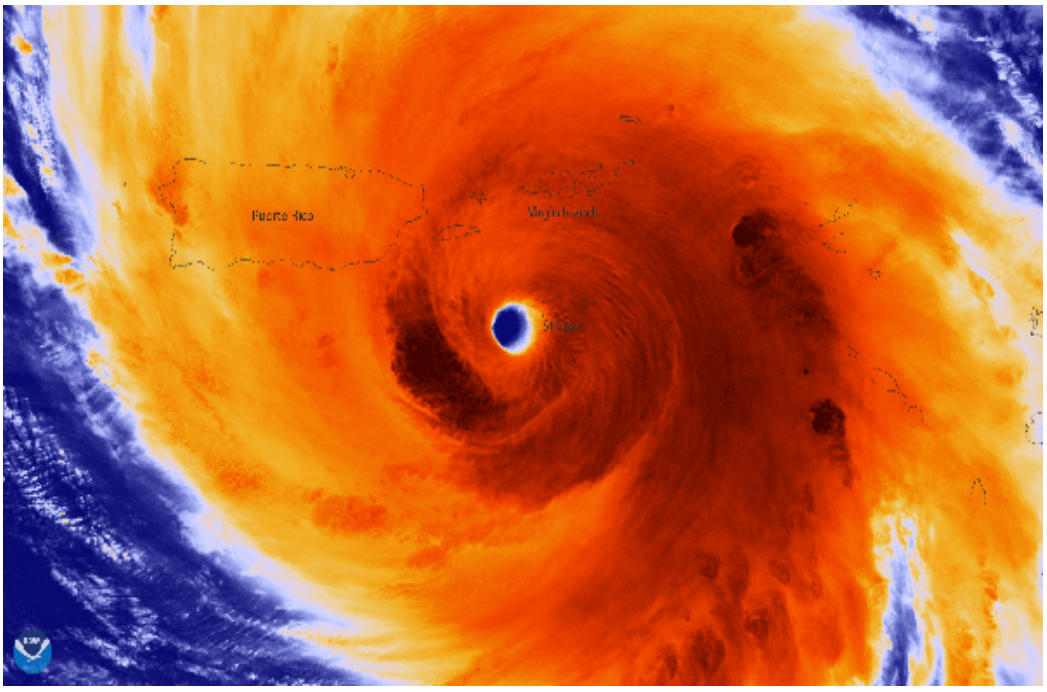
U.S. DEPARTMENT OF COMMERCE/ National Oceanic and Atmospheric Administration

OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

National Hurricane Operations Plan

FCM-P12-2018



Washington, DC
May 2018

A colorized infrared image from the NOAA/NASA Suomi NPP satellite, taken on September 20, 2017 at 6:15 UTC, the well-defined eye of Hurricane Maria can be seen as it skirts the island of St Croix. Approximately three hours later, the storm made landfall in Puerto Rico as a Category 4 hurricane, with maximum sustained winds of around 150 mph. Image courtesy of NOAA.

FEDERAL COORDINATOR

FOR

METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

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NATIONAL HURRICANE OPERATIONS PLAN

FCM-P12-2018

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CHANGE AND REVIEW LOG

Use this page to record changes and notices of reviews.

Change Number	Page Numbers	Date Posted (mm/dd/yyyy)	Initials
1.	G-24-G-26	5/17/2018	DC
2.	2-5, I-1-I-2, L-1; M-3	10/1/2018	DC
3.			
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5.			

Changes are indicated by a vertical line in the margin next to the change or by shading and strikeouts.

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FOREWORD

The Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) works with Federal agency stakeholders to plan hurricane observing and reconnaissance in preparation for each hurricane season. OFCM's Working Group for Tropical Cyclone Operations and Research (WG/TCOR) manages the process of publishing an annual update to the National Hurricane Operations Plan (NHOP), which documents the agreed-upon interagency plans.

The NHOP focuses heavily on the planning, execution, and use of aerial reconnaissance conducted by the Air Force Reserve Command's 53rd Weather Reconnaissance Squadron (WRS) and NOAA's Aircraft Operations Center (AOC); addresses meteorological satellite, weather radar, and ocean observing; and a number of other, related topics.

The 2018 NHOP includes a number of noteworthy changes, including:

- Revised tropical cyclone names and pronunciations (Tables 3-2 through 3-5).
- Additional dropsonde drops during flights (Chapter 5)
- Updated meteorological satellite information (Chapter 7).
- A reconfigured Appendix G, including information on the Vortex Data Message from Chapter 5. The Vortex Data Message itself has been extensively updated as well.
- Updated Mission Coordination Sheet used in weather reconnaissance missions (Appendix L).

Thanks to all the participating Federal agencies for their cooperation in reviewing last year's NHOP, identifying and drafting necessary changes, and working together to approve and incorporate those changes into the 2018 NHOP.

//SIGNED//

Dr. William J. Schulz
Federal Coordinator for Meteorological
Services and Supporting Research

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 Defense (DOD) provides the same services for the Western Pacific (WPAC) and Indian Ocean (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* provides the basis for implementing agreements reached at the Tropical Cyclone Operations and Research Forum/Interdepartmental Hurricane Conference (IHC), which is sponsored annually by the Office of the Federal Coordinator for Meteorological Services and Supporting Research. 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 Mexico, 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.

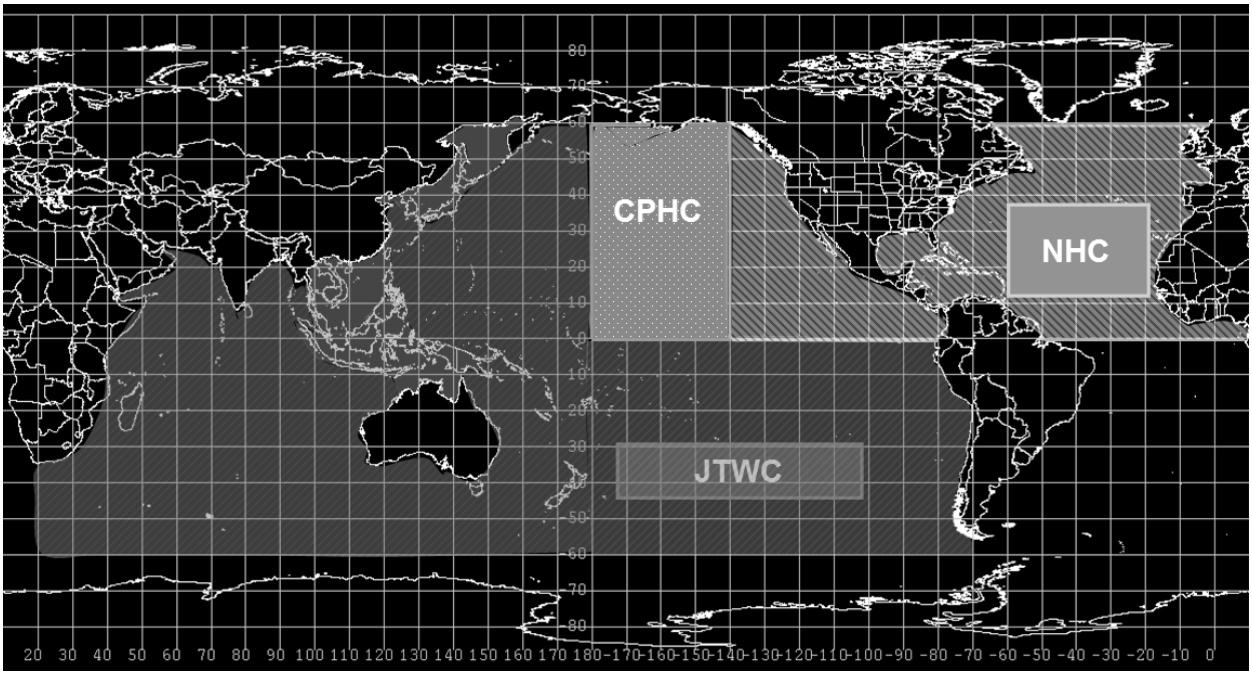


Figure 1-1. Tropical Cyclone Forecast Centers' Areas of Responsibility

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 Defense (DOD), the Department of Transportation (DOT), and the Department of Homeland Security (DHS)/U.S. Coast Guard (USCG) 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 DOD.

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

- Consult, as necessary, with the DOD 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), the coordinated DOC requirements for weather reconnaissance and other meteorological data to be acquired by the DOD on tropical or subtropical cyclones and disturbances.
- Provide facilities, administrative support, and the means to disseminate meteorological data for the Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH) as agreed to by the DOC and DOD.
- Provide the DOD 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 Mexico): Advisories are the responsibility of the Director, NHC, Miami, FL. The NHC will consult with the Fleet Weather Center (FLC), 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 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 are prepared by the NWS Weather Forecast Office (WFO) Guam, using the tropical cyclone forecasts/advisories 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.

2.2.3. Post Analysis of Tropical Cyclones.

The DOC, through NWS, will conduct an annual, post analysis, for all tropical cyclones in the Atlantic and the Pacific regions east of 180° and prepare an annual hurricane report for issue to interested agencies. The DoD, through JTWC, will conduct annual post storm analyses (position and intensity only) and reports for all tropical cyclones in the western North Pacific, North and South Indian, and South Pacific Oceans via the Annual Tropical Cyclone Report (ATCR).

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.

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. DOD Responsibilities.

The DOD will:

- Disseminate significant meteorological information on tropical and subtropical cyclones to the NWS in a timely manner.
- Provide NHC and CPHC current DOD requirements for tropical and subtropical cyclone advisories.
- Meet DOC requirements for aircraft reconnaissance and other special observations.
- Provide NHC a 24-hour aircraft operations interface—Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH).
- Designate CARCAH as the liaison to NHC. CARCAH will serve as NHC's point of contact to request special DOD observations in support of this plan (e.g., additional upper-air observations).
- Provide weather reconnaissance data monitor 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^{o}. JTWC will consult with WFO Guam regarding all tropical cyclones affecting Micronesia and Guam. 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.
- Initiate, monitor, and update 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. Atlantic Fleet (COMLANTFLT) requirements.
- At a minimum, maintain situation awareness of hurricane hunter operational 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.

2.5. Annual Liaison with Other Nations.

2.5.1. The DOD, DOC, and DOT will cooperate in arranging an annual trip to the Caribbean and the Gulf of Mexico area to carry out a continuing and effective liaison with the directors of meteorological services, air traffic control agencies, and disaster preparedness agencies of nations in those areas, regarding the provision of tropical cyclone warning services. Due to the international importance of this mission, the Air Force Reserve Command (AFRC) and NHC will jointly plan and execute this mission annually. The NHC will coordinate with the meteorological services in the countries to be visited.

2.5.2. This annual liaison trip is known as the Caribbean Hurricane Awareness Tour (CHAT). It takes place in the United States Southern Command, located in Doral, Florida and Northern Command, located in Colorado Springs, CO, areas of responsibility and supports their mission of promoting stability, collective security, and defending U.S. regional interests. The WC-130 aircraft flown by the 53rd Weather Reconnaissance Squadron (53rd 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 DOD and NOAA during 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 storm warning and emergency response.

2.5.3. This 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. The CHAT helps communicate the U.S. responsibilities in the region and it highlights the vital roles of NOAA and 53rd WRS. The media's role is to document the trip and promote the hurricane preparedness message, thus providing visibility to this important outreach activity both nationally and internationally.

2.5.4. The synergy created by all participants traveling together on the 53rd WRS WC-130 aircraft is essential to efficiently accomplishing the overall objectives of the mission while exercising fiscal responsibility. AFRC may support the mission on a non-interference basis for: U.S. Department of Commerce (DOC) and National Oceanic and Atmospheric Administration (NOAA) staff, and other U.S. officials as appropriate. Media support may be provided within

appropriate public affairs guidelines. DOD, DOC and DOT will also cooperate on an annual trip as needed to domestic sites to accomplish similar objectives. This liaison trip is known as the Hurricane Awareness Tour (HAT). The HAT historically focuses on locations along the U.S. east and Gulf coasts (alternating annually) but can include international stops (e.g., Canada).

2.6. 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.

2.6.1. Gulf of Mexico Weather Reconnaissance.

The 53rd WRS and the NOAA AOC operations officers will maintain a close working relationship with the Air Traffic Control Center (ATCSCC), the Air Route Traffic Control Centers (ARTCCs), and the Fleet Area~~Aerial~~ Control and Surveillance Facility (FACSFAC) for the coordination of weather reconnaissance flights in the Gulf of Mexico 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]).

2.6.2. 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 transmission times, can be found in the National Weather Service Instruction 10-601.

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 120 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 120 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. The following pertains to the tropical storm/hurricane/typhoon watches and warnings contained in the TCP:

- **NHC.** NHC issues tropical storm/hurricane watches/warnings for the Atlantic, Pacific, and Gulf of Mexico 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 and WFO Guam.** CPHC and Weather Forecast Office (WFO) Guam issues tropical storm/hurricane/typhoon watches/warnings for the islands of Hawaii, northwest Hawaiian Islands, Johnston Atoll, Guam, Northern Mariana Islands and selected points in the Micronesian countries. CPHC and WFO Guam issue watches when conditions along the coast are *possible* within 48 hours. CPHC and WFO Guam issue warnings when conditions are *expected* along the coast within 36 and 24 hours, respectively.

[NOTE: Because hurricane/typhoon preparedness activities become difficult once winds reach tropical storm force, CPHC and WFO Guam 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 and CPHC 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 cyclone watch, warning, and forecast information for the protection of life and property.

[Note: In the Western 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-, 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 special advisory that will contain the same watch/warning information, and indicates the special 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 is based upon the Valid Time Event Code (VTEC). It summarizes all new, continued, and cancelled tropical cyclone watches and warnings issued by the NHC for the U.S. Atlantic and Gulf coast, southern California coast, Puerto Rico, and U.S. Virgin Islands. In the Atlantic, the NHC-issued TCV also contains the inland VTEC provided by NWS Weather Forecast Offices (WFOs). 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, portions of the North East Pacific, and the North Central Pacific Ocean basin tropical cyclones.

The local TCV text is a segmented, nearly automated, VTEC product with each segment being a discrete forecast zone. It is issued by coastal Weather Forecast Offices (WFOs) in the Atlantic and North Central 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 forecast. It 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.

Several other tropical cyclone related products are issued to support the tropical cyclone forecasting and warning program. Refer to NWS Instruction 10-601 for further details on these products, which include:

- Satellite Interpretation Message (SIM).
- Tropical Weather Discussion (TWD).
- Tropical Weather Summary (TWS).
- 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
- Tropical Cyclone Surface Wind Field Graphic
- Maximum Wind Speed Probability Table
- Tropical Cyclone Storm Surge Probabilities

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 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. 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. Give tropical cyclones a name in the first advisory after intensifying to

34 knots (39 mph) or greater. 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.

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 (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.

3.3.1. Atlantic Basin.

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 in Table 3-2.

3.3.2. Pacific East of 140°W.

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 in Table 3-3.

3.3.3. Pacific West of 140°W and East of 180°.

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 in Table 3-4.

3.3.4. Pacific West of 180° and North of 0°.

Depression numbers with suffix W; e.g. 01W, 02W, 03W, etc., are assigned by JTWC when the first warning is issued and the TC is less than tropical storm intensity. 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 in Table 3-5.

3.3.5. Subtropical Depressions.

A single list of numbers and names will be used 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.

3.4. Transfer of Warning 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.

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.

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.

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 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	CPHC

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, and WFO Guam 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).

Table 3-2. Atlantic Tropical Cyclone Names

[Note: If over 21 tropical cyclones occur in a year, the Greek alphabet will be used following the W-named cyclone.]

2018

Name	Pronunciation
Alberto	al-BAIR-toe
Beryl	BEHR-ril
Chris	kris
Debby	DEH-bee
Ernesto	er-NES-toh
Florence	FLOOR-ence
Gordon	GOR-duhn
Helene	heh-LEEN
Isaac	EYE-zik
Joyce	joyss
Kirk	kurk
Leslie	LEHZ-lee
Michael	MY-kuhl
Nadine	nay-DEEN
Oscar	AHS-kur
Patty	PAT-ee
Rafael	rah-fah-ELL
Sara	SAIR-uh
Tony	TOH-nee
Valerie	VAH-lur-ee
William	WILL-yum

2019

Name	Pronunciation
Andrea	AN-dree-uh
Barry	BAIR-ree
Chantal	shahn-TAHL
Dorian	DOR-ee-an
Erin	AIR-rin
Fernand	fair-NAHN
Gabrielle	ga-bree-ELL
Humberto	oom-BAIR-toh
Imelda	ee-MEHL-dah
Jerry	JEHR-ee
Karen	KAIR-ren
Lorenzo	loh-REN-zoh
Melissa	meh-LIH-suh
Nestor	NES-tor
Olga	OAL-guh
Pablo	PAHB-lo
Rebekah	reh-BEH-kuh
Sebastien	suh-BASH-chuhn
Tanya	TAHN-yuh
Van	van
Wendy	WEN-dee

2020

Name	Pronunciation
Arthur	AR-thur
Bertha	BUR-thuh
Cristobal	krees-TOH-bahl
Dolly	DAH-lee
Edouard	eh-DWARD
Fay	fay
Gonzalo	gohn- SAH-loh
Hanna	HAN-uh
Isaias	ees-ah-EE-ahs
Josephine	JOH-seh-feen
Kyle	KY-ull
Laura	LOOR-ruh
Marco	MAR-koe
Nana	NA-na
Omar	OH-mar
Paulette	pawl-LET
Rene	re-NAY
Sally	SAL-ee
Teddy	TEHD-ee
Vicky	VIH-kee
Wilfred	WILL-fred

2021

Name	Pronunciation
Ana	AH-nah
Bill	bill
Claudette	klaw-DET
Danny	DAN-ee
Elsa	EL-suh
Fred	frehd
Grace	grayss
Henri	ahn-REE
Ida	EYE-duh
Julian	JOO-lee-uhn
Kate	kayt
Larry	LAIR-ree
Mindy	MIN-dee
Nicholas	NIH-kuh-luss
Odette	oh-DEHT
Peter	PEE-tur
Rose	rohz
Sam	sam
Teresa	tuh-REE-suh
Victor	VIK-tur
Wanda	WAHN-duh

2022

Name	Pronunciation
Alex	AL-leks
Bonnie	BAH-nee
Colin	KAH-lihn
Danielle	dan-YELL
Earl	URR-ull
Fiona	fee-OH-nuh
Gaston	ga-STAWN
Hermine	her-MEEN
Ian	EE-an
Julia	JOO-lee-uh
Karl	KAR-ull
Lisa	LEE-suh
Martin	MAR-tin
Nicole	nih-KOHL
Owen	OH-uhn
Paula	PAHL-luh
Richard	RIH-churd
Shary	SHAHR-ee
Tobias	toh-BEE-uss
Virginie	vir-JIN-ee
Walter	WALL-tur

2023

Name	Pronunciation
Arlene	ar-LEEN
Bret	bret
Cindy	SIN-dee
Don	dahn
Emily	EH-mih-lee
Franklin	FRANK-lin
Gert	gert
Harold	HAIR-uld
Idalia	ee-DAL-ya
Jose	ho-ZAY
Katia	KAH-tyah
Lee	lee
Margot	MAR-go
Nigel	NY-juhl
Ophelia	o-FEEL-ya
Philippe	fee-LEEP
Rina	REE-nuh
Sean	shawn
Tammy	TAM-ee
Vince	vinss
Whitney	WHIT-nee

Table 3-3. Eastern Pacific Tropical Cyclone Names

2017	
Name	**Pronunciation**
Adrian	AY-dree-uhn
Beatriz	BEE-a-triz
Calvin	KAL-vin
Dora	DOR-ruh
Eugene	YOU-jeen
Fernanda	fer-NAN-dah
Greg	greg
Hilary	HIH-luh-ree
Irwin	UR-win
Jova	HO-vah
Kenneth	KEH-neth
Lidia	LIH-dyah
Max	maks
Norma	NOOR-muh
Otis	OH-tis
Pilar	Pee-LAHR
Ramon	rah-MOHN
Selma	SELL-mah
Todd	tahd
Veronica	vur-RAHN-ih-kuh
Wiley	WY-lee
Xina	ZEE-nah
York	york
Zelda	ZEL-dah

2018	
Name	**Pronunciation**
Aletta	a-LET-ah
Bud	buhd
Carlotta	kar-LOT-uh
Daniel	DAN-yuhl
Emilia	ee-MILL-ya
Fabio	FAH-bee-o
Gilma	GIL-mah
Hector	HEHK-tor
Ileana	ill-ay-AH-nah
John	jahn
Kristy	KRIS-tee
Lane	layne
Miriam	MEER-yim
Norman	NOR-muhn
Olivia	uh-LIV-ee-uh
Paul	pall
Rosa	ROH-zuh
Sergio	SIR-gee-oh
Tara	TAIR-uh
Vicente	vee-CEN-tay
Willa	WIH-lah
Xavier	ZAY-vee-ur
Yolanda	yo-LAHN-da
Zeke	zeek

2019	
Name	**Pronunciation**
Alvin	AL-vin
Barbara	BAR-bruh
Cosme	COS-may
Dalila	dah-LY-lah
Erick	EHR-ik
Flossie	FLOSS-ee
Gil	gill
Henriette	hen-ree-ETT
Ivo	eye-VOH
Juliette	jew-lee-EHT
Kiko	KEE-ko
Lorena	low-RAY-na
Mario	MAR-ee-o
Narda	NAHR-duh
Octave	AHK-tayv
Priscilla	prih-SIH-luh
Raymond	RAY-mund
Sonia	SOHN-yah
Tico	TEE-koh
Velma	VELL-muh
Wallis	WAHL-lis
Xina	ZEE-nah
York	york
Zelda	ZEL-dah

2020	
Name	**Pronunciation**
Amanda	uh-MAN-duh
Boris	bor-EES
Cristina	kris-TEE-nuh
Douglas	DUG-luss
Elida	ELL-ee-dah
Fausto	FOW-sto
Genevieve	jeh-nuh-VEEV
Hernan	her-NAHN
Iselle	ee-SELL
Julio	HOO-lee-o
Karina	kuh-REE-nuh
Lowell	LO-uhl
Marie	muh-REE
Norbert	NOR-bert
Odalys	oh-DAL-ess
Polo	POH-loh
Rachel	RAY-chull
Simon	SY-muhn
Trudy	TROO-dee
Vance	vanss
Winnie	WIN-ee
Xavier	ZAY-vee-ur
Yolanda	yo-LAHN-da
Zeke	zeek

2021	
Name	**Pronunciation**
Andres	ahn-DRASE
Blanca	BLAHN-kah
Carlos	KAR-loess
Dolores	deh-LOOR-ess
Enrique	ahn-REE-kay
Felicia	fa-LEE-sha
Guillermo	gee-YER-mo
Hilda	HILL-duh
Ignacio	eeg-NAH-see-oh
Jimena	he-MAY-na
Kevin	KEH-vin
Linda	LIHN-duh
Marty	MAR-tee
Nora	NOOR-ruh
Olaf	OH-lahf
Pamela	PAM-eh-luh
Rick	rik
Sandra	SAN-druh
Terry	TAIR-ree
Vivian	VIH-vee-uhn
Waldo	WAHL-doh
Xina	ZEE-nah
York	york
Zelda	ZEL-dah

2022	
Name	**Pronunciation**
Agatha	A-guh-thuh
Blas	blahs
Celia	SEEL-yuh
Darby	DAR-bee
Estelle	eh-STELL
Frank	frank
Georgette	jor-JET
Howard	HOW-urd
Ivette	ee-VET
Javier	hahv-YAIR
Kay	kay
Lester	LESS-tur
Madeline	MAD-eh-luhn
Newton	NOO-tuhn
Orlene	or-LEEN
Paine	payne
Roslyn	RAWZ-luhn
Seymour	SEE-mor
Tina	TEE-nuh
Virgil	VUR-jill
Winifred	WIN-ih-fred
Xavier	ZAY-vee-ur
Yolanda	yo-LAHN-da
Zeke	zeek

Table 3-4. Central Pacific Tropical Cyclone Names

COLUMN 1		COLUMN 2	
Name	**Pronunciation**	**Name**	**Pronunciation**
AKONI	ah-KOH-nee	AKA	AH-kah
EMA	EH-mah	EKEKA	eh-KEH-kak
HONE	HOH-neh	HENE	HEH-neh
IONA	ee-OH-nah	IOLANA	ee-OH-lah-nah
KELI	KEH-lee	KEONI	keh-ON-nee
LALA	LAH-lah	LINO	LEE-noh
MOKE	MOH-keh	MELE	MEH-leh
NOLO	NOH-loh	NONA	NOH-nah
OLANA	Oh-LAH-nah	OLIWA	oh-LEE-vah
PENA	PEH-nah	PAMA	PAH-mah
ULANA	oo-LAH-nah	UPANA	oo-PAH-nah
WALE	WAH-leh	WENE	WEH-neh
COLUMN 3		**COLUMN 4**	
Name	**Pronunciation**	**Name**	**Pronunciation**
ALIKA	ah-LEE-kah	ANA	AH-nah
ELE	EH-leh	ELA	EH-lah
HUKO	HOO-koh	HALOLA	hah-LOH-lah
IOPA	ee-OH-pah	IUNE	ee-OO-neh
KIKA	KEE-kah	KILO	KEE-lo
LANA	LAH-nah	LOKE	LOH-keh
MAKA	MAH-kah	MALIA	mah-LEE-ah
NEKI	NEH-kee	NIALA	nee-AH-lah
OMEKA	oh-MEH-kah	OHO	OH-hoh
PEWA	PEH-vah	PALI	PAH-lee
UNALA	oo-NAH-lah	ULIKA	oo-LEE-kah
WALI	WAH-lee	WALAKA	wah-LAH-kah

[Note: Use Column 1 list of names until exhausted before going to Column 2, etc. All letters in the Hawaiian language are pronounced, including double or triple vowels.]

