ICAMS

INTERAGENCY COUNCIL FOR ADVANCING METEOROLOGICAL SERVICES

National Hurricane Operations Plan

FCM-P12-2026

Washington, DC
May 2026

Hurricane Ida, courtesy of NOAA.

FEDERAL COORDINATOR

FOR

METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

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NATIONAL HURRICANE OPERATIONS PLAN

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FCM-P12-2026
Washington, D.C.
May 2026

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NATIONAL HURRICANE OPERATIONS PLAN

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CHAPTER 1: INTRODUCTION

1.1 General.

The tropical cyclone warning service is an interdepartmental effort to provide the United States and designated international recipients with forecasts, warnings, and assessments concerning tropical and subtropical weather systems. The National Oceanic and Atmospheric Administration (NOAA), of the Department of Commerce (DOC), is responsible for providing forecasts and warnings for the Atlantic and Eastern and Central Pacific Oceans while the Department of War (DOW) provides the same services for the Western North Pacific (WPAC), South Pacific, and the North and South Indian Oceans (see Figure 1-1). NOAA, along with other Federal agencies such as the U.S. Navy and the National Aeronautics and Space Administration (NASA), also conducts supporting research efforts to improve tropical cyclone forecasting and warning services. The bottom line—this interdepartmental cooperation achieves economy and efficiency in the provision of the tropical cyclone forecasting and warning services to the Nation. The *National Hurricane Operations Plan (NHOP)* provides the basis for implementing agreements reached at the Tropical Cyclone Operations and Research Forum (TCORF)/Interdepartmental Hurricane Conference (IHC), which was sponsored by the Working Group for Tropical Cyclone Operations and Research (TCOR) in 2022. The goal of the TCORF/IHC is to bring together the responsible Federal agencies to achieve agreement on items of mutual concern related to tropical cyclone forecasting and warning services for the Atlantic and Pacific Oceans.

1.2 Scope.

The procedures and agreements contained herein apply to the Atlantic Ocean, Gulf of America, Caribbean Sea, and the Pacific Ocean. The plan defines the roles of individual agencies, participating in the tropical cyclone forecasting and warning program when more than one agency is involved in the delivery of service in any specific area. When a single agency is involved in any specific area, that agency's procedures should be contained in internal documents and, to the extent possible, be consistent with NHOP practices and procedures.

1.3 Authority.

The Working Group for Tropical Cyclone Operations and Research produced this document acting under authority of the Federal Coordinator for Meteorology (Undersecretary of Commerce for Oceans and Atmosphere).

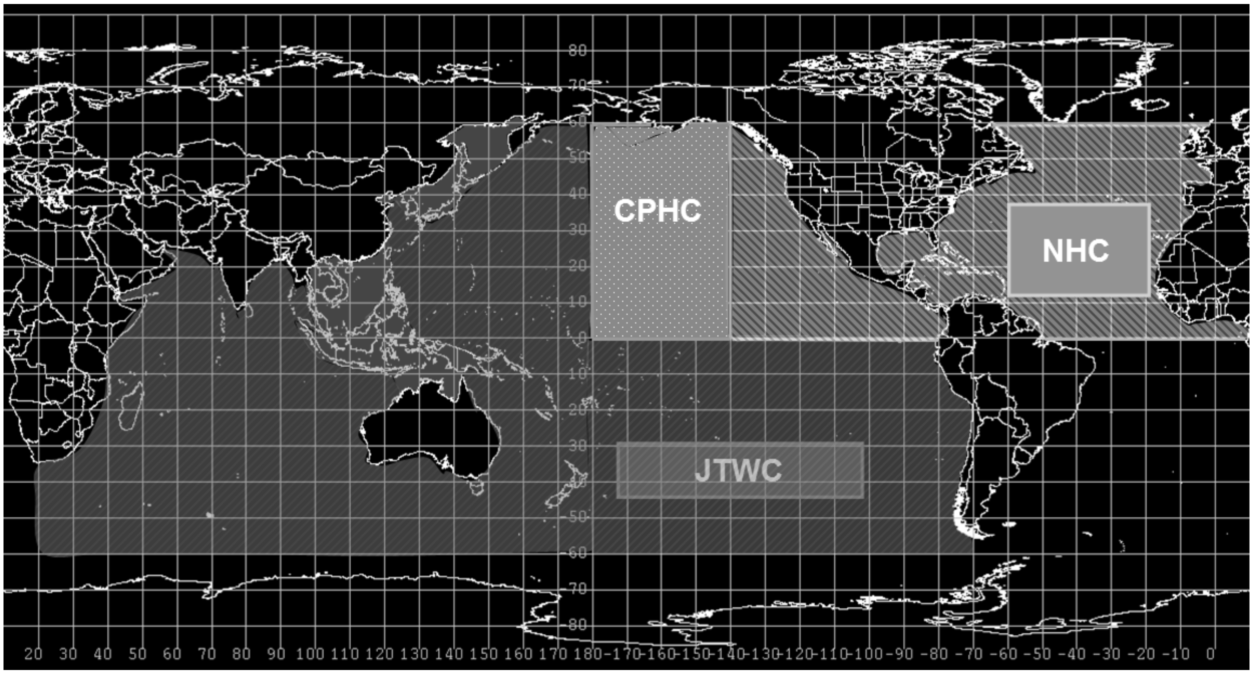

Figure 1-1. Tropical Cyclone Forecast Centers' Areas of Responsibility

CHAPTER 2: RESPONSIBILITIES OF COOPERATING FEDERAL AGENCIES

2.1. General.

The Department of Commerce (DOC), through the National Oceanic and Atmospheric Administration (NOAA), is charged with the overall responsibility to implement a responsive, effective national tropical cyclone warning service. Many local, state, and Federal agencies play a vital role in this system; their cooperative efforts help ensure that necessary preparedness actions are taken to minimize loss of life and destruction of property. The joint participation by the Department of War (DOW), the Department of Transportation (DOT), the Department of Homeland Security (DHS)/U.S. Coast Guard (USCG), and the Department of State (DOS) with the DOC brings to bear those Federal resources considered essential for storm detection and accurate forecasting. This cooperative effort has proven to be a cost-effective, highly responsive endeavor to meet national requirements for tropical cyclone warning information.

2.2. DOC Responsibilities.

2.2.1. Forecasting and Warning Services.

The DOC will provide timely dissemination of forecasts, warnings, and all significant information regarding tropical and subtropical cyclones to the appropriate agencies, marine and aviation interests, and the general public.

2.2.2. Support to DOW.

Through NOAA's National Weather Service (NWS), the DOC will:

- Consult, as necessary, with the DOW regarding their day-to-day requirements for forecast/advisory services and attempt to meet these requirements within the capabilities of the tropical cyclone warning service.
- Provide, through the National Hurricane Center (NHC) and the Central Pacific Hurricane Center (CPHC), the coordinated DOC requirements for weather reconnaissance and other meteorological data to be acquired by the DOW on tropical or subtropical cyclones and disturbances.
- Provide facilities, administrative support, IT system access and support, and the means to disseminate meteorological data for the Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH) as agreed to by the DOC and DOW.
- Provide the DOW with basic meteorological information, warnings, forecasts, and associated prognostic reasoning concerning location, intensity, and forecast movement of tropical and subtropical cyclones in the following maritime areas, including the adjacent states and possessions of the United States:

    Atlantic Ocean (north of the equator including the Caribbean Sea and Gulf of America): Advisories are the responsibility of the Director, NHC, Miami, FL. The NHC will consult with the Fleet Weather Center (FLEWEACEN), Norfolk, VA, prior to issuing initial and final advisories and prior to issuing any advisory that indicates a significant change in forecast of intensity or track from the previous advisory.

Exchange of information is encouraged on subsequent warnings when significant changes are made or otherwise required.

Eastern Pacific Ocean (north of the equator and east of 140°W): Advisories are the responsibility of the Director, NHC, Miami, FL. The NHC will consult with the Joint Typhoon Warning Center (JTWC), Pearl Harbor, HI, prior to issuing initial, special and final advisories and prior to issuing any advisory that indicates a significant change in forecast of intensity or track from the previous advisory. Exchange of information is encouraged on subsequent warnings when significant changes are made or otherwise required. The NHC will notify JTWC prior to issuance of a special Tropical Weather Outlook (TWO).

Central Pacific Ocean (north of the equator between 140°W and 180°): Advisories are the responsibility of the Director, Central Pacific Hurricane Center (CPHC), Honolulu, HI. In addition to the main Hawaiian Islands, CPHC also issues watches and warnings for Johnston Atoll, Palmyra Atoll, Midway, and the northwest Hawaiian Islands. The CPHC will consult with JTWC prior to issuing initial and final advisories and prior to issuing any advisory that indicates a significant change in forecast of intensity or track from the previous advisory. Exchange of information is encouraged on subsequent warnings when significant changes are made or otherwise required. The CPHC will notify JTWC prior to issuance of a special Tropical Weather Outlook (TWO).

West Pacific Ocean (Guam and Micronesia): Public advisories and forecast products are prepared by the NWS Weather Forecast Office (WFO) Guam, using the tropical cyclone warnings prepared by JTWC as guidance. WFO Guam issues watches and warnings for all tropical cyclones affecting the Territory of Guam, the Commonwealth of the Northern Marianas, the Republic of Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands.

Southern Pacific Ocean (American Samoa): Public forecast products are prepared by the NWS Weather Service Office (WSO) Pago Pago, using the tropical cyclone warnings prepared by JTWC as guidance. WSO Pago Pago issues watches and warnings for all tropical cyclones affecting the Territory of American Samoa.

2.2.3. Post Analysis of Tropical Cyclones.

The DOC, through NWS/NHC, will conduct an annual post analysis for all tropical cyclones in the Atlantic and the Pacific regions east of 180° and prepare Tropical Cyclone Reports on individual storms. An annual verification report will be available to interested agencies for forecasts made east of 140°W.

The DOW, through JTWC, will conduct annual post storm analyses for all tropical cyclones in the western North Pacific, North and South Indian, and South Pacific Oceans and will publish final TC best tracks via the JTWC public website. JTWC and the NWS will coordinate on any annual post storm analyses for systems which cross the dateline.

2.2.4. Environmental Satellite Systems.

The National Environmental Satellite, Data, and Information Service (NESDIS) will:

- Operate DOC environmental satellite systems capable of providing coverage of meteorological conditions in the tropics, and monitor and interpret DOC satellite imagery.

- Obtain, as necessary, National Aeronautics and Space Administration (NASA) research and development satellite data and Defense Meteorological Satellite Program (DMSP) data for NWS operational use and to comply with NHC and CPHC satellite data requirements.
- Provide surveillance support with fixes and/or intensity estimates to the Joint Typhoon Warning Center (JTWC), NHC, and CPHC through analysis of all available satellite imagery in all global basins except the South Indian Ocean and South Atlantic Ocean basins, through calendar year 2026.

2.2.5. Data Buoy Systems.

Through the National Data Buoy Center (NDBC), the DOC will, subject to available funding, develop, deploy, and operate environmental data buoy systems and automated coastal stations to support the data requirements of NHC and CPHC.

2.2.6. Weather Reconnaissance.

Through the NOAA Office of Marine and Aviation Operations (OMAO), DOC will provide weather reconnaissance flights, including synoptic surveillance, as specified in Chapter 5, unless relieved of these responsibilities by the Administrator of NOAA.

2.3. DOW Responsibilities.

The DOW will:

- Disseminate significant meteorological information on tropical and subtropical cyclones to the NWS in a timely manner.
- Provide NHC and CPHC current DOW requirements for tropical and subtropical cyclone advisories.
- Meet DOC requirements for aircraft reconnaissance, buoy deployments, and other special observations.
- Provide NHC and CPHC a 24-hour aircraft operations interface—Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH).
- Designate CARCAH as the liaison to NHC and CPHC. CARCAH will serve as NHC's and CPHC’s point of contact to request special DOW observations in support of this plan (e.g., additional aerial weather reconnaissance observations).
- Provide through CARCAH weather reconnaissance data monitoring services to evaluate and disseminate reconnaissance reports.
- Provide surveillance support with fixes and/or intensity estimates to the CPHC through analysis of available satellite imagery. The support is provided by the 17th Operational Weather Squadron Meteorological Satellite Operations (SATOPS) Flight (17 OWS/WXJ), Joint Typhoon Warning Center, Pearl Harbor, HI.
- Western Pacific Ocean (north of the equator): Provide NWS with basic meteorological information, forecasts, and associated prognostic reasoning, concerning location, intensity, wind distribution, and forecast movement of tropical cyclones for the Northwest Pacific west of 180°. JTWC will consult with WFO Guam regarding all tropical cyclones having the potential to impact Micronesia and Guam within the forecast period. Consultation will occur prior to issuing initial and final advisories and prior to issuing any advisory that indicates a significant change in forecast intensity or track from the previous advisory.

- Southern Pacific Ocean: Provide NWS with basic meteorological information, forecasts, and associated prognostic reasoning, concerning location, intensity, wind distribution, and forecast movement of tropical cyclones for the Southern Pacific Ocean. JTWC will consult with WSO Pago Pago regarding all tropical cyclones having the potential to impact American Samoa within the forecast period. Consultation will occur prior to issuing initial and final advisories and prior to issuing any advisory that indicates a significant change in forecast intensity or track from the previous advisory.
- Coordinate initiating, monitoring, and updating satellite invest areas on the tropical cyclone satellite websites provided by the Fleet Numerical Meteorology and Oceanography Center (FNMOC) and the Naval Research Laboratory (NRL), Monterey, California. NHC and CPHC will coordinate with JTWC on the initiation of desired invest areas and will provide JTWC numbers for invest areas as required.
- Deploy, through the Naval Oceanographic Office (NAVOCEANO), drifting data buoys in support of the Commander, U.S. Fleet Forces Command (USFFC) requirements.
- At a minimum, maintain situation awareness of operational aerial weather reconnaissance missions conducted in applicable combatant command areas of responsibility.

2.4. DOT and DHS Responsibilities.

2.4.1. Information Dissemination.

The DOT will provide NWS with timely dissemination of significant information received regarding tropical and subtropical cyclones.

2.4.2. Flight Assistance.

Through the Federal Aviation Administration (FAA), the DOT will provide air traffic control, communications, and flight assistance services.

2.4.3. U.S. Coast Guard.

The Department of Homeland Security (DHS) will provide the following through the U.S. Coast Guard:

- Personnel, vessel, and communications support to the NDBC for development, deployment, and operation of moored environmental data buoy systems.
- Surface observations to NWS from selected coastal facilities and vessels.
- Communications circuits for relay of weather observations to NWS in selected areas.
- Coastal broadcast facilities at selected locations for tropical storm or hurricane forecasts and warnings.

2.4.4. OCONUS Tropical Cyclone Forecast and Warning Support

DOT, through FAA, will annually provide or re-validate requirements for tropical cyclone reconnaissance, forecast, or warning support outside the NHC and CPHC areas of responsibilities (i.e., the JTWC area of responsibility) to DOW through Commander, Naval Meteorology and Oceanography Command.

DHS, through FEMA, will annually provide or re-validate requirements for tropical cyclone reconnaissance, forecast, or warning support outside the NHC and CPHC areas of responsibilities (i.e., the JTWC area of responsibility) to DOW through Commander, Naval Meteorology and Oceanography Command.

2.5. DOS Responsibilities.

2.5.1. Diplomatic Assistance.

Whenever possible, DOS will provide diplomatic assistance to DOW and DOC in the event that an aerial mission (as described in 6.1.3.1.) is prevented or delayed due to an action by a foreign state.

2.5.2. Mission Interference Recording.

DOS will maintain a record of instances, as reported to DOS by DOW or DOC, where an aerial mission was prevented or delayed due to an action by a foreign state. DOS will present this record to the diplomatic coordination working group as described in 2.6.

2.5.3 OCONUS Tropical Cyclone Forecast and Warning Support.

DOS will annually provide or re-validate requirements for tropical forecast reconnaissance, forecast, or warning support outside the NHC and CPHC areas of responsibilities (i.e., the JTWC area of responsibility) to DOW, through Commander, Naval Meteorology and Oceanography Command.

2.6. Diplomatic Coordination Working Group.

In order to reduce and mitigate interference by foreign states preventing or hindering the completion of responsibilities established by the NHOP, DOW, DOC, DOT, and DOS will establish a working group to coordinate diplomatic outreach and response. This working group may invite other offices and agencies to participate as needed. The working group will meet at least once a year to review instances where a foreign state denied or otherwise interfered with DOW and/or DOC reconnaissance and discuss appropriate diplomatic actions to reduce or mitigate future instances. DOS will serve as the liaison between the working group and U.S. foreign missions and will report to the working group on diplomatic efforts taken and outcomes identified as a result of this coordination.

2.7. Annual Liaison.

2.7.1. International.

When conditions permit, DOW, DOC, and DOT will cooperate in arranging an annual trip to the Caribbean and the Gulf of America region to carry out a continuing and effective liaison with the directors of meteorological services, air traffic control agencies, and disaster preparedness agencies of other nations in those areas regarding the provision of tropical cyclone warning services. This annual liaison trip is known as the Caribbean Hurricane Awareness Tour (CHAT). It takes place in the United States Southern Command (SOUTHCOM - Doral, FL) and Northern Command (NORTHCOM - Colorado Springs, CO) areas of responsibility. It supports their common mission of promoting stability, collective security, and defending U.S. regional interests. Due to the international importance of this mission, the Air Force Reserve Command

(AFRC) and NHC will jointly plan and execute it. The NHC will coordinate with the meteorological services in the countries to be visited.

The WC-130 aircraft flown by the 53rd Weather Reconnaissance Squadron (53 WRS) "Hurricane Hunters" is the most visible symbol of this awareness program; it serves as an educational platform and as a media focus for both dignitaries and the local populace. Tours of the aircraft demonstrate the critical partnership between DOW and NOAA in the collection of data critical to the preparation of a tropical cyclone forecast. The CHAT increases public awareness of the hurricane threat and serves to recognize and strengthen national and international teamwork for aircraft reconnaissance, storm warning, and emergency response.

The CHAT's diplomatic mission is unique in character and purpose. This joint AFRC and NOAA mission demonstrates the concerted U.S. effort to execute its hurricane program and illustrates the importance the U.S. places on hurricane forecasting, tracking, and warning. It helps communicate the U.S. responsibilities in the region and it highlights the vital roles of NOAA and the 53 WRS. The media's role is to document the trip and promote the hurricane preparedness message, providing visibility to this important outreach activity both nationally and internationally.

The synergy created by all participants traveling together on the 53 WRS WC-130 aircraft is essential in efficiently accomplishing the overall objectives of the mission while exercising fiscal responsibility. AFRC will support the transport of DOC, NOAA staff, and other U.S. officials during the CHAT on a non-interference basis as appropriate. Media support may be provided within appropriate public affairs guidelines.

2.7.2. Domestic.

DOC, DOW, and DOT will cooperate on an annual trip to domestic sites along the U.S. east or Gulf coast (alternating annually) as needed to accomplish similar objectives as the CHAT. This liaison trip is known as the Hurricane Awareness Tour (HAT). Planning is coordinated by the NHC in conjunction with other National Weather Service offices. NOAA WP-3D and/or G-IV and AFRC WC-130J aircraft may participate in this tour. While focused for domestic locations, an international stop (e.g., Canada) can be included. In addition, a Pacific Hurricane Awareness Tour (PHAT) will be undertaken approximately every three years for locations in Hawaii with planning coordinated by the CPHC.

2.8. Air Traffic Control/Flight Operations Coordination.

The operations officers of the principal flying units, the Manager, Air Traffic Control System Command Center (ATCSCC), Warrenton, VA, and the assistant managers for traffic management or assistant manager for military operations, as appropriate, at key Air Route Traffic Control Centers (ARTCC) will maintain a close working relationship on a continuing basis to ensure mission success under actual tropical storm conditions. This will involve visits to each other's facilities, familiarization flights, and telephone and electronic communications to improve the understanding of each other's requirements and capabilities.

2.8.1. Gulf of America Weather Reconnaissance.

The 53 WRS and the NOAA AOC operations officers will maintain a close working relationship with the ATCSCC, the ARTCCs, and the Fleet Aerial Control and Surveillance Facility

(FACSFAC) for the coordination of weather reconnaissance flights in the Gulf of America and over the Caribbean Sea in particular, and in the United States in general. The operations officers will:

- Request the assistance of the appropriate ARTCC/FACSFAC in support of the National Hurricane Operations Plan.
- Provide the current operations officer's name and telephone number to the appropriate ARTCC and FACSFAC.
- Publish the unit's telephone numbers [Defense Switched Network (DSN)/Commercial]).

2.8.2. Air Traffic Control Assistance.

The ATCSCC, appropriate ARTCCs, and FACSFAC will maintain a close working relationship with the weather reconnaissance units and provide airspace and air traffic control assistance to the extent possible. Those organizations will:

- Provide the current names and telephone numbers of points of contact to the flying units.
- Publish telephone numbers (DSN/Commercial)

CHAPTER 3: GENERAL OPERATIONS AND PROCEDURES OF THE NATIONAL WEATHER SERVICE HURRICANE CENTERS

3.1. General.

This chapter briefly describes the products, procedures, and communications headers used by the NHC and the CPHC. See Appendix A for a description of local National Weather Service (NWS) office products which support the tropical cyclone forecasting and warning program. Additional details of the products, including issuance criteria and transmission times, can be found in National Weather Service Instructions 10-601 and 10-607. The 10-601 is for local WFO tropical products; the 10-607 is for national center tropical products. The NWS Instructions documents can be found on the NWS directives system's operations and services website.

3.2. Products.

3.2.1. Tropical Weather Outlook (TWO).

NHC and CPHC prepare text and graphical versions of the TWO during their respective tropical cyclone seasons. The TWO covers tropical and subtropical waters and discusses areas of disturbed weather and the probability of tropical cyclone development. The NHC outlook, covering the next 168 hours, will mention tropical cyclones and subtropical cyclones, including the system's location (in either general terms or map coordinates), status, and change in status. The CPHC outlook, covering the next 168 hours, will mention tropical cyclones, including the system's location (in either general terms or map coordinates), status, and change in status.

3.2.2. Tropical Cyclone Public Advisories (TCP).

The TCP is the primary tropical cyclone information product issued to the public. The TCP comprises five sections: Summary, Watches and Warnings, Discussion and Outlook, Hazards, and Next Advisory. The NHC, the CPHC, and WFO Guam issue TCPs.

NHC. NHC issues tropical storm/hurricane watches/warnings for the Atlantic, Pacific, and Gulf of America coasts of the continental United States, the US Virgin Islands, and Puerto Rico. NHC issues watches when conditions along the coast are *possible* within 48 hours. NHC issues warnings when conditions along the coast are *expected* within 36 hours.

[NOTE: Because hurricane preparedness activities become difficult once winds reach tropical storm force, NHC issues the hurricane/typhoon watches *48 hours in advance of the anticipated onset of* ***tropical-storm-force winds.*****]**

CPHC, WFO Guam, and WSO Pago Pago. CPHC, Weather Forecast Office (WFO) Guam and Weather Service Office (WSO) Pago Pago issue tropical storm/hurricane/typhoon watches/warnings for the islands of Hawaii, northwest Hawaiian Islands, Johnston Atoll, Guam, Northern Marianas Islands, American Samoa, and selected points in the Micronesian countries. CPHC, WFO Guam and WSO Pago Pago issue watches when conditions along the coast are possible within 48 hours. CPHC issues warnings when conditions are expected along the coast within 36 hours. WFO Guam and WSO Pago Pago issue warnings when conditions are expected along the coast within 24 hours.

[NOTE: Because hurricane/typhoon preparedness activities become difficult once winds reach tropical storm force, CPHC, WFO Guam and WSO Pago Pago issue the hurricane/typhoon watches 48 hours in advance of the anticipated onset of tropical-storm-force winds.]

Intermediate public advisories will be issued in-between scheduled or special advisories when watches or warnings are in effect. They will continue to be issued when a tropical storm or hurricane is inland, even after coastal watches/warnings have been discontinued. These will retain the number of the last advisory they update plus an alphabetic designator (e.g., HURRICANE ALLISON INTERMEDIATE ADVISORY NUMBER 20A).

3.2.3. Tropical Cyclone Forecast/Advisories (TCM).

NHC, CPHC, and WPC will prepare TCMs for all tropical cyclones within their area of responsibility. See Section 4.3 for content and format of the advisories. The TCM provides critical tropical forecast information for the protection of life and property.

[Note: In the Western Pacific and Southern Pacific, tropical cyclone forecasts/advisories are issued by the JTWC. Appendix C provides a listing of the abbreviated communications headings and titles for JTWC products. Information on the broadcast of tropical cyclone information to coastal and high-seas shipping can be found in Chapter 10, Marine Weather Broadcasts.]

3.2.4. Tropical Cyclone Discussions (TCD).

The TCD is a primary tropical cyclone product explaining forecaster's reasoning behind analysis and the forecast for a tropical cyclone. It also provides coordinated 12-, 24-, 36-, 48-, 60-, 72-, 96-, and 120-hour tropical cyclone forecast positions and maximum sustained wind speed forecasts; other meteorological decisions; and plans for watches and warnings.

3.2.5. Tropical Cyclone Updates (TCU).

TCUs are issued to inform users of significant changes in a tropical cyclone in-between regularly scheduled public advisories. Such uses include, but are not limited to the following: to provide timely information of an unusual nature, such as the time and location of landfall, or to announce an expected change in intensity that results in an upgrade or downgrade of status (e.g., from a tropical storm to a hurricane); to provide a continuous flow of information regarding the center location of a tropical cyclone when watches or warnings are in effect and the center can be easily tracked with land-based radar; to provide advance notice that significant changes to storm information will be conveyed shortly, either through a subsequent TCU or through a Special Advisory; to announce changes to international watches or warnings made by other countries, or to cancel U.S. watches or warnings; or to issue a U.S. watch or warning, but only if the TCU precedes a public advisory that will contain the same watch/warning information, and indicates the public advisory will be issued shortly.

The TCU is a brief alphanumeric text product containing either block paragraph text, or a formatted storm summary section, or both. The storm summary section is identical in format to the storm summary section found in the TCP. The storm summary section is required whenever the TCU is issued to update storm intensity, location, or motion information. The storm summary section is not required for TCUs issued to provide advance notice that significant changes to storm information will be conveyed shortly, or for those issued to convey changes to watches or warnings. TCUs issued to provide hourly storm location information will contain a headline indicating the purpose of the TCU (e.g., "...11 AM POSITION UPDATE…").

3.2.6. Graphical Tropical Cyclone Surface Wind Speed Probabilities.

This graphical product portrays probabilistic surface wind speed information which will help users prepare for the potential of tropical storm or hurricane conditions. This product shows probabilities for three wind speed thresholds: 34, 50 and 64 knots. It provides cumulative probabilities through each 12 hour interval (e.g. 0 -12 hours, 0- 24 hours, etc.) from 0 through 120 hours. They are available in graphical forms in a static and an animated display. These wind speed probabilities are based on the track, intensity, and wind structure uncertainties in the official forecasts from the tropical cyclone centers.

3.2.7. Tropical Cyclone Surface Wind Speed Probabilities Text Product (PWS).

This product portrays probabilistic wind speed information helping users prepare for the potential of tropical storm or hurricane conditions.

The probabilities in this product are statistically based on the errors in the official track and intensity forecasts issued during the past five years by NHC and CPHC. Variability in tropical cyclone wind structure is also incorporated. New probability values are computed for each new official forecast issued by NHC or CPHC.

Probabilities for specific locations are provided for sustained wind speeds equal to or exceeding three wind speed thresholds: 34, 50 and 64 knots. Two types of probability values are provided in this table: onset and cumulative. Onset probabilities are provided for each of the following time intervals: 0-12 hours, 12-24 hours, 24-36 hours, 36-48 hours, 48-72 hours, 72-96 hours, and 96-120 hours. These individual period probabilities indicate the chance that the particular wind speed will *start* during each individual period at each location. Cumulative probabilities are produced for the following time periods: 0-12 hours, 0-24 hours, 0-36 hours, 0-48 hours, 0-72 hours, 0-96 hours, and 0-120 hours. These cumulative probabilities indicate the overall chance the particular wind speed will occur at each location during the period between hour 0 and the forecast hour.

3.2.8. Tropical Cyclone Watch Warning Product (TCV).

The national TCV issued by NHC includes the NWS' Valid Time Event Code (VTEC) to convey tropical hazards. It summarizes all new, continued, and canceled tropical cyclone watches and warnings issued by NWS Weather Forecast Offices (WFOs) for the U.S. Atlantic and Gulf coast, the southern California coast, Puerto Rico, and U.S. Virgin Islands. The CPHC will issue a TCV for the main islands of the State of Hawaii. The product is issued each time a U. S. tropical cyclone watch and/or warning is issued, continued, or discontinued for all Atlantic, eastern North Pacific, and the central North Pacific Ocean basin tropical cyclones.

The local TCV text is a segmented, nearly automated, VTEC product with each segment specific to a discrete forecast zone. It is issued by coastal and some inland Weather Forecast Offices (WFOs) in the Atlantic, and coastal WFOs in the eastern North Pacific and central North Pacific basins. Each segment contains land-based tropical cyclone watches/warnings in effect, meteorological information, threats (Wind, Storm Surge, Flooding Rain, Tornadoes) and their potential impacts. The product is generated from local gridded information and national guidance and is, therefore, not intended to be manually edited by the forecaster. This text product is intended for parsing by the weather enterprise, and is paired with the WFO Hurricane Local Statement (HLS) to provide a complete, localized tropical cyclone hazard and forecast information. The local TCV can also be useful to decision makers as it provides detailed information on timing, threats, and impacts on a zone level.

3.2.9. Weather Prediction Center (WPC) Public Advisories (TCP).

The National Centers for Environmental Prediction's (NCEP) WPC issues public advisories after NHC discontinues its advisories on subtropical and tropical cyclones that have moved inland in the conterminous United States or Mexico, but still pose a threat of heavy rain and flash floods in the conterminous United States or Mexico. The last NHC advisory will normally be issued when winds in an inland tropical cyclone drop below tropical storm strength, and the tropical depression is not forecast to regain tropical storm intensity or re-emerge over water. Therefore, WPC will only handle tropical depressions or remnants. WPC advisories will terminate when the threat of flash flooding has ended.

3.2.10. Other Tropical Cyclone Products.

Refer to NWS Instruction 10-607 for further details on these products, which include:

- Tropical Weather Discussion (TWD).
- Tropical Cyclone Summary – Fixes (TCS).
- Tropical Cyclone Danger Area Graphic
- Aviation Tropical Cyclone Advisory (TCA)
- Tropical Cyclone Reports (TCR)
- Tropical Cyclone Track and Watch/Warning Graphic
- Cumulative Wind Distribution Graphic
- Tropical Cyclone Surface Wind Field Graphic
- Maximum Wind Speed Probability Table
- Tropical Cyclone Storm Surge Probabilities
- Arrival of Tropical-Storm-Force Winds Graphics

3.2.11. NHC and CPHC Continuance of Advisories and Products for Post-Tropical Cyclones.

The NHC and CPHC will continue issuing advisory products after a tropical cyclone becomes post-tropical in those cases where the system continues to pose a significant threat to life and property and where the transfer or responsibility to another office would result in an unacceptable discontinuity of service. Similarly, WFO Guam and WSO Pago Pago will continue issuing advisory products after a tropical cyclone becomes post-tropical in those cases where the system continues to pose a significant threat to life and property.

3.3. Numbering and Naming of Tropical and Subtropical Cyclones.

The hurricane centers will number tropical depressions in their areas of responsibility. Depression numbers are always spelled out (e.g., "ONE," "TWO," "THREE," etc.). Depression numbers are assigned to match the seasonal cyclone number, even if a previous cyclone has bypassed the depression stage. In the North Atlantic and eastern and central North Pacific basins, the same numbering convention used for tropical depressions will also be used for potential tropical cyclones. For example, if the first tropical cyclone of the season forms directly as a storm (e.g., a fast-moving tropical wave becomes a tropical storm without ever becoming a depression), then the depression number "ONE" would simply be skipped and not used until the following year. For ease in differentiation, tropical depression numbers shall include the suffix "E" for Eastern Pacific, "C" for Central Pacific, or "W" for Western Pacific, after the number.

In both the Atlantic and Pacific, once the depression has reached tropical storm intensity, it shall be named and the depression number dropped. The depression number will not be used again until the following year. Tropical cyclones are given a name in the first advisory after intensifying to 34 knots (39 mph) or greater.

The following rules apply for tropical cyclones passing from one basin to another: Retain the name if a tropical cyclone passes from one basin into another basin as a tropical cyclone; i.e., advisories are continuous. An unnamed tropical depression will also retain its number and any existing suffix (e.g. Tropical Depression Six-E remains Tropical Depression Six-E) if it crosses into another area of responsibility. For unnamed tropical depressions moving from west to east across 180°, CPHC will use the associated Joint Typhoon Warning Center's (JTWC) number and indicate JTWC in parentheses following the number. For named systems, CPHC will use the associated RSMC Tokyo name and provide the associated JTWC number in parentheses.

Within a basin, if the remnant of a tropical cyclone redevelops into a tropical cyclone, it is assigned its original number or name. If the remnants of a former tropical cyclone regenerate in a new basin, the regenerated tropical cyclone will be given a new designation. JTWC will not give new designations to tropical cyclones that re-generate in a different sub-basin of the same basin (e.g., south Indian Ocean to south Pacific Ocean or Bay of Bengal to Arabian Sea).

In the Western Pacific, WFO Guam will use the JTWC cyclone number for all non-named systems. For Regional Specialized Meteorological Center (RSMC) Tokyo named systems, WFO Guam will use the RSMC Tokyo name with the associated JTWC number in parentheses.
In the Southern Pacific. WSO Pago Pago will use the JTWC cyclone number for all non-named systems. For Regional Specialized Meteorological Center (RSMC) Fiji named systems, WSO Pago Pago will use the RSMC Fiji name with the associated JTWC number in parentheses.

3.3.1. North Atlantic.

Depression numbers, ONE, TWO, THREE, will be assigned by the NHC after advising the Fleet Weather Center, Norfolk. Annual lists of Atlantic storm names are provided here. A supplemental list of Atlantic storm names, provided here, will be utilized if all the standard names have been exhausted for a given season.

3.3.2. North Pacific - East of 140W°.

Depression numbers, with the suffix E, e.g., ONE-E, TWO-E, THREE-E, will be assigned by the NHC after advising JTWC, Pearl Harbor, HI. The assigned identifier shall be retained even if the depression passes into another warning area. Annual lists of Eastern Pacific storm names are provided here. A supplemental list of Eastern Pacific storm names, provided here, will be utilized if all the standard names have been exhausted for a given season.

3.3.3. North Pacific - 180°E to 140W°.

Depression numbers, with suffix C; e.g., ONE-C, TWO-C, THREE-C, will be assigned by the CPHC after advising JTWC. Rotating lists of Central Pacific storm names are provided here.

3.3.4. North Pacific - Malay Peninsula to 180°.

Tropical cyclone identifiers; e.g. 01W, 02W, 03W, etc., are assigned by JTWC upon issuance of the first warning. This occurs when the TC reaches a threshold intensity of 25 knots, unless initiation of warnings at a lower intensity is operationally warranted. JTWC will include the TC number spelled out as the name until such time that RSMC Tokyo assigns a name; e.g. 01W (One), 02W (Two), 03W (Three), etc. Rotating lists of western North Pacific storm names assigned by RSMC Tokyo are provided here.

3.3.5. North Indian - 40°E to Malay Peninsula.

Tropical cyclone identifiers; e.g. 01P, 02P, 03P, etc., are assigned by JTWC upon issuance of the first warning. This occurs when the TC reaches a threshold intensity of 35 knots, unless initiation of warnings at a lower intensity is operationally warranted. JTWC will include the TC number spelled out as the name until such time that RSMC Fiji assigns a name; e.g. 01P (One), 02P (Two), 03P (Three), etc. Rotating lists of South Pacific storm names assigned by RSMC Fiji are provided here.

3.3.6. South Pacific - East of 120°W.

Tropical cyclone identifiers; e.g. 01P, 02P, 03P, etc., are assigned by JTWC upon issuance of the first warning. This occurs when the TC reaches a threshold intensity of 35 knots, unless initiation of warnings at a lower intensity is operationally warranted. JTWC will include the TC number spelled out as the name; e.g. 01P (One), 02P (Two), 03P (Three), etc.

3.3.7. South Pacific - 160°E to 120°W.

Tropical cyclone identifiers; e.g. 01S, 02S, 03S, etc., are assigned by JTWC upon issuance of the first warning. This occurs when the TC reaches a threshold intensity of 35 knots, unless initiation of warnings at a lower intensity is operationally warranted. JTWC will include the TC number spelled out as the name until such time that the Australian Tropical Cyclone Warning Centre (TCWC) assigns a name; e.g. 01S (One), 02S (Two), 03S (Three), etc. Rotating lists of storm names assigned by the Australian TCWC are provided here.

3.3.8. South Pacific - 135°E to 160°E.

Tropical cyclone identifiers; e.g. 01P, 02P, 03P, etc., are assigned by JTWC upon issuance of the first warning. This occurs when the TC reaches a threshold intensity of 35 knots, unless initiation of warnings at a lower intensity is operationally warranted. JTWC will include the TC number spelled out as the name until such time that the Australian Tropical Cyclone Warning Centre (TCWC) assigns a name; e.g. 01P (One), 02P (Two), 03P (Three), etc. Rotating lists of storm names assigned by the Australian TCWC are provided here.

3.3.9. South Indian - 90°E to 135°E.

Tropical cyclone identifiers; e.g. 01A, 02A, 03A, etc. in the Arabian Sea and 01B, 02B, 03B, etc. in the Bay of Bengal, are assigned by JTWC upon issuance of the first warning. This occurs when the TC reaches a threshold intensity of 35 knots, unless initiation of warnings at a lower intensity is operationally warranted. JTWC will include the TC number spelled out as the name until such time that RSMC New Delhi assigns a name; e.g. 01A (One), 02B (Two), etc. A non-rotating list of Northern Indian Ocean storm names assigned by the Indian Meteorological Department RSMC New Delhi Tropical Cyclone Center are provided here.

3.3.10. South Indian - West of 90°E.

Tropical cyclone identifiers; e.g. 01S, 02S, 03S, etc., are assigned by JTWC upon issuance of the first warning. This occurs when the TC reaches a threshold intensity of 35 knots, unless initiation of warnings at a lower intensity is operationally warranted. JTWC will include the TC number spelled out as the name until such time that the responsible agency (RSMC La Reunion delegates some renaming responsibility to Mauritius Meteorological Services) assigns a name; e.g. 01S (One), 02S (Two), 03S (Three), etc. Rotating lists of Southwest Indian Ocean storm names assigned by RSMC La Reunion are provided here.

3.3.11. Subtropical Depressions.

The hurricane centers will use a single list of numbers and names for all tropical and subtropical cyclones in each basin. Therefore, numbering of subtropical depressions will follow the same procedure as tropical depressions. For example, if the first subtropical depression follows the first tropical depression, the subtropical depression will be given the designation SUBTROPICAL DEPRESSION TWO. If a subtropical depression becomes a subtropical storm, it receives the next available name in the tropical cyclone naming sequence.

JTWC does not issue warnings on subtropical cyclones unless they transition to fully tropical cyclones or warnings are otherwise operationally warranted. In such cases, the cyclone’s name and designation will be determined in the same way as for tropical cyclones, and the cyclone number will be assigned from the same sequence as for tropical cyclones. For example, if JTWC issues warnings on a subtropical depression following the first tropical cyclone of the season, it will be designated TROPICAL DEPRESSION TWO.

3.4. Transfer of Warning and Best Track Responsibility.

3.4.1. NHC to CPHC.

When a tropical or subtropical cyclone approaches 140°W, the coordinated transfer of warning responsibility from NHC to CPHC will be made and the appropriate advisory issued. When an invest area approaches 140°W, the coordinated transfer of best track responsibility between NHC and CPHC will be made.

3.4.2. CPHC to JTWC/(RSMC, Tokyo)/WFO Guam.

When a tropical or subtropical cyclone crosses 180° from east to west, the coordinated transfer of warning responsibility from CPHC to JTWC will be made and the appropriate advisory issued. At the same time, the CPHC will coordinate with the RSMC, Tokyo and WFO Guam so that they are aware that CPHC will be suspending the issuance of advisories. When an invest area crosses 180° from east to west, the coordinated transfer of best track responsibility from CPHC to JTWC will be made.

3.4.3. JTWC/(RSMC, Tokyo) to CPHC.

When a tropical or subtropical cyclone crosses 180° from west to east, the coordinated transfer of warning responsibility from JTWC to CPHC will be made. At the same time, the CPHC will coordinate with RSMC, Tokyo so that they are aware that CPHC will be assuming the issuance of advisories. When an invest area crosses 180° from west to east, the coordinated transfer of best track responsibility from JTWC to CPHC will be made.

3.4.4. JTWC to OPC.

Due to the dependence of some Ocean Prediction Center (OPC) maritime products on JTWC warnings, JTWC will notify OPC, on a best effort basis, prior to issuing final warnings for western north Pacific tropical cyclones that become extratropical or subtropical in the OPC area of responsibility.

3.5. Alternate Warning Responsibilities.

3.5.1. Transfer to Alternate.

In the event of impending or actual operational failure of a hurricane forecast center, tropical warning responsibilities will be transferred to an alternate facility in accordance with existing directives and will remain there until resumption of responsibility can be made. Alternate facilities are listed in Table 3-1.

Table 3-1. Primary and alternate operational warning responsibilities.

PRIMARY	ALTERNATE
NHC	Atlantic Basin: NCEP/WPC, College Park, MD Eastern Pacific Basin: CPHC
CPHC	NHC
CARCAH	53 WRS
JTWC	Fleet Weather Center, Norfolk (FWC-N)
WFO Guam	TCP: CPHC WWA: WFO Honolulu

3.5.2. Notification.

FWC-N and JTWC, Pearl Harbor, will be advised by NHC, CARCAH, and CPHC, as appropriate, of impending or actual transfer of responsibility by the most rapid means available. JTWC will advise CPHC, NHC, WFO Guam, and WSO Pago Pago of impending or actual transfer of JTWC responsibilities. In the event of a CARCAH operational failure, direct communication is authorized between the 53 WRS and the forecast facility. Contact 53 WRS at DSN 597-2409/228-377-2409 or through the Keesler AFB Command Post at DSN 597-4181/4330; COM 228-377-4181/4330 (ask for the 53 WRS).

3.6. Abbreviated Communications Headings.

Abbreviated communications headings are assigned to advisories on tropical and subtropical cyclones and other advisories based on depression numbers or storm name and standard communications procedures governed by the World Meteorological Organization (WMO). An abbreviated heading consists of three groups with **one** space between each of the groups. The first group contains a data type indicator (e.g., WT for hurricane), a geographical indicator (e.g. NT for Atlantic Basin), and a number. The second group contains a location identifier of the message originator (e.g., KNHC for NHC). The third group is a date-time group in UTC. An example of a complete header is: WTNT61 KNHC 180400. Table 3-2 provides the abbreviated communications headings for products issued by NHC, CPHC, and WFO Guam.

Table 3-2. Summary of Products and their Associated WMO Header

PRODUCT TITLE	WMO HEADER
Tropical Weather Outlook	
Atlantic Basin	ABNT20 KNHC
Eastern Pacific	ABPZ20 KNHC
Central Pacific	ACPN50 PHFO
Tropical Weather Discussion	
Atlantic Basin	AXNT20 KNHC
Eastern Pacific	AXPZ20 KNHC
Western North Pacific	AXPQ20 PGUM
Tropical/Subtropical Cyclone Public Advisory	
Atlantic Basin	WTNT31-35 KNHC
Atlantic Basin - WPC-issued	WTNT31-35 KWNH
Eastern Pacific	WTPZ31-35 KNHC
Eastern Pacific - WPC-issued	WTPZ31-35 KWNH
Central Pacific	WTPA31-35 PHFO
Western Pacific	WTPQ31-35 PGUM
Tropical Cyclone Surface Wind Speed Probabilities Text Product	
Atlantic Basin	FONT11-15 KNHC
Eastern Pacific	FOPZ11-15 KNHC
Central Pacific	FOPA11-15 PHFO
Tropical/Subtropical Cyclone Forecast/Advisory	
Atlantic Basin	WTNT21-25 KNHC
Atlantic Basin - WPC-issued	WTNT21-25 KWNH
Eastern Pacific	WTPZ21-25 KNHC
Eastern Pacific - WPC-issued	WTPZ21-25 KWNH
Central Pacific	WTPA21-25 PHFO
Tropical Cyclone Discussion	
Atlantic Basin	WTNT41-45 KNHC
Atlantic Basin - WPC-issued	WTNT41-45 KWNH
Eastern Pacific	WTPZ41-45 KNHC
Eastern Pacific - WPC-issued	WTPZ41-45 KWNH
Central Pacific	WTPA41-45 PHFO
Tropical Cyclone Valid Time Event Code Product	
Atlantic Basin	WTNT81-85 KNHC
Eastern Pacific	WTPZ81-85 KNHC
Central Pacific	WTPA81-85 PHFO
Tropical Cyclone Update	
Atlantic Basin	WTNT61-65 KNHC
Eastern Pacific	WTPZ61-65 KNHC
Central Pacific	WTPA61-65 PHFO

Table 3-2 (continued). Summary of Products and their Associated WMO Header

PRODUCT TITLE	WMO HEADER
Tropical Cyclone Position and Intensity from Satellite Data	
South Central Pacific 120W - 160E	TXPS40 PHFO
North Central Pacific 140W - 160E	TXPN40 PHFO
Aviation Tropical Cyclone Advisory Message	
Atlantic Basin	FKNT21-25 KNHC
Eastern Pacific	FKPZ21-25 KNHC
Central Pacific	FKPA21-25 PHFO
Tropical Cyclone Summary – Fixes	
South Central Pacific 120W - 160E	TXPS41-45 PHFO
North Central Pacific 140W - 160E	TXPN41-45 PHFO

[Note: Refer to Appendix C for abbreviated communications headers and titles for the products for which JTWC is responsible.]

3.7.Hurricane Liaison Team (HLT).

The HLT is a DHS Federal Emergency Management Agency (FEMA)-sponsored team made up of federal, state, and local emergency managers who have extensive hurricane operational experience. Team members function as a bridge between scientists, meteorologists and the emergency managers who respond if the storm threatens the United States or its territories. Team members provide immediate and critical storm information to government agency decision makers at all levels to help them prepare for their response operations, which may include evacuations, sheltering, and mobilizing equipment. State and/or local officials, not the HLT, make decisions concerning evacuations.

3.7.1. National Weather Service (NWS) Responsibilities.

For more information, please see National Weather Service Instruction 10-603 “NATIONAL HURRICANE CENTER AND CENTRAL PACIFIC HURRICANE CENTER HURRICANE LIAISON TEAM”.

CHAPTER 4: NATIONAL WEATHER SERVICE PRODUCTS FOR THE DEPARTMENT OF WAR

4.1. General.

The DOW and the DOC weather forecasting, reconnaissance, and distribution agencies share technical information and some responsibilities. Mutually supportive relationships have developed over the years and have resulted in a mutual dependency. Due to the nature and distribution of DOW resources and operations, the DOW requires certain meteorological information beyond that available to the general public. Accordingly, the DOC provides DOW with special observations and advisories on tropical and subtropical storms threatening DOW resources or operations.

4.2. Observations.

The NHC and CPHC will make available to DOW all significant tropical and subtropical cyclone observations that they receive.

4.3. Tropical Cyclone and Subtropical Cyclone Forecast/Advisories.

4.3.1. General.

The NHC, CPHC, and WPC will provide to DOW forecasts and related information for ongoing and potential tropical, subtropical, and/or post tropical weather systems. Forecasts will include location, movement, intensity, and dimension of the disturbances. Tropical cyclone forecast/advisories will be disseminated through the National Weather Service (NWS) communications facility at College Park, MD to the Air Force Weather Virtual Private Cloud (AFW-VPC) for further relay to DOW agencies. The DOW forecasters, who must give advice concerning an imminent operational decision, may contact the appropriate hurricane center forecaster (see Chapter 2) when published tropical cyclone forecasts/advisories require elaboration. Telephone numbers for the hurricane centers are in Appendix I.

4.3.2. Issuance of Tropical and Subtropical Cyclone Forecast/Advisories.

The first tropical cyclone forecast/advisory will normally be issued when meteorological data indicates that a tropical or subtropical cyclone has formed. Subsequent advisories will be issued at 0300, 0900, 1500, and 2100 UTC from NHC and CPHC. The public advisories issued by the NWS Forecast Office (WFO) Guam, are issued 1 hour after the JTWC guidance that is issued every six hours. Advisories for Guam will continue to be issued until the system is classified below the depression intensity level or has moved out of their area of responsibility. In addition, special forecasts will be issued whenever the following criteria are met:

> A significant change has occurred, requiring the issuance of a revised forecast package.
> Conditions require a hurricane/typhoon or tropical storm watch or warning to be issued.
>
> > Remarks stating the reason for the special forecast or the relocation will be mandatory in all special forecasts or advisories that include a relocated position.

4.3.3. Tropical Cyclone and Subtropical Cyclone Forecast/Advisory Content.

Tropical cyclone forecast/advisories issued by the NHC and CPHC will contain appropriate information as shown in Figure 4-1. The forecast will contain 12, 24, 36, 48, 60, 72, 96, and 120-hour tropical cyclone forecast positions. As part of the header, a coded string will be appended at the end of the "Issuing Office City State" line (ie, NWS NATIONAL HURRICANE CENTER MIAMI FL BBCCYYYY). This is the Automated Tropical Cyclone Forecasting (ATCF) System Storm Identification Character String recognized by the WMO for tracking and verification of tropical cyclones. The ATCF is three spaces after the state (ie "FL") and uses the following format:

NWS NATIONAL HURRICANE CENTER MIAMI FL BBCCYYYY

or

NWS CENTRAL PACIFIC HURRICANE CENTER HONOLULU HI   BBCCYYYY

where:

BB = Ocean Basin

AL - North Atlantic basin...north of the Equator

SL - South Atlantic basin...south of the Equator

EP - North East Pacific basin...eastward of 140ºW

CP - North Central Pacific basin between the Dateline and 140ºW

WP - North West Pacific basin...westward of the Dateline

IO - North Indian Ocean basin...north of the Equator between 40ºE and 100ºE

SH - South Pacific Ocean Basin and South Indian Ocean basin

CC= Cyclone Number

Numbers 01 through 49 are reserved for tropical and subtropical cyclones and potential tropical cyclones. A cyclone number is assigned to each tropical or subtropical cyclone or potential tropical cyclone in each basin as it develops. The numbers are assigned in chronological order.

Numbers 50 through 79 are reserved for internal use by operational forecast centers.

Numbers 80 through 89 are reserved for training, exercises and testing.

Numbers 90 through 99 are reserved for tropical disturbances which could become tropical or subtropical cyclones or potential tropical cyclones. Although not required, the 90's should be assigned sequentially and reused throughout the calendar year.

YYYY=Four-digit year

This is the calendar year for the Northern Hemisphere. For the Southern Hemisphere, the year begins July 1, with calendar year plus one.

[Note: Tropical cyclone public advisories issued by the NHC, CPHC, and WFO Guam will contain appropriate information as shown in the example in Figure 4-2.]

4.3.3.1. Definition of Wind Radii by Quadrant.

The working definition of the wind radius for a quadrant is: use the largest radius of that wind speed found in the quadrant. Example: NHC's quadrants are defined as NE (0°-90°), SE (90°-180°), SW (180°-270°), and NW (270°-360°). Given a maximum 34-knot radius of 150 nautical miles (NM) at 0°, 90 NM at 120°, and 40 NM at 260°, the following line would be carried in the forecast/advisory: 150NE 90SE 40SW 150NW.

4.3.3.2. Issuance of Tropical and Subtropical Cyclone Forecast/ Advisories.

All tropical cyclone forecast/advisories for each unique system in the Atlantic and Pacific east of 180° will be numbered sequentially beginning with the number 1. Some examples are listed below:

Subtropical Depression One Forecast/Advisory Number 1

Tropical Depression Two-E Forecast/Advisory Number 1

Potential Tropical Cyclone Three-C Forecast/Advisory Number 2

Tropical Storm Anita Forecast/Advisory Number 3

Hurricane (Typhoon) Anita Forecast/Advisory Number 4

Tropical Depression Anita Forecast/Advisory Number 10

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WTNT23 KNHC 102156
TCMAT3

HURRICANE LEE FORECAST/ADVISORY NUMBER  22
NWS NATIONAL HURRICANE CENTER MIAMI FL       AL132023
2100 UTC SUN SEP 10 2023

HURRICANE CENTER LOCATED NEAR 22.1N  61.7W AT 10/2100Z
POSITION ACCURATE WITHIN  15 NM

PRESENT MOVEMENT TOWARD THE WEST-NORTHWEST OR 300 DEGREES AT   7 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  954 MB
EYE DIAMETER  20 NM
MAX SUSTAINED WINDS 105 KT WITH GUSTS TO 120 KT.
64 KT....... 40NE  35SE  30SW  40NW.
50 KT....... 90NE  70SE  50SW  80NW.
34 KT.......150NE 140SE 100SW 140NW.
4 M SEAS....300NE 180SE 240SW 300NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 22.1N  61.7W AT 10/2100Z
AT 10/1800Z CENTER WAS LOCATED NEAR 21.9N  61.4W

FORECAST VALID 11/0600Z 22.7N  62.7W
MAX WIND 115 KT...GUSTS 140 KT.
64 KT... 50NE  40SE  35SW  50NW.
50 KT... 90NE  80SE  50SW  80NW.
34 KT...150NE 140SE 100SW 140NW.

FORECAST VALID 11/1800Z 23.3N  63.9W
MAX WIND 120 KT...GUSTS 145 KT.
64 KT... 50NE  50SE  35SW  50NW.
50 KT... 90NE  80SE  60SW  80NW.
34 KT...150NE 150SE 110SW 140NW.

FORECAST VALID 12/0600Z 23.8N  65.1W
MAX WIND 120 KT...GUSTS 145 KT.
64 KT... 60NE  60SE  40SW  50NW.
50 KT... 90NE  90SE  70SW  80NW.
34 KT...150NE 150SE 120SW 140NW.

FORECAST VALID 12/1800Z 24.2N  66.2W
MAX WIND 115 KT...GUSTS 140 KT.
64 KT... 60NE  50SE  40SW  50NW.
50 KT... 90NE  90SE  70SW  80NW.
34 KT...160NE 160SE 120SW 150NW.

FORECAST VALID 13/0600Z 24.7N  67.0W
MAX WIND 105 KT...GUSTS 130 KT.
64 KT... 60NE  50SE  40SW  50NW.
50 KT...100NE 100SE  80SW  80NW.
34 KT...170NE 170SE 130SW 160NW.

FORECAST VALID 13/1800Z 25.6N  67.6W
MAX WIND 100 KT...GUSTS 120 KT.
64 KT... 60NE  50SE  40SW  50NW.
50 KT...100NE  90SE  80SW  90NW.
34 KT...180NE 180SE 140SW 180NW.

EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 125 NM
ON DAY 4 AND 175 NM ON DAY 5...AND FOR INTENSITY NEAR 15 KT EACH DAY

OUTLOOK VALID 14/1800Z 28.9N  68.0W
MAX WIND  90 KT...GUSTS 110 KT.
50 KT...110NE 100SE  90SW 100NW.
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34 KT...200NE 200SE 160SW 200NW.

