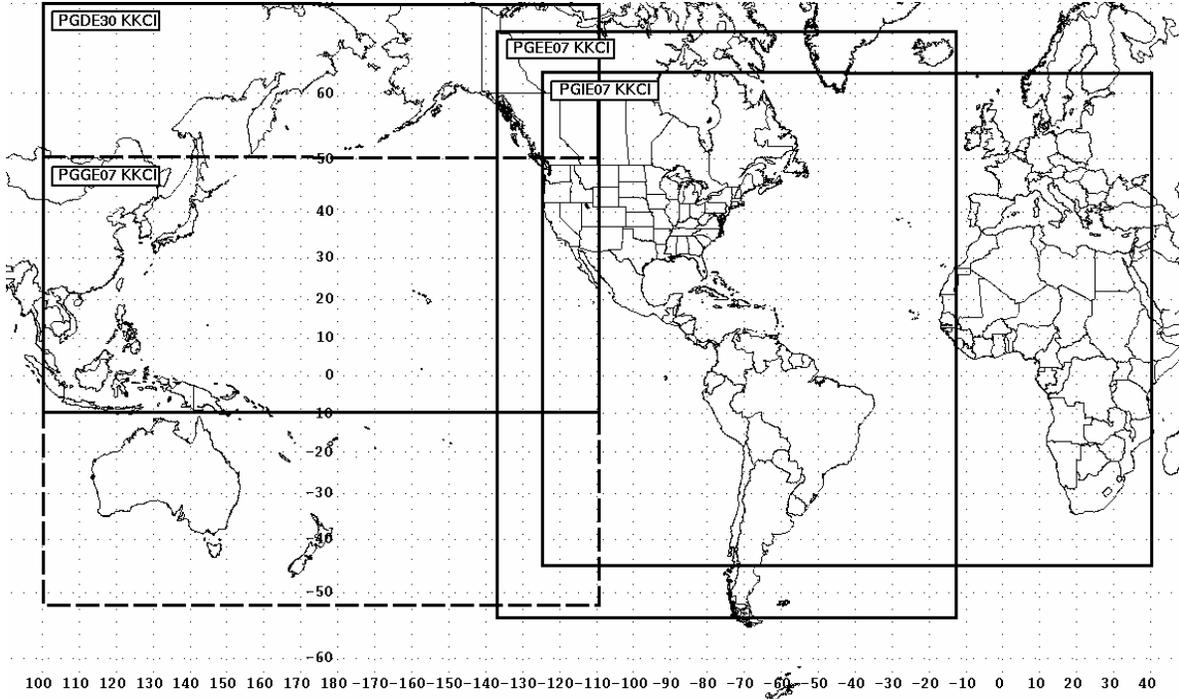
**10. Amendment Procedures.** Amendments to upper level wind and temperature forecasts should be transmitted as soon as possible prior to the next six-hour issuance in the form of amended bulletins and abbreviated plain language messages. Sample amendment messages are found in ICAO Annex 3, Attachment A.

Amendments to significant weather phenomena forecasts should be transmitted as soon as possible prior to the next six-hour issuance as abbreviated plain language messages. Guidance on the preparation of abbreviated plain language messages is given in ICAO Annex 3, Attachment A.