Table 3-5. International Tropical Cyclone Names for the Northwest Pacific and South China Sea

Contributor	I	II	III	IV	V
	NAME	NAME	NAME	NAME	NAME
Cambodia	Damrey	Kong-rey	Nakri	Krovanh	Sarika
China	Longwang	Yutu	Fengshen	Dujuan	Haima
DPR Korea	Kirogi	Toraji	Kalmaegi	Maemi	Meari
HK, China	Kai-tak	Man-yi	Fung-wong	Choi-wan	Ma-on
Japan	Tembin	Usagi	Kammuri	Koppu	Tokage
Lao PDR	Bolaven	Pabuk	Phanfone	Ketsana	Nock-ten
Macau	Chanchu	Wutip	Vongfong	Parma	Muifa
Malaysia	Jelawat	Sepat	Nuri	Melor	Merbok
Micronesia	Ewiniar	Fitow	Sinlaku	Nepartak	Nanmadol
Philippines	Bilis	Danas	Hagupit	Lupit	Talas
RO Korea	Kaemi	Nari	Changmi	Sudal	Noru
Thailand	Prapiroon	Wipha	Mekkhala	Nida	Kulap
U.S.A.	Maria	Francisco	Higos	Omais	Roke
Viet Nam	Saomai	Lekima	Bavi	Conson	Sonca
Cambodia	Bopha	Krosa	Maysak	Chanthu	Nesat
China	Wukong	Haiyan	Haishen	Dianmu	Haitang
DPR Korea	Sonamu	Podul	Pongsona	Mindulle	Nalgae
HK, China	Shanshan	Lingling	Yanyan	Tingting	Banyan
Japan	Yagi	Kajiki	Kujira	Kompasu	Washi
Lao PDR	Xangsane	Faxai	Chan-hom	Namtheun	Matsa
Macau	Bebinca	Peipan	Linfa	Malou	Sanvu
Malaysia	Rumbia	Tapah	Nangka	Meranti	Mawar
Micronesia	Soulik	Mitag	Soudelor	Rananim	Guchol
Philippines	Cimaron	Hagibis	Molave	Malakas	Talim
RO Korea	Chebi	Noguri	Koni	Megi	Nabi
Thailand	Durian	Rammasun	Morakot	Chaba	Khanun
U.S.A.	Utor	Matmo	Etau	Aere	Vicente
Viet Nam	Trami	Halong	Vamco	Songda	Saola

[NOTE: The official international name list was effective January 1, 2000. Names will be assigned in rotation starting with Damrey for the first tropical cyclone of the year 2000 which is of tropical storm strength or greater. When the last name in column 5 (Saola) is used, the sequence will begin again with the first name in column 1.]

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 3-6 provides the abbreviated communications headings for products issued by NHC, CPHC, and WFO Guam.

Table 3-6. 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
Tropical/Subtropical Cyclone Public Advisory	
Atlantic Basin	WTNT31-35 KNHC
Eastern Pacific	WTPZ31-35 KNHC
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
Eastern Pacific	WTPZ21-25 KNHC
Central Pacific	WTPA21-25 PHFO
Tropical Cyclone Discussion	
Atlantic Basin	WTNT41-45 KNHC
Eastern Pacific	WTPZ41-45 KNHC
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
Tropical Weather Summary	
Atlantic Basin	ABNT30 KNHC
Eastern Pacific	ABPZ30 KNHC
Central Pacific	ACPN60 PHFO

Table 3-6 (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	TXPS40 PHFO
North Central Pacific 140W - 180	TXPN40 PHFO
Satellite Interpretation Message	
West Pacific (Guam)	ATPQ40 PGUM
Satellite-Derived Rainfall	
Eastern Caribbean	TCCA21 KNHC
Central Caribbean	TCCA22 KNHC
Western Caribbean	TCCA23 KNHC
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	TXPS41-45 PHFO
North Central Pacific 140W - 180	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.

The NWS supports the HLT through use of NHC meteorologists, WFO personnel (typically warning coordination meteorologists and service hydrologists), and River Forecast Center (RFC) hydrologists. Eastern and Southern Region Headquarters will maintain a list of their available HLT candidates.

3.7.2. Activation/Deployment.

On June 1st, or earlier if necessary, the NHC Director will request that the FEMA activate the HLT by contacting the Disaster Operations Directorate. The HLT will remain active throughout

the season. When a tropical cyclone in the Atlantic or eastern North Pacific basins threatens the United States or its territories, the Director or Deputy Director of NHC may request NWS meteorological and/or hydrological support by contacting the appropriate NWS Regional Director. NWS personnel should deploy to NHC within 24 hours of the request for assistance.

NWS personnel will remain deployed at the HLT until the hurricane threat has passed. However, if a significant rainfall threat is expected to persist after landfall, the HLT will remain staffed by the FEMA to facilitate coordination with the WPC, who will assume briefing responsibilities until the rainfall threat has passed. NHC and WPC will coordinate the transfer of briefing responsibilities. During the inland event the HLT and WPC will coordinate with the appropriate WFOs and RFCs, and when needed, hydrologists from the RFCs will provide hydrological briefings.

If the HLT is deactivated, the WPC will assume the briefing duties provided the remnants of the tropical cyclone remain a threat to inland areas. NHC and WPC will coordinate prior to the transfer. During the inland event WPC will coordinate with the appropriate WFOs and RFCs and when needed, hydrologists from the RFCs will provide hydrological briefings.

3.7.3. Training.

Completing NWS/FEMA's distance learning training module, Community Hurricane Preparedness, is required by HLT members. The module can be taken via the Internet at: http://meted.ucar.edu/hurrican/chp/index.htm. Other training opportunities are strongly encouraged. They are: FEMA's "Introduction to Hurricane Preparedness" conducted at NHC for emergency mangers and NWS personnel, and FEMA's annual HLT training session held at NHC.

3.7.4. Meteorological Duties.

The HLT meteorologist will:

- Establish and maintain contact with the impacted WFOs, RFCs, and the WPC.
- Facilitate participation of the impacted NWS offices in conference calls, briefings, and in preparation and distribution of graphics.
- Provide meteorological interpretations on NHC advisories, WFO hurricane local statements, HURREVAC products, and storm surge forecasts for Federal, state and local agencies on request.
- Provide storm briefings via video/audio teleconferences for Federal, state and local organizations.
- Respond to meteorology-related incoming calls from Federal, state, and local emergency managers. Refer callers to the appropriate WFO for responses to localized special questions and issues.

3.7.5. Hydrologic Duties.

The HLT hydrologist will:

- Establish and maintain contact with the impacted local WFOs, RFCs, and the WPC.
- Facilitate participation of the impacted NWS offices in conference calls, briefings, and in preparation and distribution of graphics.
- Provide hydrologic interpretation on NHC advisories, WFO hurricane local statements, and WFO and RFC hydrologic products for Federal, state and local agencies on request.

- Provide technical support for RFC lead during hydrologic portion of video teleconference. In absence of the RFC, lead the hydrologic portion of the video teleconference.
- Respond to hydrology-related incoming calls from Federal, state, and local emergency managers. Refer callers to the appropriate WFO for responses to localized special questions and issues.

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

4.1. General.

The DOD 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 DOD resources and operations, the DOD requires certain meteorological information beyond that available to the general public. Accordingly, the DOC provides DOD with special observations and advisories on tropical and subtropical storms threatening DOD resources or operations.

4.2. Observations.

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

4.3. Tropical Cyclone Forecast/Advisories.

4.3.1. General.

The NHC and CPHC will provide to DOD forecasts and related information for tropical and subtropical weather disturbances of depression intensity or greater. 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 Suitland, MD, to the Weather Product Management and Distribution System (WPMDS) at the Air Force's 557th Weather Wing (557 WW), Offutt AFB, NE, for further relay to DOD agencies. The DOD forecasters, who must give advice concerning an imminent operational decision, may contact the appropriate hurricane center forecaster (see Chapter 2) when published tropical cyclone forecast/advisories require elaboration. Telephone numbers for the hurricane centers are in Appendix I.

4.3.2. Tropical Cyclone Forecast/Advisory Issue Frequency.

The first tropical cyclone forecast/advisory will normally be issued when meteorological data indicate 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. Advisories will continue to be issued until the system is classified below the depression intensity level. 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 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 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, 72, 96, and 120-hour tropical cyclone forecast positions. A code string is appended at the end of the line "NWS NATIONAL HURRICANE CENTER MIAMI FL." 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 <Storm ID> is three spaces after "FL" and uses the following format:

NWS NATIONAL HURRICANE CENTER MIAMI FL 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. A cyclone number is assigned to each tropical or subtropical 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 have the potential to become tropical or subtropical 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. Numbering of Tropical and Subtropical Cyclone Forecast/ Advisories. All tropical cyclone forecast/advisories for each unique system in the Atlantic and Pacific will be numbered sequentially beginning with the number 1. Some examples are listed below:

Subtropical Depression ONE Forecast/Advisory Number 1

Tropical Depression ONE Forecast/Advisory Number 1

Tropical Depression ONE Forecast/Advisory Number 2

Tropical Storm Anita Forecast/Advisory Number 3

Hurricane (Typhoon) Anita Forecast/Advisory Number 4

Tropical Depression Anita Forecast/Advisory Number 5

```
ZCZC MIATCMAT4 ALL
TTAA00 KNHC DDHHMM

HURRICANE IKE FORECAST/ADVISORY NUMBER 42
NWS NATIONAL HURRICANE CENTER MIAMI FL AL092008
1500 UTC THU SEP 11 2008

CHANGES IN WATCHES AND WARNINGS WITH THIS ADVISORY...

A HURRICANE WARNING HAS BEEN ISSUED FROM MORGAN CITY LOUISIANA TO BAFFIN BAY TEXAS.

A TROPICAL STORM WARNING HAS BEEN ISSUED FROM SOUTH OF BAFFIN BAY TO PORT MANSFIELD TEXAS.

SUMMARY OF WATCHES AND WARNINGS IN EFFECT...

A HURRICANE WARNING IS IN EFFECT FOR...
* MORGAN CITY LOUISIANA TO BAFFIN BAY TEXAS

A TROPICAL STORM WARNING IS IN EFFECT FOR...
* EAST OF MORGAN CITY TO THE MISSISSIPPI-ALABAMA BORDER...INCLUDING
THE CITY OF NEW ORLEANS AND LAKE PONTCHARTRAIN
* SOUTH OF BAFFIN BAY TO PORT MANSFIELD

HURRICANE CENTER LOCATED NEAR 25.5N 88.4W AT 11/1500Z
POSITION ACCURATE WITHIN 10 NM

PRESENT MOVEMENT TOWARD THE WEST-NORTHWEST OR 290 DEGREES AT 9 KT

ESTIMATED MINIMUM CENTRAL PRESSURE 945 MB
MAX SUSTAINED WINDS 85 KT WITH GUSTS TO 105 KT.
64 KT.......100NE 100SE 30SW 60NW.
50 KT.......150NE 150SE 90SW 140NW.
34 KT.......230NE 240SE 150SW 180NW.
12 FT SEAS..330NE 240SE 240SW 400NW.
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 25.5N 88.4W AT 11/1500Z
AT 11/1200Z CENTER WAS LOCATED NEAR 25.3N 88.0W

FORECAST VALID 12/0000Z 25.9N 90.0W
MAX WIND 90 KT...GUSTS 110 KT.
64 KT...100NE 100SE 30SW 60NW.
50 KT...150NE 150SE 90SW 140NW.
34 KT...230NE 240SE 150SW 180NW.

FORECAST VALID 12/1200Z 26.6N 92.0W
MAX WIND 95 KT...GUSTS 115 KT.
64 KT...100NE 100SE 50SW 60NW.
50 KT...150NE 150SE 90SW 140NW.
34 KT...230NE 240SE 150SW 180NW.

FORECAST VALID 13/0000Z 27.8N 94.2W
MAX WIND 105 KT...GUSTS 130 KT.
64 KT...100NE 100SE 50SW 60NW.
50 KT...150NE 150SE 90SW 120NW.
34 KT...230NE 240SE 150SW 160NW.

FORECAST VALID 13/1200Z 29.5N 95.9W...INLAND
MAX WIND 100 KT...GUSTS 120 KT.
50 KT...120NE 125SE 75SW 90NW.
34 KT...180NE 240SE 120SW 120NW.

FORECAST VALID 14/1200Z 34.5N 94.0W...INLAND
MAX WIND 35 KT...GUSTS 45 KT.
34 KT... 75NE 75SE 50SW 50NW.

EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 225 NM
ON DAY 4 AND 300 NM ON DAY 5...AND FOR INTENSITY NEAR 20 KT EACH DAY

OUTLOOK VALID 15/1200Z 38.0N 85.0W...POST-TROP/EXTRATROP
MAX WIND 25 KT...GUSTS 35 KT.

OUTLOOK VALID 16/1200Z...ABSORBED

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 25.5N 88.4W

NEXT ADVISORY AT 11/2100Z

$$
FORECASTER FRANKLIN
```

Figure 4-1. Tropical Cyclone Forecast/Advisory Format

[Note: NWS text products are limited to 69 characters per line. For the example above (Figure 4-1), there are more than 69 characters on some lines so the example could fit on one page.]

```
ZCZC MIATCPAT1 ALL
TTAA00 KNHC DDHHMM

BULLETIN
TROPICAL STORM ANA ADVISORY NUMBER 6
NWS NATIONAL HURRICANE CENTER MIAMI FL AL012015
500 AM EDT SAT MAY 09 2015

...ANA TRANSITIONS TO A TROPICAL STORM WHILE IT MOVES SLOWLY
NORTH-NORTHWESTWARD TOWARD THE CAROLINAS...


SUMMARY OF 500 AM EDT...0900 UTC...INFORMATION
-----------------------------------------------
LOCATION...32.4N 77.6W
ABOUT 105 MI...170 KM SSE OF CAPE FEAR NORTH CAROLINA
ABOUT 115 MI...190 KM SE OF MYRTLE BEACH SOUTH CAROLINA
MAXIMUM SUSTAINED WINDS...60 MPH...95 KM/H
PRESENT MOVEMENT...NNW OR 340 DEGREES AT 3 MPH...6 KM/H
MINIMUM CENTRAL PRESSURE...998 MB...29.47 INCHES


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

None.

SUMMARY OF WATCHES AND WARNINGS IN EFFECT:

A Tropical Storm Warning is in effect for...
* South Santee River South Carolina to Cape Lookout

A Tropical Storm Watch is in effect for...
* Edisto Beach South Carolina to South of South Santee River

A Tropical Storm Warning means that tropical storm conditions are expected somewhere within the warning area, in this case within
12-24 hours.

A Tropical Storm Watch means that tropical storm conditions are possible within the watch area, in this case within 24 hours.

Interests elsewhere in eastern North Carolina should monitor the progress of Ana.

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 48-HOUR OUTLOOK
------------------------------
At 500 AM EDT (0900 UTC), the center of Tropical Storm Ana was located near latitude 32.4 North, longitude 77.6 West. Ana is
moving toward the north-northwest near 3 mph (6 km/h). A turn toward the northwest and then back to the north at a slightly
faster forward speed is expected over the next 48 hours. On the forecast track, the center will be near the coasts of South and
North Carolina by Sunday morning. Data from NOAA Doppler weather radars indicate that maximum sustained winds are near 60 mph (95
km/h) with higher gusts.
Although Ana has made the transition to a tropical storm, little additional strengthening is forecast through today. A gradual
weakening trend is expected to begin by tonight or Sunday morning.

Tropical-storm-force winds extend outward up to 125 miles (205 km) from the center. During the past couple of hours, the Frying
Pan Shoals NOAA buoy measured a sustained wind of 41 mph (66 km/h) and a gust to 56 mph (91 km/h).

The estimated minimum central pressure is 998 mb (29.47 inches).


HAZARDS AFFECTING LAND

WIND: Tropical storm conditions are expected within the warning area, and possible within the watch area, by this afternoon or
evening.

STORM SURGE: The combination of storm surge and the tide will cause normally dry areas near the coast to be flooded by rising
waters. The water could reach 1 to 2 ft above ground at times of high tide in coastal areas from Cape Hatteras, North Carolina
southward through South Carolina. For information specific to your area, please see products issued by your local National
Weather Service forecast office.

RAINFALL: Tropical Storm Ana is expected to produce rainfall accumulations of 1 to 3 inches, with isolated amounts of 5 inches,
over eastern portions of North Carolina and South Carolina through Monday.

SURF: Swells generated by Ana are affecting portions of the southeastern U.S. coast. These swells will likely cause life-
threatening surf and rip currents. Please see statements issued byyour local National Weather Service forecast office.

NEXT ADVISORY
-------------
Next intermediate advisory at 800 AM EDT.
Next complete advisory at 1100 AM EDT.

$$
Forecaster Stewart
NNNN
```

Figure 4-2. Tropical Cyclone Public Advisory Format

[Note: NWS text products are limited to 69 characters per line. For the example above (Figure 4-2), there are more than 69 characters on some lines so the example could fit on one page.]

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. DOC has identified a requirement for, and the DOD maintains aircraft to support, up to five sorties per day. Requirements exceeding five sorties will be accomplished on a "resources-permitting" basis. In times of national emergency or war, some or all DOD reconnaissance resources may not be available to fulfill DOC needs. The Global Decision Support System (GDSS) JCS Priority Code for tasked, operational weather reconnaissance is **1A3** (IAW DOD 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. Responsibilities.

The DOD, through the AFRC's 53 WRS, and DOC, through NOAA's AOC, operate a complementary fleet of aircraft to conduct hurricane/tropical cyclone reconnaissance, synoptic surveillance, and research missions.

5.2.1. DOD.

The DOD is responsible for:

5.2.1.1. Providing operational aircraft for vortex fixes and data, synoptic surveillance missions, and investigative flights in response to DOC needs (see Figure 5-1).

5.2.1.2. Developing operational procedures and deploying data buoys to satisfy DOC needs.

5.2.1.3. Maintaining the capability of operating from two (2) deployed locations, as well as from home station, simultaneously.

5.2.2. DOC.

The DOC is responsible for aircraft operations that may be requested to:

5.2.2.1.

Provide vortex fixes, acquire airborne radar data, and conduct synoptic surveillance missions (see Figure 5-2).

5.2.2.2.

Augment AFRC aircraft reconnaissance when DOC needs exceed the capabilities of DOD resources (see Figure 5-2).

5.2.2.3. Assume responsibility for hurricane reconnaissance over foreign airspace that may be restricted for military operations.

5.2.2.4. 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. WC-130J Weather Reconnaissance Aircraft

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

5.3. Control of Aircraft.

Operational control of aircraft flying tropical and subtropical cyclone reconnaissance will remain with the operating agencies which own the aircraft.

5.4. Reconnaissance Requirements.

5.4.1. 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 along the flight track) for surface and flight level.

- Center sea-level pressure determined by dropsonde or extrapolation from within 1,500 feet of the sea surface or from the computed 925 miilbar (mb), 850 mb, or 700 mb height.
- Minimum 700, 850 or 925 mb height, if available.
- SFMR surface wind and rain rate.
- Radar reflectivity imagery.
- High density three-dimensional Doppler radial velocities of the tropical cyclone core circulation.
- Temperature at flight level.
- Sea-surface temperature.
- Dew-point temperature at flight level.

5.4.2. Accuracy.

5.4.2.1. 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.

5.4.2.2. Wind Direction.

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

5.4.2.3. Wind Speed.

- Surface: within 10 kt.
- Flight level: within 4 kt.