OUTLOOK VALID 15/1800Z 33.6N  67.4W
MAX WIND  80 KT...GUSTS 100 KT.
50 KT...120NE 100SE  90SW  90NW.
34 KT...210NE 200SE 160SW 200NW.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 22.1N  61.7W

NEXT ADVISORY AT 11/0300Z

$$
FORECASTER BROWN

NNNN
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Figure 4-1. Tropical Cyclone Forecast/Advisory Format

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ZCZC MIATCPAT4 ALL
TTAA00 KNHC DDHHMM

BULLETIN
Hurricane Michael Advisory Number  16
NWS National Hurricane Center Miami FL       AL142018
1000 AM CDT Wed Oct 10 2018

...CORE OF EXTREMELY DANGEROUS HURRICANE MICHAEL CLOSING IN ON THE
COAST OF THE FLORIDA PANHANDLE...
...LIFE-THREATENING STORM SURGE...HURRICANE FORCE WINDS...AND HEAVY
RAINFALL IMMINENT...


SUMMARY OF 1000 AM CDT...1500 UTC...INFORMATION
-----------------------------------------------
LOCATION...29.4N 86.0W
ABOUT 60 MI...95 KM SSW OF PANAMA CITY FLORIDA
ABOUT 65 MI...100 KM WSW OF APALACHICOLA FLORIDA
MAXIMUM SUSTAINED WINDS...145 MPH...230 KM/H
PRESENT MOVEMENT...NNE OR 15 DEGREES AT 14 MPH...22 KM/H
MINIMUM CENTRAL PRESSURE...928 MB...27.41 INCHES


WATCHES AND WARNINGS
--------------------
CHANGES WITH THIS ADVISORY:

A Tropical Storm Warning has been issued for the coast of North
Carolina from Surf City to Duck including the Pamlico and Albemarle
Sounds.

A Storm Surge Watch has been issued for the coast of North Carolina
from Ocracoke Inlet to Duck.

The Tropical Storm Watch for the Gulf coast west of the Mississippi/
Alabama border has been discontinued.

SUMMARY OF WATCHES AND WARNINGS IN EFFECT:

A Storm Surge Warning is in effect for...
* Okaloosa/Walton County Line Florida to Anclote River Florida

A Storm Surge Watch is in effect for...
* Anclote River Florida to Anna Maria Island Florida, including
Tampa Bay
* Ocracoke Inlet North Carolina to Duck North Carolina

A Hurricane Warning is in effect for...
* Alabama/Florida border to Suwannee River Florida

A Tropical Storm Warning is in effect for...
* Alabama/Florida border to the Mississippi/Alabama border
* Suwanee River Florida to Chassahowitzka Florida
* North of Fernandina Beach Florida to Duck North Carolina
* Pamlico and Albemarle Sounds

A Tropical Storm Watch is in effect for...
* Chassahowitzka to Anna Maria Island Florida, including Tampa Bay

A Storm Surge Warning means there is a danger of life-threatening
inundation, from rising water moving inland from the coastline. For
a depiction of areas at risk, please see the National Weather
Service Storm Surge Watch/Warning Graphic, available at
hurricanes.gov.

A Hurricane Warning means that hurricane conditions are expected
somewhere within the warning area.

A Tropical Storm Warning means that tropical storm conditions are
expected somewhere within the warning area.

A Storm Surge Watch means there is a possibility of life-
threatening inundation, from rising water moving inland from the
coastline.

A Tropical Storm Watch means that tropical storm conditions are
possible within the watch area.

Interests elsewhere across the southeastern United States should
monitor the progress of Michael.

For storm information specific to your area, including possible
inland watches and warnings, please monitor products issued by your
local National Weather Service forecast office.


DISCUSSION AND OUTLOOK
----------------------
At 1000 AM CDT (1500 UTC), the eye of Hurricane Michael was located
near latitude 29.4 North, longitude 86.0 West. Michael is moving
toward the north-northeast near 14 mph (22 km/h).  A turn toward the
northeast is expected this afternoon or tonight.  A motion toward
the northeast at a faster forward speed is forecast on Thursday
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through Friday night.  On the forecast track, the core of Michael is
expected to move ashore along the Florida Panhandle early this
afternoon, move northeastward across the southeastern United States
tonight and Thursday, and then move off the Mid-Atlantic coast away
from the United States on Friday.

Data from NOAA and Air Force Reserve Hurricane Hunter aircraft
indicate that maximum sustained winds are near 145 mph (230 km/h)
with higher gusts. Michael is an extremely dangerous category 4
hurricane on the Saffir-Simpson Hurricane Wind Scale. Some
strengthening is still possible before landfall. After landfall,
Michael should weaken as it crosses the southeastern United States.
Michael is forecast to become a post-tropical cyclone on Friday, and
strengthening is forecast as the system moves over the western
Atlantic.

Hurricane-force winds extend outward up to 45 miles (75 km) from the
center and tropical-storm-force winds extend outward up to 175 miles
(280 km).  A private weather station at Bald Point, Florida,
recently reported a sustained wind of 54 mph (87 km/h) with a gust
to 61 mph (98 km/h).  A wind gust to 46 mph (74 km/h) was recently
reported inland at Tallahassee, Florida.

The latest minimum central pressure based on data from the
reconnaissance aircraft is 928 mb (27.41 inches).


HAZARDS AFFECTING LAND
----------------------
STORM SURGE:  The combination of a dangerous storm surge and the
tide will cause normally dry areas near the coast to be flooded by
rising waters moving inland from the shoreline. The water has the
potential to reach the following heights above ground if peak surge
occurs at the time of high tide...

Tyndall Air Force Base FL to Aucilla River FL...9-14 ft
Okaloosa/Walton County Line FL to Tyndall Air Force Base FL...6-9 ft
Aucilla River FL to Cedar Key FL...6-9 ft
Cedar Key FL to Chassahowitzka FL...4-6 ft
Chassahowitzka to Anna Maria Island FL including Tampa Bay...2-4 ft
Sound side of the North Carolina Outer Banks from Ocracoke Inlet to
Duck...2-4 ft

WIND:  Tropical storm and hurricane conditions are spreading
onshore along the U.S. Gulf Coast within the warning areas.
Hurricane conditions will also spread well inland across portions of
the Florida Panhandle, southeastern Alabama and southwestern Georgia
later today and tonight.

Tropical storm conditions are expected to spread northward within
the warning area along the southeast U.S. coast beginning tonight
through Friday.

RAINFALL:  Michael is expected to produce the following rainfall
amounts through Friday...

Florida Panhandle and Big Bend, southeast Alabama, and portions of
southwest and central Georgia...4 to 8 inches, with isolated maximum
amounts of 12 inches. This rainfall could lead to life-threatening
flash floods.

The remainder of Georgia, the Carolinas, and southern Virginia...3
to 6 inches, with isolated maximum amounts of 8 inches. This
rainfall could lead to life-threatening flash floods.

Florida Peninsula, eastern Mid Atlantic, southern New England
coast...1-3 inches.

SURF:  Swells generated by Michael will affect the coasts of the
eastern, northern, and western Gulf of  America during the next day
or so.  These swells are likely to cause life-threatening surf
and rip current conditions.  Please consult products from your local
weather office.

TORNADOES:  Tornadoes are possible across parts of the Florida
Panhandle and the northern Florida Peninsula through this afternoon.
This risk will spread northward into parts of Georgia and southern
South Carolina this afternoon and tonight.


NEXT ADVISORY
-------------
Next intermediate advisory at 100 PM CDT.
Next complete advisory at 400 PM CDT.