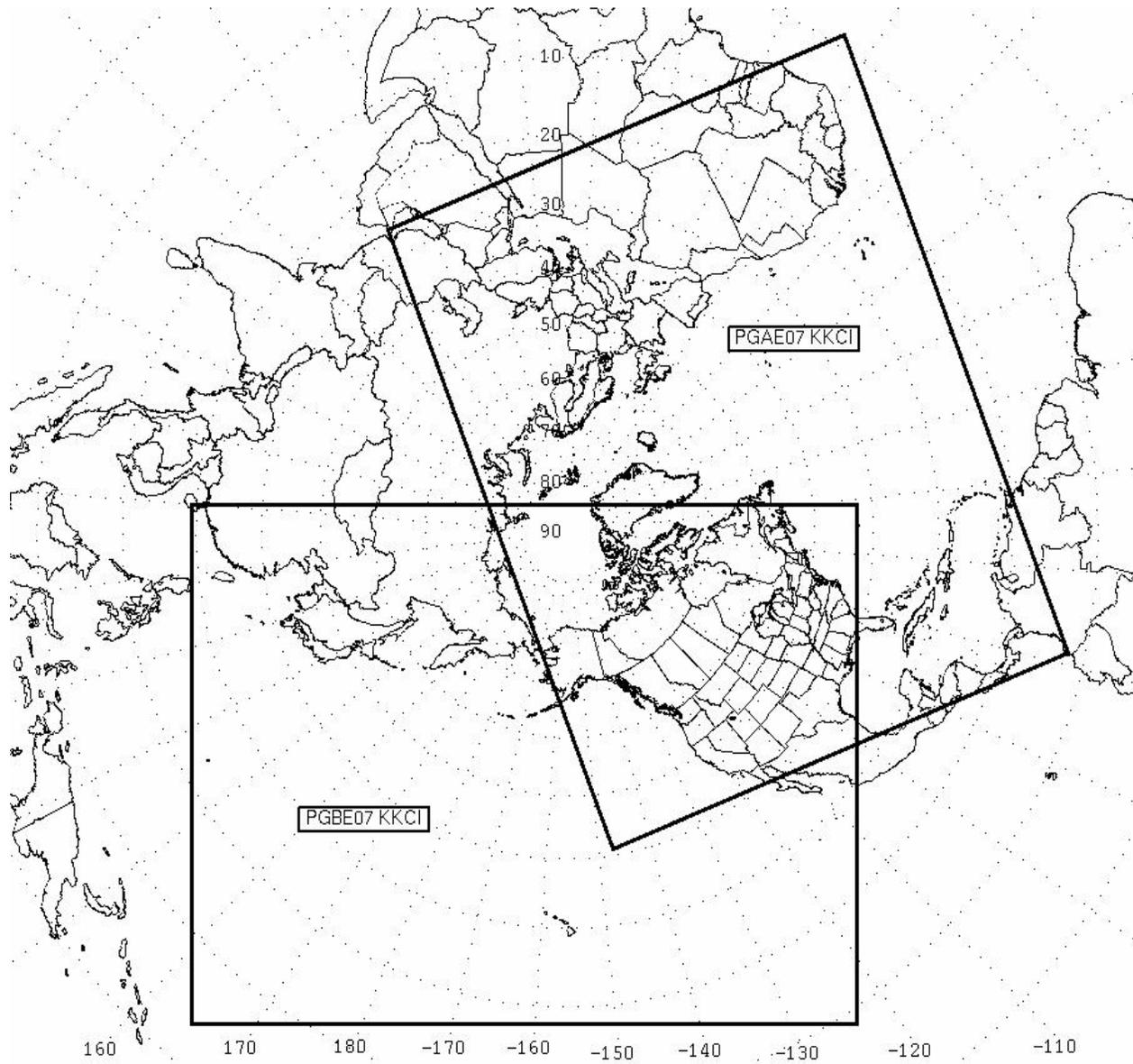
**11. Retention of Weather Documentation Materials.** In accordance with NWSI 10-2003, Records Retention, copies of forecast records will be retained for five years.

Appendix A - Maximum Areas of Coverage

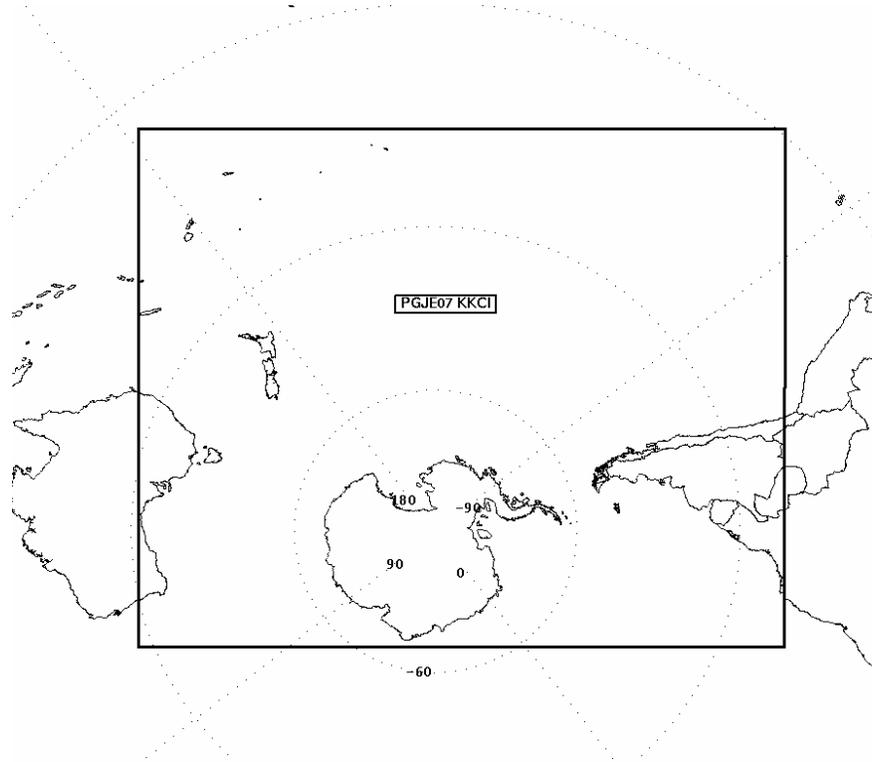
1. Maximum Areas of Coverage Mercator Projection



2. Maximum Areas of Coverage Polar Stereographic Projection



3. Maximum Area of Coverage South Pole Polar Stereographic Projection



Appendix B – Footprints of WAFC Washington Satellite Broadcasts

**U.S. National Weather Service  
International Satellite Communications System**



*Approximately 110 W to 60 E*

**Atlantic Intelsat Coverage**

**U.S. National Weather Service  
International Satellite Communications System**



*approximately 105 E to 110 W*

**Pacific Intelsat Coverage**

**Appendix C - Operational Meteorology (OPMET) Message Formats**

**WMO abbreviated heading**

TTAAii CCCC YYGGgg (BBB) where:

TT	Data designator e.g. SA for METAR, FC and FT for TAF and WS for SIGMET <sup>1</sup> ;
AA	Geographical designator , e.g. UZ for Uzbekistan, UR for Ukraine;
ii	Number used to differentiate bulletins with the same types of data from the same geographical area;
CCCC	International four-letter location indicator for station originating or compiling the bulletin (ICAO Doc. 7910 - Location Indicators) e.g. KKCI - Aviation Weather Center Kansas City Missouri;
YY	The day of the month;
GGgg	Time in hours and minutes for the time of observation in the case of METARs, and in the case of TAFs the full hour preceding the transmission time; and
BBB	Optional group to indicate whether the message is an amendment, a correction or a delayed message (WMO GTS Manual a-11.4).

**Appendix D - International Aviation Route Forecasts (ROFOR)**

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International Aviation Route Forecasts are prepared for and issued several hours in advance of regularly scheduled flights. The only NWS office that routinely issues ROFORs is Weather Forecast Office (WFO) Honolulu, by virtue of their designation as an ICAO Meteorological Watch Office (MWO). WFO Honolulu will honor all ROFOR requests for flights within the Pacific Region beginning or ending in, or having most of the flight path within, its area of responsibility (AOR). Requests for ROFORs not meeting these criteria will be referred to the MWO whose AOR encompasses the route, generally WFO (MWO) Guam. Examples of ROFORs issued by WFO Honolulu:

**Johnston Island Route**

FROC31 PHFO 301557  
RFRJON  
ROFOR VALID 29/16-18Z FOR ROUTE PHNL TO PJON  
FT 10000 30000 34000 39000  
20.3N/160.9W 0820P09 2610M34 2430M44 2530M54  
19.0N/164.3W 0915P08 2820M33 3025M42 2940M53  
SIGWX...NIL.

**Majuro to Kwajalein Route**

FROC32 PHFO 301857  
RFRKWA  
FOR WSO MAJURO  
ROFOR VALID 2102 FOR ROUTE PKMJ TO PKWA AND RETURN  
01208 4100P09 09010 4180M05 08015  
SIGWX...NIL.

**Tarawa to Majuro Route**

FROC33 PHFO 291510  
RFRFFN  
FOR PKMJYMYX  
ROFOR VALID 2008 FOR ROUTE NGTA TO PKMJ  
01205 4100P08 06010 4140P00 06015 4180M03 07020  
01201 4100P08 09015 4140P00 09020 4180M04 10025  
SIGWX...ISOL TCU/VIS 5SM SHRA  
PKMJ 221120Z 221212 NIL=

**Santa Barbara and San Francisco to Honolulu Route**

FRPN31 PHFO 301857

RFRKSF

WINDS/TEMPERATURES AND WEATHER BY ZONE FOR  
ROUTE SFO/HNL VIA 31.3N/140W VALID AT 311200Z

FLIGHT LEVELS

ZONE	FL050	FL100	FL180	FL240	ZONE WEATHER
25	3315 P16	3208 P11	3109 M07	3216 M19	6-8 STSC 010/030
26	3316 P13	3211 P09	3117 M06	3023 M18	4-6 STSC 015/045
27	3013 P12	3212 P09	3020 M06	3024 M18	6-8 MERGING LYR 200 ISOL VIS 3-5SM RA ISOL TCU TOPS FL224
28	3008 P14	3008 P08	2815 M06	2918 M18	DO
29	9905 P14	9905 P08	2609 M06	2612 M18	4-6 CUSC 020/050
30	0506 P14	9905 P08	9905 M06	2406 M18	DO
31	0818 P15	0613 P09	0307 M06	9905 M18	4-6 CUSC 020/080 ISOL -SHRA
32	0822 P15	0719 P09	0711 M05	9905 M17	DO

OVERALL COMPONENTS

P4 P2 M4 M10

ROUTE SBA/HNL VIA 29.5N/140W VALID AT 311200Z

FLIGHT LEVELS

ZONE	FL050	FL100	FL180	FL240	ZONE WEATHER
25	3509 P17	3108 P11	3011 M07	3015 M19	6-8 STSC 010/030
26	3416 P14	3312 P09	3218 M05	3123 M18	4-6 STSC 015/045
27	0111 P13	3510 P10	3017 M05	3021 M18	2-4 CUSC 020/045
28	0307 P14	3606 P09	2713 M05	2717 M18	DO
29	0406 P14	9905 P08	2507 M05	2610 M18	4-6 CUSC 020/050
30	0815 P15	0610 P09	9905 M05	9905 M17	DO
31	0821 P15	0616 P09	0408 M05	9905 M18	4-6 CUSC 020/080 ISOL -SHRA
32	0822 P15	0719 P09	0812 M06	9905 M18	DO

OVERALL COMPONENTS

P10 P5 M4 M7

SYNOPSIS...1024MB HIGH CENTERED NEAR 30N156W.