5.4.2.4. Pressure Height.

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

5.4.2.5. Temperature.

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

5.4.2.6. Dew-Point Temperature.

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

5.4.2.7. Absolute Altitude: Within 10 m.

5.4.2.8. Vertical Sounding.

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

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

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

5.4.2.9. Core Doppler Radar.

- Horizontal resolution along aircraft track: 1.5 km
- Radar beam width: 3 degrees.
- Radar radial resolution (gate length): 150 m.
- Error in radar radial velocity: 1 m/s.
- Range: 50 km.

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

5.4.3. 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, peak 10-s average surface wind speed from the stepped frequency microwave radiometer (SFMR), SFMR-derived 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.

5.4.4. 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 control points, control times and dropwindsonde locations to CARCAH for coordination with the reconnaissance units.

5.4.5. Core Doppler Radar Requirements.

When required, NHC and the Environmental Modeling Center (EMC) will coordinate to request high-density three- dimensional Doppler radial velocities in the tropical cyclone core for potential storms impacting the United States, including Puerto Rico and the Virgin Islands. EMC, NHC, and HRD will coordinate to provide specific flight plans to CARCAH for coordination with the reconnaissance units.

5.4.6. Required Frequency and Content of Observations.

Observation requirements are summarized in Table 5-1. Deviations to these requirements will be coordinated through CARCAH. All reconnaissance-aircraft data message formats, information, and code breakdowns, including RECCO, HDOB, TEMP DROP, and VDM, 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	**Vortex Data Message (VDM)**	**Vertical Data WMO Temp Drop Code (FM37-VII)**	**High Density Observation (HDOB)**
En route	Approx. every 30 minutes over water not to exceed 200 nm	NA	Approx every 300-400 nm over water, or fewer/relocated per request or sonde conservation	30-sec interval
Invest area	At major turnpoints. Also, every 15 minutes if HDOBs are INOP.	After closing a circulation	NA	30-sec interval
Fix pattern	End points of Alpha pattern legs. When necessary with radar fix information.	Each fix.	Each tasked fix at or above 850 mb. Intermediate fixes and eyewall modules as requested. Beginning and turn points of initial Alpha pattern legs	30-sec interval

5.4.7. WP-3D Configuration.

The minimum operational configuration of the WP-3D will include the stepped frequency microwave radiometer (SFMR), Doppler radar and the advanced vertical atmospheric profiling system (AVAPS).

5.5. Reconnaissance Planning and Flight Notification.

5.5.1. DOC Requests for Aircraft Reconnaissance Data.

5.5.1.1. 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 5.5.2.1. 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) and an outlook for the succeeding 24-hour period. This coordinated request will be considered the agency's request for assistance (RFA) to DOD and will be provided to CARCAH as soon as possible, but no later than 1630 UTC each day in the format of Figure 5-5.

5.5.1.2. Tropical Cyclone Plan of the Day. From the coordinated DOC request, CARCAH will publish the Tropical Cyclone Plan of the Day (TCPOD). The format for the TCPOD is shown in Figure 5-6. When DOC reconnaissance needs exceed DOD and DOC resources, CARCAH will coordinate with the NHC to establish priorities of requirements.

NHOP COORDINATED REQUEST FOR AIRCRAFT RECONNAISSANCE

___ Original

___ Amendment

(Check One)

I. ATLANTIC REQUIREMENTS

STORM NAME FIX OR ON

DEPRESSION # STATION FLIGHT
FCST NHC

SUSPECT AREA TIME COORDINATES PATTERN
MVMT PRIORITY

_____

_____

_____

GULF STREAM

_____

SUCCEEDING DAY OUTLOOK

_____

_____

REMARKS _____

_____

II. PACIFIC REQUIREMENTS

STORM NAME FIX OR ON

DEPRESSION # STATION FLIGHT
FCST NHC

SUSPECT AREA TIME COORDINATES PATTERN
MVMT PRIORITY

_____

_____

_____

SUCCEEDING DAY OUTLOOK _____

_____

REMARKS _____

_____

III. DISTRIBUTION

A. TO CARCAH BY 1630Z OR AMEND AT ANY TIME

B. Date _____ Time _____ FCSTR INITIAL _____

C. 53 WRS _____ AOC _____ Other _____

Figure 5-3. NHOP Coordinated Request for Aircraft Reconnaissance

TROPICAL CYCLONE PLAN OF THE DAY FORMAT

ATLANTIC AND CENTRAL PACIFIC OCEANS

NOUS42 KNHC _____ (DATE/UTC TIME)

WEATHER RECONNAISSANCE FLIGHTS

CARCAH, NATIONAL HURRICANE CENTER, MIAMI, FL

_____ (LOCAL TIME) ___ (TIME ZONE) ___ (DAY) ___ (MONTH/DATE), ____ (YEAR)

SUBJECT: TROPICAL CYCLONE PLAN OF THE DAY (TCPOD)

VALID _____Z (MONTH) TO _____Z (MONTH) (YEAR)

TCPOD NUMBER.....(YR)- _____

I. ATLANTIC REQUIREMENTS

1. (STORM NAME, DEPRESSION, SUSPECT AREA) or (NEGATIVE RECON RQMTS)

FLIGHT ONE (NHC PRIORITY, if applicable)/TEAL or NOAA _____ (number)

A.	_____Z	FIX/INVEST TIME
B.	_____	MISSION IDENTIFIER
C.	_____Z	DEPARTURE TIME
D.	_____	FORECAST POSITION
E.	_____Z	TIME ON STATION
F.	_____	ALTITUDE(S) ON STATION
G.	_____	REMARKS (if needed)

FLIGHT TWO (if applicable, same as FLIGHT ONE)

2. (SECOND SYSTEM, if applicable, same as in 1. above)

3. OUTLOOK FOR SUCCEEDING DAY (NHC PRIORITY, if applicable)

A. POSSIBLE (Aircraft Mission Requirement) NEAR (Location) AT (Time) Z.

II. PACIFIC REQUIREMENTS (Same as in ATLANTIC)

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

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

5.5.1.3.1. For the Atlantic, Gulf of Mexico, 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, DOD installations, and other DOD assets when specified.
- Up to two synoptic surveillance missions per 24-hour period for potentially land-falling storms.

5.5.1.3.2. In the Eastern Pacific (EPAC), reconnaissance missions may be tasked when necessary to carry out warning responsibilities.

5.5.1.3.3. Investigative flights may be requested for disturbances in areas defined above, i.e., one or two flights per day dependent upon proximity of landfall and upon known or suspected stage of development.

5.5.1.3.4. Exceptions may be made when additional reconnaissance is essential to carry out warning responsibilities.

5.5.2. DOD and DOC Reconnaissance Aircraft Responsiveness.

5.5.2.1. Requirement Notification. Notification of requirements must proceed tasked-on-station time by at least 16 hours plus enroute time to the area of concern.

5.5.2.2. 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.

5.5.2.3. 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.

5.5.2.4. 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.

5.5.2.5. NOAA WP-3D Availability. At least one WP-3D will be operationally configured (per paragraph 5.4.7) 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 July 15 to September 30. 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.

5.5.3. Reconnaissance Tropical Cyclone Plan of the Day.

5.5.3.1. Preparation. CARCAH will coordinate the TCPOD (Figure 5-6) daily during the period from June 1 to November 30 and at other times during the year as required. Transmitted TCPODs will be serially numbered each season.

5.5.3.1.1. CARCAH will coordinate the TCPOD with NHC, the 53 WRS, and NOAA AOC before publication.

5.5.3.1.1.1. Combatant command headquarters and their air component command headquarters will coordinate on missions by reviewing the proposed TCPOD, then click 'For Tomorrow' under 'Plan of the Day.'

5.5.3.1.1.2. The coordinated TCPOD is the agency's RFA to DOD. Since DOD's support to NOAA is congressionally mandated and funded through the DOD Appropriations Act, the coordinated TCPOD is considered a validated and approved RFA.

5.5.3.1.2. The TCPOD will list all DOC/NOAA AOC and DOD required tropical and subtropical cyclone operational reconnaissance missions. Research missions will also be listed in the TCPOD when provided to CARCAH before transmission time.

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

5.5.3.2. Dissemination. The TCPOD will be made available to appropriate agencies, such as FAA, DOD, and NOAA, which provide support to or control of reconnaissance aircraft or are a part of the tropical cyclone warning service. Under normal circumstances, the TCPOD will be disseminated by 1830 UTC each day 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.

[NOTE: The TCPOD is disseminated under the header "MIAREPRPD" for AWIPS users and "NOUS42 KNHC" for AWDS users. The TCPOD can be accessed via the Internet at the National Hurricane Center homepage; access the Data & Tools drop down menu, then click on 'Aircraft Reconnaissance.']

5.6. Reconnaissance Effectiveness Criteria.

5.6.1. General.

Specified reconnaissance times are established to allow sufficient time for the forecaster to analyze the data before issuing an advisory. Every effort should be made to obtain data at scheduled times. The following criteria will be used to assess reconnaissance mission effectiveness:

5.6.1.1. 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.

[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.]

5.6.1.2. 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.

5.6.1.3. Synoptic Surveillance Missions.

- SATISFIED. Requirements are considered satisfied upon completion of the assigned track and the acquired dropwindsonde data are transmitted from the aircraft prior to the WPC/OPC deadline for synoptic analysis.
- MISSED. When the requirements listed above are not satisfied.

5.6.2. 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 5-7). Mission requirements levied as "resources permitting" will not be assessed for timeliness but may be assessed for quality of data gathered.

5.6.3. Summaries.

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

MISSION EVALUATION FORM

MEMORANDUM FOR: OL-A, 53 WRS/CARCAH

FROM:_____(Director, NHC, CPHC) .

SUBJECT: Mission Evaluation
(Mission Identifier)

PUBLISHED REQUIREMENTS:

Premission Coordinates (As Updated Prior to TKO)_____N_____W

Flight Pattern _____

Mission Requirements Times _____

RECONNAISSANCE MISSION PERFORMANCE:

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

OVERALL MISSION EVALUATION:

OUTSTANDING_____

UNSATISFACTORY_____ FOR:

COMPLETENESS_____ TIMELINESS_____ ACCURACY_____

EQUIPMENT_____ PROCEDURES_____ OTHER_____

REMARKS: (Brief but specific)

_____
FORECASTER's SIGNATURE

Figure 5-5. Mission Evaluation Form

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

5.7.1. 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. An image of inner core radar reflectivity should ideally be acquired at fix time and correspond to each Vortex Data Message.

5.7.2. 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. Two examples follow:

Example 1: RADAR FIX PSBL CENTER 21.5N 83.0W, POOR RADAR PRESENTATION, SPIRAL BAND, MET ACCURACY 15NM

Example 2: RADAR FIX EYE 21 DEG 23 MIN N 78 DEG 42 MIN W GOOD RADAR PRESENTATION CIRCULAR EYE DIAM 25 NM OPEN SW.

5.7.3. 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.

5.7.4. Mission Coordination.

Mission 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.

5.7.5. 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.

5.7.6. 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.

5.7.7. 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.

5.7.8. Storm Identifier <Storm ID>.

To facilitate the automatic ingest into the NHC, CPHC, and DOD 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.

5.7.9. 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, 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.

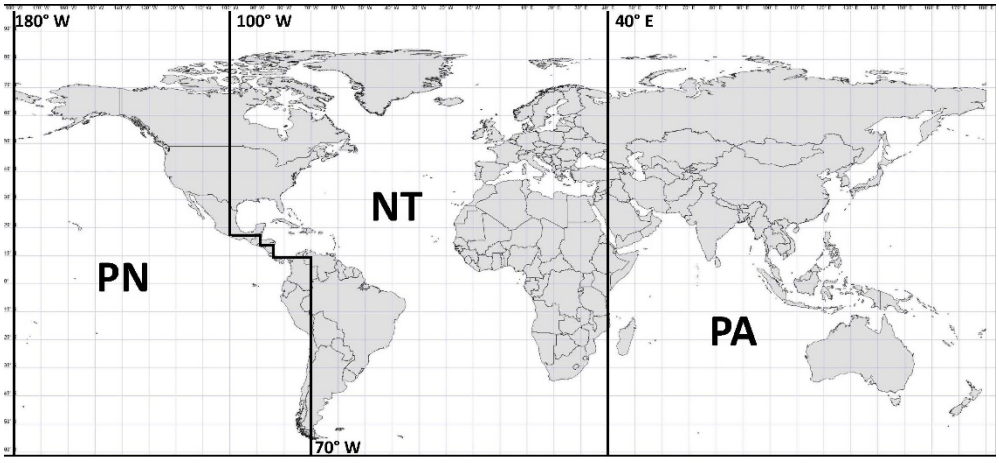


Figure 5-6. Geographical Basins in Aerial Reconnaissance Abbreviated Headings

Table 5-3. Elements of the Mission Identifier

AGENCY/ AIRCRAFT	Mission Storm System Indicator			
Agency + Aircraft Number[1][2]	Sequential number of mission in this storm or WX[3]	Two-digit depression number or two letter identifier if not a depression or greater[4]	Location A, E, C, or W[5]	Storm name or mission type (i.e., CYCLONE or INVEST)
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.			
NOAA2 01BBA INVEST	NOAA aircraft 42RF on the first mission to investigate the second unclassified suspect area in the Atlantic, Gulf of Mexico, 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.			

[1] AF plus last 3 digits of tail number

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

[3]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" (e.g., WA, WB, WC, etc.)

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

[5] A=Atlantic, Caribbean, or Gulf of Mexico; E=Eastern Pacific; C=Central Pacific; W=Western Pacific

5.7.10 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 P in a vortex data, each of the 61616 lines in a sonde TEMP DROP code, and the second line in an HDOB data message. 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 130552 CCB VORTEX DATA MESSAGE AL092008 A. 13/04:47:20Z B. 28 deg 52 min N 094 deg 37 min W . . . P. AF301 3509A IKE OB 02 CCB MAX FL WIND 103 KT 135 / 20 NM 04:30:40Z CORRECTED FOR TIME IN ITEM A	Second correction for vortex data message OB 02 from the AF301 3509A IKE mission.
UZNT13 KWBC 080739 CCA XXAA 58062 99300 70760 11606 99/// ///// ///// 00956 25616 09512 . . . 61616 NOAA9 1109A IKE OB 03 CCA 62626 0629 LST WND 894 AEV 20704 CORRECTED RPT DLM WND 08509 0071 82 = XXBB 58068 99300 70760 11606 00/// ///// 11007 26217 22977 24010 . . . 61616 NOAA9 1109A IKE OB 03 CCA 62626 0629 LST WND 894 AEV 20704 CORRECTED RPT DLM WND 08509 0071 82 =	Correction for sonde TEMP DROP code message OB 03 from the NOAA9 1109A IKE mission.

5.8. Operational Flight Patterns.

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

5.8.1. Flight Pattern ALPHA Operational Details.

5.8.1.1. Flight Levels and Sequence. 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 and 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. A horizontal observation is required at each leg end point. This data is transmitted immediately. Vertical dropsondes observations are also required at the beginning and the turn points of an initial ALPHA pattern. 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.

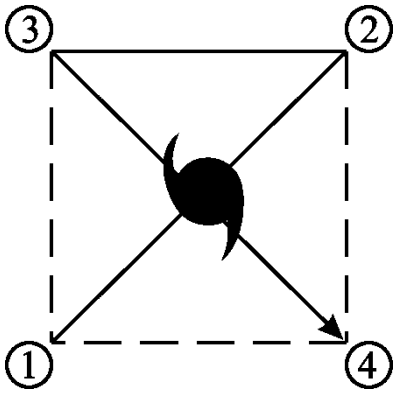


Figure 5-7. Flight Pattern ALPHA

5.8.1.2. 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 inbound 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.

5.8.2. 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.

5.8.2.1. 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.

5.8.2.2. Vortex Fix. A vortex data message is required if a vortex fix is made.

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

5.8.2.4. 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.

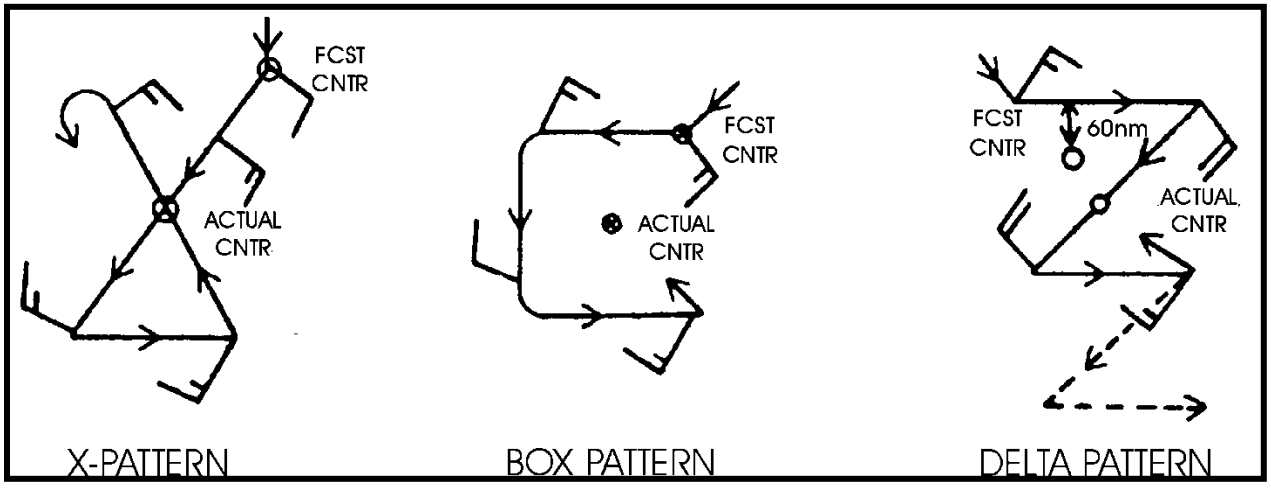


Figure 5-8. Suggested Patterns for Investigative Missions

5.8.3. Synoptic Surveillance Missions.

A synoptic surveillance mission is tasked to measure the large-scale wind and thermodynamic fields within approximately 800 nautical miles 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.

5.8.4. 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.

5.8.4.1. 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 12 km) 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 drop windsondes, 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.

5.8.4.2. Outer-Wind Field Module. On an alpha pattern, deploy drop windsondes 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.

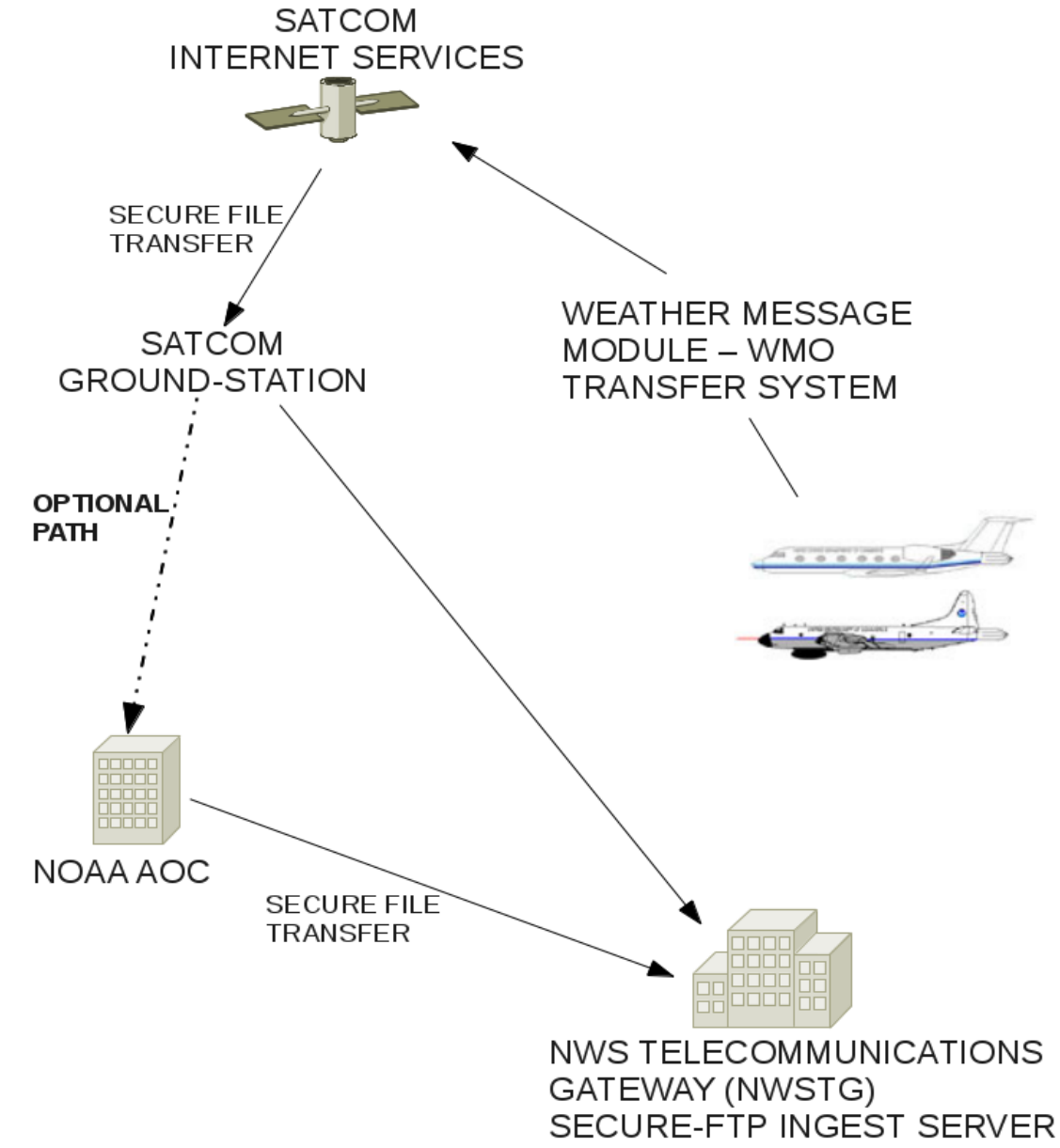
5.9. Aircraft Reconnaissance Communications.

5.9.1. General.

The 53 WRS WC-130 aircraft will normally transmit reconnaissance observations via the Air Force Satellite Communications System (AFSATCOM) 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 557th Weather Wing (557 WW), Weather Product Management and Distribution System (WPMDS) 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 NWS Telecommunication Operations Center in Silver Spring, MD. Figures 5-9 and 5-10 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.

5.9.2. Backup Air-to-Ground Communications.

The weather reconnaissance crew may relay weather data via SATPHONE or HF phone patch to the mission monitor at CARCAH. The monitor will evaluate these reports and disseminate them through the Weather Processing Message Distribution System (WPMDS) or to the NWS Telecommunications Gateway (NWSTG). Specific radio procedures and terminology will comply with Allied Communications Publication 125, Standard Telephone and Radio Procedures. 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.