$$
Forecaster Brown

NNNN
```

Figure 4-2. Tropical Cyclone Public Advisory Format

CHAPTER 5: AIRCRAFT RECONNAISSANCE

5.1. General.

All DOC tropical and subtropical cyclone aircraft reconnaissance needs will be requested and provided in accordance with the procedures of this chapter. Operational control of aircraft flying tropical and subtropical cyclone reconnaissance will remain with the operating agencies which own the aircraft.

5.2. Responsibilities.

The DOW, through the AFRC's 53 WRS, 403rd Aircraft Maintenance Squadron (AMXS), 403rd Maintenance Squadron (MXS), and DOC, through NOAA's AOC, operate a complementary fleet of aircraft to conduct hurricane/tropical cyclone reconnaissance, synoptic surveillance, and research missions over the Atlantic Ocean, Gulf of America, and North Pacific Ocean.

5.2.1. DOW.

The DOW, through the Air Force Reserve Command (AFRC), is responsible for:

- Providing operational aircraft for vortex fixes and data, synoptic surveillance missions, and investigative and system survey missions in response to DOC needs (see Figure 5-1). DOC has identified a requirement for, and the DOW maintains aircraft to support, up to five sorties per day. Requirements exceeding five sorties will be accomplished on a "resources-permitting" basis.

  NOTE – *In times of national emergency or war, some or all DOW reconnaissance resources may not be available to fulfill DOC needs.*

- Developing operational procedures and deploying buoys to satisfy DOC needs.
- DOC will request support as needed for DOW to operate 24/7 typically from up to (3) locations simultaneously irrespective of DOW's ability to fulfill these requests. Current DOW resources provide for 24/7 operations from two (2) simultaneous locations with a total commitment of five (5) sorties per day. Additional capacity may be accessible upon request pending status of resource availability.
  - To meet this requirement, the standard support package includes three (3) WC-130Js for each location. To ensure aircraft operability, each deployed location will include one (1) spare parts kit, referred to as a War Readiness Spares Kit (WRSK). **Note:** *If 3-hourly fixes are requested, a fourth aircraft will be required*.
  - Less than three (3) aircraft may be provided for buoy, synoptic requests or as agreed upon with the requesting agency.

5.2.1.1. Combatant Command (COCOM) Situational Awareness.

COCOM situational awareness should be maintained through the Tanker and Airlift Duty Officer (TADO), or equivalent, based on the area of responsibility in which weather reconnaissance missions are being conducted. For Atlantic and Gulf of America areas of operations, United States Air Forces Northern Command (USAFNORTH) is the responsible COCOM. For the

Pacific area of operations, United States Air Forces Indo-Pacific Command (USINDOPACOM) is the responsible COCOM.

5.2.1.2. Global Decision Support System (GDSS).

The GDSS JCS Priority Code for tasked, operational weather reconnaissance is **1A3** (IAW DOW Regulation 4500.9-R and Joint Publications 4-01 and 4-04). The Force Activity Designator (FAD)/Urgency of Need Designator (UND) Supply Priority Designator Determination code is **IIA2** (IAW Joint Publication 4-01 and Air Force Manual 23-110, Volume 2, Part 13, Attachment 3A-2.).

5.2.2. DOC.

The DOC, through the NOAA/OMAO, is responsible for aircraft operations that may be requested to:

- Provide vortex fixes, acquire airborne radar data, and conduct synoptic surveillance missions (see Figure 5-2).
- Augment AFRC aircraft reconnaissance when DOC needs exceed the capabilities of DOW resources.
- Assume responsibility for hurricane reconnaissance over foreign airspace that may be restricted for military operations.
- Conduct research flights.

5.2.3. DOT.

The DOT is responsible for providing air traffic control services to aircraft when within airspace controlled by the FAA. This includes offshore oceanic airspace. Procedures for the expeditious handling of reconnaissance aircraft are documented in chapter 6, Airspace Operations.

Figure 5-1. AFRC WC-130J Weather Reconnaissance Aircraft

Figure 5-2. NOAA G-IV and WP-3D Weather Surveillance/Hurricane Aircraft

5.3. Reconnaissance Requirements.

5.3.1. Meteorological Parameters.

Data needs in priority order are as follows:

- Geographical position of the flight level vortex center (vortex fix) and relative position of the surface center, if known.
- Wind data (continuous observations of speed and direction along the flight track) for surface and flight level with direction accuracy as specified in section 5.3.2.2. below.
- Center sea-level pressure determined by dropsonde or extrapolation from within 1,500 feet of the sea surface or from the computed 925 millibar (mb), 850 mb, or 700 mb height.
- Minimum 700, 850 or 925 mb height, if available.
- 10 m equivalent neutral wind.
- Radar reflectivity imagery via unsecure real-time data link. High density three-dimensional Doppler radial velocities and horizontal wind vector analyses in the tropical cyclone circulation, prioritized as listed respectively.
- Temperature at flight level.
- Sea-surface temperature.
- Wave Spectra.
- Dew-point temperature at flight level.

5.3.2. Accuracy.

5.3.2.1. Geographic Position.

- Aircraft position: within 3 nautical miles (NM).
- Storm surface center (wind/pressure): within 6 NM.
- Flight level storm center (wind/pressure): within 6 NM.

5.3.2.2. Wind Direction.

- Surface: within 10 deg.
- Flight level for winds greater than 20 knot (kt) : within 5 deg.

5.3.2.3. Wind Speed.

- Surface: 4 kt or 5% of the wind speed (whichever is higher).
- Flight level: within 4 kt.

5.3.2.4. Surface Pressure/Height of Standard Pressure Surface.

- Surface: within 2 mb.
- Flight level at or below 500 mb: within 10 m.
- Flight level above 500 mb: within 20 m.

5.3.2.5. Temperature.

- Sea surface: within lºC.
- Flight level: within lºC.

5.3.2.6. Dew-Point Temperature.

- From -20ºC to +40°C: within 1ºC.
- Less than -20ºC: within 3ºC.

5.3.2.7. Absolute Altitude

- Within 10m

5.3.2.8. Vertical Sounding.

- Pressure: within 2 mb.
- Temperature: within 1ºC.
- Dew-point temperature:

From -20ºC to +40ºC: within 1ºC.
Less than -20ºC: within 3ºC.

- Wind direction: within 10 deg.
- Wind speed: within 5 kt.

5.3.2.9. Doppler Radar.

Doppler radial velocity:

- Horizontal resolution along aircraft track: 1.5 km
- Radar beam width: 2 degrees.
- Radar radial resolution (gate length): 150 m.
- Error in radar radial velocity: 1 m/s.
- Range: 50 km.

Quality-controlled radials of Doppler velocity:
    Radial bin spacing: 1.5 km.
    Along-track spacing: ~1.5 km.

Three-dimensional earth-relative horizontal wind and reflectivity analyses:

- Horizontal resolution: 2 km.
- Vertical levels: 0.5-km interval starting from 0.5-km altitude.

5.3.2.10. Wave Spectra.

- Significant wave height: Within 0.25 m.
- Wave direction: Within 10 degrees.
- Wave period: Within 1 second.
- Frequency range: 0.05-0.5 Hz.

[NOTE: Present weather reconnaissance capabilities do not completely satisfy these requirements; data will be collected as close to stated requirements as possible.]

5.3.3. High-Density/High-Accuracy (HD/HA) Data Requirements.

The HD/HA data include UTC time, aircraft latitude, longitude, static pressure, geopotential height, extrapolated sea level pressure or D-Value, air temperature, dew point temperature, flight-level (FL) wind direction, FL wind speed, peak 10-second (10-s) average FL wind speed, p, peak 10-s average surface wind speed, rain rate and quality control flags. Except for the peak values noted above, all data provided in HDOB messages are 30-second averages, regardless of the interval at which the HDOB messages are reported. See Appendix G for HDOB message formats. The DOC requires rapid acquisition and transmission of tropical cyclone data, especially within the 24-hour period prior to landfall. If HD/HA capability is lost on an operational mission, the airborne meteorologist will immediately contact Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH) to determine data requirements for the remainder of the mission.

5.3.4. Synoptic Surveillance Data Requirements.

When required, NHC will request sounding data on the periphery of systems approaching populated areas. CPHC may request sounding data on the periphery of those that may impact the Hawaiian Islands. For all synoptic-surveillance tasking requirements, NHC will be responsible for providing specific tracks including dropsonde locations pertaining to each designated synoptic time to CARCAH for coordination with the reconnaissance units.

NHC will provide synoptic surveillance mission flight tracks to CARCAH and the applicable flying unit 24 hours before the takeoff time of any scheduled mission. Required updates to flight tracks would be provided at least 4 hours prior to takeoff.

5.3.5. Core Doppler Radar Requirements.

When required, NHC/CPHC and the Environmental Modeling Center (EMC) will coordinate to request high-density three-dimensional Doppler radial velocities in tropical systems of interest. To the greatest extent possible, a standard NOAA P-3 TDR mission consists of at least two passes through the storm center, preferably 90 degrees, but at least 60 degrees, apart, and extending 105 NM from the center. An uninterrupted aircraft center pass with a 30-degree maximum difference between inbound and outbound track is preferred for optimal TDR data quality control. This TDR mission can be adjusted to meet operational needs. For NOAA P-3 tropical cyclone investigative and fix missions, TDR data processing shall be coordinated through CARCAH. Transmission to EMC is currently excluded for investigative missions. Three-dimensional radar analysis products should be available in AWIPS-2 within 1 hour of completion of a TDR data collection period (e.g., aircraft center pass). All quality-controlled radials of Doppler velocity should be available at the NWS gateway within 3.25 hours after the targeted synoptic time unless adjusted for operational needs. Radar analyses and quality-controlled radials of Doppler velocity shall be similarly transmitted during NOAA G-IV "Synoptic Surveillance" missions the 90-NM center circumnavigation flight segment. A reasonable effort, coordinated through CARCAH, should be made to process and transmit data within 180 NM of the storm center. EMC, NHC/CPHC, and HRD will coordinate to provide specific flight plans to CARCAH for coordination with the reconnaissance units.

5.3.6. Required Frequency and Content of Observations.

Observation requirements are summarized in Table 5-1. Deviations to these requirements will be coordinated through CARCAH. Manual flight-level horizontal observations will be encoded and transmitted as standard reconnaissance code (RECCO) messages. Dropsonde vertical atmospheric sounding data consisting of upper-level pressure, temperature, humidity, and wind observations will be encoded and transmitted in World Meteorological Organization (WMO) TEMP DROP format. In addition, all dropsonde data will also be transmitted in BUFR format from the NOAA aircraft. CARCAH will only quality-control TEMP DROP code observations. All reconnaissance-aircraft data message formats, information, and code descriptions are documented in Appendix G. Inner core radar reflectivity should be provided at a rate of one image per TC fix and sent to CARCAH and duty forecasters at NHC or CPHC ideally within 30 minutes of transmission of each corresponding Vortex Data Message if aircraft communications systems are capable.

Table 5-1. Requirements for Aircraft Reconnaissance Data

		RECCO Section 1 plus 4ddff and 9VTTT as applicable	**Vertical Data Temp Drop Code (FM37-VII)**	**High Density Observation (HDOB)**	**Vortex Data Message (VDM)**
En route to Operating Area		Approx. every 30 minutes over water not to exceed 200 NM (optional when HDOBs are sent).	Approx every 300-400 NM over water, or fewer/relocated per request for sonde conservation	30-sec interval	NA
Operating Area	ALPHA Pattern	End points of pattern legs (optional when TEMP DROP is sent at these points). When necessary with radar fix information.	Each tasked fix at or above 850 mb. Intermediate fixes and eyewall modules as requested. Beginning and turn points of Alpha pattern legs	30-sec interval	Each fix
	Investigative	At or within 250 nm of the first approach to a customer-specified location and then at major turn points. Every 15 minutes if HDOBs are INOP.	NA	30-sec interval	If closing a circulation
	System Survey	At the initial point of a customer-specified flight-pattern and then at major turn points, (optional when TEMP DROP is sent at these points). Every 15 minutes if HDOBs are INOP are below 850 mb.	At customer-requested locations for patterns at or above 850 mb.	30-sec interval	If closing a circulation

		RECCO Section 1 plus 4ddff and 9VTTT as applicable	Vertical Data Temp Drop Code (FM37-VII)	High Density Observation (HDOB)	Vortex Data Message (VDM)
	Synoptic	Only if requested by customer.	At designated points.	30-sec interval	NA
	Sampling Modules	Follow ALPHA Pattern guidance.	Eyewall: Just inside the inbound and outbound Rad Max Wind (See 5.7.5.1.). In intense hurricanes (e.g 120 kt or greater), rapidly strengthening hurricanes, or hurricanes with small RMW (e.g. RMW < 10 n mi) additional immediate successive RMW dropsondes may be requested for specific quadrants by NHC, as resources permit. Outer-Wind: From center to 200 NM out in 50 NM NM intervals for inbound and outbound legs.	30-sec interval	NA
	Buoy	Only if requested by customer.	NA	30-sec interval	NA
En route from Operating Area		Approx. every 30 minutes over water not to exceed 200 NM, at ARWO / Flight Director discretion (optional when HDOBs are sent).	Approx. every 300-400 NM over water, or fewer/relocated per request for sonde conservation, at ARWO / Flight Director discretion.	30-sec interval	NA

5.3.7. WP-3D and G-IV Configuration.

5.3.7.1. WP-3D Configuration.

The minimum operational configuration of the WP-3D will include an instrument that provides high density surface wind estimates along the flight path, Doppler radar, weather message module (WMM), and the advanced vertical atmospheric profiling system (AVAPS).

5.3.7.2. G-IV Configuration.

The minimum operational configuration of the NOAA G-IV will include the advanced vertical atmospheric profiling systems (AVAPS) and tail Doppler radar.

5.4. Reconnaissance Planning and Flight Notification.

5.4.1. DOC Requests for Aircraft Reconnaissance Data.

5.4.1.1. Coordination.

Any NOAA/NWS facility requesting aircraft reconnaissance (e.g., the NWS Environmental Modeling Center (EMC), the Central Pacific Hurricane Center (CPHC)) should contact the National Hurricane Center (NHC) no later than 1630 UTC the day prior to the requirement, and within the constraints of paragraph 5.4.2.1. NHC will compile the list of the total DOC requirements for data on tropical and subtropical cyclones or disturbances for the next 24-hour period (1100 to 1100 UTC), an outlook for the succeeding 24-hour period, and potentially an additional day outlook as operational requirements dictate. This coordinated request will be provided to CARCAH as soon as possible, but no later than 1630 UTC each day in the format of Figure 5-3.

5.4.1.2. Anticipated Reconnaissance Requests.

Reconnaissance requests can be anticipated for a forecast or actual storm location.

5.4.1.2.1. Fix. For the Atlantic, Gulf of America, Caribbean, and Central Pacific areas, the requests can be:

- Up to four 6-hourly fixes per day when a storm is within 500 NM of landfall and west of 52.5ºW in the Atlantic.
- Up to eight 3-hourly fixes per day when a storm is forecast to be within 300 NM of the U.S. coast, Hawaiian Islands, Puerto Rico, Virgin Islands, DOW installations, and other DOW assets when specified.

In the Eastern Pacific (EPAC), reconnaissance missions are generally tasked for systems that pose a hurricane threat to the west coast of Mexico, with one mission a day typically flown around 1800 UTC. A second flight (likely around 0600 UTC) can be tasked in situations where rapid intensification is possible and/or the storm is expected to make landfall overnight. More frequent missions may be tasked for systems that pose a threat to U.S. interests.

5.4.1.2.2. Investigative (Invest). Investigative flights may be requested for disturbances in areas defined for Atlantic-basin fix requests, i.e., one or two flights per day dependent upon proximity of landfall and upon known or suspected stage of development.

5.4.1.2.3. System Survey. System survey flights may be requested for disturbances or existing storms in areas defined for Atlantic-basin fix requests, i.e., one or two flights per day dependent upon proximity of landfall and customer observational needs.

5.4.1.2.4. Tail Doppler Radar (TDR). Up to two NOAA WP-3D aircraft Tail Doppler Radar (TDR) missions per 24-hour period for an existing or developing tropical cyclone west of 45°W in the Atlantic or an existing tropical cyclone that is a threat to the Hawaiian Islands in the Central Pacific, subject to availability as described in subparagraph 5.4.2.1.5

5.4.1.2.5. Synoptic Surveillance. Up to two synoptic surveillance missions per 24-hour period for potentially land-falling storms.

5.4.2 Tropical Cyclone Plan of the Day (TCPOD).

The TCPOD lists all DOW/AFRC and DOC/NOAA/OMAO tropical and subtropical operational reconnaissance requirements, outlining tasked missions with scheduled takeoff times within the 24-hour valid period between 1100 UTC of the next day to 1100 UTC of the following day. Research missions will be included as remarks when provided to CARCAH before transmission time. The coordinated TCPOD is NOAA's Request for Assistance (RFA) to DOW. Since DOW's support to NOAA is congressionally mandated and funded through the National Defense Appropriations Act, it is considered a validated and approved RFA. When DOC reconnaissance needs exceed DOW and DOC resources, CARCAH will coordinate with the NHC to establish priorities of requirements.

NHOP COORDINATED REQUEST FOR AIRCRAFT RECONNAISSANCE

Original _____
Amendment _____

(Check one)

ATLANTIC REQUIREMENTS

Storm Name Depression # Suspect Area	Fix or on Station Time	Coordinates	Flight Pattern	FCST Mvmt	NHC Priority

Gulfstream ____

Succeeding Day Outlook ____

____

Remarks ____

____

PACIFIC REQUIREMENTS

Storm Name Depression # Suspect Area	Fix or on Station Time	Coordinates	Flight Pattern	FCST Mvmt	NHC Priority

Succeeding Day Outlook ____

____

Remarks ____

____

DISTRIBUTION

A. To CARCAH by 1630Z or amend at any time
B. Date __________ Time ___________ Forecaster Initials ___________
C. 53WRS _____ AOC _____ Other _____

Figure 5-3. NHOP Coordinated Request for Aircraft Reconnaissance

TROPICAL CYCLONE PLAN OF THE DAY (TCPOD) FORMAT

ATLANTIC AND PACIFIC OCEANS

NOUS42 KHNC _________________ (Date/Transmission Time in UTC)
WEATHER RECONNAISSANCE FLIGHTS
CARCAH, NATIONAL HURRICANE CENTER, MIAMI, FL
______ (Local Time) ____ (Time Zone) _____ (Day) _________________ (Issuance Date, Month, &Year)
SUBJECT: TROPICAL CYCLONE PLAN OF THE DAY (TCPOD)
VALID _______Z (Date/Time) TO _______Z (Date/Time) ______________ (Month & Year)
TCPOD NUMBER…..____ - _______ (2-Digit Year - Edition #)
I. ATLANTIC REQUIREMENTS

1. FIRST SYSTEM (Storm Name, Depression, Suspect Area) or NEGATIVE RECON REQUIREMENTS.

FLIGHT ONE – TEAL or NOAA ____ (Call Sign)
A. ____________________ (Required Fix/Invest Date/Time(s) or Designated Synoptic Date/Time in UTC)
B. ____________________ (Mission Identifier)
C. ____________________ (Estimated Departure Date/Time in UTC)
D. ____________________ (System Forecast Position at First Date/Time in Item A)
E. ____________________ (Date/Time Window of Aircraft on Station in UTC)
F. ____________________ (Altitude(s) of Aircraft on Station or for Flight Pattern)
G. ____________________ (Mission Profile)
H. ____________________ (Weather Reconnaissance Area Activation Status)
I. ____________________ (Remarks, if needed)

FLIGHT TWO (if applicable, same format as Flight One)
(Repeat for each successively tasked mission for system using same format as Flight One.)
2. SECOND SYSTEM (if applicable, same format as the first above)
3. OUTLOOK FOR SUCCEEDING DAY (NHC Priority, if applicable)
A. [POSSIBLE] ________ (Mission Requirement) NEAR ___________ (Location) AT _______Z (Date/Time).
or
BEGIN/CONTINUE __________ (Time Interval) FIXES ON __________________ (1st System) [IF IT DEVELOPS/WHILE IT REMAINS A THREAT].
or
NEGATIVE.
B. [POSSIBLE] ________ (2nd Mission Requirement) NEAR ___________ (Location) AT _______Z (Date/Time).
or
BEGIN/CONTINUE __________ (Time Interval) FIXES ON __________________ (2nd System) [IF IT DEVELOPS/WHILE IT REMAINS A THREAT].
4. REMARKS (if needed)
II. PACIFIC REQUIREMENTS (same format as Atlantic)

Figure 5-4. Tropical Cyclone Plan of the Day Format

5.4.2.1. DOW and DOC Reconnaissance Aircraft Responsiveness.

5.4.2.1.1. Requirement Notification. Notification of requirements must precede tasked-on-station time by at least 16 hours plus en route time to the area of concern.

5.4.2.1.2. Prepositioning. The "Succeeding Day Outlook" portion of the TCPOD provides advance notification of requirements and authorizes units to preposition aircraft to forward operating locations. For missions requiring prepositioning, the "Succeeding Day Outlook" may not provide adequate advance notification. In this situation, an "Additional Day Outlook" may be included in the TCPOD to authorize units to preposition aircraft.

5.4.2.1.3. Resources Permitting. When circumstances preclude the appropriate notification lead time, the requirement will be levied as "resources permitting." When a "resources permitting" requirement is levied in an amendment, the NHC will indicate the priority of all existing or remaining requirements.

5.4.2.1.4. Emergency Requirement. If a storm develops unexpectedly and could cause a serious threat to lives and property within a shorter time than provided for in the paragraphs above, CARCAH will contact the reconnaissance units, or higher headquarters, as appropriate, and request assistance in implementing emergency procedures not covered in this plan. The NHC and CPHC directors have authority to declare an emergency.

5.4.2.1.5. NOAA WP-3D Availability. At least one WP-3D will be operationally configured (per subparagraph 5.3.7.1) and available to respond to requirements within 24-hours from June 1 through November 30 annually. A second WP-3D with the same operational configuration will be available each hurricane season from August 1 to October 31. When maintenance and programmatic considerations permit, the second aircraft could be made available until November 30 also. The frequency of flights when two aircraft are available and with present staffing shall be every 12 hours.

5.4.2.2. Preparation.

After coordinated requests are received from NHC and CPHC, CARCAH will convey the requirements to the 403rd Wing Current Operations section and NOAA AOC and task operational reconnaissance missions. CARCAH will then prepare and publish the TCPOD daily during the period from June 1 to November 30 and at other times during the year as required using the format depicted in Figure 5-4. Transmitted TCPODs will be serially numbered each season as shown in the figure.

Amendments to the TCPOD will be prepared and published only when requirements change. When amended, the impact on each listed flight will be identified (i.e., No Change, Change Added, or Canceled).

5.4.2.3. Dissemination.

The TCPOD will be made available to appropriate departments and agencies, such as FAA, DOW, and NOAA, which provide support to or control of reconnaissance aircraft or are a part of the tropical cyclone warning service. Under normal circumstances, CARCAH is responsible for disseminating it by **1830 UTC** each day during the period specified in 5.4.2.2, including weekends and holidays. If there are no current day or succeeding-day reconnaissance requirements, a negative report, which covers the appropriate time frame, will be disseminated.

Amendments will be disseminated as required. If any errors are discovered, a corrected TCPOD will be sent out promptly.

COCOM headquarters and their air component command headquarters will pull weather reconnaissance RFA information daily after 1830 UTC from the NHC Aircraft Reconnaissance webpage.

5.4.2.4. November Publication.

The last month of hurricane season and the first month of winter season both occur in November. During this overlapping period, CARCAH may receive RFAs for NHOP and National Winter Season Operations Plan (NWSOP) aerial reconnaissance requirements. Both types will be published within a single TCPOD message rather than separate TCPOD and Winter Season Plan of the Day (WSPOD) messages. The NWSOP items will appear as a note below the NHOP items. Should the combined NHOP and NWSOP needs exceed the number of available DOW and DOC resources, CARCAH will notify the duty SDM and lead forecasters at the National Hurricane Center (NHC) and/or the Central Pacific Hurricane Center (CPHC). The NWS Centers will coordinate internally on priority and communicate their decision to CARCAH prior to TCPOD publication. The NHOP requirements will normally have precedence over the NWSOP.

NOTE -*The POD "For Today" identifies missions flying that day while the POD "For Tomorrow" identifies future flying requirements to incorporate into air tasking orders.*

[NOTE: The TCPOD is disseminated under the header "MIAREPRPD" for AWIPS users and "NOUS42 KNHC" for AWDS users. The TCPOD can also be accessed via the National Hurricane Center **homepage; access the Data & Tools drop down menu, then click on 'Aircraft Reconnaissance,' and then select 'For Today' or 'For Tomorrow' under the 'Plan of the Day' heading.]**

5.5. Reconnaissance Effectiveness Criteria.

5.5.1. General.

Specified reconnaissance times are established to allow sufficient time for the forecaster to analyze the reconnaissance aircraft data before issuing an advisory and/or a sufficient number of observations to be transmitted for incorporation into the numerical weather model data assimilation process. Every effort should be made to obtain data at scheduled times and gaps in data collection between synoptic times should be minimized as resources permit. The following criteria will be used to assess reconnaissance mission effectiveness:

5.5.1.1. Tropical Cyclone Fix Mission.

- ON TIME. The fix is made no earlier than 1 hour before nor later than ½ hour after scheduled fix time.
- EARLY. The fix is made from 1 hour before scheduled fix time to one-half of the time interval to the preceding scheduled fix, not to exceed 3 hours.
- LATE. The fix is made within the interval from ½ hour after scheduled fix time to one-half of the time interval to the succeeding scheduled fix, not to exceed 3 hours.
- MISSED. Data are not obtained within the parameters specified for on-time, early, or late.

- IN-FLIGHT ADJUSTMENTS. In-flight adjustments to leg lengths will result in a change in evaluation criteria for subsequent requirements. Any requirements prior to the adjustment will comply with the standard criteria described above. Any requirements after the adjustment will be deemed “on-time” when the aircraft continues to fly the adjusted flight pattern until the final fix time. If the aircraft must depart from within 150 NM of the center before the last scheduled fix time, that requirement will be considered “missed”, unless the customer and aircrew coordinate otherwise through CARCAH. (Example: For an 1130 and 1730 UTC fix mission that is adjusted at 1400 UTC, the 1130 UTC fix will be evaluated based on the standard criteria and the 1730 UTC fix will be considered “on-time” if the aircraft is flying the adjusted flight pattern and is within 150 NM of the center until 1730 UTC.)
- CANCELED. Customer communicates to CARCAH that the fix requirement is rescinded prior to the scheduled fix time. When possible, cancellation of requirements prior to the scheduled aircraft departure is desirable.

[NOTE: Appropriate credit will be given when the aircraft arrives in the requested area but is unable to locate a center due to storm dissipation, the absence of a fixable center, or rapid movement. Credit will also be given for radar fixes if penetration is not possible due to geographic or other flight restrictions.]

5.5.1.2. Tropical Cyclone Investigative Missions.

- ON TIME. An observation must be taken within 250 NM of the specified coordinates by the scheduled time.
- LATE. An observation is taken within 250 NM of the specified coordinates after the scheduled time but not later than the scheduled time plus 2 hours.
- MISSED. When the aircraft fails to be within the 250 NM of the specific coordinates by the scheduled time plus 2 hours or is unable to provide meaningful data.
- CANCELED. Customer communicates to CARCAH that the mission is no longer needed prior to the scheduled aircraft departure.

5.5.1.3. Synoptic Surveillance Missions.

- SATISFIED. Customer requirements are considered satisfied when 80% or more of the requested flight-pattern drops are accomplished and the dropsonde data transmitted from the aircraft are received at NCEP Central Operations (NCO).
- PARTIALLY SATISFIED. Customer requirements are considered partially satisfied when 50-79% of the drops requested are accomplished and the dropsonde data transmitted from the aircraft are received at NCEP Central Operations (NCO).
- DEGRADED. Customer requirements are considered degraded when at least one but less than 50% of the drops requested are accomplished and the dropsonde data transmitted from the aircraft are received at NCEP Central Operations (NCO).
- MISSED. When none of the customer dropsonde requirements are accomplished.
- CANCELED. Customer communicates to CARCAH that the mission is no longer needed prior to the scheduled aircraft departure.

5.5.1.4. System Survey Missions.

- SATISFIED. Customer requirements are considered satisfied when FL wind and drop observations, if requested, are collected and transmitted for 80% or more of the predetermined flight pattern and the aircraft arrives at the initial point coordinates no later than two hours from the scheduled time.
- PARTIALLY SATISFIED. Customer requirements are considered partially satisfied when FL wind and drop observations, if requested, are collected and transmitted for 50-79% of the predetermined flight pattern and the aircraft arrives at the initial point coordinates no later than two hours from the scheduled time.
- DEGRADED. Customer requirements are considered degraded when FL wind and drop observations, if requested, are collected and transmitted for less than 50% but more than 0% of the predetermined flight pattern and the aircraft arrives at the initial point coordinates no later than two hours from the scheduled time.
- LATE. When the aircraft arrives at the initial point coordinates of the predetermined flight pattern more than two hours after the scheduled time, regardless of the amount of observations are collected and transmitted.
- MISSED. When the predetermined flight pattern is not accomplished, or no observations from the flight pattern are transmitted in real time.
- CANCELED. Customer communicates to CARCAH that the mission is no longer needed prior to the scheduled aircraft departure.

5.5.2. Mission Assessment.

The NHC or CPHC will provide CARCAH a written assessment of the reconnaissance mission anytime its timeliness or quality is outstanding or substandard (see Figure 5-5). Mission requirements levied as "resources permitting" will not be assessed for timeliness but may be assessed for quality of data gathered.

5.5.3. Summaries.

CARCAH will maintain monthly and seasonal reconnaissance summaries, detailing requirements tasked by NHC and CPHC and missions accomplished.

MISSION EVALUATION FORM

DATE: ____

MEMORANDUM FOR: OL-A, 53 WRS/CARCAH

FROM: ____
(Director, NHC or CPHC)

SUBJECT: MISSION __________________ EVALUATION
(Mission Identifier)

<u>PUBLISHED REQUIREMENTS:</u>

Pre-mission Coordinates (As Updated Prior to TKO) ____________________N___________________W

Flight Pattern ____

Mission Requirements Times ____

<u>RECONNAISSANCE MISSION PERFORMANCE:</u>

Flight Flown: _______ Completely ______ Partially _______ Other

Horizontal Data Coverage: _______ Complete _______ Timely _______ Accurate

_______ Incomplete _______ Untimely _______ Inaccurate

Vertical Data Coverage: ______ Complete _______ Timely _______ Accurate

_______ Incomplete _______ Untimely _______ Inaccurate

Requirements Accomplished: _______ On Time ______ Early _______ Late _______ Missed

<u>OVERALL MISSION EVALUATION</u>:

Outstanding _______

Unsatisfactory ______ for: _______ Completeness _______ Accuracy _______ Timelines

_______ Equipment _______ Procedures _______ Other

<u>REMARKS</u>: (Brief but specific)

____
Forecaster's Signature

Figure 5-5. Mission Evaluation Form

5.6. Aerial Reconnaissance Weather Encoding, Reporting, and Coordination.

5.6.1. Vortex Data.

A Vortex Data Message (Appendix G, Figure G-7) will be prepared for all fixes, using all observed vortex fix information, each time the aircraft penetrates the center of a tropical cyclone. An image of inner core radar reflectivity should ideally be acquired at fix time and correspond to each Vortex Data Message.

5.6.2. Aircraft Radar Fix Data.

When proximity to land, air traffic control restriction, or other factors prevent actual penetration of the vortex by the reconnaissance aircraft, it is permissible to fix the cyclone by radar. Radar fixes may be reported in a vortex data message using available observed information or as a remark appended to a RECCO observation taken at fix time. The remark stating the type of radar fix and quality of the radar presentation is in accordance with chapter 8, paragraph 8.3.2. An example follows:

RADAR FIX PSBL CENTER 21.5N 83.0W, POOR RADAR PRESENTATION, SPIRAL BAND, MET ACCURACY 15NM

5.6.3. Peripheral Data.

Storm penetration and collection of peripheral data will normally begin at the operational altitude approximately 105 NM from the center as determined by the flight meteorologist. The radial distance for sampling one or more quadrants may be modified by the lead operational agency as specified in subparagraph 5.7.1.1 before and during mission execution in coordination with CARCAH and the aircrew.

5.6.4. Mission Coordination.

Coordination for all missions will be accomplished through CARCAH. Meteorological discussions for Central Pacific missions may be accomplished directly with the CPHC; however, any changes to tasking will be accomplished through CARCAH.

5.6.5. Post-flight Debriefing.

Unless otherwise directed, the flight meteorologist will provide either an airborne or post-flight debriefing to the appropriate hurricane center through CARCAH to ensure all observations were received and understood.

5.6.6. Aerial Reconnaissance Abbreviated Communications Headings.

Each type of aerial weather-reconnaissance message (defined in Appendix G) is assigned designated abbreviated communications headings that are dependent on the geographical region. Table 5-2 provides the WMO and Advanced Weather Interactive Processing System (AWIPS) abbreviated headers for each data product. The WMO header consists of three groups. The first has four letters followed by a two-digit product index number. The initial two letters of that group indicate the data type: UR for aerial reconnaissance horizontal observations and UZ for aerial reconnaissance vertical observations. The next two letters depict the basin of the observation: NT for Atlantic, PN for EPAC and Central Pacific, and PA for WPAC (see Figure 5-6). The second element of the header has the ground location ICAO at which the message is received from the aircraft and subsequently disseminated through channels described in paragraph 5.9.1. The remaining element is a date-time group with the time listed in UTC. The AWIPS product ID contains five letters followed by a product index number. The first three letters indicate the message type: REP for standard observations (RECCO, vortex, and dropsonde) and AHO for high-density observations. The other two letters depict the basin location using the same geographical conventions as the WMO header.

5.6.7. Mission Identifier.

Aerial weather-reconnaissance messages will include the five-character agency/aircraft indicator followed by the CARCAH-assigned mission/storm-system indicator. Table 5-3 summarizes elements of the mission identifier.

5.6.8. Storm Identifier <Storm ID>.

To facilitate the automatic ingest into the NHC, CPHC, and DOW tropical cyclone forecast computing systems, the storm identifier will be added 3 spaces after the Vortex Data Message title (see Appendix G, Figure G-7) in the following format: Vortex Data Message BBCCYYYY. For the definition of BBCCYYYY, see Chapter 4, paragraph 4.3.3.

5.6.9. Observation Numbering.

All aerial weather reconnaissance messages will contain the mission identifier followed by an observation number as the first mandatory remark. Standard observation messages (RECCO, vortex, and dropsonde) will be sequentially numbered in the order they are transmitted from the aircraft. The final message will contain a "LAST REPORT" remark. High-density observation (HDOB) messages will also be numbered sequentially but separately from the other messages.

Table 5-2. Summary of Aerial Reconnaissance Data Products and their Associated Headers

PRODUCT	WMO HEADER	AWIPS ID
RECCO (non-tasked mission)		
Atlantic	URNT10 *ICAO* ddhhmm	REPNT0
East and Central Pacific	URPN10 *ICAO* ddhhmm	REPPN0
West Pacific	URPA10 *ICAO* ddhhmm	REPPA0
RECCO (tasked invest, survey, tropical cyclone, or subtropical cyclone mission)		
Atlantic	URNT11 *ICAO* ddhhmm	REPNT1
East and Central Pacific	URPN11 *ICAO* ddhhmm	REPPN1
West Pacific	URPA11 *ICAO* ddhhmm	REPPA1
Vortex Data Message		
Atlantic	URNT12 *ICAO* ddhhmm	REPNT2
East and Central Pacific	URPN12 *ICAO* ddhhmm	REPPN2
West Pacific	URPA12 *ICAO* ddhhmm	REPPA2
TEMP DROP Code (dropsonde observation)		
Atlantic	UZNT13 *ICAO* ddhhmm	REPNT3
East and Central Pacific	UZPN13 *ICAO* ddhhmm	REPPN3
West Pacific	UZPA13 *ICAO* ddhhmm	REPPA3
High-Density Observation		
Atlantic	URNT15 *ICAO* ddhhmm	AHONT1
East and Central Pacific	URPN15 *ICAO* ddhhmm	AHOPN1
West Pacific	URPA15 *ICAO* ddhhmm	AHOPA1

NOTE: *ICAO is KNHC (National Hurricane Center--primary) or KBIX (Keesler Air Force Base--backup) for data messages originating from USAFR/53 WRS aircraft and KWBC (National Weather Service HQ) for data messages originating from NOAA or other agency aircraft.*

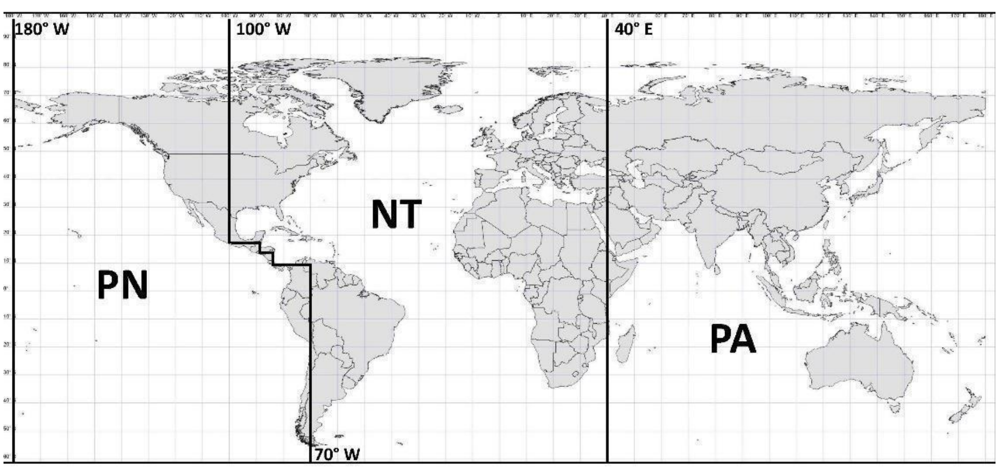

Figure 5-6. Geographical Basins in Aerial Reconnaissance Abbreviated Headings

Table 5-3. Elements of the Mission Identifier

AGENCY/ AIRCRAFT	**Mission Storm System Indicator**			
Agency + Aircraft Number[1][2][3]	Sequential number of mission in this storm or WX[4]	Two-digit depression number or two letter identifier if not a depression or greater[5]	Location A, E, C, or W[6]	Storm name or mission type (i.e., CYCLONE, INVEST, or SURVEY)
EXAMPLES				
AF306 0201C CYCLONE		USAF aircraft 5306 on the second mission for Tropical or Subtropical Depression One in the Central Pacific. Mission type can be fix or surveillance, as specified in the TCPOD.		
AF307 0403E CARLOS		USAF aircraft 5307 on the fourth mission for the third classified tropical or subtropical system that formed in the Eastern Pacific and acquired the name Carlos.		
AF302 0207A SURVEY		USAF aircraft 5302 on the second mission to survey Potential Tropical Cyclone Seven in the Atlantic, Gulf of America, or Caribbean.		
NOAA2 01BBA INVEST		NOAA aircraft N42RF on the first mission to investigate the second unclassified suspect area in the Atlantic, Gulf of America, or Caribbean.		
NOAA9 WAWXA AL92		NOAA aircraft N49RF on the first flight of a sequence of non-tasked research missions into Atlantic suspect area AL92.		
NOAA3 WF13A KARL		NOAA aircraft N43RF on the sixth flight of a sequence of non-tasked research missions into the system that developed from suspect area AL92 into the thirteenth tropical or subtropical cyclone in the Atlantic Basin and acquired the name Karl.		

5.6.10 Corrections to Observations.

A correction indicator should be appended to the WMO abbreviated header after the date/time group and to any lines containing the mission identifier and observation number within corrected aircraft messages. This includes the first remark line in a RECCO, Item U in a vortex data, each of the 61616 lines in a sonde TEMP DROP code, and the second line in an HDOB data message.

---

[1] AF plus last 3 digits of tail number

[2] NOAA, plus last digit of aircraft registration number

[3] UA plus three digits specifying the type of platform and seasonal platform number as defined in Appendix H

[4] Non-tasked missions will be assigned WX. For sequential research missions into the same system, another letter can optionally be substituted for “X,” starting with “A” for manned heavy aircraft (e.g., WA, WB, WC, etc.) and “K” for sUAS (e.g., WK, WL, WM, etc.).

[5] The letters CC should not be used in an invest or survey identifier. WX indicates an unclassified system without operational invest/survey tasking.

[6] The basin identifier is determined by the system origin location or mission departure point if the two preceding characters are WX. For Northern Hemisphere (North of Equator): A=Atlantic, Caribbean, or Gulf of America (West of 40°E to North/Central/South America [approximately 100°W]); E=Eastern Pacific (From North/Central/South America [approximately 100°W] to 140°W); C=Central Pacific (140°W to 180°); W=Western Pacific (West of 180° to 100°E); I= Indian (West of 100°E to 40°E). For Southern Hemisphere (South of Equator): L= Southern Atlantic (West of 30°E to 70°W); S= Southern Indian and Pacific Ocean (West of 70°W to 30°E).

The first corrected message will have an indicator of CCA; subsequent corrections will have indicators of CCB, CCC, etc. Examples of corrected observations are in Table 5-4 below:

Table 5-4. Examples of Corrected Observations

EXAMPLES	
URNT11 KNHC 111629 CCA 97779 16264 51286 90000 30400 09054 11071 /3136 40545 RMK AF303 2709A IKE OB 01 CCA	Correction for RECCO message OB 01 from the AF303 02709A IKE mission.
URNT12 KNHC 130149 CCA VORTEX DATA MESSAGE AL062018 A. 13/01:06:50Z B. 31.72 deg N 073.41 deg W C. 700 mb 2729 m . . . U. AF308 1306A FLORENCE OB 06 CCA MAX FL WIND 103 KT 046 / 56 NM 23:45:00Z MAX FL TEMP 20 C 120 / 14 NM FROM FL CNTR	Correction for vortex data message OB 06 from the AF308 1306A FLORENCE mission.
UZNT13 KWBC 240705 CCB XXAA 74078 99276 70727 08072 99948 270// ///// 00/// ///// ///// 92218 260// 18001 85959 228// 16002 88999 77999 31313 09608 80649 51515 10190 70634 61616 NOAA2 1815A MARIA OB 08 CCB 62626 CENTER LST WND 029 MBL WND 13501 AEV 33304 WL150 14502 103 REL 2762N07267W 064953 SPG 2762N07267W 065327 = XXBB 74078 99276 70727 08072 00948 270// 11850 228// 22723 176// 21212 00948 ///// 11944 09504 22937 15501 33850 16002 44723 01505 31313 09608 80649 51515 10190 70634 61616 NOAA2 1815A MARIA OB 08 CCB 62626 CENTER LST WND 029 MBL WND 13501 AEV 33304 WL150 14502 103 REL 2762N07267W 064953 SPG 2762N07267W 065327 =	Second correction for sonde TEMP DROP code message OB 08 from the NOAA2 1815A MARIA mission.

5.7. Operational Flight Patterns.

This section details the operational flight patterns that provide vortex and peripheral data on tropical and subtropical cyclones.

5.7.1. Flight Pattern ALPHA Operational Details.

5.7.1.1. Flight Levels and Sequences.

Flight levels will normally be 1,500 ft, 925 mb, 850 mb, or 700 mb, depending on data requirements and flight safety. Legs will normally be 105 NM long unless modified to meet operational needs and will normally be flown on intercardinal tracks (45 degrees off cardinal tracks). The flight sequence is shown in Figure 5-7. The ALPHA pattern can be started at any intercardinal point and then repeated throughout the mission. Prior to starting an inbound or outbound track the aircrew should evaluate all available data, e.g., radar presentation, satellite imagery, for flight safety. Once started on course, every effort should be made to maintain a straight track and the tasked altitude. Vertical dropsonde observations are also required at the beginning of the initial ALPHA pattern and every subsequent turn point, provided sufficient resources and the flight level is at or above 850 mb. A horizontal observation is only required at each leg end point when the flight level is below 850 mb or a dropsonde is not released. These data are transmitted immediately. The flight track may be modified to satisfy unique customer requirements (such as extending legs to examine the wind profile of a strong or large storm) or because of proximity of land or warning areas.

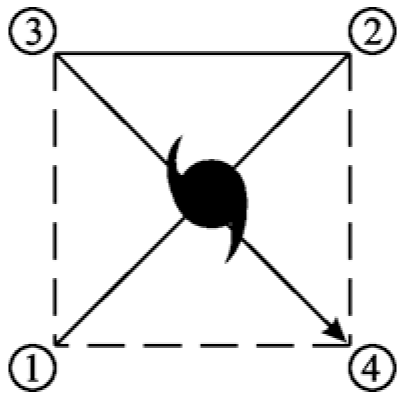

Figure 5-7. Flight Pattern ALPHA

5.7.1.2. Vortex fix data.

On each transit of the center a fix will be made and a vortex data message completed, using data gathered on the track since the previous fix and will be transmitted immediately. Center dropsonde data will also be provided for scheduled fixes made at 850 mb or above. The dropsonde will be released at the flight-level center coordinates (item BRAVO of the vortex data message). For fixes when dropsonde-measured SLP is not available, an extrapolated SLP will be computed and reported.

5.7.2. Investigative Missions.

An investigative mission is tasked on tropical or subtropical disturbances to determine the existence or non-existence of a closed circulation, supply reconnaissance observations in required areas, and locate the vortex center, if any.

5.7.2.1. Flight Levels.

Flight level will normally be at or below 1,500 ft absolute altitude but may be adjusted as dictated by data requirements, meteorological conditions, or flying safety factors.

5.7.2.2. Vortex Fix.

A vortex data message is required if a vortex fix is made.

5.7.2.3. Closed Circulation.

A closed circulation is supported by at least one sustained vector wind observation reported in each quadrant of the cyclone. Surface winds are preferred.

5.7.2.4. Flight Pattern.

The preferred approach is to fly to the tasked coordinates of the forecasted center and then execute a pattern as observed conditions dictate. Suggested patterns are the X, Box, or Delta patterns, but the flight meteorologist may choose any approach. See Figure 5-8. Turns are usually made to take advantage of tailwinds whenever possible. Note: The depicted pattern may be converted to a mirror image if entry is made from a different direction.

- On the X pattern, the aircraft is turned to head directly towards the center, as indicated by the surface or flight level winds. The aircraft is flown through the calm center until winds from the opposite direction occur (second quadrant). The aircraft is then turned to a cardinal heading until a wind shift occurs (third quadrant). Finally, the aircraft is turned towards the center and flown straight through the center to the last quadrant.
- On the Box pattern, the aircraft is flown on cardinal headings around the suspected center. The track resembles three sides of a square.
- On the Delta pattern, the aircraft is flown on a cardinal heading to pass 60 NM from the forecasted center. After observing a wind shift (second quadrant) the aircraft is turned to pass through the center until winds from the opposite direction occur (third quadrant). Finally, the aircraft is turned on a cardinal heading (parallel to the initial heading) to pick up the fourth quadrant winds. If data indicate that the aircraft is far north of any existing circulation, the pattern is extended as shown by the dashed lines.

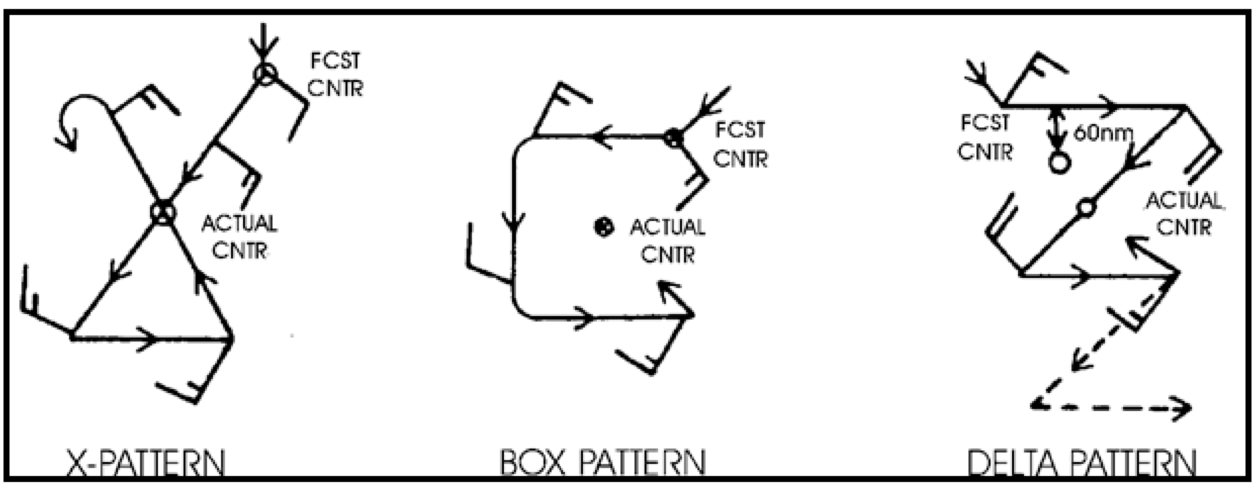

Figure 5-8. Suggested Patterns for Investigative Missions

5.7.3. System Survey Missions.

A system survey mission is tasked to supply observations on the structure and characteristics of an existing tropical cyclone or a disturbance that has the potential to develop into a tropical or subtropical cyclone, including information about the vortex center, if it exists.

5.7.3.1. Flight levels.

Flight level or a range of flight altitudes will be recommended by the customer but may be adjusted as dictated by data requirements, meteorological conditions, or flying safety factors. Vertical dropsonde observations may be requested based on customer needs and the flight level is at or above 850 mb.

5.7.3.2. Vortex Fix.

A vortex data message is required if a vortex fix is made.

5.7.3.3. Closed Circulation.

A closed circulation is supported by at least one sustained vector wind observation reported in each quadrant of the cyclone. These winds may be measured at flight level by the aircraft, observed visually on the ocean surface, or remotely-sensed by aircraft instruments

5.7.3.4. Flight Pattern.

The preferred approach is to execute a pattern (for example, Figure 5-9) based on a reference point specified by the customer as observed conditions dictate to sample the structure of the system's wind field. The flight track may be modified to satisfy customer requirements or because of proximity to land or warning areas.

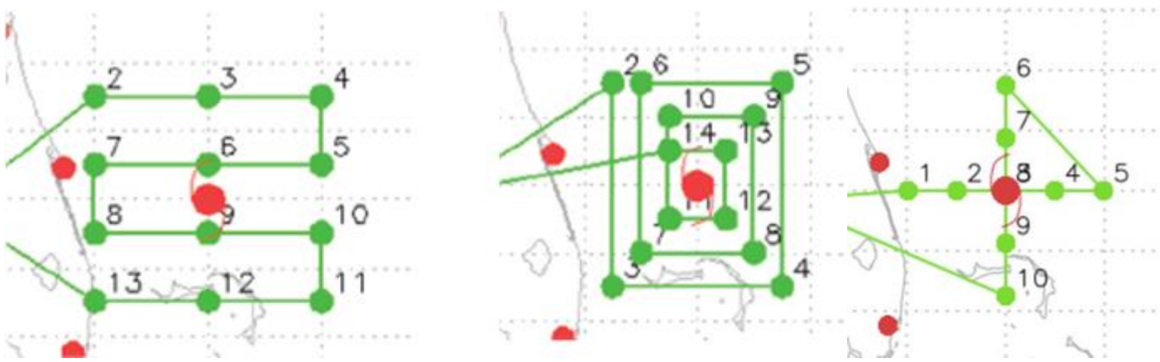

Figure 5-9. Suggested Patterns for System Survey Missions. Lawnmower pattern is left, the square spiral is center, and a Figure-4 (alpha) type pattern is right.

5.7.4. Synoptic Surveillance Missions.

A synoptic surveillance mission is tasked to measure the large-scale wind and thermodynamic fields within approximately 800 NM of tropical cyclones. Specific flight tracks will vary depending on storm location and synoptic situation, and multiple aircraft may be required to satisfy surveillance mission requirements.

5.7.5. Eyewall and Outer-Wind Field Sampling Modules.

These are patterns of dropwindsonde releases designed to measure the maximum surface wind, as well as the extent of hurricane and tropical storm force surface winds. They are meant to be flown using the operational alpha pattern. Dropwindsonde releases in these modules are in addition to any other releases required by Table 5-1. In intense hurricanes (e.g 120 kt or greater), rapidly strengthening hurricanes, or hurricanes with small RMW (e.g. RMW < 10 n mi) additional immediate successive RMW dropsondes may be requested for specific quadrants by NHC, as resources permit.

5.7.5.1. Eyewall Module.

While executing a standard alpha pattern to satisfy a fix requirement, one sounding will be taken during each inbound and outbound passage through the eyewall (except as noted below), for a total of four soundings. The releases should be made at or just inward (within 6.5 NM) of the flight-level radius of maximum wind (RMW). If the radar presentation is suitable, the inner edge of the radar eyewall may be used to identify the release point. If possible, and when resources and safety permit, two dropwindsondes, spaced less than 30 seconds apart, should be deployed on the inbound leg on the side of the storm believed to have the highest surface winds (normally the right-hand side). In this case, the outer of the two releases should be made at the RMW, with the second release following as soon as possible. Typically, the eyewall module will be tasked within 48 hours of a forecasted hurricane landfall.

5.7.5.2. Outer-Wind Field Module.

On an alpha pattern, deploy dropwindsondes at 50 NM intervals from the center on each of two successive inbound and outbound legs, outward to 200 NM. A release should also be made at the midpoint of the cross (downwind) leg, for a total of 19 soundings, including center drops. The length of the legs and the sounding interval may be adjusted, depending on the size of the storm.

5.8. Aircraft Reconnaissance Communications.

5.8.1. General.

The 53 WRS WC-130 aircraft will normally transmit reconnaissance observations via the Air Force Satellite Communications System (SATCOM) to a ground station at NHC (primary) or Keesler AFB (backup). The CARCAH or 53 WRS mission monitor is responsible for quality-controlling the airborne weather-data messages before sending them securely to the Air Force Weather Virtual Private Cloud (AFW-VPC) system at Offutt AFB for global dissemination. The NOAA G-IV and WP-3D aircraft will normally transmit aircraft messages via commercial SATCOM to a secure ingest server that is part of the National Weather Service Telecommunications Gateway (NWSTG) located at the NOAA Center for Weather and Climate Prediction in College Park, MD with backup located in Boulder, CO. Figures 5-10 and 5-11 depict the NOAA and AFSATCOM communications links. Flight meteorologists should maintain contact with CARCAH continuously throughout the mission to ensure the transmitted data are received and properly formatted.

5.8.2. Backup Air-to-Ground Communications.

The weather reconnaissance crew may relay weather data via SATPHONE to the mission monitor at CARCAH. The monitor will evaluate these reports and disseminate them through the AFW-VPC or to the NWSTG. The NOAA aircraft may optionally send messages to a ground-relay system located at AOC, which, in turn, will transfer them to the NWSTG if direct transmission from the aircraft is not possible.

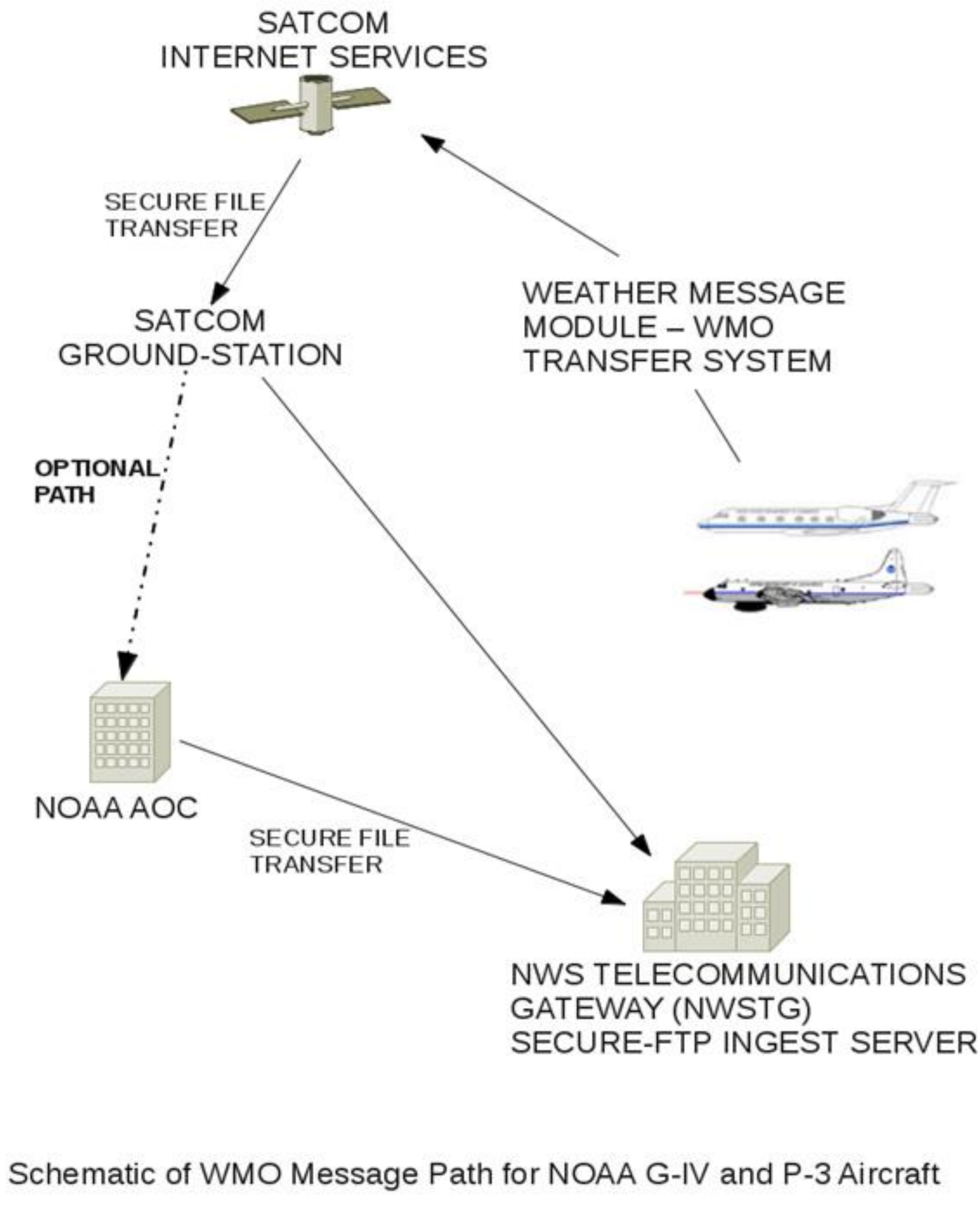

Figure 5-10. Schematic of WMO Message Path for NOAA G-IV and P-3 Aircraft

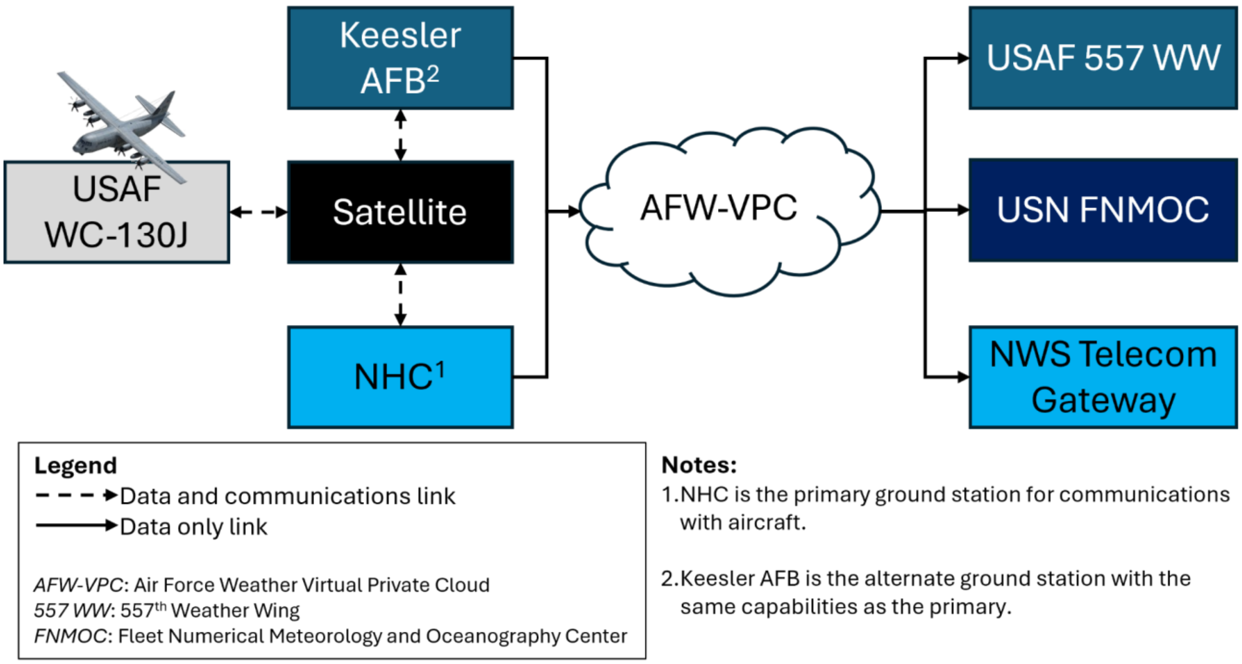

Figure 5-11. Schematic of Aircraft-To-Satellite Data Link for AFRC WC-130 Aircraft

[Note: *An Internet link from Keesler AFB to NHC provides the capability for all observation types to be passed directly to NHC without going through the AFW-VPC.***]**

5.8.3. Backup CARCAH Procedures.

Satellite ground stations, which are used to receive and process data from AFRC reconnaissance aircraft, are installed at CARCAH (located within NHC) and the 53 WRS (located at Keesler Air Force Base). The backup 53 WRS ground station has a configuration and communications capability similar to the primary satellite ground station installed at CARCAH. Each ground station can fully transmit data using SATCOM to the other ground station. Both can securely send reconnaissance aircraft messages to AFW-VPC, which then relays them to the GTS and NWSTG for world-wide distribution, and to an NHC local server (see Figure 5-10). In the event that backup procedures are required due to severe communications failures, severe weather conditions, or other extreme events affecting NHC, some or all CARCAH responsibilities may need to be transferred to the 53 WRS, ensuring reconnaissance aircraft data flow remains uninterrupted.

5.8.3.1. Satellite Antenna Communications Failure at NHC.

If an outage is expected to be temporary, CARCAH will coordinate with the 53 WRS to have operators man the ground station located at Keesler AFB. They will be responsible for maintaining contact with airborne reconnaissance aircraft. There is currently no established method of relaying the data to the CARCAH ground station when this situation occurs. However, one using the Internet may be developed and implemented in the future. In the event communications lines between Keesler AFB and NHC are also severed, the 53 WRS ground station will be configured to transmit data directly to the AFW-VPC system. The aircraft data can also be uploaded directly to a WPC local server at the NOAA Center for Weather and Climate Prediction, which is one of NHC's Continuity of Operations (COOP) backup sites.

For long-term outages, CARCAH will send personnel to Keesler AFB if necessary. They will monitor the aircraft data and ensure they are transmitted to AFW-VPC and downstream to the GTS, NWSTG, and external users from that location.

5.8.3.2. Network Communications Failure.

In the event there is a long-term network communications outage between NHC and AFW-VPC, the CARCAH ground station will still be able to receive aircraft data and send them to local NHC servers. If Internet access problems originate at NHC, the CARCAH ground station will be configured to relay the data to Keesler AFB ground station via SATCOM. The 53 WRS ground station will in turn be configured to automatically transmit them to the AFW-VPC . However, if network connectivity issues between the CARCAH ground station and AFW-VPC are beyond NHC's purview, the data may alternately be sent to the AFW-VPC through the Air Force Weather Web Services (AFW-WEBS) portal. Finally, if there is a circuit breach between the AFW-VPC and the NWSTG, which would affect data being routed to the GTS and received by non-military users, CARCAH can send aircraft messages directly to the NWSTG via the NWS Email Data Input System (EDIS).

5.8.3.3. NHC Emergency Backup Plan.

In the event NHC activates the WPC or CPHC COOP backup plan, designated CARCAH personnel will deploy to Keesler AFB to operate the 53 WRS ground station. The reconnaissance data will be obtained at the WPC COOP site either through AFW-VPC or the NWSTG.

CHAPTER 6: AIRCRAFT OPERATIONS

6.1. Mission Coordination.

6.1.1. Administration.

6.1.1.1. Annual Liaison Meetings.

An annual liaison meeting will be conducted between the following participants:

- National Oceanic and Atmospheric Administration (NOAA) Aircraft Operations Center (AOC)
- U.S. Air Force Reserve Command (AFRC) 53rd Weather Reconnaissance Squadron (53 WRS)
- Federal Aviation Administration (FAA) Air Traffic Control System Command Center (ATCSCC), System Operations Security, and participating en route Air Traffic Control (ATC) facilities[7]
- Department of War (DOW) Policy Board on Federal Aviation (PBFA) designated representative (optional)

This meeting will review the previous season's operations, any proposed changes to the current NHOP; the trilateral Memorandum of Agreement (MOA) between the FAA Air Traffic Organization (ATO), NOAA AOC, and AFRC 53 WRS[8]; supporting Letters of Agreement (LOA); arranging FAA familiarization flights; and procedures to conduct international oceanic operations in accordance with International Civil Aviation Organization (ICAO) standards and recommended practices.

6.1.1.2. Visits and Briefings.

Annual visits by participating FAA en route ATC facilities, System Operations Security, and ATCSCC; and briefings by 53 WRS aircrews, NOAA AOC aircrews, and FAA Military Liaisons are encouraged. These joint visits emphasize the unique challenges and non-standard operational procedures, communication and coordination required to successfully and safely accomplish aerial weather reconnaissance missions into tropical and subtropical cyclones.

6.1.1.3. FAA Familiarization Flights.

FAA familiarization flights on USAF (IAW AFI 11-401 and DOW 4515.13) and NOAA weather reconnaissance aircraft are authorized and encouraged. These flights are important in providing FAA controllers with a better understanding of weather reconnaissance/research operations, and how to better provide Air Traffic Control (ATC) services to these critical flights. These familiarization flights may be requested by FAA controllers, in accordance with FAA Order 3120.29, Flight Deck Training Program.

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[7] Specifically includes FAA Air Route Traffic Control Centers (ARTCC), Center Radar Approach Controls (CERAP), and, in select cases, Combined Control Facilities (CCF) such as the Honolulu Control Facility (HCF). Only facilities, which have established or intend to establish a Letter of Agreement (LOA) in accordance with the national template supporting the *trilateral Memorandum of Agreement between the FAA Air Traffic Organization, NOAA AOC, and the AFRC 53 WRS, will participate.*

[8] Refers to the MOA cited by footnote 6.

6.1.2. Weather Reconnaissance/Research Aircraft.

6.1.2.1. Participating Aircraft.

A "Participating Aircraft" for the purposes of the NHOP and related documents[9] is defined as a NOAA AOC or 53 WRS manned aircraft listed in the Tropical Cyclone Plan of the Day (TCPOD) for a reconnaissance/research mission that is conducted in a Weather Reconnaissance Area (WRA) with the following call signs:

- **53 WRS:** "TEAL 70 through 79" (WC-130J aircraft)
- **NOAA AOC:** "NOAA 42 and 43" (WP-3D aircraft)

6.1.2.2. Other Weather Reconnaissance/Research Aircraft.

- **NASA:** "NASA 817" (DC-8 aircraft); "NASA 928" (WB-57 aircraft); "NASA 872" (Global Hawk UAS)
- **NRL:** "WARLOCK 587" (NP-3 aircraft)
- **NSF/NCAR:** "N677F" (G-V aircraft)
- **NOAA AOC:** "NOAA 49" (G-IV aircraft)

6.1.2.3. Uncrewed Aircraft Systems (UAS) Operations.

Small Uncrewed Aircraft Systems (sUAS) operations are permitted to operate concurrently with manned aircraft within a WRA as specified in paragraph 6.2.3.8 and 6.2.3.9. No other UAS operations are permitted in a WRA.

For any permitted sUAS already operating in a WRA with manned aircraft, operations may continue until mission completion, even after participating manned aircraft have departed. The WRA will remain active through the conclusion of the mission.

6.1.3. Definitions.

6.1.3.1. Mission.

For purposes of this chapter, a mission is defined as a flight by an aircraft, as described in the NHOP, to conduct weather reconnaissance/research operations.

6.1.3.2. NHOP Mission.

Any operational mission tasked on the TCPOD in support of NHOP.

6.1.3.3. Weather Reconnaissance Area.

A Weather Reconnaissance Area (WRA) is airspace with defined dimensions and published by Notice to Airmen (NOTAM), which is established to support weather reconnaissance/research flights. ATC services are not provided within WRAs.[10] Only participating weather reconnaissance/research aircraft from NOAA AOC and 53 WRS are permitted to operate within

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[9] Including the aforementioned trilateral MOA and any executing LOAs.

[10] The FAA may provide ATC services to participating flights in transit to and from WRAs, but will not provide ATC services, specifically including separation, to these flights within a WRA.

a WRA. A WRA may only be established in airspace within U. S. Flight Information Regions (FIRs) outside of U.S. territorial airspace.

6.1.3.4. Command Aircraft.

A command aircraft is the participating manned aircraft responsible for the release of a sUAS and its subsequent command, control, and communications while active within a WRA.

6.1.4. Pre-Mission Coordination.

6.1.4.1. Mission Coordination Sheet.

Crews of all manned aircraft missions must provide a Mission Coordination Sheet to the ATCSCC and the affected en route ATC facilities, as soon as possible, but no later than 1 hour prior to departure time (see Appendix L). Aircrews must also coordinate with DOW facilities in accordance with the appropriate LOAs.

NOTE- *Every effort will be made to accommodate release of Special Use Airspace (SUA). However, in some cases, SUA will not be available for release. SUA Using Agencies determine if Department of War (DOW) operational requirements are compatible with the establishment of a WRA and should define de-confliction procedures for SUA that may not be released.*

6.1.4.2. Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH).

CARCAH's pre-mission coordination procedures include:

- Preparing, publishing TCPOD, and disseminating the Tropical Cyclone Plan of the Day (TCPOD) daily during hurricane season as stipulated in Section 5.4.2.
- Overseeing the process of obtaining advance overflight clearances for 53 WRS aircraft that will be operating over or within the sovereign airspace of Mexico and Cuba.
- Coordinating with the affected en route ATC facilities and the ATCSCC as required.
- Briefing 53 WRS and NOAA AOC aircrews flying operational NHOP missions tasked in the TCPOD about requirements, conditions, and other relevant information.
- Notifying 53 WRS and NOAA AOC flight crews flying operationally-tasked or research missions about any other weather reconnaissance aircraft and externally launched sUAS that will be airborne in or near the operations area at the same time, including the call signs, planned altitude or block altitudes, and other essential information.
- Briefing aircrews of all other reconnaissance aircraft that will be operating simultaneously within the WRA of a command aircraft about any sUAS release plans.

6.1.4.3. USAF Reserve Command and NOAA.

- Aircrews shall submit the Mission Coordination Sheet (see Appendix I) according to sub-paragraph 6.1.4.1.
- Aircrews shall submit a request to the appropriate FAA en route ATC facility for a WRA NOTAM.
- **Missions Not Listed in the TCPOD.** In the event of an unscheduled mission, the flying unit will contact the ATCSCC. The ATCSCC will initiate a conference call with the unit and all affected ARTCCs.
- **Use of NORAD Mode 3/A Transponder Codes.** 53 WRS and NOAA AOC NHOP missions may request NORAD assigned mode 3/A transponder codes. These codes are only

applicable in FAA controlled airspace in the Gulf of America and Atlantic. These codes are issued by the 601st Air -Operations Center, Airspace Management Team (DSN 523-5837 or COM 850-283-5837) and must be requested as needed.

  - If a transponder code is not assigned by NORAD, a code will be assigned by ATC.

- Crews flying Tail Doppler Radar (TDR), synoptic surveillance, or research missions should make a best effort to confirm that CARCAH has received information about the planned flight track and is aware of any adjustments to the pattern. (For research missions see note in subparagraph 6.1.4.4.)
- **Planned sUAS Launch within a WRA.** The UAS Division of the NOAA Uncrewed Systems Operations Center or the responsible agency's flying unit shall:
  - Initially notify CARCAH of any proposed sUAS launch from a participating command aircraft at least 24 hours prior to the mission departure.
  - Provide CARCAH with the approximate time, relative location, operating altitudes, and duration of each sUAS deployment no later than 12 hours preceding the launch (first launch if multiple sUAS releases are planned). The information may be included as remarks in the TCPOD.
  - Coordinate with CARCAH regarding changes and updates to sUAS deployment plans and any additional deployment information.
  - Have command aircraft crew include sUAS deployment time, altitudes, location, and duration on the submitted mission coordination sheet.
- **Planned sUAS Launch outside a WRA.** The UAS Division of the NOAA Uncrewed Systems Operations Center shall:
  - Coordinate with the organization responsible for the planned deployment and determine if and when the sUAS will be entering a WRA.
  - Initially notify CARCAH of any proposed sUAS launch from the responsible organization at least 24 hours in advance.
  - Provide CARCAH with the approximate launch time, entry time and octant into a WRA, operating altitudes within the WRA, and duration of each sUAS deployment no later than 12 hours preceding the launch (first launch if multiple sUAS releases are planned). The information may be included as remarks in the TCPOD.
  - Coordinate with CARCAH regarding changes and updates to sUAS deployment plans and any additional deployment information.

6.1.4.4. Flying Agencies (other than the USAF Reserve Command or NOAA).

- NASA, NRL, NSF or any other agency planning research missions into or around the forecast or actual storm location, including aboard high-altitude large UAS, must first coordinate with affected FAA en route ATC facilities and CARCAH as soon as possible prior to all flights.
- The flying unit must submit its Mission Coordination Sheet (see Appendix I) according to sub paragraph 6.1.4.1.
- Flights in support of the NHOP (conducted by the 53 WRS and NOAA AOC operations) are outlined and published in the TCPOD, by 1830 UTC daily during hurricane season. Research missions will be listed as remarks, provided CARCAH is notified about them prior to

publication. Reference the TCPOD to assist in de-confliction efforts. (See section 5.4.2 for a description of the TCPOD elements and format.)

- The flying unit will provide CARCAH with advance details of all planned research missions in areas where NHOP operations are being conducted, including proposed flight tracks, aircraft altitudes, and locations where weather instruments may be released and/or sensors may be activated; this information, including relevant updates, should be e-mailed to CARCAH prior to aircraft departure.
- Transponder codes will be assigned by ATC.

NOTE - *CARCAH coordination is normally restricted to what is required between the 53 WRS, NOAA AOC, NHC, CPHC, and ARTCCs in support of operational tasking. Due to staffing constraints, the CARCAH unit's operating hours vary and often depend on the requirements levied. Its ability to coordinate non-operational missions is extremely limited. When there is a tasked mission, research missions will only be supported by CARCAH on a non-interference basis or when data collected will be directly beneficial to NHC or CPHC in real time.*

6.1.4.5. Flight Plan Filing Procedures.

- Flight plans must be filed with the FAA as soon as practicable before departure time.
- For flights into all U.S. Flight Information Regions (FIRs), include delay time in the route portion of the international flight plan – this will keep the IFR flight plan active throughout operations, especially for a delay in a WRA.
- Only the following remarks should be included in the "Other Information" block:

  1. "EET" to FIR boundaries,
  2. Navigation Performance (ex. RNP-10)
  3. "RMK/MDCN" diplomatic clearance information.

6.1.4.6. Mission Cancellation.

When a mission is canceled or delayed, the unit flying the mission must notify the Primary en route ATC facility responsible for the WRA and the ATCSCC as soon as possible.

6.1.5. FAA Coordination.

6.1.5.1. Responsibilities.

The ATCSCC and the affected en route ATC facilities are responsible for operational coordination in support of the NHOP.

6.1.5.2. ATCSCC Procedures.

- Review the TCPOD, available daily on the NHC Aircraft Reconnaissance webpage by 1830 UTC during hurricane season, for notification of scheduled NHOP missions, WRA activation status, and any updates. (See Figure 5-4 for explanation of format.)
- Activate the Hurricane desk, if required.
- Review the Mission Coordination Sheet (see Appendix L). Prepare a public Flow Evaluation Area (FEA) based on the latitude/longitude points specified in the Mission Coordination sheet when a mission is scheduled to be flown. The FEA naming convention is the aircraft call sign. Modify the FEA when requested by the affected facilities. (The flying unit will

submit their Mission Coordination Sheet to the ATCSCC and the affected en route ATC facilities at least 1 hour prior to flight departure time).

- Coordinate with the impacted en route ATC facilities as required and designate a primary en route ATC Facility when the Operations Area includes airspace managed by multiple ATC facilities.
- In the event of an unscheduled mission that is not listed on the TCPOD, the flying unit will contact the ATCSCC. The ATCSCC will initiate a conference call with the unit and all affected en route ATC facilities.
- When NOAA or TEAL aircraft receive priority handling as specified in FAA Order 7110.65, assist en route ATC facilities with traffic flow priorities.
- Conduct hurricane and customer teleconferences, as necessary.

6.1.5.3. En Route ATC Procedures

- Review the TCPOD, available daily on the NHC Aircraft Reconnaissance webpage by 1830 UTC during hurricane season, for notification of scheduled NHOP missions, WRA activation status, and any updates. (See Figure 5-4 for explanation.)
- Review the Mission Coordination Sheet (see Appendix L) - the flying unit will submit their Mission Coordination Sheet to the ATCSCC and affected en route ATC facilities at least 1 hour prior to flight departure time.
- Coordinate with all impacted en route ATC and Terminal facilities within their area of responsibility.
- Coordinate with all impacted DOW facilities and SUA Using Agencies in accordance with Letters of Agreement (LOA), including de-confliction procedures for SUA that may not be approved for release.
- When applicable, assign 53 WRS and NOAA aircraft the designated NORAD transponder code associated with their call sign listed on the Mission Coordination Sheet.