Schematic of WMO Message Path for NOAA G-IV and P-3 Aircraft

Figure 5-9. Schematic of WMO Message Path for NOAA G-IV and P-3 Aircraft

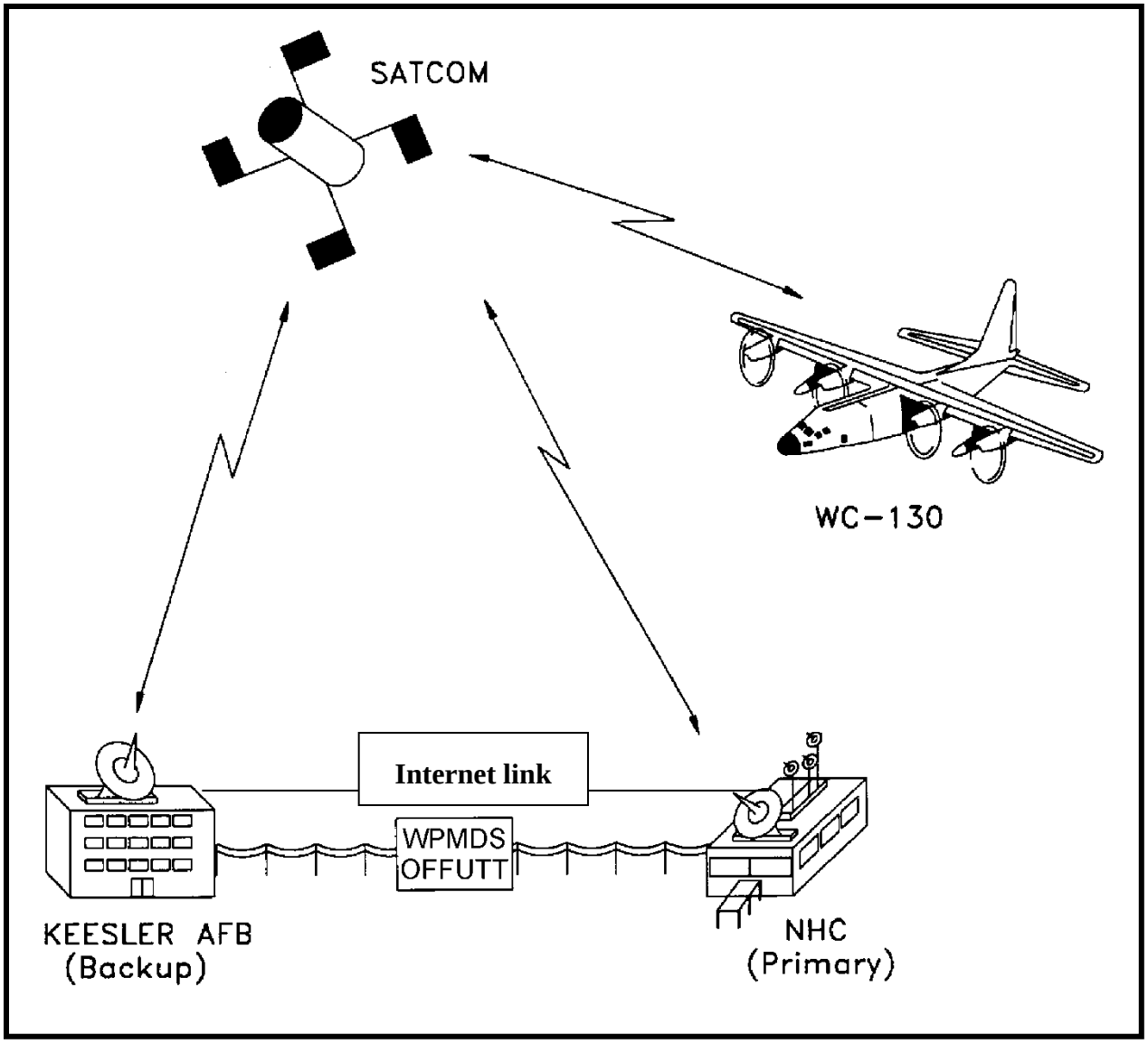


Figure 5-10. Schematic of Aircraft-To-Satellite Data Link for AFRC WC-130 Aircraft

[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 Offutt Air Force Base.]

5.9.3. 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 similar configuration and communications capability as the primary satellite ground station installed at CARCAH. Each ground station can fully transmit data using SATCOM or land line to the other ground station. Both can securely send reconnaissance aircraft messages to the WPMDS, which then relays them to the 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 will be transferred to the 53 WRS, ensuring reconnaissance service is uninterrupted.

5.9.3.1. 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 and relaying data via land line to the CARCAH ground station. 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 WPMDS. No procedure is currently implemented for sending the aircraft data directly to local servers at WPC or CPHC (NHC's Continuity of Operations [COOP] backup site); consequently, all data or observations will need to be accessed from the WPMDS or obtained from the NWSTG.

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

5.9.3.2. Internet Communications Failure. In the event there is a long-term network communications outage between NHC and 557 WW, 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 557 WW WPMDS server. However, if the Internet disruptions occur at 557 WW, no data can be sent to the WPMDS, NWSTG, and external users until service is restored.

5.9.3.3. 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 the WPMDS 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 (53rd WRS)
- Federal Aviation Administration (FAA) Air Traffic Control System Command Center (ATCSCC), System Operations Security, and participating enroute Air Traffic Control (ATC) facilities[6]
- Department of Defense (DOD) 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 53rd WRS[7]; 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. This meeting will normally be conducted in conjunction with the Office of the Federal Coordinator for Meteorology (OFCM)-sponsored Interdepartmental Hurricane Conference (IHC).

6.1.1.2. Visits and Briefings. Annual visits by participating FAA enroute ATC facilities, System Operations Security, and ATCSCC; and briefings by 53rd 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 the Hurricane Hunter mission.

6.1.1.3. FAA Familiarization Flights. FAA familiarization flights on USAF (IAW AFI 11-401 and DOD 4515.13) and NOAA Hurricane Hunter 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.

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[8] is defined as a NOAA AOC or 53rd WRS manned aircraft listed in the

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[6] 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 53rd WRS, will participate.*

[7] Refers to the MOA cited by footnote 1.

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

Tropical Cyclone Plan of the Day (TCPOD) or tasked with an unscheduled operational mission that is conducted in a Weather Reconnaissance Area (WRA).

- **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. Unmanned Aircraft Systems (UAS) Operations. Unmanned Aircraft Systems (UAS) operations are permitted with manned aircraft within a WRA as described in paragraph 6.2.3.7. No other UAS operations are permitted in a WRA.

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. 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.[9] Only participating weather reconnaissance/research aircraft from NOAA AOC and 53rd WRS are permitted to operate within a WRA. A WRA may only be established in airspace within U. S. Flight Information Regions (FIRs) outside of U.S. territorial airspace.

6.1.4. Pre-Mission Coordination.

6.1.4.1. Mission Coordination Sheet. All 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).

NOTE- *Every effort will be made to accommodate release of SUA. However, in some cases, SUA will not be available for release. SUA Using Agencies determine if Department of Defense (DOD) 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 (CARCAH). CARCAH's pre-mission coordination procedures include:

- Publishing TCPOD when required.
- Coordinating with the affected en route ATC facilities and the ATCSCC as required.
- Notifying 53rd WRS and NOAA AOC flight crews when other research missions will be airborne in the operations area at the same time.

6.1.4.3. 53rd WRS and NOAA AOC.

- Submit the Mission Coordination Sheet (see Appendix I) according to sub-paragraph 6.1.4.1.

[9] 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.

- 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.** 53rd 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 Mexico 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.

6.1.4.4. Flying Agencies (other than the 53 WRS or NOAA AOC).

- NASA, NRL, NSF or any other agency planning reconnaissance/research missions into or around the forecast or actual storm location must coordinate with affected FAA en route ATC facilities and CARCAH as soon as possible prior to all flights.
- The flying unit must submit the Mission Coordination Sheet (see Appendix I) according to sub-paragraph 6.1.4.2.
- Flights in support of the NHOP (conducted by the 53rd WRS and NOAA AOC operations) are normally published in the TCPOD at by 1830 UTC. Reference the TCPOD to assist in de-confliction efforts.
- Issue advance notification to CARCAH of all planned reconnaissance/research missions in areas where NHOP operations are being conducted, including proposed flight tracks, aircraft altitudes, and locations where weather instruments may be released; this information can be e-mailed to ncep.nhc.carcah@noaa.gov or faxed to 305-553-1901 (please indicate "CARCAH" on submitted materials).

NOTE - *CARCAH coordination is normally restricted to what is required between the 53 WRS, NOAA AOC, NHC, 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. Reconnaissance/research missions can only be considered on a non-interference basis when flown concurrently with a tasked mission or when data collected will be directly beneficial to NHC in real time.*

- Transponder codes will be assigned by ATC.

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:

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

6.1.4.6. Mission Cancellation. When a mission is cancelled or delayed, the unit flying the mission must notify the Primary enroute 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 enroute ATC facilities are responsible for operational coordination in support of the NHOP.

6.1.5.2. ATCSCC Procedures.

- Review the TCPOD by 1830 UTC.
- 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 enroute ATC facilities at least 1 hour prior to flight departure time).
- Coordinate with the impacted enroute ATC facilities as required and designate a primary enroute 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 enroute ATC facilities.
- When NOAA or TEAL aircraft receive priority handling as specified in FAA Order 7110.65, assist enroute 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 at http://www.nhc.noaa.gov/reconlist.shtml, by 1830 UTC.
- Review the Mission Coordination Sheet (see Appendix L) - the flying unit will submit their Mission Coordination Sheet to the ATCSCC and affected enroute ATC facilities at least 1 hour prior to flight departure time.
- Coordinate with all impacted enroute ATC and Terminal facilities within their area of responsibility.
- Coordinate with all impacted DOD 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 53rd WRS and NOAA aircraft the designated NORAD transponder code associated with their call sign listed on the Mission Coordination Sheet.
- When designated by ATCSCC as the Primary ATC Facility, responsibilities will include:

    - 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 53Rd WRS may apply MARSA, in accordance with FAA Order 7110.65 and FAA Order 7610.4, between 53rd WRS aircraft. MARSA may not be applied between 53rd 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 DOD) 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 back-up (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 Procedures. Aircrews of participating aircraft are required to maintain contact with CARCAH at all times. CARCAH is responsible for ensuring that ATC clearances, clearance requests and messages are relayed in an accurate manner through any means available. Only use this method when the aircraft or ATC is unable to contact each other.

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 and provide standard vertical separation between all IFR aircraft and will provide VFR traffic advisories as far as practical. Prior to departing controlled airspace, advise ATC and state your intentions; ATC will not cancel your 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 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 already in the WRA and verify the center coordinates and maximum radius within the WRA.
- Arriving aircraft will commence entry to the WRA from FL15010, 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 (Primary: VHF 123.05 MHz, Secondary: UHF 304.8 MHz, Back-up: HF 4701 KHz) the other participating aircraft 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.

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.
- 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

[10] The upper limit of WRAs may be negotiated between NOAA AOC, 53rd 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.

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[11], 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.
- 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 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

[11] See footnote 5 for information on WRAs with lowered ceilings.

to release or activation. (Examples of weather instruments are dropsondes, UASs, and oceanographic profilers (OP)). When UAS weather instruments are released or activated within a WRA: (a) only a single participating aircraft conducting the UAS weather instrument release is permitted to operate within the WRA, and (b) the aircraft commander is responsible for ensuring no other participating aircraft are operating in the WRA.

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 enroute to adjust to the forecast track of the storm. CARCAH will be responsible for relaying any revisions to the flight crew. The 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 enroute, 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 FL 190 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 participating aircraft must be made using the frequencies listed in the second bullet of paragraph 6.2.1.8.
- 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.

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 East.

GOES-East (GOES-16) is stationed at 75.2°W 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 West.

GOES-West is currently stationed at 135°W. The anticipated placement of GOES-17 at the GOES-West position in late 2018 will change the GOES-West location to 137°W due to improved GOES-R series sensor capabilities. 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-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-13.

GOES-13 was launched on May 24, 2006. GOES-13 was the first of the GOES-N series of satellites and served in the GOES-East position for many years before being moved to current station at 60°W and awaiting a decision on whether it will be utilized by a NOAA partner agency or be moved into a decommission orbit.

GOES-14.

GOES-14 was launched on June 27, 2009. It is currently positioned at 105°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. Before the month was over, GOES-13 had recovered and GOES-14 was put back into storage mode and subsequently drifted back to 105°W.

GOES-15.

The last of the GOES N series, GOES-15, was launched on March 4, 2010, is currently serving as the operational GOES-West satellite.

GOES-R Series.

The capabilities of GOES-R Series satellites (16,17,T,U) are much greater than with the GOES-N series satellites. Routine imaging over the CONUS occurs at 5 minute frequency with Full Disk coverage every 15 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 will also be available. This series of satellites does not have a sounder instrument. The Geostationary Lightning Mapper (GLM) instrument aboard GOES-16 detects total lightning activity across the Western Hemisphere: in cloud, cloud-to-cloud, and cloud-to-ground.

GOES-16.

GOES-16 launched on November 19, 2016. GOES-16 is the first of the GOES-R series of satellites and is currently the operational GOES-East spacecraft. GOES-16 began drifting to the GOES-East operational location of 75.2°W longitude on November 30, 2017. Drift was complete on December 11, 2017, and nominal operations resumed on December 18, 2017 when the satellite was declared GOES-East.

GOES-17.

The second in a series of four next-generation weather satellites in geosynchronous orbit above the Earth will move to the GOES-West operational location and be designated as GOES-17. NOAA's GOES-17 launched on March 1, 2018. After post-launch testing and calibration is complete, the first imagery from the satellite is expected in mid-May 2018. Then, a six-month on-orbit checkout of its instruments and systems, followed by operational handover procedures will commence. The satellite will move to its operational location at 137°W longitude in late 2018 and become NOAA's GOES West.

GOES-17 will provide faster, more accurate, and more detailed data in near real-time to track storm systems, lightning, wildfires, coastal fog, and other hazards that affect the western U.S., Hawaii and Alaska. An operational GOES-17 will give the Western Hemisphere two next-generation geostationary satellites. Together, GOES-16 and GOES-17 will monitor weather and environmental hazards from the west coast of Africa all the way to New Zealand.

7.1.1.2. EUMETSAT Meteosat Geostationary Satellites.

EUMETSAT's current series of geostationary satellites, Meteosat Second Generation, consists of Meteosat-8, -9, -10, and -11, each supporting a specific mission. Located at different positions, the four (4) 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 EUMETSAT's prime operational geostationary satellite stationed at 0° longitude. The satellite provides a full earth scan every 15 minutes in 12 spectral channels. Meteosat-11 also provides geostationary earth radiation budget data, search and rescue monitoring, and relay of Data Collection Platform data.

Meteosat-10, stationed at 9.5°E and launched in July 2012, 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.

Meteosat-9, stationed at 3.5°E and launched in December 2005, provides backup to prime Meteosat-11 in the event of a failure.

Meteosat-8, stationed at 41.5°E and launched in August 2002, supports the full earth scan mission over the Indian Ocean. It also provides Search and Rescue monitoring and Data Collection Platform relay service.

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 allows meteorologists to analyze the characteristics of atmospheric air masses and reconstruct a three-dimensional view of the atmosphere.

Around 2022, EUMETSAT will launch its first Meteosat Third Generation (MTG) geostationary satellite. The satellite platform will host instruments with additional channels with better spatial, temporal and radiometric resolution, compared to the current MSG satellites. MTG will consist of a two satellite system, one for imaging and the other for sounding, MTG-I and MTG-S, respectively. (JP).

7.1.1.3: Himawari.

The current 8th and 9th geostationary weather satellites operated by the Japan Meteorological Agency are named Himawari -8 and -9. Himawari-8 was launched in October 2014 and effective July 2015, is currently operating at 140.7° East, the prime geostationary satellite position to support JMA’s meteorological and environmental monitoring services over eastern Asia and the West Pacific Ocean. Himawari-9 was launched in November 2016 and is positioned near 141 degrees East as a backup to Himawari-8 in the event of a failure. Himawari-8 replaced MTSAT-2 as JMA’s prime geostationary satellite in July 2015. Himawari-8 introduced a new series of imager instrument, Advanced Himawari Imager (AHI), which 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 provide 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 agreement, NOAA acquires Himawari data from JMA’s Himawari Cloud service and then makes the data available to NOAA sites including NESDIS SAB and NWS NCO and DoD.

7.1.1.4: COMS-1.

The Communication, Ocean and Meteorology Satellite (COMS) is the first operational weather and ocean satellite from The Republic of Korea. COMS-1 was developed by the Korean Astronomical Research Institute (KARI) through contract with EADS Astrium, and carries a 5 channel imager similar to the imager on board GOES L-N. Full disk images are directly broadcast from the satellite every 27 minutes. Stationed at 128°E, the Korean Meteorological Administration (KMA) began prime operations of COMS-1 in 2011, providing supplemental coverage of the West Pacific and East Indian oceans. The primary U.S government user of COMS-1 data is DoD.

7.1.2: Low Earth Orbiting (LEO) Satellites

7.1.2.1: Initial Joint Polar System (IJPS).

Two primary operational polar orbiting satellites, NOAA's NOAA-19 and EUMETSAT's Metop-B, 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 direct 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 sub-sampled 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 DOD, 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) 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. Normal spectral resolution (NSR) and full spectral resolution (FSR) operational modes provide a total of 1305 and 2211 radiance channels, respectively. 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 new generation polar-orbiting operational environmental satellite system. 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 will become the primary operation spacecraft this later year. 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 will feature several instruments similar to those found on NOAA-20—VIIRS, CrIS, ATMS and OMPS-N—and provide 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 is scheduled to launch in 2021. JPSS-3, the third spacecraft in the JPSS series, is scheduled to launch in 2026. Benefiting from on 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, JPSS-2, 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, EUMESTAT 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 the NASA Earth Observing System (EOS) satellites: Terra, Aqua, and Aura; CORIOLIS from the Department of Defense; Jason-2 and Jason-3 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. 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.

In February 2016, a power failure aboard DMSP F19 left the command-and-control subsystem without the ability to reach the satellite's processor, according to the US Air Force Space Command investigation released in July 2016 that also announced that DMSP F19 was considered to be 'lost.' The failure left F14, F15, F16, F17 and F18 – all significantly past their expected 3–5 year lifespan – operational. There are no remaining DMSP satellites to be launched.

7.1.3.2: GCOM-W1.

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 13:30 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, including bTPW, eTRaP, GCOM-W1 AMSR2 Algorithm Software Package (GAASP). NESDIS also reformats the GCOM-W1 AMSR2 data into the BUFR for use by the NOAA NWP community, and some international agencies.

7.1.3.3: Jason-2 and Jason-3.

Jason-2 and its follow-on mission Jason-3 are joint NOAA, NASA, CNES, and EUMETSAT satellites launched on June 20, 2008 and January 17, 2016, respectively.

Jason-2 is in a long-repeat orbit (LRO) with Jason-3, 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-2 and Jason-3 each utilize a two-frequency Poseidon radar altimeter operating at 13.575 GHz (Ku-band) and 5.3 GHz (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.

7.1.3.4: Scatsat-1.

Scatsat-1 is an Indian satellite, launched September 26, 2016, by the Indian Space Research Organisation (ISRO). Scatsat-1 is a continuity mission for Oceansat-2 Scatterometer to provide wind vector data products for weather forecasting, cyclone detection and tracking services to the users. The satellite carries Ku-band Scatterometer similar to the one flown onboard Oceansat-2.

7.1.3.5: GPM

The Global Precipitation Measurement (GPM) mission is an international network of satellites that provide the 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 National Hurricane Center, including Microwave Integrate Retrieval System (MiRS), Blended Total Precipitable Water (bTPW), Ensemble Tropical Rainfall Potential (eTRaP). 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 3-5, "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 32°N in both the Atlantic and eastern Pacific east of 140°W.

7.2.2.2. Satellite Interpretation Messages.

WFO Guam issues these discussions two times a day to describe synoptic features and significant weather over the Micronesian waters.

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 global tropical cyclone development, including location and intensity analysis based on the Dvorak technique (Table 7-1). Estimates of cumulative rainfall expected over coastal areas derived using the eTRaP methodology are provided for tropical cyclones and posted to a web site in support of CPHC, WPC, NHC, forecast offices in U.S. territories, and international customers. 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
TXST20-21 KNES	South Atlantic Ocean	VIS/IR
TXNT	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
TXXS	South 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 (stand-by at 104°W) GOES-15 (134.5°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 including 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) 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 (75.2°W) GOES-17 (137°W when operational)	Multi-band imager (16 spectral channels)	Full disk every 15 minutes CONUS 5 minute frequency Mesoscale Sector coverage every 30 seconds	1. ABI band 2 is .5 km resolution 2. Bands 1, 3, 5 are 1 km resolution and all other banks are 2 km resolution. 3. GLM provides total lightning activity across the Western Hemisphere. 4. For list of baseline products see: http://www.goes-r.gov/products/baseline.html (Note: GOES-16 L2+ products are not yet available.) 5. Global Hydro-Estimator (GHE)
METEOSAT-11 at 3.4° W (Prime Meridian) METEOSAT-8 at 41.5°E (Indian Ocean)	Multi-spectral Spin-Scan Radiometer (SEVIRI) and High Resolution Visible (HRV)	SEVIRI: Full disk image every 15 minutes. HRV: Sector scan to move with local noon/available daylight.	1. 1 km resolution VIS imagery (HRV); 3 km resolution IR imagery (SEVIRI). 2. 3 km resolution VIS and IR WEFAX imagery. 3. 3 km water vapor imagery. 4. Tropical storm monitoring and intensity analysis. 5. Volcanic ash detection and analysis. 6. Advanced Dvorak Technique (ADT) 7. Tropical Cyclone Formation Probability Guidance Product(TCFP) 8. Ensemble Tropical Rainfall Potential (eTRaP) 9. Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) 10. 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
Himawari-8 and 9 at 140.7°E (Asian Pacific)	Multi-band imager (16 spectral channels)	Full disk every 10 minutes	1. AHI .5 km band 3 resolution 2. 1 km resolution for bands 1, 2, and 4. All other bands 2 km resolution. 3. Tropical storm monitoring and intensity analysis. 4. Volcanic ash detection and analysis 5. Aerosol monitoring. 6. Advanced Dvorak Technique (ADT) 7. Tropical Cyclone Formation Probability Guidance Product(TCFP) 8. Ensemble Tropical Rainfall Potential (eTRaP) 9. Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) 10. Global Hydro-Estimator (GHE)
COMS-1 at 128°E (Asian Pacific)	Meteorological Imager (MI) (5 spectral channels)	Full disk every 30 minutes	1. MI 1 km resolution VIS imagery. 2. MI 4 km resolution in 4 IR channels. 3. Tropical storm monitoring. 4. Aerosol monitoring.
GPM (Global Precipitation Mission)	GMI	Fluctuates from 60°N to 60°S	1. Microwave Integrate 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	VIIRS and ATMS	Every 12 hours	1. Microwave Integrate Retrieval System (MiRS) 2. Blended Total Precipitable Water (bTPW) 3. Ensemble Tropical Rainfall Potential (eTRaP) 4. Cross-track Infrared Sounder (CrIS) to monitor moisture and pressure 5. Microwave based tropical cyclone intensity estimates. 6. Blended Rain Rate

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

SATELLITE	TYPE OF DATA	SCAN TIME	PRODUCTS
S-NPP	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
GCOM-W1	AMSR2	Sun-synchronous orbit (~700 km altitude) ascending node equator crossing time of 13:30 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
MetOp-A and B NOAA-19 NOAA-18 (secondary) NOAA-15 (secondary)	AVHRR (GAC and LAC [recorded]); HRPT (direct); (AMSU-A; MHS [N-19]; HIRS)	Local Crossing Times: MetOp-B: 0931D / 2131A MetOp-A: 0929D / 2129A 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 analysis. 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 Integrate Retrieval System (MiRS) 17. Blended Rain Rate

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

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 DOD tactical terminals. 3. SSM/IS data transmitted to NESDIS and FNMOC from 557 WW. 4. Ensemble Tropical Rainfall Potential (eTRaP) 5. Advanced Dvorak Technique (ADT)

[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 DOD, 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 DOD, 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 as a sub-link to the National Hurricane Operations Plan on the OFCM web site. It is also available via fax from the ROC Hotline (1-800-643-3363).