- When designated by ATCSCC, the primary ATC facility will:
    - Coordinate with CARCAH and aircrew(s) on flight plan specifics, when necessary.
    - If the mission profile changes, coordinate with the ATCSCC for FEA modifications, and ensure other affected ATC facilities are aware of the change.
    - Advise the ATCSCC and other affected ATC facilities of any mission cancellation or delay information received from the flying unit.

6.2. Mission Execution.

6.2.1. Aircrew Responsibilities.

6.2.1.1. Aircraft Commander Authority.

Aircraft Commanders must exercise their authority in the interest of safety or during an aircraft emergency, regardless of NHOP procedures.

6.2.1.2. Priority Handling.

ATC will provide priority handling to TEAL and NOAA aircraft, when requested by the aircrew. The aircraft commander will only ask for priority handling when necessary to accomplish the mission.

6.2.1.3. Altitude.

Aircrews are responsible for maintaining their own clearance from the surface of the sea, obstacles, and oil platforms while operating below the Minimum IFR Altitude (MIA).

6.2.1.4. Military Assumes Responsibility for Separation of Aircraft (MARSA).

Aircrews of the 53 WRS may apply MARSA, in accordance with FAA Order 7110.65 and FAA Order 7610.4, between 53 WRS aircraft. MARSA may not be applied between 53 WRS aircraft and NOAA AOC participating aircraft.

6.2.1.5. ATC Communications.

The aircrew normally maintains ATC communications with only the primary ATC Facility. When operating within an ATC terminal area depicted on the NHOP Operational Maps (see Appendix K), the aircrews will be in contact with both the primary ATC Facility and the terminal facility (FAA or DOW) if it is operating. Normally, VHF, UHF or HF radios will be used for communications with ATC, when within range. In the storm environment, HF exhibits poor propagation tendencies. When HF is unusable, satellite communications (SATCOM) may be used as a backup (see Appendix L). IFR aircraft flying in domestic or international airspace are required to maintain continuous two-way communications with ATC, even while flying in uncontrolled airspace (Class F or G). Monitor the active ATC radio frequency for any other air traffic transiting the area.

NOTE - *While in international airspace, aircrews will make periodic "Operations Normal" calls to the primary ARTCC if not in radar contact and no transmissions have been made within the previous 20-40 minutes (reference: ICAO 4444/RAC 501/12 VI, 2.1).*

6.2.1.6. Backup ATC Communications.

Aircrews of participating aircraft are required to maintain contact with CARCAH at all times. When unable to contact ATC via radio or SATPHONE, they should request CARCAH to assist in relaying communications as described in Section 6.2.6 if the aircraft has the capability to communicate through the digital satellite communications (SATCOM) relay.

6.2.2. NHOP Missions Outside a WRA.

6.2.2.1 International Airspace.

International airspace is defined as the airspace beyond a sovereign State's 12 NM territorial sea limit. Beyond this limit ICAO rules apply. In international airspace, VFR flight is not allowed at night. In class A controlled airspace, aircraft must operate using IFR procedures: ATC separation is provided between IFR aircraft. In class E controlled airspace, both VFR and IFR operations are allowed; separation is provided between IFR aircraft but only traffic and terrain advisories are provided to VFR traffic.

6.2.2.2. IFR Procedures and Clearance.

Aircrews will conduct flight operations to and from the WRA utilizing Instrument Flight Rule (IFR) procedures to the maximum extent possible and will not normally conduct these flight operations under the provisions of "Due Regard." When departing the WRA, if the aircraft commander determines that mission, ATC communications, weather, and/or safety requirements dictate, they may exercise their operational prerogative and declare "Due Regard." When conducting "Due Regard" operations, aircrews will comply with as many IFR procedures as possible. If an aircrew is able to notify ATC before declaring "Due Regard," ATC will retain flight plan information. If an aircrew is unable to notify ATC beforehand, they will inform them when able. As soon as practical, the aircrew will notify ATC that they are terminating "Due Regard" operations and request resumption of IFR services. These procedures do not preclude aircraft commanders from exercising their authority in the interest of safety or during an aircraft emergency.

6.2.2.3. Operations in Controlled Airspace.

While IFR and not operating in a WRA, ATC will assign an altitude or a block of altitudes, provide standard vertical separation between all IFR aircraft, and provide VFR traffic advisories as far as practical. Prior to departing controlled airspace, ATC should be advised and intentions should be stated; ATC will not cancel the IFR flight plan.

6.2.2.4. Operations in Uncontrolled Airspace (Class F and G).

Per FAA Order 7110.65, ATC is not authorized to assign altitudes in nor provide separation between aircraft in uncontrolled airspace. While in uncontrolled airspace, the aircraft commander is the IFR clearance authority. In addition, aircrews are responsible for maintaining their own separation from the surface of the sea, obstacles, and oil platforms while operating below the Minimum IFR Altitude (MIA). In class F and G uncontrolled airspace, both Visual Flight Rule (VFR)and IFR operations are allowed. When operating in uncontrolled airspace, flight information service, which includes known traffic information, is provided and the pilot is responsible for situating the aircraft to avoid other traffic (ICAO, Annex 11).

6.2.3. NHOP Mission Operations in a WRA.

The procedures for participating aircraft operations in a WRA are in accordance with the MOA between the FAA, NOAA, and 53 WRS.

6.2.3.1. General Operations.

The airspace within a WRA is normally at or below FL150 with a radius of 200 NM but it can be modified based on geographical locations to a size no less than 150 NM around a set of center coordinates. An ATC facility prevents non-participating aircraft receiving ATC services from entering the WRA during the effective time of the WRA as published in the NOTAM. This area can include the terminal areas (Class D Airspace) depicted on the NHOP Operational Maps (see Appendix K), and any other airspace within 50 NM of the CONUS shoreline after radio contact is established with ATC. If not in radar contact within the area as shown on the NHOP Operational Maps (see Appendix K), the aircrew will make position reports in relation to designated navigational aids as requested by ATC along the coast. Any changes to the WRA will be coordinated with the primary ARTCC.

6.2.3.2. Participating aircraft arrival to a WRA.

- Participating aircraft must use ATC services to the WRA.

- Prior to entering the WRA, the arriving aircraft must obtain the position and altitude of each aircraft and any active sUAS already in the WRA and verify the center coordinates and maximum radius within the WRA.
- Arriving aircraft will commence entry to the WRA from FL150[11], unless otherwise coordinated with ATC and other participating aircraft.
- Arriving aircraft must report entering the WRA to ATC.

6.2.3.3. Participating Aircraft Procedures in a WRA.

The following actions must be taken by the aircrews to de-conflict operations and enhance situational awareness with other participating aircraft within the WRA:

- Set 29.92 (inches Hg) in at least one pressure altimeter per aircraft.
- Contact other participating aircraft via the established radio frequencies on Table 6-1 and confirm (as a minimum) the pressure altitude, location relative to a center point position, true heading, and operating altitude or block of altitudes.
- Monitor the frequency during the duration of the flight and maintain communication with all other participating aircraft at all times.
- The center coordinates will be used for the duration of the flight. If a WRA is moved due to operational reasons, a different center point will be coordinated between all participating aircraft.
- If any aircraft is unable to maintain assigned altitude(s), immediately notify all participating aircraft and take actions to ensure sufficient vertical and/or lateral separation is maintained or attained as soon as practical.
- Use “see and avoid” principles to the maximum extent possible within the WRA. Aircraft must periodically broadcast GPS position reports to other aircraft within the WRA and use air-to-air TACAN and cockpit displays/maps to maintain awareness of other aircraft locations.

Table 6-1. Aircraft Radio Communications Frequencies for NHOP Missions

METHOD	FREQUENCY
Primary	VHF 123.05 MHz
Secondary	UHF 304.8 MHz
Backup	HF 4701 KHz

6.2.3.4. Separation between participating aircraft within a WRA.

- Aircraft 10 NM or more from other aircraft operating in the same WRA must maintain vertical separation within the WRA of at least 1,000 feet between their operating altitudes or block altitudes, or as specified in the applicable LOA.

[11] The upper limit of WRAs may be negotiated between NOAA AOC, 53 WRS, and the responsible FAA en route ATC. While the default WRA will extend from SFC through 15,000 feet, the WRA ceiling may be lowered, especially when established closer to land where ATC services are provided at lower altitudes.

- Aircraft less than 10 NM from other aircraft operating in the same WRA, must apply vertical separation of at least 2,000 feet between operating altitudes or block altitudes, or as specified in the applicable LOA. Aircraft may use air-to-air TACAN and TCAS to assist with visual acquisition. Reduced vertical separation may be applied with concurrence from other aircraft within the WRA.

6.2.3.5. Altitude changes between participating aircraft within the WRA.

- Aircraft must initiate communications with each other prior to the altitude change and maintain two-way aircraft-to-aircraft communications throughout the duration of the altitude change.
- Aircraft must ensure positive lateral separation prior to descending or climbing through the altitude(s) of other participating aircraft by reference to the WRA center point using the appropriate aircraft navigation systems.
- Aircraft that are not in visual contact and separated by 30 NM or more, as indicated by the appropriate aircraft navigation systems, may transition through the altitude of other participating aircraft.
- Aircraft that are not in visual contact and separated by less than 30 NM, as indicated by the appropriate aircraft navigation systems, must confirm with each other that they are not on converging courses prior to an altitude change.
- Aircraft that are in visual contact may apply visual separation in accordance with the following procedures:

    1. An aircraft that initiates visual separation must advise the other aircraft that the aircraft is in sight and will maintain visual separation from it.
    2. The observed aircraft must acknowledge the use of visual separation by the initiating aircraft prior to the altitude change.
    3. The aircraft changing altitude must advise the other aircraft upon reaching and maintaining the altitude to which it was climbing or descending.
    4. Visual separation may be discontinued when the altitude change is complete.

- An altitude change is complete when the aircraft changing altitude advises the other aircraft, and receives an acknowledgement, that the altitude to which it was climbing or descending is reached and maintained.

6.2.3.6. Participating aircraft departure from a WRA.

- Prior to departing the WRA, aircraft will establish communications with the appropriate ATC facility and request an IFR clearance.
- Aircraft will depart a WRA at FL140[12], unless otherwise coordinated with ATC and other participating aircraft.
- Prior to departing the WRA, aircraft will verify and maintain vertical and lateral separation from other aircraft in the WRA.
- Should an aircraft lose communications with the other aircraft within a WRA, it will maintain the last altitude that was coordinated with the other aircraft until it departs the WRA.

[12] See footnote 10 for information on WRAs with lowered ceilings.

- If navigation systems become unreliable, the flight crew will terminate the mission and depart the WRA at the last coordinated altitude, or as coordinated with ATC if radio communications are available.
- Departing aircraft will report “leaving (tropical activity name) WRA,” to other aircraft in the WRA.

NOTE - *The tropical activity name is identified by the National Hurricane Center and is part of the identification of the WRA. Examples: Isabelle WRA, Sandy WRA, Tropical Storm Emily WRA, etc.*

6.2.3.7. Weather Instrument Release or Sensor Activation in a WRA.

The aircraft commander is the sole responsible party for all weather instrument releases or sensor activations. Aircraft commanders will ensure coordination with other participating aircraft prior to release or activation. (Examples of weather instruments are dropsondes and oceanographic profilers (OP). An example of a sensor is a Doppler wind lidar.)

6.2.3.8. sUAS Release in a WRA from Participating Aircraft.

The aircraft commander of the participating command aircraft is the sole responsible party for all sUAS releases and activations.

6.2.3.8.1. Manned Aircraft Coordination. When a sUAS will be launched within a WRA and only the command aircraft is present, the aircrew is responsible for ensuring vertical self separation with the sUAS. If it will be launched when multiple participating aircraft are present, the procedures below shall be followed:

- Communications between the command and all other aircraft shall be established via radio frequencies listed in Table 6.1 or through CARCAH messages if radio contact is unsuccessful.
- The crew of the command aircraft must broadcast intent to launch sUAS and confirm consent with all other aircraft five minutes prior to release when those aircraft are within 75 NM. If communications are relayed through CARCAH, additional time may be necessary.
- All other aircraft within the WRA must be operating at an altitude above FL025.
- Prior to sUAS launch, the command aircraft shall coordinate with other reconnaissance aircraft within 75 NM to ensure it is operating at a lower pressure altitude. A minimum of 2,000 ft. MSL vertical separation is required between all of the aircraft.
- A lost communications profile will be relayed to CARCAH by the crew of the command aircraft in conjunction with each sUAS launch.
- After an approximate three-minute sUAS stabilization period following launch and positive two-way communications between command aircraft and sUAS are confirmed, all aircraft may resume operating altitudes or block altitudes at PIC discretion, conforming to the WRA minimum vertical separation requirements in paragraph 6.2.3.4.
- Other participating aircraft must maintain a minimum lateral separation of 10 NM from the command aircraft during the three-minute sUAS stabilization period.

6.2.3.8.2. sUAS Operations.

- When operationally feasible, sUAS releases must be coordinated with the appropriate en route ATC facility by advising of a pending sUAS release about 10 minutes before the event when in direct radio contact with ATC. If not in direct radio contact with ATC, relay the information through CARCAH.

- sUAS shall operate at a maximum of 5,000 ft. MSL with at least 2,000 ft. of vertical separation from any participating aircraft and remain within the command aircraft WRA.
- An operator on the command aircraft shall be responsible for managing an active sUAS.
- Periodic updates from the command aircraft of active sUAS positions and altitudes shall be provided to all aircraft operating in the WRA and CARCAH.
  - Updates should be provided at least every 60 minutes, or more frequently if requested by CARCAH or any other aircraft operating in the WRA.
  - If a sUAS is operating within 15 NM of another aircraft in the WRA, updates of sUAS position and altitude should be provided at least once every 15 minutes.
- In the event communications with active sUAS are lost, the command aircraft shall immediately alert the other aircraft and CARCAH and provide the last reported sUAS position and altitude, the next programmed way point position and altitude, and estimated remaining flight time (if available). If communications are restored, the command aircraft shall notify the other participating aircraft and CARCAH as soon as practical.
- CARCAH shall maintain situational awareness of any active sUAS and provide periodic status updates to other participating aircraft as required.

6.2.3.9. Externally-launched sUAS Operations within a WRA.

The UAS Hurricane Mission Commander (UHMC) and the Remote Pilot in Command (RPIC) are jointly responsible for all NOAA externally-launched sUAS releases and activations.

- Communications between the UHMC and participating aircraft shall be relayed through CARCAH.
- The UHMC shall notify CARCAH when the sUAS is launched and when it is approximately 15 minutes from entering a WRA. CARCAH shall confirm consent with all participating aircraft prior to the WRA entry.
- All participating aircraft within the WRA must be operating at an altitude above FL025.
- A lost communications profile will be relayed to CARCAH by the UHMC in conjunction with each sUAS launch.
- sUAS shall operate within the WRA at a maximum of 5,000 ft. MSL and maintain at least 2,000 ft. of vertical separation from any participating aircraft.
- Periodic updates from the UHMC of active sUAS positions and altitudes shall be provided to CARCAH and relayed to all participating aircraft operating in the WRA.
- Updates should be provided at least every 60 minutes, or more frequently if requested by CARCAH or any other aircraft operating in the WRA.
- If a vertical deviation from the sUAS flight-profile ceiling occurs in which there is less than 2,000 ft. of separation from a participating aircraft, CARCAH shall be notified immediately and the sUAS position and altitude shall be provided at least once every 15 minutes until the deviation ceases.
- In the event communications with active sUAS are lost, the UHMC shall immediately alert CARCAH and provide the last reported sUAS position and altitude, the next programmed way point position and altitude, and estimated remaining flight time (if available), and

CARCAH relays the information to all participating aircraft in the WRA. If communications are restored, the UHMC shall notify CARCAH as soon as practical.

- CARCAH shall maintain situational awareness of any active sUAS.

6.2.4. Buoy Deployment Mission.

Regardless of the designated class of airspace (A through G) the following rules apply:

6.2.4.1. Flight Plan.

A normal IFR flight plan will be filed for this mission. The coordinates for some of the planned deployments may need to be changed while en route to adjust to the forecast track of the storm. The flight crew will be notified of any revisions by CARCAH. Aircraft routing will not be altered by ATC because the buoys must exit the aircraft in a specified order and they cannot be rearranged in flight.

6.2.4.2. Procedures.

It is preferred that these missions be filed and flown using IFR procedures in either controlled or uncontrolled airspace. However, with the concurrence of the aircraft commander, they may be flown VFR. If this change is made en route, ATC flight following and traffic advisories will be requested by the aircrew, and any changes to the route of flight must be relayed to ATC by the aircrew.

6.2.5. High Altitude Synoptic Track Missions.

6.2.5.1. Flight Plan.

A normal IFR flight plan will be filed for this mission.

6.2.5.2. NOTAM.

A NOTAM request must be submitted by the 53 WRS, NOAA AOC, NASA, NSF, or NRL for any High Altitude Synoptic Track mission that will release weather instruments (e.g., dropsondes, etc). The NOTAM must contain individual coordinates or an area defined by coordinates for all releases. Submit NOTAM request per Appendix D procedures.

6.2.5.3. Release of Dropsondes.

During NHOP missions and when operationally feasible, dropsonde instrument releases from FL190 or higher and sensor activation must be coordinated with the appropriate en route ATC facility by advising of a pending drop or sensor activation about 10 minutes prior to the event when in direct radio contact with ATC. When ATC has radar contact with the aircraft, they will notify the aircrew of any known traffic below them that might be affected. The aircraft commander is solely responsible for release of the instrument after clearing the area by all means available.

- When contact with ATC is via ARINC, event coordination must be included with the position report prior to the point where the action will take place, unless all instrument release points have been previously relayed to the affected ATC facilities. Contact between reconnaissance/research aircraft must be made using the frequencies listed in Table 6.1.

- During NHOP missions, approximately five (5) minutes prior to release the aircrew will broadcast in the blind on radio frequencies 121.5 MHz and 243.0 MHz to advise any traffic in the area of the impending drop. Pilots must not make these broadcasts if they will interfere with routine ATC communications within the vicinity of an ATC facility. The aircraft commander is responsible for determining the content and duration of a broadcast, concerning the release or sensor activation.

6.2.6. CARCAH Responsibilities.

When missions are in progress, CARCAH is responsible for:

- Maintaining regular situational awareness of airborne operational and research flights from all agency flying units plus any active UAS that will be operating in the vicinity of the manned aircraft.
- Providing logistical and general support to 53 WRS aircrews.
- Briefing 53 WRS and NOAA AOC aircrews flying operational NHOP missions tasked in the TCPOD about changes to requirements, conditions, and other essential information.
- Handling backup communications to ensure that ATC clearances, clearance requests, and messages are relayed in an accurate manner through any means available, but only when contact cannot be established directly between an aircraft and ATC.
- Relaying any revisions to the coordinates of planned releases for a buoy deployment mission to the aircrew as described in paragraph 6.2.4.1.

CHAPTER 7: SATELLITE SURVEILLANCE OF TROPICAL AND SUBTROPICAL CYCLONES

7.1. Satellites.

7.1.1 Geostationary

7.1.1.1 Geostationary Operational Environmental Satellite (GOES).

GOES-N Series.

The multi-mission GOES N-Series (13 through 15) became vital contributors to weather, solar and space operations, and science. The series introduced several improvements over previous GOES spacecraft, including a highly advanced attitude control system fostering enhanced instrument performance for improved weather service quality. NASA and NOAA set a high standard of accuracy for the series, including data pixel location to two kilometers from geosynchronous orbit.

GOES-14.

GOES-14 was launched on June 27, 2009. It is currently positioned at 108.2°W and is in backup storage mode. It experienced a brief period of operational utilization in October 2012 when it was called into service and drifted to GOES-East during a GOES-13 anomaly. Due to the Loop Heat Pipe (LHP) anomaly impacting GOES-17 Advanced Baseline Imager (ABI), it was decided that GOES-14 would provide joint-backup capabilities alongside GOES-17 in the event of a GOES-East/West anomaly. In order to accommodate the flow of data from both satellites at the same time, the decision was made to drift GOES-14 to 108.2°W.

GOES-R Series.

The capabilities of GOES-R Series satellites (16, 17, 18, 19) are much greater than the GOES-N series satellites. Routine imaging over the CONUS occurs at 5 minute frequency with Full Disk coverage every 10 minutes. There is also the capability for mesoscale sector coverage, which includes tropical cyclones, as frequently as every 30 seconds. There are 16 spectral bands on the imager - 2 in the visible spectrum and 14 in the Infrared/Near-Infrared. Band 2 (0.64 µm in the red visible wavelength) has a nominal resolution of .5 km while band 1 (0.47 µm in the blue visible wavelength) has a resolution of 1 km. Two of the Near-IR bands (band 3 at .86 µm and band 5 at 1.6 µm) have 1 km resolution. All other Near-IR and IR bands are at 2 km resolution. In addition to the individual channel imagery a number of multispectral derived products for a wide variety of applications are also available. This series of satellites does not have a sounder instrument. The Geostationary Lightning Mapper (GLM) instrument aboard GOES-16 and GOES-17 detects total lightning activity across the Western Hemisphere: in cloud, cloud-to-cloud, and cloud-to-ground.

GOES East.

GOES-East (GOES-16) is stationed at 75.2°W. GOES-16 became operational on December 18, 2017 and serves NOAA operations, including the NHC, other Federal agencies, and the private sector. Various imager channels are being utilized to monitor the intensification and movement of tropical cyclones over the Atlantic Ocean and a portion of the East Pacific.

GOES-16 will “nudge“ from 75.2°W to 75.5°W – March 21- April 1, 2025. GOES-16 will drift to its storage of 105°W from April 4, 2025 to June 4, 2025, and will become the backup satellite to GOES-East (GOES-19).

GOES West.

GOES-West (GOES-18) is currently stationed at 137°W. The GOES-18 satellite became operational in the GOES-West position, replacing GOES-17 on January 4, 2023. The routine scanning mode of GOES-West provides coverage of the Northern and Southern Hemisphere eastern Pacific Ocean as well as the western United States. The GOES-West satellite also supports the missions of the NHC, the Central Pacific Hurricane Center (CPHC), and the Joint Typhoon Warning Center (JTWC), and provides coverage of tropical cyclones over the East and Central Pacific.

GOES-17.

GOES-17 was launched on March 1, 2018 and operated as the GOES-West satellite from February 12, 2019 until GOES-18 assumed the GOES-West role on January 4, 2023. Shortly after launch it was discovered that the cooling system was operating in a sub-optimal manner. The Loop Heat Pipe (LHP) subsystem was not able to sufficiently maintain the detectors at the intended temperature, thereby causing degradation of the infrared imagery at certain times of the year during peak warming of the instrument (eclipse season). Following the declaration of GOES-18 as GOES-West, GOES-17 initiated a drift to the storage location at 104.7°W, which it reached on February 10, 2023. It is currently undergoing an extensive checkout at the storage location, after which all on-board instruments will be powered off and the satellite placed in storage mode. From the storage location, GOES-17 is well-placed to provide backup capabilities in the event of a GOES-East/West anomaly, with GOES-14 providing joint backup support during periods of LHP anomaly impacts.

GOES-19 (GOES East).

GOES-19 was launched on June 25, 2024 and is currently stationed at the checkout location of 89.5°. Drift of GOES-19 to the GOES-East location stationed at 75.2°W will begin on March 21, 2025 and end on April 1, 2025. GOES-19 will become GOES-East on April 4, 2025. Drift of GOES-16 to the storage location of 105°W will begin on April 4, 2025 and arrive at the storage (backup) location of 105°W on June 4, 2025.

7.1.1.2. EUMETSAT Meteosat Geostationary Satellites.

EUMETSAT’s current series of geostationary satellites, Meteosat Second Generation, consists of Meteosat-9, -10, and -11, each supporting a specific mission. Located at different positions, the three (3) satellites cover Europe, Africa, and the Indian Ocean. The designed life for a MSG satellite is seven (7) years, but some satellites have exceeded that time frame.

Meteosat-11 launched in July 2015 is stationed at 9.5°E longitude. The satellite provides the Rapid Scanning Service, delivering more frequent images every five minutes over parts of Europe, Africa and adjacent seas. It also provides Search and Rescue monitoring. In spring 2023, Meteosat-10 replaced Meteosat-11 in support of the prime 0° FES service. After the transition, Meteosat-11 began support of the Rapid Scanning Service (RSS) at 9.5°E.

Meteosat-10, stationed at 0° and launched in July 2012, provides the Full Earth Scan (FES) every 15 minutes in 12 spectral channels. Meteosat-10 also provides geostationary earth radiation budget data, search and rescue monitoring, and relay of Data Collection Platform data.

Meteosat-9, stationed at 45.5°E and launched in December 2005, currently provides primary IODC service. EUMETSAT replaced Meteosat-8 with Meteosat-9 to support the IODC mission; Meteosat-9 took over Meteosat-8 as the primary IODC satellite on June 1, 2022. Meteosat-9 satellite is no longer used as backup for the Full Earth Scan (FES) service and no longer provides RSS gap-filling during Meteosat-11 RSS interruptions. The fuel lifetime of Meteosat-9 is stated to be through 2022 but was recently extended until 2027.

Meteosat-8, previously stationed at 41.5°E and launched in August 2002, after two decades of reliable service, was deorbited/decommissioned in October 2022.

The MSG satellites carry a pair of instruments: the Spinning Enhanced Visible and InfraRed Imager (SEVIRI); and the Geostationary Earth Radiation Budget (GERB) instrument, a visible-infrared radiometer for Earth radiation budget studies. SEVIRI has twelve spectral channels, compared to three spectral channels on Meteosat First Generation satellites. These provide more precise data throughout the atmosphere, giving improved quality to the starting conditions for numerical weather prediction models. Eight of the channels are in the thermal infrared, providing, among other information, permanent data about the temperatures of clouds, land and sea surfaces. One of the SEVIRI channels is called the High Resolution Visible (HRV) channel, and has a sampling resolution at nadir of 1 km, compared to the 3 km resolution of the other visible channels. The improved horizontal image resolution for the visible light spectral channel helps weather forecasters in detecting and predicting the onset or end of severe weather. Using infrared channels that absorb ozone, water vapor and carbon dioxide, MSG satellites allow meteorologists to analyze the characteristics of atmospheric air masses and reconstruct a three-dimensional view of the atmosphere.

On December 13, 2022, EUMETSAT launched its first Meteosat Third Generation (MTG) geostationary satellite, MTG-I1 now called MET-12. Slated to be fully operational in late 2025, this satellite will support the imager service; "I1" being the first in the MTG series of imaging satellites. Meteosat-12 will replace Meteosat-10 at 0° after a period of parallel operations. The MTG satellite platform will host instruments with additional channels with better spatial, temporal and radiometric resolution, compared to the current MSG satellites and is comparable to the GOES-R series. MTG will consist of a coupled satellite system, one for imaging and the other for sounding, MTG-I and MTG-S, respectively.

7.1.1.3: Himawari.

The current series of weather satellites in geostationary orbit operated by the Japan Meteorological Agency are named Himawari -8 and -9. Himawari-8 was launched in October 2014 and effective July 2015, was operating at 140° E as the primary geostationary satellite until December 13, 2022. Himawari-8 was placed into standby mode as a backup to Himawari-9 in the event of a failure. Himawari-9 was launched in November 2016 and is positioned at 140.75°E, now the prime geostationary satellite position to support JMA's meteorological and environmental monitoring services over eastern Asia and the West Pacific Ocean. Himawari-8 replaced MTSAT-2 as JMA's prime geostationary satellite in July 2015. Himawari-8 introduced the Advanced Himawari Imager (AHI), a new series of imager instruments. AHI consists of 16 spectral channels at higher spatial resolution for improved sensing of the earth's atmosphere and surface. Full earth scans are transmitted every 10 minutes. The higher spatial resolution and higher number of channels from the AHI also provides significant improvements in monitoring, intensity estimation, and forecasting of tropical cyclones over the West Pacific Ocean, many of which transition to major typhoons. The Himawari AHI is analogous to NOAA's GOES-R series Advanced Baseline Imager (ABI). Through an interagency agreement, NOAA/NESDIS acquires Himawari data from JMA's HimawariCloud service and then makes the level 1b data available to NOAA users and DOW. Work is progressing on Himawari-10, the follow on to Himawari-9. Contractor selections were announced, and launch is still expected to take place in 2028. Himawari-10 is expected to take over operations from Himawari-9 at 140.75°E, and will be comparable to the GEO-XO mission.

7.1.1.4: Korean Meteorological Agency (KMA) Geostationary Satellites.

The Communication, Ocean and Meteorology Satellite (COMS) or GEO-Kompsat-1, was the first operational weather and ocean satellite from The Republic of Korea. COMS-1 was developed by the Korean Astronomical Research Institute (KARI) through a contract with EADS Astrium, and carried a 5 channel imager similar to the imager on board GOES L-N. It was primarily operated by the Korean Meteorological Agency (KMA). COMS-1 reached its end of life on April 1, 2021.

The GEO-KOMPSAT-2A (GK2A) was launched on December 5, 2018 and has 16 channels for observation. Full disk images are captured every 10 minutes, and it is stationed at 128.2°E. GK2A began nominal operations on July 25, 2019 and has a lifespace of 10 years. GK2A data is available on the NOAA Open Data Dissemination (NODD) program AWS buckets.

7.1.2: Low Earth Orbiting (LEO) Satellites

7.1.2.1: Initial Joint Polar System (IJPS).

Two operational polar orbiting satellites, NOAA's NOAA-19 (PM Prime Services Mission) and EUMETSAT's Metop-B (AM Primary), provide image coverage four times a day over a respective area in 6 spectral channels (however only 5 channels can be supported at one time; channel switching is used to support the 6th channel). These satellites cross the U.S. twice per day at 12-hour intervals for each geographical area near the Equatorial crossing times listed in Table 7-2.

NOAA-19 and Metop-B provide the same capabilities as previous NOAA satellites, except that the Advanced Microwave Sounding Unit–B (AMSU-B) sensor flown aboard NOAA-17 and previous polar orbiters has been replaced by the Microwave Humidity Sounder (MHS) on NOAA-19. Data are available via direct readout—high-resolution picture transmission (HRPT) or automatic picture transmission (APT)—or via central processing. The 557 WW receives global data from the Advanced Scatterometer (ASCAT) on board Metop-B directly from central readout sites on a pass-by-pass basis. The AMSU data are used as input to tropical cyclone intensity estimation algorithms used by NHC, CPHC and JTWC.

The Command and Data Acquisition (CDA) stations at Fairbanks, AK, and Wallops, VA, acquire recorded global area coverage data subsampled to a 4 km spatial resolution, and then route the data to NESDIS computer facilities in Suitland, MD, where the data are processed and distributed to the NOAA, the DOW, and private communities. Ground equipment installed at various NWS regions including Kansas City, Miami (NOAA/AOML), and Monterey enable direct readout and data processing of 1.1 km resolution AVHRR and VIIRS data from NOAA-19 and Metop-B. The high resolution polar data and products generated at AOML complement other satellite data sources to support tropical mission objectives.

7.1.2.2: S-NPP.

Suomi National Polar-Orbiting Partnership satellite (S-NPP) launched in October, 2011, is part of the Joint Polar Satellite System (JPSS), the next generation polar-orbiting operational environmental satellite system. S-NPP carries five instruments, including Visible Infrared Imaging Radiometer Suite (VIIRS), Advanced Technology Microwave Sounder (ATMS), Ozone Mapping and Profiler Suite (OMPS), Clouds and Earth's Radiant Energy Sensor (CERES) and Cross-track Infrared Sounder (CrIS). CrIS provides global hyperspectral infrared observations twice daily for profiling atmospheric temperature and water vapor, critically needed information for improving weather forecast accuracy out to seven days. CrIS also supplies information used to retrieve greenhouse gases, land surface and cloud properties. CrIS measures infrared spectra in three spectral bands: the long-wave IR (LWIR) band from 650 to 1095 cm^{-1}, mid-wave IR (MWIR) band from 1210 to 1750 cm^{-1} and short-wave IR (SWIR) band from 2155 to 2550 cm^{-1}. (S-NPP lost the MWIR band in July 2021.) Full spectral resolution (FSR) operational modes provide a total of 1305 radiance channels. The time scale of tropical cyclone track and intensity changes is on the order of 12 hours, which makes JPSS instruments well suited for the forecasting of these parameters. Two basic methods exist for improving tropical cyclone forecasts with S-NPP. First is to assimilate data in numerical forecast models, and second is to improve analysis and statistical post-processing forecast products. NOAA/NESDIS has integrated the S-NPP data into operational applications whose products are used by National Hurricane Center, including MiRS, bTPW, eTRaP, and statistical intensity and wind structure estimation algorithms. NESDIS also reformats the S-NPP ATMS data into the BUFR for use by the NOAA NWP community, and some international agencies.

7.1.2.3: JPSS Satellites.

The Joint Polar Satellite System (JPSS) is the Nation's next generation of polar-orbiting operational environmental satellite systems. JPSS is a collaborative program between NOAA and its acquisition agent, NASA. This interagency effort is the latest generation of U.S. polar-orbiting, non-geosynchronous environmental satellites. JPSS-1, now designated NOAA-20, was launched on November 18, 2017 into a 1330 Local Time Ascending Node (LTAN) sun-synchronous polar orbit and is now the PM primary operational spacecraft. Capitalizing on the success of Suomi NPP, NOAA-20 features five similar instruments: (1) VIIRS, (2) CrIS, (3) ATMS, (4) OMPS-N, and (5) CERES-FM6. NOAA-20 has a design life of seven years and it will circle the Earth in the same orbit as Suomi NPP, although the two satellites will be separated in time and space by 50 minutes.

Forty-eight days after launch, on January 5, 2018, the NOAA-20 Cross-track Infrared Sounder (CrIS) started collecting science data. With the same design as Suomi NPP CrIS, NOAA-20 CrIS provides global hyperspectral infrared observations twice daily for profiling atmospheric temperature and water vapor, critically needed information for improving weather forecast accuracy out to seven days. CrIS also supplies information used to retrieve greenhouse gases, land surface and cloud properties.

The JPSS-2 spacecraft features several instruments similar to those found on NOAA-20—VIIRS, CrIS, ATMS and OMPS-N—and provides operational continuity of satellite-based observations of atmospheric, terrestrial and oceanic conditions for both weather forecasting and long-term climate and environmental data records. It was launched on November 10, 2022 and renamed NOAA-21 upon reaching orbit. JPSS-3, the third spacecraft in the JPSS series, is scheduled to launch in 2027. Benefiting from the success of previous JPSS spacecraft, JPSS-3 will carry instruments similar to those found on earlier JPSS satellites: VIIRS, CrIS, ATMS and OMPS-N. Scheduled to launch in 2031, JPSS-4 is the fourth and final spacecraft of the JPSS constellation. Similar to previous JPSS spacecraft, JPSS-4 will host the latest versions of the VIIRS, CrIS, ATMS and OMPS-N instruments.

The ground system for the JPSS mission is a global network of receiving stations linked to NOAA, which distributes the satellite data and derived products to users worldwide. The versatile ground system controls the spacecraft, ingests and processes data and provides information to users like NOAA's National Weather Service. The JPSS ground system delivers fresh data from the next generation of polar-orbiting satellites to users more quickly than ever before.

In addition to supporting the Suomi NPP, NOAA-20, NOAA-21, JPSS-3 and JPSS-4 satellite missions, the ground system provides support to the wide variety of polar missions, which include but are not limited to: NESDIS Free Flyer Satellites, EUMETSAT Metop Satellites, The Japanese Global Change Observation Mission (GCOM), and the U.S. Navy Windsat Mission.

7.1.3: Non-NOAA LEO Satellites.

NOAA uses dedicated ground support systems to ingest and process data from select non-NOAA satellite systems for use in operational forecasting and tropical cyclone analysis. These include data from DMSP and WSF-M from the Department of War; Jason-3 and Sentinel-6 from the joint NOAA, NASA, Centre National d'Etudes Spatiales (CNES), and EUMETSAT mission; and SARAL from the cooperative altimetry technology mission of the Indian Space Research Organisation and CNES and the Cryosat-2 mission of the European Space Agency. These satellites employ multiple infrared and microwave radiometers as well as active scatterometers to assess environmental features on the ocean surface.

7.1.3.1: Defense Meteorological Satellite Program (DMSP).

Defense Meteorological Satellite Program (DMSP). DMSP has been collecting weather data for U.S. military operations for over five decades. Two operational DMSP satellites are in polar orbits at about 458 nautical miles (nominal) at all times. The primary weather sensor on DMSP is the Operational Linescan System, which provides continuous visual and infrared imagery of cloud cover over an area 1,600 nautical miles wide. Additional satellite sensors measure atmospheric vertical profiles of moisture and temperature. Military weather forecasters use these data to monitor and predict regional and global weather patterns, including the presence of severe thunderstorms, hurricanes and typhoons.

The Special Sensor Microwave Imager / Sounder (SSMIS) is a 24-channel, linearly polarized passive microwave radiometer system. The instrument is flown on board the DMSP F-16, F-17, F-18 and F-19 satellites, which were launched in October 2003, November 2006, October 2009, and April 2014 respectively. It is the successor to the Special Sensor Microwave/Imager (SSM/I). These microwave imagers have been particularly useful for tropical storm reconnaissance and analysis in the vast reaches over the Pacific Ocean. These imagers are also used by NHC to monitor inner core structure changes of tropical cyclones, including eyewall evolution and secondary eyewall formation.

Subject to change, the end of functional life for the SSMIS on board the F-16, F-17, and F-18 satellites is not fixed and is dependent on various factors, including on-orbit performance degradation and system failures.

7.1.3.2: Weather System Follow-on (WSF)

The Weather System Follow-on is the next-generation operational environmental satellite program for the Department of War (DOW) to succeed the DMSP. The Weather System Follow-on – Microwave (WSF-M) was launched on April 11, 2024 and leverages the Global Precipitation Measurement (GPM) Microwave Imager (GMI) instrument, which is the on-orbit reference standard for calibrating precipitation measurements in NASA's GPM constellation.

The Microwave Imager (MWI) is a 6-channel, fully polarimetric passive microwave radiometer that is flown on the WSF-M satellite and the successor to SSMIS. Its full polarimetric capability results in 17 channels overall, like GMI. Its horizontal spatial resolution of 15x10 km for the 37 GHz and 89 GHz channels improves the analysis of tropical cyclone structure, including the detection of small eyes and vertical tilt, over that of SSMIS.

A second WSF-M is slated to launch during fiscal year 2027 and become operational by the second quarter of fiscal year 2028.

7.1.3.3: COWVR/TEMPEST on ISS

As part of the Department of War (DOW)-sponsored Space Test Program 8 (STP-8), the Compact Ocean Wind Vector Radiometer (COWVR) and Temporal Experiment for Storms and Tropical Systems (TEMPEST) were launched on an International Space Station (ISS) resupply mission on December 21, 2021. The systems were deployed on the Japanese ISS module, on what is planned to be a 3-year technology maturation mission, providing research and development evaluation of microwave sensors planned for launch on board the future Weather System Follow-on – Microwave (WSF-M). The COWVR sensor is a technological demonstration of a compact, multi-polarimetric microwave radiometer for wind measurement over the sea, operating at 18.7GHz, 23.8GHz and 33.9 GHz. The TEMPEST sensor is a new technology microwave radiometer designed to be fitted to a cubesat-sized satellite, measuring microwave radiances at five frequencies (89GHz, 165GHz, 176GHz, 180GHz and 182GHz). While not an operational capability, the COWVR/TEMPEST sensor package is providing valuable near-real time microwave imagery to tropical cyclone forecasters on a daily basis via NRL TC Web page and ATCF.

7.1.3.4: GCOM-W1 and GOSAT-GW.

The "Global Change Observation Mission" (GCOM) is a series of Japan Aerospace Exploration Agency (JAXA) Earth missions lasting 10-15 years designed to obtain observations related to water and climate. The GCOM-W1 was launched May 18, 2012 and is the first satellite of the GCOM-W series. GCOM-W1 is in a sun-synchronous orbit (~700 km altitude) and part of the "A-Train" with an ascending node equator crossing time of 1330 UTC. The AMSR2 (Advanced

Microwave Scanning Radiometer 2) instrument onboard the GCOM-W1 satellite will continue Aqua/AMSR-E observations of water vapor, cloud liquid water, precipitation, SST, sea surface wind speed, sea ice concentration, snow depth, and soil moisture. NOAA/NESDIS has integrated the GCOM-W1 data into a few operational applications whose products are used by National Hurricane Center (NHC), including bTPW, ADT, eTRaP, and GCOM-W1 AMSR2 Algorithm Software Package (GAASP). NESDIS also reformats the GCOM-W1 AMSR2 L1 data into the BUFR for use by the NOAA NWP community, and some international agencies.

AMSR3 was launched onboard the GOSAT-GW satellite on June 29, 2025. It adds 5 new channels, targeting solid precipitation, high altitude water vapor, and sea surface temperature sensing capabilities. Full operational capability is estimated to begin in June 2026.

7.1.3.5: Jason-3 and Sentinel-6.

Jason-3 and its follow-on mission Sentinel-6 are joint NOAA, NASA, CNES, and EUMETSAT satellites launched on January 17, 2016 and November 21, 2020, respectively.

Jason-3 is in an interleaved orbit with Sentinel-6, providing maximum global spatial coverage. The Jason missions are designed to study ocean surface topography and provide near real-time sea surface height, ocean surface wind speed, and significant wave height measurements. Jason-3 and Sentinel-6 each utilize a two-frequency Poseidon radar altimeter operating at 13.575 GHz (Ku-band) and 5.3 GHz (Jason-3) and 5.41 GHz (Sentinel-6) (C-Band) and an Advanced Microwave Radiometer consisting of three separate channels at 18.7, 23.8 and 34 GHz. The 23.8 GHz channel is the primary water vapor sensing channel, meaning higher water vapor concentrations lead to larger 23.8 GHz brightness temperature values. The addition of the 34 GHz channel and the 18.7 GHz channel, which have less sensitivity to water vapor, facilitate the removal of the contributions from cloud liquid water and excess surface emissivity of the ocean surface due to wind, which also act to increase the 23.8 GHz brightness temperature. The sea-surface height measurements are made with a globally averaged RMS accuracy of 3.4 cm (1 sigma), or better, assuming 1 second averages.

7.1.3.6: GPM.

The Global Precipitation Measurement (GPM) mission is an international network of satellites that provide next-generation global observations of rain and snow. The GPM core Observatory, initiated by NASA and JAXA as a global successor to TRMM, serves as a reference standard to unify precipitation measurements from the GPM constellation of research and operational satellites. The GPM Core Observatory was launched on February 27th, 2014 at 1:37pm EST from Tanegashima Space Center. The onboard instrument, GPM microwave imager (GMI) measures microwave radiance at seven frequencies (10.65GHz, 18.70GHz, 23.80GHz, 36.50GHz, 89.0GHz), which are subsequently processed and converted into different GPM data and products. NOAA/NESDIS has integrated the GPM GMI data into a few operational applications whose products are used by the National Hurricane Center, including Microwave Integrated Retrieval System (MiRS), Blended Total Precipitable Water (bTPW), Advanced Dvorak Technique (ADT), and Ensemble Tropical Rainfall Potential (eTRaP), and NESDIS also reformats the GPM data, specifically the L1C-R data, into the Binary Universal Format (BUFR) for use by the NOAA NWP community, and some international agencies.

7.2. National Weather Service (NWS) Support.

7.2.1. Station Contacts.

The GOES imagery is available in support of the surveillance of tropical and subtropical cyclones at specific NWS offices. Satellite meteorologists can be contacted at these offices; telephone numbers are in Appendix I.

7.2.2. Products.

Satellite-related products are listed in Chapter 3, Table 3-7, "Summary of Products and their Associated WMO Header."

7.2.2.1. Tropical Weather Discussions.

NHC issues these discussions four times a day based on satellite imagery, meteorological analysis, weather observations and radar. They describe significant features and significant weather areas for the Gulf of Mexico, the Caribbean, and between the equator and 31°N in the Atlantic and in the eastern Pacific from 03.4°S to 30°N east of 120°W including the Gulf of California and from the equator to 30°N between 120°W and 140°W.

WFO Guam issues these discussions once a day based on satellite imagery, meteorological analysis, weather observations and radar. They describe significant features and significant weather areas for the western North Pacific between the Equator and 25°N from 130°E to 180.

7.2.2.2 Tropical Cyclone Summary Fixes.

The Tropical Cyclone Summary (TCS) is an alphanumeric product provided by CPHC when there is classifiable (using the Dvorak technique) tropical cyclone activity in the central North Pacific or central South Pacific. The TCS is a satellite-based estimate of tropical cyclone location, movement, and intensity with a brief remarks section. For the TCS, CPHC's AOR is the area north of the equator between 140°W and 160°E and from the equator to 25°S between 120°W and 160°E.

7.3 NESDIS Satellite Analysis Branch (SAB).

The SAB operates 24 hours a day to provide satellite support to the WPC/OPC, NHC, CPHC, JTWC, and other worldwide users. SAB provides pertinent information on tropical cyclone development, including location and intensity analysis based on the Dvorak technique (Table 7-1). Telephone numbers for the SAB are located in Appendix I.

Table 7-1. Communications Headings for SAB Dvorak Analysis Products

WMO HEADING	OCEANIC AREA	TYPE OF DATA
TXNT20-29	Atlantic	VIS/IR
TXPN	Central Pacific	VIS/IR
TXPQ	West Pacific	VIS/IR
TXPS	South Pacific	VIS/IR
TXPZ	East Pacific	VIS/IR
TXIO	North Indian	VIS/IR

7.4. Air Force Support

Data covering the NHOP areas of interest are received centrally at the Air Force 557 WW and distributed to the Air Force's Operational Weather Squadrons (OWS) and the Navy's FNMOC at Monterey, CA. Satellite data covering the Central Pacific area are received at or shipped to the 17th OWS Meteorological Satellite Operations (SATOPS) Flight (17 OWS/WXJ), JTWC, Pearl Harbor, HI. The 17 OWS/WXJ uses all available meteorological satellite data when providing fix and or intensity information to Central Pacific Hurricane Center forecasters.

7.4.1. Central Pacific Surveillance.

The 17 OWS/WXJ (JTWC Satellite Operations) will provide position and intensity information on TCs in the CPHC area of responsibility, between 140W and the International Dateline.

7.5. Satellites and Satellite Data Availability for the Current Hurricane Season.

Table 7-2 lists satellite capabilities for the current hurricane season.

7.6. Current Intensity and Tropical Classification Number Using the Dvorak Technique.

The current intensity (C.I.) number relates directly to the intensity of the storm. The empirical relationship between the C.I. number and a storm's wind speed is shown in Table 7-3. The C.I. number is the same as the tropical classification number (T-number) during the development stages of a tropical cyclone but is held higher than the T-number while a cyclone is weakening. This is done because a lag is often observed between the time a storm pattern indicates weakening has begun and the time when the storm's intensity decreases. An added benefit of this rule is the stability it adds to the analysis when short-period fluctuations in the cloud pattern occur.

Table 7-2. Satellite and Satellite Data Availability for the Current Hurricane Season

SATELLITE	TYPE OF DATA	SCAN TIME	PRODUCTS
GOES-14 (on orbit spare at 108.2°W)	Multispectral Imager and Sounder; 5 Channels for Imager; 19 Channels for Sounder	GOES East and GOES West: Every 30 min, in Routine Scan Mode, provides 3 sectors with prescribed coverages: Northern Hemisphere (NH) or Extended NH; CONUS or PACUS; and Southern Hemisphere. Exception is transmission of full disk every 3 hours. (Available Rapid Scan Operations yield increased transmissions to 7.5 minute intervals to capture rapidly changing, dynamic weather events).	1. 1, 2, 4, and 8 km resolution visible standard sectors. 2. 4 km equivalent resolution IR sectors. 3. Equivalent and full resolution IR enhanced imagery. 4. Full disk IR every 3 hours. 5. 4 km water vapor sectors 6. Quantitative precipitation estimates; high density cloud and water vapor motion wind vectors; and experimental visible and sounder winds. 7. Operational moisture sounder data (precipitable water) in four levels for inclusion in NCEP numerical models. Other sounder products include gradient winds, vertical temperature and moisture profiles, mid-level winds, and derived product imagery (precipitable water, lifted index, and surface skin temperature). 8. Tropical storm monitoring and derivation of intensity analysis. 9. Volcanic ash monitoring and dissemination of Volcanic Ash Advisory Statements. 10. Daily northern hemisphere snow cover analysis. 11. Twice daily fire and smoke analysis over specific areas within CONUS. 12. Advanced Dvorak Technique (ADT)/AI-enhanced 13. Tropical Cyclone Formation Probability Guidance Product(TCFP) 14. Ensemble Tropical Rainfall Potential (eTRaP) 15. Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) 16. Global Hydro-Estimator (GHE)

Table 7-2. Satellite and Satellite Data Availability for the Current Hurricane Season, continued

SATELLITE	TYPE OF DATA	SCAN TIME	PRODUCTS
GOES-16 (Operational East at 75.2°W) GOES-18 (Operational West at 137.0°W) GOES-17 (on-orbit spare at 104.7°W) GOES-19 (Operational East at 75.2°W on April 4, 2025)	Multi-band imager (16 spectral channels)	Full disk every 10 minutes CONUS 5 minute frequency Mesoscale Sector coverage up to every 30 seconds	ABI band 2 is .5 km resolution Bands 1, 3, 5 are 1 km resolution and all other banks are 2 km resolution. GLM provides total lightning activity across the Western Hemisphere. For list of baseline products see GOES-R series data products website. Quantitative precipitation estimates; high density cloud and water vapor motion wind vectors; and experimental visible and sounder winds. Tropical storm monitoring and derivation of intensity analysis. Daily northern hemisphere snow cover analysis. Twice daily fire and smoke analysis over specific areas within CONUS. Advanced Dvorak Technique (ADT) and AI-enhanced Dvorak Technique (AiDT) Tropical Cyclone Formation Probability Guidance Product (TCFP) Ensemble Tropical Rainfall Potential (eTRaP) Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) Global Hydro-Estimator (GHE) Global Mosaic of Geostationary Satellite Imagery (GMGSI)

Table 7-2. Satellite and Satellite Data Availability for the Current Hurricane Season, continued

SATELLITE	TYPE OF DATA	SCAN TIME	PRODUCTS
METEOSAT-11 at 0° (Prime Meridian) METEOSAT-10 at 9.5°E (Indian Ocean) METEOSAT-9 at 45.5° E (IODC service replaced MET-8)	Spinning Enhanced Visible and InfraRed Imager (SEVIRI) and High Resolution Visible (HRV) channel	SEVIRI: Full disk image every 15 minutes. HRV: Specialized sector scan of Europe which shifts according to available daylight.	1. 1 km resolution VIS imagery (HRV); 3 km resolution IR imagery (SEVIRI). 2. EUMETCast and HRIT VIS and IR imagery. 3. Tropical storm monitoring and intensity analysis. 4. Volcanic ash detection and analysis. 5. Advanced Dvorak Technique (ADT) and AI-enhanced Dvorak Technique (AiDT) 6. Tropical Cyclone Formation Probability (TCFP) guidance product 7. Ensemble Tropical Rainfall Potential (eTRaP) 8. Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) 9. Global Hydro-Estimator (GHE) 10. Sea Surface Temperature (L2) 11. Derived Motion Winds (various levels) 12. Global Mosaic of Geostationary Satellite Imagery (GMGSI)
Himawari-8 at 140°E (operational back-up) Himawari-9 at 140.7°E (operational)	AHI multi-band imager (16 spectral channels)	Full disk image every 10 minutes	.5 km - 1 km resolution VIS imagery; 2 km resolution IR imagery Sea Surface Temperature (ACSPO L2 and L3 hourly products) Tropical storm monitoring and intensity analysis. Volcanic ash detection and analysis Advanced Dvorak Technique (ADT) Tropical Cyclone Formation Probability (TCFP) guidance product Ensemble Tropical Rainfall Potential (eTRaP) Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) Global Hydro-Estimator (GHE) Derived Motion Winds (various levels) Global Mosaic of Geostationary Satellite Imagery (GMGSI)

Table 7-2. Satellite and Satellite Data Availability for the Current Hurricane Season, continued

SATELLITE	TYPE OF DATA	SCAN TIME	PRODUCTS
COMS-1 at 128°E (Asian Pacific)	Meteorological Imager (MI) (5 spectral channels)	Full disk every 30 minutes	MI 1 km resolution VIS imagery. MI 4 km resolution in 4 IR channels. Tropical storm monitoring. Aerosol monitoring.
GPM (Global Precipitation Mission)	GMI	Fluctuates from 60°N to 60°S	1. Microwave Integrated Retrieval System (MiRS) 2. Blended Total Precipitable Water (bTPW) 3. Ensemble Tropical Rainfall Potential (eTRaP) 4. Advanced Dvorak Technique (ADT) 5. Blended Rain Rate
S-NPP (PM Tertiary) NOAA-20 (PM Primary) NOAA-21 (PM Secondary)	VIIRS and ATMS	Granular	1. Microwave Integrated Retrieval System (MiRS) 2. Sea surface temperature (ACSPO L2 and L3) 3. Blended Total Precipitable Water (bTPW) 4. Ensemble Tropical Rainfall Potential (eTRaP) 5. Cross-track Infrared Sounder (CrIS) to monitor moisture and pressure 6. Microwave based tropical cyclone intensity estimates. 7. Blended Rain Rate
S-NPP (PM Secondary) NOAA-20 (PM Primary)	OMPS	Granular	1. OMPS Nadir Mapper Total Ozone Environmental Data Record (EDR) 2. OMPS Nadir Profiler Ozone Profile Environmental Data Record (EDR) 3. OMPS Nadir Mapper SO2 EDR 4. OMPS Limb Profiler (LP) EDR
GCOM-W1	AMSR2	Sun-synchronous orbit (~700 km altitude) ascending node equator crossing time of 1330 UTC	1. Blended Total Precipitable Water (bTPW) 2. Ensemble Tropical Rainfall Potential (eTRaP) 3. GCOM-W1 AMSR2 Algorithm Software Package (GAASP) 4. Advanced Dvorak Technique (ADT) 5. Blended Rain Rate 6. AMSR-2 SST

Table 7-2. Satellite and Satellite Data Availability for the Current Hurricane Season, continued

SATELLITE	TYPE OF DATA	SCAN TIME	PRODUCTS
MetOp-B (AM Primary) MetOp-C NOAA-19 (PM Secondary) NOAA-18 (PM secondary) NOAA-15 (AM secondary)	AVHRR (GAC and LAC [recorded]); HRPT (direct); (AMSU-A; MHS [N-19]; HIRS) NOAA-19, NOAA-18, and NOAA-15. Responsibility has transitioned to Parsons as a Ground System as a Service on a best effort basis. Level2+ Products have been, or are being retired, that use data from NOAA 19, 18, and 15.	Local Crossing Times: MetOp-B: 0931D / 2131A NOAA-19: 0246D / 1436A NOAA-18: 0553D / 1753A NOAA-15: 0546D / 1746A	1. 1 km resolution HRPT and Local Area Coverage (LAC) data. 2. 4 km resolution APT and Global Area Coverage (GAC) data. 3. Mapped imagery. 4. Unmapped imagery (all data types) at DMSP sites. 5. Sea-surface temperature (ACSPO L2 and L3). 6. Soundings. 7. Moisture profiles. 8. Remapped GAC sectors. 9. Sounding-derived products--total precipitable water, rain rate, and surface winds under sounding 10. Daily northern hemisphere snow cover analysis. 11. Twice daily fire and smoke analysis over specific areas within CONUS. 12. AMSU based tropical cyclone intensity estimates. 13. Ensemble Tropical Rainfall Potential (eTRaP) 14. Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) 15. Blended Total Precipitable Water (bTPW) 16. Microwave Integrated Retrieval System (MiRS) 17. Blended Rain Rate 18. ASCAT 25KM Ocean Surface Winds 19. ASCAT 50KM Ocean Surface Winds 20. ASCAT Ulta High Resolution Winds

Table 7-2. Satellite and Satellite Data Availability for the Current Hurricane Season, continued

SATELLITE	TYPE OF DATA	SCAN TIME	PRODUCTS
DMSP F-16 Secondary DMSP F-18 Ops	OLS Imagery (recorded and direct), SSM/IS	Local Crossing Times: F16: 0350D / 1550D F-18: 0610D/ 1810A	1. 0.3 nm (regional) and 1.5 nm (global) resolution (visual and infrared) imagery available via stored data recovery through 557 WW. 2. Regional coverage at 0.3 nm and 1.5 nm resolution (visual and infrared) imagery available from numerous DOW tactical terminals. 3. SSM/IS data transmitted to NESDIS and FNMOC from 557 WW. 4. Ensemble Tropical Rainfall Potential (eTRaP)
Multi-satellites, both geostationary and polar orbiting. S-NPP, NOAA-20, Metop-B, GOES-16, GOES-18, Himawari-9, Meteosat-11, Meteosat-9	Data from imagers and radiometers from satellites in column 1 including, AVHRR, VIIRS, ABI, AHI, and SEVIRI	Daily update frequency	1. 5km Global Geo-Polar Blended SST (Day/Night) 2. 5km Global Geo-Polar Blended SST (Night-only) 3. 5km Global Geo-Polar Blended SST (Day/Night with diurnal correction)

[1] D - descending

[2] A – ascending

Table 7-3. The Dvorak Technique: The Empirical Relationship* between the C.I. Number and the Maximum Wind Speed and the Relationship between the T-Number and the Minimum Sea-Level Pressure (SLP)

C.I. NUMBER	MAXIMUM WIND SPEED	T-NUMBER	MINIMUM SLP (Atlantic)	MINIMUM SLP (NW Pacific)
1	25 kt	1	-	-
1.5	25	1.5	-	-
2	30	2	1009 mb	1000 mb
2.5	35	2.5	1005	997
3	45	3	1000	991
3.5	55	3.5	994	984
4	65	4	987	976
4.5	77	4.5	979	966
5	90	5	970	954
5.5	102	5.5	960	941
6	115	6	948	927
6.5	127	6.5	935	914
7	140	7	921	898
7.5	155	7.5	906	879
8	170	8	890	858

*Dvorak, V, 1984: Tropical Cyclone Intensity Analysis Using Satellite Data. NOAA Tech Report NESDIS 11, Washington., D.C.

CHAPTER 8: SURFACE RADAR REPORTING

8.1. General.

Radar observations of tropical cyclones will be made at DOW, NWS, and FAA Weather Surveillance Radar-1988 Doppler (WSR-88D) facilities. Participating radar sites are listed in Table 8-1.

8.2. The WSR-88D.

The WSR-88D is a computerized radar data collection and processing system. The design and implementation of the WSR-88D was a joint effort of the DOW, NWS, and FAA, and the utilization of the radar continues to be governed by tri-agency agreement. The WSR-88D is an S-band (10-cm), coherent radar, with a nominal beam width of 1 degree. The maximum data ranges are 248 NM (reflectivity) and 124 NM (velocity), although velocity data out to 162 NM can be obtained from radars using "super-resolution." Radar scanning strategies are selectable, using predetermined Volume Coverage Patterns (VCPs). The VCP in use depends upon which weather phenomena are under surveillance. Once the radar data has been collected, it is processed automatically at the radar site by a suite of algorithms which provide graphical products for forecaster use. NHC, as an external user, obtains these products through a network connection. CPHC obtains products directly from four WSR-88Ds in Hawaii operated by the NWS Weather Forecast Office in Honolulu.

8.3. Procedures.

As a tropical cyclone approaches, NHC uses the WSR-88D to perform radar center-fixing and to obtain other diagnostic information. Therefore, it is important to optimize WSR-88D performance for tropical cyclones and to allow other users, especially the NHC, access to radar products in the area of landfall. Most of the changes must be issued through the Master System Control Function (MSCF), Radar Product Generator (RPG) Human Computer Interface (HCI). To facilitate this process, NHC in cooperation with the Radar Operations Center (ROC) has developed an operations plan for use during tropical cyclone events. The current WSR-88D Tropical Cyclone Operations Plan is available here.

The 17 OWS/WXJ (JTWC Satellite Operations) provides radar fix information on TCs within the range of DOW owned WSR-88D systems in the Pacific Ocean.

8.3.1. Radar Observation Requirements, WSR-88D.

Chief among the requirements is the appropriate display of hurricane-force winds. Changes must be made at the radar site, guided by the WSR-88D Tropical Cyclone Operations Plan, in order to deal effectively with hurricane conditions. The physical characteristics of the tropical cyclone are best represented by use of the precipitation mode. Choice of VCP may significantly enhance (or degrade) collection of velocity data (see WSR-88D Tropical Cyclone Operations Plan for further information). The recommended WSR-88D products for tropical cyclones are: CC, DCC, DMD, DR, DSA, DUA, DV, ET, EET, MD, OHA, OHP, SDR, SDV, SDW, SRM, STI, SW, THP, TRU, TVS, USP, VCS, VWP (acronyms definitions can be found in Appendix P).

Table 8-1. Participating WSR-88D Radar Stations[13]

NWS Radars *U.S. Gulf and Atlantic Coasts*	**NWS Radars** *U.S. Southwest*	**FAA Radars**	**DOW Radars**
Albany, NY	Los Angeles, CA	Molokai, HI	Andersen AFB, Guam
Atlanta, GA	Phoenix, AZ	Kohala, HI	Columbus AFB, MS
Binghamton, NY	San Diego, CA	San Juan, PR	Dover AFB, DE
Birmingham, AL	Santa Ana Mtns, CA	South Hawaii, HI	Eglin AFB, FL
Boston, MA	Tucson, AZ	South Kauai, HI	Fort Hood, TX
Brandon/Jackson, MS	Yuma, AZ		Fort Polk, LA
Brownsville, TX			Fort Rucker, AL
Caribou, ME			Maxwell AFB, AL
Charleston, SC			Moody AFB, GA
Columbia, SC			Robins AFB, GA
Corpus Christi, TX			Camp Humphreys, Republic of Korea
Ft. Worth, TX			Kunsan AFB, Republic of Korea
Greer, SC			
Houston, TX			
Huntsville/Hytop, AL			
Jacksonville, FL			
Key West, FL			
Lake Charles, LA			
Melbourne, FL			
Miami, FL			
Mobile, AL			
Morehead City, NC			
New Orleans/Baton Rouge, LA			
New York City, NY			
Philadelphia, PA			
Portland, ME			
Raleigh/Durham, NC			
Roanoke, VA			
San Antonio, TX			
Shreveport, LA			
State College, PA			
Sterling, VA			
Tallahassee, FL			
Tampa, FL			
Wakefield, VA			
Wilmington, NC			

[13]The criterion for selection is that the radar site is located within approximately 124 NM (legacy maximum velocity range) of the coastline.

8.3.2. Central Region Report.

The following fix definitions and criteria are used in reporting tropical cyclone radar observations:

If the central region of a storm is defined by an identifiable circular, or nearly circular, wall cloud with an echo-free center, the fix (the geometric center) is reported as an "**EYE**".

If the central region is recognizable, but not well-defined by a wall cloud (as in the case of a tropical storm), it is reported as a "**CENTER**."

When the eye or center is only occasionally recognizable or some other central region uncertainty exists, the eye or center is reported as **"PSBL EYE"** or **"PSBL CENTER."**

Remarks stating the degree of confidence will be included and will be classified as either "good," "fair," or "poor." If an eye is present, a "good" fix is reported when the eye is symmetrical--virtually surrounded by wall cloud; a "poor" fix is reported when the eye is asymmetrical--less than 50 percent surrounded by wall cloud; a "fair" fix is reported to express a degree of confidence between "good" and "poor." Note that a partial eyewall may be the result of excessive range from the radar, or represent the true structure of the system. Doppler velocities will, in general, increase confidence in the center position and, if available, should always be examined prior to establishing a fix.

8.3.3. Transmission of Radar Reports.

When the location of the center of a tropical cyclone can be reliably determined from radar data, and coastal tropical cyclone watches or warnings are in effect, the appropriate tropical cyclone warning center (NHC, CPHC, or WFO Guam) will issue a Tropical Cyclone Update (TCU) on an hourly basis in between Tropical Cyclone Public Advisory issuances.

CHAPTER 9: OCEAN OBSERVING CAPABILITIES AND REQUIREMENTS

9.1. General

This chapter outlines the marine-based meteorological and oceanographic observational capabilities and requirements necessary to support national tropical cyclone warning and forecast services. It is known that heat exchange at the surface of the ocean is the primary source of energy that drives a tropical cyclone's intensity changes, yet observations of the upper ocean have historically been inadequate in space and time. For every 100 land observations, there is one marine observation. This chapter details the current observing efforts and capabilities across NOAA, Navy, and partner institutions that support forecasting services.

[NOTE: Present ocean observing capabilities do not completely satisfy these requirements; data will be collected as close to stated requirements as possible.]

9.2. Moored Buoys.

9.2.1. National Data Buoy Center.

The National Data Buoy Center (NDBC) maintains automated reporting stations in the coastal and deep ocean areas of the Gulf of America, the Atlantic and Pacific Oceans, and in the Great Lakes. These data acquisition systems collect real-time meteorological and oceanographic measurements for operational and research purposes. Moored buoys are deployed in the southern Gulf of America, the Caribbean, and the Atlantic Ocean east of the Lesser Antilles for the primary purpose of supporting National Hurricane Center operations. NDBC also quality controls and releases meteorological data from the National Ocean Service (NOS) Water Level Observing Network and from moorings and coastal stations operated by cooperating Regional Ocean Observing Systems. The NDBC website provides locations, latest operating status, and site-specific information for NDBC stations and provides links to details on partner organization stations. Specific questions may be addressed to NDBC Mission Control Branch, Stennis Space Center, Mississippi 39529-6000, phone 228-688-2805.

9.2.1.1. Observational Parameters.

The standard suite of observations on NDBC Coastal Weather Buoys include sea level pressure, wind speed and direction, peak wind (labeled as wind gusts), air temperature, relative humidity (transmitted as dew point temperature), sea surface temperature, and wave spectra data (significant wave height, dominant and average wave period, and wave direction). All Coastal-Marine Automated Network (C-MAN) sites measure winds, atmospheric pressure, and air temperature. Relative humidity (transmitted as dew point temperature) is measured at most C-MAN stations.

The sampling scheme used by NDBC is related to the observing network, the data acquisition system, and type of observation. All NDBC Coastal Weather Buoys use the Self-Contained Ocean Observing Payload (SCOOP). The C-MAN network utilizes multiple different data acquisition systems. All NDBC observations are time stamped at the end of the acquisition interval or after the end of the acquisition. For the C-MAN network, a small number of stations collect observations at a higher frequency, depending on the data acquisition system installed.