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). Further discussion of product usage appears in Section 4.11 of FMH-11, Part D, Unit Description and Operational Applications. A recommended WSR-88D product list associated with tropical cyclones appears in Table 4-3 of FMH-11, Part D.

Table 8-1. Participating WSR-88D Radar Stations[12]

NWS Radars *U.S. Gulf and Atlantic Coasts*	**NWS Radars** *U.S. Southwest*	**FAA Radars**	**DOD 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			
Ft. Worth, TX			
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			

[12]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 or CPHC) will issue a Tropical Cyclone Update (TCU) on an hourly basis in between Tropical Cyclone Public Advisory issuances.

CHAPTER 9: NATIONAL DATA BUOY CAPABILITIES AND REQUIREMENTS

9.1. General.

9.1.1. Automated Reporting Stations.

The National Data Buoy Center (NDBC) maintains automated reporting stations in the coastal and deep ocean areas of the Gulf of Mexico, 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 Mexico, 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 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 Data Management and Communications Branch, Stennis Space Center, Mississippi 39529-6000, phone 228-688-2835.

9.1.2. Data Acquisition.

Moored buoy and Coastal-Marine Automated Network (C-MAN) stations routinely acquire, store, and transmit data every hour; a few selected stations report more frequently. Data obtained operationally include sea level pressure, wind speed and direction, peak wind, and air temperature. Sea surface temperature and wave spectra data are measured by all moored buoys and a limited number of C-MAN stations. Relative humidity is measured at several stations. Ocean currents and salinity are measured at a few coastal stations.

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.

9.1.3. Drifting Buoys.

9.1.3.1. NDBC.

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

9.1.3.2. 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 1 to 2 years, and the data are available through the NAVOCEANO homepage 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. Atlantic Fleet (COMLANTFLT). Currently, COMLANTFLT 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.

9.2. Requests for Drifting Buoy Deployment.

Drifting buoy deployments should be coordinated through the DOC, NOAA. Deployments will be requested through the Office of the Federal Coordinator for Meteorology (OFCM) to HQ Air Force Reserve Command (AFRC). Deployments in advance of a U.S. land-threatening hurricane require a 36- to 48-hour notification.

9.2.1. CARCAH.

CARCAH will issue, through the TCPOD, an alert or outlook for drifting buoy deployment 48 hours before the planned deployment. Hard tasking for the deployment will be issued via the TCPOD at least 16 hours, plus flying time to the deployment location, before the event.

9.2.2. Deployment of Buoys.

DOC may request the deployment of a drifting buoy and subsurface float array with up to 40 elements at a distance of 200 to 400 nm from the storm center, depending on the dynamics of the storm system. DOC will ensure the buoys and mission-related DOC personnel are delivered to AFRC. The specific DOC request for placement of the buoys will depend on several factors, including:

- Characteristics of the storm, including size, intensity, and velocity.
- Storm position relative to the coast and population centers.
- Availability of aircraft and *Loadmasters (LM)* certified for buoy deployment.

The Navy often works with the 53rd 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.

9.2.3. Deployment Position.

The final deployment position will be provided before the flight crew briefing. An example of a possible buoy and float deployment pattern from the recent CLBAST Experiment is shown in Figure 9-1.

9.3. Communications.

Moored buoy and C-MAN data are transmitted via NOAA Geostationary Operational Environmental Satellite (GOES) to the National Environmental Satellite, Data, and Information Service (NESDIS) or via the Iridium 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. 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. Drifting buoys transmit data via NOAA's Polar Orbiting Environmental Satellites (POES) to the U.S. Argos Global Processing Center, Largo, Maryland. Service Argos processes and formats the data into WMO FM18 BUOY code. The messages are then routed to the NWSTG for distribution. The formats for WMO encoded messages may be found in the WMO Manual on Codes Volume One, WMO-No. 306.

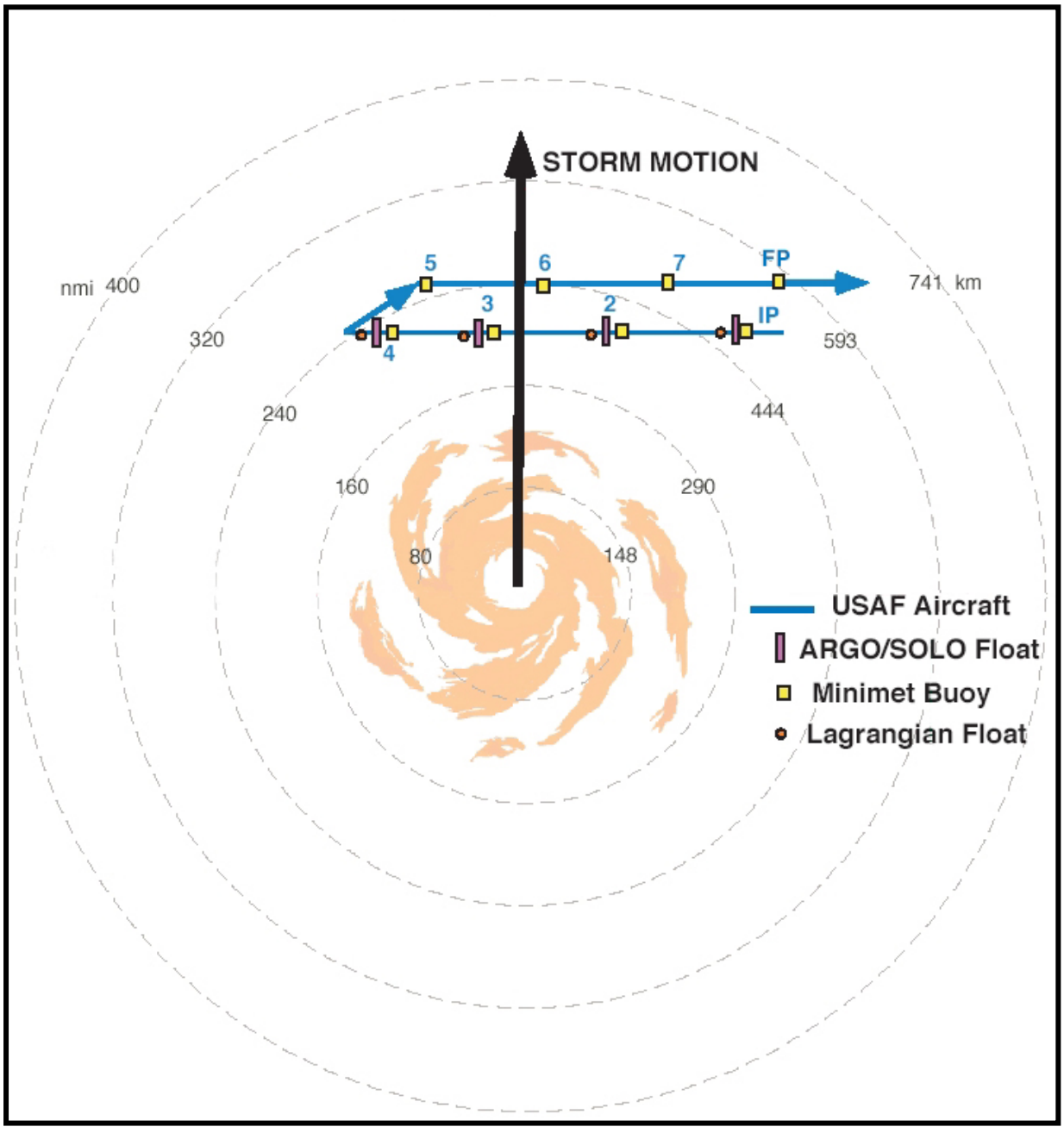


Figure 9-1. Example Buoy and Float Deployment Pattern

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 the 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 two primary GMDSS systems--NAVTEX and Inmarsat-C SafetyNET.

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. NAVTEX is broadcast from the 12 USCG stations. Coverage is reasonably continuous along the east, west, and Gulf coasts of the United States, as well as the area around Kodiak, Alaska, Guam, and Puerto Rico. Typical NAVTEX transmissions range from 200-400 nm.

10.2.2. SafetyNET.

Satellite systems operated by Inmarsat Ltd. are an important element of the GMDSS. Inmarsat-C 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; and the SafetyNET service. The Inmarsat-C SafetyNET service is a satellite-based worldwide maritime safety information 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.

10.3. 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. Medium Frequency Radiotelephone (Voice).

The USCG broadcasts offshore forecasts and storm warnings of interest to mariners on 2670 kHz, after first being announced on the distress, safety, and calling frequency 2182 kHz.

10.3.3 NOAA Weather Radio.

The NOAA Weather Radio network continually broadcasts coastal and marine forecasts on frequencies near 162 MHZ. Recorded voice broadcasts have largely been supplanted by a synthesized voice. The network provides near-continuous coverage of the coastal U.S., Great Lakes, Hawaii, Guam, Commonwealth of the Northern Mariana Islands, 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 DOD station); and Kodiak, AK (NOJ). Limited satellite imagery, sea surface temperature maps, and text forecasts 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).

Atlantic high seas warnings are broadcast at 7 and 8 minutes past the hour over WWV (Boulder, CO) on the following HF frequencies: 2.5, 5, 10, 15, and 20 MHZ; Pacific high seas warnings are broadcast at 9 minutes past the hour. Pacific high seas warnings are broadcast from 48-51 minutes past the hour over WWVH (Honolulu, HI) at 2.5, 5, 10, and 15 MHZ. These are the National Institute of Standards and Technology (NIST) standard time/frequency broadcasts.

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

In addition, the National Geospatial-Intelligence Agency (NGA), Publication 117, Radio Navigational Aids (Maritime Safety Information webpage; click on "Publications;" from Menu Options, select "Radio Navigational Aids"), contains detailed information on maritime safety information broadcasts within the U.S. and worldwide.

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
  P.O. Box 6829
  MacDill AFB, FL 33608-0829
- The Office of the Federal Coordinator for Meteorological Services and Supporting Research
  1325 East West Highway, Suite 7130
  Silver Spring, MD 20910

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, and Hawaii. 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
WDPN31-36 PGTW	Prognostic Reasoning Bulletin, Northwest Pacific Ocean
WTIO21-25 PGTW	Tropical Cyclone Formation Alert, North Indian Ocean
WTIO31-35 PGTW	Tropical Cyclone Warning, North Indian Ocean
WTPS21-25 PGTW	Tropical Cyclone Formation Alert, Southwest Pacific Ocean
WTPS31-35 PGTW	Tropical Cyclone Warning, Southwest Pacific Ocean
WTXS21-26 PGTW	Tropical Cyclone Formation Alert, South Indian Ocean
WTXS31-36 PGTW	Tropical Cyclone Warning, South Indian Ocean
WTPN21-25 PHNC	Tropical Cyclone Formation Alert, Northeast Pacific Ocean
WTPN31-35 PHNC	Tropical Cyclone Warning, Northeast Pacific Ocean
FKPN31-35 PHNC	Prognostic Reasoning Bulletin, Northeast Pacific Ocean
WTPS21-25 PHNC	Tropical Cyclone Formation Alert, Southeast Pacific Ocean
WTPS31-35 PHNC	Tropical Cyclone Warning, Southeast 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, Southwest 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 facsimile 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

A. 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. Flights that are flying in the storm environment will utilize the ARTCC whose airspace is mostly affected.

B. 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.

C. 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.

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

G. 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 E: SAFFIR-SIMPSON HURRICANE WIND SCALE

The Saffir-Simpson Hurricane Wind Scale (SSHWS) is a scale on a 1 to 5 categorization based on the hurricane's intensity at the indicated time. The scale provides examples of the type of damages and impacts associated with winds of the indicated intensity. In general, damage rises by a factor of four for every category increase. The maximum sustained surface wind peak (peak 1-minute wind at the standard meteorological observation height of 10 m (33 ft) over unobstructed exposure) associated with the cyclone is the determining factor in the scale. (Note that sustained winds can be stronger in hilly or mountain terrain compared with that experienced over flat terrain). Details for the Atlantic and Eastern Pacific Hurricane Basins and Central Pacific Hurricane Basin regarding the SSHWS can be found at the web sites indicated below.

- Atlantic and Eastern Pacific Hurricane Basins
- Central Pacific Hurricane Basin

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 Mexico, 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.[13] Only participating weather reconnaissance/research aircraft from NOAA AOC and 53rd WRS are permitted to operate within a WRA.

2. A "Participating Aircraft" is defined for the purposes of this MOA and related documents[14] 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.

[13] 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.

[14] Including the NHOP's Chapter 6 and any executing LOAs.

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- Unmanned 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.

(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,[15] 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.

(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.

[15] 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).

(c) Arriving aircraft will enter the WRA at FL150,[16] 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:

(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)

[16] 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.

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.[17]

(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.

[17] See footnote 4 for information on WRAs with lowered ceilings.

(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:

1. 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.

2. 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.

3. 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.

4. 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.

5. 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

6. 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 2 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[18], which is responsible for the airspace in which the weather reconnaissance/research

[18] 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).

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 Defense (DOD) 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:

a. [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).

(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),
(DOD Component)

ATTACHMENT 2

WRA NOTAM TEMPLATE

!FDC **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 **XXXXXX**N**XXXXXXX**W **(ARTCCS/CERAPS/HCF AND SUA USING AGENCIES MUST COORDINATE TO PUBLISH ANY REQUIRED AIRSPACE CUT OUTS)** SFC-XXX. VERTICAL MANEUVERING AND RELEASE OF DROPSONDES ARE EXPECTED. NONPARTICIPATING AIRCRAFT SHOULD AVOID THE WRA. IFR AIRCRAFT CAN EXPECT REROUTES.

TIME-TIME

NOTES-

1. WRAs are not permitted over land.
2. Cut-outs should include Class B, Class C, Class D, and SUA, as applicable.
3. Distance (NM) for the WRA radius must be coordinated. It will be dependent on the WRA location and ATC operational requirements.
4. 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.
5. WRA NOTAM must be domestic and international for widest dissemination.

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), dropsonde observations (TEMP DROP), and Vortex Data Messages (VDMs).

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 5.7.6 for details).*

KNHC: ICAO of National Hurricane Center where RECCO message is received and disseminated *(see Chapter 5, paragraph 5.7.6 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 99005.

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 (s*ee Note 10 in Table G-4 for wind speeds above 130 kt*). Note: light and variable winds < 10 kt are encoded as 99005.

RMK: Beginning of RECCO plain-language remarks section (*see Note 3 of Table G-4*).

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 5.7.8 for details).*

SWS=41KTS: Observed **s**urface **w**ind **s**peed measured by SFMR 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*).

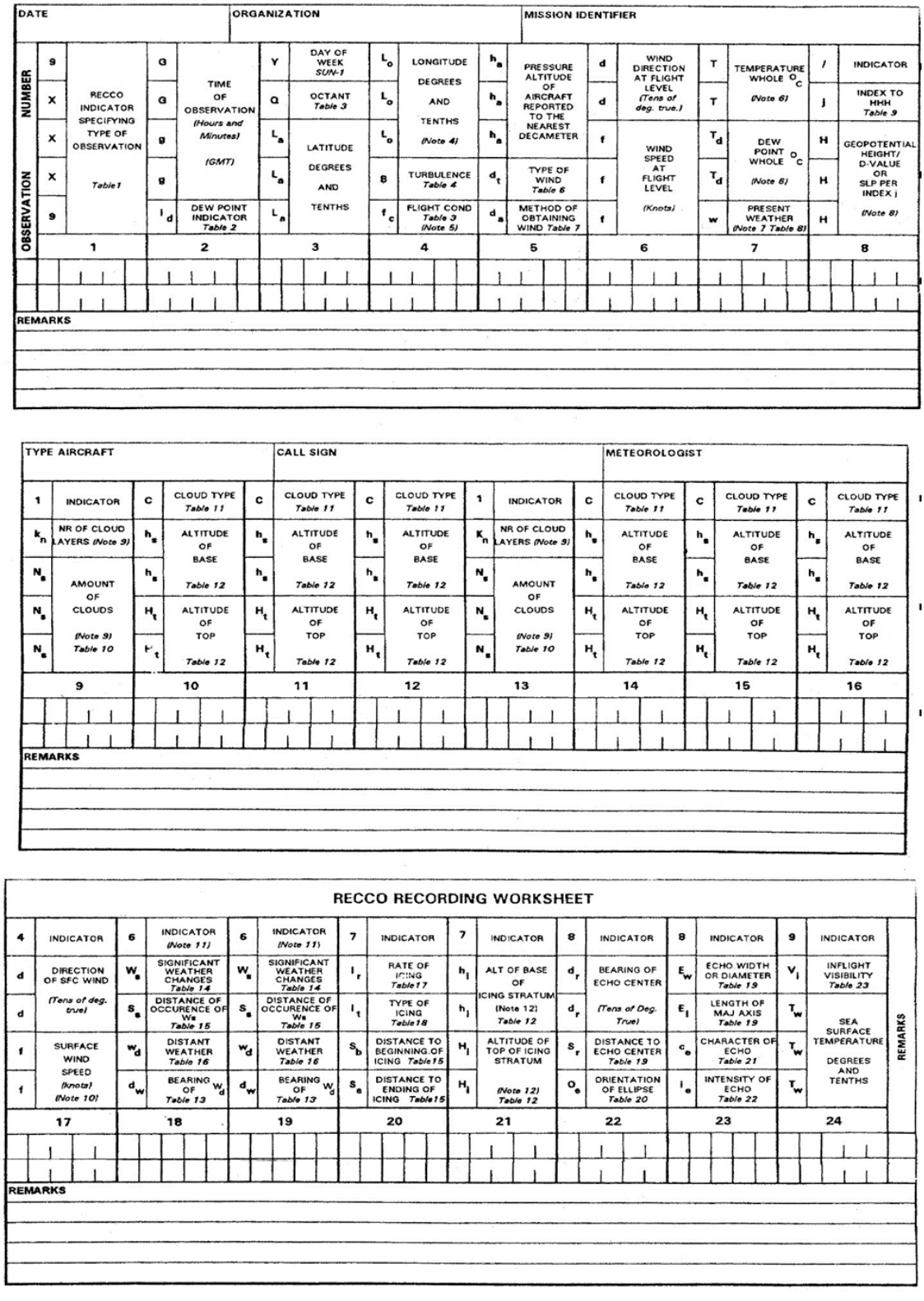
93273: The first digit, 9, indicates a sea-surface temperature measurement. The second digit, 3, indicates that the inflight visibility is greater than 3 miles *(see "Table 23" section of Table G-3).* The last three digits show the observed sea-surface temperature is 27.3°C.

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

NUMBER	9	RECCO INDICATOR SPECIFYING TYPE OF OBSERVATION Table 1	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)
OBSERVATION	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	
	1		2		3		4		5		6		7		8	

REMARKS

TYPE AIRCRAFT | CALL SIGN | METEOROLOGIST

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	
9		10		11		12		13		14		15		16	

REMARKS

RECCO RECORDING WORKSHEET

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	W_s	SIGNIFICANT WEATHER CHANGES Table 14	W_s	SIGNIFICANT WEATHER CHANGES Table 14	I_r	RATE OF ICING Table 17	h_l	ALT OF BASE OF ICING STRATUM (Note 12) Table 12	d_r	BEARING OF ECHO CENTER	E_w	ECHO WIDTH OR DIAMETER Table 19	V_i	INFLIGHT VISIBILITY Table 23		
d	(Tens of deg. true)	S_s	DISTANCE OF OCCURENCE OF Ws Table 15	S_s	DISTANCE OF OCCURENCE OF Ws Table 15	I_t	TYPE OF ICING Table 18	h_l		d_r	(Tens of Deg. True)	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 Table 15	H_l	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			REMARKS
f		d_w	BEARING OF W_d Table 13	d_w	BEARING OF W_d Table 13	S_e	DISTANCE TO ENDING OF ICING Table 15	H_l		O_e	ORIENTATION OF ELLIPSE Table 20	I_e	INTENSITY OF ECHO Table 22	T_w			
17		18		19		20		21		22		23		24			

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 $h_sh_sH_tH_th_ih_ih_iH_iH_i$

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 GGgg_{i_d} YQL$_a$L$_a$L$_a$ L$_o$L$_o$L$_o$Bf$_c$ h$_a$h$_a$h$_a$h$_a$d$_t$d$_a$

ddfff TTT$_d$T$_d$w /jHHH

SECTION TWO (ADDITIONAL)

1k$_n$N$_s$N$_s$N$_s$ Ch$_s$h$_s$H$_t$H$_t$ 4ddff

6W$_s$S$_s$W$_d$d$_w$ 7I$_r$I$_t$S$_b$S$_e$ 7h$_i$h$_i$H$_i$H$_i$ 8d$_r$d$_r$S$_r$O$_e$

8E$_w$E$_l$c$_e$i$_e$ 9V$_i$T$_w$T$_w$T$_w$

SECTION THREE (INTERMEDIATE)

9XXX9 GGgg_{i_d} YQL$_a$L$_a$L$_a$ L$_o$L$_o$L$_o$Bf$_c$ h$_a$h$_a$h$_a$h$_a$d$_t$d$_a$

ddfff TTT$_d$T$_d$w /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 //.