For the Coastal Weather Buoy and the C-MAN networks, NDBC uses the aneroid barometer. Air pressure at station level (also known as station pressure) is measured in hectopascals (hPa) by the barometer at the elevation of each sensor. For SCOOP payloads, this is a 1-minute average. Air pressure at sea level (also known as sea level pressure) is the station pressure reduced to sea level in units of hPa. The conversion to sea level pressure is made using the procedures described in the NWS Technical Procedures Bulletin No. 291 (NWS 1980), (NDBC/NTSC 2007), and (WBAN 1964). Also for SCOOP payloads, additional atmospheric measurements (i.e, air temperature and dew point) are reported as 10-minute averages.

For the Coastal Weather Buoy stations, the primary wind sensor is an impeller-driven wind-vane anemometer and the secondary wind measurements are collected with an all-in-one instrument that utilizes a sonic anemometer. The C-MAN stations use an impeller-driven wind-vane anemometer for both primary and secondary wind measurements. In addition, wind gusts from Coastal Weather Buoy and C-MAN stations are reported in meters per second (m/s). The wind direction is a unit vector average, whereas the wind speed is a scalar average. The wind gust is the highest wind speed measured in the sampling period. It is calculated from the highest 5-second running mean during the sampling period. For SCOOP payloads, this is a 10-minute average. Coastal Weather Buoys and C-MAN stations also report the wind speed adjusted to 10 m and 20 m above the site elevation. These values are derived from an algorithm as given by Liu et al. (1979). For most moorings, the anemometer is ~3-4 m above the surface, while the barometer is typically between 2-3 m above the surface. The NDBC webpage on sensor heights provides a list of sensor heights on NDBC and non-NDBC buoys and stations.

Many NDBC Coastal Weather Buoys and C-MAN stations can be exposed to intense low pressure systems that can result in severe weather events. As a result, NDBC has the capability to measure and report 1-minute average air pressure data as recorded at sea level. The supplemental pressure data are: (1) the lowest measured air pressure for the hour is called minimum 1-minute air pressure, (2) The time that the minimum 1-minute air pressure is reported as the minute within the hour that this observation occurred. Coastal Weather Buoys that are climatologically in the path of hurricanes or other intense storms have the capability to report the maximum 1-minute wind speed and direction recorded during the sampling interval. This capability will be available on all Coastal Weather Buoys in the near future.

Ocean wave observations are derived from a time series of buoy heave, pitch, roll, and azimuth. Significant wave height is calculated as the average of the highest one-third of all wave heights during the 20-minute sampling period. The NDBC webpage on wave measurements provides more details. Sea surface temperature (SST) on all SCOOP payloads is the instantaneous reading at the reported time.

Additionally, some partner moorings include ocean current observations from Acoustic Doppler Current Profiler (ADCP) sensors, while others may include oceanographic data, such as salinity, water temperature at depth, and conductivity.

9.2.1.2. Data Acquisition and Dissemination.

Many NDBC owned and operated moored buoy and C-MAN stations routinely acquire, store, and transmit data every 10 minutes; some stations report hourly. Some NDBC stations have redundant sensors to ensure data flow in the event of a single sensor failure.

NDBC acquires, encodes, and distributes data from partner organizations via NWS dissemination systems. Data from partner organizations pass through NDBC data quality control procedures prior to NWS dissemination. Frequency and timeliness of transmissions from these stations varies by organization.

The primary objective of the NDBC quality control and quality assurance process is to verify that NDBC observations are accurate and reliable while ensuring usability and confidence in the observations. These real-time automated QC checks include gross error checks that detect communication transmission errors, missing data, and total sensor failure and can be overridden when storms or other unusual environmental phenomena are anticipated to generate out of the ordinary, but valid measurements. To ensure the highest quality observations, adjustments may be applied to the raw data received at NDBC. The type of adjustment is dependent on the sensor and/or payload type. Some adjustments are applied onboard while other adjustments are applied after the data are received by NDBC. In general, onboard adjustments are restricted to magnetic anomalies and hull response. More details can be found in the Handbook of Automated Data Quality Control Checks and Procedures.

Moored buoy and C-MAN data are transmitted via satellite communication system and then are relayed to the NWS Telecommunications Gateway (NWSTG) for processing and dissemination. Data from partner organizations acquired by NDBC are relayed to the NWSTG for processing and dissemination. Moored buoy observations are formatted into the World Meteorological Organization (WMO) FM13 SHIP code and BUFR template TM315008. C-MAN and other partner organization coastal station data are formatted into C-MAN code, which is very similar to the WMO FM12 SYNOP code, and BUFR template TM307079.

Observations from the Prediction and Research Moored Array in the Atlantic (PIRATA), which is not owned or operated by NDBC, are transmitted to the Global Telecommunication System (GTS) though NOAA’s Pacific Marine Environmental Laboratory (PMEL). Further information on this transmission is available. Data can be accessed via NDBC.

A file providing the latest standard meteorological observations (updated every 5 minutes) is available. This file essentially contains the same data elements as the standard meteorological data file; however, this file has the most recent observation (provided that the observation is less than two hours old) from all stations hosted on the NDBC website, as well as the position information (latitude and longitude) for each station.

9.3. Drifting Buoys.

9.3.1. National Data Buoy Center.

NDBC is capable of acquiring, preparing, and deploying drifting buoys; however, an operational drifting buoy requirement has not been identified or funded.

9.3.2. NOAA's Global Drifter Program.

The NOAA-supported Global Drifter Program (GDP) maintains a global 5° latitude x 5° longitude gridded array of ~1,200 satellite-tracked surface drifting buoys to meet the need for an accurate and globally dense set of in-situ observations of mixed layer currents, sea surface temperature, atmospheric pressure, winds, waves, and salinity. Drifter sea level pressure observations are routinely utilized by operational centers (e.g., European Centre for Medium-Range Weather Forecasts (ECMWF)) to improve numerical weather prediction (NWP) and considered to be extremely valuable by the NOAA/NWS Environmental Modeling Center (EMC) for validating several operational systems including NOAA's Hurricane Analysis and Forecast System (HAFS).

9.3.2.1. Observational Parameters.

All drifting buoys are equipped with a thermometer to measure sea surface temperature (±0.05°C accuracy), a GPS receiver, a satellite transmitter, and a microcomputer. The standard Surface Velocity Program (SVP) drifter also measures 15-m averaged upper ocean current velocity due to a drogue that allows the drifter to follow the upper ocean currents accurately. Approximately 50% of these drifters are also equipped with barometers (SVPB) to measure sea level atmospheric pressure (±0.4 hPa accuracy).

Typical hurricane packages consist of additional drifter types, such as Minimets (SVPB + wind speed and direction), Autonomous Drifting Ocean Station (ADOS; thermistor chains to 150 m depth replacing the Minimet drogue), Directional Wave Spectrum Drifters (DWSB), and SVPB drifters. They continue to operate throughout the season, even after targeted deployments. Recently expanded observational capabilities include A-sized drifters that are deployed from the NOAA WP-3D and the USAFR WC-130J aircraft that measure 3D wave spectrum, sea surface temperature, and sea level barometric pressure; see Section 9.4 below for more details.

9.3.2.2. Data Acquisition and Dissemination.

Drifters typically collect and transmit measurements via iridium satellites every hour at the top of the hour. However, the reporting intervals can be changed based on the scientific use of the drifter (i.e., down to 5-minute sampling rate). The observations are received by the GDP Data Processing Center at Scripps Institution of Oceanography where they are decoded and sent to the GTS under the recommended format (i.e., BUFR template TM315009) for use and assimilation into NWP models.

The Drifter Data Assembly Center (DAC) at the NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) also receives the decoded satellite messages, applies quality control procedures to drifting buoy data (position and temperature), and interpolates the data to 1-hour and 6-hour intervals using an optimum interpolation procedure. The publicly available drifter data in real time are available from Scripps via their ERDDAP server.

9.3.3. Navy.

Since 1998, the Naval Oceanographic Office (NAVOCEANO) has deployed meteorological drifting buoys to report surface meteorological and oceanographic measurements, for operational purposes, as tropical systems move through data sparse regions tracking toward the U.S. East

Coast. Additionally, Navy drifting buoys have been deployed in the Intertropical Convergence Zone (ITCZ). The drifting buoy measurements, which are available to tropical forecasters, provide invaluable input for defining tropical storm movement and intensity, improve forecast model initialization, and give tropical forecasters a much better sense of storm characteristics and track as they approach the fleet concentration areas of Jacksonville, FL and Norfolk, VA. Drifting buoys typically have a life span of one to two years, and the data are available through the NAVOCEANO website and through standard World Meteorological Organization (WMO) data sources.

NAVOCEANO acquires, prepares, and deploys drifting meteorological buoys based on operational requirements identified by the Commander, U.S. Fleet Forces Command (USFFC). Currently, USFFC has identified the Navy's drifting buoy support as a standing requirement to support fleet safety, assist in fleet sortie decisions, and enhance tropical weather preparedness.

9.4. Aircraft Deployed Buoys.

Routine ocean buoy observations are often insufficient in time and/or space to provide the data necessary to improve tropical cyclone and/or storm surge model forecasts and to assist forecasters with storm-relevant information. However, these observations can be augmented with buoys and floats certified for WC-130J and/or WP-3D deployment by relevant USAF and NOAA instructions. Typical hurricane drifter packages (see Section 9.3.2.1 for drifter types) are deployed in a line transecting the projected path of the system (Figure 9-1). Air-deployment practices require this to be in advance of the storm outside the extent of tropical-storm-force winds.

Air-deployed ocean buoys are broadly categorized by deployment mechanism. Some are "A-sized" (5" diameter and 36" long) and can be deployed from the A-sized tubes in the WC-130J and WP-3D. Often A-sized instruments are deployed during tasked fix/invest weather reconnaissance missions as part of normal operations. These types of buoy deployments do not require Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH) coordination.

Larger buoys, however, must be deployed from the cargo ramp of the WC-130J. These open ramp deployments require dedicated buoy missions (since the WC-130J ramp is not opened during fix/invest missions), a larger crew (a second loadmaster on the ramp), and additional qualifications (the whole crew must be buoy-qualified and current). These missions require coordination through the defense support of civil authorities (DSCA) request for assistance (RFA) process.

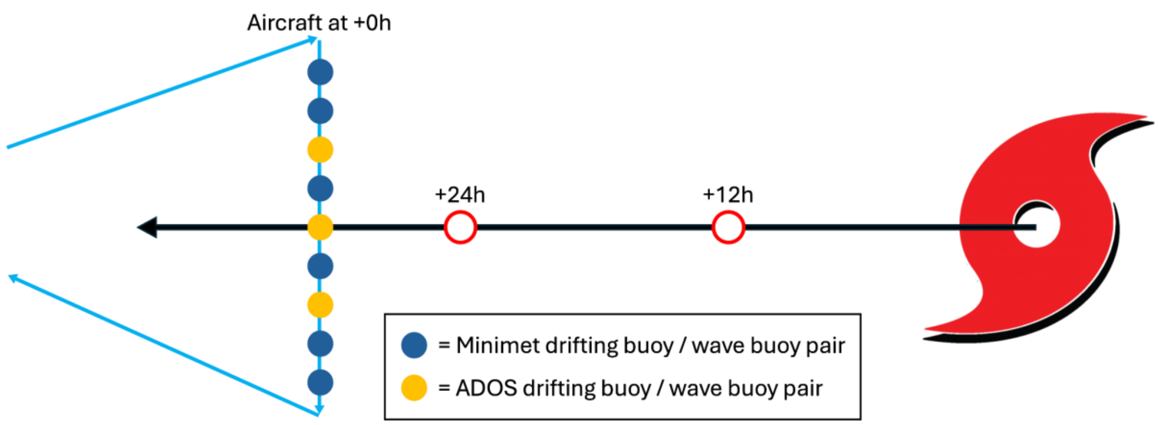

Figure 9-1. Example deployment line of drifter pairs 24h ahead of the arrival of tropical-storm-force winds, from a WC-130J.

9.4.1. The Defense Support of Civil Authorities (DSCA) Request for Assistance (RFA) Process.

DOC/NOAA may request DOW/USAF weather reconnaissance aircraft to deploy buoys and subsurface floats in the vicinity of, yet a safe distance from, a tropical or subtropical system. Safe distances depend on dynamics of the storm, but a typical minimum stand-off distance is 150 NM from the TC center. Often these are positioned ahead of the forecast track of the tropical or subtropical system. DOC/NOAA may seek assistance with assessing the need and mission requirements for buoy missions from a panel of experts, hereafter referred to as the "Ocean Sensing Group (OSG)." This group may consist of individuals internal or external to the United States Federal Government (USG) enterprise, however, any RFAs to the DOW/USAF must come from a USG representative (e.g., NOAA/AOML Global Drifter Program). Coordination of buoy missions occurs in three phases: The RFA process, mission requirement definition, and mission requirement refinement.

9.4.1.1. The RFA Process (approximately two days from mission execution).

All initial requests for reconnaissance aircraft buoy and float deployment missions shall be coordinated between authorized USG personnel and CARCAH. Deployments in advance of a tropical or subtropical system require a minimum 48-hour notification before the start of the desired buoy release period; additional notification time may be necessary for forward operating locations. Any requests that do not provide the required 48 hours notice will be considered on a resources-permitting basis.

The RFA process is mapped in Figure 9-2. Once a requirement is identified by the OSG and approved by the USG representative (e.g., NOAA/AOML Global Drifter Program), the request for assistance is sent to CARCAH for coordination. If the request has been determined to be supportable by the AFRC 403rd Wing (403 WG), the RFA is incorporated into the succeeding day outlook section of the Tropical Cyclone Plan of the Day (TCPOD - see Section 5.4.2), depicted in Figure 5-4, by CARCAH and is considered a validated request. This process takes place primarily via email communication.

Note: *Requesting agencies must provide buoys and floats to be deployed. To do this, these expendables should be shipped to the 53rd Weather Reconnaissance Squadron (53 WRS) at Keesler Air Force Base, MS well in advance, along with any mission-related personnel, as required.*

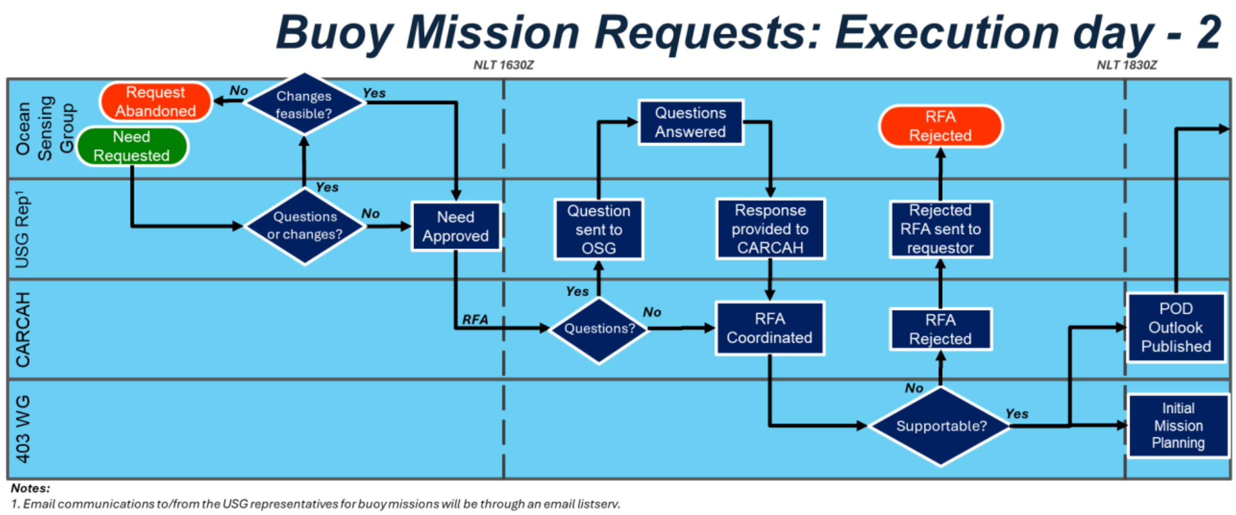

Figure 9-2. The Request for Assistance (RFA) Process

9.4.1.2. Defining Mission Requirements (approximately one day from mission execution).

Once a validated RFA has been established, the process of defining mission requirements begins (Figure 9-3). The OSG will determine the following mission details: deployment release period date/time range, array configuration and orientation (locations, spacing, quantity, etc.), buoy/float types, and order of release. This information will be provided within a draft Buoy Tasking Request (BTR - see an example in Figure 9-4). The placement of the buoys and floats will depend on several factors, including:

- Characteristics of the tropical or subtropical system, such as size, intensity, and movement
- Storm position relative to the coast and population centers

The draft BTR information will normally be communicated to a USG representative (e.g., NOAA/AOML Global Drifter Program) via a virtual chat platform. The use of chat may be substituted by phone calls, or other collaborative means. When a chat platform is used, the plan will be provided in a collaboration channel that includes the OSG, USG representatives, CARCAH, and 53 WRS members, as required. The deployment pattern will be reviewed with questions answered and adjustments made to the mission details as needed. A final version of the BTR shall be sent by the USG representative to CARCAH, preferably by email, as soon as possible but no later than 1630 UTC. CARCAH will then convey the BTR to the 403 WG Current Operations section and will task the mission via the TCPOD at least 16 hours prior to on-station time plus transit time to the initial deployment location.

Note: *Once CARCAH has tasked the mission on the TCPOD, additional coordination between the OSG, USG representatives, and CARCAH may continue on the mission details as necessary.*

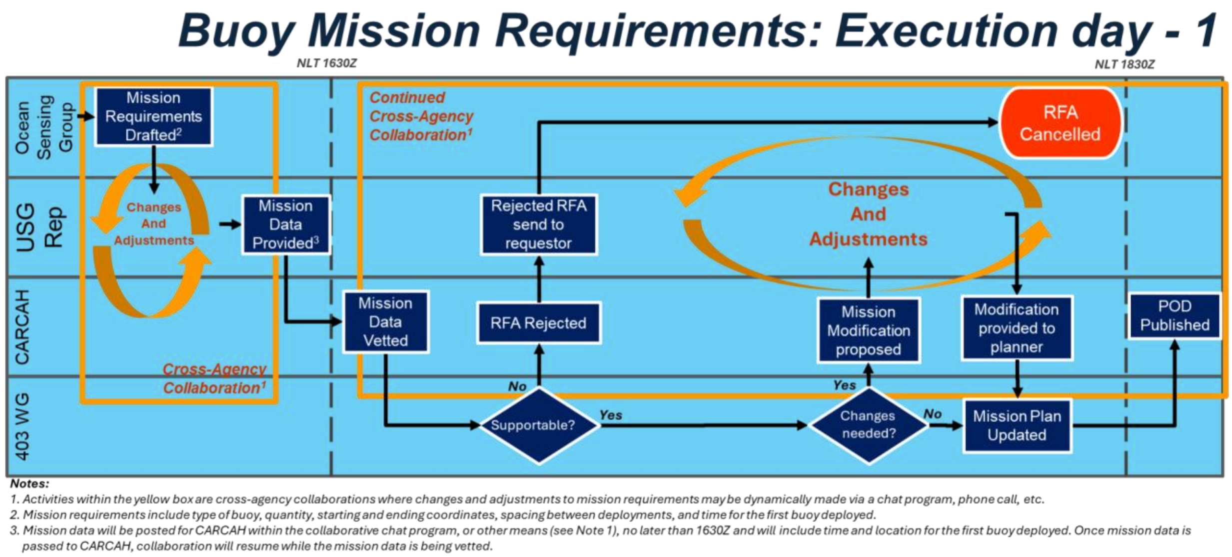

Figure 9-4. Defining Mission Requirements BUOY TASKING REQUEST
DTG: 8/1300 OCT 18
VALID FOR DEPLOYMENTS BETWEEN 8/1800 OCT 18 AND 8/2100 OCT 18
TAKEOFF TIME 8/1700 OCT 18

LINE: SP 25 15N 88 23W EP 25 15N 84 31W HEADING 090T SPACING/RADIUS 30/5nm
1: Barometric-1
2: Minimet-1
3: Minimet-2, APEX-EM-1
4: Barometric-2
5: Minimet-3, APEX-EM-2
6: Barometric-3
7: Minimet-4, APEX-EM-3
8: Minimet-5

END BUOY TASKING REQUEST DTG: 8/1300 OCT 18

Figure 9-4. Example Buoy Tasking Request

9.4.1.3. Mission Requirement Refinement (day of mission execution).

To ensure the latest information will be considered for mission planning, the OSG will continue to monitor the environmental situation to determine if any changes are needed. Just prior to crew alert time (three hours and fifteen minutes before scheduled takeoff), CARCAH will confirm whether the mission is still desired and will notify the 53 WRS of the mission status. Adjustments can be made to the deployment times, pattern, and buoy platforms specified in the BTR ahead of the mission. If changes are made, a revised BTR must be sent to CARCAH by a

USG representative prior to crew show time (two hours and fifteen minutes before scheduled takeoff); and CARCAH, in turn, will relay it to the 53 WRS. See Figure 9-5 for this process mapping.

Note: *The confirmation may be established as a "cancellation by exception" policy in which the mission is assumed to still launch with no material changes unless told otherwise. Once crews show up to begin mission preflight activities, CARCAH will provide any updated mission details.*

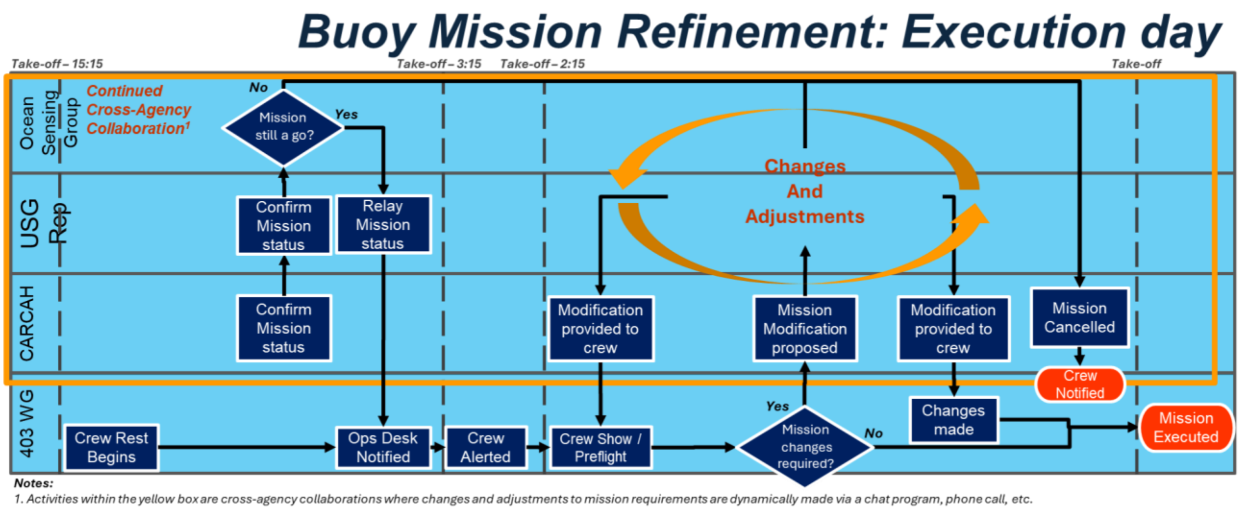

Figure 9-5. Refining Mission Requirements

9.4.2. DOW Initiatives.

The DOW's responsibility to provide support to civil authorities falls under the Commanders of US Northern Command and US Indo-Pacific Command. As such, DOW service components involved in the same DSCA effort may support each other under DSCA authority. If no other direction is provided by the supported combatant command, service components should follow the procedures established in this plan to coordinate support.

Additionally, the USN often works with the 53 WRS to conduct ocean observations as part of regularly tasked tropical cyclone reconnaissance missions on a not-to-interfere basis, to include A-sized buoy deployments at transit altitudes. No coordination with CARCAH is required for these operations.

9.5. Ships.

Currently, all Tropical Cyclone Forecast Advisories issued by the National Hurricane Center request 3-hourly ship reports within 300 NM of the center of any system.

For the past ~150 years, the WMO has utilized the Volunteer Observing Ship (VOS) project wherein ships take and transmit meteorological observations. In addition to their use in NWP models, reports from ships at sea are also used in the preparation of forecasts and warnings, including forecasts issued specifically for mariners and those for the Global Maritime Distress and Safety System (GMDSS - see section 10.2).

9.5.1. Observational Parameters.

Ships through the VOS program are provided with a barometer, dry and wet-bulb thermometers, sea water thermometer, and an anemometer. The observations requested are: atmospheric pressure, tendency and characteristic; wind speed and direction; air and wet-bulb temperature and dew point; visibility; cloud heights, amounts and type; past and present weather; ship course and speed; sea surface temperature; and sea waves and swell – period, direction and height. Since this VOS is a volunteer based program, not all reports have a complete set of observations. Pressure tendency and change are based on the 3-hour change. Wind speed and direction are based on an average over a 10-minute period. Some wind speeds may not be directly measured and are estimated on the sea state appearance. However, estimated wind speeds are indicated. Ship course and speed are based on the course and speed made good during the three prior hours.

9.5.2. Data Acquisition and Dissemination.

NOAA and WMO request ships to take and transmit observations every six hours at 0000, 0600, 1200, and 1800 UTC. The 0000 and 1200 UTC observations are the most important. Intermediate observations are taken at 0300, 0900, 1500, and 2100 UTC. If ship operations prevent transmission at or near the reporting hour, reports should be sent as soon as possible, but no later than three hours after the time of observation. Observations can be transmitted via INMARSAT or email. At this time, shipboard weather observations are accessible to the public. A NOAA National Centers for Environmental Information (NCEI) webpage provides an observation count for VOS Ships.

9.6. Upper Ocean Observations.

Subsurface ocean observations are required to quantify critical ocean features relevant for tropical cyclone intensification, such as barrier layers and regions of high ocean heat content. The continuous monitoring of the upper ocean’s thermal and salinity structure has been requested by NOAA/NWS/EMC to address the dearth of subsurface ocean data and improve operations by accurately constraining and validating coupled ocean-atmosphere models.

9.6.1. Ocean Gliders.

The NOS Integrated Ocean Observing System (IOOS) Office coordinates a community of multi-institutional, multi-regional glider operators (i.e., IOOS Regional Associations, NOAA, and academic partners) conducting missions during the Atlantic and Pacific hurricane seasons. Further, the U.S. Navy Commander, Naval Meteorology and Oceanography Command (CNMOC), and its operational command, NAVOCEANO, contribute ~10 Navy Littoral Battlespace Sensing gliders (LBS-G) each hurricane season to advance these efforts. Throughout the hurricane season, gliders are ideally positioned to continuously monitor and track ocean features linked to tropical cyclone intensity changes.

Observations from these gliders are assimilated into NOAA’s operational forecasting models to help provide oceanic initial conditions, correct modeled processes and dynamics, and contribute to a more realistic ocean simulation.

9.6.1.1. Observational Parameters.

All gliders measure water column temperature, salinity, and pressure (closely related to depth) at a vertical resolution of 1 m. While various glider manufacturers and users may use different sensors, the most common sensor for measuring the temperature, salinity, and pressure is a Sea-Bird conductivity, temperature, and depth (CTD) instrument. Salinity, calculated based on the temperature and conductivity, has accuracy of ±0.0035. Temperature has an accuracy of ±0.002°C, and pressure has an accuracy of ±2 dbar.

Select gliders are also equipped with current meters. Gliders are capable of collecting higher resolution data; however, lower sampling rates are typically used to conserve power. In the open ocean, gliders typically dive down to 1,000 m, which takes ~4-5 hours. Gliders are capable of more frequent profiles to shallower depths and should be prioritized in extreme weather conditions.

9.6.1.2. Data Acquisition and Dissemination.

After each dive and upon surfacing, gliders transmit data back and receive updated commands via Iridium satellite communications. Data is sent back to a base station where it is analyzed, undergoes quality control, and sent to the IOOS Glider Data Assembly Center (GDAC). The GDAC also performs basic QC checks to ensure all data are of high quality. NDBC harvests the glider temperature and salinity data every hour from the GDAC and submits them to the GTS in BUFR format (currently as a modified drifting buoy template TM315009, with plans to transition template TM315012 in Q2 of 2026) for use and assimilation into NWP models. For further information regarding the quality control of glider data at the GDAC, see the IOOS Manual for Quality Control of Temperature and Salinity Data Observations from Gliders. Access to real-time glider data, as well as a map of current glider positions, is located on a website.

9.6.2. Argo.

Argo profiling floats are the dominant source of subsurface ocean data for the global ocean observing system, provide over thousands of temperature and salinity profiles each month, and are critical for monitoring changes to ocean heat content during hurricane season.

9.6.2.1. Observational Parameters.

On the top of every Argo float is a Conductivity (used to calculate salinity, ±0.001), Temperature (±0.001˚C), and Depth (calculated from pressure, ±0.1 dbar) sensor.

Argo floats typically operate on a 10-day cycle. For tropical cyclone observing applications, the float mission can be successfully modified to collect profiles every 5 days, 2.5 days, or every 6-12 hours to provide key insights regarding the ocean’s role in rapid intensification.

9.6.2.2. Data Acquisition and Dissemination.

For the majority of Argo floats, measurements are collected as the float ascends from 2,000 m to the surface. Some floats are also set to sample as they descend and as they drift at 1,000 m depth. As the float surfaces, it transmits its measurements via satellite to national data assembly centers (DAC), where the data undergo real-time quality control and are sent to the GTS in BUFR format (template TM315003) for operational use and assimilation. The U.S. DAC for the Argo program is NOAA/AOML and the median time from observation transmission to the GTS is ~2 hours.

Real-time data is also sent from the DACs to Argo's two Global Data Assembly Centers (GDACs): USGODAE Argo Global Data Assembly Center in Monterey, California and Coriolis Argo Global Assembly Center in Brest, France. A map of float locations and profiles can be accessed at the Euro Argo Data Selection website.

9.7. Uncrewed Surface Vehicles.

Since 2021, NOAA has invested in advancing the use of Uncrewed Surface Vehicles (USVs) for tropical cyclone operations and successfully demonstrated their utility. Given their mobility, these USVs are able to be directed to the path of oncoming tropical cyclones and collect critical measurements at the air-sea interface through the passage of the storm. Some of these observations are used directly by operational forecasters and assimilated into the operational models, such as the Global Forecast System (GFS), and have the potential for assimilation into other operational models such as the HAFS and Real Time Ocean Forecast System (RTOFS).

9.7.1. Observational Parameters.

USVs measure wind speed, direction, and gusts; air temperature; relative humidity; atmospheric pressure; and ocean temperature. Some platforms can also measure sea surface salinity, temperature, and salinity profiles; ocean current profiles; and incoming solar radiation. Wave height and period can also be calculated in real-time based on the vehicle motion. Different platforms collect meteorological measurements at different heights above the ocean surface, usually within the first 5 m. Ocean current profiles are measured via an Acoustic Doppler Current Profiler (ADCP) that reach depths of nearly 100 m. Temperature and salinity profiles are collected in the upper few hundred meters using a winched CTD instrument. Some platforms may contain onboard cameras to collect photos and videos.

The National Hurricane Center has cited the USV observed winds, waves, SST, and pressure in several advisories.

9.7.2. Data Acquisition and Dissemination.

USV platforms may differ in their exact method of transmitting data off the vehicles. Typically, real-time data is transmitted via satellite at a resolution ranging from 1-minute to 30-minutes with a latency of less than one hour. Efforts to collect and transmit higher resolution frequencies are prioritized when vehicles are within and near tropical cyclones.

The data are directed to NOAA/PMEL, where it undergoes gross data integrity and quality control checks. From there, NDBC retrieves and transmits the data to the GTS in BUFR format (template TM315011) for operational use and assimilation.

PMEL also serves the data publicly through an ERDDAP server. Data for each USV, along with tasking directions, are visible through each company's dashboard. For access, please email the project lead: Dr. Gregory Foltz (NOAA/AOML).

CHAPTER 10: MARINE WEATHER BROADCASTS

10.1. General.

The NWS and the DHS USCG broadcast forecast products that include information on tropical cyclones issued by the NHC and the CPHC. The broadcast of these products supports the U.S. participation in the Global Maritime Distress and Safety System (GMDSS), which provides communications support to the International Maritime Organization's (IMO) global search and rescue plan.

10.2. Global Maritime Distress and Safety System.

The goals of GMDSS are to provide more effective and efficient emergency and safety communications, and to disseminate maritime safety information to all ships on the world's oceans regardless of location or atmospheric conditions. These goals are defined in the International Convention for the Safety of Life at Sea (SOLAS) 1974, as amended. GMDSS is based upon a combination of satellite and terrestrial radio services and has changed international distress communications from being primarily ship-to-ship based to ship-to-shore (rescue coordination center) based. GMDSS provides for automatic distress alerting and locating, and requires ships to receive broadcasts of maritime safety information which could prevent a distress from happening in the first place. The NWS participates directly in the GMDSS by preparing weather forecasts and warnings for broadcast via the GMDSS systems-- NAVTEX (radio services) and approved satellite systems Inmarsat’s SafetyNET II and Iridium’s Safetycast.

10.2.1. NAVTEX.

NAVTEX is an international, automated system for instantly distributing maritime navigational warnings, weather forecasts and warnings, search and rescue notices, and similar information to ships. It has been designated by the IMO as the primary means for transmitting coastal urgent marine safety information to ships worldwide. In the United States, NAVTEX is broadcast from Coast Guard facilities in Cape Cod, Chesapeake VA, Savannah GA, Miami FL, New Orleans LA, San Juan PR, Cambria CA, Pt. Reyes CA, Astoria OR, Kodiak AK, Honolulu HI, and Guam. Although NAVTEX broadcasts from Guam have not been operational since July 2018, Guam continues to broadcast NAVTEX on its backup frequency 4209.5 kHz. Coverage is reasonably continuous along the east, west, and Gulf coasts of the United States, as well as the area around Kodiak, Alaska, Hawaii, Guam, and Puerto Rico. Typical NAVTEX transmissions have a range of 200 NM.

10.2.2. SafetyNET II.

Satellite systems operated by Inmarsat are an important element of the GMDSS. In January 2024, the NWS upgraded to Inmarsat’s SafetyNET II for broadcasting High Seas forecasts and warnings, Tropical Cyclone Bulletins (when applicable) and Tsunami Bulletins (when applicable) to METAREAs IV and XII. SafetyNET II provides ship/shore, shore/ship, and ship/ship store-and-forward data and telex messaging; the capability for sending preformatted messages to a rescue coordination center. The SafetyNET II service is a satellite-based worldwide maritime safety information (MSI) broadcast service of high seas weather warnings, navigational warnings, radionavigation warnings, ice reports and warnings generated by USCG-conducted International Ice Patrol, and other information not provided by NAVTEX.

10.2.3 Safetycast

Iridium's Safetycast GMDSS service is a satellite-based worldwide MSI broadcast service of high seas weather warnings, navigational warnings, radionavigation warnings, ice reports and warnings generated by USCG-conducted International Ice Patrol, and other information not provided by NAVTEX. The NWS began using Safetycast operationally in June 2023 as a requirement of the GMDSS. The Safetycast system is similar to SafetyNET II in that it broadcasts High Seas forecasts and warnings, Tropical Cyclone Bulletins (when applicable) and Tsunami Bulletins (when applicable) to METAREAs IV and XII.

10.3. Coastal Maritime Safety Broadcasts.

In addition to NAVTEX, the USCG and other government agencies broadcast maritime safety information, using a variety of different radio systems to ensure coverage of different ocean areas for which the United States has responsibility and to ensure all ships of every size and nationality can receive this vital safety information.

10.3.1. VHF Marine Radio.

The USCG broadcasts nearshore and storm warnings of interest to the mariner on VHF channel 22A (157.1 MHZ) following an initial call on the distress, safety, and calling channel 16 (156.8 MHZ). Broadcasts are made from over 200 sites, covering the coastal areas of the U.S., including the Great Lakes, major inland waterways, Puerto Rico, Alaska, Hawaii, and Guam. All ships in U.S. waters over 20 meters in length are required to monitor VHF channel 16 and must have radios capable of tuning to the VHF simplex channel 22A. Typical coverage is 25 NM offshore.

10.3.2 NOAA Weather Radio.

The NOAA Weather Radio network continually broadcasts coastal and marine forecasts on seven frequencies (MHz) (162.400, 162.425, 162.450, 162.475, 162.500, 162.525 and 162.550). Recorded voice broadcasts have largely been supplanted by a synthesized voice. The network provides near-continuous coverage of the coastal U.S., Great Lakes, Puerto Rico and the U.S. Virgin Islands, Hawaii, Guam, Commonwealth of the Northern Mariana Islands, American Samoa, and the populated Alaska coastline. Typical coverage is 25 NM offshore.

10.4. High Seas Broadcasts.

NWS high seas weather forecasts and warnings are also available on the following high frequency (HF) broadcasts.

10.4.1. HF Radiotelephone (Voice).

Weather forecasts and warnings for high seas and offshore areas are broadcast over scheduled HF single sideband (SSB) radiotelephone channels from USCG communications stations using a very distinctive and recognizable computer-synthesized voice.

10.4.2. HF Radiofacsimile.

The USCG broadcasts NWS high seas weather maps from five communications stations--Boston, MA (NMF); Point Reyes, CA (NMC); New Orleans, LA (NMG), Honolulu, HI (KVM-70) (a DOW station); and Kodiak, AK (NOJ). These radiofax charts can also be viewed on the internet. Limited satellite imagery, sea surface temperature maps, and tropical cyclone charts are also available.

10.4.3. HF Radiotelex (HF SITOR).

High seas forecasts in text format, recognized by the GMDSS, are broadcast over scheduled GMDSS HF narrow-band direct printing channels from USCG communications stations. Limited offshore forecasts are also available.

10.4.4. WWV, WWVH HF Voice (Time Tick).

On January 31, 2019, the NWS discontinued dissemination of High Seas and Storm Warnings portion of the National Institutes of Science and Technology (NIST) time frequency broadcasts as issued by WWV and WWVH "shortwave" radio covering the Atlantic, Gulf of America and the Pacific.

10.5. Additional Information.

Further information concerning these and other marine broadcasts, including schedules, frequencies, and links to products can be found at:

- National Weather Service Marine Forecasts
- DHS USCG Maritime Communications

Refer to National Geospatial-Intelligence Agency (NGA) publication 117 Radio Navigational Aids, which is updated through Notice to Mariners, for the latest official listing of US Coast Guard broadcast schedules. The British Admiralty List of Radio Signals is also an excellent source for NAVTEX and GMDSS information

CHAPTER 11: PUBLICITY

11.1. News Media Releases.

News media releases, other than warnings and advisories, for the purpose of informing the public of the operational and research activities of the Departments of Commerce, Defense, and Transportation should reflect the joint effort of these agencies by giving due credit to the participation of other agencies.

11.2. Distribution.

Copies of these releases should be forwarded to the following agencies:

NOAA Office of Public Affairs
Herbert C. Hoover Building
14th and Constitution Avenue, N.W.
Washington, DC 20230

Commander, Naval Meteorology and Oceanography Command
1100 Balch Boulevard
Stennis Space Center, MS 39522-3001

HQ Air Force Reserve Command (AFRC/PA)
Robins AFB, GA 31093

Joint Staff Weather Officer
The Joint Chiefs of Staff (J3/DDGO-ROD)
Pentagon Room 2D-921G
Washington, DC 20318-3000

Federal Aviation Administration (APA-310)
800 Independence Avenue, S.W.
Washington, DC 20591

Director, NOAA Aircraft Operations Center
3450 Flightline Drive
Lakeland, FL 33811-2836

APPENDIX A: LOCAL NATIONAL WEATHER SERVICE (NWS) OFFICE PRODUCTS

A.1. General.

This appendix briefly describes some of the products issued by local NWS offices which support the tropical cyclone forecasting and warning program. Additional details of all the products can be found in National Weather Service Instruction 10-601.

A.2. Products.

A.2.1. Hurricane/Typhoon Local Statements (HLS).

WFOs with coastal county responsibilities and selected inland WFOs will issue these products which are very specific and designed to inform media, local decision makers, and the public on present and anticipated storm effects in their county warning area (CWA) and adjacent coastal waters. HLSs will add localized details to tropical cyclone center's advisory releases and should not conflict with or repeat advisory information not directly applicable to the local office's CWA.

Coastal WFOs are defined as those having at least one county with significant tidal influences. Those are:

EASTERN REGION	SOUTHERN REGION	WESTERN REGION	PACIFIC REGION
Caribou, ME Portland, ME Boston, MA New York City, NY Philadelphia, PA Baltimore, MD/ Washington, DC Wakefield, VA Newport/ Morehead City, NC Wilmington, NC Charleston, SC	Brownsville, TX Corpus Christi, TX Houston/Galveston, TX Lake Charles, LA New Orleans, LA Mobile, AL Tallahassee, FL Tampa Bay, FL Miami, FL Key West, FL Melbourne, FL Jacksonville, FL San Juan, PR	San Diego, CA Los Angeles/ Oxnard, CA	Honolulu, HI Guam WSO Pago Pago, American Samoa

A.2.2. Extreme Wind Warning (EWW).

Short duration warnings are issued by WFOs to protect lives and property. WFO forecasters issue short duration EWW products to provide the public with advance notice of the onset of extreme tropical cyclone winds, usually associated with the eyewall of a major (category 3 or higher) tropical cyclone. Extreme Wind Warnings inform the public of the need to take immediate shelter in an interior portion of a well-built structure due to the onset of extreme tropical cyclone winds.

A.2.3. Post-Tropical Cyclone Reports (PSH).

The PSH is the primary WFO post tropical cyclone product issued to the public to report and document local tropical cyclone impacts. The PSH product is intended to provide the NHC, NWS Headquarters, the media, the public, and emergency management officials with a record of peak tropical cyclone conditions. This data is then used to formulate other post-event reports, news articles and historical records.

APPENDIX B: DEFINING POINTS FOR TROPICAL CYCLONE WATCHES/WARNINGS

The coastal areas placed under tropical storm and hurricane/typhoon watches and warnings are described through the use of "breakpoints" or geographical positions. The National Weather Service (NWS) designates the locations along the U.S. East, Gulf, and California coasts, Puerto Rico, Hawaii, American Samoa, Guam and the Commonwealth of the Northern Mariana Islands, as well as points across the Republic of Palau, Federated States of Micronesia, and Republic of the Marshall Islands. Individual countries across the Caribbean, Central America, and South America provide coastal locations for their areas of responsibility to the NWS for the National Hurricane Center's use in tropical cyclone advisories when watches/warnings are issued by international partners. The NWS conveys the approximate lateral extent of areas at risk for life-threatening storm surge in its text products using fixed 'communication points', similar to the breakpoints used to convey the tropical cyclone watches and warnings. The tropical cyclone warning breakpoints will also serve as surge communication points, with additional surge communication points. The National Hurricane Center has a webpage dedicated to Graphical representation of the breakpoints and storm surge communication points. An additional source for tropical storm and hurricane watch and warning breakpoint information is NWS Instruction 10-605.

APPENDIX C: JOINT TYPHOON WARNING CENTER (JTWC) BULLETINS

Below are the abbreviated communications headers and titles for the products for which JTWC is responsible. A brief description of each product, to include scheduled transmission times, is available on the Naval Oceanography Portal.

ABIO10 PGTW	Significant Weather Advisory, Indian Ocean
ABPW10 PGTW	Significant Weather Advisory, Western Pacific Ocean
WTPN21-26 PGTW	Tropical Cyclone Formation Alert, Northwest Pacific Ocean
WTPN31-36 PGTW	Tropical Cyclone Warning, Northwest Pacific Ocean
WDPN31-39 PGTW	Prognostic Reasoning Bulletin, Northwest Pacific Ocean
WTIO21-25 PGTW	Tropical Cyclone Formation Alert, North Indian Ocean
WTIO31-39 PGTW	Tropical Cyclone Warning, North Indian Ocean
WDIO31-39 PGTW	Prognostic Reasoning Bulletin, North Indian Ocean
WTPS21-25 PGTW	Tropical Cyclone Formation Alert, South Pacific Ocean
WTPS31-39 PGTW	Tropical Cyclone Warning, South Pacific Ocean
WDPS31-39 PGTW	Prognostic Reasoning Bulletin, South Pacific Ocean
WTXS21-26 PGTW	Tropical Cyclone Formation Alert, South Indian Ocean
WTXS31-39 PGTW	Tropical Cyclone Warning, South Indian Ocean
WDXS31-39 PGTW	Prognostic Reasoning Bulletin, South Indian Ocean
WTPN21-25 PHNC	Tropical Cyclone Formation Alert, Northeast Pacific Ocean
WTPN31-39 PHNC	Tropical Cyclone Warning, Northeast Pacific Ocean
TPPN10-19 PGTW	Tropical Cyclone Position and Intensity, Northwest Pacific Ocean
TPIO10-19 PGTW	Tropical Cyclone Position and Intensity, North Indian Ocean
TPPS10-19 PGTW	Tropical Cyclone Position and Intensity, South Pacific Ocean
TPXS10-19 PGTW	Tropical Cyclone Position and Intensity, Southern Indian Ocean
TPPZ01-05 PGTW	Tropical Cyclone Position and Intensity, Central North Pacific Ocean

APPENDIX D: FORMAT FOR NHOP/NWSOP FLIGHT INFORMATION FOR INTERNATIONAL AND DOMESTIC NOTAM ISSUANCE

Flight information shall be sent to the Notice to Airmen (NOTAM) office via email, for dissemination as an International and Domestic NOTAM in the following format (Note: The request is made for a domestic NOTAM which will then automatically makes its way into the international NOTAM system):

HEADER

Request a Domestic NOTAM be Issued

Affected Center(s). This field will include all affected ARTCCs in 3-letter identifier format; e.g., ZNY, ZOA, ZAN. Synoptic track flights will probably utilize more than one ARTCC, and any adjacent ARTCC should be included when the flight track is within 100 miles of the adjacent center's airspace.Start Time (YYMMDDZZZZ). For example, 0006011600. This time would correspond to the entry time on a reconnaissance track or time at the storm fix latitude/longitude.

Ending Time (YYMMDDZZZZ). This would be the completion time of reconnaissance track or the time exiting the storm environment.

E.* Text. This field is free form and should include the following information: route of flight for the mission portion (latitude/longitude, fixes, airways), type of activity (laser, dropsonde, etc.), frequency/location of deployment, broadcast frequencies, any other pertinent information that may concern other flights. Include a unit/agency phone number and point of contact for possible questions.

Lower Altitude (during mission). Use "Surface" since the dropsonde is the "reason" for the NOTAM as much or more so than the aircraft altitude.

Upper Altitude (during mission). For example, FL450.

If only one altitude is to be used, then F and G may be combined. If altitude is going to vary throughout the mission, utilize "see text" and the information can be inserted there and the altitudes may be explained in field E.

* Note that there is no paragraph "D". It is reserved for FAA use.

NOTES:

1. Only ICAO approved contractions may be used.
2. Using this format will help ensure timely and accurate information dissemination.

APPENDIX F: OFFICIAL INTERAGENCY AGREEMENTS

The following enclosure is the Memorandum of Agreement (MOA) between the Air Force Reserve Command (AFRC), the National Oceanic and Atmospheric Administration (NOAA), and the Federal Aviation Administration (FAA), effective April 13, 2016. The purpose of this agreement is to establish policies, principles, and procedures under which the AFRC, NOAA, and FAA provide aircraft weather reconnaissance and surveillance in support of NOAA's tropical cyclone forecast, warning, and research missions.

MEMORANDUM OF AGREEMENT

BETWEEN THE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AIRCRAFT OPERATIONS CENTER, U.S. AIR FORCE RESERVE COMMAND 53RD WEATHER RECONNAISSANCE SQUADRON,

AND

THE FEDERAL AVIATION ADMINISTRATION AIR TRAFFIC ORGANIZATION

IN SUPPORT OF THE NATIONAL HURRICANE OPERATIONS PLAN

A. PURPOSE: The purpose of this Memorandum of Agreement (MOA) is to establish responsibilities for the National Oceanic and Atmospheric Administration (NOAA) Aircraft Operations Center (AOC), U.S. Air Force Reserve Command (AFRC) 53rd Weather Reconnaissance Squadron (WRS), and the Federal Aviation Administration (FAA) Air Traffic Organization (ATO), which are hereinafter referred to as the "Parties", to enable NOAA AOC and the 53rd WRS to assume the responsibility for separating participating manned aircraft conducting storm tracking operations within a Weather Reconnaissance Area (WRA). The procedures and agreements contained herein, which apply to the Atlantic Ocean, Gulf of America, Caribbean Sea, and the Pacific Ocean, are operationally executed through Letters of Agreement (LOA) between responsible Air Traffic Control (ATC) facilities and the NOAA AOC, 53rd WRS, and, as applicable, Using Agencies.

B. AUTHORITY: The NOAA AOC enters into this MOA under the authority of the Weather Service Organic Act, 15 United States Code (USC) § 313 and 49 USC § 44720. The AFRC 53rd WRS enters into this MOA under the authority of the *National Hurricane Operations Plan (NHOP)*. The FAA enters into this MOA under the authority of 49 USC § 106(f) and §106(m).

C. BACKGROUND: The Department of Commerce, through NOAA, is charged with the overall responsibility to implement a responsive, effective national tropical cyclone warning service, including weather reconnaissance/research flights. The AFRC, through the 53rd WRS, and the U.S. Department of Transportation, through the FAA, also play roles in this NOAA led mission. The roles and responsibilities of these agencies are codified in the NHOP and in this MOA.

D. DEFINITIONS:

1. A Weather Reconnaissance Area (WRA) is airspace with defined dimensions and published by Notice to Airmen (NOTAM), which is established to support weather reconnaissance/research flights. ATC services are not provided within WRAs.[14] Only participating weather reconnaissance/research aircraft from NOAA AOC and 53rd WRS are permitted to operate within a WRA.

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[14] The FAA may provide ATC services to participating flights in transit to and from WRAs, but will not provide ATC services, specifically including separation, to these flights within a WRA.

2. A “Participating Aircraft” is defined for the purposes of this MOA and related documents[15] as a NOAA AOC/53rd WRS manned aircraft listed in the Tropical Cyclone Plan of the Day (TCPOD) or tasked with an unscheduled operational mission that is conducted in a WRA.

E. ACTIVITIES: Activities covered under this MOA are limited to NOAA AOC and AFRC 53rd WRS manned flight operations conducted in accordance with the NHOP, applicable LOAs, and as described in a published NOTAM for a WRA.

NOTE- Uncrewed Aircraft Systems (UAS) operations are conducted in accordance with the applicable Certificate of Waiver or Authorization (COA) and are not permitted to participate with manned aircraft within a WRA.

F. RESPONSIBILITIES:

1. NOAA AOC must:

(a) Enter into LOAs (using the template provided in attachment 1) with ATC facilities, the 53rd WRS, and, as applicable, the appropriate Special Use Airspace (SUA) using agencies.

(b) Provide coordinated procedures and training for aircrews of NOAA AOC participating aircraft to operate in a WRA. These procedures must include, but not be limited to: minimum lateral and vertical separation, methods of determining such separation, and aircraft-to-aircraft communication phraseology when operating in a WRA.

(c) Provide procedures and training for aircrews of NOAA AOC participating aircraft to use communication, navigation and surveillance (CNS) equipment that will support safe operations within a WRA.

(d) Identify aircraft and define minimum functioning CNS equipment that must be used under this MOA.

(e) Ensure the appropriate separation procedures, described in paragraph G of this MOA, for use within specific WRAs are briefed to aircrews of NOAA AOC participating aircraft.

2. AFRC 53rd WRS must:

(a) Enter into LOAs (using the template provided in attachment 1) with ATC facilities, the NOAA AOC, and, as applicable, the appropriate Special Use Airspace (SUA) using agencies.

(b) Provide coordinated procedures and training for 53rd WRS aircrews to operate in a WRA. These procedures must include, but not be limited to: minimum lateral and vertical separation, methods of determining such separation, and aircraft-to-aircraft communications phraseology when operating in a WRA.

[15] Including the NHOP’s Chapter 6 and any executing LOAs.

(c) Provide procedures and training for 53rd WRS aircrews to use communication, navigation and surveillance (CNS) equipment that will support safe operations within a WRA.

(d) Identify aircraft and define minimum functioning CNS equipment that must be used under this MOA.

(e) Ensure the appropriate separation procedures, described in paragraph G of this MOA, for use within specific WRAs are briefed to aircrews of 53rd WRS participating aircraft.

3. FAA must:

(a) Enter into LOAs (using the template provided in attachment 1) with NOAA AOC, the AFRC 53rd WRS, and, as applicable, the appropriate Special Use Airspace (SUA) using agencies. This action will be taken by ATC facilities that are responsible for airspace in which the participating aircraft will operate.

(b) Receive and coordinate WRA NOTAM request.

(c) Issue WRA NOTAMs in support of the NHOP (using the template provided in attachment 2).

(d Provide ATC services to participating aircraft in accordance with FAA Order 7110.65, *Air Traffic Control*, FAA Order 7610.4, *Special Operations,* and appropriate LOAs in support of NHOP as follows:

(1) Until participating aircraft report entering the NOTAM-defined WRA NOTAM airspace; and

(2) When participating aircraft report exiting the NOTAM-defined WRA airspace.

(e) Prevent non-participating aircraft receiving ATC services from entering the WRA during the effective time of the WRA as published in the NOTAM.

G. PROCEDURES:

1. Chief Aerial Reconnaissance Coordination All Hurricanes (CARCAH): The CARCAH must advise aircrews when participating aircraft will be in the WRA and brief call signs and mission information.

2. WRA NOTAM Request:

(a) NOAA AOC, 53rd WRS, or CARCAH must submit, in accordance with the NHOP, a request for a WRA NOTAM to the en route ATC facility,[16] which is responsible for the airspace in which the subject weather reconnaissance/research flights will be operated, and the Air Traffic Control System Command Center (ATCSCC) as soon as practical prior to the start of the mission. The request must contain detailed information regarding the geographic definition of the WRA and altitude information.

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16 Specifically includes FAA Air Route Traffic Control Centers (ARTCC), Center Radar Approach Controls (CERAP), and, in select cases, Combined Control Facilities (CCF) such as the Honolulu Control Facility (HCF).

(b) NOAA AOC, 53rd WRS, or CARCAH must coordinate with the en route ATC facility, which received and agreed to support the aforementioned request, and the ATCSCC, to request FAA support of any proposed changes to the defined WRA.

3. Flight Plan Filing: Participating aircraft must file a flight plan, as soon as practicable, that includes a delay time in the WRA. Failure to include a delay time will result in flight plan cancellation.

4. Participating Aircraft Arrival to a WRA:

(a) Participating aircraft must use ATC services in transit to and from the WRA.

(b) Prior to entering the WRA, the arriving aircraft must obtain the position and altitude of each aircraft already in the WRA and verify the defined dimensions of the WRA, including center coordinates and maximum radius.

(c) Arriving aircraft will enter the WRA at FL150,[17] unless otherwise coordinated with ATC and the other participating aircraft.

5. Participating Aircraft Operations within a WRA: The following actions will be taken by aircraft, in accordance with NHOP, to de-conflict operations and enhance situational awareness with other aircraft while operating within a WRA:

(a) Set 29.92 (inches Hg) in at least one pressure altimeter per aircraft.

(b) Contact (Primary: VHF 123.05 MHZ; Secondary: UHF 304.8 MHZ; Back-up: HF 4701 KHz) the other participating aircraft and confirm, at a minimum, the pressure altitude, location relative to the WRA center point position, true heading, and operating altitudes.

(c) Monitor the contact frequencies indicated above during the duration of the flight and maintain communication with all other participating aircraft at all times.

(d) The WRA center coordinates will be used for the duration of the flight. If a WRA is moved due to operational reasons, a different WRA center point will be coordinated between all participating aircraft and impacted ATC facilities as soon as possible.

(e) If any aircraft is unable to maintain assigned altitude(s), immediately notify all participating aircraft and take actions to ensure sufficient vertical and/or lateral separation is maintained or attained as soon as practical.

(f) Use "see and avoid" principles to the maximum extent possible within the WRA. Aircraft must periodically broadcast GPS position reports to other participating aircraft within the WRA and use air-to-air TACAN and cockpit displays/maps to maintain awareness of other aircraft locations.

6. Separation between participating aircraft within a WRA:

[17] The upper limit of WRAs may be negotiated between NOAA AOC, 53rd WRS, and the responsible FAA en route ATC. While the template NOTAM indicates SFC-15,000 feet, the WRA ceiling may be lowered, especially when established closer to land where ATC services are provided at lower altitudes.

(a) Aircraft 10 NM or more from other aircraft operating in the same WRA must maintain vertical separation within the WRA of at least 1,000 feet between their operating altitudes or block altitudes, or as specified in the applicable LOA.

(b) Aircraft less than 10 NM from other aircraft operating in the same WRA, must apply vertical separation of at least 2,000 feet between operating altitudes or block altitudes, or as specified in the applicable LOA. Aircraft may use air-to-air TACAN and TCAS to assist with visual acquisition. Reduced vertical separation may be applied with concurrence from other aircraft within the WRA.

NOTE- *The 53Rd WRS may apply Military Assumes Responsibility for Separation of Aircraft (MARSA), in accordance with FAA Order 7110.65 and FAA Order 7610.4, between 53rd WRS aircraft within the WRA. MARSA may not be applied between 53rd WRS aircraft and NOAA AOC aircraft.*

7. Altitude changes between participating aircraft within the WRA:

(a) Aircraft must initiate communications with each other prior to altitude changes and maintain two-way aircraft-to-aircraft communications throughout the duration of the altitude change.

(b) Aircraft must ensure positive lateral separation (in accordance with sub-paragraphs (d), (e), and (f) in this section) prior to descending or climbing through the altitude(s) of other aircraft by reference to the WRA center point using the appropriate aircraft navigation systems.

(c) An altitude change is complete when the aircraft changing altitude advises the other aircraft, and receives an acknowledgement, that the altitude to which it was climbing or descending is reached and maintained.

(d) Aircraft that are not in visual contact and separated by 30NM or more, as indicated by the appropriate aircraft navigation systems, may transition through the altitude of other participating aircraft.

(e) Aircraft that are not in visual contact and separated by less than 30 NM, as indicated by the appropriate aircraft navigation systems, must confirm with each other that they are not on converging courses prior to an altitude change.

(f) Aircraft that are in visual contact may apply visual separation in accordance with the following procedures:

(1) The aircraft that initiates visual separation must advise the other aircraft that the aircraft is in sight and will maintain visual separation from it.

(2) The observed aircraft must acknowledge the use of visual separation by the initiating aircraft prior to the altitude change.

(3) The aircraft changing altitude must advise the other aircraft upon reaching and maintaining the altitude to which it was climbing or descending.

(4) Visual separation may be discontinued when the altitude change is complete according to sub-paragraph (c) in this section.

8. Participating Aircraft Departure from a WRA:

(a) Prior to departing the WRA, aircraft will establish communications with the appropriate ATC facility and request an IFR clearance.

(b) Prior to departing the WRA, aircraft will verify and maintain vertical and lateral separation from other participating aircraft in the WRA.

(c) Aircraft will depart the WRA at FL140, unless otherwise coordinated with ATC and other aircraft in the WRA.[18]

(d) Departing aircraft will report, "leaving (tropical activity name) WRA," to other aircraft in the WRA.

NOTE- The tropical activity name (as identified by the National Hurricane Center) provides identification of the WRA. Examples: Isabelle WRA, Sandy WRA, Tropical Storm Emily WRA, etc.

(e) Should an aircraft lose communications with the other participating aircraft within a WRA, it will maintain the last altitude that was coordinated with the other aircraft until it departs the WRA.

(f) If navigation systems become unreliable, the flight crew will terminate the mission and depart the WRA at the last coordinated altitude, or as coordinated with ATC if radio communications are available.

H. FUNDS AND OTHER RESOURCES: This MOA neither documents nor provides for the exchange of funds or other resources, including personnel, among the Parties, nor does it make any commitment of funds or other resources. Each Party makes appropriate resource and funding decisions under their own authorities in order to maximize the benefits of the partnership and cooperation under this MOA.

I. PERSONNEL: Each Party is responsible for all costs of its personnel engaged in activities covered by this MOA, including pay and benefits, support, and travel. Each Party is responsible for supervision and management of its personnel.

J. GENERAL PROVISIONS:

This MOA supersedes any existing MOAs, memorandums of agreement, or other agreements between the Parties, insofar as any such document is inconsistent with this MOA.

Nothing in this MOA is intended nor may be construed to limit or affect in any way the authority or legal responsibilities of the Parties.

Nothing in this MOA is intended nor may be construed to obligate the Parties to any current or future expenditure of resources in advance of the availability of appropriations from Congress. This MOA does not obligate the Parties to expend funds on any particular activity, even if funds are available.

[18] See footnote 16 for information on WRAs with lowered ceilings.

Specific activities implemented pursuant to this MOA that involve the transfer of funds, services, or property between the Parties will require the execution of separate agreements.

POINTS OF CONTACT: The following points of contact will be used by the Parties to communicate in the implementation of this MOA. Each Party may change its point of contact upon reasonable notice to the other Party.

(a) FOR NOAA AOC: Commanding Officer, Aircraft Operations Center

(b) FOR AFRC 53rd WRS: Commander, 403rd Operations Group

(c) FOR FAA ATO: Manager, Strategic Operations Security

This MOA is not transferrable.

K. DURATION AND MODIFICATIONS: This MOA shall remain in effect unless cancelled by one of the Parties. This MOA may be jointly reviewed upon request by a signatory Party, and may be modified by mutual written consent of the undersigned. Joint reviews should be completed prior to the annual Interdepartmental Hurricane Conference.

L. EFFECTIVE DATE: This MOA becomes effective beginning on the day after the last Party signs.

Attachments
1. WRA Letter of Agreement Template
2. WRA NOTAM Template

APPROVED:

____//SIGNED//_________________________ _7 April 2016__

Robert H. Sweet — Date
Manager (Acting), Strategic Operations Security,
Air Traffic Organization, System Operations Security
Federal Aviation Administration

____//SIGNED//_________________________ ___4/7/2016___

Anthony Tisdall — Date
Air Traffic Manager, Air Traffic Control System Command Center
Air Traffic Organization, System Operations Services
Federal Aviation Administration

____//SIGNED//__________________________ _11 APR16____

Captain Michael Silah — Date
Commanding Officer, Aircraft Operations Center
National Oceanic and Atmospheric Administration

____//SIGNED//__________________________ __12 APR 2016_

Colonel David J. Condit — Date
Commander, 403rd Operations Group
U.S. Air Force Reserve Command

ATTACHMENT 1

LETTER OF AGREEMENT TEMPLATE

BETWEEN

[INSERT NAME AND LOCATION ID OF FAA EN ROUTE ATC FACILITY OR FACILITIES]

AND THE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AIRCRAFT OPERATIONS CENTER AND

U.S. AIR FORCE RESERVE COMMAND 53RD WEATHER RECONNAISSANCE SQUADRON

SUBJECT: PARTICIPATING WEATHER RECONNAISSANCE / RESEARCH AIRCRAFT OPERATIONS WITHIN WEATHER RECONNAISSANCE AREAS

1. PURPOSE: To define responsibilities and procedures for the National Oceanic and Atmospheric Administration (NOAA) Aircraft Operations Center (AOC) and the U.S. Air Force Reserve Command (AFRC) 53rd Weather Reconnaissance Squadron (53rd WRS) to conduct weather reconnaissance/research operations with participating manned aircraft in a Weather Reconnaissance Area (WRA) within the Flight Information Region (FIR) of the Federal Aviation Administration (FAA) Air Traffic Control (ATC) facility or facilities identified in paragraph two of this Letter of Agreement (LOA).

2. SCOPE: This LOA is applicable to [insert name and location ID of ATC facility or facilities], NOAA AOC, and the 53rd WRS. The provisions of this LOA are only applicable in United States controlled FIRs.

3. AUTHORITY: [insert location ID of ATC facility or facilities], NOAA AOC, and 53rd WRS enter into this agreement under the authority of the trilateral Memorandum of Agreement (MOA), *Memorandum of Agreement Between the National Oceanic and Atmospheric Administration Aircraft Operations Center, U.S. Air Force Reserve Command 53rd Weather Reconnaissance Squadron, and the Federal Aviation Administration Air Traffic Organization in Support of the National Hurricane Operations Plan*.

4. RESPONSIBILITIES:

a. The NOAA AOC and 53rd WRS must:

(1) Ensure that all operations personnel are briefed on the provisions of this LOA.

(2) Submit, when logistically possible, a pre-planning package to [insert location ID of ATC facility or facilities] and the Air Traffic Control System Command Center (ATCSCC) a minimum 1 hours prior to planned mission start. The package should contain information on aircraft call signs, beacon codes, geographic definition of proposed mission area, and other pertinent mission information.

(3) Submit a WRA Notice to Airmen (NOTAM) request to the en route ATC facility[19], which is responsible for the airspace in which the weather reconnaissance/research flight will be operated, and the Air Traffic Control System Command Center (ATCSCC) as soon as practical prior to the start of mission. The request must contain detailed information regarding the geographic definition and altitude information of the WRA.
(4) Coordinate with the responsible en route ATC facility and the ATCSCC to request FAA support of any proposed changes to the defined WRA.
(5) Ensure that pilots operating under the provisions of this LOA are responsible for remaining within the vertical and lateral confines of the airspace as defined in the published WRA NOTAM.
(6) Ensure that pilots understand their responsibility for separation from Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) aircraft operating in uncontrolled airspace.

NOTE*: Operations within offshore and oceanic airspace include areas of uncontrolled airspace. Aircraft may encounter non-participating, untracked aircraft operating under VFR or IFR at and below 5,500 feet MSL.*

b. [insert location ID of ATC facility or facilities] must:

(1) Ensure that all ATC personnel are briefed on the provisions of this LOA.
(2) Review the Tropical Cyclone Plan of the Day (TCPOD) by 1830 UTC.
(3) Coordinate, as necessary, with other affected ATC facilities to ensure a complete understanding of each facility's responsibilities and procedures.
(4) Coordinate requested WRAs with the NOAA AOC, 53rd WRS, and impacted Special Use Airspace (SUA) Using Agencies.
NOTE *–SUA Using Agencies determine if Department of War (DOW) operational requirements are compatible with the establishment of a WRA and should define de-confliction procedures for SUA that may not be released.*
(5) Establish WRAs by published NOTAMs.
(6) Prevent non-participating aircraft receiving ATC services from entering the WRA during the effective time of the WRA as published in the NOTAM.
(7) Submit a signed copy of the LOA to ATO System Operations Security (9-ATOR-HQ-IFOS@faa.gov) for recordkeeping purposes.

5. PROCEDURES:

[insert location ID of ATC facility or facilities] Procedures:

(1) Provide ATC services to and from the WRA in accordance with FAA Order 7110.65, *Air Traffic Control*, FAA Order 7610.4, *Special Operations*, the trilateral MOA cited in Section 3 of this LOA, and applicable ATC facility Standard Operating Procedures (SOP).

[19] Specifically includes FAA Air Route Traffic Control Centers, Center Radar Approach Controls (CERAP), and, in select cases, Combined Control Facilities (CCF) such as the Honolulu Control Facility (HCF).

(2) Provide NOAA AOC and 53rd WRS participating aircraft with a clearance into the WRA in accordance with the trilateral MOA cited in Section 3 of this LOA.

(3) Provide an IFR clearance to participating aircraft requesting to depart the WRA.

b. Participating Aircraft Procedures: Pilots request entry to and departure from the WRA according to the trilateral MOA cited in Section 3 of this LOA.

6. DURATION AND MODIFICATIONS: This LOA shall remain in effect unless cancelled by one of the Parties. This LOA may be jointly reviewed upon request by either Party, and may be modified by mutual written consent of the undersigned.

7. EFFECTIVE DATE: This LOA becomes effective beginning on the day after the last Party signs.

APPROVED BY:

____ _________________

(Name) Date

Air Traffic Manager

(ATC Facility)

____ __________________

(Name) Date

Commanding Officer, Aircraft Operations Center

National Oceanic and Atmospheric Administration

_____________________________________ _________________

(Name) Date

Commander, 403rd Operations Group,

U.S. Air Force Reserve Command

_____________________________________ _________________

(Name) Date

(Using Agency Title),

(DOW Component)

ATTACHMENT 2

WRA NOTAM TEMPLATE

!CARF X/XXXX (APPLICABLE ARTCSS(s)) (AXXXX/XX)…AIRSPACE (HURRICANE/TYPHOON/TROPICAL STORM) (NAME OF TROPICAL DISTURBANCE) WEATHER (WX) RECONNAISSANCE FLIGHTS WI THE WX RECONNAISSANCE AREA (WRA) DEFINED AS XXX NM RADIUS OF XXXXXXNXXXXXXXW (ARTCCS/CERAPS/HCF AND SUA USING AGENCIES MUST COORDINATE TO PUBLISH ANY REQUIRED AIRSPACE CUT OUTS) SFC-XXX. VERTICAL MANEUVERING AND RELEASE OF WEATHER INSTRUMENTS ARE EXPECTED. NONPARTICIPATING AIRCRAFT SHOULD AVOID THE WRA. IFR AIRCRAFT T CAN EXPECT REROUTES. NONPARTICIPATING AIRCRAFT, SUCH AS EMERGENCY, MEDEVAC, OR OIL PLATFORM AIRCRAFT THAT REQUIRE ACCESS TO AIRSPACE WITHIN THE WRA SHOULD CONTACT XXX AT (XXX) XXX-XXXX (ARTCC IDENTIFIER AND TELEPHONE NUMBER). FOR ANY QUESTIONS REGARDING THIS WRA NOTAM PLEASE CONTACT XXX AT (XXX) XXX-XXXX (ARTCC IDENTIFIER AND TELEPHONE NUMBER)

TIME-TIME

NOTES-

WRAs may only be established in airspace within U.S. FIRs outside of U.S. territorial airspace (12 NM).

Cut-outs should include Class B, Class C, Class D, and SUA, as applicable.

Distance (NM) for the WRA radius must be coordinated. It will be dependent on the WRA location and ATC operational requirements.

If more than one WRA is required, the WRA boundaries must be no closer than the lateral separation standards required for aircraft operations defined in FAA JO 7110.65 and Letters of Agreement.

WRA NOTAM must utilize CARF identifier for widest domestic and international dissemination.

The ARTCC responsible for originating the NOTAM should include their contact information.

APPENDIX G: RECCO, HDOB, AND TEMP DROP, AND VDM CODES, TABLES, AND REGULATIONS

G.1. General.

This appendix contains the formats and detailed explanations of encoded data messages transmitted by weather reconnaissance aircraft. The products include reconnaissance coded observations (RECCOs), high-density/high-accuracy observations (HDOBs) Vortex Data Messages (VDMs), and dropsonde observations (TEMP DROP and BUFR).

G.2. Aerial Reconnaissance Messages.

G.2.1. RECCO.

The RECCO message is routinely used to convey horizontal weather observations taken manually by meteorologists aboard USAF and NOAA weather reconnaissance aircraft. At the time of the observation the aircraft observing platform is considered to be located on the axis of a right vertical cylinder with a radius of 30 nautical miles bounded by the earth's surface and the top atmosphere. Flight level winds, temperature, dew point, and geopotential height values are sensed or computed and reported as occurring at the center of the observation circle. Radar echoes, significant weather changes, distant weather, icing, and cloud coverage, types, and amounts are phenomena that may also be observed and reported. Code groups identifying these phenomena may be reported as necessary to adequately describe the meteorological conditions observed. All geopotential computations are made relative to the 1976 US Standard Atmosphere (adjustable altimeters set to 29.92 inches Hg). Since all height reports are in units of geopotential by convention of the World Meteorological Organization, pressure surface height reports from reconnaissance aircraft are in geopotential units.

Sample USAFR/53 WRS and NOAA RECCO messages are shown in Figure G-1. A breakdown of these messages is provided in Tables G-1 and G-2. Figure G-2 shows the standard RECCO recording form worksheet with each element described in Table G-3 and regulations explained in Table G-4.