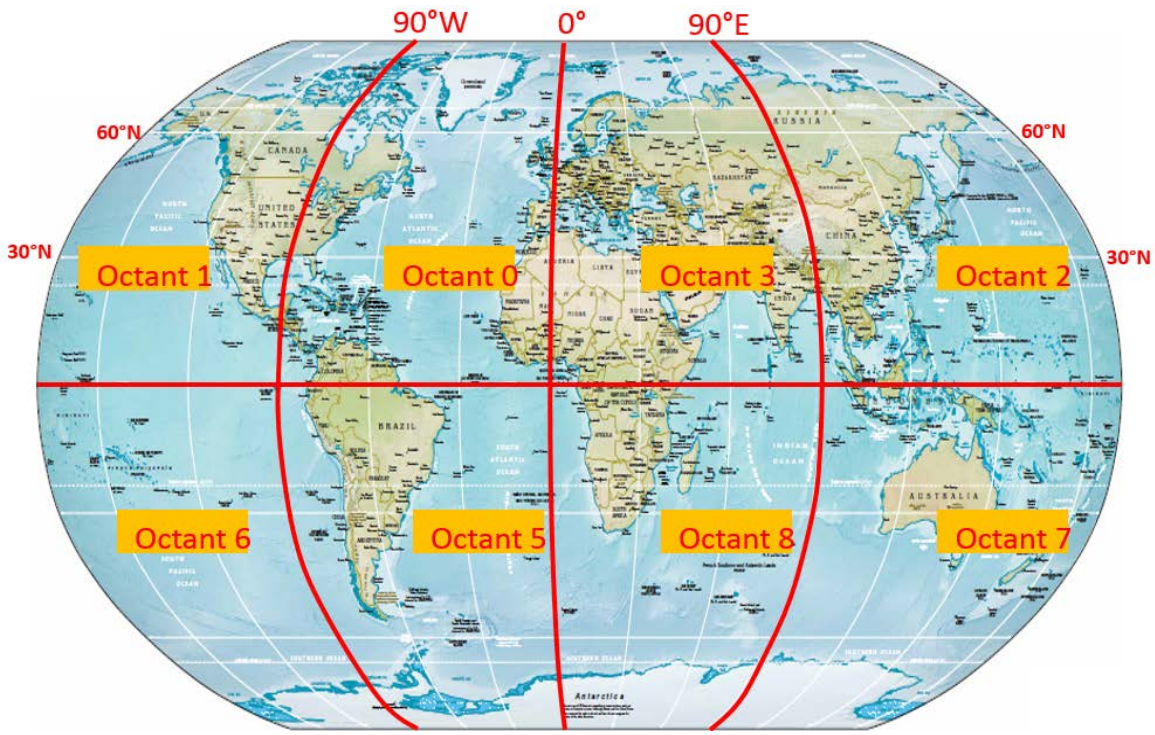


Figure G-3. Geographical Depiction of Octants Encoded in RECCO Messages

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 5.7.6, 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 SFMR 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
--------------------------------------------------------------------------
IIIIIIIIIIIIIIIIIIIIIIIIIIIII HDOB NN YYYYMMDD
AF302 1712A KATRINA HDOB 41 20050928 ← example
```

III...III:	Mission identifier, as determined in Chapter 5, paragraph 5.7.7.
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: Wind direction in degrees (30-s average). North winds are coded as 000. /// indicates missing value.

SSS: Wind speed, in kt (30-s average). /// indicates missing value.

MMM: Peak 10-second average 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 from the Stepped Frequency Microwave Radiometer (SFMR), in kt. /// indicates missing value.

ppp: SFMR-derived 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	SFM R parameter(s) questionable
4	T/TD and FL winds questionable
5	T/TD and SFMR questionable
6	FL winds and SFMR questionable
9	T/TD, FL winds, and SFMR 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 10 31313

51515 101A_{df} A_{df} 0$P_nP_nP'_nP'_n$.

or

101A_{df} A_{df} $P_nP_nh_nh_nh_n$

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 $n_o n_o P_o P_o P_o$ $d_o d_o f_o f_o f_o$

$n_1 n_1 P_1 P_1 P_1$ $d_1 d_1 f_1 f_1 f_1$

$n_n n_n P_n P_n P_n$ $d_n d_n f_n f_n f_n$

SECTION 7 31313 $s_r r_a r_a s_a s_a$ 8GGgg

SECTION 9 51515 $101 A_{df}$ A_{df} or

$101 A_{df}$ A_{df} $0 P_n P_n P'_n P'_n$. or

$101 A_{df}$ A_{df} $P_n P_n h_n h_n h_n$

SECTION 10 61616

62626

PART ALPHA (A)

IDENTIFICATION LETTERS: $M_J M_J$

Identifier: **$M_J M_J$ -** Identifier for Part A of the report.

DATE/TIME GROUP: YYGGI_d

Identifier: **YY -** Date group

Identifier: **GG -** Time group

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

LATTITUDE: 99$L_a L_a L_a$

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

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

LONGITUDE: $Q_c L_o L_o L_o L_o$

Identifier: **Q_c** – The octant of the globe.

Identifier: **$L_o L_o L_o L_o$** – Longitude in tenths of degrees

MARSDEN SQUARE: MMM$U_{la} U_{lo}$

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: 99$P_0 P_0 P_0$ $T_0 T_0 T_0 D_0 D_0$ $d_0 d_0 f_0 f_0 f_0$

Identifier: **99** – Indicator for data at the surface level follows

Identifier: **$P_0 P_0 P_0$** – Indicator for pressure of specified levels in whole millibars (thousands digit omitted)

Identifier: **$T_0 T_0 T_0$–** 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.

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.

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: 77$P_nP_nP_n$ $d_nd_nf_nf_nf_n$ 4$v_bv_bv_av_a$

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: 4$v_bv_bv_av_a$

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 0$P_nP_nP_nP_n$

Identifier: **51515** – Additional data in regional code follow

Identifier: **10166** – Geopotential data are doubtful between the following levels 0$P_nP_nP_nP_n$. 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 0$P_nP_nP_nP_n$. 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.

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 dddff** - 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 ALPHA (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** - Date group

Identifier: **GG -** Time group

Identifier: **8** - Indicator for the use of satellite navigation for windfinding.

LATTITUDE: 99$L_aL_aL_a$ (Same as Part A)

LONGITUDE: $Q_cL_oL_oL_oL_o$ (Same as Part A)

MARSDEN SQUARE: MMM$U_{la}U_{lo}$ (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. 295° at 125 knots encoded as 29625.

Same notes in Part A apply.

31313, 51515, 61616, 62626 – Repeated from Part A.

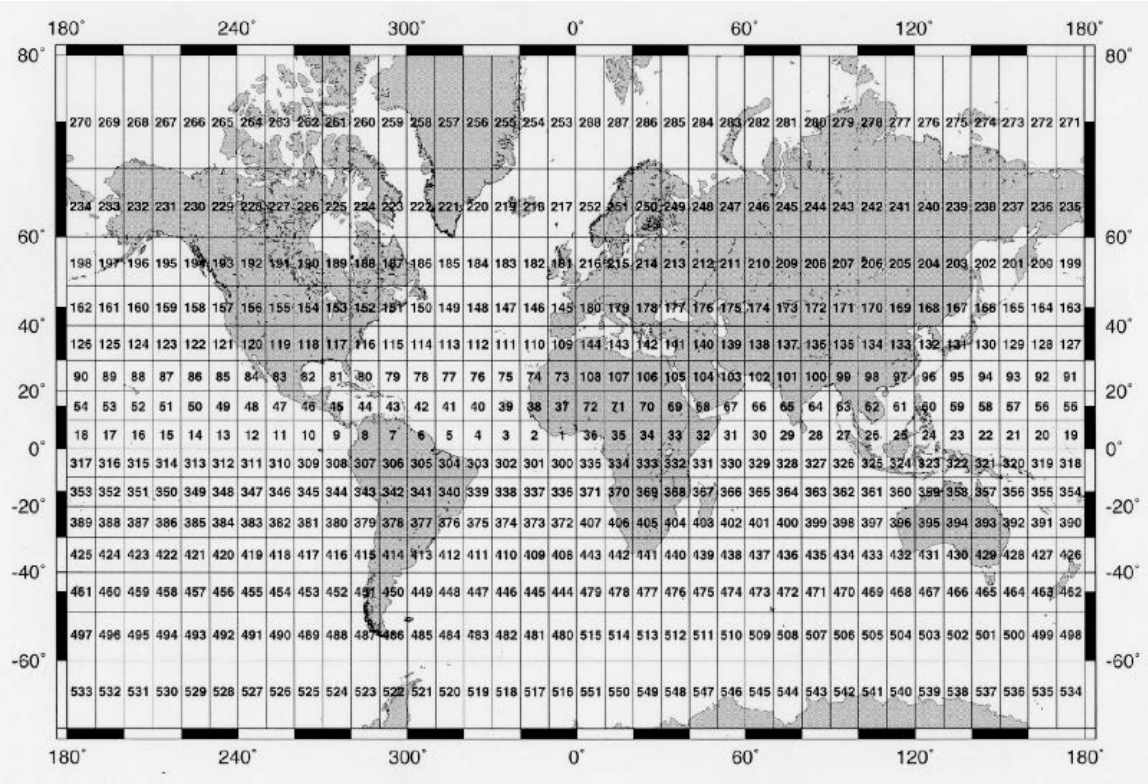


Figure G-6. Marsden Square Reference Diagram

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		
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 SFMR surface wind data are unavailable, the reported surface winds may be determined visually; note this in item UNIFORM remarks.
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 SFMR surface wind data are unavailable, the reported surface winds may be determined visually; note this in item UNIFORM remarks.
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.
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.

DATA ITEM	ENTRY
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 5.7.9; (2) the maximum flight level wind observed, time of observation, and the position relative to the flight level center of the observed wind on the latest pass through any octant 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, and (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.

Table G-8. Vortex Data Message Entry Explanation, continued

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 Operations Satellite Coordinator	Honolulu, HI	 COM 808-973-5272 COM 808-973-5284 COM 808-973-5270 FAX 808-973-5281 COM 808-973-5285
NOAA Aircraft Operations Center	MacDill AFB, FL	COM 863-500-3979 ~~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		
OFCM	Silver Spring, MD	COM 301-628-0112
Department of Defense		
17 OWS/WXJ (Satellite Analyst)~~JTWC (Typhoon Duty Officer)~~	Pearl Harbor, HI~~Pearl Harbor, HI~~	COM: 808-471-3533 DSN: 471-3533~~COM 808-474-2320~~
53rd Weather Reconnaissance Squadron (WRS) Supervisor of Flights Chief ARWO Alternate CARCAH~~53rd Weather Reconnaissance Squadron (WRS)~~ ~~Supervisor of Flights~~ ~~Chief ARWO~~ ~~Alternate CARCAH~~	53 WRS 817 H Street, Suite 201 Keesler AFB, MS 39534-2453~~53 WRS~~ ~~817 H Street, Suite 201~~ ~~Keesler AFB, MS 39534-2453~~	DSN: 597-2409 COM: 228-377-2409 DSN 597-3207 COM 228-377-3207 DSN 597-9060 COM 228-377-9060~~DSN 597-2409~~ ~~COM 228-377-2409~~ ~~DSN 597-3207~~ ~~COM 228-377-3207~~ ~~DSN 597-9060~~ ~~COM 228-377-9060~~
557th Weather Wing (557 WW)~~CARCAH OLA, 53d WRS~~	Offutt AFB, NE~~Miami, FL~~	COM 402-294-2586 DSN 271-2586~~COM 305-229-4474~~ ~~DSN 434-3420~~
601 AOC/CODW~~Keesler AFB Command Post~~	Tyndall AFB, FL~~Keesler AFB, MS~~	COM 850-283-5119

		DSN 523-5119~~COM 228-377-4181/4330~~ ~~DSN 597-4181/4330~~
CARCAH OLA, 53d WRS~~557th Weather Wing (557 WW)~~	Miami, FL~~Offutt AFB, NE~~	COM 305-229-4474 DSN 434-3420~~COM 402-294-2586~~ ~~DSN 271-2586~~
FACSFAC VACAPES OAC~~FACSFAC VACAPES OAC~~	Oceana, VA~~Oceana, VA~~	COM 804-433-1233 DSN: 433-1233~~COM 804-433-1233~~ ~~DSN 433-1233~~
FACSFAC San Diego~~17 OWS/WXJ (Satellite Analyst)~~	San Diego, CA~~Pearl Harbor, HI~~	COM: 619-545-5589~~COM 808-471-3533~~ ~~DSN 471-3533~~