```
URNT11 KNHC 041322
97779 13204 10295 56518 30500 22068 10089 /3051
42045
RMK AF305 1511A JOAQUIN           OB 13
SWS = 41KTS

URNT11 KWBC 202029
97779 20284 50267 72800 04500 14009 24218 /0004 41311 93273
RMK NOAA3 01GGA INVEST            OB 10
```

Figure G-1. Example USAF and NOAA Aircraft RECCO Messages for Tropical Cyclones

Table G-1. Decoded USAF Aircraft RECCO Message

URNT11 KNHC 041322
97779 13204 10295 56518 30500 22068 10089 /3051
42045
RMK AF305 1511A JOAQUIN OB 13
SWS = 41KTS

URNT11:	WMO abbreviated communications header for a RECCO taken during a tasked invest, tropical cyclone, or subtropical cyclone mission in the Atlantic basin (*see Chapter 5, paragraph 5.6.6 for details*).
KNHC:	ICAO of National Hurricane Center where RECCO message is received and disseminated (*see Chapter 5, paragraph 5.6.6 for details*).
041322:	RECCO transmission date and time is 4th day of the month at 1322 UTC.
97779:	The 9's in the first and last digits are standard delimiters of the first RECCO observation section. The middle three digits, 777, indicate that the observation is taken aboard an aircraft with radar capabilities (*see "Table 1" section of Table G-3*).
13204:	The first four digits are the time observation is taken of 1320 UTC. The last digit, 4, indicates the aircraft has dew point measuring capability and is below 10 km (*see "Table 2" section of Table G-3*).
10295:	The first digit, 1, indicates the observation is taken Sunday. The second digit, 0, indicates the observation is taken in the northern hemisphere between 0° and 90° W longitude (*see "Table 3" section of Table G-3 and Figure G-3 for graphical depiction*). The last three digits show the observation is taken at 29.5° N latitude.
56518:	The first three digits show the observation is taken at 56.5° W longitude.2.1 (*see Note 4 in Table G-4*). The fourth digit, 1, indicates light aircraft turbulence (*see "Table 4" section in Table G-3*). The last digit, 8, indicates aircraft flight conditions of in and out of clouds (*see "Table 5" section of Table G-3 and Note 5 of Table G-4*).
30500:	The first three digits show the aircraft pressure altitude is 3050 m. The fourth digit, 0, indicates that the wind observation is a spot measurement (*see "Table 6" section of Table G-3*). The last digit, 0, shows that the wind is obtained by Doppler radar or inertial systems (*see "Table 7" section of Table G-3*).
22068:	Observed Flight-level wind is approximately from 220° (between 215° and 224°) at 68 kt. Note: light and variable winds < 10 kt are encoded as 9905.
10089:	The first two digits indicate the observed flight-level temperature is 10°C. The next two digits indicate the flight-level dew point temperature is 8°C (*see Note 6 of Table G-4 for encoding negative temperature values*). The last digit, 9, indicates that there are thunderstorms within 30 nm of the aircraft (*see "Table 8" section of Table G-3 and Note 7 of Table G-4*).
/3051:	The "/3" indicates an observed geopotential height measurement at 700 mb. The last three digits show the height of 3051 m (*see "Table 9" section of Table G-3 and Note 8 of Table G-4*).
42045:	The first digit, 4, indicates a manually observed surface wind from a flight level of 700 mb or below. The remaining four digits show that the surface wind is from approximately 200° (between 195° and 204°) at 45 kt (*see Note 10 in Table G-4 for wind speeds above 130 kt*). Note: light and variable winds < 10 kt are encoded as 9905.
RMK:	Beginning of RECCO plain-language remarks section (*see Note 3 of Table G-4*).

URNT11:	WMO abbreviated communications header for a RECCO taken during a tasked invest, tropical cyclone, or subtropical cyclone mission in the Atlantic basin (*see Chapter 5, paragraph 5.6.6 for details*).
AF305:	Aircraft in mission ID is U.S. Air Force C-130J with tail number 5305 (*see Chapter 5, Table 5-4 for details*).
1511A:	Index group in mission ID indicates the 15th mission of the 11th classified tropical or subtropical system of the year in the Atlantic basin (*see Chapter 5, Table 5-4 for details*).
JOAQUIN:	Official name of system in mission ID is "Joaquin" (*see Chapter 5, Table 5-4 for details*).
OB 13:	Observation number 13 is assigned to this RECCO (*see Chapter 5, paragraph 5.6.9 for details*).
SWS=41KTS:	Observed surface wind speed is 41 kt.

Table G-2. Decoded NOAA Aircraft RECCO Message

URNT11 KWBC 202029
97779 20284 50267 72800 04500 14009 24218 /0004 41311 93273
RMK NOAA3 01GGA INVEST OB 10

All items are decoded in a similar manner to the USAF Aircraft RECCO message depicted in Table G-1, except for the following:

/0004:	The "/0" indicates an extrapolated sea-level pressure measurement. The last three digits show the sea-level pressure of 1004 mb *(see "Table 9" section of Table G-3 and Note 8 of Table G-4*).
93273:	The first digit, 9, indicates a sea-surface temperature measurement. The second digit, 3, indicates that the inflight visibility is greater than 3 miles *(see "Table 23" section of Table G-3).* The last three digits show the observed sea-surface temperature is 27.3°C.
NOAA3:	Aircraft in mission ID is NOAA WP-3D with tail number N43RF *(see Chapter 5, Table 5-4 for details).*
01GGA:	Index group in mission ID indicates the first mission of the 7th unclassified suspect system of the year in the Atlantic basin *(see Chapter 5, Table 5-4 for details).*
INVEST:	Indicates invest mission in the storm ID (*see Chapter 5, Table 5-4 for details).*

NOTE: The observed surface wind group, indicated by the first digit of 4, is placed on the same line as the other numeric encoded groups in a NOAA aircraft RECCO message rather than on a separate line.

DATE	ORGANIZATION	MISSION IDENTIFIER

OBSERVATION NUMBER	1		2		3		4		5		6		7		8	
	9	RECCO INDICATOR SPECIFYING TYPE OF OBSERVATION Table1	G	TIME OF OBSERVATION (Hours and Minutes) (GMT)	Y	DAY OF WEEK SUN-1	L_o	LONGITUDE DEGREES AND TENTHS (Note 4)	h_a	PRESSURE ALTITUDE OF AIRCRAFT REPORTED TO THE NEAREST DECAMETER	d	WIND DIRECTION AT FLIGHT LEVEL (Tens of deg. true.)	T	TEMPERATURE WHOLE °C (Note 6)	/	INDICATOR
	X		G		Q	OCTANT Table 3	L_o		h_a		d		T		j	INDEX TO HHH Table 9
	X		g		L_a	LATITUDE DEGREES AND TENTHS	L_o		h_a		f	WIND SPEED AT FLIGHT LEVEL (Knots)	T_d	DEW POINT WHOLE °C (Note 6)	H	GEOPOTENTIAL HEIGHT/ D-VALUE OR SLP PER INDEX j (Note 8)
	X		g		L_a		B	TURBULENCE Table 4	d_t	TYPE OF WIND Table 6	f		T_d		H	
	9		i_d	DEW POINT INDICATOR Table 2	L_a		f_c	FLIGHT COND Table 3 (Note 5)	d_a	METHOD OF OBTAINING WIND Table 7	f		w	PRESENT WEATHER (Note 7 Table 8)	H	

REMARKS

TYPE AIRCRAFT	CALL SIGN	METEOROLOGIST

9		10		11		12		13		14		15		16	
1	INDICATOR	C	CLOUD TYPE Table 11	C	CLOUD TYPE Table 11	C	CLOUD TYPE Table 11	1	INDICATOR	C	CLOUD TYPE Table 11	C	CLOUD TYPE Table 11	C	CLOUD TYPE Table 11
k_n	NR OF CLOUD LAYERS (Note 9)	h_s	ALTITUDE OF BASE Table 12	h_s	ALTITUDE OF BASE Table 12	h_s	ALTITUDE OF BASE Table 12	K_n	NR OF CLOUD LAYERS (Note 9)	h_s	ALTITUDE OF BASE Table 12	h_s	ALTITUDE OF BASE Table 12	h_s	ALTITUDE OF BASE Table 12
N_s	AMOUNT OF CLOUDS (Note 9) Table 10	h_s		h_s		h_s		N_s	AMOUNT OF CLOUDS (Note 9) Table 10	h_s		h_s		h_s	
N_s		H_t	ALTITUDE OF TOP Table 12	H_t	ALTITUDE OF TOP Table 12	H_t	ALTITUDE OF TOP Table 12	N_s		H_t	ALTITUDE OF TOP Table 12	H_t	ALTITUDE OF TOP Table 12	H_t	ALTITUDE OF TOP Table 12
N_s		H_t		H_t		H_t		N_s		H_t		H_t		H_t	

REMARKS

RECCO RECORDING WORKSHEET

17		18		19		20		21		22		23		24		REMARKS
4	INDICATOR	6	INDICATOR (Note 11)	6	INDICATOR (Note 11)	7	INDICATOR	7	INDICATOR	8	INDICATOR	8	INDICATOR	9	INDICATOR	
d	DIRECTION OF SFC WIND (Tens of deg. true)	W_s	SIGNIFICANT WEATHER CHANGES Table 14	W_s	SIGNIFICANT WEATHER CHANGES Table 14	I_r	RATE OF ICING Table17	h_i	ALT OF BASE OF ICING STRATUM (Note 12) Table 12	d_r	BEARING OF ECHO CENTER (Tens of Deg. True)	E_w	ECHO WIDTH OR DIAMETER Table 19	V_i	INFLIGHT VISIBILITY Table 23	
d		S_s	DISTANCE OF OCCURENCE OF Ws Table 15	S_s	DISTANCE OF OCCURENCE OF Ws Table 15	I_t	TYPE OF ICING Table18	h_i		d_r		E_l	LENGTH OF MAJ AXIS Table 19	T_w	SEA SURFACE TEMPERATURE DEGREES AND TENTHS	
f	SURFACE WIND SPEED (knots) (Note 10)	w_d	DISTANT WEATHER Table 16	w_d	DISTANT WEATHER Table 16	S_b	DISTANCE TO BEGINNING OF ICING Table15	H_i	ALTITUDE OF TOP OF ICING STRATUM (Note 12) Table 12	S_r	DISTANCE TO ECHO CENTER Table 19	c_e	CHARACTER OF ECHO Table 21	T_w		
f		d_w	BEARING OF w_d Table 13	d_w	BEARING OF w_d Table 13	S_e	DISTANCE TO ENDING OF ICING Table15	H_i		O_e	ORIENTATION OF ELLIPSE Table 20	i_e	INTENSITY OF ECHO Table 22	T_w		

REMARKS

Figure G-2. Reconnaissance Code Recording Form

Table G-3. Reconnaissance Code Tables

TABLE 1 XXX

222	Sec One Observation without radar capability
555	Sec Three (intermediate) observation with or without radar capability
777	Sec One Observation with radar capability

TABLE 2 i_d

0	No dew point capability/acft below 10,000 meters
1	No dew point capability/acft at or above 10,000 meters
2	No dew point capability/acft below 10,000 meters and flight lvl temp -50°C or colder
3	No dew point capability/acft at or above 10,000 meters and flight lvl temp -50°C or colder
4	Dew point capability/acft below 10,000 meters
5	Dew point capability/acft at or above 10,000 meters
6	Dew point capability/acft below 10,000 meters and flight lvl temp -50°C or colder
7	Dew point capability/acft at or above 10,000 meters and flight lvl temp -50°C or colder

TABLE 3 Q

0	0° -90° W	Northern
1	90° W - 180°	Northern
2	180° - 90° E	Northern
3	90° - 0° E	Northern
4	Not Used	
5	0° - 90° W	Southern
6	90° W - 180°	Southern
7	180° - 90° E	Southern
8	90° - 0° E	Southern

TABLE 4 B

0	None
1	Light turbulence
2	Moderate turbulence in clear air, infrequent
3	Moderate turbulence in clear air, frequent
4	Moderate turbulence in cloud, infrequent
5	Moderate turbulence in cloud, frequent
6	Severe Turbulence in clear air, infrequent
7	Severe Turbulence in clear air, frequent
8	Severe Turbulence in cloud, infrequent
9	Severe Turbulence in cloud, frequent

TABLE 5 f_c

0	In the clear
8	In and out of clouds
9	In clouds all the time (continuous IMC)
/	Impossible to determine due to darkness or other cause

TABLE 6 d_t

0	Spot of Wind
1	Average wind
/	No wind reported

TABLE 7 d_a

0	Winds obtained using doppler radar or inertial systems
1	Winds obtained using other navigation equipment and/or techniques
/	Navigator unable to determine or wind not compatible

TABLE 8 w

0	Clear
1	Scattered (trace to 4/8 cloud coverage)
2	Broken (5/8 to 7/8 cloud coverage)
3	Overcast/undercast
4	Fog, thick dust or haze
5	Drizzle
6	Rain (continuous or intermittent precip - from stratiform clouds)
7	Snow or rain and snow mixed
8	Shower(s) (continuous or intermittent precip - from cumuliform clouds)
9	Thunderstorm(s)
/	Unknown for any cause, including darkness

TABLE 9 j

0	Sea level pressure in whole millibars (thousands fig if any omitted)
1	Altitude 200 mb surface in geopotential decameters (thousands fig if any omitted)
2	Altitude 850 mb surface in geopotential meters (thousands fig omitted)
3	Altitude 700 mb surface in geopotential meters (thousands fig omitted)
4	Altitude 500 mb surface in geopotential decameters
5	Altitude 400 mb surface in geopotential decameters
6	Altitude 300 mb surface in geopotential decameters
7	Altitude 250 mb surface in geopotential decameters (thousands fig if any omitted)
8	D - Value in geopotential decameters; if negative 500 is added to HHH
9	Altitude 925 mb surface in geopotential meters
/	No absolute altitude available or geopotential data not within ± 30 meters/4 mb accuracy requirements

TABLE 10 N_s

0	No additional cloud layers (place holder)
1	1 okta or less, but not zero (1/8 or less sky covered)
2	2 oktas (or 2/8 of sky covered)
3	3 oktas (or 3/8 of sky covered)
4	4 oktas (or 4/8 of sky covered)
5	5 oktas (or 5/8 of sky covered)
6	6 oktas (or 6/8 of sky covered)
7	7 oktas or more but not 8 oktas
8	8 oktas or sky completely covered
9	Sky obscured (place holder)

TABLE 11 C

0	Cirrus (Ci)
1	Cirrocumulus (Cc)
2	Cirrostratus (Cs)
3	Altocumulus (Ac)
4	Altostratus (As)
5	Nimbostratus (Ns)
6	Stratocumulus (Sc)
7	Stratus (St)
8	Cumulus (Cu)
9	Cumulonimbus (Cb)
/	Cloud type unknown due to darkness or other analogous phenomena

TABLE 12 $h_sh_sH_tH_th_ih_iH_iH_i$

00	Less than 100
01	100 ft
02	200 ft
03	300 ft
etc, etc	
49	4,900 ft
50	5,000 ft
51-55 Not used	
56	6,000 ft
57	7,000 ft
etc, etc	
79	29,000 ft
80	30,000 ft
81	35,000 ft
82	40,000 ft
etc, etc	
89	Greater than 70,000 ft
//	Unknown

TABLE 13 d_w

0	No report	5	SW
1	NE	6	W
2	E	7	NW
3	SE	8	N
4	S	9	all directions

TABLE 14 W_s

0	No change
1	Marked wind shift
2	Beginning or ending or marked turbulence
3	Marked temperature change (not with altitude)
4	Precipitation begins or ends
5	Change in cloud forms
6	Fog or ice fog bank begins or ends
7	Warm front
8	Cold Front
9	Front, type not specified

TABLE 15 $S_bS_eS_s$

0	No report
1	Previous position
2	Present position
3	30 nautical miles
4	60 nautical miles
5	90 nautical miles
6	120 nautical miles
7	150 nautical miles
8	180 nautical miles
9	More than 180 nautical miles
/	Unknown (not used for S_s)

Table G-3 (continued). Reconnaissance Code Tables

TABLE 16 w_d

0	No report
1	Signs of a tropical cyclone
2	Ugly threatening sky
3	Duststorm or sandstorm
4	Fog or ice fog
5	Waterspout
6	Cirrostratus shield or bank
7	Altostratus or altocumulus shield or bank
8	Line of heavy cumulus
9	Cumulonimbus heads or thunderstorms

TABLE 17 I_r

7	Light
8	Moderate
9	Severe
/	Unknown or contrails

TABLE 18 I_t

0	None
1	Rime ice in clouds
2	Clear ice in clouds
3	Combination rime and clear ice in clouds
4	Rime ice in precipitation
5	Clear ice in precipitation
6	Combination rime and clear ice in precip
7	Frost (icing in clear air)
8	Nonpersistent contrails (less than 1/4 nautical miles long)
9	Persistent contrails

TABLE 19 S_r, E_w, E_l

0	0NM	5	50NM
1	10NM	6	60-80NM
2	20NM	7	80-100NM
3	30NM	8	100-150NM
4	40NM	9	Greater than 150NM
		/	Unknown

TABLE 20 O_e

0	Circular
1	NNE - SSW
2	NE - SW
3	ENE - WSW
4	E - W
5	ESE - WNW
6	SE - NW
7	SSE - NNW
8	S - N
/	Unknown

TABLE 21 c_e

1	Scattered Area
2	Solid Area
3	Scattered Line
4	Solid Line
5	Scattered, all quadrants
6	Solid, all quadrants
/	Unknown

TABLE 22 i_e

2	Weak
5	Moderate
8	Strong
/	Unknown

TABLE 23 V_i

1	Inflight visibility 0 to and including 1 nautical mile
2	Inflight visibility greater than 1 and not exceeding 3 nautical miles
3	Inflight visibility greater than 3 nautical miles

ECCO SYMBOLIC FORM

SECTION ONE (MANDATORY)

$9XXX9\ GGggi_d\ YQL_aL_aL_a\ L_oL_oL_oBf_c\ h_ah_ah_ad_td_a$

$ddfff\ TTT_dT_dw\ /jHHH$

SECTION TWO (ADDITIONAL)

$1k_nN_sN_sN_s\ Ch_sh_sH_tH_t$ 4ddff

$6W_sS_sW_dd_w\ 7I_rI_tS_bS_e\ 7h_ih_iH_iH_i\ 8d_rd_rS_rO_e$

$8E_wE_lc_ei_e\ 9V_iT_wT_wT_w$

SECTION THREE (INTERMEDIATE)

$9XXX9\ GGggi_d\ YQL_aL_aL_a\ L_oL_oL_oBf_c\ h_ah_ah_ad_td_a$

$ddfff\ TTT_dT_dw\ /jHHH$

Table G-4. Reconnaissance Code Regulations

1. At the time of the observation the aircraft observing platform is considered to be located on the axis of a right vertical cylinder with a radius of 30 nautical miles bounded by the earth's surface and the top atmosphere. Present weather, cloud amount and type, turbulence, and other subjective elements are reported as occurring within the cylinder. Flight level winds, temperature, dew point, and geopotential values are sensed or computed and reported as occurring at the center of the observation circle. Radar echoes, significant weather changes, distant weather, and icing are phenomena that may also be observed/reported. Code groups identifying these phenomena may be reported as necessary to adequately describe met conditions observed.

2. The intermediate observation (Section Three) is reported following Section One (or Section Two if appended to Section One) in the order that it was taken.

3. Plain language remarks may be added as appropriate. These remarks follow the last encoded portion of the horizontal or vertical observation and will clearly convey the intended message. Vertical observations will not include meteorological remarks. These remarks must begin with a letter or word-e.g. "FL TEMP" vice "700 MB FL TEMP." The last report plain language remarks are mandatory, i.e., “LAST REPORT. OBS 01 thru 08 to KNHC, OBS 09 and 10 to KBIX."

4. The hundreds digit of longitude is omitted for longitudes from 100° to 180°.

5. Describe conditions along the route of flight actually experienced at flight level by aircraft.

6. TT, T_dT_d. When encoding negative temperatures, 50 is added to the absolute value of the temperature with the hundreds figure, if any, being omitted. A temperature of -52°C is encoded as 02, the distinction between -52°C and 2°C being made from i_d. Missing or unknown temperatures are reported as //. When the dew point is colder than -49.4°C, Code T_dT_d as // and report the actual value as a plain language remark - e.g. "DEW POINT NEG 52°C".

7. When two or more types of w co-exist, the type with the higher code figure will be reported. Code Figure 1, 2 and 3 are reported based on the total cloud amount through a given altitude, above or below the aircraft, and when other figures are inappropriate. The summation principle applies only when two or more cloud types share a given altitude.

8. When j is reported as a /, HHH is encoded as ///.

9. If the number of cloud layers reported exceeds 3, k_n in the first 1-group reports the total number of cloud layers. The second 1-group reports the additional number of layers being reported exclusive of those previously reported. In those cases where a cloud layer(s) is discernible, but a descriptive cloud picture of the observation circle is not possible, use appropriate remarks such as "Clouds Blo" or "As Blo" to indicate the presence of clouds. In such cases, coded entries are not made for group 9. The sequence in which cloud amounts are encoded depends upon type of cloud, cloud base, and vertical extent of the cloud. The cloud with the largest numerical value of cloud type code (C) is reported first, regardless of coverage, base, or vertical extent. Among clouds of the same cloud type code, sharing a common base, the cloud of greatest vertical extent is reported first. The summation principle is not used; each layer is treated as though no other clouds were present. The total amount of clouds through one altitude shared by several clouds will not exceed 8 oktas. Only use code figure 0 as a place holder when you can determine that no additional cloud layers exist. In case of undercast, overcast, etc., use code figure 9 as a placeholder.

10. Due to limitations in the ability to distinguish sea state features representative of wind speeds above 130 knots, surface wind speeds in excess of 130 knots will not be encoded. Wind speeds of 100 to 130 knots inclusive will be encoded by deleting the hundreds figure and adding 50 to dd. For wind speeds above 130 knots, dd is reported without adding 50 and ff is encoded as // with a plain language remark added, i.e., "SFC WIND ABOVE 130 KNOTS."

11. Significant weather changes which have occurred since the last observation along the track are reported for W_s.

12. When aircraft encounters icing in level flight, the height at which the icing occurred will be reported for h_ih_i. The H_iH_i will be reported as //.

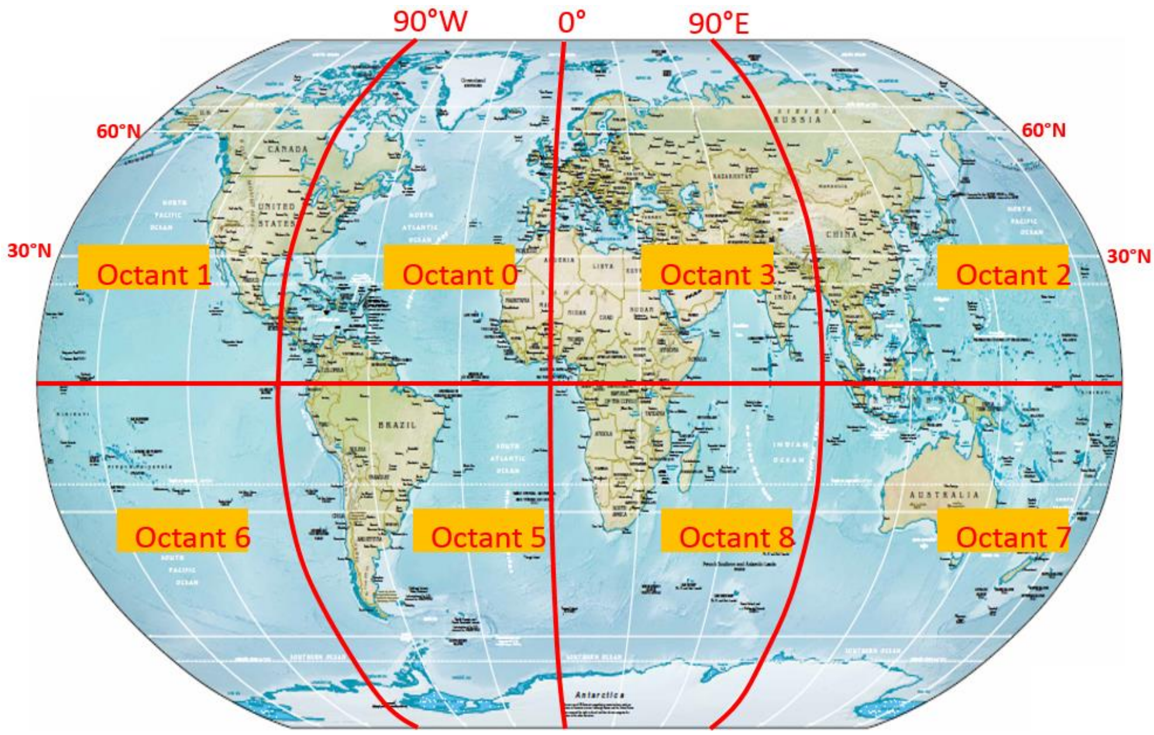

Figure G-3. Geographical Depiction of Octants Encoded in RECCO Messages

G.2.2. HDOB.

The HDOB message is used to transmit High-Density/High-Accuracy (HD/HA) meteorological data from hurricane reconnaissance aircraft. These are created automatically by the system software. Each message consists of a communications header line described in Chapter 5, paragraph 5.6.6, a mission/ob identifier line (Table G-5), and 20 lines of HD/HA data (Table G-6).

Within an HDOB message, the time interval (resolution) between individual HD/HA observations can be set by the operator to be 30, 60, or 120 seconds. However, regardless of the time resolution of the HD/HA data, the meteorological parameters in the HDOB message always represent 30-second averages along the flight track (except for certain peak values as noted in Table G-6).

The nominal time of each HD/HA record is the midpoint of the 30-second averaging interval. This means that an HD/HA record at time *t* will include data measured at time *t*±15 seconds., For purposes of determining peak flight-level and surface winds, the encoding interval begins 15 seconds after the nominal time of the last HD/HA record and ends 15 seconds after the nominal time of the record being encoded.

A sample HDOB message is shown in Figure G-4 (message begins with URNT15...):

```
0         1          2         3         4         5           6        7
01234567890123456789012345678901234567890123456789012345678901234567890
-----------------------------------------------------------------------
URNT15 KNHC 281426
AF302 1712A KATRINA HDOB 41 20050928
142030 2608N 08756W 7093 03047 9333 +192 +134 133083 089 080 /// 00
142100 2609N 08755W 7091 03054 9330 +166 +146 133106 115 103 /// 00
142130 2610N 08754W 7058 03040 9295 +134 +134 135121 124 111 /// 00
142200 2611N 08753W 7037 03060 9291 +124 +124 138129 136 122 /// 00
.
.
.
142230 2612N 08752W 7010 03057 9282 +102 +102 141153 166 148 /// 00
142300 2612N 08751W 7042 03010 9293 +088 +083 133159 164 147 /// 00
142330 2613N 08750W 6999 03064 9279 +088 +088 138158 161 144 /// 00
142400 2614N 08749W 7005 03046 9281 +080 +080 138155 158 142 /// 00
142430 2614N 08748W 6998 03048 9278 +078 +078 138151 153 137 /// 00
142500 2615N 08747W 7002 03048 9279 +084 +084 140146 148 133 /// 00
$$
```

Figure G-4. Example HDOB Message for Tropical Cyclones

Table G-5. Mission/Ob Identifier Line Format for HDOB Messages

A sample mission/ob identifier line is given below (beginning with AF302...), followed by a description of the parameters.

```
0         1          2         3         4         5           6        7
01234567890123456789012345678901234567890123456789012345678901234567890
-----------------------------------------------------------------------
IIIIIIIIIIIIIIIIIIIIIIIIIIIIII HDOB NN YYYYMMDD
AF302 1712A KATRINA HDOB 41 20050928 ← example
```

III...III:	Mission identifier, as determined in Chapter 5, paragraph 5.6.7.
NN:	Observation number (01-99), assigned sequentially for each HDOB message during the flight. This sequencing is independent of the numbering of other types of messages (RECCO, DROP, VORTEX, etc.), which have their own numbering sequence.
YYYYMMDD:	Year, month, and day of the first HD/HA data line of the message.

Table G-6. HD/HA Data Line Format for HDOB Messages

```
0         1         2         3         4         5         6         7
01234567890123456789012345678901234567890123456789012345678901234567890
-----------------------------------------------------------------------
hhmmss LLLLH NNNNNH PPPP GGGGG XXXX sTTT sddd wwwSSS MMM KKK ppp FF
142230 2612N 08752W 7010 03057 9282 +102 +102 141153 166 148 /// 00
```

hhmmss:	Observation time, in hours, minutes and seconds (UTC). The observation time is the midpoint of the 30-s averaging interval used for the record's meteorological data.
LLLLH:	The latitude of the aircraft at the observation time in degrees (LL) and minutes (LL). The hemisphere (H) is given as either N or S.
NNNNNH:	The longitude of the aircraft at the observation time, in degrees (NNN) and minutes (NN). The hemisphere (H) is given as either E or W.
PPPP:	Aircraft static air pressure, in tenths of mb with decimal omitted, at the observation time. If pressure is equal to or greater than 1000 mb the leading 1 is dropped.
GGGGG:	Aircraft geopotential height, in meters, at the observation time. '/////'indicates missing value.
XXXX:	Extrapolated surface pressure or D-value (30-s average). Encoded as extrapolated surface pressure if aircraft static pressure is 550.0 mb or greater (i.e., flight altitudes at or below 550 mb). Format for extrapolated surface pressure is the same as for static pressure. For flight altitudes higher than 550 mb, XXXX is encoded as the D-value, in meters. Negative D-values are encoded by adding 5000 to the absolute value of the D-value. //// indicates missing value.
s:	Sign of the temperature or dew point (+ or -).
sTTT:	The air temperature in degrees and tenths Celsius, decimal omitted (30-s average). //// indicates missing value.
sddd:	The dew point temperature, in degrees and tenths Celsius, decimal omitted (30-s average). //// indicates missing value.
www:	Flight-level wind direction in degrees (30-s average). North winds are coded as 000. /// indicates missing value.
SSS:	Flight-level wind speed, in kt (30-s average). /// indicates missing value.
MMM:	Peak 10-second average flight-level wind speed occurring within the encoding interval, in kt. /// indicates missing value.
KKK:	Peak 10-second average surface wind speed occurring within the encoding interval, in kt. /// indicates missing value.
ppp:	Rain rate, in mm hr-1, evaluated over the 10-s interval chosen for KKK. /// indicates missing value.
FF:	Quality control flags.

First column indicates status of positional variables as follows:

0	All parameters of nominal accuracy
1	Lat/lon questionable
2	Geopotential altitude or static pressure questionable
3	Both lat/lon and GA/PS questionable

Second column indicates status of meteorological variables as follows:

0	All parameters of nominal accuracy
1	T or TD questionable
2	Flight-level winds questionable
3	Surface winds questionable
4	T/TD and FL winds questionable
5	T/TD and surface winds questionable
6	FL winds and surface winds questionable
9	T/TD, FL winds, and surface winds questionable

G.2.3. TEMP DROP.

The TEMP DROP code message provides a representation of quality-controlled vertical measurements of pressure, temperature, moisture, and winds acquired from dropsondes released from reconnaissance aircraft. The message consists primarily of two main sections: Part A and B. In Part A, temperature, dew point depression, and wind measurements are reported at the surface and at every mandatory pressure level the dropsonde traverses as it descends from flight level. A hydrostatically-computed sea-level pressure obtained from sonde data is reported with the surface data. Calculated geopotential heights based on upward or downward hydrostatic integration of the sonde data are also reported with the mandatory pressure levels. In Part B, thermodynamic (temperature and dew point depressions) and wind measurements are reported at significant pressure levels traversed by the dropsonde from flight level to the surface. The significant levels are selected from a quality-control algorithm where local extrema occur in the vertical profiles of the thermodynamic and wind data and at other set criteria. Additional information is provided in remarks lines at the end of each section, including but not limited to aircraft mission ID, observation number, and dropsonde release and splash times and locations. If the dropsonde is released by an aircraft at a pressure altitude above 100 mb, the TEMP DROP message will contain additional Parts C and D, which are analogous to Parts A and B, for mandatory and significant level measurements < 100 mb.

Sample USAFR/53 WRS and NOAA TEMP DROP messages are shown in Figure G-5. A detailed explanation of each element within a TEMP DROP message is presented in Table G-7.

Figure G-5. Example TEMP DROP Message for Tropical Cyclones

```
UZNT13 KNHC 142311
XXAA 64237 99217 70659 07915 99980 26006 06101 00678 ///// /////
92510 22606 09596 85247 20034 11595 70897 09802 15605 88999 77999
31313 09608 82244
61616 AF302 0608A GONZALO  OB 10
62626 EYEWALL 045 MBL WND 08107 AEV 07775 DLM WND 11593 980697 WL
150 07105 083 REL 2167N06592W 224447 SPG 2173N06603W 224927 =
XXBB 64238 99217 70659 07915 00980 26006 11910 21808 22888 22644
33850 20034 44787 15207 55712 12008 66697 09200
21212 00980 06101 11977 06598 22973 06605 33967 07107 44961 08617
55953 08621 66947 08610 77944 08613 88939 09103 99932 09603 11926
09596 22910 10101 33901 10594 44894 10599 55850 11595 66697 15605
31313 09608 82244
61616 AF302 0608A GONZALO  OB 10
62626 EYEWALL 045 MBL WND 08107 AEV 07775 DLM WND 11593 980697 WL
150 07105 083 REL 2167N06592W 224447 SPG 2173N06603W 224927 =
UZNT13 KWBC 022227
XXAA 52221 99312 70715 11611 99020 27647 19010 00175 26037 18510
92859 21858 20007 85587 17459 17508 70224 10883 24008 50593 08549
28509 40762 19161 33506 30970 33964 17507 25095 43970 24007 20241
56165 21008 15419 679// 30013 88999 77999
31313 09608 82202
61616 NOAA9 0701A ARTHUR   OB 20
62626 MBL WND 18510 AEV 07725 DLM WND 23505 019148 WL150 18510 08
2 REL 3119N07150W 220214 SPG 3120N07148W 221846 =
XXBB 52228 99312 70715 11611 00020 27647 11969 23829 22958 24261
33935 22457 44891 19661 55883 19050 66869 18460 77855 17656 88850
17459 99838 16862 11807 14856 22794 14461 33789 14259 44781 14264
55702 11083 66670 07867 77648 06283 88601 01868 99573 00778 11559
01970 22546 03562 33525 06361 44515 07323 55494 09356 66453 13928
77416 17163 88411 17759 99405 18561 11363 24357 22355 25363 33343
27159 44328 28767 55313 31563 66286 36371 77190 58765 88148 683//
21212 00020 19010 11965 19010 22895 20003 33850 17508 44661 25010
55643 24010 66448 35010 77324 19511 88187 32513 99162 29514 11154
33017 22148 28513
31313 09608 82202
61616 NOAA9 0701A ARTHUR   OB 20
62626 MBL WND 18510 AEV 07725 DLM WND 23505 019148 WL150 18510 08
2 REL 3119N07150W 220214 SPG 3120N07148W 221846 =
```

Table G-7. TEMP DROP CODE

EXTRACT FROM: WMO-No. 306 MANUAL ON CODES

FM 37-X Ext. TEMP DROP: Upper-level pressure, temperature, humidity and wind report from a sonde released by carrier balloons or aircraft. See Figure G-5 for an example TEMP DROP message for tropical cyclone operations.

CODE FORM:
PART A

SECTION 1	$M_iM_iM_jM_j$ YYGGI_d 99$L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ MMM$U_{La}U_{Lo}$
SECTION 2	99$P_oP_oP_o$ $T_oT_oT_{ao}D_oD_o$ $d_od_of_of_of_o$
	$P_1P_1h_1h_1h_1$ $T_1T_1T_{a1}D_1D_1$ $d_1d_1f_1f_1f_1$
	$P_nP_nh_nh_nh_n$ $T_nT_nT_{an}D_nD_n$ $d_nd_nf_nf_nf_n$
SECTION 3	88$P_tP_tP_t$ $T_tT_tT_{at}D_tD_t$ $d_td_tf_tf_tf_t$ or 88999
SECTION 4	77$P_mP_mP_m$ $d_md_mf_mf_mf_m$ (4$v_bv_bv_av_a$) or
	66$P_mP_mP_m$ $d_md_mf_mf_mf_m$ (4$v_bv_bv_av_a$) or 77999
SECTION 7	31313 $s_rr_ar_as_as_a$ 8GGgg
SECTION 9	51515 101A_{df} A_{df} or
	101A_{df} A_{df} 0$P_nP_nP'_nP'_n$. or
	101A_{df} A_{df} $P_nP_nh_nh_nh_n$
SECTION 10	61616 62626

PART B

SECTION 1	$M_iM_iM_jM_j$ YYGG8 99$L_aL_aL_a$ $Q_cL_oL_oL_o$ MMM$U_{La}U_{Lo}$
SECTION 5	$n_on_oP_oP_oP_o$ $T_oT_oT_{ao}D_oD_o$
	$n_1n_1P_1P_1P_1$ $T_1T_1T_{a1}D_1D_1$
	$n_nn_nP_nP_nP_n$ $T_nT_nT_{an}D_nD_n$
SECTION 6	21212 $n_on_oP_oP_oP_o$ $d_od_of_of_of_o$
	$n_1n_1P_1P_1P_1$ $d_1d_1f_1f_1f_1$
	$n_nn_nP_nP_nP_n$ $d_nd_nf_nf_nf_n$
SECTION 7	31313 $s_rr_ar_as_as_a$ 8GGgg
SECTION 9	51515 101A_{df} A_{df} or
	101A_{df} A_{df} 0$P_nP_nP'_nP'_n$. or
	101A_{df} A_{df} $P_nP_nh_nh_nh_n$
SECTION 10	61616 62626

PART ALPHA (A)

IDENTIFICATION LETTERS: M_JM_J

Identifier: **M_JM_J -** Identifier for Part A of the report.

DATE/TIME GROUP: $YYGGI_d$

Identifier: **YY -** Day group, when wind data are included 50 is added to the day.

Identifier: **GG -** Time group

Identifier: **I_d -** The highest mandatory level for which wind is available.

LATTITUDE: $99L_aL_aL_a$

Identifier: **99 –** Indicator for data on position follows.

Identifier: **$L_aL_aL_a$** – Latitude in tenths of degrees

LONGITUDE: $Q_cL_oL_oL_oL_o$

Identifier: **Q_c** – The octant of the globe.

Identifier: **$L_oL_oL_oL_o$** – Longitude in tenths of degrees

MARSDEN SQUARE: $MMMU_{la}U_{lo}$

Identifier: **MMM** - Marsden square"*(see Figure G-6 for geographical depiction)* .

Identifier: **$U_{la}U_{lo}$** – Units digits in the reported latitude and longitude.

SEA LEVEL PRESSURE: $99P_0P_0P_0$ $T_0T_0T_0D_0D_0$ $d_0d_0f_0f_0f_0$

Identifier: **99** – Indicator for data at the surface level follows

Identifier: **$P_0P_0P_0$** – Indicator for pressure of specified levels in whole millibars (thousands digit omitted)

Identifier: **$T_0T_0T_0$–** Tens and digits of air temperature (not rounded off) in degrees Celsius, at specified levels beginning with surface.

Identifier: **D_0D_0 –** Dewpoint depression at standard isobaric surfaces beginning with surface level.

NOTE: When the depression is 5.5°C or less, encode the integer units and tenths digits of the depression. Encode depressions of 5.6°C through 5.9°C as 56. Dew point depressions of 6.0°C and above are encoded in tens and units with 50 added. (Examples: dew point depressions of 3.2°C, 5.7°C, and 20.0°C should be encoded as 32, 56, and 70, respectively.)

Identifier: **d_od_o –** True direction from which wind is blowing rounded to nearest 5 degrees. Report hundreds and tens digits. The unit digit (0 or 5) is added to the hundreds digit of wind speed.

Identifier: **$f_of_of_o$ –** Wind speed in knots. Hundreds digit is sum of speed and unit digit of direction, i.e. 29<u>5</u>° at 125 knots encoded as 29<u>6</u>25.

NOTE: 1. When flight level is just above a standard surface and in the operator's best meteorological judgment, the winds are representative of the winds at the standard surface, then the operator may encode the standard surface winds using the data from flight level. If the winds are not representative, then encode /////.

NOTE: 2. The wind group relating to the surface level ($d_od_of_of_of_o$) will be included in the report; when the corresponding wind data are not available, the group will be encoded as /////.

STANDARD ISOBARIC SURFACES : $P_1P_1h_1h_1h_1$ $T_1T_1T_1D_1D_1$ $d_1d_1f_1f_1f_1$

Identifier: **P_1P_1** – Pressure of standard isobaric surfaces in units of tens of millibars.

(1000 mbs = 00, 925mbs = 92, 850mbs = 85, 700mbs = 70, 500mbs = 50, 400mbs = 40, 300mbs = 30, 250mbs = 25).

Identifier: **$h_1h_1h_1$ –** Heights of the standard pressure level in geopotential meters or decameters above the surface. Encoded in decameters at and above 500mbs omitting, if necessary, the thousands or tens of thousands digits. Add 500 to the absolute value of hhh for negative 1000mb or 925mb heights. Report 1000mb group as 00/// ///// ///// when pressure is less than 950mbs.

Identifier: **$T_1T_1T_1D_1D_1$** – Same temperature/dew point encoding procedures apply to all levels.

Identifier : **$d_1d_1f_1f_1f_1$ –** Same wind encoding procedures apply to all levels.

DATA FOR TROPOPAUSE LEVELS: 88 $P_tP_tP_t$ $T_tT_tT_tD_tD_t$ $d_td_tf_tf_tf_t$

Identifier: **88 –** Indicator for Tropopause level follows

Identifier: **$P_tP_tP_t$–** Pressure at the tropopause level reported in whole millibars. Report $88P_nP_nP_n$ as 88999 when tropopause is not observed.

Identifier: **$T_tT_tT_tD_tD_t$ –** Same temperature/ dew point encoding procedures apply.

Identifier: **$d_td_tf_tf_tf_t$ -** Same wind encoding procedures apply.

MAXIMUM WIND DATA: $77P_nP_nP_n$ $d_nd_nf_nf_nf_n$ $4v_bv_bv_av_a$

Identifier: 77 – Indicator that data for maximum wind level and for vertical wind shear follow when max wind does not coincide at flight. If the maximum wind level coincides with flight level encode as 66. Report 77PnPnPn as 77999 when maximum wind data has not been observed.

Identifier: $P_nP_nP_n$.– Pressure at maximum wind level in whole millibars.

Identifier: **$d_nd_nf_nf_nf_n$ -** Same wind encoding procedures apply.

VERTICAL WIND SHEAR DATA: $4v_bv_bv_av_a$

Identifier: **4 –** Data for vertical wind shear follow.

Identifier: **v_bv_b –** Absolute value of vector difference between max wind and wind 3000 feet BELOW the level of max wind, reported to the nearest knot. Use "//" if missing and a 4 is reported. A vector difference of 99 knots or more is reported with the code figure "99".

Identifier: **v_av_a –** Absolute value of vector difference between max wind and wind 3000 feet above the level of max wind, reported to the nearest knot. Use "//" if missing and a 4 is reported. A vector difference of 99 knots or more is reported with the code figure "99".

SOUNDING SYSTEM INDICATION, RADIOSONDE/ SYSTEM STATUS, LAUNCH TIME:

31313 $s_rr_ar_as_as_a$ 8GGgg

Identifier: **$s_rr_ar_as_as_a$ -** Sounding system indicator, radiosonde/ system status: $s_ar_ar_as_as_a$

Identifier**: s_a -** Solar and infrared radiation correction (**0** – no correction)

Identifier: **r_ar_a** – Radiosonde/sounding system used (**96** – Descending radiosonde)

Identifier: **s_as_a** – Tracking technique/status of system used (**08** – Automatic satellite navigation)

Identifier: **8GGgg** – Launch time

Identifier: **8** – Indicator group

Identifier: **GG** – Time in hours

Identifier: **gg** – Time in minutes

ADDITIONAL DATA GROUPS: 51515 101XX $0P_nP_nP_nP_n$

Identifier: **51515** – Additional data in regional code follow

Identifier: **10166** – Geopotential data are doubtful between the following levels $0P_nP_nP_nP_n$. This code figure is used only when geopotential data are doubtful from one level to another.

Identifier: **10167** – Temperature data are doubtful between the following levels $0P_nP_nP_nP_n$. This code figure shall be reported when only the temperature data are doubtful for a portion of the descent. If a 10167 group is reported a 10166 will also be reported. EXAMPLE: Temperature is doubtful from 540mbs to 510mbs. SLP is 1020mbs. The additional data groups would be : 51515 10166 00251 10167 05451.

Identifier: **10190** – Extrapolated altitude data follows:

When the sounding begins within 25mbs below a standard surface, the height of the surface is reported in the format **10190 $P_nP_nh_nh_nh_n$**. The temperature group is not reported. EXAMPLE: Assume the release was made from 310mbs and the 300mb height was 966 decameters. The last reported standard level in Part A is the 400mb level. The data for the 300mb level is reported in Part A and B as 10190 30966.

When the sounding does not reach surface, but terminates within 25mbs of a standard surface, the height of the standard surface is reported in Part A of the code in standard format and also at the end of Part A and Part B of the code in the format as **10190 $P_nP_nh_nh_nh_n$**.

EXAMPLE: Assume termination occurred at 980mbs and the extrapolated height of the 1000mb level was 115 meters. The 1000mb level would be reported in Part A of the code as 00115 ///// ///// and in Part B as 10190 00115.

Identifier: **10191** – Extrapolated surface pressure precedes. Extrapolated surface pressure is only reported when the termination occurs between 850mbs and the surface. Surface pressure is reported in Part A as $99P_0P_0P_0$ ///// and in Part B as $00P_0P_0P_0$ /////. When surface pressure is extrapolated the 10191 group is the last additional data group reported in Part B.

AIRCRAFT AND MISSION IDENTIFICATION: 61616 AFXXX XXXXX XXXXX OB X

Identifier: **61616** – Aircraft and mission identification data follows.

Identifier: **AFXXX –** The identifier AF for U.S. Air Force and the last three digits of the aircraft's tail number.

Identifier: **XXXXX XXXXX –** The identifier for the type of mission being flown.

If a training mission the mission identifier is **WXWXA TRAIN.** The fifth letter "A" is the only character that could possibly change. The "A" indicates that the flight originated in the Atlantic basin. The letter "C" identifies the Central Pacific area, the letter "E" identifies the Eastern Pacific, and the letter "W" identifies the Western Pacific.

If an operational storm mission: the first two numbers Identifier the number of times an aircraft has flown this system and the second two numbers Identifier the system number. The last character again identifies the basin flown. The name of the storm would replace TRAIN.

EXAMPLE: AF968 0204A MARIE – Aircraft number 50968, this was the second flight into this system and the system was the fourth of the season. The system reached tropical storm strength and was named MARIE.

Identifier: **OB 14** – The observation (both vertical and horizontal) number as transmitted from the aircraft.

NATIONALLY DEVELOPED CODES: 62626

Identifier: **62626** – This is the remarks section. Only the remarks CENTER, EYEWALL XXX, MXWNDBND, or RAINBAND will be used. If the remark EYEWALL is used it will be followed by the octant (degrees) sonde is located relative to eye center. Example: If the sonde is released in the NE quad of the storm, XXX is 045. An eyewall remark can be used with any amount of total observed eyewall throughout the storm. It is not contingent upon the VDM criteria stated within Table G-8.

Identifier: **REL XXXXNXXXXXW hhmmss -** the time and location of the highest (in altitude) wind reported in the temp drop message.

Identifier: **SPG XXXXNXXXXXW hhmmss -** the time and location of the lowest (in altitude) wind reported in the temp drop message.

Identifier: **SPL XXXXNXXXXXW hhmm -** Impact location of the sonde based on its last GPS position and the splash time. (SPL has less precision than SPG and is now obsolete).

Identifier: **LST WND XXX -** Height of the last reported wind. If a surface wind is reported the Last Wind remark is omitted. XXX will never be less than 13 meters

Identifier: **MBL WND ddfff -** The mean boundary level wind. The mean wind in the lowest 500 meters of the sounding

Identifier: **AEV XXXXX -** This is the software version being used for the sounding.

Identifier: **DLM WND ddfff bbbttt -** The Deep Layer Mean wind. It is the average wind over the depth of the sounding. Where ddfff is the wind averaged from the first to the last available wind (these would correspond to the first and last significant levels for wind); ttt is the pressure at the top of the layer, and bbb is the pressure at the bottom of the layer (in whole mbs, with thousands digit omitted).

Identifier: **WL150 ddfff zzz -** Average wind over the lowest available 150 m of the wind sounding. Where ddfff is the mean wind over the 150 m layer centered at zzz m.

PART BRAVO (B)

DATA FOR SIGNIFICANT TEMPERATURE AND RELATIVE HUMIDITY LEVELSSIGNIFICANT ISOBARIC LEVELS:

$n_0n_0P_0P_0P_0$ $T_0T_0T_0D_0D_0$

IDENTIFICATION LETTERS: M_JM_J

Identifier: **M_JM_J -** Identifier for Part B of the report.

DATE/TIME GROUP: YYGG8

Identifier: **YY -** Day group, when wind data are included 50 is added to the day.

Identifier: **GG -** Time group

Identifier: **8 -** Indicator for the use of satellite navigation for windfinding.

LATTITUDE: $99L_aL_aL_a$ (Same as Part A)

LONGITUDE: $Q_cL_oL_oL_oL_o$ (Same as Part A)

MARSDEN SQUARE: $MMMU_{la}U_{lo}$ (Same as Part A)

SEA LEVEL PRESSURE: $n_on_oP_0P_0P_0$ $T_0T_0T_0D_0D_0$

Identifier: **nono** – Indicator for number of level starting with surface level. Only surface will be numbered as **"00".**

Identifier: **$P_0P_0P_0$** – Indicator for pressure of specified levels in whole millibars (thousands digit omitted)

Identifier: **$T_0T_0T_0$**– Tens and digits of air temperature (not rounded off) in degrees Celsius, at specified levels beginning with surface.

Identifier: **D_0D_0 –** Dewpoint depression at standard isobaric surfaces beginning with surface level. Encoded the same as Part A.

FOR STORM DROPS ONLY. If SLP is less than 950mb encode the 1000mb group as 00/// ///// /////. When the SLP is between 950mb and 999mb encode 1000mb as 00PoPoPo ///// ///// (500 meters are added to height below surface).

DATA FOR SIGNIFICANT WIND LEVELS: $n_0n_0P_0P_0P_0$ $d_od_of_of_of_o$

Identifier: **n_0n_0 –** Number of level starting with surface level. Only surface will be numbered as **"00".**

Identifier: **$P_0P_0P_0$ –** Pressure at specified levels in whole millibars.

Identifier: **d_od_o –** True direction from which wind is blowing rounded to nearest 5 degrees. Report hundreds and tens digits. The unit digit (0 or 5) is added to the hundreds digit of wind speed.

Identifier: **$f_of_of_o$ –** Wind speed in knots. Hundreds digit is sum of speed and unit digit of direction, i.e. $29\underline{5}^o$ at 125 knots encoded as $29\underline{6}25$.

Same notes in Part A apply.

31313, 51515, 61616, 62626 – Repeated from Part A.

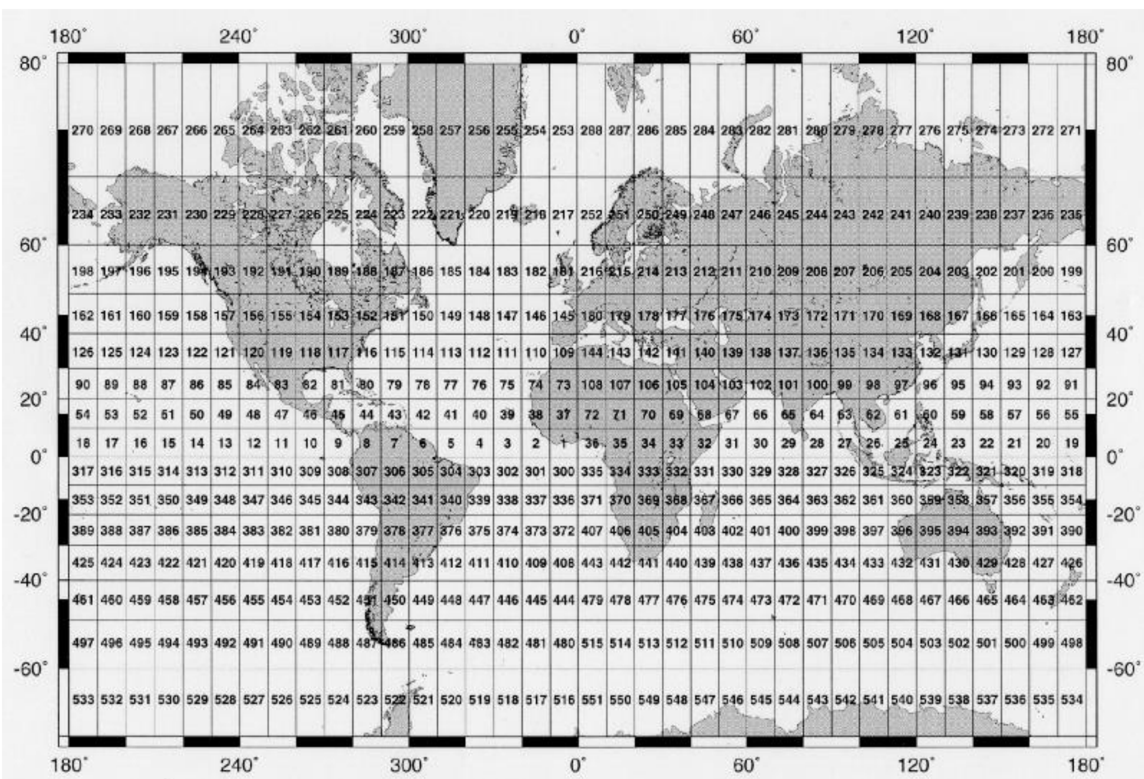

Figure G-6. Marsden Square Reference Diagram

G.2.4. VDM.

The Vortex Data Message provides details about a fix of an existing tropical cyclone or a suspect (invest) system with a closed circulation made by meteorologists aboard USAF and NOAA weather reconnaissance aircraft following a center penetration. Information includes the date, time, and geographical coordinates of the fix; center observations and characteristics; maximum surface and flight-level wind measurements or estimates during the inbound and outbound legs; thermodynamic measurements within and outside the center; and fix attributes. All geopotential computations reported in the VDM are made relative to the 1976 US Standard Atmosphere (adjustable altimeters set to 29.92 inches Hg). The minimum sea-level pressure for a fix is often determined by dropsondes launched in the center when aircraft are flying at altitudes at or above 5,000 ft and extrapolated when flying below that level.

A sample VDM is shown in Figure G-7. A VDM entry form worksheet is presented in Figure G-8 with each of the items further explained in Table G-8.

```
URNT12 KNHC 241133
VORTEX DATA MESSAGE   AL162016
A. 24/11:12:50Z
B. 10.97 deg N 082.77 deg W
C. 700 mb 2927 m
D. 977 mb
E. 210 deg 11 kt
F. CLOSED
G. C20
H. 90 kt
I. 144 deg 5 nm 11:07:00Z
J. 253 deg 78 kt
K. 158 deg 8 nm 11:07:30Z
L. 95 kt
M. 314 deg 5 nm 11:17:00Z
N. 033 deg 108 kt
O. 349 deg 14 nm 11:17:30Z
P. 10 C / 3042 m
Q. 18 C / 3045 m
R. NA / NA
S. 12345 / 7
T. 0.02 / 1 nm
U. AF301 0616A OTTO OB 13
MAX FL WIND 108 KT 349 / 14 NM 11:17:00Z
```

Figure G-7. Example Vortex Data Message (VDM) for the WC-130J

VORTEX DATA MESSAGE		ATCF STORM ID	ARWO/FD
A	Z	DATE AND TIME OF FIX	
B	DEG N S DEG E W	LATITUDE AND LONGITUDE OF VORTEX FIX (DECIMAL DEGREES)	
C	MB M	MINIMUM HEIGHT AT STANDARD ATMOSPHERIC LEVEL	
D	MB	MINIMUM SEA LEVEL PRESSURE COMPUTED FROM DROPSONDE OR EXTRAPOLATED FROM FLIGHT LEVEL. IF EXTRAPOLATED, CLARIFY IN REMARKS.	
E	DEG KT	CENTER DROPSONDE SURFACE WIND	
F		CENTER CHARACTER: Closed wall, poorly defined, open SW, etc.	
G		CENTER SHAPE/ORIENTATION/DIAMETER. CODE CENTER SHAPE AS: C - Circular; CO - Concentric; E- Elliptical. TRANSMIT DIAMETER IN NAUTICAL MILES. IF ELLIPTICAL, TRANSMIT ORIENTATION OF MAJOR AXIS IN TENS OF DEGREES (i.e., 01-010 to 190; 17-170 to 350). Examples: C8 - Circular center of 8 NM diameter. E09/15/5 - Elliptical center, major axis 090-270, length of major axis 15 NM, length of minor axis 5 NM. CO8-14 - Concentric eyewalls, diameter inner eyewall 8 NM, outer eyewall 14 NM.	
H	KT	ESTIMATE OF INBOUND MAXIMUM SURFACE WIND OBSERVED	
I	DEG NM Z	BEARING AND RANGE FROM CENTER AND TIME OF INBOUND MAXIMUM SURFACE WIND	
J	DEG KT	MAXIMUM INBOUND FLIGHT LEVEL WIND NEAR CENTER	
K	DEG NM Z	BEARING AND RANGE FROM CENTER AND TIME OF INBOUND MAXIMUM FLIGHT LEVEL WIND	
L	KT	ESTIMATE OF OUTBOUND MAXIMUM SURFACE WIND OBSERVED	
M	DEG NM Z	BEARING AND RANGE FROM CENTER AND TIME OF OUTBOUND MAXIMUM SURFACE WIND	
N	DEG KT	MAXIMUM OUTBOUND FLIGHT LEVEL WIND NEAR CENTER	
O	DEG NM Z	BEARING AND RANGE FROM CENTER AND TIME OF OUTBOUND MAXIMUM FLIGHT LEVEL WIND	
P	C/ M	MAXIMUM FLIGHT LEVEL TEMP/PRESSURE ALTITUDE OUTSIDE CENTER	
Q	C/ M	MAXIMUM FLIGHT LEVEL TEMP/PRESSURE ALTITUDE INSIDE CENTER	
R	C/ C	DEW POINT TEMP/SEA SURFACE TEMP INSIDE CENTER	
S	/	FIX DETERMINED BY/FIX LEVEL**. FIX DETERMINED BY:** 1 - Penetration; 2 - Radar; 3 - Wind; 4 - Pressure; 5 - Temperature. **FIX LEVEL:** Indicate surface center if visible; indicate both surface and flight level centers only when they are within 5 NM of each other: 0 - Surface; 1 - 1500 ft; 9 - 925 mb; 8 - 850 mb; 7 - 700 mb; 5 - 500 mb; 4 - 400 mb; 3 - 300 mb; 2 - 200 mb; NA - Other.	
T	/ NM	NAVIGATION FIX ACCURACY/METEOROLOGICAL ACCURACY	
U	REMARKS: __________AGENCY/AIRCRAFT NUMBER __________WX MISSION ID ______________SYSTEM NAME OB _____ MAX FL WIND ________________KT ___________BEARING / RANGE NM ____________________Z SLP EXTRAP FROM (BELOW 1500 FT/ 925 MB/ 850 MB/ 700 MB/ ___________FT/ DROPSONDE) SFC CNTR ________________________ / _____________NM FROM FL CNTR MAX FL TEMP _________C _________ / __________NM FROM FL CNTR INBOUND [AND] OUTBOUND SURFACE WIND[S] OBSERVED VISUALLY SECONDARY INBOUND MAX FL WIND ____________KT ___________BEARING / RANGE NM _______________Z SECONDARY OUTBOUND MAX FL WIND ____________KT __________BEARING / RANGE NM _______________Z CENTER SONDE LAST WIND ____________M ____________DEG ____________KT		
INSTRUCTIONS: Items A through C (and D when extrapolated) and H through K are transmitted from the aircraft immediately following the fix. The remainder of the message is transmitted as soon as available.			

Figure G-8: Vortex Data Message Worksheet

Table G-8. Vortex Data Message Entry Explanation

DATA ITEM	ENTRY
ATCF Storm ID	The Automated Tropical Cyclone Forecasting System storm identifier, as determined in Chapter 4, paragraph 4.3.3.
ARWO/FD	The aircraft flight meteorologist: Aerial Reconnaissance Weather Officer (ARWO) for USAF missions or Flight Director (FD) for NOAA missions.
A (ALPHA)	Date and time (UTC) of the flight level center fix (dd/hh:mm:ss). If the flight level center cannot be fixed and the surface center is visible, enter the time of the surface center fix.
B (BRAVO)	The latitude and longitude of the center fix in decimal degrees (with two-digit precision) associated with item ALPHA. NOTES: (1) Longitude values less than 100 should be specified with a leading zero digit. (2) If the surface center is fixable, enter the position relative to the flight level center in item UNIFORM remarks if they are separated by over 5 nm.
C (CHARLIE)	Indicate the standard atmospheric surface, e.g. 925, 850 or 700 mb, and the minimum height of the standard surface observed inside the center. If at 1,500 ft or below or not within 1,500 ft of a standard surface, enter NA.
D (DELTA)	The minimum sea level pressure (SLP) to the nearest millibar observed at the center coordinates reported in item BRAVO. Preface the SLP with "EXTRAP" (extrapolated) when the data are not derived from dropsonde or when the SLP is extrapolated from a dropsonde that terminated early, and clarify the difference in item UNIFORM remarks (e.g., "SLP EXTRAPOLATED FROM BELOW 1,500 FEET/925 MB/850 MB/700 MB/ XXXX FT/DROPSONDE").
E (ECHO)	Surface wind direction and speed from the center dropsonde, if available. Enter NA if item DELTA is extrapolated or not reported.
F (FOXTROT)	Describe the attributes of the center if at least 50 percent has an eyewall, otherwise enter NA. Closed wall--if the center has 100 percent coverage with no eyewall weakness. Open XX--if the center has 50 percent or more but less than 100 percent coverage. State the direction of the eyewall weakness. Spiral band—report item GOLF with the best approximation of the shape/diameter of the inner core.
G (GOLF)	Indicate the shape (circular, concentric, or elliptical) and size of the center only if item FOXTROT is reported, otherwise enter NA.
H (HOTEL)	The maximum surface wind observed during the inbound leg associated with this fix. When instrument-derived surface wind data are unavailable, the reported surface winds may be determined visually; note this in item UNIFORM remarks. All winds reported should be 10-s averages.
I (INDIA)	The position relative to the coordinates reported in item BRAVO and time (hh:mm:ss UTC) of the maximum inbound surface wind observed in item HOTEL.
J (JULIET)	The maximum flight level wind observed during the inbound leg associated with this fix. If a significant secondary maximum wind is observed, report it in item UNIFORM remarks. All winds reported should be 10-s averages.
K (KILO)	The position relative to the coordinates reported in item BRAVO and time (hh:mm:ss UTC) of the maximum inbound flight level wind observed in item JULIET.
L (LIMA)	The maximum surface wind observed during the outbound leg associated with this fix. When instrument-derived surface wind data are unavailable, the reported surface winds may be determined visually; note this in item UNIFORM remarks. All winds reported should be 10-s averages.
M (MIKE)	The position relative to the coordinates reported in item BRAVO and time (hh:mm:ss UTC) of the maximum outbound surface wind observed in item LIMA.
N (NOVEMBER)	The maximum flight level wind observed during the outbound leg associated with this fix. If a significant secondary maximum wind is observed, report it in item UNIFORM remarks. All winds reported should be 10-s averages.

DATA ITEM	ENTRY
O (OSCAR)	The position relative to the coordinates reported in item BRAVO and time (hh:mm:ss UTC) of the maximum outbound flight level wind observed in item NOVEMBER.
P (PAPA)	The maximum flight level temperature taken just outside the central region of a cyclone (i.e., just outside the eyewall or just beyond the maximum wind band) on the inbound leg. This temperature may not be the highest recorded on the inbound leg but is representative of the environmental temperature just outside the central region of the storm. Indicate the pressure altitude at the location the maximum temperature is observed.
Q (QUEBEC)	The maximum flight level temperature observed within 5 nm of the center fix coordinates reported in item BRAVO. If a higher temperature is observed at a location more than 5 nm away from the flight level center, it is reported in item UNIFORM remarks along with the position relative to the center. Indicate the pressure altitude at the location the maximum temperature is observed.
R (ROMEO)	The dew point temperature and sea surface temperature collected at the same location as the maximum temperature reported in item QUEBEC. Enter NA if not observed.
S (SIERRA)	Fix determination criteria: Always report 1. Report 2 if radar indicates curvature or banding consistent with fix location. Report 3 if recorded or observed winds indicate a closed center. Report 4 if the fix pressure is lower than all reported on the inbound leg. Report 5 if the fix temperature is at least higher than any reported on the inbound leg. Fix level: Report 0 alone if fix is made solely on surface winds. Report 0 plus the flight level code if the centers are within 5 nm of each other.
T (TANGO)	Report navigational fix and meteorological accuracy as the upper limit of probable error. Meteorological accuracy is normally reported as one-half of the diameter of the light and variable wind center.
U (UNIFORM)	Remarks to enhance the data reported above. Required remarks include: (1) agency/aircraft number, weather mission identifier, and name of storm system as defined according to Chapter 5, Table 5-4, and two-digit observation number as defined in Chapter 5, paragraph 5.6.9; (2) the maximum flight level wind observed, time of observation, and the position relative to the flight level center of the observed wind relative to the flight level center of the most recent observed wind across all octants of the storm., i.e., 337.5-22.5 degrees, 22.5-67.5 degrees, etc.; (3) the method of deriving the central SLP when extrapolated; (4) the relative position of the surface center and/or maximum flight level temperature if not within 5 nm of the flight level center; (5) if the inbound and/or outbound surface winds are visual estimates, (6) any significant secondary maximum flight level wind observed inbound and/or outbound, the time of observation, and its position relative to the flight level center, and (7) the center dropsonde last wind and altitude, if available, when sonde wind telemetry terminates at 13 m or above before reaching the surface.

Table G-8. Vortex Data Message Entry Explanation, continued

G.2.5 BUFR

The Binary Universal Form for the Representation of meteorological data (BUFR) is a binary data format maintained by the World Meteorological Organization (WMO). The format can be found in the WMO Manual on Codes (WMO-No. 306).

APPENDIX H: MISSION IDENTIFIER ASSIGNMENTS FOR SMALL UNCREWED AIRCRAFT SYSTEM PLATFORMS

The five-character agency/aircraft indicator designated for sUAS platforms, comprising the first element of a mission identifier within aircraft data messages, has the format of **UApxx** where:

p - Platform index:

1 Anduril Industries Altius 600

2 Black Swift Technologies S0

3 Dragoon Technology Coriolis

xx - Seasonal platform number (01 for the first launched, 02 for the second launched, etc.)

Note: xx resets back to 01 for every platform at the beginning of each hurricane season.

APPENDIX I: TELEPHONE LISTING

AGENCY	LOCATION	TELEPHONE
Department of Commerce		
NHC Director Atlantic Forecast Operations Pacific Forecast Operations Admin Admin Fax TAFB Pacific/Classification Desk	Miami, FL	COM 305-229-4402 COM 305-229-4415 COM 305-229-4417 COM 305-229-4470 FAX 305-553-1901 COM 305-229-4425
CPHC Director Forecaster and Warning Desk Admin Admin Fax	Honolulu, HI	COM 808-973-5272 COM 808-973-5291 COM 808-973-5270 FAX 808-973-5271
NOAA Aircraft Operations Center	Lakeland, FL	COM 863-500-3990
NCEP/NCO Senior Duty Met (Data QC)	College Park, MD	COM 301-683-1500
Weather Prediction Center (NCEP/WPC)	College Park, MD	COM 301-683-1530
NESDIS Satellite Analysis Branch	College Park, MD	COM 301-683-1400
WFO Guam	Tiyan, Guam	COM 671-472-0950/1/2
NDBC - Operations Branch	Stennis Space Center, MS	COM 228-688-7720
NWS National Operations Center (Headquarters)	Silver Spring, MD	COM 301-244-9650
Interdepartmental		
Department of War		
JTWC (Typhoon Duty Officer)	Pearl Harbor, HI	COM 808-474-2320
US Air Force Reserve Command Weather (AFRC/A3OW)	155 Richard Ray Blvd Robins AFB, GA 31098 HQAFRC.A3.OW@us.af.mil	COM 478-222-6106 COM 478-327-0306
53rd Weather Reconnaissance Squadron (WRS) Supervisor of Flights/ Alternate CARCAH Chief ARWO	53 WRS 817 H Street, Suite 201 Keesler AFB, MS 39534-2453	DSN 312-597-2409 COM 228-377-2409 DSN 312-597-3207 COM 228-377-3207
CARCAH OLA, 53d WRS	Miami, FL	COM 305-229-4474
Keesler AFB Command Post	Keesler AFB, MS	COM 228-377-4181/4330 DSN 312-597-4181/4330
557th Weather Wing (557 WW)	Offutt AFB, NE	COM 402-294-2586 DSN 312-271-2586
FACSFAC VACAPES OAC	Oceana, VA	COM 804-433-1233 DSN 312-433-1233
17 OWS/WXJ (Satellite Analyst)	Pearl Harbor, HI	COM 808-471-3533 DSN 315-471-3533
601 AOC/CODW	Tyndall AFB, FL	COM 850-283-5119 DSN 312-23-5119
Fleet Weather Center Norfolk (Command Duty Officer)	Norfolk, VA	COM 757-444-7583/7750 DSN 312-564-7583/7750

TMC – Traffic Management Coordinator
OMIC - Operations Manager in Charge
STMC – Supervisor Traffic Management Coordinator

Department of Transportation

Air Route Traffic Control Center (ARTCC)

ARTCC	Facility ID	Primary Operations Contact Point	Secondary Operations Contact Point (24 hour number)	Operations Fax Number	Center Weather Service Unit (CWSU)
ANCHORAGE	ZAN	907-269-1103 (OMIC)	907-269-1108 (TMC)	907-269-1343	907-269-1145
BOSTON	ZBW	603-879-6663 (TMC)	603-879-6655 (OMIC)	603-879-6461	603-879-6698
HOUSTON	ZHU	281-230-5563 (Missions)	281-230-5560 (OMIC)	281-230-5561	281-230-5676
JACKSONVILLE	ZJX	904-845-1542 (Missions)	904-845-1537 (OMIC)	904-845-1843	904-845-1840 or 904-845-1839
LOS ANGELES	ZLA	661-265-8287 (Missions)	661-265-8205 (OMIC)	661-265-8277	661-265-8258
MIAMI	ZMA	305-716-1589 (Missions)	305-716-1588 (OMIC)	305-716-1511 or 305-716-1577	305-716-1635
NEW YORK	ZNY	631-468-1427 (Missions)	631-468-1080 (STMC)	631-468-4224	631-468-1082
OAKLAND	ZOA	510-745-3332 (Missions)	510-745-3331 (OMIC)	510-745-3339	510-745-3425
SEATTLE	ZSE	253-351-3523 (Missions)	253-351-3520 (OMIC)	253-351-3594 or 253-351-3538	253-351-3741
WASHINGTON	ZDC	703-771-3473 (Missions)	703-771-3470 (OMIC)	703-771-3444	703-771-3480
HONOLULU HCF	ZHN	808-840-6204 (TMC)	808-840-6201 (Front Line Manager)	808-840-6210	N/A
SAN JUAN CERAP	ZSU	787-253-8665 (Front Line Manager)	787-253-8664 (Front Line Manager)	787-253-8650	N/A
GUAM CERAP	ZUA	671-473-1210 (Front Line Manager)	671-473-1270 (Missions)	671-473-1217	N/A

Air Traffic Control System Command Center (ATCSCC)

OFFICE	**TELEPHONE**
MANAGER, ATCSCC	COM 540-422-4004
PRIMARY OPERATIONS CONTACT POINT INTERNATIONAL OPERATIONS POSITION	COM 540-422-4158 FAX 540-422-4196
SECONDARY OPERATIONS CONTACT POINT NATIONAL OPERATIONS MANAGER (NOM)	COM 540-422-4100/4101/4102 800-333-4286 (Military Use Only) FAX 540-422-4196
CENTRAL ALTITUDE RESERVATION FUNCTION (CARF)	COM 540-422-4211/4212 FAX 540-422-4291
US NOTAM Office	COM 540-422-4260/4261 FAX 540-422-4983
DOW Air Traffic Services Cell	COM 540-422-4250 DSN 510-422-4250

Federal Aviation Administration Head Quarters

OFFICE	TELEPHONE
FAA Interagency Flight Operations Security (After-Hours NOTAM Support)	COM (202) 320-9238 COM (202) 679-4842

Transport Canada (ANS Regulatory Authority)

Civil Aviation Contingency Operations (CACO) Office — COM (Toll-free from Canada) 1-877-992-6853
FAX (Toll-free from Canada) 1-866-993-7768

NAV CANADA (ANS Provider)

National Operations Centre (NOC)

OFFICE	**TELEPHONE**
Admin Hours	0600-2200 (local Eastern time)
NOC (24 Hours) (ATCSCC of Canada)	COM 613-563-5626 COM 613-563-5667 COM (Toll-free from Canada) 1-866-561-9053 COM (Toll-free from U.S.A.) 1-866-651-9056 FAX 613-563-3481
International NOTAM Office (Canada)	COM 613-248-4000 FAX 613-248-4001

Altitude Reservation Units (ARU)

OFFICE	TELEPHONE
ARU West (Edmonton ACC) (responsible for Vancouver, Edmonton and Winnipeg FIRs)	COM 780-890-4739 FAX 780-890-4738
ARU East (Gander ACC) (responsible for Toronto, Montreal, Moncton and Gander FIRs)	COM 709-651-5243 FAX 709-651-5288

Area Control Centers (ACC)

ACC	**Facility ID**	**Primary Operations Contact Point (Shift Manager)**	**Secondary Operations Contact Point**	Fax Number
TORONTO	ZYZ	905-676-4509	905-676-4562	905-612-5613
MONTREAL	ZUL	514-633-3365	514-633-2871	514-633-3371
MONCTON	ZOM	506-867-7173	506-381-4684	506-867-7180
WINNIPEG	ZWG	204-983-8338	204-983-8483	204-984-0030
EDMONTON	ZEG	780-890-8397	780-890-8323	780-890-8011
GANDER	ZQX	709-651-5207	709-651-5223	709-651-5234
VANCOUVER	ZVR	604-598-4500	604-598-4850	604-586-4502

APPENDIX J: GEOGRAPHICAL DEFINING POINTS AND PHONETIC PRONUNCIATIONS

Abaco	AB-a-KO
Abreojos	aahbray-oh-hoes
Amalie	a-MAHL-ye
Angel	aan-hel
Anguilla	ang-GWIL-a
Antigua	an-TEE-ga
Arena	aah-ray-nah
Arista	ah-ree-staa
Aruba	ah-ROO-ba
Antilles	an-TILL-leez
Azores	uh-ZOHRZ
Bahia	ba-e-yuh
Ballenas	ba-yaynas
Barahona	ba-ra-HO-na
Barbados	bar-BAY-dohz
Barbuda	bar-BOO-dah
Barra	baa-rra
Barranquilla	Bahr-rahn-KEE-yah
Basse-Terre	baha-TER
Bimini	BIM-I-ni
Bonaire	ba-NAIR
Burros	bhoorroes
Cap Haitien	kahp ah-ee-SYAN
Caracas	kah-RAH-kahs
Cardenas	car-denaass
Caribbean	kar-a-BE-an
Castries	KAS-tree
Cayman	kay-MAHN
Champerico	chaam-per-e-coe
Charlotte	SHAR-luht
Colima	coleema
Corrientes	cor-re-ehn-tays
Cozumel	koh-soo-MEL
Curacao	koor-a-SOH
Cuyutlan	coo-yootlaan
Dominica	dom-I-NEE-ka
Eleuthera	el-OO-thera
Escondido	es-cond-dee-dow
Eugenia	ayuh-hen-yuh
Exuma	ek-SOO-ma
Flores	FLO-rish
Fort de France	for-de-FRAHCS
Galera	gaa-lehra
Grenada	gre-NAY-dah
Guadaloupe	GWAH-deh-loop
Guasave	gwaa-saa-ve
Guaymas	gwhy-maahs
Huatulco	whaa-tool-coe
Islas	eeslas
Jalisco	ha-lee-sco
Juanico	whaa-nee-coe
Lazaro	laasa-roe
Loreto	lo-ae-toe
Leeward	LEE-werd
Manzanillo	manza-nee-oh
Maracaibo	mar-a-KYE-boh
Maracay	mah-rah-KYE
Marigot	ma-ree-GOH
Mateo	muh-ta-yo
Mayaguez	may-yah-GWAYS
Medano	may-daa-no
Melaque	may-laa-kay
Merida	MAY-re-thah
Mochis	mo-chees
Montego	mon-TEE-go
Montserrat	mont-se-RAT
Mugu	muhgu
Mulege	moo-lay-hay
Nicaragua	nik-a-RAH-gwah
Ocho Rios	OH-cho REE-os
Oranjestad	o-RAHN-yuh-stat
Paramaribo	par-a-MAR-I-boh
Parguera	par-GWER-a
Penasco	pen-yaas-co

Pointe-a-Pitre	pwan-ta-PEE-tr
Ponce	PON-sa
Port-au-Prince	port-oh-PRINS
Punta	poonta
Revillagigedo	ray-veeaheehaydo
Saba	SAH-ba
Sao Miguel	soun ME-gel
Sipacate	see-paa-caa-tay
St Croix	ST croy
St Lucia	ST LOO-she-a
Soufriere	soo-free-AR
Surinam	SOOR-I-nam
Tampico	tam-PEE-ko
Tehuantepec	te-whaan-te-pec
Tela	TAY-lah
Tobago	to-BAY-go
Todos	todohs
Tomas	tow-maas
Tonala	ton-aahla
Tosca	toesca
Vallarta	vah-yar-ta
Yavaros	yaa-vaa-roce
Yucatan	yoo-ka-TAN
Zihuatanejo	zeeh-whaa-tanay-ho

APPENDIX K: NHOP OPERATIONAL MAPS

(TERMINAL AREAS)

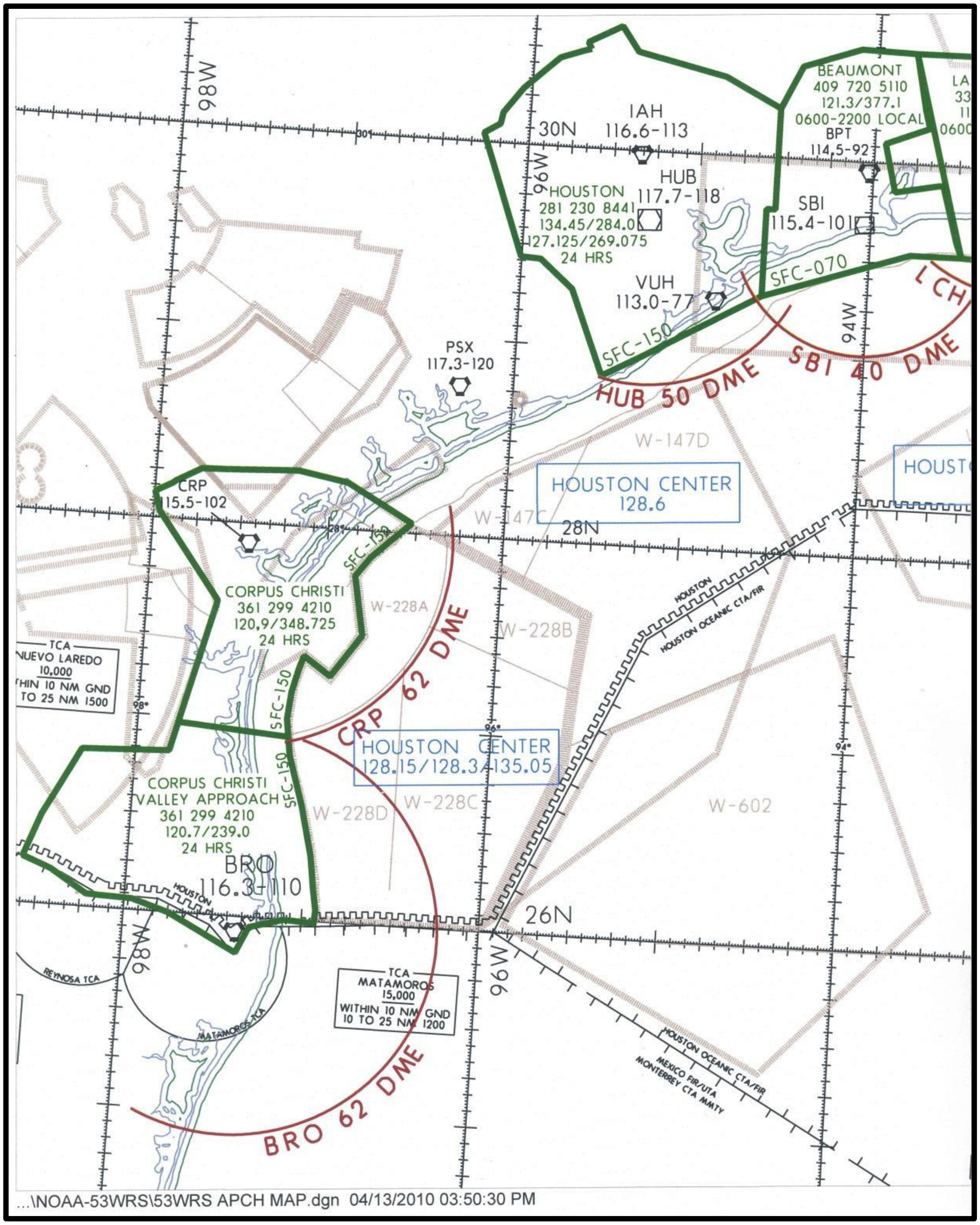

Figure K-1. Texas Coast

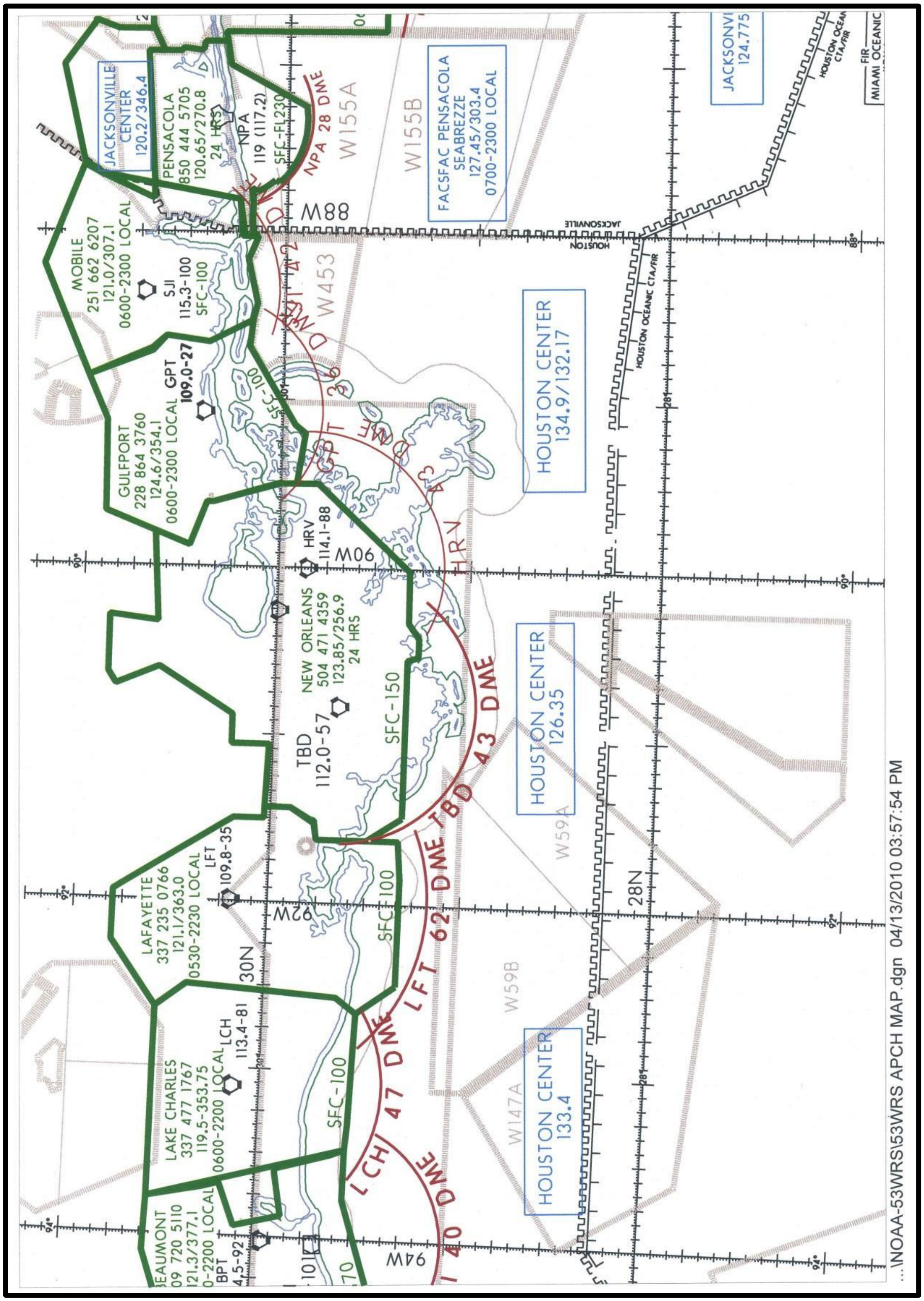

Figure K-2. Lake Charles, LA - Pensacola, FL

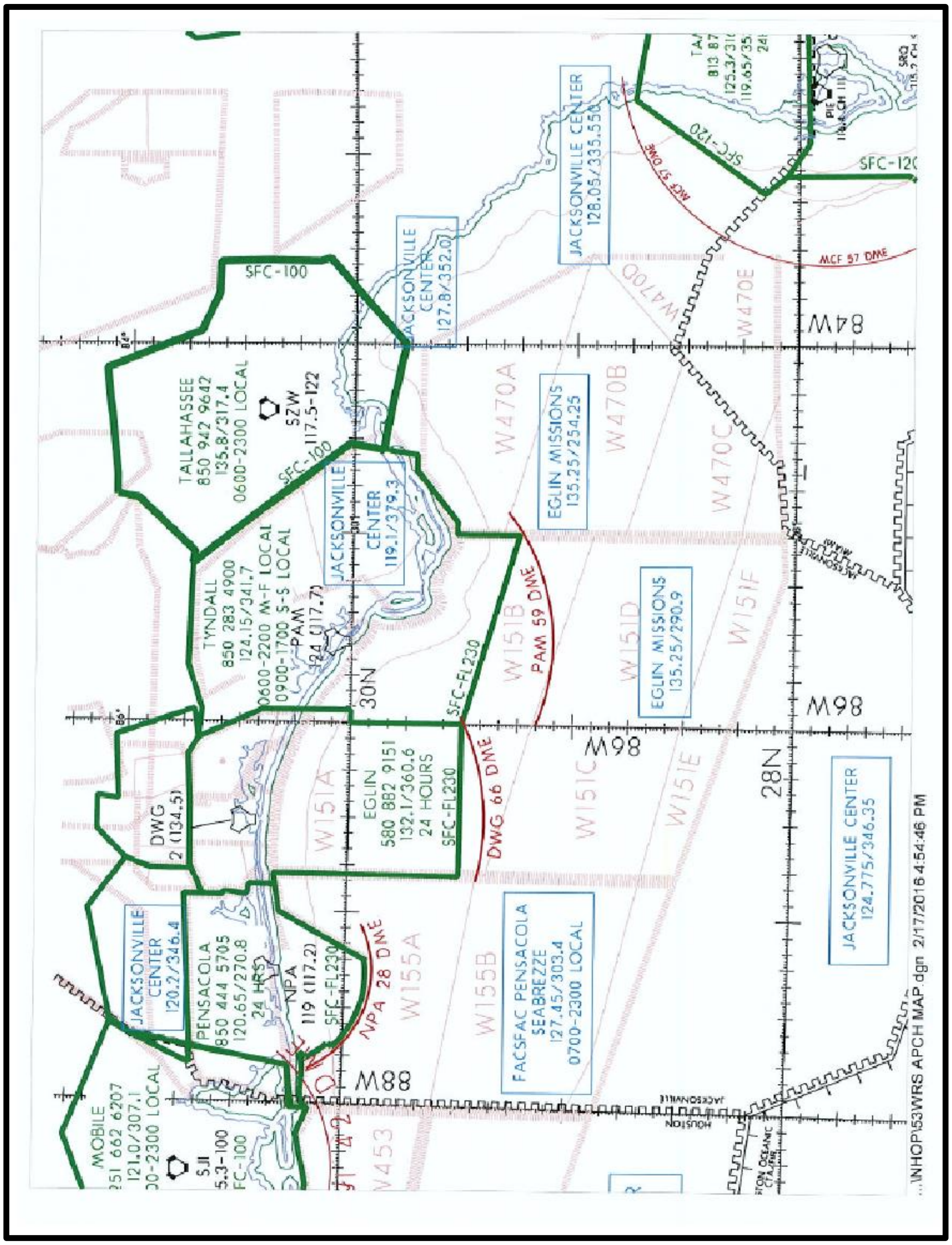

Figure K-3. Pensacola, FL – Tallahassee, FL

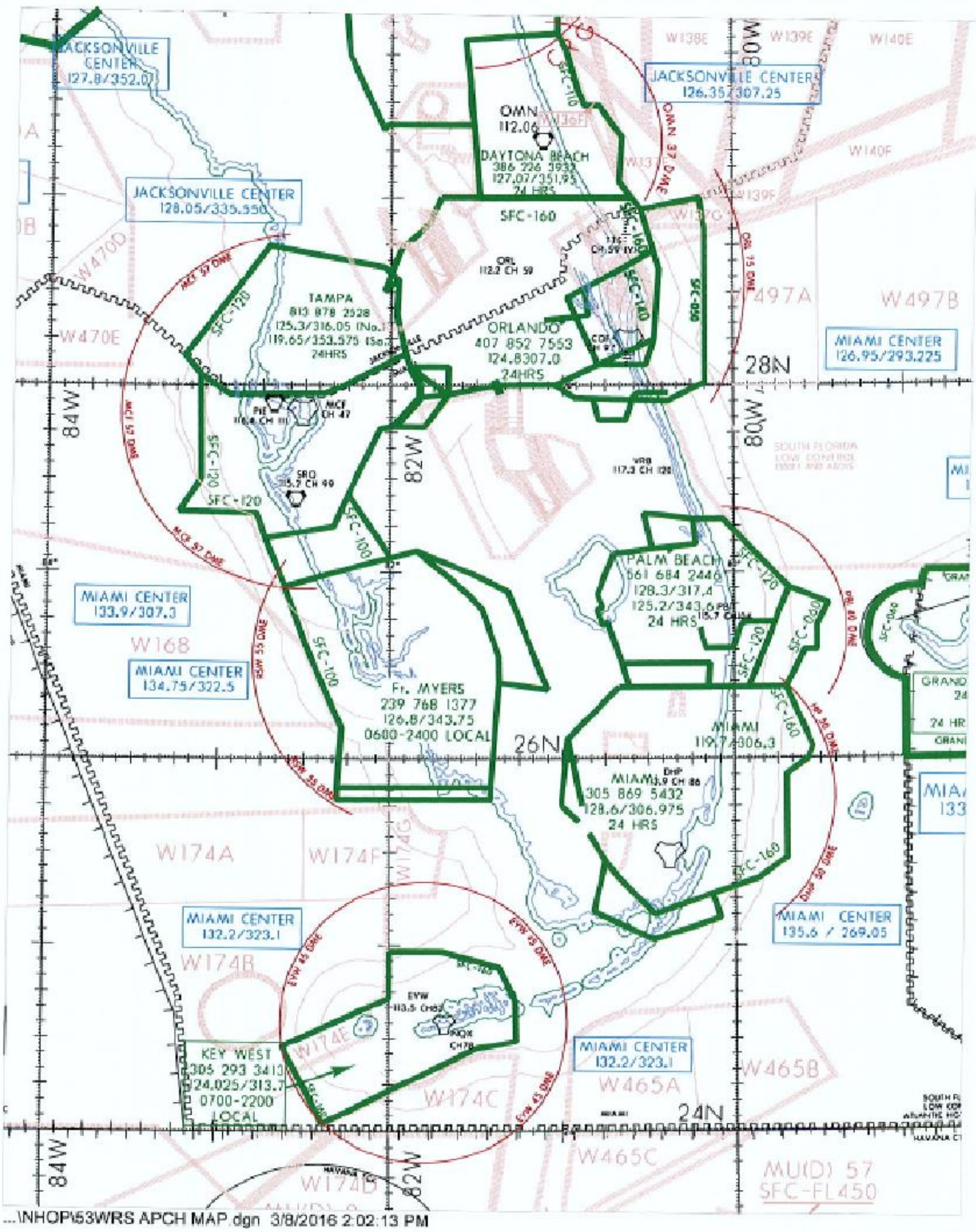

Figure K-4. Central/Southern Florida

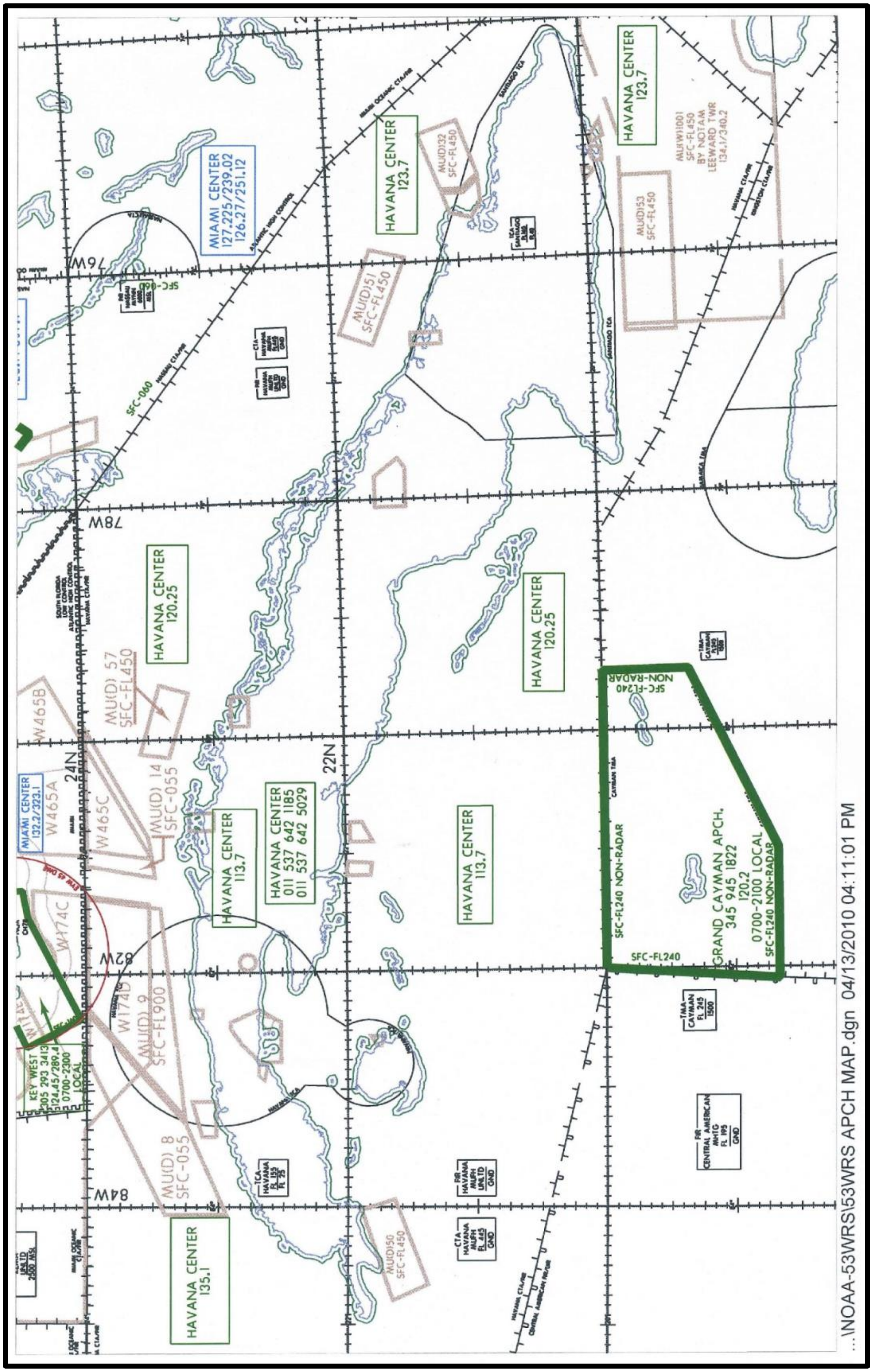

Figure K-5. Cuba – Grand Cayman

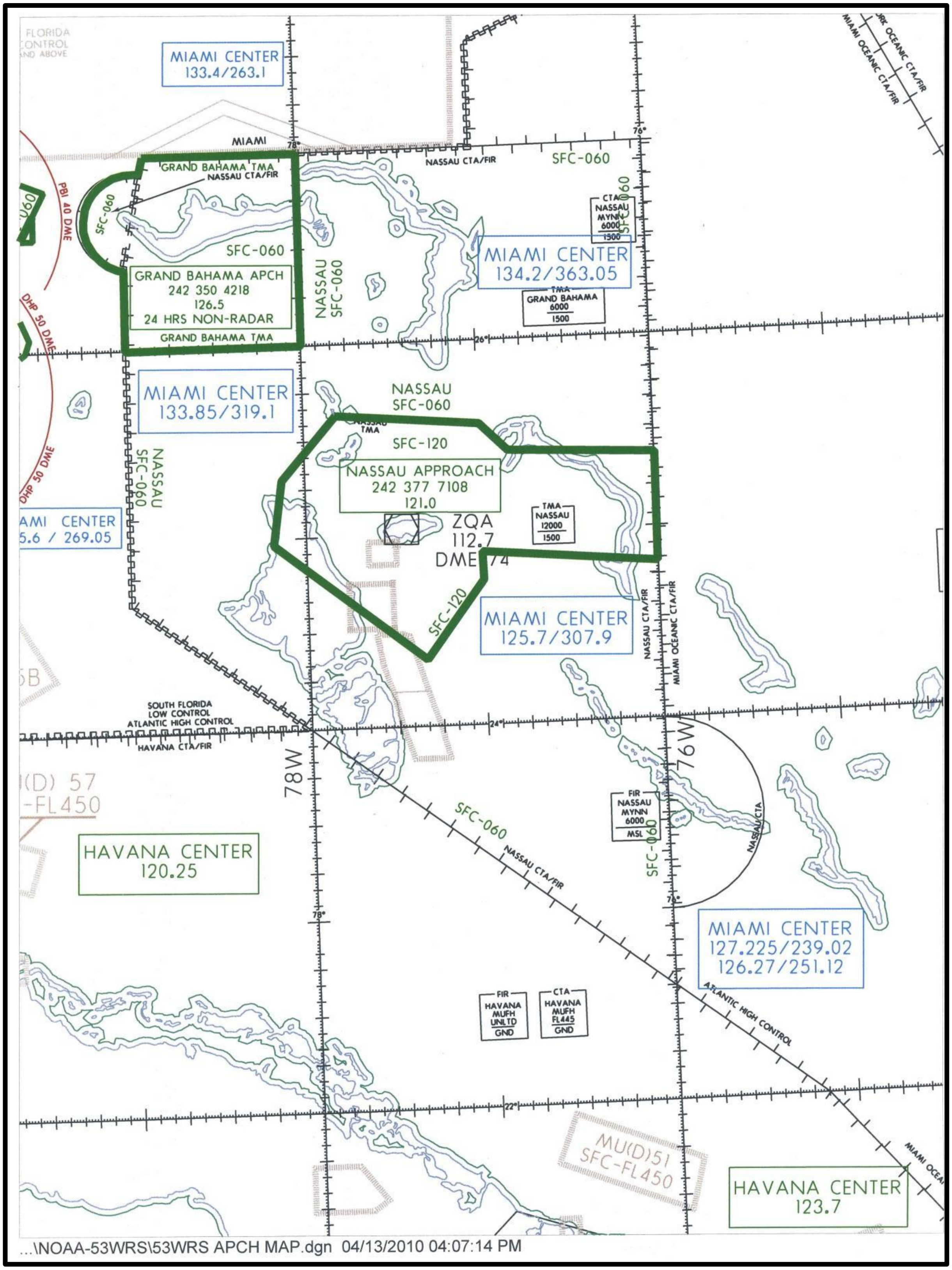

Figure K-6. The Bahamas: Nassau - Freeport

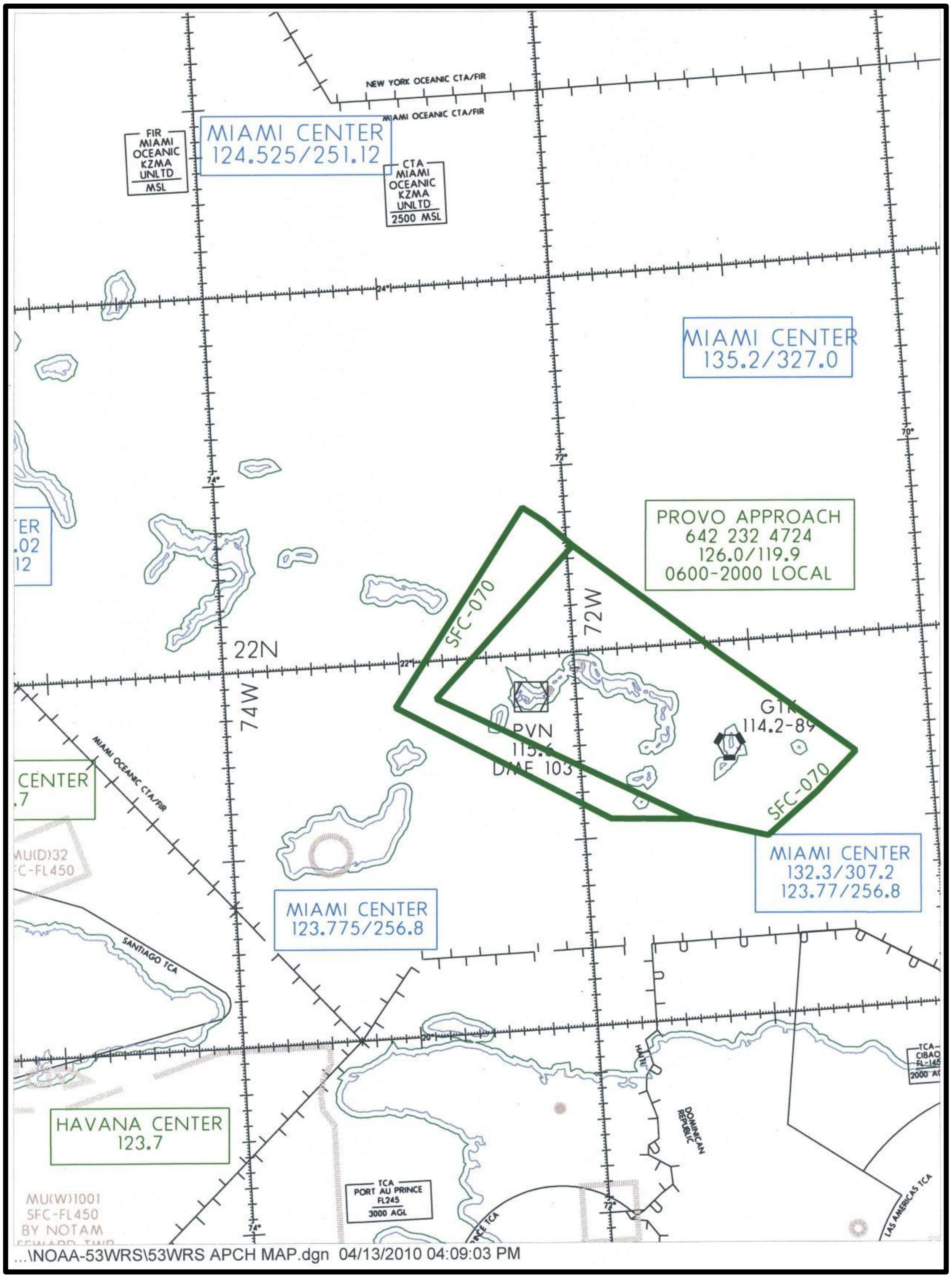

Figure K-7. Turks & Caicos Islands: Grand Turk - Providenciales

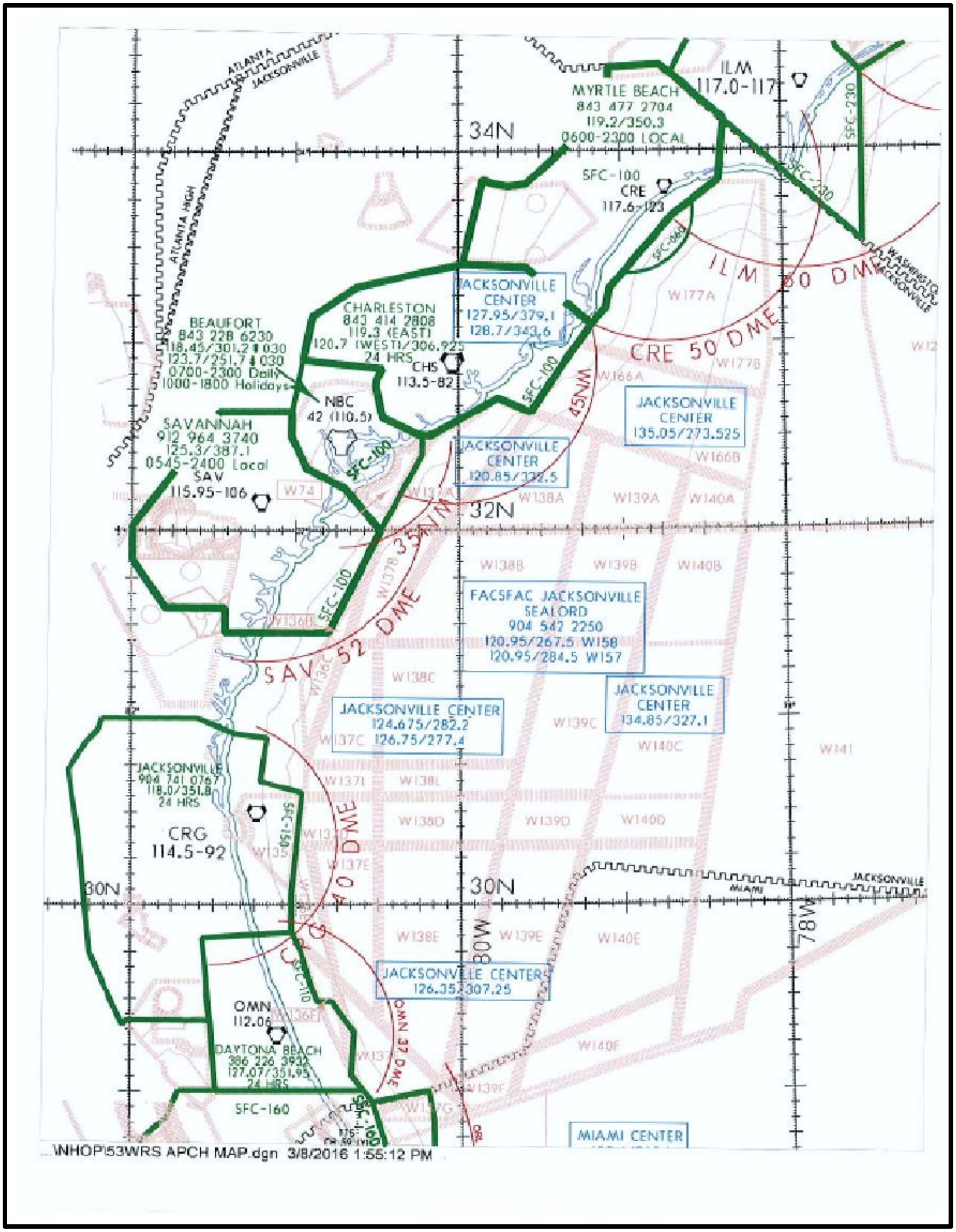

Figure K-8. Daytona Beach, FL – Myrtle Beach, SC

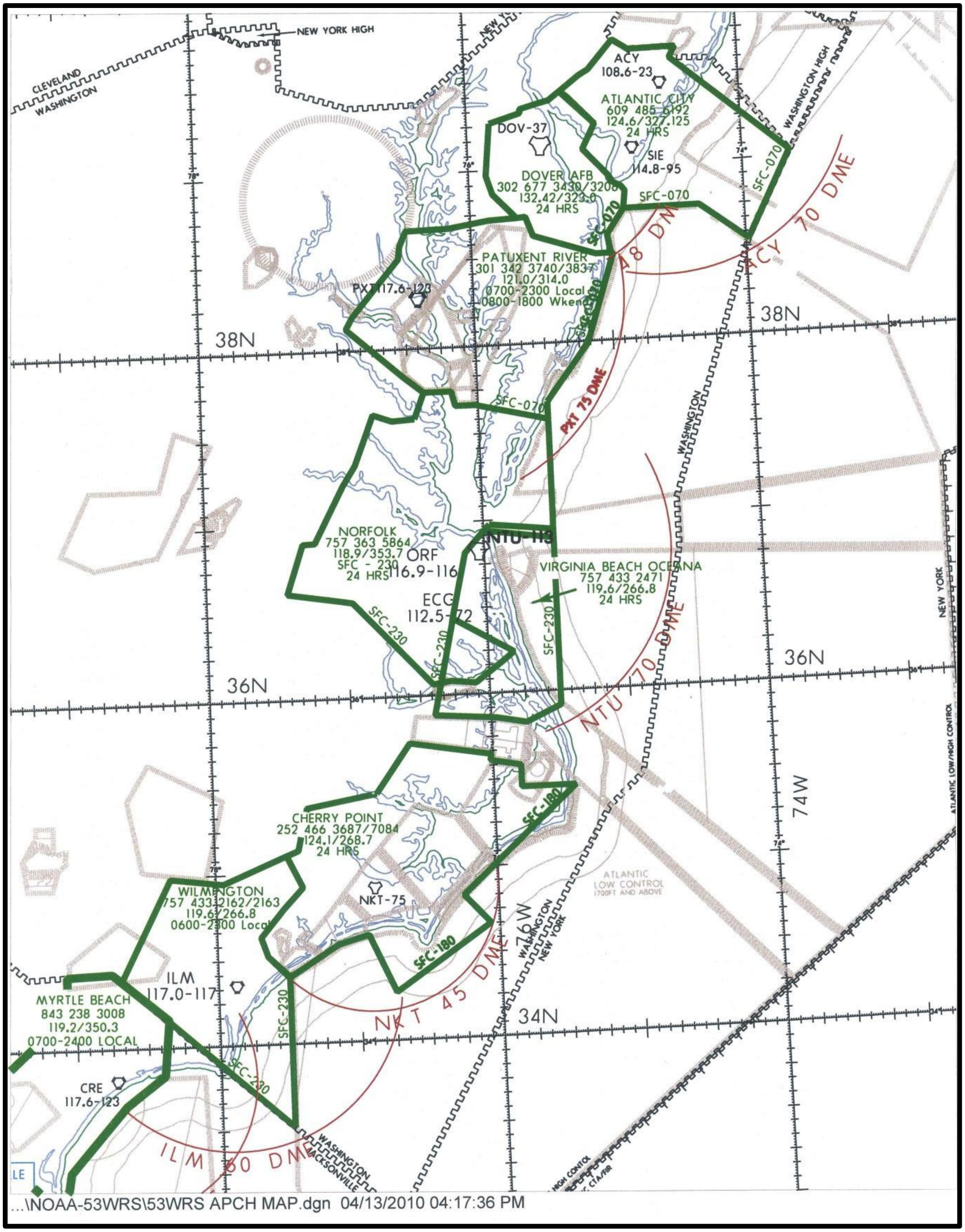

Figure K-9. Wilmington, DE – Atlantic City, NJ

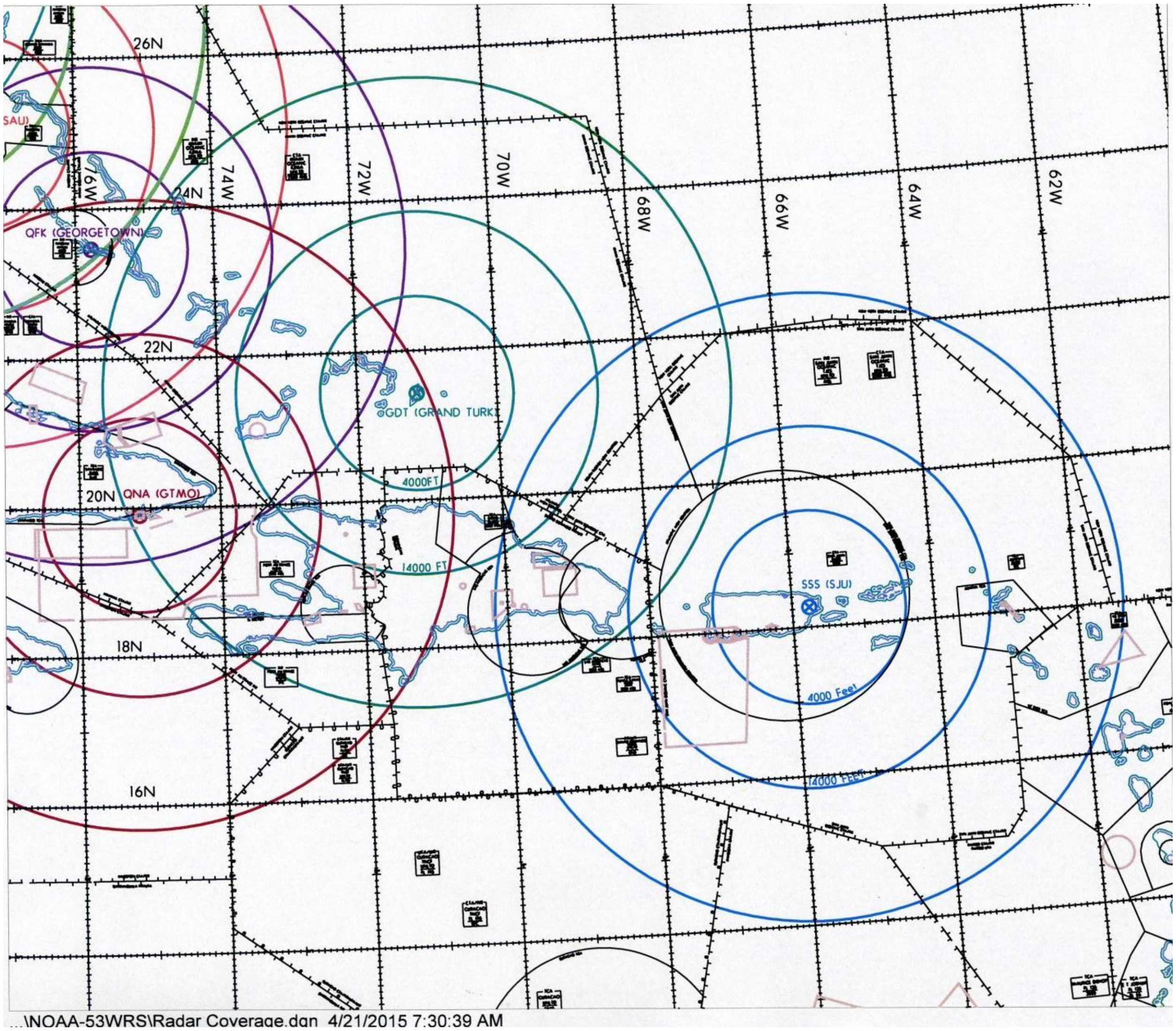

Figure K-10. Radar coverage map – San Juan, PR, Air Route Traffic Control Center. Radar range rings based on line-of-sight shown in color.

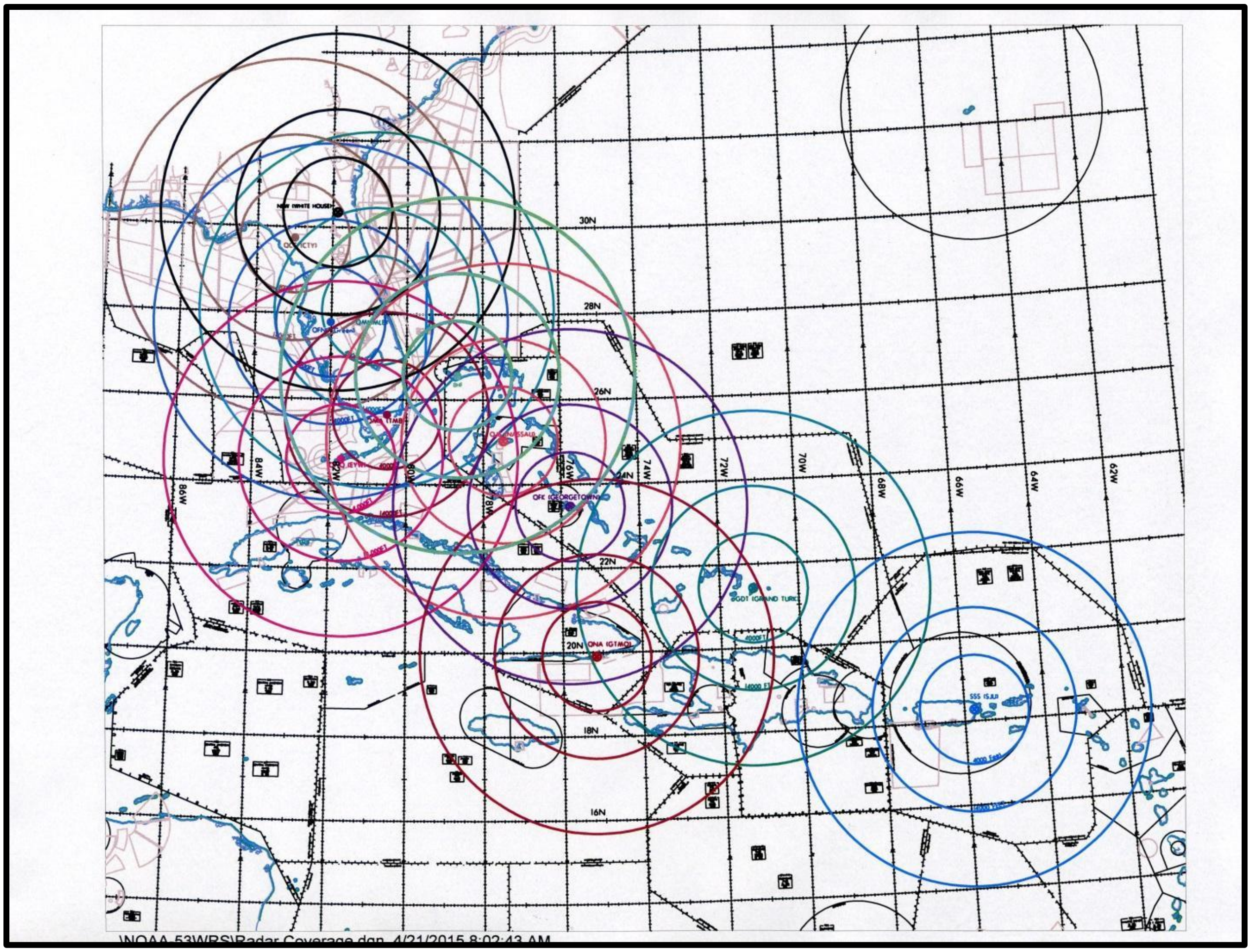

Figure K-11. Radar coverage map – Miami, FL, Air Route Traffic Control Center.

Radar range rings based on line-of-sight shown in color

APPENDIX L: 53rd WRS/NOAA MISSION COORDINATION SHEET

Aircraft Call Sign:______________ Route of Flight:_______________

TCPOD Number: ______________ Flight Number:________________

Departure Airfield:______________

PARTICIPATING AIRCRAFT REQUESTS A CARF NOTAM FOR WRA ________________

BE SET / SHIFTED WITH THE FOLLOWING INFORMATION:

Delay/WRA Center Coordinates: ____

Radius of Operation from Center Coordinates: ☐200 NM ☐150 NM ☐OTHER*______ NM (*must be > 150 NM)

Valid Time for WRA: ____

Requested Block Altitude: _____________________SFC – 15000' MSL___________

Name of Storm: ____

Aircraft Tail #: ____

SATPHONE: GROUND to AIRCRAFT: ___________________________

AIRCRAFT to AIRCRAFT: __________________________

HF Selcal (if applicable):

Requested NORAD Transponder Code: _____________________________________

Aircraft-Launched sUAS Deployments (if applicable): ____

____

AIRSPACE POCs:

_____ ATCSCC PRI OPS CONTACT (INT'L OPS) FAX: 540-422-4196 // VOICE: 540-422-4100

_____ HOUSTON (ZHU) FAX: 281-230-5561 // VOICE: 281-230-5563 // EMAIL: AJT-ZHU-STMC@FAA.GOV AND AJT-ZHU-TMC@FAA.GOV

_____ JACKSONVILLE (ZJX) FAX: 904-845-1843 // VOICE: 904-845-1542/1543/1546 // EMAIL: 7-ASO-ZJX-MOS@FAA.GOV

_____ MIAMI (ZMA) FAX: 305-716-1511/1577 // VOICE: 305-716-1588/1589 // EMAIL: 7-ASO-ZMA-MOS@FAA.GOV

_____ WASHINGTON (ZDC) FAX: 703-771-3444 // VOICE: 703-771-3470 OPT 1 // EMAIL: AEA-ZDC-530@FAA.GOV

_____ NEW YORK (ZNY) FAX: 631-468-4224 // VOICE: 631-468-1427/1080 // EMAIL: AEA-ZNY-MOS@FAA.GOV

_____ GIANT KILLER (FACSFAC Vacapes, VA) FAX: 757-433-1209 // VOICE: 757-433-1231 // SCHEDULERS: 757-433-1230 EMAIL: FFVCSKEDS@NAVY.MIL

_____ SEALORD (FACSFAC Jacksonville, FL) FAX: 904-542-2525 // VOICE: 904-542-2250 // EMAIL: FACSFAC_JAXS_SEALORD_FWS_@NAVY.MIL

_____ ATC System Command Center (NOM) EMAIL: 9-ATOR-HQ-ATCSCC-NOM@FAA.GOV

_____ FAA International Flight Operations Security (After-Hours NOTAM Assistance) VOICE: 202-320-9238 / 202- 679-4842 // EMAIL: 9-ATOR-HQ-IFOS@FAA.GOV

53RD WRS OPS: 228-377-2409 **NOAA OPS: 863-500-3979**

CARCAH OPS: 305-229-4474 / EMAIL: ncep.nhc.carcah@noaa.gov

Name / Phone Number: ____

APPENDIX M: ACRONYMS/ABBREVIATIONS

-A-

AB	Data type header for Tropical Weather Outlook
ABI	Advanced Baseline Imager
ACC	Area Control Centers (NAV Canada)
ACSPO	Advanced Clear Sky Processor for Ocean
ADCP	Acoustic Doppler Current Profiler
ADOS	Autonomous Drifting Ocean Station
ADT	Advanced Dvorak Technique
AFB	Air Force Base
AFRC	Air Force Reserve Command
AFSATCOM	Air Force Satellite Communications System
AFW-VPC	Air Force Weather Virtual Private Cloud
AGL	Above Ground Level
AHI	Advanced Himawari Imager
AI	Artificial Intelligence
AiDT	AI-enhanced Dvorak Technique
AIM	Airman's Information Manual
AMSR2	Advanced Microwave Scanning Radiometer 2
AMSU	Advanced Microwave Sounding Unit
AMXS	Aircraft Maintenance Squadron (USAF)
AOC	Aircraft Operations Center (NOAA)
AOML	Atlantic Oceanographic Meteorological Laboratory (NOAA)
AOR	Area of Responsibility
APT	Automatic Picture Transmission
ARINC	Aeronautical Radio, Incorporated
ARSA	Airport Radar Service Area
ARTCC	Air Route Traffic Control Center
ARU	Altitude Reservation Unit (NAV Canada)
ARWO	Aerial Reconnaissance Weather Officer
ASCAT	Advanced Scatterometer
ATC	Air Traffic Control
ATCF	Automated Tropical Cyclone Forecasting System
ATCSCC	Air Traffic Control System Command Center
ATMS	Advanced Technology Microwave Sounder
ATO	Air Traffic Organization (FAA)
ATSC	Air Traffic Services Cell (DOW; Hq USAF/A3OP)
AVAPS	Advanced Vertical Atmospheric Profiling System
AVHRR	Advanced Very High Resolution Radiometer
AWIPS	Advanced Weather Interactive Processing System
AWS	Amazon Web Services

-B-

bTPW	Blended Total Precipitable Water

BTR	Buoy Tasking Request
BUFR	Binary Universal Format

-C-

CACO	Civil Aviation Contingency Operations (Transport Canada)
CARCAH	Chief, Aerial Reconnaissance Coordination, All Hurricanes
CARF	Central Altitude Reservation Function
CCF	Combined Control Facilities (FAA)
CDA	Command and Data Acquisition
CERAP	Combined Center RAPCON (FAA)
CERES	Clouds and Earth's Radiant Energy Sensor
CFR	Code of Federal Regulations
CHAT	Caribbean Hurricane Awareness Tour
C.I.	Current Intensity
C-MAN	Coastal-Marine Automated Network
CNES	Centre National d'Etudes Spatiales (France)
CNMOC	U.S. Navy Commander, Naval Meteorology and Oceanography Command
CNS	communication, navigation and surveillance
COA	Certificate of Waiver or Authorization (FAA)
COCOM	Combatant Command
COM	Commercial (telephone)
COMS	Communication, Ocean and Meteorology Satellite
CONUS	Continental United States
COOP	Continuity of Operations
COWVR	Compact Ocean Wind Vector Radiometer
CPHC	Central Pacific Hurricane Center
CrIS	Cross-track Infrared Sounder
CTD	conductivity, temperature, and depth

-D-

DA	Daylight Ascending
DAC	Drifter Data Assembly Center
dbar	
deg	degree (latitude or longitude)
DHS	Department of Homeland Security
DLM WND	deep layer mean wind
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DOW	Department of War
DOS	Department of State
DOT	Department of Transportation
DROP	dropsonde/dropwindsonde
DSCA	Defense Support of Civil Authorities
DSN	Defense Switched Network (formerly AUTOVON)
DWSB	Directional Wave Spectrum Drifters

-E-

ECMWF	European Centre for Medium-Range Weather Forecasts
EDIS	NWS Email Data Input System
EDR	Environmental Data Record
EMC	Environmental Modeling Center (NCEP)
ERDDAP	Environmental Research Division Data Access Program (NOAA/NMFS)
ESA	European Space Agency
eTRaP	Ensemble Tropical Rainfall Potential
EUMETCast	EUMETSAT dissemination system
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EWW	Extreme Wind Warning

-F-

FAA	Federal Aviation Administration
FACSFAC	Fleet Aerial Control and Surveillance Facility
FAD	Force Activity Designator
FCST	forecast
FD	Flight Director
FEA	Flow Evaluation Area (FAA)
FEMA	Federal Emergency Management Agency
FES	Full Earth Scan
FIR	Flight Information Region
FL	flight level
FLEWEACEN	Fleet Weather Center (USN)
FWC-N	Fleet Weather Center, Norfolk (USN)
FNMOC	Fleet Numerical Meteorology and Oceanography Center (USN)
FSR	Full Spectral Resolution
ft	foot/feet

-G-

GAASP	GCOM-W1 AMSR2 Algorithm Software Package
GAC	Global Area Coverage
GCOM	Global Change Observation Mission
GDAC	Glider Data Assembly Center
GDP	NOAA-supported Global Drifter Program
GDSS	Global Decision Support System
GERB	Geostationary Earth Radiation Budget
GFS	Global Forecast System
GHE	Global Hydro-Estimator
GHz	gigahertz
GK2A	GEO-KOMPSAT-2A Satellite
GLM	Geostationary Lightning Mapper
GMGSI	Global Mosaic of Geostationary Satellite Imagery

GMI	GPM microwave imager
GMDSS	Global Maritime Distress and Safety System
GOES	Geostationary Operational Environmental Satellite
GPM	Global Precipitation Measurement
GTS	Global Telecommunication System

-H-

h	hour/hours
HA	High Accuracy
HAFS	Hurricane Analysis and Forecast System
HAT	Hurricane Awareness Tour
HCF	Honolulu Control Facility (FAA)
HCI	Human Computer Interface
HD	High Density
HDOB	High Density Observation
HF	High Frequency
HIRS	High-Resolution Infrared Radiation Sounder
HLS	Hurricane Local Statement
HLT	Hurricane Liaison Team (FEMA)
hPa	hectopascals
HRD	Hurricane Research Division (NOAA/OAR/AOML)
HRIT	High Rate Information Transmission
HRPT	High Resolution Picture Transmission
HRV	high resolution visible
Hz	hertz

-I-

IAW	in accordance with
ICAMS	Interagency Council for Advancing Meteorological Services
ICAO	International Civil Aviation Organization
ID	identification
IHC	Interdepartmental Hurricane Conference
IFR	Instrument Flight Rules
IJPS	Initial Joint Polar System
IMO	International Maritime Organization
INVEST	investigative
IODC	Indian Ocean Data Coverage
IOOS	NOAA/NOS Integrated Ocean Observing System
IR	Infrared
ISS	International Space Station
ITCZ	Intertropical Convergence Zone

-J-

JPSS	Joint Polar Satellite System
JSC	Joint Chiefs of Staff

JTWC	Joint Typhoon Warning Center
JAXA	Japan Aerospace Exploration Agency
JMA	Japan Meteorological Agency

-K-

KARI	Korean Astronomical Research Institute
KHz	kilohertz
km	kilometer/kilometers
KBIX	ICAO identifier for Keesler AFB, MS
KMA	Korean Meteorological Administration
KNHC	ICAO identifier for the National Hurricane Center, Miami, FL
kt	knot/knots
KWBC	ICAO identifier for National Weather Service HQ

-L-

L2	Level 2 Sea Surface Temperature data
L3	Level 3 Sea Surface Temperature data
LAC	Local Area Coverage
LBS-G	Navy Littoral Battlespace Sensing gliders
LEO	Low Earth Orbiting Satellite
LOA	Letter of Agreement
LHP	Loop Heat Pipe
LP	Limb Profiler
LST WND	elevation of last wind reported from a dropsonde
LTAN	Local Time Ascending Node
LWIR	long-wave IR

-M-

m	meter/meters
m/s	meters per second
MARSA	Military Assumes Responsibility for Separation of Aircraft
MAX	maximum
mb	millibar/millibars
MBL	mean boundary layer wind of a dropsonde
MET	meteorological
METAREA	GMDSS geographic sea region (WMO)
METEOSAT	European Space Agency (ESA) geostationary meteorological satellite
MHz	megahertz
MI	Microwave Imager
MIA	Minimum IFR Altitude
min/MIN	minute
MiRS	Microwave Integrated Retrieval System
MHS	Microwave Humidity Sounder
MOA	Memorandum of Agreement

MOA	Military Operations Area
mph	mile/miles per hour
MSCF	Master System Control Function
MSG	Meteosat Second Generation
MSI	maritime safety information
MSL	Mean Sea Level
MTG	Meteosat Third Generation
MTSAT-1R	Japanese Geostationary Satellite
MTCSWA	Multiplatform Tropical Cyclone Surface Winds Analysis
MVMT	movement
MWIR	mid-wave IR
MXWNDBND	maximum wind band (dropsonde)
MXS	Maintenance Squadron (USAF)

-N-

NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAVOCEANO	Naval Oceanographic Office
NAVTEX	Navigational Telex
NCAR	National Center for Atmospheric Research
NCEI	National Centers for Environmental Information (NOAA)
NCEP	National Centers for Environmental Prediction (NOAA/NWS)
NCO	NCEP Central Operations
NDBC	National Data Buoy Center
NESDIS	National Environmental Satellite, Data, and Information Service
NGA	National Geospatial-Intelligence Agency
NH	Northern Hemisphere
NHC	National Hurricane Center
NHOP	National Hurricane Operations Plan
NIST	National Institutes of Science and Technology
NM	nautical miles
NOAA	National Oceanic and Atmospheric Administration
NOC	National Operations Centre (NAV Canada)
NODD	NOAA Open Data Dissemination
NOM	National Operations Manager (FAA)