FACSFAC Pearl Harbor~~601 AOC/CODW~~	Pearl Harbor, HI~~Tyndall AFB, FL~~	COM: 808-472-7337~~COM 850-283-5119~~ ~~DSN 523-5119~~
FFVC Ocean Airspace~~Fleet Weather Center~~	Norfolk, VA~~Norfolk, VA~~	COM: 757-433-1233~~COM 757-444-7583/7750~~ ~~DSN 564-7583/7750~~
Fleet Weather Center~~Fleet Weather Center Norfolk (FWC-N) (Alternate JTWC)~~	Norfolk, VA~~Norfolk, VA~~	COM 757-444-7583/7750 DSN 564-7583/7750~~COM 757-445-1872~~ ~~DSN 878-4325~~

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
DoD Air Traffic Services Cell	COM 540-422-4250 DSN 510-422-4250

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-h o

APPENDIX K: NHOP OPERATIONAL MAPS

(TERMINAL AREAS)

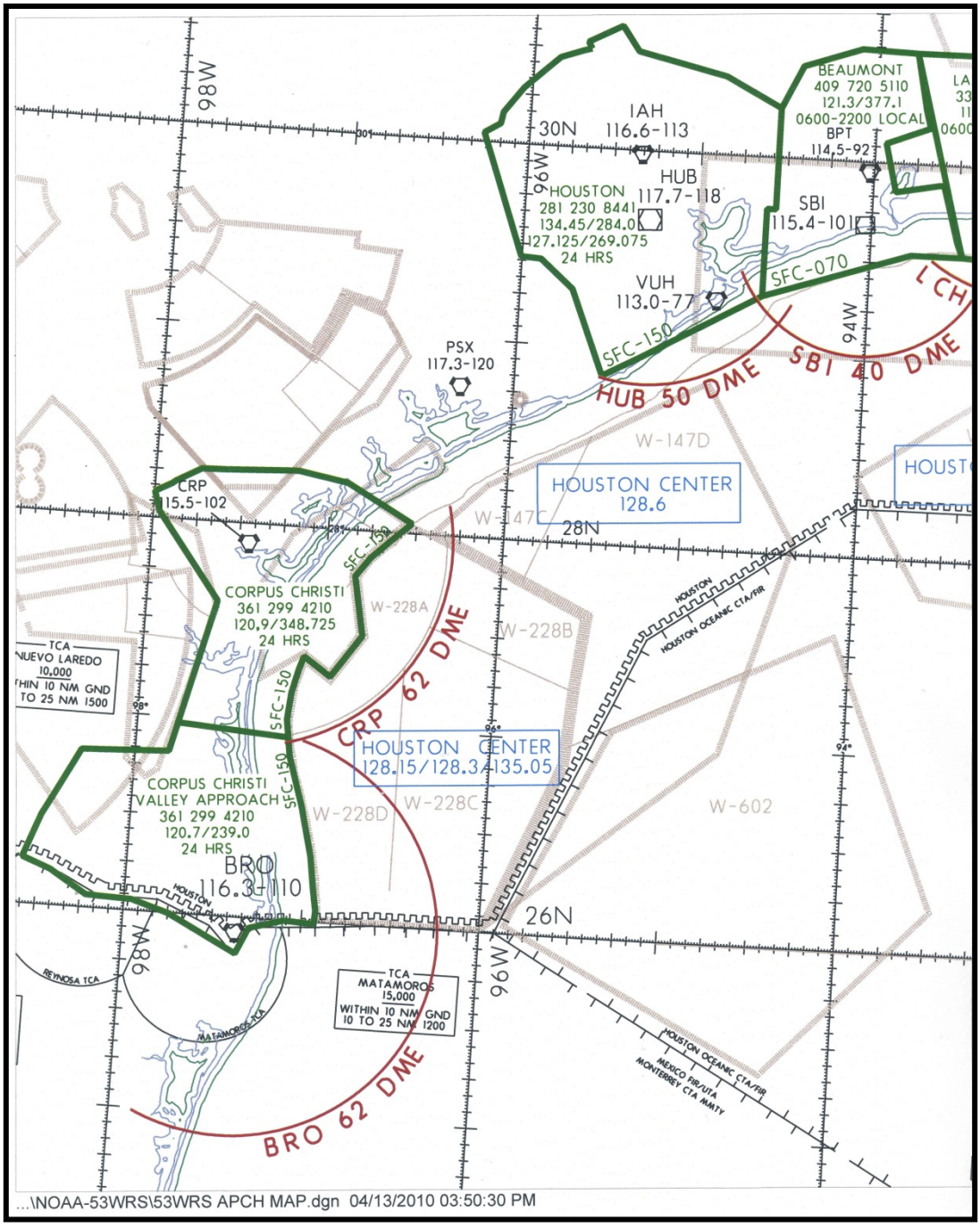


Figure K-1. Texas Coast

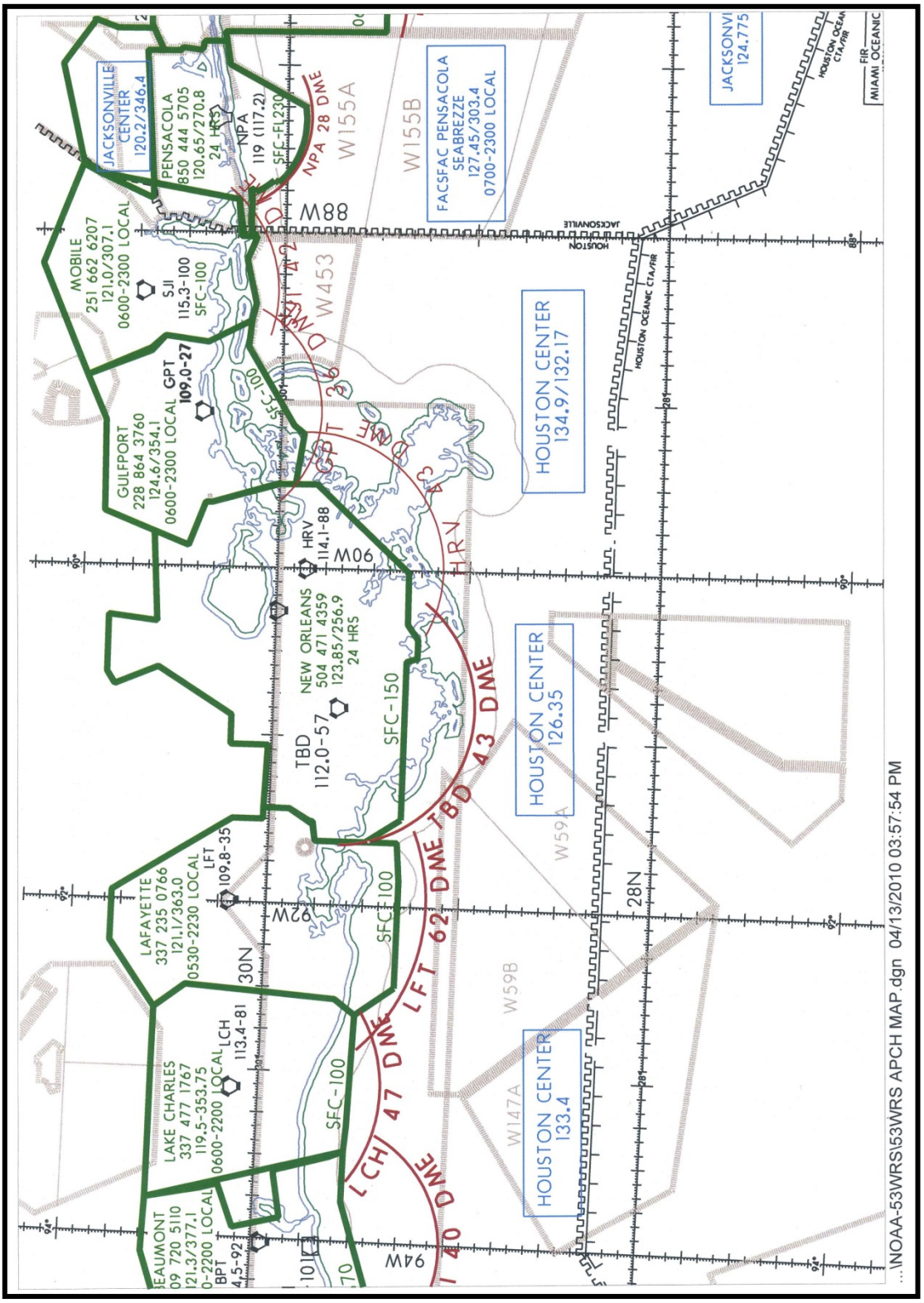


Figure K-2. Lake Charles, LA - Pensacola, FL

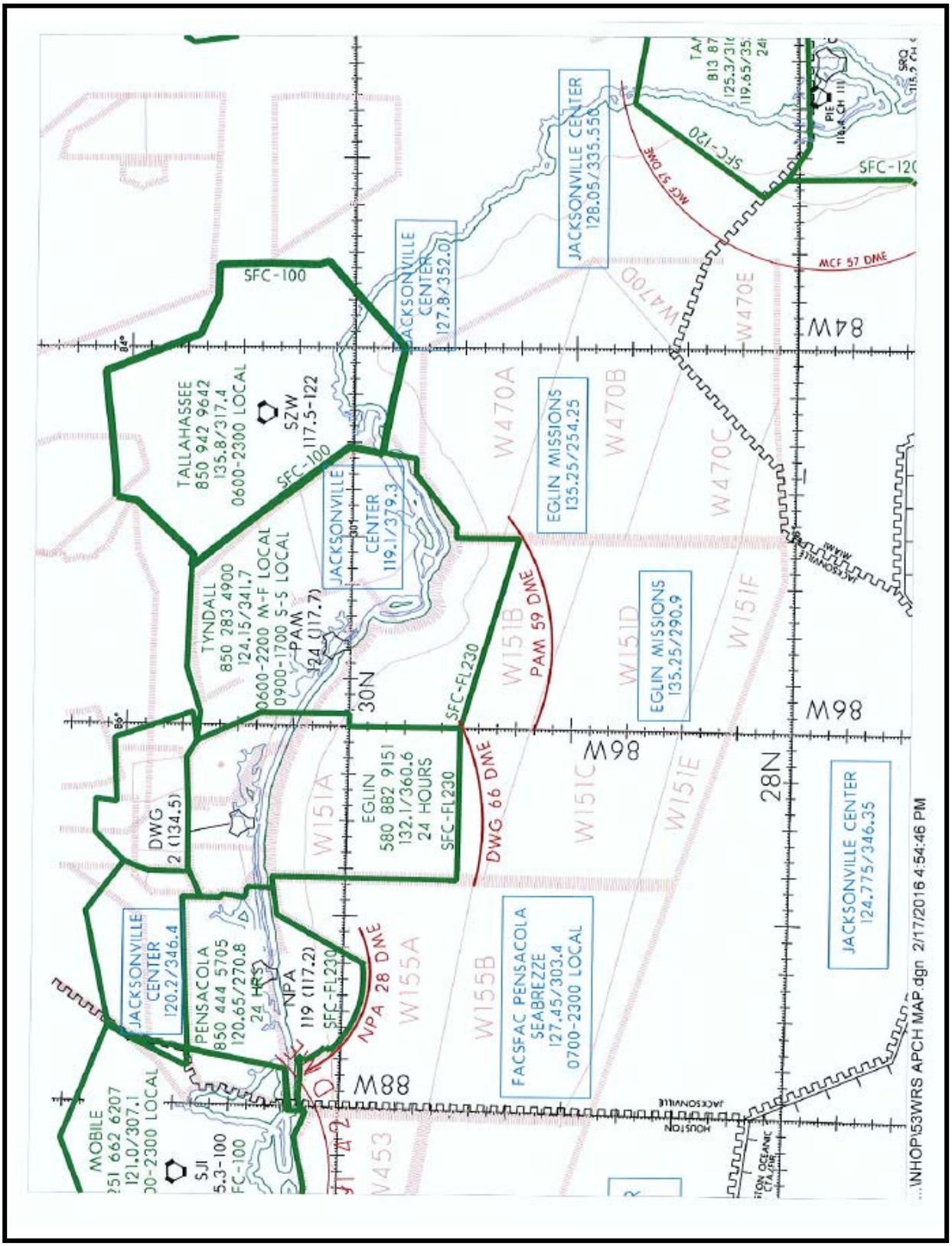


Figure K-3. Pensacola, FL – Tallahassee, FL

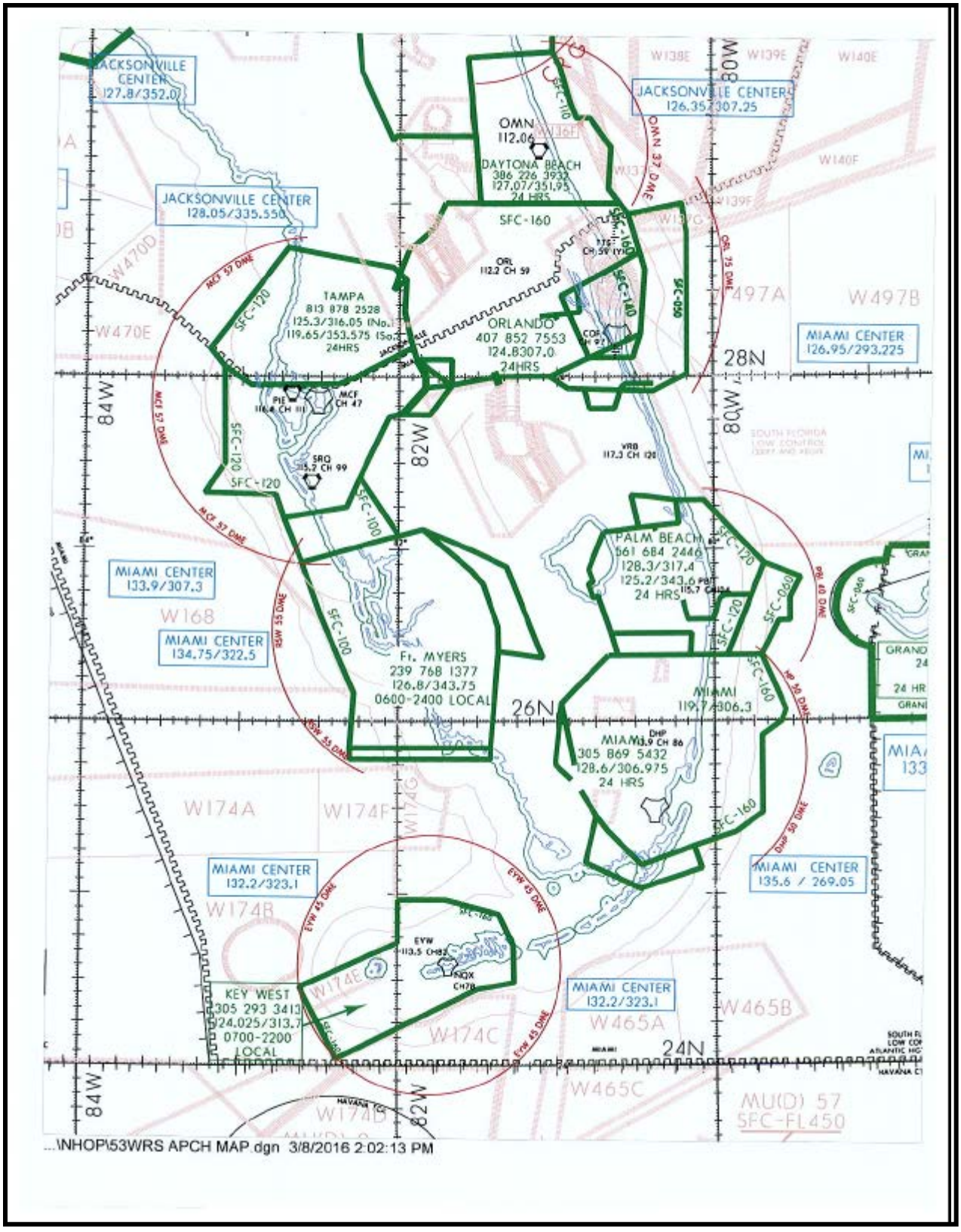


Figure K-4. Central/Southern Florida

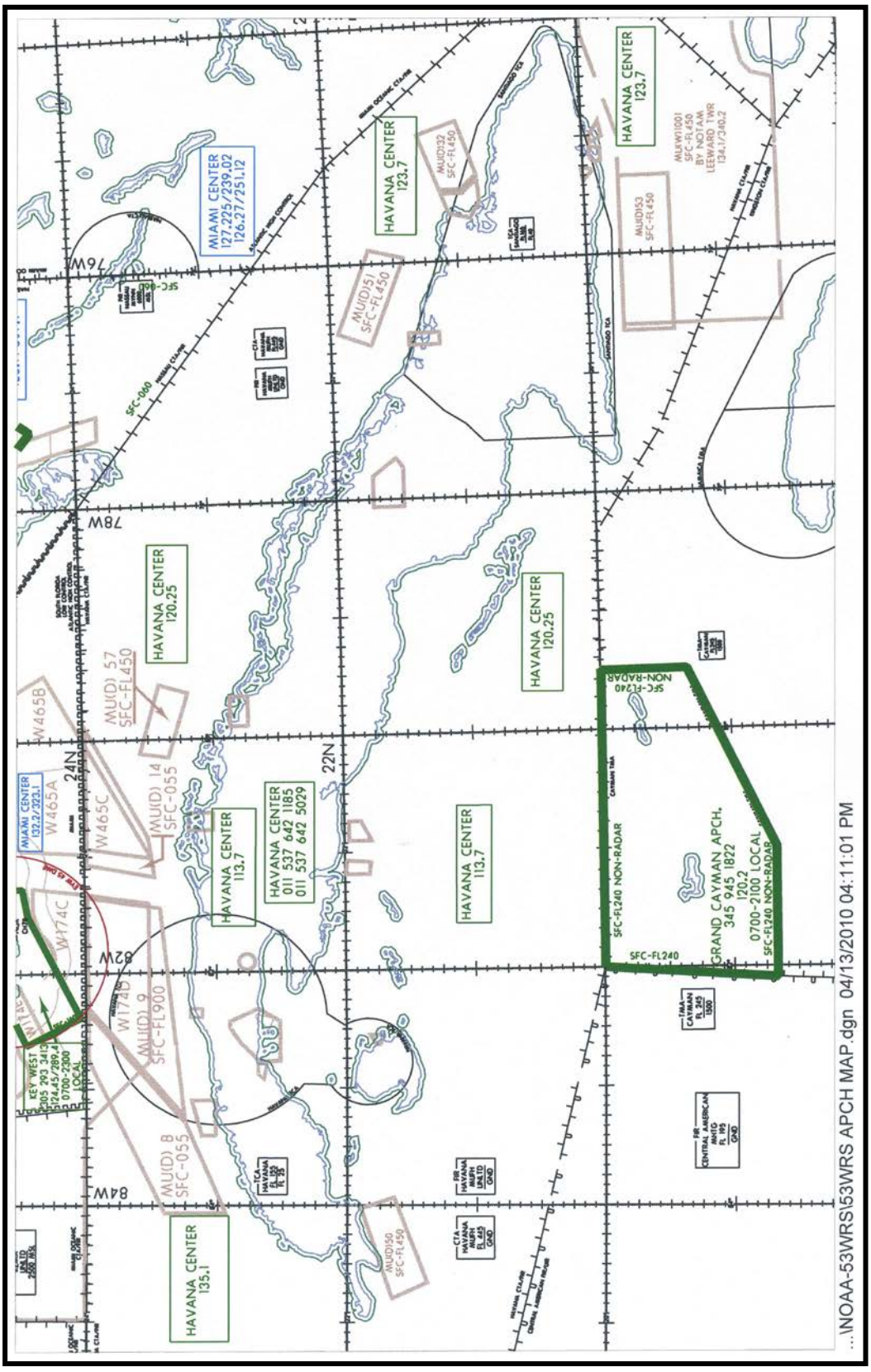


Figure K-5. Cuba – Grand Cayman

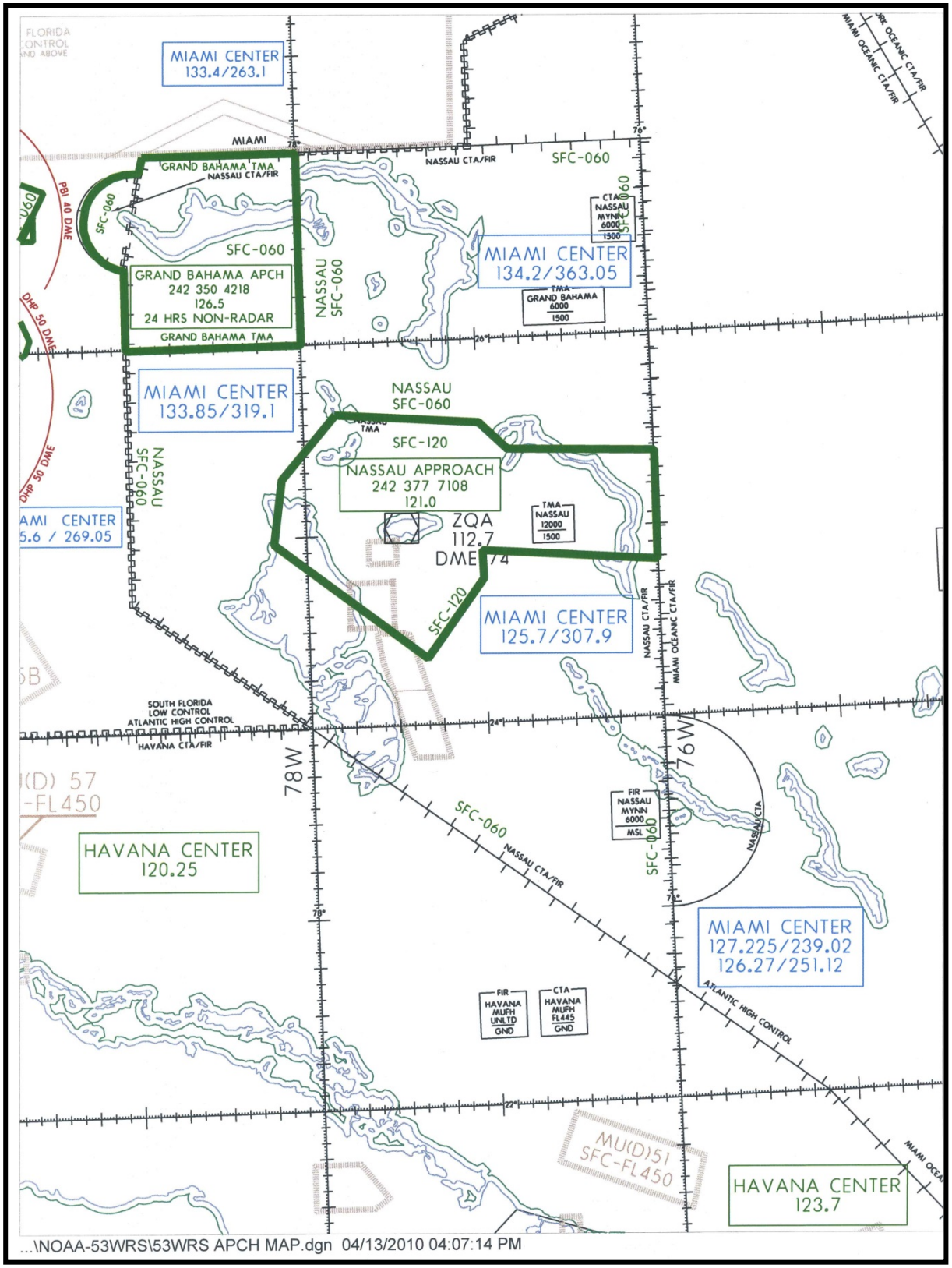


Figure K-6. The Bahamas: Nassau - Freeport

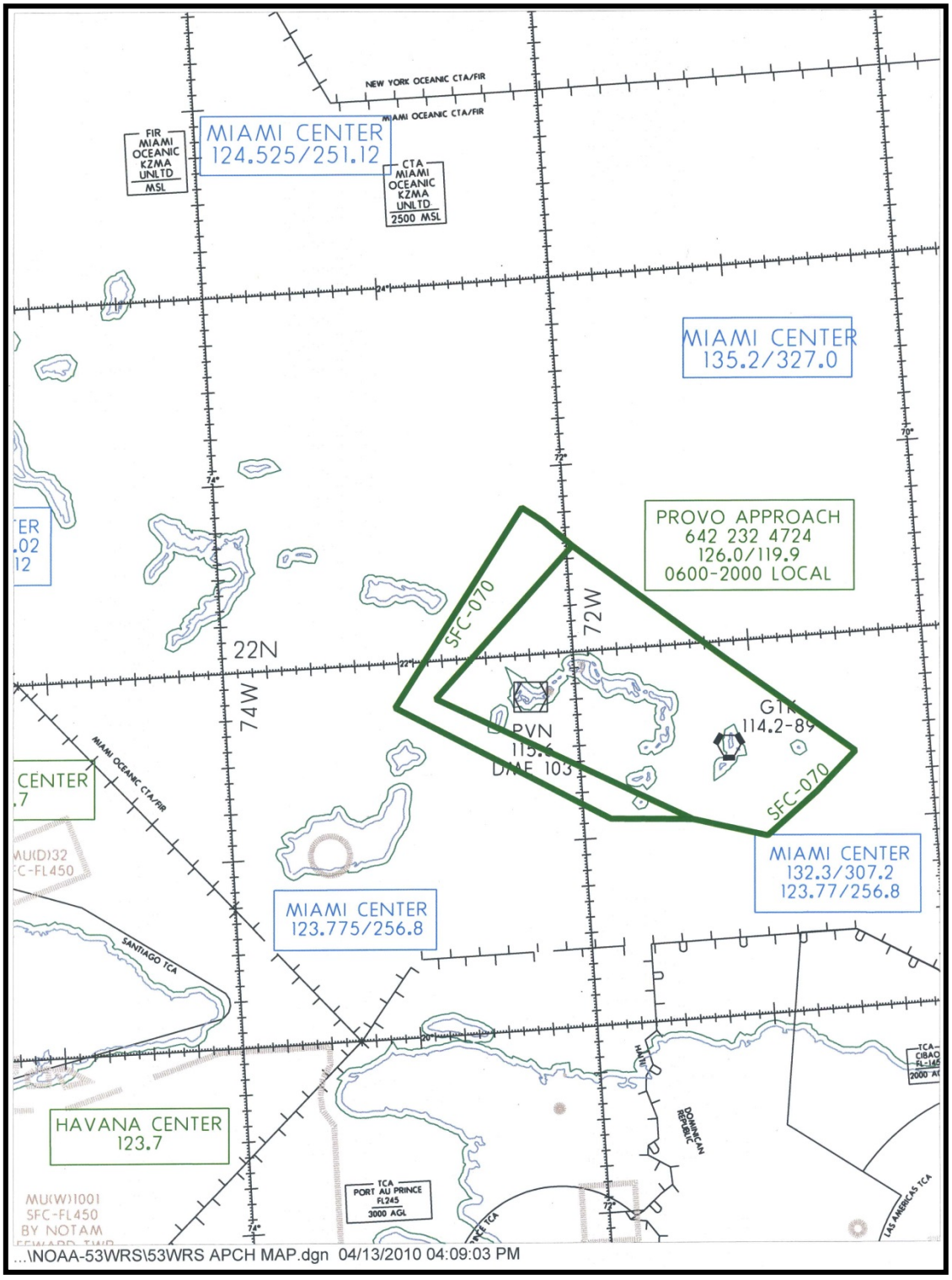


Figure K-7. Turks & Caicos Islands: Grand Turk - Providenciales

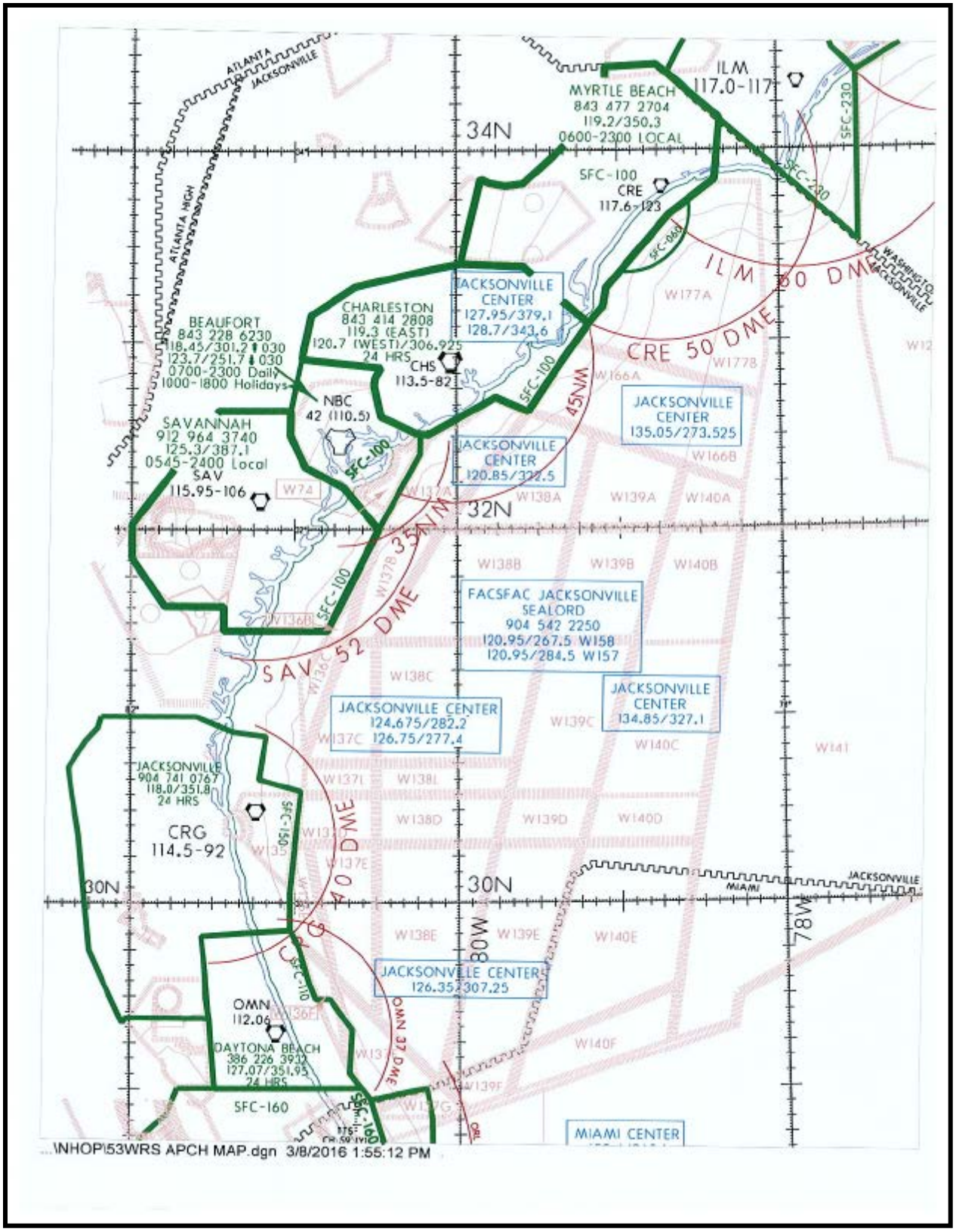


Figure K-8. Daytona Beach, FL – Myrtle Beach, SC

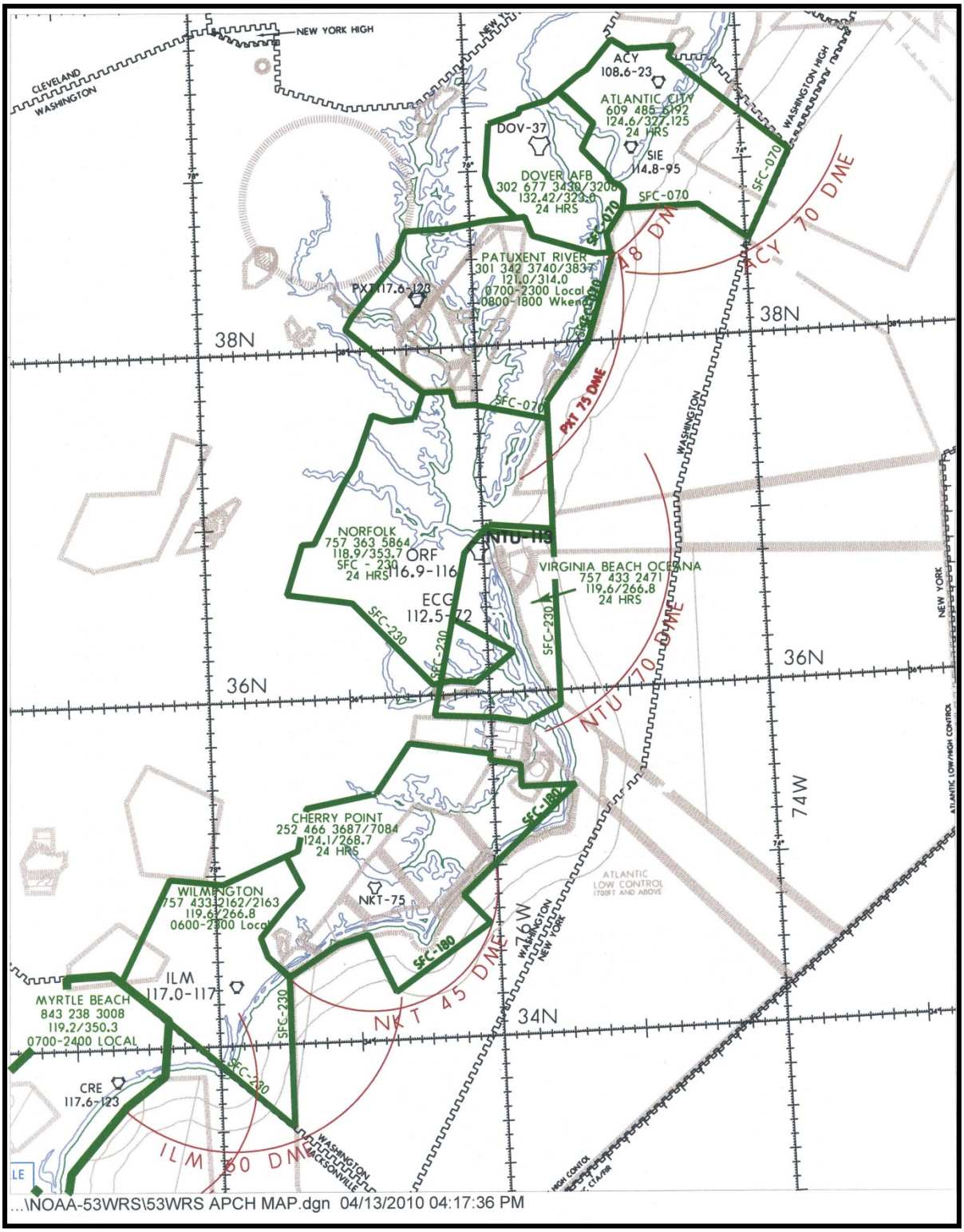


Figure K-9. Wilmington, DE – Atlantic City, NJ

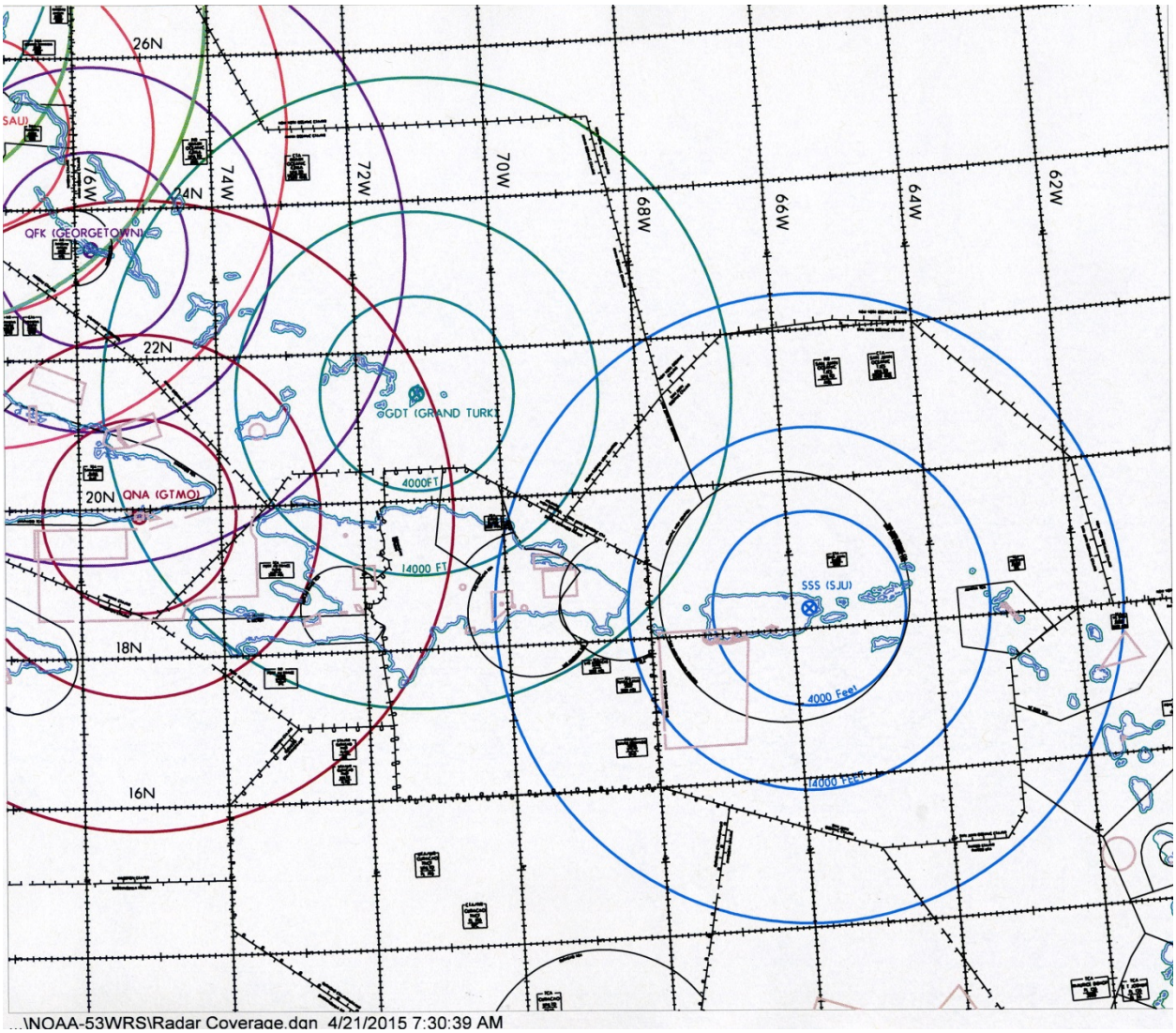


Figure K-10. Radar coverage map – San Juan, PR, Air Route Traffic Control Center. Radar range rings based on line-of-sight shown in color.

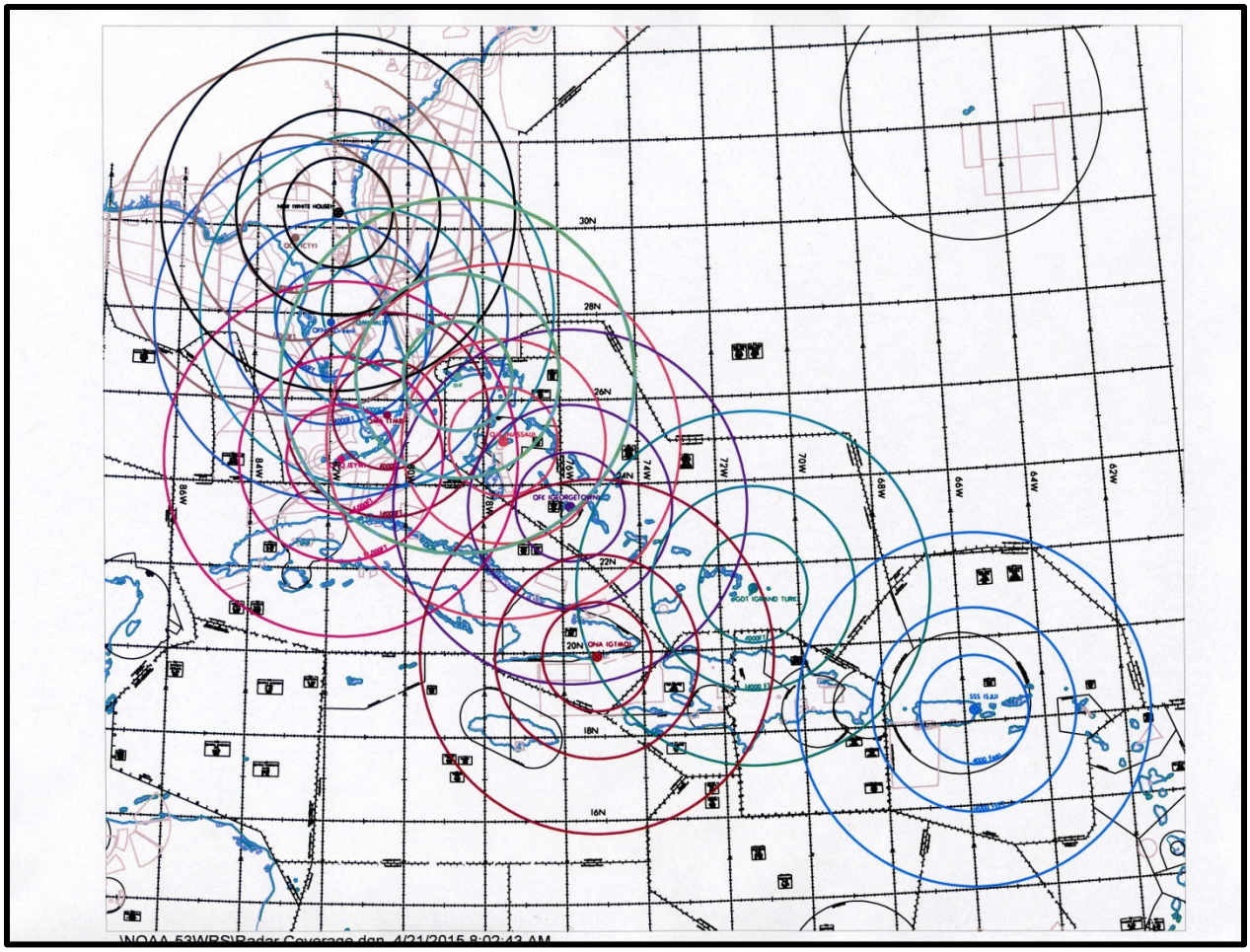


Figure K-11. Radar coverage map – Miami, FL, Air Route Traffic Control Center.

Radar range rings based on line-of-sight shown in color

APPENDIX L: 53d WRS/NOAA MISSION COORDINATION SHEET

Aircraft Call Sign:
TCPOD Number:
Departure Airfield:
Route of Flight:

PARTICIPATING AIRCRAFT REQUESTS AN FDC NOTAM FOR WRA _____ BE SET / SHIFTED WITH THE FOLLOWING INFORMATION:

Delay/WRA Center Coordinates:
Radius of Operation from Center Coordinates: 200 NM
Valid Time for WRA:
Requested Block Altitude: SFC – 15000' MSL
Name of Storm:
Aircraft Tail #:
SATPHONE: GRND to AIRCRAFT _____
AIRCRAFT to AIRCRAFT _____
HF Selcal (if applicable):
Requested NORAD Transponder Code:

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: AJE-EC-ZHU-TMC-MOS@FAA.GOV

_____ JAXVILLE (ZJX) FAX: 904-549-1843 VOICE: 904-549-1542/1543/ 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: CALL TO GET SUPERVISOR EMAIL

_____ NEW YORK (KZNY) FAX: 631-468-4224 / VOICE: 631-468-1427/1080 // EMAIL: CALL TO GET SUPERVISOR EMAIL

_____ GIANT KILLER (Vacapes, VA) / FAX: 757-433-1209 / COMM 757-433-1231 / EMAIL: BRYAN.PENNY1@NAVY.MIL

_____ PEARL HARBOR/COMM 808-472-7337/ EMAIL: PRLH_FACSFAC_ATC_FWS@navy.mil, W_PRLH_FACSFAC_SOC_US@navy.mil

_____ FACSFAC San Diego/ COMM 619-545-5589/ EMAIL: FACSFACSD_AIRSPACE@NAVY.MIL

_____ SEALORD (Jacksonville, FL) / FAX: 904-542-2250 / COMM 904-542-2250 / EMAIL: FACSFAC_JAXS_SEALORD_FWS_@NAVY.MIL

_____ VIRGINIA BEACH/VOICE: 757-433-1233/

_____ SEALORD (Jacksonville, FL) / FAX: 904-542-2525 / COMM 904-542-2250 / EMAIL: FACSFAC_JAXS_SEALORD_FWS_@NAVY.MIL

53d WRS OPS: 228-377-2409 NOAA OPS: 863-500-3979 DATE:

53d WRS OPS: (228) 377-2409 NOAA OPS: (813) 828-4338 DATE:

APPENDIX M: ACRONYMS/ABBREVIATIONS

-A-

AB	Data type header for Tropical Weather Outlook
AFB	Air Force Base
AFRC	Air Force Reserve Command
AFSATCOM	Air Force Satellite Communications System
AGL	Above Ground Level
AHI	Advanced Himawari Imager
AMSR2	Advanced Microwave Scanning Radiometer 2
AMSU	Advanced Microwave Sounding Unit
AOC	Aircraft Operations Center (NOAA)
APT	Automatic Picture Transmission
ARGOS	Argos, Inc., a French data collection system
ARINC	Aeronautical Radio, Incorporated
ARSA	Airport Radar Service Area
ARTCC	Air Route Traffic Control Center
ARWO	Aerial Reconnaissance Weather Officer
ASCAT	Advanced Scatterometer
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATMS	Advanced Technology Microwave Sounder
ATSC	Air Traffic Services Cell (DoD; Hq USAF/A3OP)
AVAPS	Advanced Vertical Atmospheric Profiling System
AVHRR	Advanced Very High Resolution Radiometer
AWIPS	Advanced Weather Interactive Processing System
AXBT	Airborne Expendable Bathythermograph

-B-

bTPW	Blended Total Precipitable Water
BUFR	Binary Universal Format

-C-

CARCAH	Chief, Aerial Reconnaissance Coordination, All Hurricanes
CARF	Central Altitude Reservation Function
CDA	Command and Data Acquisition
CERAP	Combined Center RAPCON (FAA)
CFW	Coastal/Lakeshore Hazard Message products (AWIPS Product Category CFW)
C.I.	Current Intensity
C-MAN	Coastal-Marine Automated Network
CNMI	Commonwealth of the Northern Mariana Islands
COM	Commercial (telephone)
COMS	Communication, Ocean and Meteorology Satellite
CONUS	Continental United States
CPHC	Central Pacific Hurricane Center

-D-

DA	Daylight Ascending
deg	degree (latitude or longitude)
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DOD	Department of Defense
DOMSAT	domestic satellite
DOT	Department of Transportation
DPTD	departed
DROP	dropsonde/dropwindsonde
DSN	Defense Switched Network (formerly AUTOVON)

-E-

EOS	(NASA) Earth Observing System
ESA	European Space Agency
ESPC	Environmental Satellite Processing Center
ETA	Estimated Time of Arrival
eTRaP	Ensemble Tropical Rainfall Potential

-F-

FAA	Federal Aviation Administration
FACSFAC	Fleet ~~Aerial~~ Area Control and Surveillance Facility
FCMSSR	Federal Committee for Meteorological Services and Supporting Research
FCST	forecast
FCSTR	forecaster
FEA	Flow Evaluation Area (FAA)
FL	flight level
FLT LVL	flight level
FMH	Federal Meteorological Handbook
FNMOC	Fleet Numerical Meteorology and Oceanography Center
USN)	
FSM	Federated States of Micronesia
ft	foot/feet

-G-

GAASP	GCOM-W1 AMSR2 Algorithm Software Package
GAC	Global Area Coverage
GCOM	Global Change Observation Mission
GLM	Geostationary Lightning Mapper
GMI	GPM microwave imager
GMDSS	Global Maritime Distress and Safety System
GOES	Geostationary Operational Environmental Satellite
GPM	Global Precipitation Measurement

-H-

HA	High Accuracy
HD	High Density
HDOB	High Density Observation
HF	High Frequency
h	hour/hours
HLS	Hurricane Local Statement
HNL	Honolulu (CPHC)
HRD	Hurricane Research Division (NOAA/OAR/AOML)
HRPT	High Resolution Picture Transmission
HRV	high resolution visible

-I-

ICAO	International Civil Aviation Organization
ICMSSR	Interdepartmental Committee for Meteorological Services and Supporting Research
ID	identification