NORAD	North American Aerospace Defense Command
NORTHCOM	United States Northern Command
NOS	National Ocean Service
NOTAM	Notice to Airmen
NRL	Naval Research Laboratory
NSF	National Science Foundation
NWP	Numerical Weather Prediction
NWS	National Weather Service
NWSOP	National Winter Storms Operations Plan

NWSTG	National Weather Service Telecommunications Gateway

-O-

OAC	Oceanic Aircraft Coordinator (USN)
OB	observation
OLS	Operational Linescan System
OM	Operations Manager (FAA)
OMAO	Office of Marine and Aviation Operations (NOAA)
OMIC	Operations Manager In Charge (FAA)
OMPS	Ozone Mapping and Profiler Suite
OP	Oceanographic Profiler
OPC	Ocean Prediction Center (NCEP)
OPS	operations
OSG	Ocean Sensing Group
OWS	Operational Weather Squadron

-P-

PA	Public Affairs
PACUS	Pacific United States
PHAT	Pacific Hurricane Awareness Tour
PIC	Pilot in Command
PIRATA	Prediction and Research Moored Array in the Atlantic
PHFO	ICAO identifier for Honolulu, HI
PMEL	Pacific Marine Environmental Laboratory (NOAA)
POD	Plan of the Day
PSBL	possible
PSH	Post-Tropical Cyclone Reports
PWS	Tropical Cyclone Surface Wind Speed Probabilities

-R-

RAPCON	Radar Approach Control
RECCO	Reconnaissance Code
RECON	reconnaissance
REL	release location and time of a dropsonde
RFA	Request for Assistance
RMS	Root Mean Square
RMW	Radius of Maximum Winds
ROC	Radar Operations Center
RPG	Radar Product Generator
RPIC	Remote Pilot in Command
RSMC	Regional/Specialized Meteorological Center (WMO)
RSS	Rapid Scanning Service
RTOFS	Real Time Ocean Forecast System

-S-

S-NPP	Suomi National Polar-Orbiting Partnership Satellite

SAB	Satellite Analysis Branch
SATCOM	Satellite Communications
SATOPS	17th OWS Meteorological Satellite Operations
SCAT	Scatterometer
SCOOP	Self-Contained Ocean Observing Payload
SEVIRI	Spinning Enhanced Visible and InfraRed Imager
SFC	surface
SLP	Sea Level Pressure
SOLAS	International Convention for the Safety of Life at Sea
SOUTHCOM	United States Southern Command
SPG	splash location and time of a dropsonde
SSB	scheduled HF single sideband
SSM/I	Special Sensor Microwave Imager (DMSP)
SSM/IS	Special Sensor Microwave Imager Sounder
SST	sea surface temperature
STMC	Supervisory Traffic Management Coordinator (FAA)
STP	Space Test Program (DOW)
SUA	Special Use Airspace
sUAS	Small Uncrewed Aircraft System
SVP	Surface Velocity Program
SVPB	Surface Velocity Program with barometers
SWIR	short-wave IR

-T-

T-	Dvorak number Tropical classification number
TACAN	Tactical Air Navigation System
TAFB	Tropical Analysis Forecast Branch (NHC)
TADO	Tanker and Airlift Duty Officer (USAF)
TCA	Aviation Tropical Cyclone Advisory
TCAS	Traffic Alert and Collision Avoidance System
TCD	Tropical Cyclone Discussion
TCFP	Tropical Cyclone Formation Probability Guidance Product
TCM	Tropical Cyclone Forecast/Advisories
TCORF	Tropical Cyclone Operations and Research Forum
TCP	Tropical Cyclone Public Advisory
TCPOD	Tropical Cyclone Plan of the Day
TCR	Tropical Cyclone Reports
TCS	Tropical Cyclone Summary
TCU	Tropical Cyclone Update
TCV	Tropical Cyclone Watch Warning Product
TCWC	Tropical Cyclone Warning Centre (Australia)
TD	Tropical Depression
TDR	Tail Doppler Radar
TEMP	temperature
TEMP	temporary
TEMP DROP	Dropwindsonde Code

TEMPEST	Temporal Experiment for Storms and Tropical Systems
TKO	takeoff
TMC	Traffic Management Coordinator (FAA)
TRACON	Terminal Radar Approach Control (FAA)l
TRMM	Tropical Rainfall Measurement Mission
TWD	Tropical Weather Discussion
TWO	Tropical Weather Outlook

-U-

UAS	Uncrewed Aircraft System
UHF	Ultra High Frequency
UHMC	UAS Hurricane Mission Commander
UND	Urgency of Need Designator
US/U.S.	United States
USAF	United States Air Force
USAFNORTH	United States Air Forces Northern Command
USAFR	United States Air Force Reserve
USC	United States Code
USCG	United States Coast Guard
USG	United States Federal Government
USFFC	United States Fleet Forces Command
USGODAE	United State Global Ocean Data Assimilation Experiment (USN)
USINDOPACOM	United States Air Forces Indo-Pacific Command
USN	United States Navy
USV	Uncrewed Surface Vehicle
UTC	Universal Coordinated Time

-V-

VCP	Volume Coverage Pattern (WSR-88D)
VDM	Vortex Data Message
VFR	Visual Flight Rules
VHF	Very High Frequency
VIS	Visible
VIIRS	Visible Infrared Imaging Radiometer
VOS	Volunteer Observing Ship
VTEC	Valid Time Event Code

-W-

WFO	Weather Forecast Office
WL150	average wind over the lowest available 150 m of dropsonde sounding
WMO	World Meteorological Organization
WND	wind
WPAC	Western Pacific
WPC	Weather Prediction Center (NCEP)

WRA	Weather Reconnaissance Area
WRS	Weather Reconnaissance Squadron
WRSK	War Readiness Spares Kit (USAF)
WSF	Weather System Follow-on (DOW)
WSO	Weather Service Office
WSPOD	Winter Season Plan of the Day
WSR-88D	Weather Surveillance Radar-1988 Doppler
WT	Data type header for hurricane bulletins
WW	Weather Wing
WX	Weather

-Z-

Z	Zulu (UTC)

-NUMERIC-

17 OWS/WXJ	JTWC Satellite Operations
53 WRS	53rd Weather Reconnaissance Squadron (AFRC)
403 WG	403rd Wing

APPENDIX N: GLOSSARY

-A-

Agency. Any Federal agency or organization participating in the tropical cyclone forecasting and warning service.

Airport Radar Service Area (ARSA). Regulatory airspace surrounding designated airports wherein ATC provides radar vectoring and sequencing on a full-time basis for all IFR and VFR aircraft. The service provided in an ARSA is called ARSA Service which includes: IFR/IFR-standard IFR separation; IFR/VFR-traffic advisories and conflict resolution; and VFR/VFR-traffic advisories and, as appropriate, safety alert. The Airman's Information Manual (AIM) contains an explanation of ARSA. The ARSA's are depicted on VFR aeronautical charts.

Air Traffic Control System Command Center (ATCSCC). The FAA facility that monitors and manages the flow of air traffic throughout the National Airspace System (NAS), producing a safe, orderly, and expeditious flow of traffic while minimizing delays. The ATCSCC is a 24 hour a day, 7 day a week operation.

Air Traffic Services Cell (ATSC). The Air Traffic Services Cell (DOW ATSC/ HAF/A3OP) is a Joint Military and Civil organization which provides liaison, facilitation, and coordination between emergency preparedness and operations organizations as the DOW representative. Additionally the ATSC ensures efficient flow of DOW aircraft in response to wartime mobilization, contingencies, and natural disasters throughout the National Airspace System (NAS). The ATSC is physically located at the FAA ATC Systems Command Center, Warrenton, VA.

-C-

Center Fix. The location of the center of a tropical or subtropical cyclone obtained by means other than reconnaissance aircraft penetration. See also Vortex Fix.

Controlled Airspace. An airspace of defined dimensions within which air traffic control service is provided to IFR flights and to VFR flights in accordance with the airspace classification.

Controlled airspace is a generic term that covers Class A, Class B, Class C, Class D, and Class E airspace.

Controlled airspace is also that airspace within which all aircraft operators are subject to certain pilot qualifications, operating rules, and equipment requirements in 14 CFR Part 91 (for specific operating requirements, please refer to 14 CFR Part 91). For IFR operations in any class of controlled airspace, a pilot must file an IFR flight plan and receive an appropriate ATC clearance. Each Class B, Class C, and Class D airspace area designated for an airport contains at least one primary airport around which the airspace is designated (for specific designations and descriptions of the airspace classes, please refer to 14 CFR Part 71).

Controlled airspace in the United States is designated as follows:

CLASS A: Generally, that airspace from 18,000 feet MSL up to and including FL 600, including the airspace overlying the waters within 12 nautical miles (NM) of the coast of the 48 contiguous States and Alaska. Unless otherwise authorized, all persons must operate their aircraft under IFR.

CLASS B: Generally, that airspace from the surface to 10,000 feet MSL surrounding the Nations's busiest airports in terms of airport operations or passenger enplanements. The configuration of each Class B airspace area is individually tailored and consists of a surface area and two or more layers (some Class B airspaces areas resemble upside-down wedding cakes), and is designed to contain all published instrument procedures once an aircraft enters the airspace. An ATC clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation services within the airspace. The cloud clearance requirement for VFR operations is "clear of clouds."

CLASS C: Generally, that airspace from the surface to 4,000 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower, are serviced by a radar approach control, and that have a certain number of IFR operations or passenger enplanements. Although the configuration of each Class C area is individually tailored, the airspace usually consists of a surface area with a 5 NM radius, a circle with a 10 NM radius that extends no lower than 1,200 feet up to 4,000 feet above the airport elevation and an outer area. Each person must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while within the airspace. VFR aircraft are only separated from IFR aircraft within the airspace.

CLASS D: Generally, that airspace from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower. The configuration of each Class D airspace area is individually tailored and when instrument procedures are published, the airspace will normally be designed to contain the procedures. Arrival extensions for instrument approach procedures may be Class D or Class E airspace. Unless otherwise authorized, each person must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while in the airspace. No separation services are provided to VFR aircraft.

CLASS E: Generally, if the airspace is not Class A, Class B, Class C, or Class D, and it is controlled airspace, it is Class E airspace. Class E airspace extends upward from either the surface or a designated altitude to the overlying or adjacent controlled airspace. When designated as a surface area, the airspace will be configured to contain all instrument procedures. Also in this class are Federal airways, airspace beginning at either 700 or 1,200 AGL used to transition to/from the terminal or en route environment, en route domestic, and offshore airspace areas designated below 18,000 feet MSL. Unless designated at a lower altitude, Class E airspace begins at 14,500 MSL over the United States, including that airspace overlying the waters within 12 NM of the 48 contiguous States and Alaska, up to, but not including 18,000 MSL, and the airspace above FL 600.

Cyclone. An atmospheric closed circulation rotating counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

-E-

Extratropical cyclone. A cyclone (of any intensity) for which the primary energy source is baroclinic (i.e., results from the temperature contrast between warm and cold air masses).

Eye. The relatively calm center of the tropical cyclone that is more than one half surrounded by wall cloud.

Eye Wall. An organized band of cumuliform clouds immediately surrounding the center of a tropical cyclone. Eye wall and wall cloud are used synonymously.

-H-

High-Density/High-Accuracy (HD/HA) Data. Those data provided by automated airborne systems--WP-3s or WC-130s equipped with the Improved Weather Reconnaissance System.

Hurricane/Typhoon. A warm-core tropical cyclone in which the maximum sustained surface wind speed (l-min mean) is 64 kt (74 mph) or more.

Hurricane/Typhoon/Tropical Cyclone Season. The portion of the year having a relatively high incidence of hurricanes/typhoons/tropical cyclones. The seasons for the specific areas are as follows (Note: tropical cyclones can occur during any month of the year in the Western Pacific.):

Atlantic, Caribbean, and the Gulf of America	June 1 to November 30
Eastern Pacific	May 15 to November 30
Central Pacific	June 1 to November 30
Western Pacific	July 1 to December 31

Hurricane Warning Offices. The designated hurricane warning offices follow:

National Hurricane Center, Miami, Florida
Central Pacific Hurricane Center, Honolulu, Hawaii

Hurricane / Typhoon Warning for the Atlantic, Eastern Pacific, Central Pacific, and western North Pacific basins. Sustained winds of 64 knots (74 mph or 119 kilometers / hour) or higher are expected somewhere within the specified area in association with a potential or ongoing tropical cyclone, a subtropical cyclone, or a post-tropical cyclone. Because hurricane and typhoon preparedness activities become difficult once winds reach tropical storm force, the hurricane / typhoon warning is issued 36 hours in advance of the anticipated onset of tropical storm force winds (24 hours for the western North Pacific).

Hurricane / Typhoon Watch for the Atlantic, Eastern Pacific, Central Pacific, and western North Pacific basins. Sustained winds of 64 knots (74 mph or 119 kilometers / hour) or higher are possible within the specified area in association with a potential or ongoing tropical cyclone, a subtropical cyclone, or a post-tropical cyclone. Because hurricane and typhoon preparedness activities become difficult once winds reach tropical storm force, the hurricane / typhoon watch is issued 48 hours in advance of the anticipated onset of tropical storm force winds.

-I-

ICAO-Controlled Airspace. An airspace of defined dimensions within which air traffic control service is provided to IFR flights and to VFR flights in accordance with the airspace classification. (Note: Controlled airspace is a generic term which covers Air Traffic Service airspace Classes A, B, C, D, and E).

-L-

Light and Variable Winds. Winds with sustained speeds of 6 kt or less and frequent azimuthal fluctuations.

-M-

Major Hurricane. A "major" hurricane is one that is classified as a Category 3 or higher.

Maximum 1-Min Sustained Surface Wind. When applied to a particular weather system, refers to the highest 1-minute average wind (at an elevation on 10 meters with an unobstructed exposure) associated with that weather system at a particular point in time.

Micronesia. An area defined by the Commonwealth of the Northern Marianas Islands, the Republic of Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands.

Miles. The term "miles" used in this plan refers to nautical miles (NM) unless otherwise indicated.

Mission Identifier. The nomenclature assigned to tropical and subtropical cyclone aircraft reconnaissance missions for weather data identification. It's an agency-aircraft indicator followed by a Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH) assigned mission-system indicator.

-N-

National Operations Manager. Supervisor in charge of operations of the Air Traffic Control System Command Center.

National Traffic Management Specialist. ATCSCC personnel responsible for the active management of traffic throughout the NAS.

-O-

Operations Manager. Supervisor in charge of operations of an FAA Terminal Radar Approach Control (TRACON).

Operations Manager in Charge. Supervisor in charge of operations of an FAA Air Route Traffic Control Center (ARTCC).

-P-

Post-Tropical Cyclone. A former tropical cyclone. This generic term describes a cyclone that no longer possesses sufficient tropical characteristics to be considered a tropical cyclone. Post-tropical cyclones can continue carrying heavy rains and high winds. Note that former tropical cyclones that have become fully extratropical, as well as remnant lows, are two specific classes of post-tropical cyclones.

Present Movement. The best estimate of the movement of the center of a tropical cyclone at a given time and at a given position. This estimate does not reflect the short-period, small-scale oscillations of the cyclone center.

-R-

Reconnaissance Aircraft Sortie. A flight that meets the requirements of the tropical cyclone plan of the day.

Relocated. A term used in an advisory to indicate that a vector drawn from the preceding advisory position to the latest known position is not necessarily a reasonable representation of the cyclone's movement.

Remnant Low. A post-tropical cyclone that no longer possesses the convective organization required of a tropical cyclone and has maximum sustained winds of less than 34 kt. The term is most commonly applied to the nearly deep-convection-free swirls of stratocumulus in the eastern North Pacific.

Remote Pilot in Command (RPIC). Official directly responsible for and is the final authority for UAS operation and safety during flight.

Resources Permitting. An aerial reconnaissance requirement which either does not meet coordination timing requirements or occurs outside the standard season as defined in the applicable operations plan. These missions are conducted only if dedicated aircraft, crew, support and maintenance assets are available.

-S-

Small Uncrewed Aircraft System (sUAS). A remotely-piloted uncrewed aircraft weighing less than 55 pounds upon takeoff (including payload) and its associated elements (including communication links and the components that control the small uncrewed aircraft) required for safe and efficient operation in the national airspace system, as defined in 14 CFR Part 1.

Special Activity Airspace. Any airspace with defined dimensions within the National Airspace System wherein limitations may be imposed upon aircraft operations. This airspace may be restricted areas, prohibited areas, military operations areas, air ATC assigned airspace, and any other designated airspace areas. The dimensions of this airspace are programmed into URET and can be designated as either active or inactive by screen entry. Aircraft trajectories are constantly tested against the applicable sectors when violations are predicted.

Special Use Airspace. Airspace of defined dimensions identified by an area on the surface of the earth wherein activities must be confined because of their nature and/or wherein limitations may be imposed upon aircraft operations that are not a part of those activities. Types of special use airspace are:

Alert Area- Airspace which may contain a high volume of pilot training activities or an unusual type of aerial activity, neither of which is hazardous to aircraft. Alert Areas are depicted on aeronautical charts for the information of nonparticipating pilots. All activities within an Alert Area are conducted in accordance with Federal Aviation Regulations, and pilots of participating aircraft as well as pilots transiting the area are equally responsible for collision avoidance.

Controlled Firing Area- Airspace wherein activities are conducted under conditions so controlled as to eliminate hazards to nonparticipating aircraft and to ensure the safety of persons and property on the ground.

Military Operations Area (MOA)- A MOA is airspace established outside of Class A airspace area to separate or segregate certain nonhazardous military activities from IFR traffic and to identify for VFR traffic where these activities are conducted.

(Refer to AIM.)

Prohibited Area- Airspace designated under 14 CFR Part 73 within which no person may operate an aircraft without the permission of the using agency.

(Refer to AIM.)

(Refer to En Route Charts.)

Restricted Area- Airspace designated under 14 CFR Part 73, within which the flight of aircraft, while not wholly prohibited, is subject to restriction. Most restricted areas are designated joint use and IFR/VFR operations in the area may be authorized by the controlling ATC facility when it is not being utilized by the using agency. Restricted areas are depicted on en route charts. Where joint use is authorized, the name of the ATC controlling facility is also shown.

(Refer to 14 CFR Part 73.)

(Refer to AIM.)

Warning Area- A warning area is airspace of defined dimensions extending from 3 NM outward from the coast of the United States, that contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning area is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both.

Storm Surge. An abnormal rise in sea level accompanying a hurricane or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. Storm surge is usually estimated by subtracting the normal or astronomic tide from the observed storm tide.

Storm Surge Warning. The danger of life-threatening inundation from rising water moving inland from the shoreline somewhere within the specified area, generally within 36 hours, in association with an ongoing or potential tropical cyclone, a subtropical cyclone or a post-tropical cyclone. The warning may be issued earlier when other conditions, such as the onset of tropical-storm-force winds, are expected to limit the time available to take protective actions for surge (e.g., evacuations). The warning may also be issued for locations not expected to receive life-threatening inundation but could potentially be isolated by inundation in adjacent areas.

Storm Surge Watch: The possibility of life-threatening inundation from rising water moving inland from the shoreline somewhere within the specified area, generally within 48 hours, in association with an ongoing or potential tropical cyclone, a subtropical cyclone, or a post-tropical cyclone. The watch may be issued earlier when other conditions, such as the onset of tropical storm-force winds, are expected to limit the time available to take protective actions for surge (e.g., evacuations). The watch may also be issued for locations not expected to receive life-threatening inundation, but could potentially be isolated by inundation in adjacent areas.

Storm Tide. The actual level of sea water resulting from the astronomic tide combined with the storm surge.

Subtropical Cyclone. A non-frontal low-pressure system that has characteristics of both tropical and extratropical cyclones. Like tropical cyclones, they are non-frontal, synoptic-scale cyclones that originate over tropical or subtropical waters, and have a closed surface wind circulation about a well-defined center. In addition, they have organized moderate to deep convection, but lack a central dense overcast. Unlike tropical cyclones, subtropical cyclones derive a significant proportion of their energy from baroclinic sources, and are generally cold-core in the upper troposphere, often being associated with an upper-level low or trough. In comparison to tropical cyclones, these systems generally have a radius of maximum winds occurring relatively far from the center (usually greater than 60 NM), and generally have a less symmetric wind field and distribution of convection.

Subtropical Depression. A subtropical cyclone in which the maximum sustained surface wind speed (l-min mean) is 33 knots (38 mph) or less.

Subtropical Storm. A subtropical cyclone in which the maximum sustained surface wind speed (1-min mean) is 34 knots (39 mph) or higher.

Super Typhoon. A "super" typhoon is one that is classified as having winds of 130 knots (150 mph) or greater.

Sustained Surface Wind. The 1-minute averaged wind at the 10-meter elevation with an unobstructed exposure.

Synoptic Surveillance (formerly Synoptic Track). Weather reconnaissance mission flown to provide vital meteorological information in data sparse ocean areas as a supplement to existing surface, radar, and satellite data. Synoptic flights better define the upper atmosphere and aid in the prediction of tropical cyclone motion and intensity.

-T-

Tropical Cyclone. A warm-core, non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center.

Tropical Cyclone Plan of the Day. A coordinated mission plan that tasks operational weather reconnaissance requirements during the period between 1100 UTC the next day and 1100 UTC the following day or as required, describes reconnaissance flights committed to satisfy both operational and research requirements, and identifies possible reconnaissance requirements for the succeeding 24-hour period.

Tropical Depression. A tropical cyclone in which the maximum sustained surface wind speed (l-min mean) is 33 kt (38 mph) or less.

Tropical Disturbance. A discrete tropical weather system of apparently organized convection--generally 100 to 300 mi in diameter--originating in the tropics or subtropics, having a nonfrontal migratory character, and maintaining its identity for 24 hours or more. It may or may not be associated with a detectable perturbation of the wind field.

Tropical Storm. A tropical cyclone in which the maximum sustained surface wind speed (l-min mean) ranges from 34 kt (39 mph) to 63 kt (73 mph).

Tropical Storm Warning for the Atlantic, Eastern Pacific, Central Pacific, and western North Pacific basins. Sustained winds of 34 to 63 knots (39 to 73 mph or 63 to 118 km / hour) are expected somewhere within the specified area within 36 hours (24 hours for the western North Pacific) in association with a potential or ongoing tropical cyclone, a subtropical cyclone, or a post-tropical cyclone.

Tropical Storm Watch for the Atlantic, Eastern Pacific, Central Pacific, and western North Pacific basins. Sustained winds of 34 to 63 knots (39 to 73 mph or 63 to 118 km / hour) are possible within the specified area within 48 hours in association with a potential or ongoing tropical cyclone, a subtropical cyclone, or a post-tropical cyclone.

Tropical Wave. A trough or cyclonic curvature maximum in the trade-wind easterlies. The wave may reach maximum amplitude in the lower middle troposphere or may be the reflection of an upper tropospheric cold low or equatorial extension of a middle latitude trough.

Tropical Weather System. A designation for one of a series of tropical weather anomalies. As such, it is the basic generic designation, which in successive stages of intensification, may be classified as a tropical disturbance, wave, depression, storm, or hurricane.

Typhoon/Hurricane. A warm-core tropical cyclone in which the maximum sustained surface wind speed (l-min mean) is 64 kt (74 mph) or more.

-U-

Uncontrolled Airspace (Class G Airspace). That portion of the airspace that has not been designated as Class A, Class B, Class C, Class D, or Class E and within which Air Traffic Control has neither the authority nor the responsibility for exercising control over air traffic.

Uncrewed Aircraft System (UAS). An uncrewed aircraft and its associated elements (including communication links and the components that control the uncrewed aircraft) that are required for the safe and efficient operation of the uncrewed aircraft in the airspace of the United States, as defined in 14 CFR Part 1.

UAS Hurricane Mission Commander (UHMC). Official who maintains general oversight of operations and is considered the federal authority responsible for safe, efficient UAS mission execution.

-V-

Vortex Fix. The location of the surface and/or flight level center of a tropical or subtropical cyclone obtained by reconnaissance aircraft penetration. See Center Fix, also.

-W-

Wall Cloud. An organized band of cumuliform clouds immediately surrounding the center of a tropical cyclone. Wall cloud and eye wall are used synonymously.

Weather Reconnaissance Area (WRA). Airspace established to support NHOP weather reconnaissance/research missions with defined dimensions and published by Notice to Airmen (NOTAM). It is normally at or below FL150 with a radius of 200 NM but it can be modified based on geographical locations to a size no less than 150 NM around a set of center coordinates. It may only be established in airspace with U.S. Flight Information Regions outside of U.S. territorial space. Only participating weather reconnaissance/research aircraft from NOAA and the USAF Reserve Command are permitted to operate within the airspace, and ATC services are not provided.

APPENDIX O: BASIN DEFINITIONS

The tropical cyclone ocean basins recognized by U.S. Federal agencies are defined in Table O-1 and Figure O-1 below.

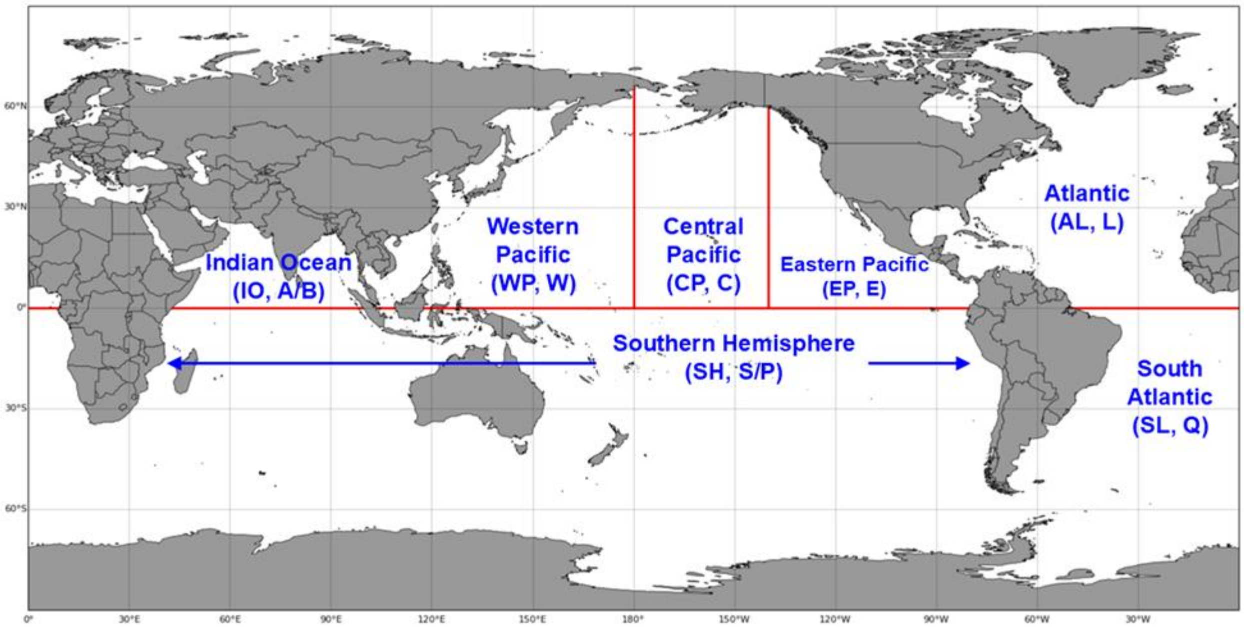

Figure O-1: Names and geographical boundaries of tropical cyclone ocean basins recognized by U.S. Federal agencies. The two-character ATCF basin identifiers (left) and single-character sub-region code(s) within each basin (right) are listed in parentheses.

Table O-1: Names and definitions of the tropical cyclone ocean basins recognized by U.S. Federal agencies.

Name	Definition	ATCF Basin Identifier	Sub-region Identifiers
Atlantic	Atlantic Ocean north of the Equator	AL	L
Eastern Pacific	Pacific Ocean north of the Equator and east of 140°W	EP	E
Central Pacific	Pacific Ocean north of the Equator between the International Date Line and 140°W	CP	C
Western Pacific	Pacific Ocean north of the Equator, east of the Malay Peninsula, and west of the International Date Line	WP	W
Indian Ocean	Indian Ocean north of the Equator and west of the Malay Peninsula	IO	A, B
Southern Hemisphere	Indian and Pacific Oceans south of the Equator	SH	S, P
South Atlantic	Atlantic Ocean south of the Equator	SL	Q

APPENDIX P: RECOMMENDED WSR-88D PRODUCT LIST ASSOCIATED WITH TROPICAL CYCLONES

CC – Correlation Coefficient Product: 16 level/0.54 nm

DCC – Correlation Coefficient Data Array Product: 256 level/0.13 nm

DMD – Mesocyclone Detection Data Array Product

DR – Base Reflectivity Data Array Product: 256 level/0.54 nm

DSA – Dual-Pol Digital Storm Total Accumulation: 256 level/0.13 nm

DUA – Dual-Pol Digital User-Selectable Accumulation Product: 256 level/0.13 nm

DV – Base Velocity Data Array Product: 256 level/0.13 nm

ET – Echo Tops: 16 level/2.2 nm

EET – Enhanced Echo Tops: 71 level/0.54 nm

MD – Mesocyclone Detection Product

OHA – Dual-Pol One Hour Accumulation: 16 level/1.1 nm

OHP – Surface Rainfall Accumulation (1 hr): 16 level/1.1 nm

SDR – Super Resolution Reflectivity Data Array Product: 256 level/0.13 nm

SDV – Super Resolution Velocity Data Array Product: 256 level/0.13 nm

SDW – Super Resolution Spectrum Width Data Array Product: 256/0.13 nm

SRM – Storm Relative Velocity (Map): 16 level/0.54 nm

STI – Storm Tracking Information

SW – Base Spectrum Width: 8 level/0.54 nm

THP – Surface Rainfall Accumulation (3 hr): 16 level/1.1 nm

TRU – Tornado Vortex Signature Rapid Update

TVS – Tornado Vortex Signature

USP – User-Selectable Storm Total Precipitation: 16 level/1.1 nm

VCS – Velocity Cross Section 16 level/0.54 x 0.27 nm

VWP – Velocity Azimuth Display (VAD) Wind Profile