IFR	Instrument Flight Rules
IJPS	Initial Joint Polar System
IOM	International Operations Manager (FAA)
IR	Infrared
ISRO	Indian Space Research Organisation

-J-

JTWC	Joint Typhoon Warning Center
JAXA	Japan Aerospace Exploration Agency

-K-

KARI	Korean Astronomical Research Institute
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

-L-

LAC	Local Area Coverage
LI	Long Island

-M-

m	meter/meters
MAX	maximum
mb	millibar/millibars
METEOSAT	European Space Agency geostationary meteorological satellite
MIA	Minimum IFR Altitude

min/MIN	minute
MiRS	Microwave Integrate Retrieval System
MHS	Microwave Humidity Sounder
mph	mile/miles per hour
MSG	Meteosat Second Generation
MSL	Mean Sea Level
MTSAT-1R	Japanese Geostationary Satellite
MVMT	movement

-N-

NASA	National Aeronautics and Space Administration
NAVLANTMETOCFAC	Naval Atlantic Meteorology and Oceanography Facility
NAVMETOCCOM	Naval Meteorology and Oceanography Command
NAVOCEANO	Naval Oceanographic Office
NAVPACMETOCCEN	Naval Pacific Meteorology and Oceanography Center
NAVTRAMETOCFAC	Naval Training Meteorology and Oceanography Facility
NCEP (NOAA/NWS)	National Centers for Environmental Prediction
NCO	NCEP Central Operations
NCWCP	NOAA Center for Weather and Climate Prediction
NDBC	National Data Buoy Center
NESDIS	National Environmental Satellite, Data, and Information Service
NHC	National Hurricane Center
NHOP	National Hurricane Operations Plan
nm	nautical miles
NOAA	National Oceanic and Atmospheric Administration
NOM	National Operations Manager (FAA)
NOTAM	Notice to Airmen
NRL	Naval Research Laboratory
NSC	NOAA Science Center
NWS	National Weather Service
NWSOP	National Winter Storms Operations Plan
NWSTG	National Weather Service Telecommunications Gateway

-O-

OAC	Oceanic Aircraft Coordinator (USN)
OB	observation
OCM	Ocean Colour Monitor
OFCM	Office of the Federal Coordinator for Meteorological Services and Supporting Research
OM	Operations Manager (FAA)
OMIC	Operations Manager In Charge (FAA)
OPC	Ocean Prediction Center (NCEP)
OSS	Operations Support Squadron (USAF)

-P-

PA	Public Affairs
PHFO	ICAO identifier for Honolulu, HI
POD	Plan of the Day
POES	Polar-Orbiting Environmental Satellite

-R-

RAPCON	Radar Approach Control
RECCO	Reconnaissance Code
RECON	reconnaissance
ROC	Radar Operations Center
RSMC	Regional/Specialized Meteorological Center (WMO)
RSO	GOES Rapid Scan Operations

-S-

SAA	Special Activity Airspace
SAB	Satellite Analysis Branch
SATCOM	Satellite Communications
SATOPS	17th OWS Meteorological Satellite Operations
SCAT	Scatterometer
SFC	surface
SIM	Satellite Interpretation Message
SLP	Sea Level Pressure
SPC	Storm Prediction Center (NCEP)
SSM/I	Special Sensor Microwave Imager (DMSP)
SSM/IS	Special Sensor Microwave Imager Sounder
SSM/T	Special Sensor Microwave Temperature Sounder
STMC	Supervisory Traffic Management Coordinator (FAA)
SUA	Special Use Airspace

-T-

TAFB	Tropical Analysis Forecast Branch (NHC)
TCA	Aviation Tropical Cyclone Advisory
TCD	Tropical Cyclone Discussion
TCM	Tropical Cyclone Forecast/Advisories
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
TD	Tropical Depression
TEMP	temperature
TEMP	temporary
TEMP DROP	Dropwindsonde Code
TF	Thermal Fine
TKO	takeoff

TMC	Traffic Management Coordinator (FAA)
T-	Dvorak number Tropical classification number
TRMM	Tropical Rainfall Measurement Mission
TWD	Tropical Weather Discussion
TWO	Tropical Weather Outlook
TWS	Tropical Weather Summary

-U-

UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle
UCP	unit control position (WSR-88D)
UHF	Ultra High Frequency
US/U.S.	United States
USAF	United States Air Force
USCG	United States Coast Guard
USN	United States Navy
UTC	Universal Coordinated Time

-V-

VAS	VISSR Atmospheric Sounder
VCP	volume coverage pattern (WSR-88D)
VDM	Vortex Data Message
VIS	Visible
VIIRS	Visible Infrared Imaging Radiometer

-W-

WEFAX	Weather Facsimile
WFO	Weather Forecast Office
WMO	World Meteorological Organization
WND	wind
WPC	Weather Prediction Center (NCEP)
WPMDS (Offutt AFB)	Weather Product Management and Distribution System
WRA	Weather Reconnaissance Area
WRS	Weather Reconnaissance Squadron
WS	Weather Squadron
WSR-88D	Weather Surveillance Radar-1988 Doppler
WT	Data type header for hurricane bulletins
WW	Weather Wing
WX	Weather

-Z-

Z	Zulu (UTC)

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 (DoD ATSC/ HAF/A3OP) is a Joint Military and Civil organization which provides liaison, facilitation, and coordination between emergency preparedness and operations organizations as the DoD representative. Additionally the ATSC ensures efficient flow of DoD 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 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 nautical mile (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 nautical miles 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.

-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 Mexico — 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. An announcement that sustained winds of 64 knots (74 mph or 119 km/hr) or higher are *expected* somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical-storm-force winds (24 hours for the Western North Pacific). The warning can remain in effect when dangerously high water or a combination of dangerously high water and waves continue, even though winds may be less than hurricane force.

Hurricane/Typhoon Watch. An announcement that sustained winds of 64 knots (74 mph or 119 km/hr) or higher are *possible* within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane 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).

-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.

-S-

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 nautical miles 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 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 next 1100 to 1100Z UTC 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. An announcement that sustained winds of 34 to 63 knots (39 to73 mph or 63 to 118 km/hr) are *expected* within 36 hours within the specified coastal area in association with a tropical, subtropical or post-tropical cyclone. NHC, CPHC, and WFO Guam issue warnings when conditions are *expected* within 36 hours.

Tropical Storm Watch. An announcement that sustained winds of 34 to 63 knots (39 to 73 mph or 63 to 118 km/hr) are *possible* somewhere in the specified area within 48 hours in association with a tropical, subtropical or post-tropical cyclone. NHC, CPHC, and WFO Guam issue watches when conditions are *possible* within 48 hours.

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.

-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.